

EN307 Cruise Report

ACKNOWLEDGEMENTS

We would like to thank the captain and crew of the R/V ENDEAVOR for an enjoyable and 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 and shiptime provided by NSF. Support for the bio-optical oceanographic research conducted on this cruise was provided by an award from the ONR Young Investigator Program.

This report was prepared by Charles Greene, Peter Wiebe, Heidi Sosik, Mark Benfield, and Ann Bucklin with assistance from others in the Scientific Party. This cruise was sponsored by the National Science Foundation and the National Oceanographic and Atmospheric Administration.

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INTRODUCTION

R/V ENDEAVOR Cruise 307 was conducted as a U.S. GLOBEC process cruise to examine autumn conditions in the Gulf of Maine relevant to ecosystem processes on Georges Bank. The major scientific objectives of the cruise included:

1. 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,

2. Collecting MOCNESS samples of *Calanus finmarchicus* for molecular studies of its diapause physiology and population genetics,

3. Conducting broad-scale surveys to map the spatial distribution of bio-optical properties in the Gulf of Maine,

The cruise was laid out as a series of tracklines traversing the major basins in the Gulf of Maine with turning points marking a change in the direction of ship as data were being collected (Figure 1). The original turning points were modified during the cruise in response to sea and work related conditions. The trackline had us leaving Woods Hole (turning point #1), working first in Georges Basin (turning points 4-7), then moving into Jordan Basin (turning points 8,9), and after a short stop in Portland ME to allow some participants to leave the vessel, moving into Wilkinson Basin (turning points 10-21). In addition to the along-track data collection, time was allotted each day for a CTD cast between 1000 and 1400 hours to accommodate the needs of the Bio-optical Group lead by Heidi Sosik and one or two MOCNESS tows.

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

NARRATIVE

The R/V ENDEAVOR departed Woods Hole on cruise EN-307 at 19:00 on 8 October 1997 (Figure 2). The sky was clear and the winds were light during departure. All scientific events conducted during the cruise, beginning with the ship's departure, can be found in the cruise report event log (see Appendix 1).

The early part of the first evening was spent in Vineyard Sound practicing deployment of the BIOMAPER II (BIO-optical Multiple-frequency Acoustic and Physical Environmental Recorder), a large tow body carrying a variety of bio-optical, acoustical, and physical remote-sensing instruments. After we were satisfied with the BIOMAPER II's performance, we changed course and headed for our first station at the western end of Franklin Basin, a southwest to northeast-oriented extension of Georges Basin.

We arrived at station 1 during the late morning of 9 October. Activities at this station included two unsuccessful CTD casts (CTD 1,2) because the rosette water bottle release mechanism was not working properly, a successful CTD cast (CTD 3), and deployment of a tethered, free-fall vertically-profiling spectral radiometer. When these activities were completed, BIOMAPER II was deployed and systems were checked. After several deployments and recoveries, all systems were operational and we began collecting BIOMAPER II data along a survey trackline to the second station at the southwestern edge of the main portion of Georges Basin.

We arrived at station 2 during the early morning of 10 October. BIOMAPER II continued to collect data at the surface while an oblique MOCNESS tow (M-01-001) was conducted. After the MOCNESS tow was completed, we continued along our trackline toward the third station with BIOMAPER II continuing to collect data. Our first towyos with BIOMAPER II were conducted at this time.

We arrived at station 3 during the late morning of 10 October. BIOMAPER II was recovered and then typical mid-day station activities were conducted. These activities included a CTD cast (CTD 4), deployment of the tethered free-fall spectral radiometer, and an oblique MOCNESS tow (M-01-002). After completion of station 3, we continued northward along our survey trackline. Barometric pressure dropped during the day, the wind steadily increased and the skies were cloudy (Figure 3). As the trackline turned from northward to westward, we deployed BIOMAPER II and collected data as we steamed towards station 4 (Figure 2). While the seas did not reach heights that interfered with the data acquisition, our course deviated from the planned survey trackline due to 30 knot winds from the south blowing the ship towards the wire from which BIOMAPER II was being towed. The course change allowed us to continue towyoging BIOMAPER II until station 4. At station 4, BIOMAPER II continued to collect data at the surface while an oblique MOCNESS tow (M-01-003) was conducted. After the MOCNESS tow was completed, we continued towyoging BIOMAPER II on our survey trackline towards station 5.

During the late morning of 11 October, we arrived at station 5. Barometric pressure rose during the day and the winds became light (Figure 3). BIOMAPER II remained in the water collecting data while the typical mid-day station activities were conducted. These activities again included a CTD cast (CTD 5) and deployment of the tethered free-fall spectral radiometer. After completion of station 5 activities, we changed course and steamed northward towards Jordan Basin. Initially, we collected data with BIOMAPER II towed at the surface. At 15:00, we began towyoging BIOMAPER II along our survey trackline for Jordan Basin. Towyoging continued until we reached station 6.

We arrived at station 6 in Jordan Basin shortly after mid-night on 12 October. At this station, BIOMAPER II remained at the surface collecting data while an oblique MOCNESS tow (M-01-004) was conducted. After the MOCNESS tow, towyoging of BIOMAPER II resumed until shortly after sunrise (07:44) when the system was recovered to work on its bio-optical instruments.

At 08:55, we arrived at station 7 and conducted an oblique MOCNESS tow (M-01-005). This was followed by a CTD cast (CTD 6) and deployment of the tethered free-fall spectral radiometer. After the mid-day station activities, BIOMAPER II was redeployed. We resumed towyoging BIOMAPER II for the remainder of the day as we surveyed Jordan Basin. As we headed west from Jordan Basin just after midnight on October 13, we conducted a procedure to calibrate BIOMAPER II's compass and made measurements of background acoustic noise. This involved steaming the ship in three consecutive tight circles. At 02:45, we recovered BIOMAPER II and steamed to Portland to drop off four members of the scientific party. At mid-day on a mild fall day with a shoreline lined with trees showing their fall colors, we arrived in Portland harbor where a chartered boat met the R/V ENDEAVOR and ferried the departing party to shore.

After departing Portland, we steamed toward Wilkinson Basin. During the early afternoon of 13 October at station 8, a CTD cast (CTD 7) and the tethered free-fall spectral radiometer were deployed. When these station activities were completed, we resumed steaming towards Wilkinson Basin. At 17:05, BIOMAPER II was redeployed, and we began our survey of Wilkinson Basin at turning point 11 (Figure 1). BIOMAPER II was towed along the survey trackline as we steamed towards station 9 (Figure 2).

At midnight, we arrived at station 9 where MOCNESS tow (M-01-006) was conducted while BIOMAPER II continued to collect data at the surface. After the MOCNESS tow was completed at 02:20, we resumed towyoging BIOMAPER II along the survey trackline until mid-morning. We arrived at station 10 during the late morning of 14 October and conducted a CTD cast (CTD 8) and deployed the tethered free-fall spectral radiometer. Once completed, we resumed towyoging BIOMAPER II along the survey trackline. During mid-afternoon, we arrived at station 11. BIOMAPER II continued to collect data at the surface while an oblique MOCNESS tow (M-01-007) was conducted. After the MOCNESS tow was completed at 16:28, we resumed towyoging BIOMAPER II along the survey trackline until mid-morning of the next day.

We arrived at station 12 at 11:15 on October 15. BIOMAPER II was recovered to allow calibration of its bio-optical sensors. We then deployed the tethered free-fall spectral radiometer and conducted a CTD cast (CTD 9). BIOMAPER II was redeployed at 14:15, and we resumed towyoing along our survey trackline.

Right after midnight (00:30) on October 16, we arrived at station 13 and while BIOMAPER II collected data at the surface, an oblique MOCNESS tow (M-01-008) was conducted. After the MOCNESS tow was completed, we resumed towyoing BIOMAPER II along the survey trackline until early morning of the next day (05:45) when the broad-scale survey of the Gulf of Maine deep basins was completed.

Other than the moderate, 6 - 9' seas associated with the brief windy period on October 10, we experienced exceptionally good weather, with light winds and 2 -4' seas throughout the broad-scale survey portion of the cruise. This allowed us to complete the survey with about 12 hours to spare. We used this extra time to conduct a series of observations on soliton propagation in the region. These solitons are probably generated in the vicinity of Georges Bank when standing lee waves, formed at the edge of the Bank during the off-Bank tidal flow, are released during the changing tide.

To observe the solitons, we returned to the region of Wilkinson Basin near station 10 where such solitons had been observed previously. The winds increased during the day to 15 to 25 kts and the seas reached 6 - 9'. Windrows of macroalgae, associated with Langmuir circulation, were observed throughout the day. BIOMAPER II was towed at the surface towards station 13. We arrived at station 13 at approximately noon on 16 October and conducted a CTD cast (CTD 10) and deployed the tethered free-fall spectral radiometer. We then resumed towing BIOMAPER II in search of solitons. A soliton, consisting of a packet of about eight internal waves, was detected in the late afternoon while steaming back towards Georges Bank. The surface manifestation of this soliton could be seen on the ships' radar, and thus the ship's watch could track the soliton's location from the bridge. A description of the work that ensued is provided in the acoustic results section below. After a series of passes over the soliton, a final MOCNESS tow (M-01-009) was taken which cut across the soliton. After this pass was completed, we recovered the MOCNESS and BIOMAPER II and steamed for Woods Hole.

The cruise ended when the ship tied up to the Woods Hole dock about noon on 17 October.

INDIVIDUAL REPORTS

1.0 Processes Regulating the Recruitment of *Calanus finmarchicus* from the Gulf of Maine to Georges Bank (Principal Project).

(C.H. Greene, M.C. Benfield, and P.H. Wiebe)

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 and the Scotian Shelf east of the Bank. It is hypothesized that processes which 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 are 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 and feeding experiments 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*'s seasonal and diel vertical migration behaviors to seed Georges Bank with new recruits during winter.

1.2 Methods

1.2.1 Broad-scale survey

A broad-scale survey of the Gulf of Maine deep basins was conducted from October 8 - 17, 1997. The survey track included multiple transect lines in Georges, Jordan, and Wilkinson Basins (Figure 2). This initial survey was designed as a pilot study to test our methods prior to the first full field season in 1998.

The survey was conducted using a high-speed, deep-towed system, BIOMAPER II (BIOlogical Multiple-frequency Acoustic Platform and Physical Environmental Remote-sensing system - Figure 4), configured with multiple-frequency (43 kHz, 120 kHz, 200 kHz, 420 kHz, and 1000 kHz) acoustics, a video plankton recorder (VPR), an environmental sensing package (pressure, temperature, conductivity, fluorescence, transmissometry), and several bio-optical sensors (down- and upwelling spectral radiometers, spectrally matched attenuation 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 towed. Echo integration was conducted at 30-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 (DAT), while the processing for echo integration was carried out in real time.

The VPR mounted on BIOMAPPER sampled a volume of 2.43 liters min⁻¹. It had an imaging volume with a height of 6.5 mm, a width of 8.0 mm, and a depth of field of 13.0 mm. All video images were recorded on SVHS tape for post-cruise processing at WHOI. GPS data were synchronized with the VPR signal and stamped on the video time code.

1.2.2 MOCNESS stations

During the broad-scale survey cruise of the Gulf of Maine deep basins, 1-m² MOCNESS tows were conducted at three stations in Georges Basin, two stations in Jordan Basin, and four stations in Wilkinson Basin (Figure 2, Appendix II). The MOCNESS was equipped with nine nets made of 335 μ m nylon nitex mesh. Splits from the MOCNESS samples were preserved in formalin for ground-truthing and inter-comparisons with the BIOMAPER II acoustics and VPR data, and preserved in alcohol or frozen in liquid nitrogen for molecular studies of copepod population genetics by Ann Bucklin (University of New Hampshire), and diapause physiology, by Patrick Hassett (University of Ohio). Additional detail about the latter work is given below.

1.3 Results

1.3.1 Broad-scale survey

1.3.1.1 Multi-frequency acoustics

The multi-frequency acoustics, bio-optical (including VPR), and physical oceanographic data were collected during nine deployments of BIOMAPER II throughout the Gulf of Maine. Two major acoustic sections were obtained in Georges Basin, one line extended from Georges Basin to Jordan Basin, two lines were taken in Jordan Basin, and four lines were taken in Wilkinson Basin (Figure 5). The last line involved a special study of a soliton (See section below). The total trackline distance along which data were collected was 1017 km (549 nm - Table 1). During the deployments, data were collected in a down-looking mode with BIOMAPER II towed just below the surface, in a down and up-looking mode while towed horizontally at some sub-surface depth, or towed from the surface to within 10 to 30 m of the ocean bottom. As described above, during some periods of BIOMAPER II data acquisition, MOCNESS tows were taken to collect planktonic animals (Figure 2). Aliquots of these samples will be analyzed to produce numbers and size data of the major taxa making up the samples and these data will be used in combination with theoretical models to develop predicted volume backscattering values for comparison with those values observed with BIOMAPER II.

Table 1. Distance of BIOMAPER II Trackline Sections on R/V ENDEAVOR Cruise 307 (7-17 October 1997).

Section	Year-day Start Time	Year-day End Time	km	nm
1	282.885	283.440	126.5	68.3
2	283.848	284.478	82.3	44.5
3	284.628	285.004	85.4	46.1
4	285.092	285.322	42.6	23.0
5	285.531	286.010	96.6	52.2
6	286.728	288.154	280.6	151.5
7	288.237	288.477	55.6	30.0
8	288.631	289.239	126.6	68.4
9	289.296	289.951	120.9	65.3
Total			549.2	1017.1

The instrument systems on BIOMAPER II worked very well with the exception of one of the 43 kHz transducers which suffered an, as yet undefined, electronic hardware failure during the first trackline section and the Environmental Sensing System's (ESS) pressure transducer which gave poor pressure readings until it was repaired during the transit from Jordan Basin to Portland, ME. 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). Each transducer was allocated 200 1-m depth strata and data were collected in 30 second intervals (averages). 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. In addition, the raw data for each ping were recorded on DAT tape for postprocessing of either target strengths or echo-integrations on a different time averaging basis. Each tape recorded two gigabytes of data and a total of 62 tapes were recorded during the cruise.

Post-processing software, which was still under development on the cruise, was used to combine the up-looking and down-looking data for a given frequency and then display the data as color enhanced echogram. During the cruise significant progress was made by Erhan Mutlu in making improvements in the MATLAB code used in the post-processing and it is now possible to create plots of the volume backscattering in the water column shortly after a BIOMAPER II section has been completed.

There are several general observations that result from an initial look at the post-processed acoustic data. Diel vertical migration is evident in the echograms from all three basins with somewhat lower volume backscattering in the surface waters during the day and higher levels in this depth interval at night (Figure 6). During the same period, increased scattering occurred at mid-depth levels i.e. 50 to 150 meters during the day which became much weaker or disappeared at night.

There were basin to basin differences in the acoustic structure as well. A distinct layer was present near the bottom in Georges Basin which does not show up in the echograms from Jordan Basin. Such a layer did exist in Wilkinson Basin, but it was not as well formed nor as strong. On the other hand, in Jordan Basin there were many isolated but quite strong targets (perhaps small fish schools) which occurred from just above the bottom (around 240 to 250 m) up to 100 meters depth which were not nearly as evident in the other two basins. Interpretation of these trends in terms of the biological entities present must await the analysis of the VPR video tapes and the MOCNESS samples.

Soliton Experiment: After completing the survey of Wilkinson Basin at Turning Point 21 on 16 October (Figure 1), we began a short study of internal wave packets or solitons which were observed during work in the vicinity of Turning Points 13 and 14. The vessel steamed back towards Turning Point 13 at about 6 kts with BIOMAPER II deployed at about 5 m and operating in the down-looking mode. We arrived at this location about noon and commenced a light profile cast and a CTD cast. During the period of this work, no

substantial internal wave activity was observed. Once the station work was completed, we began to steam towards Georges Bank at about 4 kts., because it was a likely source of internal wave activity.

At 1513, the bridge called down to say that they could see strong banding on the radar was which reflected the presence of internal waves. There were about 8 wave crests in the soliton visible on the radar screen. A few minutes later, the acoustic records clearly showed the first crest of the internal wave packet (Figure 7). The radar image of the sea surface manifestation of the soliton together with the acoustic echogram of its internal structure enabled determination of the direction of packet propagation which was approximately 310 degrees. Within 45 minutes, the ENDEAVOR had passed the soliton. The ship's course was reversed and BIOMAPER II was lowered to 50 m depth. This was done to enable the up-looking transducers to provide acoustic measurements right to the sea surface. It took much longer (more than 100 minutes) to return to the front of the soliton because we were steaming in the direction of its propagation which was estimated to be 1 to 1.5 kts. Once past the soliton, BIOMAPER II was lowered to within 30 m of the bottom to get a profile of environmental properties and then brought to the surface before again reversing the ship's course.

The third pass through the internal wave packet was made at 25 to 30 m depth which was where volume backscattering appeared to be most intense in the wave crests on previous tows. About 2009 (42 28.43 N; 68 45.24 W), the radar on the bridge showed that we were again in the soliton and about to enter the second wave trough. On this occasion, the estimate was that the waves were heading on a course of 330 degrees.

Once through the packet, we again returned on a reciprocal course (339 deg true). A fourth pass across a portion of the internal wave packet was done at 6 kts with BIOMAPER II at the surface. About halfway into the wave packet, the ship was slowed to about 2 kts and the 1-m² MOCNESS was deployed. The net system was shot to 175 m and then nets were opened and closed at 175, 150, 125, 100, 80, 60, 40, 20 and 0 m. With the closing of the last net, the data acquisition of this special experiment was ended, the gear brought onboard, and the ENDEAVOR began its steam back to the port of Woods Hole.

Initial results from the first pass over the soliton provided a very interesting picture of the frequency dependence of the volume backscattering from the wave packet (Figure 7). In the 43 kHz record, most of the energy echoed back to BIOMAPER II came from wave crests and trough close to the surface. At 120 kHz, a deeper structure became evident as proportionately more energy was received. This trend continued with the 200 kHz record where about equal amounts of energy came from the near surface and deeper wave forms, and then with the 420 kHz record where the dominant source of energy came from the deeper wave form. At 1000 kHz, the soliton was also visible, but only near the surface due to the short range of that frequency. Additional work is required to explain this frequency dependence.

Instrumentation improvements: As with any new instrument system, this first scientific cruise of BIOMAPER II was not without some difficulties. Some problems were identified which have relatively easy solutions. These include:

- 1) Extending the VPR camera and strobe to position further in front of the BIOMAPER II nose to get around probable avoidance problems. As described in the section on the VPR by M. Benfield, there did seem to be evidence that some of the animals were making move to avoid the region where their picture was taken.
- 2) There was also some indication in the pitch data displayed on the Bio-engineering computer that pitch values started to be large when vertical velocities exceed 10 m/min. For this and other reasons, the vertical descent and ascent rates should be kept around 5 m/min. Perhaps more importantly, the pitch and roll data need to be logged to a computer file so that these parameters can be examined after a tow has been completed.
- 3) For a number of situations, it is desirable to collect echo integration data at intervals smaller than 30 seconds. When starting the internal wave study described below, there was an attempt made to average over 10 second intervals. The HTI software, however, developed severe timing problems and eventually the acquisition program failed and the computer system had to be re-booted. HTI is aware of the need to fix this problem. In addition, while the acoustic processing software generally worked well, it was still subject to failures of undetermined origin which may be solved by using a more powerful computer.
- 4) Some of the difficulties with the HTI data acquisition system may also be related to the Lantastic LAN system used to connect all the computers that are involved in data handling in BIOMAPER II. There is a need to improve the LAN system so that data can be more easily passed from one to the other. There is also a need to put SCSI interfaces in strategic computers so that JAZ drives can be used to move data to computers not on the Network.
- 5) During the operation of BIOMAPER II, there were times when the oil temperature got close to the perceived upper limit on the hydraulic system for the winch and power pack. The extent to which this is a problem needs to be examined. At the least the winch/power pack should have the vital instrument readouts wired so that the readings can be displayed and recorded by the BIO_Engineering computer.
- 6) There is also a need for a count-down timer for alerting watch-standers of DAT and video recording tapes that are about to run out. Data were lost because tapes were not exchanged on a timely basis.
- 7) There is a need for red lights inside the BIOMAPER II van which would allow people to work and read while enabling them to watch the external and VPR monitors with much less glare. Better lighting outside the van is also needed.

A problem of concern, but of uncertain origin, has to do with the volume backscattering anomalies that are evident in the echograms within 10 to 15 meters above and below BIOMAPER II when the system is being towed (Figure 8). In regions of the water column where volume backscattering is high, the values within 10 to 15 m of the towed body are enhanced and where volume backscattering is low, the values are depressed. The effect is not apparent when BIOMAPER II is held at a constant depth either near the surface or at some depth below the surface. The effect may have something to do with the towing wire and tow-bar assembly, but it is not clear at this writing how these structures could have an effect on both the up-looking and the down-looking transducers.

1.3.1.2 Video plankton recorder (VPR)

The VPR on BIOMAPER remained operational throughout the entire cruise. It was not possible to view still images from the VPR in real time because the camera was not connected to a region of interest (ROI) extraction system. However, the presence of a video

monitor afforded us brief glimpses of abundant taxa as they flashed by at 60 fps. Subsequent examination of an extremely limited subset of the video data was undertaken using a field by field SVHS editing deck. The results indicated that the quality of individual images was superb. The oil sacs, antennular and urosome segments, and prosome details were all clearly visible on *Calanus finmarchicus*.

The orientations of *Calanus* suggested that this species may have detected the presence of BIOMAPER II. Some individual copepods had their antennae folded against their sides and occasionally had their urosome folded anteriorly. Examination of four 2.5-5.0-min sections of tape 49 revealed that the frequency of *Calanus* in alarm postures was higher than normal postures (Figure 9); however, this difference was not statistically significant ($p=0.26$, one-tailed t-test). In light of the relatively high incidence of animals in alarm postures, we suggest that the camera and strobe be moved further forward so that they can collect images from an undisturbed volume of water.

The concentrations of *C. finmarchicus* estimated from these tape sections ranged from 493-1150 copepods m^{-3} . Concentrations were not estimated for other taxa, however, siphonophores, ctenophores, salps, chaetognaths, amphipods, small copepods, and diatom chains were all frequently observed on the video monitor. It is important to emphasize that these results are based on an extremely small sub-sample of the total VPR data set and that we cannot associate these video fields with specific locations and depths until their time codes have been referenced to the other BIOMAPER II data sets.

1.3.2 MOCNESS stations

MOCNESS samples revealed large, qualitative differences in zooplankton composition and distribution among the Gulf of Maine deep basins. Zooplankton composition in Georges Basin exhibited a strong influence from the Slope Water, especially from samples collected at the station nearest Northeast Channel. *Calanus* was moderately abundant in the deeper waters of the Basin, but diminished in abundance along a west to east gradient. Gelatinous zooplankton, including chaetognaths, ctenophores, scyphomedusae, and salps, were extremely abundant in the Basin. Salps dominated the zooplankton biomass in the surface waters of two of the three MOCNESS stations (stations 2 and 3).

Zooplankton biomass in Jordan Basin was strongly dominated by *Calanus*. *Calanus*

was extremely abundant in the deeper waters of the Basin and diminished rapidly at mid-water depths. Zooplankton biomass was sparse at these mid-water depths. Small copepods were abundant in the upper water column.

Zooplankton biomass in Wilkinson Basin was dominated by *Calanus*, Meganyctiphanes, decapod shrimp, and salps. *Calanus* was abundant in the deeper and middle portions of the water column and salps were very abundant in the upper water column. The Meganyctiphanes and decapod shrimp were strong migrators, occurring in the deeper waters by day and in the upper 100 m by night.

2.0 Spatio-Temporal Variability of Bio-Optical Properties in the Gulf of Maine (Ancillary Project).

(H.M. Sosik)

2.1 Introduction

Our long term objectives are to characterize spatial and temporal variability in the optical properties related to phytoplankton biomass and productivity in the Georges Bank/Gulf of Maine region. This will be accomplished by a combination of optical measurements made from vertical-profiling moorings, towed vehicles, earth-orbiting satellites, and research vessels conducting conventional station surveys. This cruise is the first field phase of the project, aimed at testing equipment and methods for optical characterization from the BIOMAPER II towed vehicle.

2.2 Methods

We successfully integrated several optical instruments on to 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, Satlantic, Inc.) and a spectral upwelling radiance sensor (OCR-200 series, Satlantic, Inc.). One of the Ac-9's measured whole-water properties and the other was configured with an in-line 0.2 μm water filter to assess absorption by dissolved material. 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]. 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 enabled storage of data files on a desktop PC aboard the ship. 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.) mounted above the deck of the ship.

Sampling conducted on the cruise also included water collection and vertical profiles of downwelling irradiance and upwelling radiance with a free-fall spectral radiometer (SPMR/SMSR system, Satlantic, Inc.) deployed away from the ship. This work was conducted at mid-day on each day of the cruise. Water samples were collected for pigment analysis and for estimation of light absorption by particulate and dissolved material. Pigment samples were concentrated on Whatman GF/F filters and extracted in 90% acetone for spectrophotometric 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 μm filtrate in 10 cm cuvettes. These spectra were acquired with 1 nm resolution between 300 and 800 nm. The free-fall radiometer has the same spectral bands as the optical heads on BIOMAPER and profiles were conducted between 10:00 and 14:00 local time, immediately prior to or immediately after the CTD/water sampling casts.

Trial measurements with a new Fast Repetition Rate Fluorometer (FastTracka FRRF, Chelsea Instruments) also were made in flow-through mode using the ship's uncontaminated seawater for most of the cruise duration.

2.3 Results

Optical data were successfully collected from BIOMAPER II during each of the deep basin surveys. Initial processing suggests that operation in tow-yo mode proved very successful in mapping distributions of optical properties. An example of the type of data collected in the survey of Wilkinson Basin shows spatial variations in scattering and absorption coefficients associated with water column structure (Figure 10 a-f). Highest values were found near the bottom and in conjunction with phytoplankton patches in the upper 50 m. Absorption by dissolved material exhibited less patchiness than found for particles, but in the blue region of the spectrum, the dissolved component consistently appeared to be the major source of absorption in the mid-water column.

Approximately 80 water samples were analyzed for pigment and high spectral resolution absorption. Water was collected from 10 or 11 depths selected from throughout the water column on 8 CTD/rosette casts (CTD3-10). Pigment concentrations and particle absorption coefficients exhibited subsurface maxima (several $\mu\text{g l}^{-1}$) at a depth of approximately 30 m, with magnitude falling off rapidly below 50 m. Absorption by non-phytoplankton particulates was very low in the surface waters.

Figure 10. Bio-optical and hydrographic data obtained from sensors deployed on BIOMAPER II during three towyo sections across Wilkinson Basin on 13-15 October 1997. a) temperature, b) salinity, c) chlorophyll fluorescence, d) beam attenuation coefficient for particles (c_p), e) absorption coefficient for particles (a_p), f) absorption coefficient for soluble material (a_s). Absorption and attenuation coefficients have been corrected for instrumental temperature dependence in the ac-9's and for differences in temperature and salinity from the calibration water. Preliminary corrections for residual scattering effects on absorption estimates have also been applied. The distributions presented here have not been completely corrected for the time lag in a_s measurements (due to slower flow caused by the in-line particle filter); some distortions are evident particularly during the third transect (when the filter throughput was decreasing).

Figure 10. b) salinity. See Figure 10 a for complete legend.

Figure 10. c) chlorophyll fluorescence. See Figure 10 a for complete legend.

Figure 10. d) beam attenuation coefficient for particles (c_p). See Figure 10 a for complete legend.

Figure 10. e) absorption coefficient for particles (a_p). See Figure 10 a for complete legend.

Figure 10. f) absorption coefficient for soluble material (a_s). See Figure 10 a for complete legend.

The free-fall radiometer was successfully deployed at 8 stations with 2-3 replicate vertical profiles conducted during each deployment. Casts with the sensor caps 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.

After some initial problems with data acquisition, several days of data were collected with the FRR fluorometer. Preliminary results show daily variations in photosystem II efficiency, with inhibition evident just after local noon on a sunny day and absent on a cloudy day.

3.0 Distribution and relative abundance of *Pseudocalanus* spp. in the Gulf of Maine (Ancillary Project)

(Ann Bucklin)

3.1 Introduction

The calanoid copepod species, *Pseudocalanus moultoni* and *P. newmani*, differ in geographic distribution and life history - but they cannot be reliably distinguished using morphological characters. Previous studies have concluded that *Pseudocalanus* is endemic to Georges Bank and Davis (1984: J. Mar. Res. 42:573) considered that the life history of *Pseudocalanus* sp. may be adapted to ensure retention in the cyclonic gyre patterns over the Bank. A revision of the genus by Frost (1989: Can. J. Zool. 67:525) concluded that two sibling species of *Pseudocalanus* occur sympatrically on Georges Bank. Both species are thought to be present in waters over the Bank throughout much of the year and may reproduce nearly continuously on the Bank.

The primary source of recruitment may be local reproduction of Bank populations, in contrast to another copepod, *Calanus finmarchicus*, that repopulates the Bank each spring from surrounding waters. This project identifies and discriminates individuals of the two species by sequence-specific gene amplification by the polymerase chain reaction (PCR). Temporal and spatial distributions of larval, juvenile, and adult female stages of both species are being determined from zooplankton samples of the Georges Bank Study Broadscale Survey cruises. Patterns of distribution will be characterized monthly from January to June of 1997 and 1998 to determine how stage-specific distributions interact with circulation patterns on the Bank. Image analysis will be used to size the individuals of each stage to determine whether rates of growth and development differ between the species.

Collaborative work with bio-physical modelers will be done to place the stage-structured populations of each species in realistic flow fields. It is hypothesized that the life histories of the *Pseudocalanus* spp. on Georges Bank differ in ways that are suited to the geographic distribution and reproductive ecology of the species. Failure to discriminate the species has prevented our understanding of how zooplankton life histories interact with Bank circulation patterns to determine the likelihood of retention and successful recruitment. Comparison between the life histories of *P. moultoni* and *P. newmani*, based on stage-specific distributions in time and space over Georges Bank, will help reveal the mechanisms of population maintenance for each species and determine whether and how the sibling species differ.

3.2 Methods

Samples from all 9 MOCNESS tows were split and preserved in alcohol for molecular analysis. *Pseudocalanus moultoni* adult females will be sorted from the #7 net, the 50 - 25 m depth interval on most tows. Species-specific PCR amplifications will be used to identify the species. The distribution and relative abundance of female *P. moultoni* will be determined for the sampled domain. In addition, the DNA sequence of the mitochondrial cytochrome oxidase I (COI) gene will be sequenced for female *P. moultoni*, and the sequence data will be used for population genetic analysis of the species from the Gulf of Maine and Georges Bank.

MOCNESS samples that consisted predominantly of *Calanus finmarchicus* were size-sorted by washing the sample through a stacked series of sieves with decreasing mesh sizes (2000 um > 1000 um > 500 um > 333 um). The contents of each sieve were visually checked for *Calanus*; up to 300 cc of sample volume was removed with a spoon from the sieve with the greatest concentration of *Calanus*, placed in a plastic bag, wrapped in aluminum foil, and flash-frozen in liquid nitrogen. One size-sorted sample of *Calanus* was frozen for each MOCNESS tow, for a total of nine samples. These samples of nearly pure *C. finmarchicus* will be used for molecular genetic analyses. Portions of the samples will be shipped to Dr. Pat Hassett (Miami University, Oxford, Ohio) as he has requested.

3.3 Results

There appeared to be dense populations of *Pseudocalanus* spp. in some of the MOCNESS samples. Some of the individuals were females with attached egg clusters. These individuals will be targeted for molecular identification, to determine whether one or both of the species are actively reproducing at this time in the Gulf of Maine.

There were dense populations of *C. finmarchicus* at some locations along the cruise track. The MOCNESS samples at these sites yielded nearly pure samples of the copepod, which will be useful for a suite of molecular and biochemical analyses.

CRUISE PARTICIPANTS

Scientific Personnel

1. Charles Greene Cornell University (Chief Scientist)
2. Louise McGarry Cornell University
3. Bruce Monger Cornell University
4. Karen Fisher Cornell University
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12. Heidi Sosik Woods Hole Oceanographic Institution
13. Anne Canaday Woods Hole Oceanographic Institution
14. Benjamin Halpern Woods Hole Oceanographic Institution
15. Sean Hill University of New Hampshire
16. Sam Johnson Hydroacoustic Technology Incorporated
17. William Fanning University of Rhode Island

Officers and Crew

1. Thomas R. Tyler Master
2. Everett A. McMunn Chief Mate
3. Stephen S. Vetra Second Mate
4. Jack E. Buss Boat-Swain
5. Glen D. Prouty Able-Seaman
6. Richard P. Foley Able-Seaman
7. David T. J. Rocha Able-Seaman
8. James P. Cobleigh Assistant Engineer
9. William A. Appleton Chief Engineer
10. Timothy S. Varney Assistant Engineer
11. Daniel T. Butler Steward/Cook

APPENDIX 1. Event Log for R/V ENDEAVOR Cruise 307.

U.S. GLOBEC Gulf of Maine Event Log (October 1997)

						10/97	Local +4	Start			Water	Cast				
YearDay	Event	Instrument	Cast #.	Station	Turn	Date	h:r:mn	End	Lat (N)	Lon (W)	Depth (m)	Depth (m)	Investigator	Region	Comments	
281.792	1	Calibration			1:2	8	19:00:00						Greene	WHOI	Finish calibrations; depart	
281.875	2	BIOMAPER	BMP1		1:2	8	21:00:00	s	4125.62	7048.55	21	3	Greene	Vineyard Sound	BIOMAPER II Dip test	
281.938	3	BIOMAPER	BMP1		1:2	8	22:31:00	e	4122.24	7054.93	15	3	Greene	Vineyard Sound	Recover BIOMAPER II	
282.434	4	CTD	CTD1	1		9	10:25:00	s	4148.82	6822.98	213	200	Sosik/Houghton	Georges Basin	Deploy CTD	
282.460	5	CTD	CTD1	1		9	11:02:00	e	4148.65	6823.05	213				Recover CTD (bottle misfire)	
282.470	6	Radiometer	SPMR1	1		9	11:17:00	s	4148.63	6823.12	210	200	Sosik	Georges Basin	Deploy Radiometer	
282.491	7	Radiometer	SPMR1	1		9	11:47:00	e	4148.63	6823.34	210				Recover Radiometer	
282.499	8	CTD	CTD2	1		9	11:58:00	s	4148.65	6823.39	210		Sosik/Houghton	Georges Basin	Deploy CTD	
282.514	9	CTD	CTD2	1		9	12:20:00	e	4148.75	6823.53	210	200			Bottle Misfire	
282.516	10	CTD	CTD3	1		9	12:23:00	s	4148.75	6823.53	210		Sosik/Houghton	Georges Basin	Deploy CTD	
282.530	11	CTD	CTD3	1		9	12:43:00	e	4148.87	6823.63	210				Recover CTD	
282.573	12	BIOMAPER	BMP2	1	3:4	9	13:45:00	s	4149.71	6823.40	210		Greene	Georges Basin	Deploy BIOMAPER II	
282.606	13	BIOMAPER	BMP2	1	3:4	9	14:32:00	e	4150.74	6822.02	210				Recover BIOMAPER II	
282.653	14	BIOMAPER	BMP3	1	3:4	9	15:41:00	s	4152.19	6820.34	207	40	Greene	Georges Basin	Deploy BIOMAPER II	
282.850	15	BIOMAPER	BMP3	1	3:4	9	20:24:00	e	4210.74	6753.26	243				Recover BIOMAPER II	
282.885	16	BIOMAPER	BMP4		3:4	9	21:15:00	s	4210.62	6753.19	250	200	Greene	Georges Basin	RE-redeploy BIOMAPER	
283.065	17	MOCNESS	MOC1	2		10	01:33:00	s	4221.78	6735.36	275	244	Wiebe	Georges Basin	Deploy MOCNESS	
283.146	18	MOCNESS	MOC1	2		10	03:30:00	e	4217.18	6734.17					Recover MOCNESS	
283.486	19	BIOMAPER	BMP4			10	11:40:00	e	4216.53	6629.07	250				Recover BIOMAPER II	
283.507	20	CTD	CTD4	3	4:5	10	12:10:00	s	4215.71	6627.96	250	240	Sosik/Houghton	Georges Basin	Deploy CTD	
283.528	21	CTD	CTD4	3	4:5	10	12:41:00	e	4215.63	6627.02					Recover CTD	
283.542	22	Radiometer	SPMR2	3	4:5	10	13:00:00	s	4215.78	6627.89	250	100	Sosik	Georges Basin	Deploy Radiometer	
283.564	23	Radiometer	SPMR2	3	4:5	10	13:32:00	e	4215.18	6626.69	250				Recover Radiometer	
283.624	24	MOCNESS	MOC2	3		5	10	14:58:00	s	4213.87	6625.01	225		Wiebe	Georges Basin	Deploy MOCNESS
283.688	25	MOCNESS	MOC2	3		5	10	16:30:00	e	4211.49	6623.73					Recover MOCNESS
283.792	26	BIOMAPER	BMP5			10	19:00:00	s	4227.90	6640.00			Greene/Wiebe	Georges Basin	Deploy BIOMAPER	
284.151	27	MOCNESS	MOC3	4	6:7	11	03:38:00	s	4225.30	6700.25	360	330	Wiebe	Georges Basin	Deploy MOCNESS	
284.210	28	MOCNESS	MOC3	4	6:7	11	05:02:00	e	4226.31	6703.30					Recover MOCNESS	
284.478	29	CTD	CTD5	5		11	11:29:00	s	4235.28	6730.91	245		Sosik/Houghton	Georges Basin	Deploy CTD	
284.500	30	CTD	CTD5	5		11	12:00:00	e	4235.29	6730.75					Recover CTD	
284.508	31	Radiometer	SPMR3	5		11	12:12:00	s	4235.34	6730.60	245	180	Sosik		Deploy Radiometer	
284.531	32	Radiometer	SPMR3	5		11	12:44:00	e	4235.60	6730.59					Recover Radiometer	
285.049	33	MOCNESS	MOC4	6		12	01:10:00	s	4330.94	6753.20	254	240	Wiebe	Jordan Basin	Deploy MOCNESS	
285.101	34	MOCNESS	MOC4			12	02:25:00	e	4333.22	6753.56					Recover MOCNESS	
285.322	35	BIOMAPER	BMP5			12	07:44:00	e	4347.70	6730.42				Jordan Basin	Recover BIOMAPER	
285.372	36	MOCNESS	MOC5	7	TP 8	12	08:55:00	s	4349.13	6729.60	202	190	Wiebe	Jordan Basin	Deploy MOCNESS	
285.420	37	MOCNESS	MOC5	7		12	10:05:00	e	4349.59	6729.56					Recover MOCNESS	
285.441	38	CTD	CTD6	7		12	10:35:00	s	4347.97	6730.09	230	220	Sosik	Jordan Basin	Deploy CTD	
285.460	39	CTD	CTD6	7		12	11:02:00	e	4347.83	6730.25					Recover CTD	
285.468	40	Radiometer	SPMR4	7		12	11:14:00	s	4347.75	6730.33	230		Sosik	Jordan Basin	Deploy Radiometer	
285.483	41	Radiometer	SPMR4	7		12	11:35:00	e	4347.68	6730.38					Recover Radiometer	
285.528	42	BIOMAPER	BMP6			12	12:40:00	s							Deploy BIOMAPER	
286.010	43	Calibration	CMPS			13	00:14:00	s/e	4314.28	6810.39	230				Compass calib, noise test	
286.115	44	BIOMAPER	BMP6			13	02:45:00	e	4314.28	6810.39					Recover BIOMAPER	
286.115	45	Radiometer	SPMR5			13	02:45:00	s							Deploy Radiometer	
286.594	46	Radiometer	SPMR5	8		13	14:16:00	e	4320.06	7001.71			Sosik	Wilkinson Basin	Recover Radiometer	
286.601	47	CTD	CTD7	8		13	14:25:00	s	4320.09	7001.77	180	172	Sosik	Wilkinson Basin	Deploy CTD	
286.618	48	CTD	CTD7	8		13	14:50:00	e	4320.11	7001.63	165		Sosik	Wilkinson Basin	Recover CTD	
286.712	49	BIOMAPER	BMP7			13	17:05:00	s	4259.05	6955.12	240		Greene		Deploy BIOMAPER	
287.014	50	MOCNESS	MOC6	9		14	00:20:00	s	4239.40	6925.13	240	220	Wiebe	Wilkinson Basin	Deploy MOCNESS	
287.097	51	MOCNESS	MOC6	9		14	02:20:00	e							Recover MOCNESS	
287.451	52	CTD	CTD8	10		14	10:50:00	s	4214.90	6844.83	200				Deploy CTD	
287.467	53	CTD	CTD8	10		14	11:12:00	e	4215.03	6844.70			Sosik/Houghton		Recover CTD	
287.472	54	Radiometer	SPMR6	10		14	11:20:00	s	4215.01	6844.64	200	150	Sosik		Deploy Radiometer	
287.490	55	Radiometer	SPMR6	10		14	11:45:00	e	4215.60	6844.69					Recover Radiometer	
287.620	56	MOCNESS	MOC7	11		14	14:53:00	s	4224.04	6849.03	205	185	Wiebe	Wilkinson Basin	Deploy MOCNESS	
287.686	57	MOCNESS	MOC7	11		14	16:28:00	e	4224.93	6844.22			Wiebe	Wilkinson Basin	Recover MOCNESS	
288.477	58	BIOMAPER	BMP7	12		15	11:27:00	e	4216.63	6915.57			Greene	Wilkinson Basin	Recover BIOMAPER	
288.479	59	Radiometer	SPMR7	12		15	11:30:00	s	4216.63	6915.57	230		Sosik	Wilkinson Basin	Deploy Radiometer	
288.493	60	Radiometer	SPMR7	12		15	11:50:00	e	4216.72	6915.23					Recover Radiometer	
288.503	61	CTD	CTD9	12		15	12:05:00	s	4216.70	6915.15	230		Sosik/Houghton	Wilkinson Basin	Deploy CTD	
288.523	62	CTD	CTD9	12		15	12:33:00	e	4216.70	6915.15					Recover CTD	
288.594	63	BIOMAPER	BMP8			15	14:15:00	s	4204.98	6912.53	197		Greene/Wiebe	Wilkinson Basin	Deploy BIOMAPER II	
289.019	64	MOCNESS	MOC8	13		16	00:27:00	s	4206.23	6940.48			Wiebe	Wilkinson Basin	Deploy MOCNESS	
289.081	65	MOCNESS	MOC8	13		16	01:57:00	e	4204.48	6936.04	226	200			Recover MOCNESS	
289.535	66	CTD	CTD10	14		16	12:50:00	s	4224.96	6844.68	210		Sosik/Houghton	Wilkinson Basin	Deploy CTD	
289.562	67	CTD	CTD10	14		16	13:29:00	e	4225.20	6844.29					Recover CTD	
289.896	68	MOCNESS	MOC9	15	TP 13	16	21:30:00	s	4228.70	6845.00	180	170	Wiebe	Wilkinson Basin	Deploy MOCNESS for soliton	
289.949	69	MOCNESS	MOC9	15		16	22:46:00	e	4230.97	6846.69	200				Recover MOCNESS	
289.951	70	BIOMAPER	BMP8	15		16	22:50:00	e	4230.97	6846.69	200				Recover BIOMAPER	

APPENDIX 2. MOCNESS tow details.

MOCNESS Tow Summary Table				
Tow/File Number	Date 1997 (yearday)	Time Local	Start	End
		(+4 GMT)	Lat/Lon	Lat/Lon
M-01-001 PRO	10 October	22:16	42.369473	42.290423
M-01-001 RAW	(282)	00:20	-067.593958	-067.557
M-01-01B PRO				
M-01-002 PRO	11 October	14:49	42.234527	42.284400 -066.425680
M-01-002 RAW	(283)	17:36	-066.421407	
M-01-02B PRO				
M-01-003 PRO M-01-003 RAW	12 October	03:00	42.415045	42.438582
M-01-03B PRO	(284)	05:03	-066.982088	-067.055007
M-01-004 PRO	12 October	00:30	43.497600	43.553743 -067.892618
M-01-004 RAW	(285)	02:28	-067.882165	
M-01-005. PRO	12 October	08:54	43.8164	43.8391
M-01-005 .RAW	(285)	09:52	-067.4939	-067.4898
M-01-006. PRO	14 October	00:19	42.684370	42.579158
M-01-006. RAW	(287)	03:38	-069.493045	-069.220497
M-01-006. TAB				
M-01-007. PRO	14 October	14:47	42.400900	42.417122
M-01-007. RAW	(287)	17:20	-068.821992	-068.841355
M-01-008. PRO	16 October	00:27	42.103848	42.074440
M-01-008. RAW	(289)	01:58	-69.675125	-69.6000462
M-01-009. PRO	16 October	21:34	424.478703	42.511017
M-01-009. RAW	(289)	22:37	-68.750728	-68.772520

APPENDIX 3. BIOMAPER II event log.

Gulf of Maine ACOUSTIC Log Form (Oct. 1997)												
			GLOBEC	DAT	VPR							
Yearday	DECLAT	DECLON	Event	Tape #	Tape #	Day	S.D.	Time	Lat (N)	Lon (W)	Comments	
281.792	41.427	70.809	2	0	001	8	281	19:00	4125.62	7048.55	Dip Test (Noise Assessment,Ducers Off, Slow Speed, 4 knots)	
281.899	41.400	70.853	2	0	001	8	281	21:35	4124.01	7051.16	Increase to 6 knots, Noise Assessment, Cross Talk Checks	
281.928	41.361	70.929	2	0	001	8	281	22:16	4121.65	7055.75	Change direction toward Leg 2	
281.938	41.371	70.915	3	0	001	8	281	22:31	4122.24	7054.93	Dip Test Ended (Fish out)	
282.573	41.829	68.390	12	1	001	9	282	13:45	4149.71	6823.40	Short test, winch brake needs repair	
282.606	41.846	68.367	13	1	001	9	282	14:32	4150.74	6822.02	fish out	
282.653	41.870	68.339	14	1	001	9	282	15:41	4152.19	6820.34	fish in, no data logging yet, thresholds being set, no VPR, radiometer only	
282.688	0.000	0.000	14	1	001	9	282	16:30			Increased spd to 6.2 knots	
282.706	0.000	0.000	14	1	001	9	282	16:57			data logging on	
282.712	0.000	0.000	14	1	001	9	282	17:05			fish lowered for pressure sensor calibration	
282.722	0.000	0.000	14	1	001	9	282	17:20			at 4 meters for dinner, then decision for pressure/depth	
282.772	0.000	0.000	14	1	001	9	282	18:32			to 3 knots	
282.776	0.000	0.000	14	1	001	9	282	18:38			change to 6 knots at surface	
282.836	42.162	67.914	14	1	001	9	282	20:04	4209.75	6754.83	start tow-yo from 38 meters depth, wire angle 30degrees	
282.840	42.170	67.903	14	1	001	9	282	20:10	4210.18	6754.19	shut down data acquisition after single tow; adjust stabilizer to reduce roll (+2degrees)	
282.850	42.179	67.888	15	1	001	9	282	20:24	4210.74	6753.26	Recover BIOMAPER	
282.885	42.177	67.887	16	1	001	9	282	21:15	4210.62	6753.19	RE-redeploy BIOMAPER (NOTE: This Lat/Lon is NavTrac NOT P-code)	
282.895	0.000	0.000	16	1	001	9	282	21:29			Down to 26.5m. Monitor readings. 6 knots.	
282.903	0.000	0.000	16	1	001	9	282	21:40			Start down again. (At 100m switch to 5 knots.)	
282.956	0.000	0.000	16	1	001	9	282	22:56			Slow to 4 knots ~147m down.	
282.958	0.000	0.000	16	1	001	9	282	23:00			175m Test winch for pull up. Lever pulled only 1/3. So continue down.	
282.972	0.000	0.000	16	2	002	9	282	23:19			Tape change 004. fish 12 m below surface	
282.979	42.322	67.684	16			9	282	23:30	4219.32	6741.02	200m. Start bringing BIOMAPER up.	
282.999	0.000	0.000	16			9	282	23:59			Patch. VPR Time: 03:59:24	
283.047	0.000	0.000	16	4	3?	10	283	01:07			several acoustic test files, tape 004 in	
283.078	0.000	0.000	16	4		10	283	01:52			steady fish tow at 10 meters	
283.158	0.000	0.000	16	4		10	283	03:47			new file, tow down to 150 meters	
283.174	0.000	0.000	16	5	4	10	283	04:11			VPR tape 4 in, tape 3 had run out, partially overwritten	
283.202	0.000	0.000	16	5	4	10	283	04:51			Software restarted after screen freeze; gps suspected	
283.218	42.273	67.358	16	5	4	10	283	05:14	4216.40	6721.50	TOWYO from 120 meters to 25 meters begins UP	
283.232	0.000	0.000	16	6	4	10	283	05:34			tape 6 in, tape 5 had run out, oscill. stopped (How long?)	
283.232	0.000	0.000	16	6	4	10	283	05:34			TOWYO down from 17 meters DOWN	
283.262	0.000	0.000	16	6	5	10	283	06:17			VPR tape 005	

283.262	42.278	67.228	16	6	5	10	283	06:17	4216.67	6713.66	TOWYO up from 200? UP
283.283	42.275	67.171	16	6	5	10	283	06:48	4216.52	6710.27	TOWYO DOWN: patch pass through at 10:53:30; siphonophores at 11:24:15
283.309	42.271	67.090	16	6	5	10	283	07:25	4216.28	6705.39	TOWYO from 220 meters (in 240m depth) UP
283.317	0.000	0.000	16	7	5	10	283	07:37			DAT TAPE 007 in
283.328	42.269	67.024	16	7	5	10	283	07:53	4216.16	6701.46	TOWYO down from 29 meters DOWN
283.347	0.000	0.000	16	7	6	10	283	08:20			VPR TAPE 006 in
283.352	42.269	66.939	16	7	6	10	283	08:27	4216.15	6656.32	217m depth. On last wrap. Start up. Stop. Pay out. Paint drum.
283.356	42.269	66.927	16	7	6	10	283	08:32	4216.15	6655.59	Start up again.
283.369	42.269	66.875	16	7	6	10	283	08:52	4216.11	6652.49	150m. Pay out to 204m to fix wrap problem.
283.401	0.000	0.000	16	8	6	10	283	09:37			DAT TAPE 008 in.
283.415	42.266	66.705	16	8	6	10	283	09:57	4215.99	6642.32	182m. Start Biomaper back up. Wrap problem fixed.
283.433	0.000	0.000	16	8	7	10	283	10:24			VPR TAPE 007 in.
283.440	42.264	66.604	16	8	7	10	283	10:34	4215.81	6636.21	19m Turn off acoustics. Hold fish at this depth to test.
283.442	0.000	0.000	16	8	7	10	283	10:36			DAT TAPE turned off. Put in fresh tape with restart.
283.444	0.000	0.000	16	8	7	10	283	10:40			VPR TAPE turned off.
283.486	42.275	66.485	19		7	10	283	11:40	4216.53	6629.07	Recover BIOMAPER
283.507	42.265	66.466				10	283	12:10	4215.91	6627.96	Deploy ctd
283.486	42.260	66.450				10	283	12:41	4215.63	6627.02	Recover CTD
283.792	42.465	66.667	20	9	7	10	283	19:00	4227.90	6640.00	BIOMAPER GOING IN; up and down adjust; pressure recalib
283.842	0.000	0.000		9	7	10	283	20:13			TOWYO down on new course
283.842	0.000	0.000	26	9	7	10	283	20:13			Patch VPR (30M)
283.848	42.427	66.635	26	9	7	10	283	20:21	4225.60	6638.11	Holding near sfc (16m). Bring to sfc to begin towyo down.
283.850	42.424	66.638	26	9	7	10	283	20:24	4225.46	6638.27	Begin towyo down.
283.860	42.411	66.656	26	9	7	10	283	20:38	4224.66	6639.34	Slow to 4 knots. 109m. Stop Payout.
283.868	0.000	0.000	26	9	8	10	283	20:50			Start VPR tape 008
283.869	0.000	0.000	26	10	8	10	283	20:52			Start DAT tape 010
283.875	0.000	0.000	26	10	8	10	283	21:00			At 255m stop to test pull up.
283.876	42.398	66.675	26	10	8	10	283	21:02	4223.86	6640.48	275m. Hold depth.
283.882	42.393	66.680	26	10	8	10	283	21:10	4223.59	6640.81	Start new file (s2832110) 275m. Start towyo up. NOTE: Calanus (?) at 225m?
283.895	42.383	66.695	26	10	8	10	283	21:29	4222.97	6641.70	Increase to 5 knots
283.898	0.000	0.000	26	10	8	10	283	21:33			BIG layer at 45m.
283.901	0.000	0.000	26	10	8	10	283	21:37			20m. Stop. Hold position. Bring up slowly with Wire Watch.
283.903	42.375	66.708	26	10	8	10	283	21:41	4222.52	6642.50	Bring plastic 1' our of water. Start back down.
283.906	0.000	0.000	26	10	8	10	283	21:44			Open new file (S2832143). Winch oil temp 140F. Hold at 20m.
283.916	42.363	66.727	26	10	8	10	283	21:59	4221.78	6643.63	Start back down.
283.929	42.350	66.745	26	10	8	10	283	22:18	4220.97	6644.68	200m. Reduce to 4 knots.
283.934	42.346	66.752	26	10	8	10	283	22:25	4220.76	6645.14	280m. Hold.
283.935	42.346	66.752	26	10	8	10	283	22:27	4220.74	6645.14	Start towyo up.
283.947	42.347	66.766	26	10	8	10	283	22:44	4220.84	6645.95	Increase to 5 knots.
283.949	0.000	0.000	26	10	8	10	283	22:46			47m. Siphonophores?
283.952	42.349	66.773	26	10	8	10	283	22:51	4220.96	6646.38	Open new file (S2832252)
283.955	42.351	66.779	26	11	9	10	283	22:55	4221.09	6646.75	Start VPR tape 9. Start DAT tape 11. Start towyo down.
283.960	42.354	66.787	26	11	9	10	283	23:02	4221.23	6647.19	Reduce to 4 knots.
283.971	42.358	66.800	26	11	9	10	283	23:18	4221.49	6647.97	Reduce to 3 knots.
283.975	42.359	66.801	26	11	9	10	283	23:24	4221.54	6648.08	274m. Start towyo back up.
283.981	0.000	0.000	26	11	9	10	283	23:32			200m. Calanus.
283.988	42.363	66.813	26	11	9	10	283	23:42	4221.78	6648.79	Increase to 4 knots.
283.994	42.366	66.822	26	11	9	10	283	23:52	4221.97	6649.32	Top of ascent <5m from surface.
283.997	0.000	0.000	26	11	9	10	283	23:55			New file.
283.997	0.000	0.000	26	11	9	10	283	23:56			Start towyo down.
284.006	42.371	66.838	26	11	9	11	284	00:08	4222.25	6650.29	Slow to 3 knots.
284.006	0.000	0.000	26	11	9	11	284	00:08			TIMEOUT ERROR in setting BNC Sync Out Command.
284.014	0.000	0.000	26	11	9	11	284	00:20			COMMUNICATIONS ERROR. Echo Sounder Sequences not synchronized. Or problem sending next sampling sequence definition.
284.015	42.372	66.846	26	11	9	11	284	00:22	4222.34	6650.74	270m. Hold.
284.016	0.000	0.000	26	11	9	11	284	00:23			Problems encountered in sending stop processing command.
284.018	0.000	0.000	26	11	9	11	284	00:26			New file. S2840025
284.018	0.000	0.000	26	11	9	11	284	00:26			Problems encountered. Exited program. Desktop colors changed. Lost mouse. Tried ALT F4. Tried CTRL/ALT/DEL. POWERED OFF.
284.022	0.000	0.000	26	11	9	11	284	00:32			New file. S2840032.
284.023	42.374	66.854	26	11	9	11	284	00:33	4222.42	6651.24	257m. Start towyo ascent.
284.042	0.000	0.000	29	12?	10?	11	284	01:00			Begin surface tow through MOCNESS
284.044	42.382	66.880	29			11	284	01:03	4222.95	6652.81	End S2840032 Biomaper @11.8meters; Begin S2840105 Biomaper DOWN
284.060	42.389	66.900	29			11	284	01:27	4223.35	6654.00	Begin S2840128 TOWYO UP
284.079	42.399	66.930	29			11	284	01:54	4223.96	6655.80	Begin S2840156 TOW @5meters during MOCNESS
284.124	42.414	66.981	29	13?	11?	11	284	02:59	4224.86	6658.87	Begin S2840301 TOW@5 meters
284.226	42.443	67.083	29	14?	12?	11	284	05:25	4226.60	6705.00	Begin S2840525 TOW @5 meters, MOC in, new ESSBM2_007.pro(.raw)
284.243	42.367	67.096	29			11	284	05:50	4222.05	6705.77	TOWYO DOWN
284.249	0.000	0.000	29			11	284	05:58			Salinity peak at 50 meters, strong scatter on all 5 down lookers
284.251	42.458	67.117	29			11	284	06:02	4227.50	6707.00	Salinity off scale, interleaved water masses, strong layer scatter, 130 meters salinity leaves, > 34.5
284.271	0.000	0.000	29			11	284	06:30			250 meters: TOWYO UP
284.290	42.487	67.195	29			11	284	06:57	4229.20	6711.70	surface: TOWYO DOWN, seas rising
284.291	0.000	0.000	29	15	13	11	284	06:59			DAT 015 VPR 013in, Begin S2840525 Bottom layer green, 95 meters thick on 43 and 120, we hit the upper edge...
284.315	42.507	67.248	29	15	13	11	284	07:33	4230.40	6714.90	TOWYO up from 65 meters above bottom (315 meters) LAYERING DISTINCT
284.337	42.522	67.298	29	15	13	11	284	08:05	4231.34	6717.85	Begin S2840802, TOWYO DOWN from 2 meters
284.356	42.530	67.326	26	15	13	11	284	08:32	4231.83	6719.55	NOTE: Vert Vel went from -10m/min to +5.6m/min. Shear? Screen captured. ~200m.
284.361	42.533	67.336	26	15	13	11	284	08:40	4231.97	6720.18	250m. Bottom of towyo. Start S2840842 file. Start towyo ascent.
284.364	0.000	0.000	26	15	13	11	284	08:44			Patch 225m.
284.375	0.000	0.000	26	16	14	11	284	09:00			Begin DAT tape 16 and VPR tape 14.

284.383	42.545	67.375	26	16	14	11	284	09:11	4232.72	6722.50	Surface. Start new file. Start down.
284.407	42.558	67.419	26	16	14	11	284	09:46	4233.48	6725.13	240m. Hold. Errors on HTI program. Exit program. Reboot.
284.409	0.000	0.000	26	16	14	11	284	09:49			New File S2840948. Start up.
284.425	0.000	0.000	26	16	14	11	284	10:12			Patch 35m.
284.428	42.570	67.458	26	16	14	11	284	10:16	4234.21	6727.49	Biomaper at surface. New file. Towyo back down.
284.435	0.000	0.000	26	16	14	11	284	10:27			Patch 100m. Slow to 3.5 knots.
284.443	42.580	67.489	26	16	14	11	284	10:38	4234.78	6729.31	220m. Bottom of towyo. New File S2841039. Patch. Start ascent.
284.455	0.000	0.000	26	16	14	11	284	10:55			Patch 60m.
284.459	0.000	0.000	26	16	14	11	284	11:01			END TAPES: DAT 016 and VPR 014. Holding BIOMAPER at surface during CTD.
284.460	0.000	0.000	26	17	-----	11	284	11:02			Recording no tapes. New file: s2841102.
284.478	42.588	67.515	26	17	-----	11	284	11:29	4235.29	6730.91	ctd deployed
284.622	0.000	0.000	26	17	15	11	284	14:55			new vpr tape #015
284.628	42.838	67.510	26	17	15	11	284	15:05	4250.30	6730.57	start descent of biomapper
284.638	0.000	0.000	26	17	15	11	284	15:18			biomaper at 50 m begin ascent
284.642	0.000	0.000	26	17	15	11	284	15:25			biomaper at surface begin descent
284.650	0.000	0.000	26	17	15	11	284	15:36			biomaper at 50m begin ascent
284.658	0.000	0.000	26	17	15	11	284	15:47			biomaper at surface begin descent
284.668	0.000	0.000	26	18	15	11	284	16:02			change DAT tape to 018
284.669	0.000	0.000	26	18	15	11	284	16:03			biomaper at 53m begin ascent
284.688	42.992	67.507	26	18	15	11	284	16:30	4259.50	6730.40	tow @5 meters (hawk on board); layer structure strongest on 120 kHz, thick layers (50m), something at 200 meters, just out of range...)
284.706	0.000	0.000	26	18	16	11	284	16:57			change VPR to 016 thick layer structure persists, layer at 200 meters
284.752	43.203	67.505	26	19	17	11	284	18:03	4312.20	6730.30	resync of DAT and VPR Tapes; strong layer at 200 meters, one at approx 30 meters, thick layers gone
284.773	43.237	67.533	26	19	17	11	284	18:33	4314.23	6731.97	TOWYO DOWN from 5 meters
284.778	0.000	0.000	26	19	17	11	284	18:40			TOWYO UP from 143 meters/180 depth
284.791	43.260	67.564	26	19	17	11	284	18:59	4315.57	6733.83	TOWYO DOWN from 4 meters (sight)
284.805	43.277	67.583	26	19	17	11	284	19:19	4316.62	6735.00	TOWYO UP from 170/220
284.821	43.295	67.612	26	19	17	11	284	19:42	4317.70	6736.70	TOWYO DOWN from sight, begin S2841942
284.831	43.305	67.627	26	19	17	11	284	19:56	4318.30	6737.60	TOWYO UP 165/220
284.839	0.000	0.000	26	20	18	11	284	20:08			Patch at surface (virtual patch in layer due to cross through?)
284.844	43.320	67.645	26	20	18	11	284	20:15	4319.20	6738.70	TOWYO DOWN from sight
284.858	43.336	67.666	26	20	18	11	284	20:35	4320.18	6739.99	Bottom of descent. 191.4m.
284.870	0.000	0.000	26	20	18	11	284	20:53			Patch 35m...looks to continue throught towyo.
284.874	43.352	67.689	26	20	18	11	284	20:58	4321.14	6741.36	End S2841942. Begin S2842058. Top of towyo. Boot to sfc.
284.888	43.366	67.710	26	20	18	11	284	21:19	4321.97	6742.59	Bottom of towyo descent 200m.
284.901	43.380	67.730	26	20	18	11	284	21:38	4322.80	6743.81	Top of ascent. Boot to sfc.
284.919	43.397	67.754	26	20	18	11	284	22:03	4323.84	6745.25	S2842204 New file. Bottom of towyo descent. 220m
284.922	0.000	0.000	26	21	18	11	284	22:07			Start DAT tape 21.
284.924	0.000	0.000	26	21	19	11	284	22:10			Start VPR tape 19.
284.935	0.000	0.000	26	21	19	11	284	22:27			HUGE patch of critters on VPR.
284.939	43.419	67.786	26	21	19	11	284	22:32	4325.16	6747.14	Top of towyo ascent. Boot to sfc. Abundant critters.
284.955	43.433	67.806	26	21	19	11	284	22:55	4326.00	6748.38	Bottom of descent 204m.
284.957	0.000	0.000	26	21	19	11	284	22:58			Resync VPR mid tape.
284.969	0.000	0.000	26	21	19	11	284	23:16			LOTS of critters!
284.972	43.451	67.830	26	21	19	11	284	23:19	4327.07	6749.78	Top of ascent. Boot to sfc. New file S2842320
284.988	43.469	67.855	26	21	19	11	284	23:43	4328.12	6751.31	217m bottom of towyo. Start up.
285.004	43.486	67.878	26	21	19	12	285	00:06	4329.13	6752.66	S2850006 New file. Top of ascent. Hold at 5m for MOCNESS. LOTS of critters.
285.008	0.000	0.000	26	22	20	12	285	00:11			Start new DAT tape #22. Start new VPR tape #20.
285.053	0.000	0.000	26	22	20	12	285	01:16			Begin S2850116 (computer crashed); Moc tow#4, ESS BM@_010.pro/.raw
285.092	43.544	67.891	26	23	21	12	285	02:13	4332.65	6753.48	Start dat 23 while towing moc, new vpr 021 for bugs
285.131	43.578	67.878	26	23	21	12	285	03:08	4334.67	6752.70	End S2850116
285.134	43.581	67.872	26	23	21	12	285	03:13	4334.87	6752.30	Begin S2850313 Transect leg to #8, towyo
285.178	43.636	67.782	26	24	22	12	285	04:16	4338.16	6746.94	Restart computer, rewind tapes
285.194	43.659	67.745	26	24	22	12	285	04:39	4339.52	6744.68	S2850437 TOWYO DOWN
285.218	43.687	67.696	26	24	22	12	285	05:14	4341.19	6741.74	TOWYO UP from 180/220
285.233	43.704	67.667	26	24	22	12	285	05:36	4342.21	6740.02	TOWYO surfaces; close files
285.235	43.704	67.666	26	24	22	12	285	05:38	4342.25	6739.94	Begin S2850537, TOWYO DOWN
285.267	43.741	67.598	26	24	22	12	285	06:24	4344.45	6735.90	Screen CAPTURE S2850537.bmp, begin S2850629
285.271	43.743	67.597	26	24	22	12	285	06:30	4344.56	6735.83	TOWYO DOWN
285.281	43.753	67.579	26	25	23	12	285	06:44	4345.19	6734.76	Change tapes, VPR full of action, 1mHz heavy scatter at bottom
285.298	43.772	67.548	26	25	23	12	285	07:09	4346.31	6732.89	Surface, remove seaweed from termination
285.299	43.773	67.547	26	25	23	12	285	07:10	4346.35	6732.82	SCRCAP S2850629.bmp
285.301	43.775	67.542	26	25	23	12	285	07:14	4346.52	6732.52	Begin S2850714
285.303	43.776	67.540	26	25	23	12	285	07:17	4346.55	6732.40	TOWYO DOWN from Surface
285.316	43.789	67.517	26	25	23	12	285	07:35	4347.33	6731.03	TOWYO UP calanus in VPR, thick "green layer" over bottom
285.322	43.795	67.507	38	25	23	12	285	07:44	4347.70	6730.42	RECOVER BIOMAPER to check rad. stuff
285.516	0.000	0.000	42	25	23	12	285	12:23			Biomaper back in water
285.531	43.730	67.498	42	25	23	12	285	12:44	4343.77	6729.88	Biomaper starts down
285.545	43.700	67.498	42	25	23	12	285	13:05	4341.98	6729.88	biomaper at 205 m begin up
285.555	43.682	67.503	42	26	24?	12	285	13:19	4340.91	6730.17	change DAT tape to #26
285.561	43.668	67.503	42	26	24?	12	285	13:28	4340.09	6730.17	biomaper at surface begin down
285.577	43.630	67.509	42	26	24?	12	285	13:51	4337.82	6730.55	biomaper at 200m begin up
285.592	43.595	67.519	42	26	24?	12	285	14:13	4335.67	6731.16	biomaper at surface change file !S2851415
285.615	43.546	67.525	42	26	24?	12	285	14:46	4332.78	6731.48	biomaper at 208m begin up
285.633	43.517	67.538	42	26	24?	12	285	15:12	4331.02	6732.29	drag on winch - possible snag with lobster trap...
285.638	0.000	0.000	42	26	24?	12	285	15:19			...check-out okay; disable ducers and check in-air switch
285.642	43.510	67.542	42	27	25	12	285	15:24	4330.58	6732.50	biomaper restarted at surface new file !S2851525 new DAT tape #27
285.646	43.504	67.545	42	27	25	12	285	15:30	4330.23	6732.71	biomaper begin down

285.660	43.478	67.558	42	27	25	12	285	15:51	4328.69	6733.47	TOWYO UP from 200 meters
285.675	43.450	67.568	42	27	25	12	285	16:12	4327.00	6734.10	SCR CAP begin S2851525, change to D drive for data
285.685	0.000	0.000	42	27	25	12	285	16:27			Restart software/data acq. begin S2851627, TOWYO DOWN from surface
285.714	43.372	67.606	42	27	25	12	285	17:08	4322.34	6736.36	TOWYO UP from 200/226
285.728	43.345	67.621	42	28	26	12	285	17:29	4320.69	6737.27	Changed VPR and DAT tapes- last 15 min VPR missing
285.733	43.339	67.624	42	28	26	12	285	17:36	4320.35	6737.44	TOWYO DOWN from termination at surf. SCRCAP, begin S2851738
285.756	43.302	67.643	42	28	26	12	285	18:09	4318.10	6738.59	TOWYO UP from 217/247
285.774	43.267	67.650	42	28	26	12	285	18:35	4316.00	6739.00	TOWYO DOWN begin S2851838
285.792	43.239	67.683	42	28	26	12	285	19:01	4314.34	6740.95	TOWYO UP from 200/230
285.808	43.228	67.703	42	28	26	12	285	19:24	4313.70	6742.18	Surface tow to #9 (9.6 meters on 43kHz)
285.810	43.229	67.705	42	29	27	12	285	19:26	4313.72	6742.30	Tape Swaps, TOWYO DOWN interrupt in data file begin S2851935
285.827	43.231	67.748	42	29	27	12	285	19:51	4313.85	6744.86	TOWYO UP 190/220
285.840	43.231	67.776	42	29	27	12	285	20:09	4313.84	6746.53	top of towyo ascent seaweed check...
285.843	0.000	0.000	42	29	27	12	285	20:14			...s2851935 close open s2852014
285.844	43.232	67.822	42	29	27	12	285	20:16	4313.89	6749.34	bottom of towyo
285.879	43.233	67.872	42	29	27	12	285	21:06	4313.95	6752.30	top of ascent new file s2852110
285.890	0.000	0.000	42	29	27	12	285	21:22			re-boot monitor computer (ground fault monitor) new file s2852131
285.901	0.000	0.000	42	30	28	12	285	21:38			vpr tape #28 and DAT tape #30 stoped decent at 2120h contiued at 2147h
285.913	43.235	67.967	42	30	28	12	285	21:55	4314.12	6758.04	bottom 177m
285.925	43.236	67.994	42	30	28	12	285	22:12	4314.17	6759.64	top of ascent close s2852131 new file 2852214
285.947	43.238	68.043	42	30	28	12	285	22:43	4314.25	6802.56	BOTTOM OF towyo big patches of critters at 03:04:10 UCT
285.965	43.238	68.086	42	30	28	12	285	23:09	4314.30	6805.18	top of ascent open new file s2852311
285.981	43.239	68.127	42	30	28	12	285	23:33	4314.37	6807.60	bottom of towyo
285.987	43.239	68.144	42	31	29	12	285	23:41	4314.34	6808.63	new vpr tape #29 new dat tape #31
286.002	43.256	69.166	42	31	29	13	286	00:03	4315.34	6909.96	top of ascent stop towyo for testing stop tapes (vpr 29, DAT 31)
286.010	43.238	68.173	43	-----	-----	13	286	00:14	4314.28	6810.39	compass calibration/ noise assessments no tapes software reset to pulse from chirp
286.115	0.000	0.000	44	-----	-----	13	286	02:45			BIOMAPER back on board
286.712	0.000	0.000	49	31	29	13	286	17:05			BIOMAPER redeployed; powered up
286.728	42.984	69.919	49	31	29	13	286	17:29	4259.05	6955.12	BIOMAPER file S2861727
286.751	42.984	69.919	49	31	29	13	286	18:01	4259.05	6955.12	HTI program locked - rebooted new file S2861801
286.760	42.931	69.919	49	31	29	13	286	18:15	4255.87	6955.13	bottom of towyo
286.785	42.884	69.918	49	31	29	13	286	18:51	4253.04	6955.05	top of towyo
286.787	0.000	0.000	49	31	29	13	286	18:53			closed file S2861801
286.792	0.000	0.000	49	31	29	13	286	19:00			started file BM2_016.pro + M2_016.raw
286.801	0.000	0.000	49	31	29	13	286	19:13			end DAT tape 31
286.804	0.000	0.000	49	32	30	13	286	19:18			start DAT tape 32 start VPR tape 30
286.809	0.000	0.000	49	32	30	13	286	19:25			offset about 4 meters as BMP turned from 9 to 12
286.813	42.831	69.909	49	32	30	13	286	19:31	4249.85	6954.54	S2861902 make turn to transect leg 2 Wilkinson Basin note surface sadata at top of file
286.839	42.812	69.854	49	32	30	13	286	20:08	4248.70	6951.22	bottom of towyo
286.842	42.809	69.838	49	32	30	13	286	20:13	4248.54	6950.26	HTI locked up Open new file S2862051
286.858	42.798	69.810	49	32	30	13	286	20:36	4247.88	6948.60	top of towyo
286.879	42.782	69.762	49	32	30	13	286	21:06	4246.95	6945.73	bottom of towyo descent
286.881	0.000	0.000	49	32	30	13	286	21:08			end S2863108 begin S2862108
286.882	0.000	0.000	49	32	30	13	286	21:10			error communication cannot connect to DES
286.882	0.000	0.000	49	32	30	13	286	21:10			came up to 160m
286.889	0.000	0.000	49	32	30	13	286	21:20			restart collect data communication software
286.890	0.000	0.000	49	33	30	13	286	21:21			start new file S286118 start VPR tape 31
286.892	0.000	0.000	49	33	31	13	286	21:24			start DAT tape 33
286.903	42.758	69.701	49	33	31	13	286	21:40	4245.49	6942.06	top of towyo
286.913	42.749	69.675	49	33	31	13	286	21:55	4244.94	6940.47	stop winch for squeeky bearings at 94m
286.932	42.732	69.624	49	33	31	13	286	22:22	4243.93	6937.43	bottom of towyo
286.958	42.710	69.561	49	33	31	13	286	22:59	4242.61	6933.64	top of towyo end file S286118 begin file S2862300
286.978	0.000	0.000	49	33	32	13	286	23:28			new VPR tape
286.979	0.000	0.000	49	34	32	13	286	23:30			new DAT tape
286.984	42.682	69.487	49	34	32	13	286	23:37	4240.94	6929.22	225 bottom of towyo
287.002	42.667	69.443	49	34	32	14	287	00:03	4240.00	6926.58	top of towyo close file S2862300 mocness started
287.002	0.000	0.000	49	-----	-----	14	287	00:03			open file S2870005
287.015	0.000	0.000	49	-----	-----	14	287	00:22			VPR and DAT tape turned off
287.099	42.603	69.294	49	34	32	14	287	02:22	4236.16	6917.63	5 knots, TOWYO DOWN still on S2870005, surface data at top no tape
287.116	0.000	0.000	49	34	32	14	287	02:47			4 knots, at 100 meters
287.125	42.581	69.226	49	34	32	14	287	03:00	4234.87	6913.56	TOWYO UP BIO_ENG locked up at 02:33 data ok
287.138	42.573	69.195	49	34	32	14	287	03:19	4234.38	6911.70	5 knots
287.149	42.563	69.168	49	35	33	14	287	03:34	4233.78	6910.05	TOWYO surfaces, new file, new Tapes, software rebooted, BIO_ENG and fish restarted, powered up
287.160	0.000	0.000	49	35	33	14	287	03:50			begin S2870350;
287.163	42.549	69.130	49	35	33	14	287	03:54	4232.96	6907.77	TOWYO DOWN
287.176	0.000	0.000	49	35	33	14	287	04:14			4knots, bmp at 100 meters
287.183	42.531	69.080	49	35	33	14	287	04:24	4231.83	6904.82	TOWYO UP
287.191	0.000	0.000	49	35	33	14	287	04:35			5knots
287.201	0.000	0.000	49	35	33	14	287	04:50			coming up
287.202	42.514	69.037	49	35	33	14	287	04:51	4230.82	6902.20	back to surface
287.204	0.000	0.000	49	35	33	14	287	04:54			TOWYO DOWN
287.219	0.000	0.000	49	35	33	14	287	05:16			4knots
287.229	0.000	0.000	49	35	33	14	287	05:30			TOWYO UP from 183/222
287.231	42.492	68.976	49	35	33	14	287	05:32	4229.51	6858.58	TOWYO ACTUALLY UP, 200/222
287.244	42.483	68.948	49	36	34	14	287	05:52	4228.96	6856.90	TAPE CHANGE
287.252	42.478	68.935	49	36	34	14	287	06:03	4228.67	6856.11	TOP again, reboot bioeng, (locked up with calculator running?)
287.258	0.000	0.000	49	36	34	14	287	06:12			begin S2870611

287.265	0.000	0.000	49	36	34	14	287	06:22			BIOESS restarts on umpteenth try
287.268	42.465	68.898	49	36	34	14	287	06:26	4227.92	6853.88	Start new towyo down (S2870611)
287.296	42.449	68.842	49	36	34	14	287	07:06	4226.94	6850.50	Bottom of towyo
287.315	42.435	68.824	49	36	34	14	287	07:34	4226.07	6849.44	Top of towyo. Close File S2870611
287.318	42.437	68.821	49	36	34	14	287	07:38	4226.22	6849.24	New File Started S2870737
287.331	42.427	68.787	49	37	35	14	287	07:57	4225.63	6847.19	Tape Change DAT/VPR
287.333	0.000	0.000	49	37	35	14	287	08:00			Hold Fish near surface while waiting for turn.
287.347	42.415	68.751	49	37	35	14	287	08:19	4224.88	6845.07	Begin descent.
287.354	42.394	68.750	49	37	35	14	287	08:30	4223.65	6845.01	Bottom of towyo. Begin ascent. Very shallow <200m to bottom.
287.365	42.378	68.750	49	37	35	14	287	08:46	4222.69	6845.02	Top of ascent. 5m from surface.
287.367	0.000	0.000	49	37	35	14	287	08:48			Close File S2870737. Open S2870848.
287.376	42.358	68.750	49	37	35	14	287	09:01	4221.45	6845.02	Bottom of descent 180m.
287.389	42.336	68.750	49	37	35	14	287	09:20	4220.14	6845.01	Top of ascent.
287.403	422.460	68.748	49	37	35	14	287	09:40	42187.60	6844.88	Bottom of descent 190m.
287.413	0.000	0.000	49	38	36	14	287	09:55			Start VPR tape 36 and DAT tape 38.
287.419	42.285	68.747	49	38	36	14	287	10:03	4217.08	6844.79	Close File S2870848. Open File S2871003.
287.431	0.000	0.000	49	38	36	14	287	10:20			VPR something stuck on film...Fishing Line?
287.431	42.264	68.745	49	38	36	14	287	10:21	4215.85	6844.68	Bottom of towyo 189m.
287.442	42.249	68.749	49	38	36	14	287	10:37	4214.96	6844.92	Top of ascent. Hold at surface for CTD. Check what's on VPR. VPR item clears itself.
287.443	0.000	0.000	49	38	36	14	287	10:38			Turn off VPR and DAT tapes for CTD.
287.444	0.000	0.000	49	38	36	14	287	10:39			Close File S2871003. Stop recording for CTD.
287.450	42.247	68.749	49	38	36	14	287	10:48	4214.84	6844.91	CTD deployed.
287.467	42.245	68.752	49	38	36	14	287	11:12	4214.72	6845.10	CTD recovered.
287.472	42.251	68.744	49	38	36	14	287	11:20	4215.07	6844.64	Radiometer depolyed.
287.494	42.260	68.745	49	38	36	14	287	11:51	4215.60	6844.69	Radiometer recovered.
287.499	42.263	68.750	49	38	36	14	287	11:58	4215.76	6845.01	TOWYO DOWN after CTD and Radiometer; no bmp data during station;
287.511	0.000	0.000	49	38	36	14	287	12:16			fish diving under hull though wind on stbd. course change to 350; wave packet/soliton pass through
287.519	0.000	0.000	49	38	36	14	287	12:28			course change another 10 degrees
287.552	42.359	68.817	49	38	36	14	287	13:15	4221.52	6849.03	TOWYO BACK TO SURFACE, new files starting
287.558	42.359	68.817	49	39	37	14	287	13:23	4221.52	6849.03	begin S2871322
287.567	42.361	68.842	49	39	37	14	287	13:37	4221.63	6850.53	TOWYO DOWN
287.585	42.381	68.865	49	39	37	14	287	14:02	4222.87	6851.87	TOWYO UP
287.600	42.401	68.846	49	39	37	14	287	14:24	4224.09	6850.78	TOWYO BACK TO SURFACE for MOC
287.604	42.403	68.840	49	39	37	14	287	14:30	4224.17	6850.38	begin S2871430
287.685	42.416	68.737	49	-----	-----	14	287	16:26	4224.93	6844.23	paused, no tape change, started data tranfer
287.686	42.416	68.737	49	-----	-----	14	287	16:28	4224.93	6844.22	took out tapes 39 and 37, new tapes not started; data transfer and steam back to track from MOC end.
287.755	42.418	68.952	49	40	38	14	287	18:07	4225.08	6857.14	Begin S2871809, start tapes, TOWYO DOWN at 5.5knots, drop to 4.5 at 100meters depth
287.785	0.000	0.000	49	40	38	14	287	18:50			TOWYO UP from 185/204
287.797	0.000	0.000	49	40	38	14	287	19:08			back to 5.5knots at 100 meters
287.810	42.418	69.106	49	40	38	14	287	19:27	4225.08	6906.33	TOWYO at SURFACE, begin S2871928, Low T layer at 150 meters, resync VPR,
287.813	0.000	0.000	49	40	38	14	287	19:30			TOWYO DOWN at 5.5 knots
287.829	0.000	0.000	49	40	38	14	287	19:54			drop to 4.5 knots
287.836	42.418	69.186	49	40	38	14	287	20:04	4225.06	6911.15	TOWYO UP
287.842	42.417	69.202	49	41	39	14	287	20:12	4225.01	6912.09	Change VPR and DAT to 39 and 41 respectively
287.854	0.000	0.000		41	39	14	287	20:30			Winch OVERHEATING (135 degrees)... due to faster tow?
287.857	42.424	69.245	49	41	39	14	287	20:34	4225.41	6914.71	Top of ascent
287.860	42.427	69.253	49	41	39	14	287	20:38	4225.60	6915.20	Winch temp 135F. Hold at 30m to check winch.
287.869	42.436	69.280	49	41	39	14	287	20:52	4226.16	6916.79	Bring fish to sfc to evaluate winch temp prob.
287.872	42.439	69.289	49	41	39	14	287	20:56	4226.36	6917.33	Tow fish at sfc
287.906	42.476	69.385	49	41	39	14	287	21:44	4228.56	6923.10	Winch temp 120F. Begin towyo down. Active VPR screen.
287.917	42.487	69.415	49	41	39	14	287	22:01	4229.20	6924.88	Active VPR screen still.
287.928	42.494	69.437	49	42	40	14	287	22:16	4229.63	6926.24	Change DAT/VPR tapes.
287.938	42.501	69.458	49	42	40	14	287	22:30	4230.08	6927.47	Bottom of towyo descent.
287.963	42.521	69.516	49	42	40	14	287	23:06	4231.26	6930.94	Top of towyo. Start new file: S2872306. Winch 140F keep towyoing.
287.989	42.540	69.571	49	42	40	14	287	23:44	4232.42	6934.24	Bottom of descent. Begin ascent.
288.010	42.556	69.610	49	43	41	15	288	00:15	4233.36	6936.59	towyo at surface - kept at surface
288.013	42.556	69.610	49	43	41	15	288	00:19	4233.36	6936.59	new DAT tape # 43, VPR tape #41
288.021	42.556	69.610	49	43	41	15	288	00:30	4233.36	6936.59	begin record, begin down cast file S2880030
288.052	42.587	69.691	49	43	41	15	288	01:15	4235.23	6941.48	bottom of towyo begin up
288.076	42.604	69.733	49	43	41	15	288	01:49	4236.24	6943.97	top of towyo stop S2880154
288.079	42.607	69.743	49	43	41	15	288	01:54	4236.42	6944.55	begin down cast S2880154
288.106	42.629	69.803	49	43	41	15	288	02:32	4237.74	6948.19	bottom of towyo begin up
288.108	42.631	69.809	49	43	41	15	288	02:36	4237.87	6948.53	new DAT tape #43, VPR tape #42
288.130	42.645	69.855	49	44	42	15	288	03:07	4238.72	6951.28	top of towyo - begin run at surface
288.154	42.664	69.916	49	44	42	15	288	03:42	4239.81	6954.99	end file S2880154, shut down system and transect south to next turning point
288.226	0.000	0.000	49	-----	-----	15	288	05:25			leg 16 to 17, start file S2880545 @6knots,
288.237	42.484	69.865	49	44	42	15	288	05:41	4229.06	6951.88	starting up ESS and sonar, trying to get software running
288.408	42.480	69.853	49	44	42	15	288	09:47	4228.78	6951.16	TOWYO DOWN 5knots
288.256	0.000	0.000	49	44	42	15	288	06:08			100 meters, 4knots
288.261	0.000	0.000	49	44	42	15	288	06:16			Layer just off bottom on 43 and 120, 10 meters thick, T min at 80 meters
288.272	0.000	0.000	49	44	42	15	288	06:32			begin S2880632 after: hold off on winch, sonar off ??? button hit on mouse, restarting software, depth from bridge 134 fathoms, flat line until restart to get pulse
288.278	42.454	69.774	49	45	43	15	288	06:41	4227.22	6946.46	change tapes, descending at 6.4 meters/min
288.285	42.441	69.761	49	45	43	15	288	06:51	4226.43	6945.65	TOWYO UP
288.306	0.000	0.000	49	45	43	15	288	07:20			5 knots, 100 meters
288.315	42.428	69.701	49	45	43	15	288	07:33	4225.67	6942.07	TOWYO at surface
288.317	42.426	69.695	49	45	43	15	288	07:37	4225.58	6941.70	begin S2880736 TOWYO DOWN

288.333	0.000	0.000	49	45	43	15	288	08:00			down to 4knots
288.345	42.404	69.635	49	45	43	15	288	08:17	4224.23	6938.07	Bottom of towyo. 220/250m. Begin ascent.
288.358	42.394	69.609	49	45	43	15	288	08:36	4223.63	6936.55	Patch on VPR at 60m.
288.364	42.389	69.595	49	46	44	15	288	08:44	4223.35	6935.71	Close file. Open file: S2880844. Top of ascent. Change VPR/DAT tapes.
288.388	42.370	69.541	49	46	44	15	288	09:18	4222.22	6932.44	Bottom of descent. 222/240m. Begin ascent.
288.402	42.359	69.511	49	46	44	15	288	09:39	4221.53	6930.64	Patch on VPR at 100m.
288.410	42.353	69.488	49	46	44	15	288	09:51	4221.18	6929.28	Top of ascent. Close file: S2880844. Open file: S2880951.
288.417	42.354	69.469	49	46	44	15	288	10:00	4221.26	6928.14	Stop descent at 50m. Start fish to sfc.
288.420	42.351	69.458	49	46	44	15	288	10:05	4221.06	6927.48	Hold fish at sfc. to get back on course. Steam to waystop #17.
288.425	42.346	69.445	49	46	44	15	288	10:12	4220.74	6926.71	Bringing speed to 8 knots.
288.451	42.301	69.336	49	47	45	15	288	10:50	4218.08	6920.14	New DAT/VPR tapes (probably missed a couple of minutes.) Winch temp 115F.
288.469	42.273	69.259	49	47	45	15	288	11:15	4216.41	6915.51	Close file: S2880951. Stop DAT/VPR tapes.
288.477	42.277	69.259	49	47	45	15	288	11:27	4216.63	6915.57	BIOMAPER recovered.
288.000	0.000	0.000		47	45	15	288	00:00			
288.624	42.088	69.223		47	45	15	288	14:58	4205.28	6913.41	Begin S2881453, ducers soaped, vpr cleaned, bmp redeployed, rebooted
288.627	42.098	69.232		47	45	15	288	15:03	4205.88	6913.90	Begin S2881502 to change interval duration in seq. summ. from 0.5 to 0.17
288.628	0.000	0.000		47	45	15	288	15:05			changes did not take effect, see 16:44 entry
288.631	42.095	69.241		47	45	15	288	15:08	4205.71	6914.44	Begin S2881507try again with interval duration at 0.167...bmp at surface, waiting
288.635	42.099	69.250		47	45	15	288	15:15	4205.96	6915.02	TOWYO DOWN
288.667	42.126	69.316		47	45	15	288	16:01	4207.57	6918.96	Dat tape not recording (on pause), now 1 hour out of sync with vpr
288.670	0.000	0.000		47	45	15	288	16:05			TOWYO UP Begin S2881613, SCRCAP
288.674	0.000	0.000		47	45	15	288	16:10			TOWYO DOWN
288.685	0.000	0.000		47	46	15	288	16:26			VPR tape change
288.691	0.000	0.000		47	46	15	288	16:35			spd to 4 knots
288.695	42.155	69.368		47	46	15	288	16:41	4209.30	6922.09	TOWYO UP from 156/186
288.702	0.000	0.000		47	46	15	288	16:51			5knots
288.706	0.000	0.000		47	46	15	288	16:57			bottom coming up dramatically under us on way up
288.711	0.000	0.000		47	46	15	288	17:04			TOWYO at SURFACE, changing ping interval again, need to push add button, and delete other seq.
288.712	42.172	69.422		47	46	15	288	17:05	4210.33	6925.30	Begin S2881705
288.730	42.191	69.469		47	46	15	288	17:31	4211.48	6928.13	Begin S2881729/fix interval duration to .167 seconds
288.736	42.199	69.486		48	46	15	288	17:40	4211.91	6929.16	dat tape change
288.749	0.000	0.000		48	46	15	288	17:59			TOWYO UP from 200/225 moon rise
288.754	0.000	0.000		48	46	15	288	18:06			software crashed, 541 seconds behind due to interval shortening, stopped, winch being repaired too
288.757	42.223	69.526		48	46	15	288	18:10	4213.37	6931.56	Begin S2881810, restart with 30 second integrations
288.768	42.246	69.530		48	46	15	288	18:26	4214.76	6931.80	CRASH and RESTART, begin S2881826
288.776	42.270	69.525		48	47	15	288	18:38	4216.22	6931.50	VPR tape change
288.778	42.271	69.525		48	47	15	288	18:40	4216.25	6931.52	TOWYO to surface
288.781	42.275	69.535		48	47	15	288	18:45	4216.47	6932.12	Return to tract and start to 50 meters with wire checks by bridge
288.783	0.000	0.000		48	47	15	288	18:48			25 meters, wire ok
288.786	0.000	0.000		48	47	15	288	18:52			50 meters, wire ok
288.790	0.000	0.000		48	47	15	288	18:57			75 meters, wire ok
288.792	42.279	69.565		48	47	15	288	19:00	4216.72	6933.87	90 meters, TOWYO UP (wire not ok, headed under ship)
288.797	0.000	0.000		48	47	15	288	19:07			50 meters
288.801	0.000	0.000		48	47	15	288	19:14			15 meters
288.802	42.282	69.602		48	47	15	288	19:15	4216.90	6936.10	TOWYO DOWN, ctenophores, SCRCAPa
288.808	42.283	69.613		48	47	15	288	19:24	4217.00	6936.80	50 meters
288.813	42.285	69.626		48	47	15	288	19:31	4217.08	6937.56	80 meters
288.824	42.289	69.660		48	47	15	288	19:47	4217.33	6939.59	sit @surface, SCRCAP
288.826	42.289	69.664		48	47	15	288	19:49	4217.35	6939.82	Begin S2881949, down to 210 meters
288.851	42.298	69.741		48	47	15	288	20:26	4217.89	6944.46	TOWYO UP
288.861	42.302	69.765	63	49	48	15	288	20:40	4218.14	6945.91	Top of ascent. Came out of water. New VPR Tape. Hold at sfc for turn to south. Close file S2881949. Open file S2882043.
288.866	42.298	69.770	63	49	48	15	288	20:47	4217.85	6946.21	Turn on new course for turning point 20. Commencing tow. Large surface patch.
288.883	42.274	69.767	63	49	48	15	288	21:12	4216.44	6946.00	Begin ascent at 220m.
288.900	42.244	69.761	63	49	48	15	288	21:36	4214.64	6945.69	Top of ascent. Begin back down.
288.907	42.231	69.761	63	50	49	15	288	21:46	4213.88	6945.63	Replace DAT/VPR tapes to get tapes in sync. ~1 hour left on VPR tape.
288.919	42.214	69.759	63	50	49	15	288	22:03	4212.84	6945.54	Bottom of descent. 210/235m.
288.938	42.179	69.755	63	50	49	15	288	22:30	4210.75	6945.32	Errors @ 35m.
288.000	0.000	0.000	63	50	49	15	288				"Problems Encountered in Sending Stop Processing Command."
288.000	0.000	0.000	63	50	49	15	288				"Problems Getting Data from Echo Sounder."
288.000	0.000	0.000	63	50	49	15	288				"The System has been disabled. Check the Sounder-PC Network Connections."
288.000	0.000	0.000	63	50	49	15	288				Fish came out too high.
288.941	42.172	69.754	63	50	49	15	288	22:35	4210.31	6945.24	Exit program. Restart program. (Must have also started new file here.)
288.942	42.168	69.754	63	50	49	15	288	22:37	4210.11	6945.21	Start towyo down.
288.958	42.141	69.751	63	50	49	15	288	23:00	4208.44	6945.04	Bottom of towyo 194/215m.
288.971	42.122	69.748	63	50	49	15	288	23:18	4207.31	6944.87	Top of ascent. End File. Start New File: S2882319.
288.982	42.131	69.750	63	51	50	15	288	23:34	4207.86	6945.00	Change tapes. Start towyo down. (~15 minutes left on tapes.)
288.997	42.120	69.715	63	51	50	15	288	23:56	4207.22	6942.89	Bottom of towyo 195/220m.
289.008	42.111	69.693	63	51	50	16	289	00:11	4206.69	6941.57	Locked up the processing program-- REBOOT
289.015	42.106	69.679	63	51	50	16	289	00:21	4206.37	6940.74	begin S2890020
289.068	42.081	69.617	63	52	51	16	289	01:38	4204.85	6937.00	change DAT and VPR tapes
289.097	42.065	69.576	63	52	51	16	289	02:19	4203.91	6934.58	Moc on board
289.097	0.000	0.000	63	52	51	16	289	02:19			begin S2890221 TOWYO DOWN
289.126	42.036	69.499	63	52	51	16	289	03:01	4202.14	6929.95	TOWYO UP
289.147	42.013	69.442	63	52	51	16	289	03:32	4200.79	6926.54	TOWYO at surface
289.149	0.000	0.000	63	53	52	16	289	03:35			new DAT and VPR tapes
289.167	41.990	69.386	63	53	52	16	289	04:00	4159.43	6923.19	TOWYO UP
289.188	41.965	69.342	63	53	52	16	289	04:31	4157.91	6920.50	TOWYO AT SURFACE, begin S2890434
289.190	41.963	69.335	63	53	52	16	289	04:34	4157.78	6920.10	TOWYO DOWN to 75 meters

289.212	41.945	69.278	63	53	52	16	289	05:05	4156.69	6916.69	END TOWYO at 90 meters
289.239	41.921	69.211	63	53	52	16	289	05:44	4155.26	6912.66	END TOWYO from 90 meters down, close file bmp at 7 meters for transit
289.241	0.000	0.000	63	53	52	16	289	05:47			Begin S2890546
289.243	0.000	0.000	63	54	53	16	289	05:50			restarted tapes
289.247	0.000	0.000	63	54	53	16	289	05:56			Start turn, steam with fish at 7 meters toward SOLITON SURVEY (13 and 14)
289.278	0.000	0.000	63	54	53	16	289	06:40			Suns coming up, dat tapes running out.
289.296	42.032	69.102	63	54	53	16	289	07:06	4201.93	6906.14	Software locked up ð REBOOT, power down sonar
289.299	0.000	0.000	63	54	53	16	289	07:11			restart processing
289.325	42.090	69.048	63	54	53	16	289	07:48	4205.42	6902.86	wave structures and layers at 15, 130, 160 meters under fish
289.327	0.000	0.000	63	55	54	16	289	07:51			change VPR and DAT tapes
289.365	0.000	0.000	63	55	54	16	289	08:45			bottom dropping off with strong sSSC paralleling dropoff
289.417	42.269	68.885	63	56	55	16	289	10:00	4216.13	6853.07	tape change (bit late) lots of salps and siphns 15:10:00
289.501	42.414	68.750	63	57	56	16	289	12:02	4224.84	6844.99	tape change, at turn pt. 13, begin S2891201
289.523	42.416	68.749	63	57	56	16	289	12:33	4224.94	6844.91	total system RESTART after powerdown begin S2891240
289.585	42.431	68.733	63	58	57	16	289	14:02	4225.85	6843.98	tape change at turn pt. 13
289.650	42.336	68.679	63	58	57	16	289	15:36	4220.16	6840.75	BMP at surface in mid-SOLITON wave packet
289.667	42.311	68.667	63	58	57	16	289	16:00	4218.68	6840.01	turn 180 degrees to resample SOLITON
289.672	42.311	68.671	63	59	58	16	289	16:08	4218.68	6840.27	tape change begin S2891607, BMP to 50 meters
289.692	42.346	68.687	63	59	58	16	289	16:37	4220.75	6841.25	coming up on SOLITON again BMP@50 meters (47-56 meters) T structure from 15 at surface to 4 at 50 meters
289.697	42.456	68.692	63	59	58	16	289	16:44	4221.36	6841.53	Bridge RADAR: propagation wave packet at 310 degrees, 5 packets ahead
289.754	42.462	68.747	63	59	58	16	289	18:06	4227.35	6844.84	end of packet
289.756	42.486	68.751	63	60	59	16	289	18:08	4227.70	6845.03	tape replenishment
289.771	42.506	68.763	63	60	59	16	289	18:30	4229.17	6845.79	TOWYO DOWN from 50 meters
289.783	ERR	68.772	63	60	59	16	289	18:47	4230.37	6846.34	TOWYO UP from 171/200 (copepods deep)
289.786	0.000	0.000	63	60	59	16	289	18:52			wire rattling against hull; course mod.
289.790	0.000	0.000	63	60	59	16	289	18:58			45 meters siphonophore layer
289.794	42.527	68.782	63	60	59	16	289	19:03	4231.62	6846.92	TOWYO SURFACES, goes to 5 meters for 180 degree turn to track @25 meters
289.798	42.532	68.778	63	60	59	16	289	19:09	4231.90	6846.66	TURN to 139
289.800	42.529	68.775	63	60	59	16	289	19:12	4231.74	6846.48	begin S2891912, SCR CAP, TOWYO DOWN to 25 meters
289.838	42.476	68.756	63	60	59	16	289	20:06	4228.57	6845.34	approaching SOLITON, RADAR can see, we're on one, one ahead
289.843	42.470	68.751	63	61	62	16	289	20:14	4228.21	6845.04	tape change
289.938	0.000	0.000	63	62	61	16	289	22:30			late tape change
289.951	42.512	68.773	63	62	61	16	289	22:50	4230.70	6846.35	BMP on board, steaming for WHOI