R/V *New Horizon* Cruise #1208 'Ocean Acidification Pteropod Study' Cruise Report

NH1208a: August 9 – August 21, 2012

NH1208b: August 26 – September 18, 2012

Report prepared by Gareth Lawson, Peter Wiebe, Aleck Wang, Andone Lavery, Amy Maas, Nancy Copley, Leocadio Blanco Bercial, Katherine Hoering, Tom Bolmer, Alexander Bergan, Sophie Chu, Liza Roger, and Taylor Crockford.

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Biological and Chemical Oceanography Data Management Office
Woods Hole Oceanographic Institution
Woods Hole, MA 02543
http://bcodmo.org/

NSF Ocean Acidification Program Grant # OCE-1041068 (PIs: Lawson, Lavery, Wang, Wiebe)
"*Horizontal and Vertical Distribution of Thecosome Pteropods in Relation to Carbonate Chemistry in the Northwest Atlantic and Northeast Pacific*"

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1. Acknowledgements

The success of this cruise would not have been possible without the outstanding efforts of Captain Ian Lawrence and the New Horizon's officers and crew, and we are very appreciative of their hard work. Ed Lagrasso and Oscar Buan's work in the galley was particularly appreciated. Likewise, the excellent support of our Resident Technicians Meghan Donohue, John Calderwood, and Dan Schuller was indispensable to the success of the cruise. A strong sense of camaraderie and collaboration among scientists and crew pervaded. We are also grateful for the efforts of the SIO Ship Operations and Marine Technical Support groups prior to and following the cruise with respect to planning, logistics, and installing all equipment. This cruise was supported by NSF grant OCE-1041068.

2. Background

The impact of ocean acidification on marine ecosystems represents a vital question facing both marine scientists and managers of ocean resources. Thecosome pteropods are a group of calcareous planktonic molluscs widely distributed in coastal and open ocean pelagic ecosystems of the world's oceans. These animals secrete an aragonite shell and thus are highly sensitive to ocean acidification due to the water column's changing carbonate chemistry, and particularly the shoaling of the aragonite compensation depth at which seawater becomes corrosive to aragonite. In many regions, however, relatively little is known about the abundance, distribution, vertical migratory behavior, and ecological importance of pteropods. Assessing the likely ecosystem consequences of changes in pteropod dynamics resulting from ocean acidification will require a detailed understanding of pteropod distribution and abundance relative to changing aragonite saturation in the water column.

The primary objective of this project is to quantify the distribution, abundance, species composition, shell condition, and vertical migratory behavior of oceanic thecosome pteropods in the northwest Atlantic and northeast Pacific, and correlate these quantities to hydrography and concurrent measurements of carbonate chemistry, including vertical and horizontal distributions of aragonite saturation. In particular, the project is capitalizing on present-day variability in the depth distribution of aragonite saturation levels within and between the Atlantic and Pacific Oceans as a 'natural experiment' to address the hypotheses that pteropod vertical distribution, species composition, and abundance vary as the compensation depth becomes shallower. Secondary objectives are to develop acoustic protocols for the remote quantification

of pteropod abundance for future integration into ocean acidification monitoring networks, and to characterize carbonate chemistry and nutrients along portions of two WOCE/CLIVAR Repeat Hydrography transects (A20 in the Atlantic and P17N in the Pacific) to identify decadal-scale changes in the carbonate system.

To this end, our inter-disciplinary team has conducted two cruises along survey transects between 35 and 50°N in the northwest Atlantic (2011 cruise) and northeast Pacific (2012 cruise) involving a combination of station-work and underway measurements, and a comprehensive array of instruments, including acoustic, optical, net, hydrographic, and carbonate chemistry sensors. The first project cruise took place from August 7 – September 1, 2011, on the R/V *Oceanus*. The second project cruise, described in this report, was on the R/V *New Horizon* and occurred in two legs: NH1208a, from August 9 – August 21 and NH1208b, from August 26 – September 18, 2012. This is an NSF-funded project with WHOI scientists Gareth Lawson, Zhaohui 'Aleck' Wang, Peter Wiebe, and Andone Lavery as PIs.

3. Cruise Objectives

The central goal of this cruise was to sample various aspects of the biology of pteropods and other associated zooplankton concurrent to sampling of the carbonate chemistry system and hydrography, both along-track and at pre-defined stations along a survey transect extending from 50N, 150W to 35N, 135W. The specific objectives included:

1. To survey hydrographic conditions via underway sampling systems and a CTD rosette at a series of 31 pre-defined stations.
2. To sample the carbonate system along-track using underway sampling systems for surface *f*CO2, air *p*CO2, pH, and Dissolved Inorganic Carbon (DIC).
3. To sample the carbonate system and associated chemical conditions at stations via Niskin bottle sampling and shipboard analyses of pH, DIC, alkalinity, nutrients, salinity, and dissolved oxygen.
4. To conduct tows with a Multiple Opening/Closing Net and Environmental Sensing System (MOCNESS) during both daytime and nighttime at select stations to quantify the vertical and horizontal distribution and abundance of pteropods and other zooplankton.
5. To conduct Video Plankton Recorder (VPR) casts at all stations, and during both daytime and nighttime at select stations, to quantify the vertical and horizontal distribution and abundance of pteropods and other zooplankton.
6. To conduct Reeve net tows to capture live animals for respirometry studies, photography, gene expression studies, and analyses of shell composition.
7. To preserve net samples of pteropods and other zooplankton for later analyses of taxonomic composition (formalin), shell condition (70% ethanol), DNA barcoding (70 or 95% ethanol), and gene expression (flash freezing in liquid nitrogen).
8. To collect multi-frequency acoustics continuously along-track and at stations to characterize the distribution of zooplankton, ideally including pteropods, across spatial scales.
9. To collect broadband acoustic data via profiles at multiple stations and small-scale surveys at select stations, in order to assess the utility of such data for providing enhanced information on the taxonomic composition of scatterers present, and ideally enhanced information on the abundance and distribution of pteropods.

4. Survey Design

The majority of survey activities took place along a line running between 50N 150W and 33.5N 135W in the Northeast Pacific (Figs 4.1, 4.2), corresponding to a segment of CLIVAR/WOCE line P17N. The

original survey design called for ‘regular’ stations every 1/2 degree of latitude and ‘day-night’ stations every 2 degrees, starting at Station #1 (at 50N).

Upon arriving at the first station, however, issues with the MOCNESS led it to be changed to a regular station and Station #2 to a day-night station. Mid-way through the daytime activities at Station #2, the vessel blew a generator, which required an immediate return to port for emergency repairs. Upon resuming the survey 15 days later, Station #3 was made a day-night station and subsequent day-night stations were conducted every 2 degrees of latitude, until later in the survey when favorable weather and timely progress allowed the separation between day-night stations to be decreased to 1.5 degrees and then to 1 degree. Time savings also allowed the survey transect to be extended southwards to 33.5N (from the planned 35N) and a total of 34 stations were completed, exceeding the planned 31.

The main survey line was divided into two sub-sections: Transect 1 running towards the southeast from 50N 150W to 41N 135W and Transect 4 running towards the southeast from 41N 135W to 33.5N 135W. The initial transit from the port of departure, Newport, Oregon, to the survey start was designated Transect 0. The transit to Newport for generator repairs and then the return to the survey line were designated Transects 2 and 3, respectively. The final transit from the survey’s end-point to the cruise end port of Port Hueneme, California, was designated Transect 5.

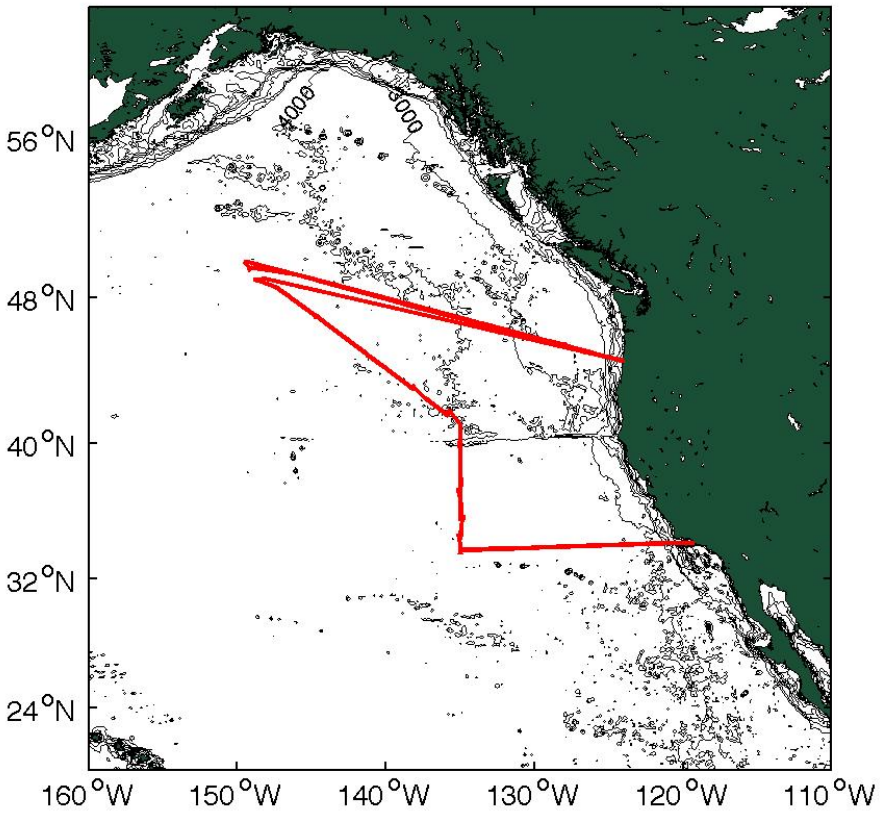


Figure 4.1 - NH1208 Cruise Track

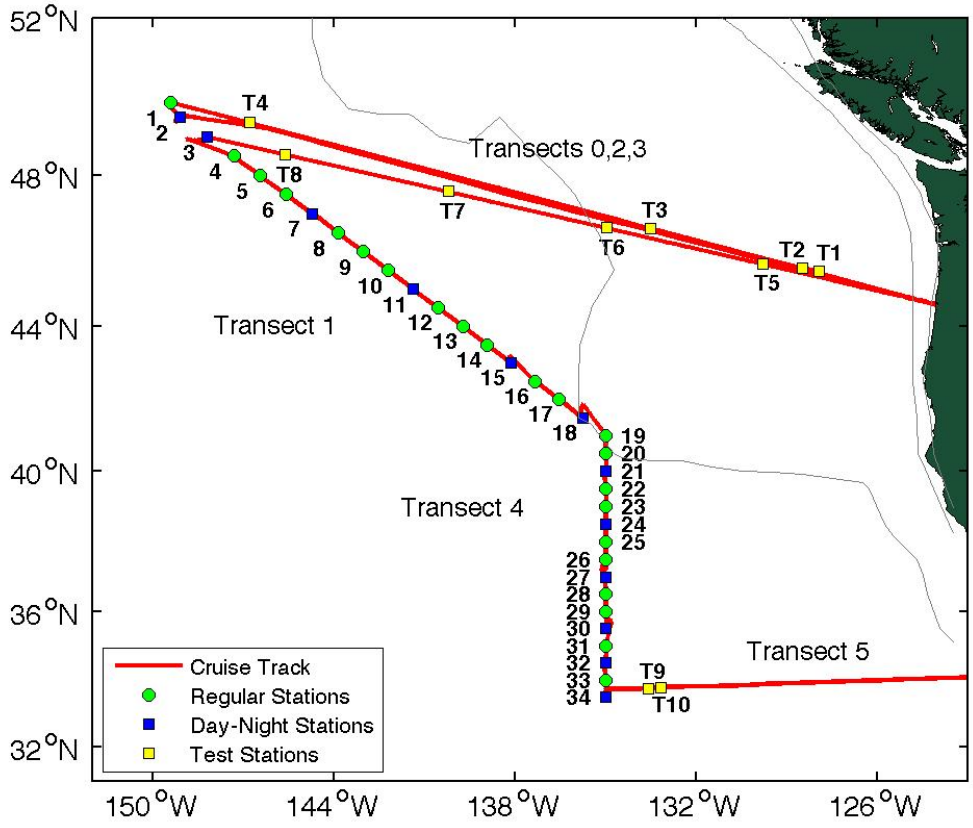


Figure 4.2 - NH1208 survey transects and station locations

Surveying involved a combination of station-based and underway activities:

1. Underway data were collected continuously along-track between stations at a survey speed of 8-10 knots using a multi-frequency acoustic system with transducers mounted on a sled deployed via the vessel's moon pool, a Multi-parameter Inorganic Carbon Analyzer (MICA), a General Oceanics pCO_2 system, and the ship's underway measuring systems (sea surface and meteorological conditions).
2. A total of 22 "regular" stations were conducted at intervals of 1/2 degree in latitude along the survey transects. Minimally at each regular station a cast was conducted to 1000m with a CTD-VPR package, including Niskin bottle samples of seawater. Water samples were processed by chemistry team personnel between stations.
3. A total of 11 "day-night" stations were conducted initially at intervals of nominally 2 degrees of latitude, and later at intervals of 1.5 degrees and then 1 degree of latitude, due to timely progress and favorable weather. Station #2 constituted a failed twelfth day-night station with only some of the daytime activities completed. The exact start of day-night operations was occasionally shifted slightly towards the north, in order to allow day- or night-time operations to be conducted during day or night, without sampling during the dusk and dawn transitions. Day- and night-time MOCNESS 1000 m net tows and 1000 m CTD-VPR casts were made. When timing allowed, HammarHead deployments were also made during both day and night; in some instances it was only feasible to do either day or night HammarHead tows. Some HammarHead casts were done

while waiting out the dawn or dusk transition and thus were especially long. Between day and night operations, also often while waiting for dawn/dusk to pass, a CTD cast with Niskin bottle sampling was made to 3000 m.

4. Once per day, at the first station reached after sunset or at some other logistically favorable station, whether regular or day-night, a Reeve net tow was conducted to sample live organisms.
5. In addition to the 34 main stations, eight 'test' stations were conducted during the two transits to the study transect. The first of these was used to test the equipment and practice the over-the-side operations. The other seven were Reeve net deployments to collect live organisms. Two additional such test stations with Reeve net deployments were conducted during the final return transit following the cessation of survey activities, for a total of 10 test stations overall. XBTs were also deployed in advance of most of these test station Reeve net deployments to inform the choice of sampling depths.

The science party was divided into 'biology' (9 members) and 'chemistry' (6 members) teams, for a total of 15 participants and 24-hour operations were conducted. The biology team kept 12-hour watches from 0800-2000 and 2000-0800 while the chemistry stood 0200-1400 and 1400-0200 watches. The teams combined forces and worked together in many situations, particularly for deck operations and when drawing water from the Niskin bottles. Amy Maas on the biology team kept irregular hours to conduct her physiology experiments and Reeve net sampling. The two SIO resident technicians facilitated deck operations and were responsible for ship's scientific equipment, standing watches of 0000-1200 and 1200-0000.

5. Cruise Narrative

Gareth Lawson

NH1208a (LEG I)

Sunday August 5, 2012

Gareth Lawson, Peter Wiebe, Alex Bergan, and Robert Levine flew in to Portland, OR Sunday, arriving at 1500. Kevin Manganini and Liza Roger had arrived previously and the six of us headed down to Newport, OR in a minivan. Aleck Wang, Sophie Chu, Britta Voss, and Katherine Hoering flew in on a later flight, met Amy Maas and Leo Blanco Bercial and then joined us in Newport, where the team stayed at La Quinta Inn, very close to the NOAA/OSU facilities where the *New Horizon* was to be tied up.

Monday August 6, 2012

The day started with overcast skies and fog, temperatures around 60. The team mustered in the hotel breakfast room at 0730 and headed over to the NOAA Marine Operations Center - Pacific (MOC-P) facility at 0830. Once there the four foreign nationals (Lawson, Wang, Blanco Bercial, and Roger) were denied entrance onto the base because the approval for them as Foreign National Guests was to work on the vessel, but the vessel hadn't yet arrived. There was some initial question as to whether they could work on the pier at all, but eventually it was decided that once the vessel had tied up they could work in its vicinity. The US citizens on the team therefore got to work unloading the van and setting up gear while the foreign nationals headed back to the hotel until the ship arrived. With the ship arrived everything proceeded smoothly, setting up the MOCNESS and HammarHead on the dock, and unpacking/re-arranging the van. Nick Tuttle and Kelly Knorr arrived in Newport late in the evening.

Tuesday August 7, 2012

The previous science party (Roger Gauss and Orest Dialchuk) were clear of the vessel by 1200, allowing us to move onto the vessel and start installing gear. The storage and lab vans were moved onboard, and

the portable winch situated on the main deck. The storage van was too heavy by a couple 1000 lbs for the crane, which had a limit of 10,000 lbs, and so we had to empty a number of things out to get that van on. None of the bench layout modifications we had requested had been done, so we had to re-arrange benches and break down one extra one, after which we moved gear on.

Wednesday August 8, 2012
Many of the big tasks were accomplished this day. The chemistry team ran their air-line, we loaded on all of the large items, got the vans hooked up, and re-terminated the 0.322" wire on the portable winch. A lot of the setup was done in the labs too.

Thursday August 9, 2012 – Day 1
A number of tasks remained to be done before sailing, including installing the tow sled with the HTI transducers into the moon pool, hose-clamping the CTD to the VPR sub-frame, testing the electrical connection on the portable winch, and finalizing all of the tie-down, including in the storage van. It was a busy day, but by the time we sailed everything was well tied down and ship shape. The connectivity on the 0.322" termination wasn't great though, and so the plan was to first try redoing the soldering of the pigtails to the cable coming off the wire. The chemistry team's Seabird 49 also wasn't working.

We sailed at 1600 under clear skies but a growing wind. The science party mustered on the 02 deck to watch the scenery. Shortly after we cleared the breakwaters we had a safety drill led by Rene Buck, the chief mate, during which everyone had to don their survival suits. After dinner the captain and Dan Schuller, one of the two res techs, led a meeting covering the rules and policies of the vessel. By 1800 most of the science party had retired to their bunks and the night's transit proved to be a little rocky.

Friday August 10, 2012 – Day 2
Last night the engineers discovered that the evaporators that provide freshwater for the ship were not working. They worked at fixing them until midnight at which point the Captain turned the ship around to return to Newport. By 0730 we were back in Newport and tied up at the NOAA pier shortly thereafter. Unfortunately there were no evaporator experts closer than Seattle so the ship's engineers kept on working on their own.

While the evaporators were being fixed, the chemistry team set about finding a replacement part for a cracked fitting in the GO pCO2 system. Aleck contacted GO and then the part manufacturer, ultimately finding out that there was a distributor just south of Portland, OR. Katherine and Britta therefore set off to pick up the part, in a rented UHaul because the only car rental place in Newport was out of cars. In the meantime, the rest of the science party either rested or set about completing a number of outstanding tasks. Aleck and Sophie worked on the MICA. John, Dan, and Kevin set up the CTD. Peter and Gareth worked on the strobe bar that had been leaking by adding some oil, re-stoppering the end, and putting on a new hose clamp; it wasn't clear that the other end (with the wire) may not have been the culprit though. Peter, Gareth, Robert, Kevin, and John then started working on the 0.322" wire and portable winch trying to increase the bandwidth for the HammarHead. Much sleuthing with a mega-ohmeter led to the slip rings being identified as the source of reduced quality in the connection. The slip rings were swapped out but the Edgetech bandwidth stayed about the same, or perhaps a bit improved.

By 1700 the evaporators were fixed, producing slightly saline water but that was expected to go away after a short time. By 1800 Katherine and Britta were back and the lines were cast off at 1830 and we were back underway. Aleck and team installed the new fitting into the GO system and it was working, so we were fully in business.

Saturday August 11, 2012 – Day 3

The morning started with slightly grey skies and much reduced seas relative to two nights earlier. The morning's activities were slow, mostly just setting up the instruments for deployment. Alex checked the voltage on the VPR and mounted the hard-drive. Kevin and Gareth set up the HammarHead for deployment, coupling the mechanical termination and wiring things carefully for the cruise, with lots of chaffing gear and strain relief. In setting up the HammarHead we realized that the Sea Mac portable winch level wind was not operating properly, and so John started working on getting it operational.

Test station #1 started at 1300 with a MOCNESS tow. Setting up the system took longer than anticipated because we had forgotten to set the angle and somehow the pressure cal data had been lost from the laptop we use to control the system. Deployment was fairly smooth although the cable termination nearly went up into the block on a couple of occasions. Once in the water the cable snapped severely a few times until the system was deeper. We started with a ½ nm flowmeter calibration with net 0 at a depth of 50m run on a course of 340, followed by a ½ nm run back on a course of 160. The results of the cal were very similar to the previous two times we've done this. We then fired nets 1 and 2 on the up-cast. Recovery wasn't quite as smooth as deployment, in part because the system was brought way up the fantail, instead of just being stood up at the end of the fantail for rinsing.

Next up was a 500m CTD cast. During the MOC tow there had been a lesson on how to cock the bottles. Deployment also included walk-throughs of all the steps involved in tending a tag-line. The New Horizon doesn't use tuggers, but rather uses 3 tag-lines. The cast went smoothly, as did recovery.

The final operation was a HammarHead cast. This required one person on the winch, one tending the 0.680" wire for the MOC, one on the A-frame, and two with tag-lines. The deployment was fairly smooth although, the fish got hung up at one point on the stern because the winch and A-frame operators were out of sync slightly. The level wind performed fine during payout, but required a lot of manual correction during haul-in, leading to the wraps not being very pretty. During the cast there was some kind of interference, perhaps 60Hz electrical noise, on the LOW channel. Mid-way through the cast the HH suddenly looked like it wasn't transmitting, but after a few minutes started producing normal-appearing data again. We weren't able to sample our usual 75/75/50m range though, which had worked on deck, suggesting that something has happened to the wire/winch/termination combo, or that there is some effect of being in the water. We thus looked at the RAW data to confirm there was no saturation and then ran at 75/75/50m with no RAW. Recovery of the HammarHead went smoothly although tending the 0.680" wire to keep it out of the way was a nuisance. We had hoped that the test station would be over by 1700 but it was 1921 by the time we broke station.

Sunset was around 2115 (PST) and so a Reeve net was scheduled for 2200, at test station #2. Deployment was via the hydrowire and the J-frame, which was much simpler than the stern deployments of last year. Amy sent the system down to ca. 100m then targeted the chlorophyll max layer at 38m for 10 minutes and then brought it aboard where people immediately started crowding around to see the catch. Large numbers of *Limacina helicina* were present, a few *Clio pyramidata*, a huge *Clio cuspidata*, as well as a good number of big and weird pseudothecosomes. The team set about preserving some of the pseudothecosomes (and some copepods and euphausiids) for genetic analysis, taking photographs of the *helicina* and some gymnosomes, and Amy/Liza headed up to the lab van with bucketfuls of *L. helicina* to get started on their work.

Sunday August 12, 2012 – Day 4

The morning started slowly as many of the biologists had been up late working with the Reeve net catch and the chemists were mostly attempting to adjust to their watch schedules. The day likewise progressed slowly as we still have a long transit ahead, but a variety of tasks were accomplished. Gareth and Robert spent much of the morning doing noise measurements with the HTI system. Since the seas were quite calm the conditions were great for taking noise profiles. The transducers were mounted on a sled

deployed via the moon pool and we had been seeing a lot of noise on the 43 kHz. The noise profile at 43 kHz was unsurprisingly high, but at the other frequencies noise levels were not much different than when the transducers were hull-mounted on the Oceanus. With the noise thresholds integrated a series of tests were done running the ADCP in slave mode via a trigger output from the HTI system and relayed to the ADCP via Wu-Jung's trigger box. Aleck, Katherine, and Kevin worked on the MICA system, getting the CTD working again and ultimately the whole pH system.

At 1500 the chemistry team met with Dan for training on the salinometer and then at 1600 we had an all-hands meeting to catch up about a few logistic items. This was followed immediately by an e-log tutorial from Nancy. After dinner, Peter, Robert, and Gareth started working on the HammarHead as the connectivity had been erratic, with data being dropped during the test cast even though the same settings (collecting data at 75/75/50m on the three channels) had been successfully tested on deck. We initially thought it was an issue with the system being in water but the problem persisted on deck. We then used the test cable but continued to get dropped data, as did using a separate computer. Ultimately we decided that we were maxing out the modem and decreased the ranges to 70/70/50m, which seems to be working.

Sunset was later than the day before since we had moved so far west and so the Reeve net at test station #3 was at 22:30. The ship rolled around a great deal once we slowed, but the launch and recovery went very smoothly. The catch again had a large number of pseudothecosomes, which were even visible at the surface from the ship. Small *L. helicina* were again abundant as were some large ones. Analysis of yesterday's catch had suggested that there are 3 formae present in this region (*helicina, pacifica*, and *acuta*).

Monday August 13, 2012 – Day 5

The day started with dense fog and cool temperatures. The biologists had again been busy late into the night with the Reeve net cast and so the lab was quiet first thing. Most of the science party spent the day working on their own projects, along with a little puttering around organizing things and making final preparations. Gareth worked up a cheat sheet for the science party, bridge, and winch operators describing the vessel and winch speeds for each of the different operations. After lunch, Aleck, Peter, and Gareth met with the two res techs Dan and John as well as the Captain to review deployment and recovery protocols for the different systems.

In the afternoon, the chemistry team had a training session on the DO and MICA systems. At 1600 there was a brief all-hands meeting of the science party and Dan the res tech to discuss deployment/recovery strategies and to assign different parts of the operations to particular people. We also covered various logistic items, including letting everyone know that we would now be returning on September 3 rather than September 2, given the 1-day delay departing from Newport. There had also been the possibility that we would change the end port to Newport, to allow the vessel to cover certain upcoming cruises previously assigned to other vessels; this appeared to no longer be a possibility and we were scheduled to return to San Diego as planned.

Since we'd been moving so far west sunset had been getting later and later, and so the Reeve net didn't go into the water until 2300. The wire started to tend a little under the vessel and so Rene on the bridge had to maneuver a little and once the wind was on the starboard quarter the line was tending nicely away from the ship. The catch again included a lot of *Limacina helicina*, but now also a good number of large *Clio pyramidata* as well as a lot of small *C. pyramidata*.

The clocks were set back one hour at midnight and so we were now at UTC – 8. We considered changing by a further hour, since sunset would be at ca. 2130 and end of nautical twilight at ca. 2230 at our most western station, but decided against, mostly because that would have also shifted dawn earlier.

Tuesday August 14, 2012 – Day 6
The day again started foggy with air temperatures around 14C. Aleck and Katherine spent much of the day working on MICA, getting the cells to stop leaking. They came up with two solutions to the leaking, first to use two rather than the usual one o-ring and second to lube up the ring with silicone. Presently they were testing the two o-ring cell and it seemed to be holding, but the system was producing unstable results. They continued to investigate. The rest of the science party continued to putter around getting small things done over the course of the day. Later in evening when all of the biologists were awake there was a VPR training session led by Alex. Since we were scheduled to arrive at the first station around 3am on the 16th we decided against doing a Reeve net in order to get to the station as early as possible and get the night operations done before dawn.

Wednesday August 15, 2012 – Day 7
At around 2am the HTI data collection program froze up. Peter and Robert spent a few hours trying to figure out the problem and then at 5am woke up Gareth. The control computer could communicate with the deck box and the box boots up fine, but didn't make its usual final happy chirp to indicate it was ready for operation and the data collection software couldn't communicate with it. An email was sent to HTI seeking suggestions as nothing we tried had any impact. HTI tried a few times to send us a copy they had made of the M244 chip's software but the 2MB zipped file didn't make it through until they sent it to the res techs. Installing the backup onto the chip got the system working again, albeit not until 1330.

The chemistry team continued to try to fix the leaking cells in the MICA system but without luck. They tried using Parker o-lube on the 2 o-ring system cell, but that leaked too.

Much of the day, like most of the previous days, was foggy but the sun broke through during the late afternoon and the biology team worked on getting the MOCNESS ready for the night's deployment, cocking it, putting the cod-ends on, and shifting it aft ready to be picked up by the A-frame.

Everyone was getting excited in the early part of the night as station 1 was set to start at midnight. We wouldn't quite be at its official location of 50N 150W, but in the interest of getting the night activities done we decided to stop the ship wherever we were at midnight and commence operations. The hope was that we would be able to continue to make progress towards that point by towing the MOCNESS and HammarHead on our current course.

Thursday August 16, 2012 – Day 8
By midnight we were still ca. 24 miles away from the official location of station 1 (50N 150W), but we started the station early. The Reeve net was allocated 30 minutes and Amy kept it to that limit nicely. The catch was only small *Limacina helicina*, a few of which Amy used for respiration runs. The MOCNESS was up next. The deployment went relatively smoothly. We had two eye bolts on the deck aft of the A-frame to which we tied tag-lines that went through the U-bolts on the base of the MOC frame and then to cleats on the A-frame. During the period when we stood up the system for the pre-deployment tests we tied it off with short lines from the upper cleats on the A-frame to the U-bolts on the top of the frame. After the tests we removed these lines for deployment. The 0.322" wire from the portable winch attached to the HammarHead was left slack and tied loosely with a loop of shock cord to the A-frame cleat such that the wire can pull itself out as necessary as the A-frame booms out. The cod-ends were thrown in but because the frame was a little way forward of the stern they didn't trail very far back. The tag-lines were kept a little too tight during deployment such that the frame was angled inwards at the bottom towards the ship as the A-frame boomed far out. Nonetheless the unit went into the water relatively smoothly.

At 200m depth the flow meter stopped reporting. At 700m the system failed entirely and had to be recovered. Once on board the chemistry team started a 1000m cast of the CTD-VPR package while the biologists started figuring out the problem with the MOCNESS. The battery was still good though a little

low. The underwater unit (#169) was unresponsive. Testing with unit #155 was initially unsuccessful, because the backup battery case being used had a blown fuse. A series of minor errors ensued, including plugging into the wrong end of the flow meter and plugging in the wrong cable from the octopus. Eventually though we ascertained that the small fuse on unit #169 had blown and once replaced it was operational again. It remained unclear what led to the fuse blowing though. This was the same symptom we had (often with a blown modem board too) in 2010 when the strobe system wasn't working as well; this was supposed to have been resolved, but this fuse blowing was suspicious. One of the two strobe bars was recently repaired after being slightly broken during Wiebe's Antarctic cruise and perhaps it was shorting or otherwise malfunctioning.

Once the 1000m cast was complete, we headed down the survey line towards station 2 during which time we installed unit #169, along with the fully charged back up battery, back onto the MOCNESS. By the time we reached station 2, the day watch was on duty and deployed the MOC as the first order of business. The deployment went smoothly. By about 20m of depth though Gareth noticed that the angle reading was 0 degrees. We therefore had to recover the system. Recovery went smoothly, other than at one point when the A-frame rested the base of the system on the deck and the winch kept paying out wire that went slack until the frame fell forward quite violently. Once on board we tried to swap in U/W unit for #155, but realized that its can was too short and didn't fit the brackets. We therefore had to use #124, even though the depth calibration on that unit was questionable – it read 5.9m at the surface, and we couldn't be sure whether that offset was linear with depth. We installed #124, calibrated the angle inclinometer, and then re-commenced our depth tests. The angle reading with the frame picked up was again 0 degrees, at which point Gareth remembered that a reading of 0 is supposed to be vertical and 90 horizontal – when unit #169 and then #124 had been installed we had calibrated them the opposite way (i.e., 0 as horizontal).

We then re-calibrated the inclinometer and re-deployed successfully for MOC tow 3. The tow proceeded smoothly. The heavy 0.680" wire was much easier to work with than 0.322" wire. Its weight made it easier to keep the net system flying near 45 degrees. At 744m depth the flow meter failed. We decided to proceed hoping that it would come back once we fired a net and started the net moving forward by hauling in. This didn't prove to be the case and it only came back at 710m depth; Peter later replaced the reed switch which was most likely broken. Mid-way through hauling in the system the trawl winch got a bad wrap and the engineers spent a good 15-20 minutes trying to fix it. For the rest of the tow they had one person keeping an eye on the wire and another on the manual level wind correction. This winch is mostly used with 5/8" trawl wire and so the sheaves weren't used to the bigger wire. The hope is that it would settle down with time. During the next MOC deployment the plan was to keep an eye on it; if it looked like there are bad wraps beyond the 1500m we'd thus far paid out (from initial installation) we'd pay out more and try to remedy it. Recovery of the net system again went smoothly. The previous two tows had recovered the system with the nets all snarled up. On this tow we had thrown the cod-ends over with the net system farther aft to try to prevent snarling. When the system was first recovered the nets seemed to be streaming nicely, but by the time we hauled the cod-ends in a few of them had become tangled; it seemed likely that this was just due to prop wash and didn't happen during the tow itself. The collar to net 5 had come loose but at least wasn't lost. With the cod-ends on board the biology team went into gear preserving the samples. Amy scanned the samples for pteropods and only found some few *Limacina helicina*, all in net 7; they were thus at shallow depths even though it was daytime.

The chemistry team with a few biologists chipping in transitioned smoothly to a 1000m CTD-VPR cast followed by a 3000m CTD cast. The deployments and recoveries for these casts were fairly smooth because conditions were calm, but there were some issues with tag-lines not being kept tight and lines getting caught on cleats and on the CTD frame. With practice the deployments should become smoother. As the CTDs were being conducted the biology team finished processing the samples and then rigged the deployment lines for the HammarHead to make for an efficient transition. The HammarHead deployment

went very smoothly and we started a tow back north towards the station since our MOC course and drift during the CTDs had taken as ca. 9 miles to the south. There was nice scattering near the surface in vertical bands suggestive of Langmuir circulation cells. We did a deep cast to 280m with several stops, but saw little scattering. There was a thin layer at ca. 220m and deeper than ca. 250m there was a weak layer of boomerang-shaped targets, likely small fish. Otherwise there were large depth ranges where scattering was virtually absent on all channels. Eerie! We brought the fish back up to 20m and parked it there for a few hours to survey the shallow scattering, which now included a strong and continuous layer (with enhancements/reductions) at ca. 20-30m range and very strong episodic patches at 0-15m range. This scattering was seemingly plankton-like and quite possibly pteropods.

Meanwhile as we were towing the HammarHead there was commotion in the engine room and blue smoke gushing out of the stack. After a while it turned out that we had blown a piston on one of the two generators. We didn't have the parts to repair it and although we only need both generators when using the trawl winch, we now didn't have a backup generator and so had to return to shore for emergency repairs. At 2200 we therefore ended science operations with a HammarHead recovery and started heading in to port.

Friday August 17, 2012 – Day 9
Last night we set out on a course that split the difference between heading to Newport OR vs. Seattle WA. By mid-morning today we had received instructions to head for Newport OR to effect the generator repairs. A flurry of emails continued throughout the day concerning whether we would be able to extend the cruise to account for the lost time. Bruce Applegate was scheduled to meet with Bob Houtman of NSF at 1400 in WA, but by the end of Friday we still didn't have any word. Most of the science party spent the day working on their own other projects or relaxing, other than the chemists who continued to work up the samples from stations 1 and 2.

Saturday August 18, 2012 – Day 10
This was another slow day of working on other projects and analyzing last samples from the present cruise. By mid-morning we had learned that Liz Brenner, the SIO ship scheduler, had a request in to NSF for an additional 14 days to be added to our cruise, to account for the 14 days that we would lose in transiting to Newport, repairing the generator, and then heading back out to the study site. That would put us back in San Diego on September 17. We were thus waiting to hear whether NSF would approve the request, and whether they would provide us with the additional funding we'd need to pay our current personnel for an additional 14 days and likely also to pay for new personnel to replace some of the students/volunteers we were likely to lose if the cruise was extended.

We started inquiring about some replacements we'd need for particular skillsets, such as operating the Edgetech broadband system. We planned to wait until we heard more definitively about whether we would be extended before putting out too many inquiries for additional hands. We also were not yet sure how many of the student volunteers would be able to convince their advisors to let them continue on the cruise.

At 2000 we had an all-hands (most-hands at least) meeting to bring everyone up to date on the situation and plans. In the late evening a number of the science party gathered to watch The Life Aquatic With Steve Zissou and there have been nightly games of whist to pass the time. A number of the science party have spent a lot of time on the fantail trolling for fish with handlines.

At midnight we advanced the clocks by an hour back to Pacific Time (UTC – 7).

Sunday August 19, 2012 – Day 11

We had still not received any definitive word on whether the cruise would be extended. We were scheduled to arrive in Newport on Tuesday August 21 and a mechanic was to be meeting us at the NOAA pier, after which we would have a better sense of the time required for the repairs. We were making tentative plans for travel home for people who wouldn't continue on the cruise and things like car rentals for those who would. The chemistry team had finished processing the bottle samples from stations 1 and 2.

People again spent the day working, relaxing, and fishing. The captain made up a set of rope quoits (rings) and some posts and we had a quoits tournament at 1400. A guitar on board was pulled out and a jam session including empty buckets as drums ensued. Shortly before dinner the guys finally caught a decent sized albacore tuna, which got everyone very excited. Overall the outdoors time, a little sunshine, and these activities kept spirits reasonably high.

Monday August 20, 2012 – Day 12
Skies were a little less grey this morning than was typical in the fogbanks farther offshore. Mid-morning we received word from Liz Brenner, the SIO ship scheduler that our cruise would be extended by 15 days. We were scheduled to depart Newport OR after the repairs on August 26, to give Meghan Donohue, the res tech replacing Dan Schuller, time to get to the ship after finishing up her current ROV work on Lake Tahoe. That would mean a return to San Diego on September 18. We hadn't heard from Dave Garrison, our program officer at OCE, whether NSF would provide any supplementary funding to cover the additional costs of this new shiptime. People were busy making plans for the 5 days in port, with some of the science party headed for Portland and others to Crater Lake National Park.

The science party again spent the day working, exercising, reading, and hanging out on the back deck, where fishing and quoits continued to be popular activities. Dinner included sashimi and grilled fillets from the albacore caught yesterday. The whole science party gathered on the fantail to admire the sunset, which even included a green flash.

Tuesday August 21 – Saturday August 25, 2012
We returned to the NOAA pier in Newport, Oregon, shortly after 10 in the morning on August 21. A mechanic joined us shortly after to start working on the generator. He confirmed immediately that it was broken and soon after determined that a valve had come loose, fallen into the cylinder, and ultimately fused itself to the piston, leaving a lot of damage in its path. The mechanic and our engineers set about repairing it.

Meanwhile the science party was organizing themselves into sightseeing expeditions. Nancy, Katherine, and Britta took a car and headed first to Eugene to rent camping equipment and then to Crater Lake. Nick, Kelly, Sophie, and Liza went to Portland. Alex headed home to California and Gareth headed to Boston for some family time. Robert and Kevin headed home as they weren't able to change their schedules and participate in the next leg of the cruise. The others, Peter, Aleck, Leo, and Amy, stayed near the vessel, planning on working and doing some local sightseeing.

By Friday August 24 everyone had returned to Newport, ready to sail again. After a great deal of searching we were able to find three new participants to replace some of the previous science party's members who were unable to continue on the extended cruise. Tom Bolmer would replace Robert, Taylor Crockford would replace Kevin Manganini, and Elliott Roberts would replace Britta. Dave Garrison from NSF OCE had indicated that we may not get any supplementary funds, since the OA funds all get spent down entirely. Any supplement would have to come out of core Bio Oc money, and even if that happened it wouldn't be until 2013. Drew Brown ran a budget for us and the cost of the 15 day extension plus the cost of replacing volunteers with paid personnel, would be ca. $110k. Dave indicated we should proceed as though we may have to absorb that cost, which is not a comforting thought. Nonetheless our first

priority was to finish the fieldwork component of the project and we were very grateful to have these replacement team members, who we are confident will fit in and do a great job.

By late Friday afternoon the vessel was ready to sail, with the generator repaired and tested, the ship re-fueled and re-stocked with supplies. Meghan Donohue, the res tech replacing Dan Schuller, wasn't able to leave her previous project (ROV work on Lake Tahoe) until Saturday, though, and so wouldn't be joining the New Horizon until Sunday.

At 0800 on Saturday August 25 the vessel shifted to the OSU dock. The night before Lieutenant Commander Colin Little (from Worcester MA) had had to escort some of us foreign nationals onto the vessel at 2230. We weren't looking forward to having to bother him to be escorted for the rest of the weekend. The Captain had therefore looked into shifting to the OSU dock, which simplified matters a great deal. The science party spent Saturday doing some last shopping, hiking, and then everyone met for a great dinner at a seafood restaurant called Panache.

NH1208b (LEG II)

Sunday August 26, 2012 – Day 1 (of the resumed cruise)
With the New Horizon scheduled to sail at 1600 the science party took advantage of the morning for a little more hiking, shopping, walking, jogging, and other things not possible for another 23 days. By mid-afternoon people started working on checking the tie-down, taking care of a few outstanding tasks (e.g., tightening the nuts on the MOC rods, tightening the collars, etc), returning the rental cars, and generally just getting ready to depart. Meghan arrived around 1430 and after unpacking started checking our tie-down and getting things shipshape. Lines were cast off on schedule and we pushed away from the dock at 1600. The breeze had been stiffening all afternoon and there was rain by the time we left. As soon as we got beyond the Newport harbor's breakwaters the ship started to roll around a great deal. Although the winds were only around 15 kt there was a decent swell hitting us broadside, with around 6 ft seas. After a brief safety drill led by Rene in the main lab, many of the science party hit their racks to get adjusted to the motion. Only a few made it to dinner.

While in transit we were still collecting data with our various underway systems. The HTI multi-frequency echosounder with its transducers mounted on a sled in the moon pool was turned on and had been operating relatively smoothly, only requiring infrequent reboots. The General Oceanics pCO2 system (air and water) was working fine. The pH part of the MICA was working, but the chemistry team continued to have problems with the DIC and pCO2 systems as the cells had been plagued by issues with leaking from new tubing. During the port call Aleck had new tubing sent out from Florida and today installed it into the DIC system's cell. It appeared to work, in that there were no leaks.

Monday August 27, 2012 – Day 2
The day started with partly cloudy skies, a welcome difference from the rain of the previous day, and winds of 20 kt out of 192. The Captain pointed out that we have swells hitting us from three different directions on our port side, leading to a very confused vessel motion that is hard to adjust to. Alex and Nick headed out for some fishing after breakfast since overnight we moved into the warmer surface temperatures (17C) that the albacore seem to like. Most of the science party didn't make it to breakfast. With 4+ days before station #3 where we were to resume our study, everyone had a long time to get over any seasickness.

Shortly after lunch the science party mustered for an all-hands meeting where Gareth gave a rundown of the cruise, a description of some of the rules of conduct, and described some of the deck operations. This was both to introduce the newcomers to our project and to give the previous science party members a

refresher. By mid-afternoon the winds had dropped to 12 kt and the seas were much calmer, and lingering seasickness was abating.

Starting at 2100 we did an XBT cast to get information on the vertical structure of the water column in the region and to help guide the Reeve net deployment. The previous XBT had been launched over the starboard side at the very stern of the ship. It had stopped reporting at 700m, potentially because the wire had touched the vessel. This second XBT was launched directly over the stern into the prop wash. It reported successfully to in excess of 1000m, revealing temperatures down to 3C at depth.

Immediately after the XBT launch we transitioned into the Reeve net at test station #5. At the time we were on track to reach station #3 and resume the survey around noon on August 31. If we were to do 1-hour Reeve net tows on each of the days of transit we would arrive on station around 1600. Station #3 had been re-designated a day-night station and arriving at that time wouldn't allow enough time to complete the daytime activities. We therefore decided to keep the Reeve net short in order to save time. The previous Reeve net cast had been kept to 30 minutes and the sample had contained lots of small pteropods but few big ones. It wasn't clear whether this was because the tow was short or because there just weren't big ones around. Nonetheless in the interest of time we chose to keep this next Reeve net short.

The protocol for the 1-hour Reeve net tows was to send the net down to an estimated 100m of depth at 20 m/min, and then haul in at 5 m/min until the net reached the depth of the chlorophyll maximum, where it was held for 10 minutes, before being hauled in to the surface at 5 m/min. For the ½-hour Reeve net tows, the protocol was to send the net to ca. 60m in depth, then haul at 5 m/min, followed by hauling at 2 m/min through some shallow depth interval that likely brackets the chlorophyll max (e.g., 60 to 25 mwo {meters of wire out}), and then again returning to the surface at 5 m/min. Taking this approach the sample came up with ca. 4 *Clio pyramidata* and hundreds of *Limacina helicina*. So the ½ hour tow appeared to be sufficient at least in this region. Amy and Liza quickly sorted out about 500 animals for their work, leaving a few for photography. Leo sorted out a few copepods but there were very few euphausiids present. Large numbers of the pseudothecosome *Corolla* were again present and a few were preserved in ethanol for genetics, along with some *Pneumoderma* gymnosomes.

Tuesday August 28, 2012 – Day 3

The day again started with partly cloudy skies and winds at 16 kt out of 321. The seas were much calmer than yesterday morning and the night before that, around 2-3 ft. The main lab was again quite quiet first thing in the morning, with just a few daytime watch-standers getting started on their activities, plus Amy setting up her respiration experiments. Some of the *Limacina helicina* had laid eggs overnight and so we spent some time taking photographs of them.

The chemistry team had been training up their new member, Elliott Roberts, and tidying up various other things. The MICA was still not working very well and continued to have a series of problems, including the pump not being strong enough to pull the water through and chronic air bubbles getting into the cell. Aleck continued to tinker with it.

The Edgetech system had been having issues with data processing, perhaps related to the RMC GPS string it was receiving not being understood or perhaps other reasons. On the first leg, Robert was unable to unpack any of the files or generate spectra. Tom Bolmer had now replaced Robert and was bringing himself up to speed on the Matlab code in order to trouble-shoot these processing issues.

Late in the day Peter had a look at the MOCNESS flowmeter, which had been sticking. He adjusted the height of the white plastic cylinder in which the magnet is embedded such that it now sat off the metal of the flowmeter slightly. He also cleaned some dirt off of the worm gear. It now was spinning smoothly.

At 2130 we did a successful XBT cast and then at 2200 stopped for a Reeve net cast at Test Station #6. Amy was worried that the day before she had caught only few *Clio pyramidata* because they were deeper than where the Reeve sampled so today the net went down to 90 mwo and then back up with a slow-down to 3 m/min (rather than yesterday's 2 m/min). The net came up full of copepods, probably *Neocalanus*, along with a good number of *Limacina helicina*. Only one *Clio*, but abundant gymnosomes.

Wednesday August 29, 2012 – Day 4
Another slightly overcast day with light winds of 7 kt out of 309. Seas remained around 2-3 feet, hitting the New Horizon mostly broadside so we continued to roll around a fair bit. The chemistry team continued today with training, calibrations, and working on the DIC cell for the MICA.

Shortly after lunch Meghan and the engineers started working on the 0.680" winch. Peter and Gareth had disconnected the termination from the MOCNESS and wrapped up the electrical termination. The plan for the afternoon was to stream the wire with a weight in order to pay out past where the bad wraps had occurred during the previous MOCNESS tow. After paying out to 1700m, the remaining wire on the drum looked well spooled and so they started hauling in again. Numerous adjustments were required to the level wind and to the slack tensioner. The former wasn't tracking consistently and the wire repeatedly sprung out of the latter. The engineers worked on these issues and were optimistic that the winch/wire would be in good shape for when we start our survey.

During the afternoon through until 1800 there was a mild panic because the internet was down. Initially it was thought that this was because we were on Fleet Broadband, but we've been on FBB for a few days now. A phone call by Meghan to UCSD main campus revealed that they had been making some security and other adjustments to the system. They had been in touch with the RV/Robert Gordon Sproul to check if the changes were having any adverse effects and because the system on the Sproul is the same as on the New Horizon they assumed that the lack of problems on the Sproul meant that the New Horizon would be fine. Apparently this wasn't the case. By 1800 the problem was resolved, though, and people were happily checking their email and Facebook accounts.

At 2130 we did an XBT in preparation for the 2200 Reeve net. We still needed to keep the Reeve deployment short, to make sure we arrive at the first survey station in sufficient time to complete the daytime operations before sunset. The plan today was therefore to send the Reeve to 100mwo, haul-in to 60mwo at 5 m/min, then at 2 m/min for 60 to 40mwo and then up to the surface at 5 m/min. This resulted in a good catch. There were fewer copepods in the sample than yesterday, but some krill, big chaetognaths, lots of gymnosomes of various types and plenty of *Limacina helicina* and *Clio pyramidata*.

Thursday August 30, 2012 – Day 5
The day started again with grey skies, but light winds (6 kt out of 257) and the smoothest seas we've seen yet. Amy's animals from last night, both *L. helicina* and *C. pyramidata*, weathered the night well and her experiments were progressing well. Some of the leftover animals from Amy and Liza's work were used for photography and some video too. Gareth, the Captain, and John and Meghan the res techs walked through the deployment and recovery protocols from the previous leg so that everyone was on the same page for the upcoming first station. At 1600 at the all-hands meeting, we reviewed who would do what during the various operations.

We finally received confirmation from Liz Brenner the SIO ship's scheduler that we would be ending the cruise in Port Hueneme on September 18. The extension of our cruise had displaced Uwe Send's mooring cruise (originally scheduled for September 6) and to facilitate his work and schedule we would end in Hueneme. That is actually 120 nm closer to our survey endpoint than San Diego and so it was in some ways a preferable ending point. With it settled that we would be ending in Hueneme, Katherine and

Nancy got to work on changing our flights, arranging for hotel and transportation, as well as shipment of our gear and samples.

The chemistry team continued to tinker with the MICA DIC system, which was still not working that well. Tom Bolmer battled with the unpacking and processing code for the Edgetech system and made some good progress, and so it was likely by the time we reached the survey he was going to be in a position to process the data as we collected them.

At 2200 an XBT was launched, showing that we continued to make our way into colder and colder waters. The Reeve net was deployed on schedule at 2230, a little while later relative to nautical twilight end compared to previous tows, but last night's tow was similarly late and caught a lot of *Clio*, so it's possible that waiting a little later to allow them to migrate shallower increased the catch. The protocol was the same as yesterday with a max of 100 mwo haul-in to 60mwo at 5 m/min, then at 2 m/min for 60 to 40mwo and then up to the surface at 5 m/min. The catch included 3 large jellyfish, large numbers of ctenophores of two sizes/types, but not many euphausiids or copepods. *Limacina helicina* was again reasonably abundant, but there was only one *Clio*.

Friday August 31, 2012 – Day 6

The day started with foggy skies and light winds (15 kt out of 167), with a brief rain squall around 0730. A developing storm was predicted to head right over us during the mid-day, albeit moving at high speed (25-30 kt), but nothing that we wouldn't be able to work through. A typhoon that already passed over SE Asia was on its way to the Aleutian Islands where seas and winds were likely to be high; we hoped to avoid most of its effects.

During the early morning, the day watch biology team got the MOCNESS ready for deployment as the first activity at day-night station #3. We arrived on station right on schedule at 1030. Deploying the MOC took a little bit longer than usual as we re-arranged lines and reminded ourselves of the protocol. The system was in the water by 1103. Once it hit 400m though we lost communication with the underwater unit. Via terminal we could communicate the deck box and got a response from the underwater unit, but the software couldn't make a connection and the terminal connection was flakey, sometimes saying ok to 300 baud, but then giving gobbledygook as we typed commands. We therefore had to abort the tow. At about 800 mwo they got a bad wrap on the drum of the 0.680" wire and spent a long time going in and out trying to make the wrap nicer. Eventually the captain told them to bring it in irrespective of a few gaps in the wrap.

With the MOC back on board, the CTD team took over with a 1000m CTD-VPR cast. In the meantime the biology team started trouble-shooting. Net 8 had a tear in it from being pinched by the foot of the system and dragged along the deck so it was replaced. Hooking up SN 169 to the deck cable and the backup battery things tested out fine, but with the voltage red and reading 0.0V, indicative of a blown 5A fuse. Upon replacing the fuse things worked fine. We therefore put SN 169 back on the system along with the backup battery. We disconnected the strobe system in case that was the problem, since we've had similar symptoms from the strobe system in the past. We also replaced the battery cable since the original one had a corroded pin. The system was redeployed and worked fine up until 400m depth and then the flowmeter stopped. It came back at the bottom of the tow as the system started forward quickly again. The nets came up with numbers 5-8 in a terrible tangle. There wasn't sample above the knot but the catch was pretty small in some of the nets and was mangled up in some of the deep ones, suggestive of animals being abraded against the net during the tow rather than caught in the cod-end. Oxygen levels were very low though below 500m and so it was hard to know if the small catch was because of low abundances or issues with tangling. There were only a couple of pteropods, in nets 6 and 7. Huge numbers of copepods were in net 8. Peter got to work on the flowmeter and found that the nuts that hold the propeller in place were loose, which seemed to be making in sticky. Tightening those down it seemed to be spinning fine.

The CTD went in for a 3000m cast shortly after the MOCNESS came up and went very quickly. The captain had a hard time staying in position and the wire had a pretty steep angle but things went well, except for bottle #21 not firing. Since the CTD went so quick we moved on to the HammarHead, rather than do the Reeve net early or sitting around doing nothing. The HammarHead deployment went fine, after the necessary shifting around of the MOC and paying out enough wire on the 0.680" to allow the deployment. There was a strong layer at ca. 25-30m depth, strongest at the lower frequencies. The HTI showed another weaker layer at 200m so we sent the fish down. The HammarHead found this to be a layer of weak single targets, strongest again at the lower frequencies. Haul in happened smoothly as the level wind was now working well. Recovery was a bit tricky as the low pressure system had been moving past us and winds/seas had been building, but nonetheless it was brought on board without mishap.

Next up was the Reeve net, which went smoothly as always. The catch included about 50 pteropods, so fewer than previously. As Amy and Leo picked through the samples the biology team got ready to deploy the MOCNESS. The strobe was still disconnected. To try to prevent tangling the cod-ends were taped together into pairs in the hopes that they would tangle less. This wasn't the case. Only two of the cod-ends were still taped together upon recovery and nets 1-7 were in a big tangle. The CTD-VPR cast went well although reportedly the VPR had issues with booting up, mostly it seems related to the people turning it on not realizing that you sometimes have to wait 4+ minutes for it to boot up if it's changing settings. By the time the final 1000m CTD-VPR was completed we were way off station, making the steam to the next station (#4, regular) a little longer than planned.

Saturday September 1, 2012 – Day 7

The day started with 19kt winds out of 288 and fairly calm seas. The ship was making 10 kt on a very smooth course towards the next station. The day consisted of just two regular stations that went smoothly. Blue whales were sighted at one point as were a few dolphins and a pair of albatross that hung around the ship while on station. Gareth, Alex, and Taylor spent most of the middle part of the day trouble-shooting the MOCNESS. It had come up from last night's tow with the net response aimed forward, as if it or the rod had slipped; the nuts were quite loose at the foot of the rods. During the tow, Peter had some odd symptoms. After trying to open net 1 he got no net response. Gareth was pretty sure he had put 3 steps on the motor and after 2 additional motor steps Peter still had no net response and so he incremented the net number. He continued to get no net responses for the rest of the tow, which came up with net 8 open. Looking at the RAW data, he could see that the net response incremented spuriously a large number of times early in the tow (the U/W unit logs these net responses, but they are not used by the software to determine what net the system is on). After the first net there were two instances of:
#MN+...
#MN*…
#MN*…

The + command steps the starboard motor, and so for a normal step net command there would be three #MN+ in a row. The * command is used to step the port motor on double MOCS. Peter wasn't sure what the +** meant but was concerned it might have been the U/W unit, since the command originates topside but is then repeated and sent back up for logging by the U/W unit. Much sleuthing and many attempts to recreate what happened during the tow led to the conclusion that if the net response is tripped within the same 4-second communication interval as the step net command is sent, the motor steps only once and +** gets logged to the RAW file. Additional, less relevant observations, were that tripping the net response immediately after the first step results in only one further step and ++*; tripping the net response after the second step results in the third step and +++; holding down the net response and releasing it either after the first step or after the third step results in +++; sending a step net command within the same 4 second interval as a net response was received results in an immediate net response and only one step. Testing of the net response with an EO pigtail indicated that it was working and that the lever did not

need to be depressed very far to get a response. Swapping out the octopus and U/W unit resulted in the same symptoms. The fact that the motor does not always step 3 times if there is a premature net response seemed like a glitch.

The hypothesis for the previous night's tow thus became that the rod had slipped and the net response somehow become stuck or repeatedly being triggered. When Peter didn't see the net response as net 1 opened he gave two extra steps making it 2 steps ahead, but then the next step net command must have come in just as a net response did (hence the +**), leading to only one step on the motor. The next step net command must also have come in at the same time as the net response, leading to the release being now 2 steps behind; consistent with the system having come up with 2 steps still on it and the last bar not having dropped. Although it wasn't clear still what happened to the net response, this explanation was consistent with the symptoms and meant that the net response unit, cables, and U/W unit were all ok. After dinner the biology team tightened up the nuts on the rods and cocked the system on deck, since the previous night's tow had been delayed by having to cock prior to deployment.

Aleck and team had been busy processing the discrete water samples from the recent CTD casts and had been keeping up, at least during the current period where the distance between stations was 46 nm. As feasible, Biology was pitching in to help draw water, which helped. The cell for the DIC system on MICA was no longer leaking, but had continued problems with air bubbles. Today Aleck and team made up new chemicals, which appeared to have solved the problem and MICA was ticking away happily.

Sunday September 2, 2012 – Day 8
Dawn broke with clear sunny skies over calm seas. Winds were less than 10 kt, out of 236. The regular stations since the last day-night station all proceeded smoothly. The VPR at Station #6 stopped collecting data at 400m on the way up. The initial thought was that it was a battery issue, but it still had 26.1V. A little more investigation revealed that it was that the hard-drive was completely full, so it was emptied prior to the next cast. This investigation also suggested that the VPR computer was in EST, based on the time of files being written.

The ship was making 10.5 kt and so we arrived at Station #7, our next day-night station, ahead of schedule at 0830. The first order of business was a MOCNESS. After consulting with Meghan and the Captain we had come up with a plan for mitigating the tangling: to deploy/tow/recover with only one of the two screws turning to minimize prop wash, to pre-fill the buckets with seawater, to stand the system further aft in order to have the cod-ends farther into the water after being tossed over, and to send the system straight down after the tag-lines are stripped without pause.

The system was already cocked from the previous night and so everything was set for deployment. There was some fiddling after arriving on station, but the system was in the water by 0900. The nets had looked great as the system went down, streaming nicely. The whole tow proceeded very smoothly. Pay out was at 10 m/min to 100 mwo, then 20 m/min to 200 mwo, then 25 m/min to 300 mwo, then 30 m/min to the bottom. The wire angle was locked in at 45 degrees and a total of only 1466 mwo went out. Hauling in was at 15 m/min, keeping the vertical speed right around 10 m/min. One small ship speed adjustment was necessary, but otherwise everything was very smooth. At recovery all of the nets were streaming nicely. A few minor cross-overs occurred while pulling the cod-ends on board, but no tangles or knots. As soon as the cod-ends were on board and the safety lines up John moved over to the CTD deployment, making for a fast transition. The 1000m CTD cast went in fine. The biology team got to work on preserving the samples, which were in much better shape and less sparse than at the last station. No pteropods were seen in any of the deep nets, but good amounts of *Clio pyramidata* were in the 25-50m sample and lots of large *Limacina helicina* in the 0-25m sample, even though this was daytime! Even more unusual was what Amy thought might be a *Clio polita* or *Clio recurva*, also in the 0-25m layer. Very interesting. A few of

the *Limacina helicina* (9) and one *Clio pyramidata* went into liquid nitrogen as some transcriptomics might be interesting.

The 1000m CTD-VPR cast took only an hour since there were no bottles. Immediately after the case the VPR came off and the system went back over for the 3000m cast. At 1500 everyone except Aleck, who was running the CTD, mustered on the 02 deck for a safety drill. After the 3000m CTD was the HammarHead. Seas were very calm and the deployment went smoothly. Layers were evident at ca. 20m, 240m, and 280m on the HTI and all of these were surveyed. The shallow one was zooplankton-like while the deep two were more fish-like and with quite low levels at the higher frequencies. After surveying the deep layers we positioned the fish at 15m for an hour or so while people ate dinner and got the MOCNESS ready for the night tow.

At 1900 we pulled the HammarHead and by 1920 were ready for a Reeve net. Meghan had noticed in a photograph on Wiebe's old laptop screen saver that in the past we have hooked the HammarHead on the towbail rather than on the U-bolts, since the towbail breaks the water first. We took that approach on the recovery, which went very well. Since the pteropods were all shallow in the daytime MOC we had decided to do the Reeve net during daylight rather than as the last order of business at the station, in order to save time. Amy sent the Reeve to 100mwo, at a steep angle, then brought it up at 5 m/min to 64mwo, 2 m/min to 25mwo, and then 5 m/min to the surface. The catch included a number of large jellies and siphonophores, as well as lots of big *Limacina helicina*, some small *Clio pyramidata*, and only a few large *Clio*, but very happy healthy ones.

With the Reeve on board, Amy and Leo started processing the catch while the day watch helped the rest of the night watch with launching the MOCNESS. The same protocol to minimize net tangling was followed as during the daytime tow. Deployment went smoothly. At recovery the nets all looked like they were streaming nicely. Meghan pulled up net 8 and it got twisted around a few other nets and most of them came up in one bundle. These were not severe and almost certainly were associated with being pulled in. This was similar to the cross-overs that occurred during the daytime tow when they were easier to see as the nets were being pulled onboard. With the MOCNESS on board the chemistry team moved soon after onto the final 1000m CTD-VPR cast of the station.

Monday September 3, 2012 – Day 9
After departing Station #7 at 00:50 the ship continued to make good speed and arrived at Station #8 at 5:23. The CTD-VPR as usual proceeded smoothly and the ship was back on course for the next station by 6:52. Dawn broke on lightly foggy and damp skies, with air temperatures of 14C, winds of 13 kt out of 202, and seas of ca. 3-5'.

The CTD has had issues the past couple of days with bottles 7 and 21 not firing. Since coming on watch at midnight John cleaned off the rosette and adjusted the lanyards and angle at which they run to the rosette trigger mechanism. On the 1000m cast at station #8 they fired both 7 and 8 at the depth for 7, using 8 as a backup, and also fired bottle 21 even though that one wasn't needed for the 15-bottle case. Both bottles fired fine, but the plan was to continue testing at the next two regular stations.

The day proceeded slowly with just regular Stations numbers 9 and 10, giving the biology team time to catch up on things and the chemistry team time to process samples. The Reeve net was postponed until Station#11, a day-night station, in order to ensure that we arrived with sufficient time to complete the nighttime operations.

Aleck and Amy were having issues with the power supply on the ship. Aleck's DIC instrument was plugged into the 'clean' power supply, but every time the winch started or stopped he got erratic behavior. He therefore swapped it yesterday into the small UPS that the ship uses to power the CTD deck units (in

case of a power failure). Amy was similarly having problems with her oxygen electrode, which she thought were related to the winches running. Unfortunately getting her cleaner power to the 01 deck van would have been tricky.

Tuesday September 4, 2012 – Day 10

Dawn broke with cloudy skies and some fog but light winds (5 kt out of 250) and very calm seas. Station #11, a day-night station, began at 2330 earlier the night before, a little before the vessel actually arrived at the station's location, so that the MOCNESS could be towed onto station. The MOC went smoothly and came up again with no tangles in the nets. The catch was extremely sparse in the upper 100m with no pteropods evident in the catch, based on the usual cursory examination. Next up was a 1000m CTD-VPR cast, which went entirely smoothly, followed by a Reeve net to 120mwo. The Reeve came up at 5 m/min to 70 mwo and then 2 m/min to 40mwo to target the chlorophyll max, followed by 5 m/min to the surface). Similar to the MOC, the Reeve came up with only a handful of pteropods. The 3000m CTD took only 2.5 hours of time in the water, putting us ahead of schedule for the HammarHead tow.

The HammarHead deployment occurred right at the start of breakfast time and so the daytime biology watch took over early to allow the night watch to eat sooner (as the time between meals for the night watch was long). We kept the HammarHead above 40m for the whole tow as there was little showing on the HTI above the DSL at 300m, other than a weak layer near 200m. At around 40-50m though there was a very interesting layer that seemed plankton-like on the Edgetech J-star display. Often there was a fairly continuous and thin layer at ca. 40m and then interesting patchy (possibly torroidal) scattering between 40-50m. A weak layer was also evident on the A1 that looked a lot like a surface reflection due to sound coming out the back of the transducer. Perhaps this was because the surface was so flat and a better reflector than usual.

After the HammarHead was the daytime MOCNESS. As these were both stern operations the transition was a little slower than going from HammarHead to other activities, but it still took only 24 minutes before the MOCNESS was in the water. The tow went entirely smoothly, coming up again with no tangles. With the cod-ends on board we proceeded to the CTD after only 15 minutes. The catch in the upper water column, like during night, was quite sparse. Three *Limacina helicina* were in the 100-200m net, and ca. 20 in the 0-25m. Net 4 lost a little sample on deck and net 0 came up with the mesh partially unglued from the inside of the bucket.

The 1000m CTD was the final operation of the station. The Captain had suggested trying hauling at 90 m/min for the up-cast, although their usual speed limit is 60 m/min. They had done a test run at that speed during the night-time 1000m cast and it had run smoothly, and the engine room was comfortable with the idea. Running that fast was very noisy in the main lab, making a disconcerting high pitch whine. We decided that since 60 m/min is the standard for PO applications and other users may be interested in our data, and to avoid any risk of damaging the winch, that we would revert to our limit of 60 m/min.

During the transit to the next station, Aleck, Meghan, and Sophie worked on the salinometer, which had been having temperature issues. It turned out to be a broken belt that drives the paddle to circulate the water bath, and was soon fixed. The chemistry team was now a little behind on the salinity measurements, and needed to catch up or else run out of salt bottles.

Station #12, our next regular station, arrived at dinner time, but went off without any issue. The seas remain flat calm, the calmest yet of the cruise. A Reeve net was the first order of business at Station #13, but came up with only a handful of pteropods, less than 10 and so barely enough for Amy to do much with.

Wednesday September 5, 2012 – Day 11

The day started with light winds, 12 kt, out of the north now that we had moved on the eastern side of the large high that had been sitting over our study area for the past while. Air temperatures were slightly warmer at 17C. Regular Station #14 was taken care of around dawn and went smoothly, followed by a light morning with the chemistry team processing samples and the biologists tidying things up. Gareth spent some time with the HTI system, checking whether the low scattering evident at 420kHz was associated with the transmit switch that sometimes sticks and leads to lower transmit powers than set in the software. This is checked by running the system at a lower power level (e.g., 21 dB). If the transmit switch is working the software can account for the lower transmit power level, but if it's not then there will be a difference in the calculated Sv for the same feature at different power levels; this did not appear to be the case and furthermore there were places where the 420 kHz was higher at other times, suggesting that the low levels were real. He also did some quick comparisons of the HTI spectrum shape and magnitude in the shallow scattering layer evident at ca. 30m and found it to be relatively similar to what was observed on the Edgetech, suggesting that the Edgetech calibrations are ok.

The day team had the MOCNESS cocked and ready prior to day-night station #15. They were out on deck to take up the extra cable and string the tag-lines at 1215 and got the system picked up and deck tests while still in transit, such that when the vessel arrived on station at 1230 it took only 8 minutes before it was in the water. One net looped under the frame as it went, in but luckily Meghan caught this, brought the system up a little, and the problem resolved itself. The nets came up without tangles. The tow had been in to the wind and the net was being hit by sub-surface currents and the bridge also had a hard time maintaining a constant speed; overall though it was a successful tow. We had slowed the haul-in rate to 5 m/min for the last 50m of the water column in an effort to find any pteropods. Overall though the catches were quite low, and there were very few pteropods. The transition to the 1000m CTD-VPR was smooth as was the next transition to the HammarHead cast. The HammarHead deployment was a little rough as Alex's tagline got caught by its tip between the wing and the body of the fish, so we had to recover and then re-deploy.

There have been various shallow layers evident on the acoustics for much of the cruise, although the exact nature of these layers has been somewhat variable. This may have been the same layer as Barraclough et al reported on in 1969 in Science, which they suggested was *Calanus* (now *Neocalanus*) *cristatus*. Analyses of the Edgetech spectra were inconclusive, partly because Tom was still figuring out the code. Most recently though the layer appeared extremely thin, ca. 2m vertically, around 15-30m with smeared scattering below that and a second layer often at ca. 40m. The HammarHead cast through the layers indicated a very thin shallow layer near 30m with more episodic but often very high patches immediately below. Tom's initial analysis of the spectra in these features indicated zooplankton-like scattering, perhaps rolling over by the HH frequency band. Gareth's analyses of nearby HTI data indicated zooplankton-like scattering increasing over the whole 43-420 kHz band in the shallow-most thin layer and zooplankton-like scattering highest at 200 and dropping off at 420 kHz just below that layer. It thus appeared to be plankton, but the MOCNESS caught very little in that depth range. The daytime CTD-VPR was done as a tow-yo, profiling initially to 40m at 30 m/min, then back up to 15 at 5 m/min, then down at 15 m/min to 40m, and then back up to the surface and all the way down for a full cast. Nothing was obvious from the VPR data as being responsible for the scattering. The MOC T/S data and the CTD casts indicate a very sharp base to the mixed layer in terms of temperature, jumping 3 degrees over a very short vertical distance. Peter speculated this might be the source of the scattering. The regularity of the shallow layer was certainly consistent with this hypothesis as the layer seems almost too regular to be plankton. The plankton-like nature of the spectra though does not seem consistent with scattering off of a physical density discontinuity, although neither Peter nor Gareth could recall exactly what the theoretical spectrum should be from a lens-like density change.

The 3000m CTD occupied the dusk period and was followed by a Reeve net at 2100, since at this location, south and east of our survey start, the sunset had moved much earlier. The Reeve was done as a

tow-yo, from 0-80mwo at 20m/min, then up to 60 at 5 m/min, then a tow-yo through 60 to 30 at 2 m/min, back down to 60, then up to the surface. Even so, the Reeve had only a handful of *Clio pyramidata* and a few *Limacina helicina*; Amy took what was there for her respirometry work. The Reeve did catch a fair number of salps, which were perhaps not as well sampled by the MOCNESS and might perhaps have been contributing to the scattering layer.

The MOCNESS was deployed after the Reeve net; this MOC to Reeve transition was working quite well for the night watch, with Amy and Leo picking through the Reeve sample and Gareth subbing in for Leo on the MOC deployment. The nets came up again untangled and the tow was overall smooth. The nets again had very few pteropods, but Amy found a few *Clio* to subsidize those she had collected from the Reeve net. The station wrapped up with a 1000m CTD-VPR cast and then a night-time HammarHead cast. This was the first station where we were able to do both day- and night-time HammarHead casts. The HammarHead deployment was again complicated by a tagline becoming completely knotted up on the fish, requiring recovery and then re-deployment. The vessel left station at 0340. The total duration of time on station was 15 hours, slightly longer than at the previous station, but mostly because of the two HammarHead casts and the CTD tow-yo, rather than to delays in transitions between operations or slow execution of the operation themselves.

Thursday September 6, 2012 – Day 12

The winds were a little higher today at 20 kt nearly out of the north (14 deg). The seas roughened a fair bit overnight and were perhaps 4-6' by morning, so the ship was taking some big rolls. Given our rapid progress and because we were scheduled to arrive at the next day-night station (#19) just before dawn, Gareth, Peter, and Aleck decided to shift the next day-night station to #18. Before that though, the first station of the day was #16, a regular station. Despite the lumpier seas the CTD-VPR deployment went fine. The VPR was strobing at deployment but came up with the strobe off. The battery voltage was 26.1V and the inside of the battery can was dry. The battery connector cable also looked fine, although we gave it a quick clean anyhow. The hard-drive showed the files associated with Leo re-focusing the system after the Station #15 nighttime cast and then one 29 Meg file from the most recent cast at Station #16, meaning it stopped functioning probably around when it hit the water. Nobody remembered it hitting the side though. Autodeck was unable to open this file. Usually when the system runs out of battery and the file ends short Autodeck can still read the file, suggesting that the system shuts down gently somehow. Presumably something happened that interrupted file writing somehow, and in a way that did not allow the system to reboot. Perhaps the hard-drive connection came loose?

Tests on deck indicated that the VPR still worked (this was with the other battery pack as the one that had been on at the time of failure was being investigated). It started up after 40 seconds indicating it was already set to S1. After checking the battery cable we reset it to S0 and then S1 and it worked both times, and was left for 1:10 minutes for a longer test to simulate the duration of a CTD cast. The strobe was still going after this test. Alex and Taylor then chatted about whether anything had struck them as unusual about the cast and Taylor commented that she had only taken one of the pins out that hold the hard-drive in place; she had assumed Alex had taken out the other one. He hadn't though, so it seemed quite likely that the hard-drive had come slightly loose, which would have caused the system to stop strobing and also would of course have stopped the file from being written abruptly. This seemed like the most parsimonious explanation and the hope was that it would work for the next cast.

By mid-afternoon with winds still around 20 kt we were taking some big rolls over waves that were over 6'. At one point Aleck spilled a small amount of acid on a cargo net while working in the fumehood. Meghan later took this on deck and sprinkled bicarbonate on it.

The CTD went in smoothly at regular Station #17 despite the rolls. While it was in the water the biology team cocked the MOCNESS since the deck was a little less wet on station than during transit. During

recovery the CTD took a pretty big hit on the side of the ship and then hit the deck quite hard upon being brought over the side. Taylor and Gareth thought the strobe was firing on deck – Taylor could hear it ticking and Gareth thought he could see the reflection of the strobe. When Alex went to turn it off though he thought the strobe was off. Refocusing to S0 and then back to S1 worked fine. Alex checked on the files and found one large one that ended at 4m depth, one 55 Meg one that was collected on deck, and then two small ones. The latter two were presumably the re-focusing. The battery charge was 24.7V; this battery had been on during the last failed cast, and the unit was turned on pretty early relative to the start of the cast. It might be that the battery gave out at 4m depth and then the system restarted on deck, then shut off again by the time Alex went to turn it off. This was battery C. The decision was to proceed, but to start keeping track of what battery was used on which cast.

Also during the CTD recovery the hydrowire jumped the sheave and got pinched between the sheave and the cheek (something that apparently should not have been possible). It needed to be cut and threaded back through the sheave and then re-terminated by Meghan.

Friday September 7, 2012 – Day 13

We arrived just before midnight at day-night station #18 and started with a Reeve net tow. The seas were the roughest we had seen thus far during the cruise, reaching 8-10'. Winds were ca. 20-25kt out of the north. The Reeve net came up with *Clio pyramidata* and *Diacria trispinosa*, indicating a new community of pteropods. There were also some enormous salps, some in chains. Amy got to work on these animals. Next up was the MOCNESS. Launch was marginally slower than previously due to the conditions, but went off without a hitch and the tow lasted less than 3 hours because only 1400m of wire went out, due to vessel speed. The catch included shallow *Clio* as well as some nice large *Cavolinia uncinata*, some of which were later videotaped. Net 5 came up with a ca. 18" tear along a seam about ½ way down the net and so the night watch replaced that net.

While the biology team processed the sample, the 1000m CTD was deployed, followed by the HammarHead. Doing all of these things concurrent to processing the samples made for complicated operations, but everything went well. Rather than pick the HammarHead up for deployment the night team just dragged it across the deck to the very end of the ship, which simplified deployment substantially. Not much scattering was evident, but the team surveyed the shallow layer for a while.

The 3000m CTD cast went smoothly and overall the team responded well to the rougher conditions, with safe and smooth deployments. Since this was hump day (or just after) we did some foam cup crushing, with most of the scientists and a number of crew decorating one or more cups.

The daytime MOC deployment was a little slow due to all the water coming over the fantail (this was true for all the stern operations), but the nets went in without any obvious tangle. The tow proceeded smoothly although the surging sea and variable vessel speed led to variable net horizontal speed. The system came up with a very large tear in net 8, presumably from a surge while at the surface. The catch included one very large *Clio pyramidata* in net 2, a number of smaller ones in net 4, and some *Cavolinia uncita* shallower.

The night 1000m CTD had come up with the VPR not flashing and it turned out that data collection had ended just before the package reached 1000m, followed by a few small files. It reportedly took a couple of knocks on the way out and/or in. During the daytime MOCNESS Taylor cleaned up all of the contacts and replaced the battery cable. Meanwhile Alex realized that the hard-drive was full even though it was supposed to have been cleared off the day before. It was likely the lack of drive space that led to the aborted cast. By the daytime 1000m CTD the VPR was in good shape and the cast went smoothly. For future VPR casts the decision was to keep track on a log sheet the battery used (A, B, C) and the starting and ending voltage. We ended things with a daytime HammarHead cast, nice and short, but ensonifying

some interesting shallow structure. Despite the rough conditions and necessarily slower and more cautious operations and transitions, we completed the station in only 15.5 hours.

The chemistry team had a series of problems, including a valve issue with the DIC analyzer. This was addressed, but then crystallized salt was found inside the machine that Aleck wasn't able to remove (partly because he was unsure what was below the area in question). He therefore wrote to the manufacturer for guidance.

By this point we were more than 2 days ahead of schedule, due to time savings and the 2 days of weather that we had built into the schedule. Since we had already completed the first 18 stations we decided to add another day/night station within the 35-50N transect, meaning that there would now be 2 regular stations between day/night stations. With any additional time the plan was to extend the transect.

Every second day or so we were doing 'most-hands' meetings at 2000, as this was the watch changeover time for the biologists. These meetings served to keep people updated on plans and to remind people of things like keeping work areas tidy, being vigilant about tie-down, and the like. Meghan the res tech also used the opportunity to issue any reminders and requests.

By evening the seas had subsided substantially and winds were only 2kt. We arrived at station #19 at 2200 and started with a Reeve net tow, which came up with 3 *Clio pyramidata* for Amy, large numbers of *Limacina inflata* (leading to the speculation that these were responsible for the shallow strong 420 kHz layer on the HTI), and a variety of large and firm salps, including the kind caught on previous tows but also another and some unidentified colonial jellies. The salps were visible as large chains at the surface. This station marked the end of transect 1 and the start of transect 4, which ran due south to the survey's end point. It was numbered transect 4 because 0 was the first run out to the survey start point, after which we started transect 1, but then the blown generator required that we head in and back out on transects 2 and 3, respectively.

Saturday September 8, 2012 – Day 14

The 1000m CTD-VPR at station #20 went off in the wee hours of the morning without a hitch. Day broke on cloudy skies with patches of rain visible in the distance and reduced winds (15) out of 340 (it was coming around to the west). By mid-morning the sun was out and with air temperatures of 17C, it was very pleasant.

Station #21 was now a day-night station, under the new system of day-night stations separated by only 2 regular stations; since we were in the portion of the survey line where stations were only 30 nm apart this meant for short turn-arounds. Activities at Station #21 started right on schedule at 0830 with a MOCNESS tow. Deployment went smoothly. The ship's speed was a little slow and we ended up putting out only 1400mwo, and overall the cast was slightly under 3 hours. The nets came up untangled and unripped. Nets 4 and 5 (i.e., 400-100) had the big salps that were shallow at night. Net 5 and shallower had abundant *Limacina inflata*, very small, and net 6 had very small *Clio pyramidata*. One *Cavolinia uncinata* was present in net 7. In previous tows, we were inconsistent in how much time we spent looking through the samples and identifying the catch; since this information is only seldom used and since the main priority is to get the animals preserved, we came up with a plan to minimize the time spent sorting the sample prior to preservation. The plan was to preserve unusual pteropods (ie not previously seen) in 95% ethanol, and then if there were obviously more than 10 of a given species of pteropods to just do the regular splitting, but if there were about 10 or fewer to pick them out to a maximum of around 5. These animals were to be preserved in 70% ethanol, for use either in shell analysis or genetics. The idea was to save time in the lab by picking out the abundant stuff, but not to delay preserving things. We also decided that for now Amy and Liza would only have access to the net 0 samples to supplement their work, and not the pteropods from the stratified net samples.

Again while part of the biology team processed the samples the chemistry team plus one biologist shifted to the daytime 1000m CTD-VPR cast, which went smoothly. This was followed by a long HammarHead cast. A few shallow weak layers were present on the HTI near 50 and 150m but these were not very strong on the Edgetech. We therefore sent the HammarHead all the way down to the deep scattering layer at 360m where it saw some very interesting scattering – single targets strongest at A1 and A2, reasonably strong on the LOW and MID, and just a few spots on the HL and HH. In order to get to this depth we paid out with the ship going 5 kt (to get us in position for the later MOCNESS). By the time the fish was at ca. 320m Alex was already at the last wrap on the drum of the portable winch. We therefore slowed the ship speed to 3 kt to get the fish to sink to 370m, where it was right above some very strong and interesting scattering. As a side note, the HTI was seeing little at this depth because it was blanked out by the noise. After sampling this layer for a while we brought the fish and ship speed back up and found a somewhat interesting layer at ca. 70 m depth. Recovery happened on schedule at 1500.

Next up was a daytime Reeve net. We had planned for a 4 hour HammarHead tow as we had time to use before being able to do the night time operations. Since the scattering was mostly just the DSL we decided to end the HammarHead and do a deep Reeve net instead, since Amy and Liza both were hoping to get more animals for their work. We sent the Reeve to 280 mwo, hoping to sample the upper 200m where the daytime MOCNESS had sampled pteropods, but avoiding deeper depths where the salps were spending the daylight hours. We came up at 5 m/min except for between 82 and 47 mwo where the HTI suggested a layer was present. The cod-end was virtually empty though, with just one lonely *Cavolinia uncinata*, and then a bunch of small *Limacina inflata*. Some of the *inflata* were preserved in 70%, 95%, and liquid nitrogen.

During the Reeve net tow the chemistry team had cocked the bottles for the CTD. A number of people had wanted to do more Styrofoam cup crushing and so a second decent sized laundry mesh bag of cups went down. The charts were showing a depth of ca. 2500m making people nervous about doing a 3000m cast. The 3.5 kHz Knudsen was showing consistently a depth of 3400+ m, with jumps on occasion to 2400m. The cast was therefore carried out cautiously with a close eye on the echosounder and the CTD's altimeter, and the package made it to 3000m without incident.

The MOCNESS was cocked and with cod-ends on during the CTD cast, ready for deployment. This was scheduled for 1930, just after sunset and thus meeting our definition of a nighttime cast where the MOCNESS can't be at depth until at least an hour after sunset. Layers were seen much later in the night moving up on the acoustics, but hopefully this timing still overall captured the nighttime distribution. Deployment went smoothly at around 1940, although Taylor noticed that the weld on one of the net response bars on the net bars had broken; we broke one of them on last year's Oceanus cruise and this might be the same one. Meghan discussed it with the engineers, and planned to have it welded in the morning. The levelwind on the 0.680" winch started knocking again, like it was much earlier in the cruise, but Tom the chief engineer wasn't worried about it. The cast went smoothly, coming up in just under an hour. *Cavolinia uncinata* were present in nets 6 (50-100m) to 4 (200-400m), and *Limacina inflata* in nets 7 and 8, especially the latter.

The 1000m CTD-VPR cast went uneventfully. Next up was a Reeve net tow, which was sent to 250mwo in an effort to sample to 200m and catch *Cavolinia uncinata*. The net came up with a few in good condition, which Amy then got started on the acclimation process for her experiments. The station ended with a HammarHead cast. A layer was evident on the HTI that was targeted with the HammarHead. Strong single targets were present, strongest at the lower frequencies. Some of these were observed moving upwards, with many hits on the same targets.

Sunday September 9, 2012 – Day 15

Dawn broke over clearer skies than seen in previous days, with clouds overhead, but clear sky on the horizon. Winds were light, at 10 kt out of 340, and seas calm, ca 2-4' with no white caps. Station #22, a regular station, proceeded smoothly, wrapping up just after schedule at 0650. Station #23 followed soon after, due to the stations now being only 30 nm apart, and the CTD-VPR cast again went without incident, with the ship departing right on schedule at 1130. Once Alex looked at the data from the VPR cast it seemed that the system had logged multiple files and had missed from 58-45m in depth; it had also come up not strobing, but then started strobing on deck, consistent with the third file. The hard-drive was emptied the cast before and the battery was reading 25.4V. This was with battery B, which we took out of circulation just in case. We also planned on cleaning the battery cable each battery swap.

At the ship's nominal speed of 9 kt, we were scheduled to arrive at Station #24, the next day-night station, at ca. 1500, a little late to complete both the daytime MOC and CTD-VPR during our definition of day (i.e., MOC or VPR at depth before 2 hours before sunset). We therefore simply made the start of Station #24 the point to which we had made it to by 1330, which was ca. 12 nm north of the actual station. Given the calm conditions we were able to tow the MOC onto station. The deployment, tow, and recovery of the MOC went smoothly. The cod-end for net 0 came up again with the mesh detaching, so Nancy removed the mesh entirely, and glued in new mesh. The PVC cement requires 15 minutes to set and 24 hours to cure; since each time Nancy has re-glued the mesh in the past it has come undone, this time she left it to cure fully overnight in the fumehood. The night tow would instead use a different net 0 cod-end, with 150 um mesh net. This one had a small tear in one of the holes, which we patched up with tape since there wasn't enough time for any glue to set before it would be next used. The bottom of net 2 had the beginnings of a tear along the bottom port side seam; Nancy had stitched this up twice previously, first just with thread and glue, then with a patch of thicker canvas (scavenged from an old 150um net). This time she just glued it up.

The transition from the MOC to the 1000m CTD went smoothly as usual. Taylor helped out with the CTD deployment while Alex and Nancy got started on processing the samples and Gareth tidied up the back deck. Processing the samples conflicted slightly with dinner, but was wrapped up in well under an hour. The VPR came up flashing and with only one file collected.

The 3000m CTD was scheduled for 1800, exactly the same time as the safety drill – the drills occurred every Sunday, since that was the day of the week we sailed on. The Captain was good enough to be flexible in scheduling the drills. The crew did their drill at 1215 while the scientists mustered in the main lab for the drill at 1800. This meant that the chemistry day watch had to stay up a little later than usual after dinner and all of the night-watch biology team had to be up, but overall this was the most civilized time to do the drill we could come up with. Chief Mate Rene reminded us briefly of safety rules, after which we had a brief all-hands meeting where everyone was present, something we haven't done since we were in transit, as everyone was now on their complicated watch schedules.

The CTD came up a few minutes ahead of schedule and was soon followed by the Reeve net deployment while the chemists and Liza got started on collecting water samples. The MOC had caught one *Cavolinia uncinata* in the 25-50m depth interval and a layer was evident at that depth range on the HTI. The day before though, the Reeve to 250 mwo had been successful. Amy therefore decided to do a cast to 200mwo, return at 5 m/min to 60 mwo and then 2 m/min to 30mwo, and then 5 m/min to the surface.

When the Reeve net came up Amy and Leo went to work sorting through the catch and Gareth subbed in for Leo on the night biology team for the MOC deployment, which went off without any problems. The Reeve net had one *Cavolinia uncinata*, abundant *Limacina inflata*, but also *Limacina bulimoides* and most excitingly *Cuvierina columnella*. The latter is one of Amy's species from last year and thus should provide an interesting comparison.

The MOCNESS was successful. Wiebe had to increase the payout rate to 35 m/min to get it to sink in a reasonable time frame. The catch included some *Cuvierina columnella* in nets 7 and 8. The 1000m CTD-VPR cast went smoothly and transitioned quickly into a HammarHead cast. A similar layer to the previous night's cast was evident with the fish at a depth of ca. 70m. This was strongest at the lower frequencies and again included some nice single targets. The team then brought the fish up to 10m, where a more diffuse layer of speckled scattering, without single targets, was present. This was again stronger on the lower frequencies and Tom's analysis of the spectrum later showed a continuously decreasing shape. The ship departed station slightly ahead of schedule.

Monday September 10, 2012 – Day 16
Dawn broke over mostly clear skies and the labs were much brighter than in previous days with sunshine streaming in the through the portholes. Winds were a mild 14 kt still out of just east of north (16 deg). We continued to be under the influence of the large high pressure system that was over much of the study region for most of the cruise. The forecast was predicting similar conditions for the next few days, with perhaps a little more wind developing associated with a coastal low.

Regular Station #25 started 15 minutes ahead of scheduled at 0545, because we had been making speeds around 10 kt. The CTD-VPR cast went smoothly, and the VPR came up flashing with only one file collected. Regular Station #26 also proceeded smoothly.

With the prompt transitions, speedy operations, and 10 kt transit times we found ourselves well ahead of schedule and due to arrive at day-night Station #27 at 1450. This would have required killing time until after dark before starting the night operations and then also killing time over dawn before doing the day operations. We therefore decided that like yesterday we would stop wherever we were at 1330 and make that the start of Station #27. This ended up being 15 nm north of the actual station location (37N 135W); the previous day we had started day-night station #24 12 nm north of the actual station though, and so this was very similar.

We therefore started again with a MOCNESS tow that went into the water right at 1333. We again were towing with the wind and the differential currents at depth led to us needing to pay out 2017m of wire to get the net to depth, and it took over an hour to get there, even going at 35 m/min for the last 1000m or so. We hauled in relatively slowly in order to filter even more water (ca. 1500 m3 for the deep nets) than before as these were sparse waters. The net response on net 5 didn't fire, and so after giving it one extra step on the motor Gareth incremented the net number. A few minutes later the net response fired, suggesting that the net had hung up. After the cast, Peter measured the distance from the top of the stack of dropped bars (with 4 dropped) to the net response, and estimated that if the bar for net 5 hung up it would be positioned such that net 5 would be 40% open and net 6 60% open. He therefore used these numbers in recalculating the volumes filtered. The nets came up untangled and recovery went smoothly. Some juvenile *Cuvierina columnella* and a few *Limacina inflata* were in net 4 (600-400m), a few *Cavolinia uncinata* were in nets 6 and 7 (100-50 and 50-25m), and then *Limacina inflata* and *bulimoides* were in net 8.

The transition to the daytime CTD-VPR was very fast as Jack on the bridge wasted no time in turning us around and into the wind very quickly. The daytime CTD-VPR to 1000m started at 1750; sunset was at 1914, so we were slightly behind schedule in our goal of having the VPR at depth 2 hours or more before sunset. The VPR operated normally, with the strobe flashing upon recovery and only one file collected. The 3000m CTD followed the 1000m cast. Many of the science party mustered on the back deck at 1914 as the sun set since it had been such a clear sunny day and this was one of the first visible sunsets in a while.

In the twilight the biology team replaced nets 1 and 3 on the MOCNESS. Net 1 had a region with a number of small holes and was overall in bad shape. Net 3 had one largish tear, ca 2" in length, along a seam about half way down. Rather than patch these up on the back deck, we decided to replace them – net 3 was replaced with the one last decent undamaged net we had, while net 1 was replaced with a net that Nancy had patched after it had been removed some casts ago. The replacement for net 3 had a small hole about 1/3 of the way down from the mouth, which was patched with some silicone. The persistent tear in net 2 that had re-opened on a few occasions despite Nancy's sewing it closed was glued with silicone yesterday about 2 hours prior to the night cast. That glue appeared to be holding.

After the 3000m CTD, next up was the Reeve net. It came up with very little catch, and only 4 small *Clio pyramidata* for Amy's work. The one *Cavolinia uncinata* went into the tank for observation and videotaping. It still had its pseudoconch, which was very interesting to look at. With Amy and Leo processing the Reeve net and the chemists working on the 3000m CTD's samples, the rest of the biologists moved on to the MOCNESS. Winds and seas had built since the morning's tow and it was no longer prudent to tow with the wind and so instead we towed on a course of 012. Deployment went smoothly, with only a couple of big waves coming over the fantail. The tow went a little longer than usual since like during the day we wanted to filter more water than previously. The catches were still relatively small, but had a reasonable amount of pteropods. *Clio pyramidata* were in nets 6-8 and some were put in liquid nitrogen. *Cavolinia unicinata*, *Cuvierina columnella*, and *Limacina inflata* were also present in the top 100m.

The nighttime 1000m CTD-VPR went smoothly and was promptly followed by the HammarHead. Scattering was moderate and mostly similar shallow DSL-looking single targets strong at the lower frequencies. Upon trying to process the data, Tom was unable to unpack the A1 and LOW (which share a sub-system). Since we were not likely to make the next day-night station in sufficient time to do any day operations as we were forecast to arrive around sunset, we had time for an extra Reeve net tow. This came up with few pteropods though, and only two more small *Clio pyramidata* for Amy's work.

Tuesday September 11, 2012 – Day 17

By morning the seas had settled down a little from the previous night and were ca. 2-4'. Although multiple people commented that they felt the winds were stronger, they were reading 14-19 kt on the anemometer, out of 43 degrees. The day-night activities at Station #27 had ended ca. 20 nm north of the planned station, making for a particularly long steam to regular Station #28. We arrived at Station #28 at 1010 and the CTD-VPR went smoothly. As on recent casts, the VPR came up with only one file and the strobe flashing.

A small bird of prey, later identified as a merlin, was spotted near to the ship, looking for a place to set down. Shortly after our lunch it caught a petrel for its own lunch. Later in the day a peregrine falcon arrived. After some dive-bombing, the two birds arrived at some understanding and after a while were perched near to one another on the MET tower. We arrived at regular Station #29 on time at 1500 and the cast went smoothly.

Arrival at day-night Station #30 was at 1945 and so we started with a 3000m CTD cast to while away the dusk transition. Next up was the Reeve net, which sampled a few pteropods for Amy's work, but not too many. The MOCNESS was delayed by nearly 45 minutes in waiting for the trawl winch to come on-line but was still done within 3.5 hours and so nearly on schedule. The nets came up in quite a tangle and the biology night team was quite concerned about the very low catches in the deepest nets (so sparse that they only preserved in formalin), until they looked at the CTD data and saw that the OMZ has shoaled up such that oxygen was nearly zero by 600m. The catches were more abundant in the shallower nets, but were quite beat up. Nets 6-8 (<100m) had some pteropods, including large *Clio pyramidata*, *Diacria quadridentata*, *Styliola subula*, and *Cavolinia inflexa*. While the biology night team processed the

samples, the CTD-VPR went back in for a night-time cast. The cast went smoothly and the VPR worked properly. The Reeve net then sampled to 70 mwo and caught a large abundance of large specimen, ideal for Amy's work.

The HammarHead cast sampled a couple of minor layers, but very little of note was evident acoustically, and the abundances of pteropods in the nets did not seem likely to be generating any substantial scattering. When Tom later went to analyze the data he was unable to unpack the HH and HL. Replaying the data in J-star, unlike the previous day where the A1 and LOW didn't unpack, but the data appeared to be present in J-star, for these newer data the HH and HL were incrementing less frequently in the early files than the other channels and not incrementing at all in later files. Tom began trouble-shooting; it appeared that minimally the wrong HH/HL pulse was being used (one of the ones where only one of the two was mangled).

Wednesday September 12, 2012 – Day 18

The daytime CTD-VPR for Station #30 began right on schedule at 0730, nearly an hour after sunrise, and thus meeting our definition of daytime. Winds had picked up to 20-25 knots and 2 or 3 different swells were at work making for a jerky ride. The skies again were overcast. The daytime MOCNESS tow started just before 0900. Deployment went smoothly, but during payout for the first 100 m of wire the ship was pitching around a lot on confused swells and the wire was snapping a great deal and the frame angle highly variable. We again got no net response upon closing net 5, although in this instance the net didn't show any evidence of hanging up and sampling with two nets part-way open. Presumably the bar simply missed the net response. Gareth incremented the net number manually, and then at the time the next net was to be stepped accidentally incremented another net number, since the mouse was already positioned over that button.

During recovery, the last 100m of wire also had a lot of snaps and rolls. The nets came up in the biggest tangle we had yet seen on the cruise. Sample was evident above the tangle for nets 1 and 2, suggesting it had been there a while. The other nets seemed fine in terms of sample being in the cod-ends, except for net 7 or 8 (we weren't sure which), where sample was found in the net above the knot. The samples were fairly sparse and very beat up. A few pteropods were present in nets 4-8 (i.e., as deep as 400-600m), but not many and none of the *Clio pyramidata* present at night that we were hoping to see. We considered redoing the net tow, but decided that since we couldn't be sure that with the seas we would have been able to do a better job and since the night tow also was sub-par, we would instead press on. We were scheduled to get to the next planned day-night station (#32) in the wee hours of the morning, with insufficient time to complete the night operations before sunrise, and so decided to make station #31 (1 degree of latitude away) a day-night station.

Over the previous few days plans had been made for the demob in Port Hueneme. Because our cruise extension displaced Uwe Send's cruise (originally scheduled for September 6), the schedule was for us to arrive on September 18 and for Send to depart that same day. This required a great deal of coordination.

Station #31, the brief regular station between two day-night stations, went quickly. Bottle #15 on the CTD mis-fired.

We arrived at Station #32 on schedule just before 2245. The winds had subsided to ca. 12-14 kt, out of the northeast. Given the issues with tangles in the MOCNESS we decided to try towing with the swell. Liza and Leo noted that the nets were surging forwards and backwards as the net system went in, but overall they thought the nets were streaming fairly well. The tow itself went smoothly but the system came up with the nets in a horrible tangle, the worst Leo had seen on the cruise. Very little sample was present in the deep nets, and all of it was preserved in formalin. Larger samples were found in the shallow nets, especially net #8. The samples were beaten up though and sample was seen above the knot, though it

wasn't noted which nets had sample above the knot. Gymnosomes were happily swimming from nets 0 and 2 though, whereas in net 6 the one gymnosome was completely shredded up. Some thecosomes were present in net 8, in reasonable condition, including *Clio pyramidata* and *Cavolinia inflexa*.

The night-time 1000m CTD-VPR cast went smoothly and the VPR again performed fine. Perhaps taking the one battery that was known to have been associated with a failure out of circulation did the trick. Next up was the Reeve net, which Amy targeted at shallow depths, catching *Cavolinia inflexa* and *Cuvierina columnella*.

The HammarHead targeted mostly shallow depths. To avoid any potential problems since the past two casts have had issues with data unpacking, Tom and Peter decided to collect data only at 1Hz with the RAW on, rather than turning off the RAW and increasing to 2 Hz, as had been typical of most other casts. The data unpacked fine. At one point, vertical streaks of high scattering were evident on the lower four channels, similar to Langmuir cells.

Thursday September 13, 2012 – Day 19

The day started with clearer skies than we'd seen in a while, light winds (ca. 12 kt) out of ca. 15 degrees, with a 4-6' swell coming out of the northeast, but otherwise light seas. Still at day-night Station #32, the HammarHead cast was followed directly by the 3000m CTD cast. The night biology team had also realized that under the latest system of walking the HammarHead to the stern before picking it up with the winch and deploying, it was no longer necessary to shift the MOCNESS so far forward to make space, simplifying transitions between operations.

The day shift of the biology team came on and started immediately with a MOCNESS tow. Given the continued problems with tangling, the tow was done into the wind, and so to the north. This put the swell very slightly on the starboard side of the vessel, leading to more rolling and less pitching. That, combined with lighter seas, made for much less snapping of the 0.680" cable. The tow went extremely well, with constant and appropriate speed and frame angle. The nets came up without any tangles and the catches were decent. Net #4, which sampled 400-600m sampled a few *Clio pyramidata*, *Cuvierina columnella*, one *Cavolinia inflexa*, as well as many small probably Limacinids. Probable *Limacina inflata* were also present in net #6, but this will await verification in the lab. Two *Cavolinia uncinata* were in net #0, one put into de-ionized water for Liza and one put in 70% ethanol. A couple of the nets had very small sample, not worth splitting, and these were put in their entirety into 95% ethanol. Oxygen levels seen on the CTD go to near-zero by 600m in this area and so the lack of large catches in the deep nets wasn't too surprising.

While the biology team processed the samples the CTD-VPR was deployed for the daytime 1000m cast. The VPR again worked fine. Within the hour of the cast the biologists finished processing the samples and were ready to deploy the HammarHead. It went in with the vessel still on the course to the north it had been on for the CTD and then came about to tow towards the south (i.e., back towards station). Virtually no scattering was evident though, on either the Edgetech or the HTI. A weak layer was evident at 10m range with the fish at ca. 70m, at a location where a thin layer was present on the HTI. This might have been one of the layers that Peter has been speculating might be due to the very strong salinity gradients we've been seeing. In any case, the HammarHead cast was kept short given the lack of interesting features, and was on board and the station completed by 1335.

Station #33, our last regular station of the cruise, started at 1800 and so continued over sunset. The horizon was a little cloudy, but the day had been sunny and a number of scientists gathered on the back deck to admire the colors of the horizon. This put us on schedule to arrive at day-night Station #34, the last station of the cruise, at 2230, pretty much the same time at which we'd started MOCNESS operations at the day-night stations of the past two nights.

We arrived at day-night Station #34, the last station of the cruise, just before 2230 and started immediately with a MOCNESS tow. The nets went in and came out very nicely, with no tangles and the sample not beaten up. A variety of pteropods were present in the upper 200m, including *Clio pyramidata, Cavolinia inflexa, Styliola subula, Diacria trispinosa, Cuvierina columnella,* and *Diacria quadridentata.* After an uneventful 1000m CTD-VPR cast the Reeve net went in. Based on the MOCNESS catch, Amy targeted the upper 25m, putting out 35m of wire and parking the net for a while at 30mwo. This resulted in *Clio pyramidata, Cavolinia inflexa,* and *Styliola subula,* among other things, but these were the species used for respirometry.

The HammarHead was up next. Peter and Tom surveyed some shallow layers that seemed potentially associated with hydrography – we were in a region of high surface salinity and strong salinity gradients. They therefore ended the cast by turning the HTI on for a while while they tow-yoed the HammarHead through the layers to get T-S data.

Friday September 14, 2012 – Day 20

Dawn broke with cloudy skies, but warm temperatures and light winds (5 kt) with the swell still out of the NE but reduced to ca. 1-2' and no chop. The 3000m CTD occupied the dawn transition. The MOCNESS went in at 0830, a little behind schedule. The deployment went well as the seas were calm. Two of the nets looped under the frame briefly, but seemed to resolve themselves. The cast proceeded very smoothly, but the nets came up in a tangle; not as bad a tangle as two days earlier, but a tangle nonetheless. Some sample was above the cod-ends, in net 1 and some of the others. It wasn't clear whether this was from before or after the tangle occurred, and it seemed for nets 7 and 8 that the cod-ends had been tipped upside down at some point. Overall it was hard to tell when the tangle occurred. The wire wasn't snapping like the previous time it tangled, but unlike yesterday when Gareth had brought the net up at 10 m/min throughout the top 100m, in this case he slowed to 5 m/min, and perhaps this gave the nets more time to tangle up. In any case, the catch was quite beaten up in the deep nets and the sample was small. Net 4 had filtered nearly 2000 m3 of water and was the net where the large pteropods were found, including *Clio pyramidata, Cavolinia inflexa,* and *Styliola*. The topmost two nets had highly ground up brown material. Gareth and Alex had noticed a smell upon recovery and so we wondered whether this might have been some kind of detritus.

After the 1000m CTD-VPR cast we decided against doing a daytime HammarHead cast due to the lack of any interesting scattering on the HTI – a weak layer was evident at ca. 50-100m on all frequencies, but when we had gone to a similar looking layer during yesterday's day tow with the HammarHead it had produced only very light speckle, not worth repeating. This therefore marked the end of survey activities.

Because the oceanographic winch's 0.322" cable needed to be reterminated, immediately after the CTD-VPR cast, we took advantage of having a winch operator and multiple hands to remove the VPR and its stand. This involve simply immobilizing the CTD with taglines and the wire, taking off all of the hose clamps, lifting the CTD off the stand and pulling the stand out.

While the chemistry team continued to process the 3000m water samples, the biology day team started taking off the MOCNESS nets and washing them down. They then started unloading some of the backup gear and other large totes from the van, in order to get access to the MOCNESS box and the empty boxes that were right in the back of the van. With a break for dinner and help from Tom and Peter, who had begun their transition to a day schedule from their night watch, the MOCNESS was fully disassembled and packed by 1900.

At 2100 we stopped at test station 9 for a Reeve net tow as Amy continued to do her physiology work. Unfortunately she only caught 3 *Clio pyramidata* suitable for her measurements. She fished mostly

shallow (30 mwo), as the MOCNESS tows of the previous nights had found pteropods in net #8. Either they had changed their vertical distribution or this was just horizontal patchiness. We did an XBT after the tow. At 0030 Amy did another Reeve tow, preceded by an XBT launch. This tow also didn't yield many animals for Amy's work. At 0400 she discussed with the Captain the idea of doing a third tow, but he preferred not to do so until we were farther towards Port Hueneme, in case we weren't able to make as good speed later in the transit. Because the van was to be packed on Sunday Amy wouldn't have had time to run any animals from a Saturday tow, and so this meant over-the-side operations were complete for the cruise.

Saturday September 15, 2012 – Day 21
The day started again with cloudy skies and calm seas, with winds of 12 kt essentially out of the north. The chemists had completed their pH, DO, and salinity measurements of the samples from the final station and were working on the backlog of DIC and TA. The biologists started packing up gear around 0830 and made good progress. By the end of the day the HammarHead was ready, the back bench of the storage van had a first layer of packed boxes (mostly computers and monitors), the aftmost wire cage was packed (of the three wire cages in a row), and a plastic cage was installed on top of that cage.

Sunday September 16, 2012 – Day 22
Overnight Amy and Leo packed up much of Amy's gear in the 01 lab van. The chemists got up early to start packing. As the chemistry team packed up their instruments and samples, the biologists got to work on the van. At 1215 there was an abandon ship drill with a competition between the biology team (represented by Amy), the chemists (represented by Elliott), and the crew (represented by John Diaz) to see who could don a survival suit the fastest. After the drill we had a series of group photos, and then Rene the chief mate opened up shop to sell ship's t-shirts and hats. By dinner time most of the gear, including the VPR (in its stand), the MOCNESS, the HammarHead, and a large assortment of totes and boxes, were secured in the shipping van.

Monday September 17, 2012 – Day 23
Although the forecast a few days earlier as we were planning our return had been for increased swells from the south associated with a tropical storm off Mexico, the day began with quite calm seas and a ca. 2' swell. Skies were grey and somewhat foggy, with an air temperature of 16C, and light winds (7 kt) out of 317.

At 0100 the ship changed its clocks to PST, but despite the lost hour of sleep much of the science party was up early for breakfast and people were soon hard at work processing data and writing the cruise report. After lunch we shut down the underway systems: MICA, the GO pCO2 system, and the HTI multi-frequency system. With these systems shut down science was fully ended and everything could be packed up. By dinner everything was in the vans and the labs were cleaned.

Tuesday September 18, 2012 – Day 24
Most of the science party was up early, some before dawn to see the sunrise. The seas were calm and skies sunny for our arrival. Soon after dawn we were seeing oil platforms, other vessels, and other signs of life, and started to smell the nearing trees. We had slowed down to 5 knots overnight to avoid getting to port too early, and then just before 0800 headed in more quickly through the channel into the commercial dock at Port Hueneme.

The gangway was soon down and work on the offload began. Two res techs from SIO had come up to facilitate the work (Jay and Lee), one of whom was taking over as res tech for the next cruise. The first order of business was to remove the sled in the moon pool housing the HTI transducers and MUX bottle. The sled was installed with four metal wires attached with turnbuckles and shackles to eye pads at the top of the shaft, and had two lines attached to it, one to its center point and one aft. John Barnes the A/B got

into the bo's'n's chair and was lowered by the crane into the shaft. Getting the crane ready had taken some time as most of the people involved hadn't previously extended the crane to its maximum extension, which required removing a few pins. John loosened the shackles then was hoisted out of the shaft. The line attached to the midpoint of the sled was looped around the crane's hook and then the metal wires detached. It turned out that the other line, tied to the back of the sled, had frayed away. The decision was thus to use two of the metal wire to raise the sled out of the well, since it was bigger than the shaft and so had to be done at an angle, and hence couldn't be done with the line attached to the center. The first few attempts were unsuccessful, likely because a corner of the sled was catching on the edge of the shaft below the hull. We therefore revised the plan and used just a single wire, which worked well.

The sled was lowered onto the main deck where it was rinsed down and the HTI transducers, MUX bottle, and mounting plate were removed from the sled and put into the box we had had constructed for their transport. The box was put into the van, all of the last items were stacked on top of it, and tied down, and then the van was ready to go. Mid-way through the removal of the sled the big crane had arrived (scheduled for 0900) and had removed the UNOLS lab van, which was loaded onto a 40' flatbed that soon left for Oregon. Once we had the blue storage van packed the crane shifted it onto the dock. Wiebe noticed that the rear lifters on the crane came off the ground by a foot or so. The Captain had requested a crane capable of 17,000 lbs as our van had been 16,600 lbs when it was moved on the ship. Apparently when it went off it was 20,000 lbs! This was partly more gear (the DO titration system and the HTI transducers), but presumably mostly due to the seawater in the formalin-preserved MOCNESS samples and TA/DIC bottles.

Katherine, Amy, and Sophie had left the ship around 0930 to pick up rental cars. Katherine and Sophie bought a cooler for the nutrient samples and shortly before lunch headed up to UCSB to drop them off at the nutrient analysis facility, along with some leftover chemicals. Amy picked up some dry ice and a cooler to ship her water samples for ammonia analysis back to WHOI. In the late morning all of the samples and items being transported via means other than the van (the nutrient samples, Amy's ammonia samples, mercury samples for Carl Lamborg, the box splitter being sent to Jeff Runge) were packed and ready.

Shortly after lunch the next science party for Uwe Send's mooring cruise started arriving and so our team shifted personal gear off the ship and onto the dock. Gareth and Peter tied down the ethanol-preserved MOC samples in the cold locker. Nancy and Taylor had wrapped these up in garbage bags earlier as the cold locker was quite wet. The refrigerated truck that was supposed to have picked these samples up had canceled on us and John Brinkerhoff had been unable to locate a replacement that he was confident in, and so the plan was to leave them on board in the cold locker so that they could be shipped from San Diego after the ship returned 4 days later. Arranging for a replacement truck ended up proving to be a time-consuming and expensive prospect, but eventually the samples did get shipped home, and the Marathon temperature loggers installed in the boxes confirmed that the temperatures they experienced never got too high.

Rather than shuttle our science party in a series of trips in the one rental car that wasn't en route to Santa Barbara, Wiebe convinced the driver of the Scripps 15 person van that had brought up the Send science party to transport our team to Ventura, where we were staying at the Best Western. By about 1230 all of our personnel and gear was clear of the vessel. The Send gear (a large buoy and various other large mooring-related items) was still being loaded, but by 1830 when Gareth checked the ship track website they had departed Port Hueneme and were well en route for the mooring site.

Elliott had left earlier in the day, having been picked up by his father (who had lunch with Aleck and Elliott) but the rest of the team went out for drinks on the Ventura beach before Nick, Kelly, and Alex had

to leave to make their flights. The remaining science party members had a last dinner together at a brewpub, and the next day dispersed for their various next destinations.

Instrumentation, Methodologies, and Preliminary Results

6. Equipment Configuration

6.1. *Deck configuration*

The CTD rosette with VPR stand was located on the starboard side working deck immediately outside the wet lab bulkhead and next to the J-frame (Figure 6.1, 6.2). Two tag lines tied to the house and a third tied to the rail were used for deployment and recovery. The CTD was deployed via the oceanographic winch with 0.322" wire and its own block on the J-frame. Two large boards were removed for each deployment/recovery to give the CTD-VPR package enough room to clear the rail. The Reeve net was deployed via the winch with hydrowire and its own block forward on the J-frame; when not in use the Reeve net was stored in the wet lab. Forward of the CTD was the cold locker, kept at near freezing and used to store ethanol and ethanol-preserved net samples. Aft of the wet lab bulkhead one full and one empty 55-gallon drums of ethanol were strapped to the house. Aft of the barrels and under the stairs to the 01 deck was the 140L tank of liquid Nitrogen, protected from the sun by a tarp (and by the lack of much sun during the cruise).

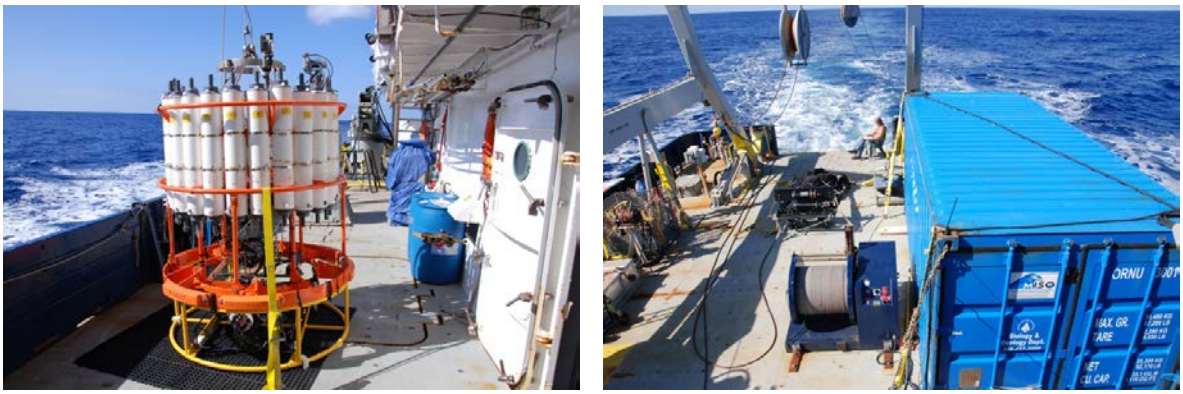
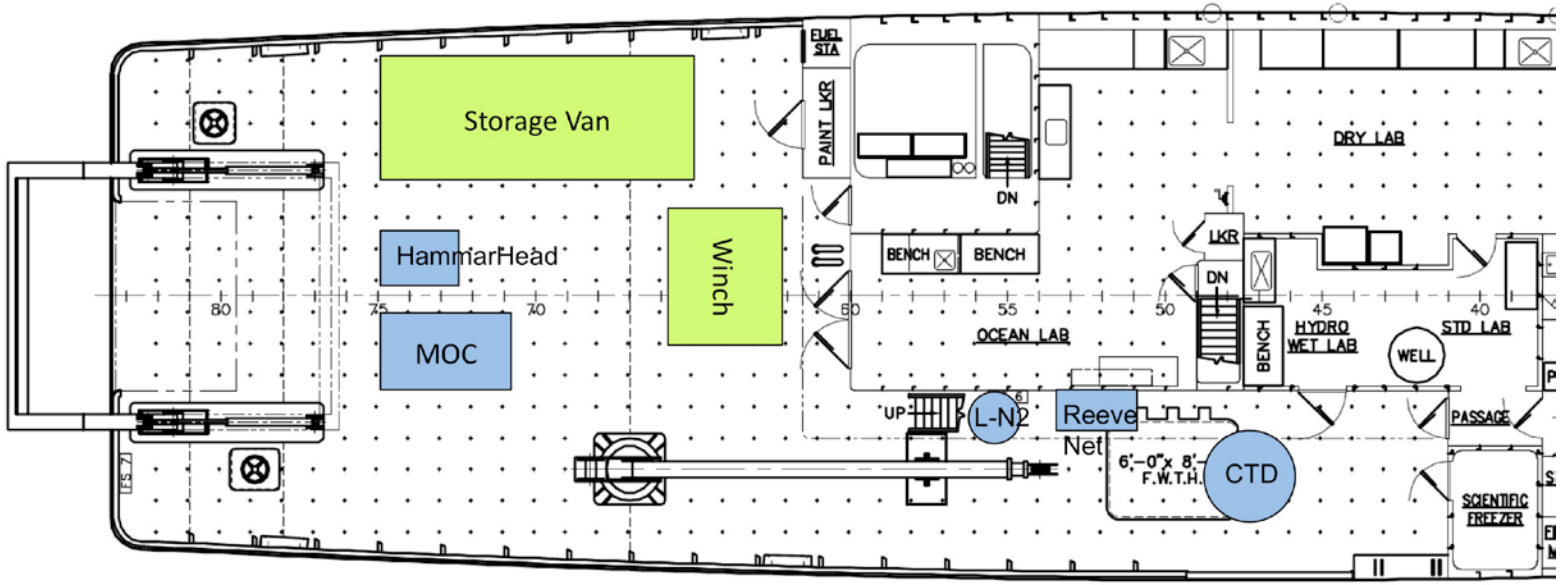


Figure 6.1 – Main deck layout. Left: Starboard-side working deck layout, with CTD outboard of wet lab bulkhead, showing ethanol drums and liquid Nitrogen canister strapped to the house. Right: Fantail layout, showing blue storage van (port side), Sea Mac portable winch, HammarHead towed body (aftmost), and MOCNESS (center of A-frame). [Photos: G. Lawson]

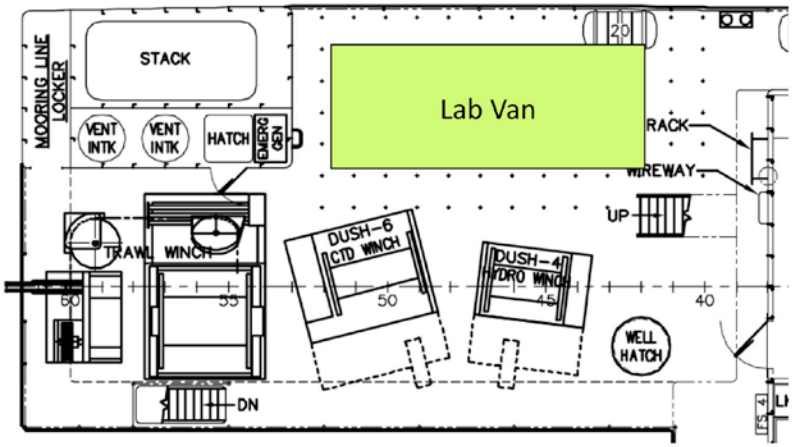
The MOCNESS was situated along the ship's centerline near the fantail and deployed via the trawl winch and 0.680" wire, through a large block on the A-frame (Figure 6.1). A SeaMac portable winch with 0.322" wire supplied by SIO was located just to port of the centerline and was used with the HammarHead towed fish, which was kept just inboard of the A-frame.

Two portable vans were installed for the cruise. One was a 20' container van (aka the blue van) used to ship gear from WHOI to Newport and used during the cruise for storage; this van was installed aft on the main deck next to the port side rail. A general purpose lab van (technically the OPP general purpose van) was supplied by Demian Bailey and the UNOLS West Coast van pool and installed on the 01 deck port side.

MAIN DECK:



01 DECK:



Ethanol

Backup Rosette

We also have 3 collapsible shipping crates (stackable, footprint 48x48"), a bench that will be removed from the lab van, and the crate for the moon pool sled electronics that will need to be stowed.

Figure 6.2 - Planned deck configuration

Figure 6.3 – Planned lab configuration.

6.2. *Lab configuration*

The dry lab (i.e., the main lab) housed, in order of increasing proximity to the stern on mostly athwartship benches and counters: (1) a high counter above a series of drawers on which were the VPR charger, data extraction computer, spare MOCNESS underwater units, and external hard-drives; (2) a T-shaped bench with the HTI multi-frequency and Edgetech echosounders and associated computers, an acoustic log/data processing computer, and a VPR processing computer, (3) a high counter above drawers and the CTD deck units on which were located a tote with frequently used items (multi-meter, tape, useful tools, label maker, drill, etc), a computer used for event logging and displaying the ship's progress, a spot for the R2R Ipad, and a radio charging station, (4) the CTD station with multiple monitors for various data collection and display computers where the MOCNESS laptop and deck unit were installed, and (5) an L-shaped bench where Peter Wiebe, Gareth Lawson, and often one other set up their laptops (Figure 6.3, 6.4). Along the port side of the lab was a high bench for the MICA, DO titration system, and DIC analyzer.

Off the main lab was the wet lab. The forward portion of the wet lab was used for microscopes and the scope camera rig. An opening leading into the passageway between the mess and the side deck was walled off with plywood, via a compression arrangement involving 2x3"s and bolts, so as not to damage the wall and paint with glue or screws. This was done in an effort to keep the forward portion of the wet lab dry, since the bulkhead at the end of this passageway is usually kept open except in the worst seas. The forward portion of the wet lab was further sectioned off with a black freezer curtain from the aft section to keep it as dry as possible given that computers were installed there. The aft section of the wet lab was used for processing seawater samples as they came from the Niskin bottles, staging them there before transfer to the instruments for analysis.

Aft of the dry lab was the L-shaped Ocean lab. On one large high bench positioned athwartship were the pH analyzing system and alkalinity titrator. A bench running along the portside housed the General Oceanics pCO2 system. An athwartship high bench with sink was used for staging samples and washing vessels. Next to this was a low computer bench where Aleck Wang and typically one other set up laptops. Due to the lack of coat hooks a rail was installed to hang foul weather gear on along the starboard side of the lab, next to a set of shelves housing work vests and hard hats. Aft of this was a small wooden bench with a tote of frequently used items (7/16 wrench and socket, DC-4, nippers, tape, multi-meter, etc) and the MOCNESS tool chest. Aft of this and before the bulkhead was a high bench used for sample processing and storage on shelves below. Facing this was the fumehood and a second high bench with sink used for sample splitting and processing. One desk suitable for laptops was available in the 01 deck lab and was typically used by the res techs.

The general purpose lab van on the 01 deck was used for Amy Maas' respirometry experiments. One of the benches was removed and stacked on top of another, making room for an 8-place gas cylinder rack and Amy's bottles. Liza Roger used the van's fumehood for drying her shells and set up her gear next to the hood on the bench. A microscope was also installed to examine specimens.

Figure 6.4 – Lab layouts. Clockwise from top left: Dry lab, microscope setup in forward portion of wet lab, wet lab, 01 lab van, aft section of ocean lab, forward section of ocean lab. [Photos: G. Lawson]

7. Hydrography and Meteorology

Peter Wiebe

7.1. *Overview*

Regional current flow and ocean color based satellite data for the months of August and September were obtained to provide a context for the data collected along the cruise trackline. Ocean color and sea surface

temperature data were obtained from:
http://coastwatch.pfeg.noaa.gov/coastwatch/CWBrowserWW180.jsp

The ocean surface currents were obtained from:
http://www.oscar.noaa.gov/datadisplay/oscar_datadownload.php

The highest chlorophyll values occurred in the coastal waters along the North American west coast, a region dominated by meso-scale eddies. The high values were in areas of offshore transport often characterized as "squirts and jets" (Figure 7.1). High values also occurred in northern portions of the Gulf of Alaska just to the northeast of the first few stations on Transect 1. In the open ocean beyond the high coastal values, moderate chlorophyll values were present down to 42 N and then they dropped to substantially lower levels south of 40 N. Along transect 1, flow was relatively slow and generally to the east. Numerous meso-scale eddies were distributed throughout the eastern central Pacific region south of 40N as evidenced by the circular current vector flow patterns.

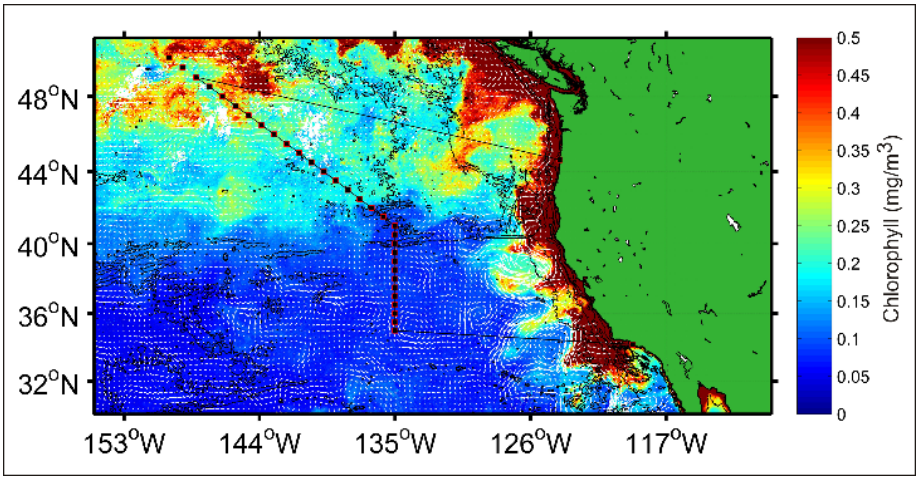


Figure 7.1. Sea surface chlorophyll and ocean current vectors (white) overlaying bottom contours (black) for the August and September 2012 period of cruise NH1208. Also displayed are the stations (red outlined squares) and the cruise trackline (black) following the last departure from New Port Oregon and arrival in Port Huemene, California.

7.2. *Underway Data*

Along-track measurements were made continuously during the course of the cruise, to provide information on environmental conditions and for certain calculations made by the chemistry team. After the end of science activities on the previous cruise, while en route back to Newport, the engineers put chlorine pucks into the filter baskets for the uncontaminated seawater line. These were designed to kill any organisms in the line and thus to minimize any changes that might occur to the seawater en route to the instruments to measure pCO_2 and other chemical properties underway on this cruise.

7.2.1. Along-track Sea Surface Data

Sea surface temperature, salinity, and fluorescence data were collected approximately once every 30 seconds upon leaving port. These data were saved on the ship's data server on a daily basis in a several file formats including the "MET" file format. These ASCII files were moved into Excel "xlsx" files and then data of interest were read directly into Matlab for further processing and plotting. The daily files were aggregated for display to correspond to the transect sections sampled on this cruise (Figure 7.2).

The transit from Newport, OR to the first station location at 50N; 150W was designated transect 0. The failure of the ship's generator shortly after starting work on Transect 1 required a transit back to Newport, OR on transect 2. After the repairs, transect 3 took us back to the position on transect 1 where the cruise work resumed. Thus, transects 0, 2, and 3 traversed nearly the same path between Newport and the first station locations. The short portion of transect 1 was combined with the data from Transect 0 for the data summary and the figures of the along track data.

Due to Columbia River outflow into near shore areas off the Oregon coast, salinities well below 32 PSU were encountered off Oregon for about 200 nm on transects 0, 2 and 3 and temperatures in the plume were slightly elevated. Further offshore sea surface temperatures were between 13 and 15 C and salinities in the 32 PSU range (Figure 7.2 A, B, C; Table 7.1). Chlorophyll values were very high (max of 23 to 29 ugat/l) either leaving or arriving in Newport, OR, but quickly dropped to values less than 2 ugat/l offshore. Nonetheless, there were a series of coarse- to meso-scale peaks and valleys with values ranging between 0.8 and 6.4 ugat/l along these three transects.

At the beginning of transect 1 in the Gulf of Alaska near 50 N; 150W that ran southeast to 41N; 135 W, salinities gradually increased from the low 32 PSU's up to about 33 PSU at the southern end of the transect (Figure 7.2 D; Table 7.1). Temperatures also showed an increase from values as low as 12.65 C at northern end of the transect (station 3) up to 18.05 C at the southern end (Station 19), but with a more rapid temperature increase mid-way along the transect that marked the move into the transition zone between the subarctic waters in the Gulf of Alaska gyre and the subtropical/tropical waters in the Central Pacific gyre. Chlorophyll values undulated strongly along transect 1 in a series of seven peaks and valleys with values ranging between 0.8 and 4.2 ugat/l until near the southern end when values became more constant (Figure 7.2 D). The reason for the strong meso-scale structure on the transects between Newport and the transect 1, and along transect 1 remain to be determined.

On transect 4, running south from 41N; 135W to 34N; 135W, temperatures and salinities increased slowly from 17.7 to 21.2 C and 32.9 to 34.3 PSU respectively, except at the two most southern stations (33 and 34), where there was an abrupt increase in surface salinity and a more modest increase in temperature (Figure 7.2 E, Table 7.1). Chlorophyll also increased gradually from about 1 to 1.9 ugat/l on the northern portion of the transect and then more rapidly up to 4.6 ugat/l on the southern portion of the section.

The trend of increasing chlorophyll continued as the New Horizon turned east for the final transect (5) east to Port Hueneme until two-thirds of the way to the southern California coast when an abrupt change in fluorescence occurred at a frontal feature that was also evident in the temperature and salinity values (Figure 7.2 F). In general temperature decreased until the ship entered the coastal waters between Santa Barbara and Los Angeles, wherein it increased slightly. Salinities along this transect varied between 33 and 34 PSU without a trend.

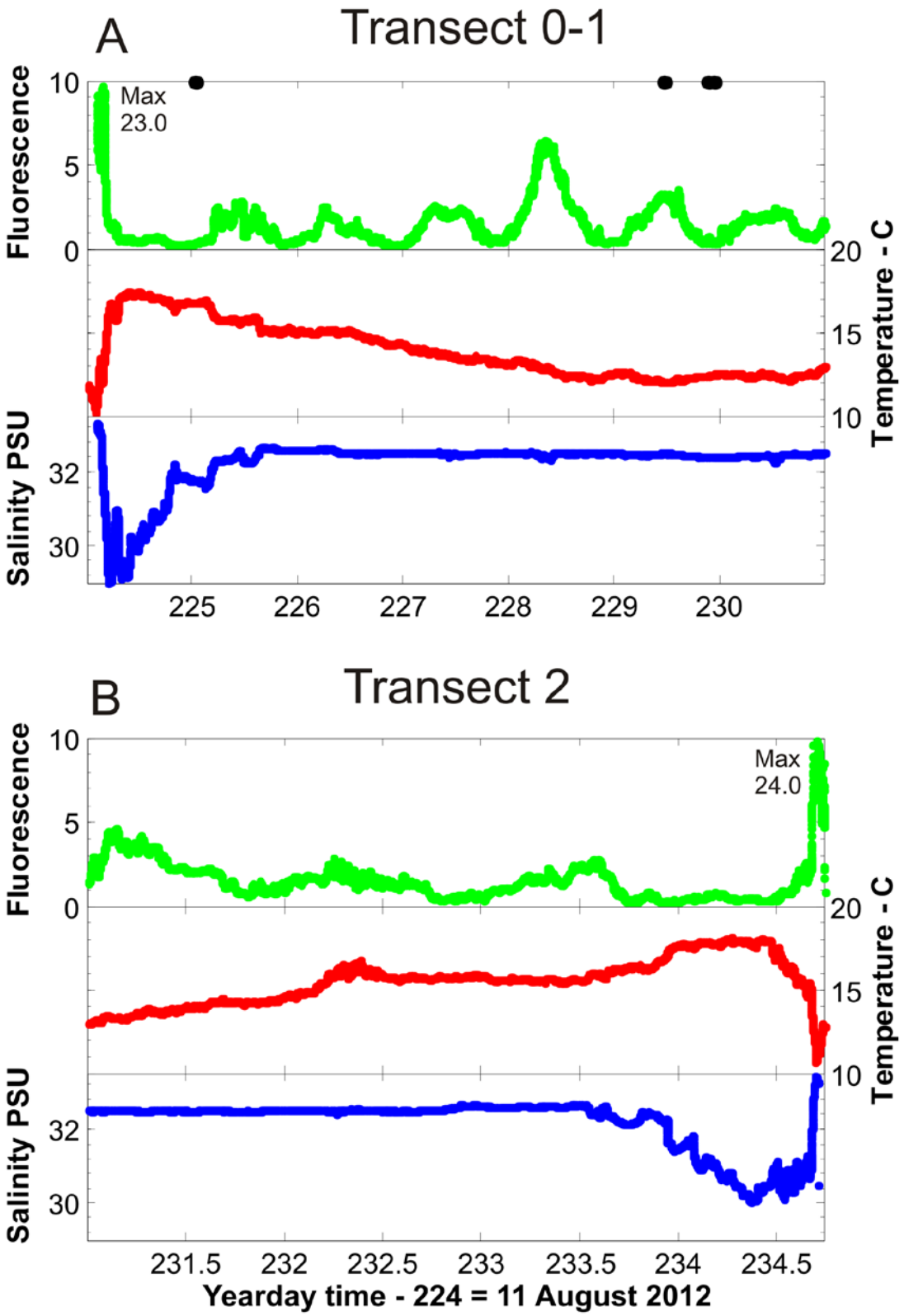
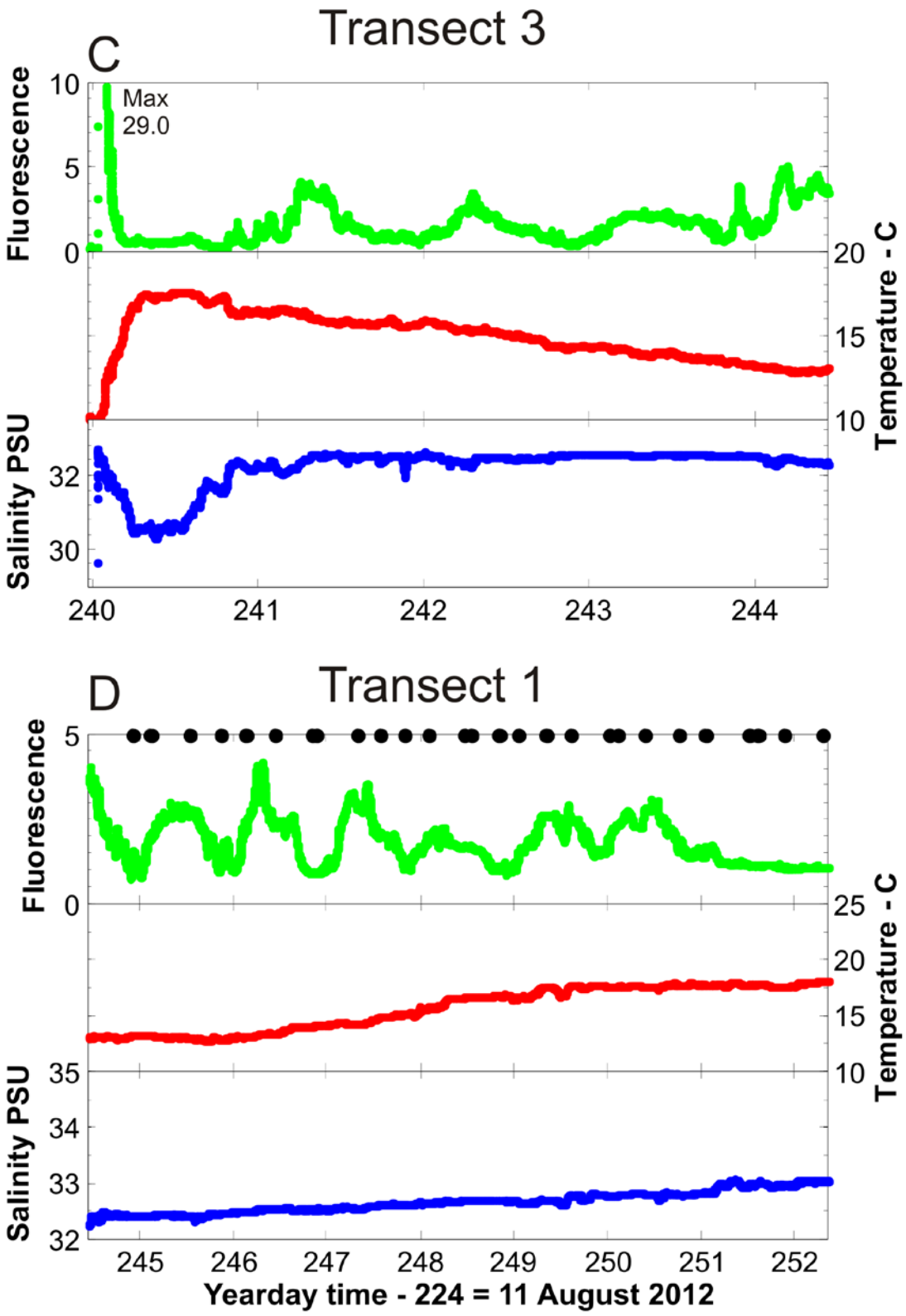


Figure 7.2. New Horizon Cruise 1208 along-track sea surface temperature, salinity, and chlorophyll measurements made along transects 0 to 5. Principal station work took place along transects 1 and 4. Some data collections were also made along transect 0, 3, and 5. CTD stations are indicated by the filled circle at the top of each plot.


C
Transect 3
Fluorescence
Max
29.0
10
5
0
Temperature - C
20
15
10
Salinity PSU
32
30
240
241
242
243
244
D
Transect 1
Fluorescence
5
0
Temperature - C
25
20
15
10
Salinity PSU
35
34
33
32
245
246
247
248
249
250
251
252
Yearday time - 224 = 11 August 2012

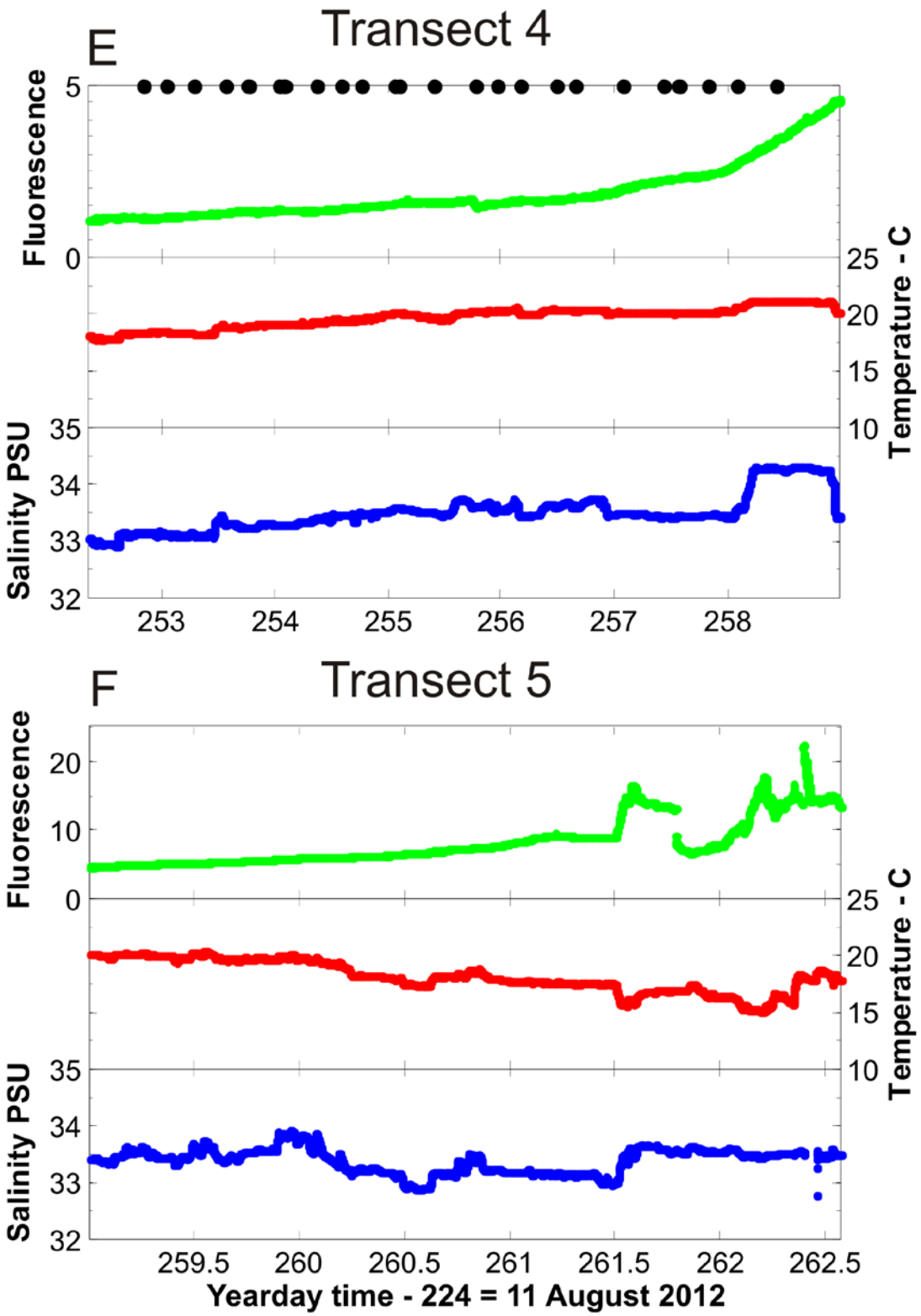

E
Transect 4
Fluorescence
5
0
Temperature - C
25
20
15
10
Salinity PSU
35
34
33
32
253
254
255
256
257
258
F
Transect 5
Fluorescence
20
10
0
Temperature - C
25
20
15
10
Salinity PSU
35
34
33
32
259.5
260
260.5
261
261.5
262
262.5
Yearday time - 224 = 11 August 2012

Table 7.1 Summary of along-track data statistics aggregated by transect on New Horizon Cruise 1208.

	Year Day	Sea Temp (C)	Salinity	Fluorescence	Air Temp (C)	Wind Speed (kts)	Barometric Pressure (mbar)	Latitude	Longitude
Transect 0-1									
mean	227.50	13.98	32.266	1.588	17.703	13.15	1019.7	47.659	-138.81
max	231.00	17.48	33.316	23.144	29.83	24.30	1024.2	49.884	-124.05
min	224.00	10.24	28.96	0.23	11.73	3.69	1013.7	44.602	-149.55
Transect 2									
mean	232.87	15.55	32.048	1.645	15.151	10.10	1015.3	46.694	-134.23
max	234.74	18.19	33.427	23.993	20.39	16.91	1017.2	48.859	-124.05
min	231.00	10.75	4.734	0.285	12.05	0.58	1013.1	44.601	-144.58
Transect 3									
mean	242.21	15.00	31.822	1.876	14.09	14.11	1017.3	46.615	-134.96
max	244.44	17.63	32.722	29.185	17.11	25.27	1023.5	48.684	-124.06
min	239.97	9.31	29.653	0.227	10.65	2.53	1010.5	44.599	-146.39
Transect 1									
mean	248.40	15.68	32.67	1.854	15.297	14.43	1024.8	45.272	-141.90
max	252.35	18.05	33.053	4.19	19.24	31.88	1033.7	48.999	-135.00
min	244.44	12.65	32.244	0.774	11.35	0.97	1004.7	40.999	-148.88
Transect 4									
mean	255.68	19.72	33.504	1.893	18.356	12.74	1022.5	36.809	-135.01
max	259.00	21.16	34.299	4.600	20.65	27.41	1026.4	41.033	-134.52
min	252.35	17.69	32.898	1.059	15.62	0.97	1015.8	33.499	-135.13
Transect 5									
mean	260.79	18.19	32.927	8.253	17.196	11.56	1018.7	33.965	-126.74
max	262.57	20.29	33.903	22.280	19.20	21.19	1023.0	34.159	-119.28
min	259.00	15.04	0.088	4.561	14.59	3.50	1013.8	33.738	-134.52

7.2.2. Along-track Meteorology Data

Atmospheric measurements of air temperature, barometric pressure, wind speed and direction, and other meteorological variables were also collected along with time, latitude, and longitude once every 30 seconds. Mean wind speeds throughout the cruise average less than 15 kts on all five transects (Figure 7.3; Table 7.1). There were two periods on transect 1 when winds stayed above 20 kts and on one occasion peaked at 31 kts (Figure 7.3 D). Seas were then uncomfortable to work in, but never high enough for long enough to curtail work at a station. Barometric pressure was also relatively constant varying between 1005 and 1024 during the cruise, except for one period when the New Horizon was under the influence of exceptionally high pressure of 1033.7 mbars on transect 1 (Figure 7.3 D; Table 7.1). Air temperature closely followed sea surface temperature and the average temperatures on the five transects varied from 14.1 to 18.4 C. Skies were mostly cloudy for the duration of the cruise with a few exceptions. When days were sunny, air temperature maximums were about 20 C.

7.2.3. ADCP Data

Data were collected continuously over most of the cruise with an RDI Ocean Surveyor ADCP (75 kHz). Similar to previous cruises, the ADCP was synchronized to our science party acoustic equipment (see

section 9.3 on multi-frequency acoustics below). The sync out pulse from the HTI system was fed to Wu-Jung's trigger box (i.e, a National Instruments computer running LabView), which then sent out logic pulse to the ADCP deck box in the 01 deck electronics locker. This triggering arrangement worked smoothly for the whole cruise, until the very end when the trigger box was disassembled for packing. At this point the sync out pulse from the HTI was fed straight to the ADCP, which no longer recognized it. Tony Koslow's acoustic tech had warned us that they have to amplify the sync pulse they use because the ADCP deck unit is so far away, and so perhaps this was the issue (Wu-Jung had indicated that the trigger box would automatically adjust the magnitude of the output pulse to make sure it got through, consistent with these observations). Unlike on some other more acoustically intensive cruises, we did not seek to synchronize the Edgetech, HTI, and ADCP all together. When the HammarHead was in the water, the HTI was shut down (which resulted in the ADCP stopping too).

Settings for the ADCP were determined in consultation with Jules Hummon at UW. The trigger settings were (1,0). Broadband data collection was disabled, and the narrowband depth bins were set to 16m. Otherwise, default settings were used.

During the cruise there was some uncertainty about whether the ADCP data looked 'normal' as the currents measured were mostly very small and there was some concern that the triggering arrangement was somehow affecting the ADCP data. During the cruise and after we consulted with Jules who thought the data looked overall fine (and also looked similar to the few times when we turned off the sync and to data collected on the next cruise while in the same region). Nonetheless, some caution should be applied in interpreting the ADCP data.

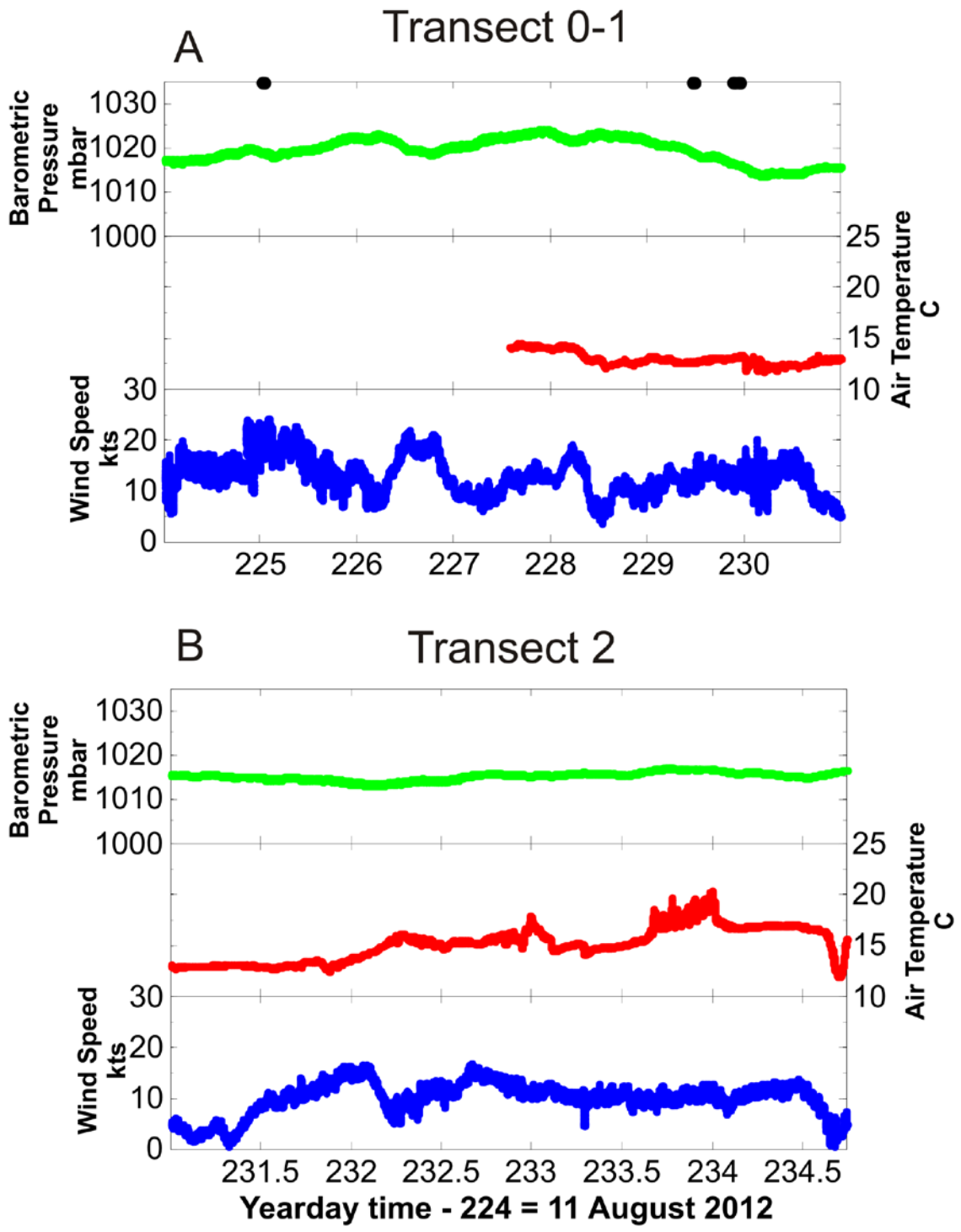
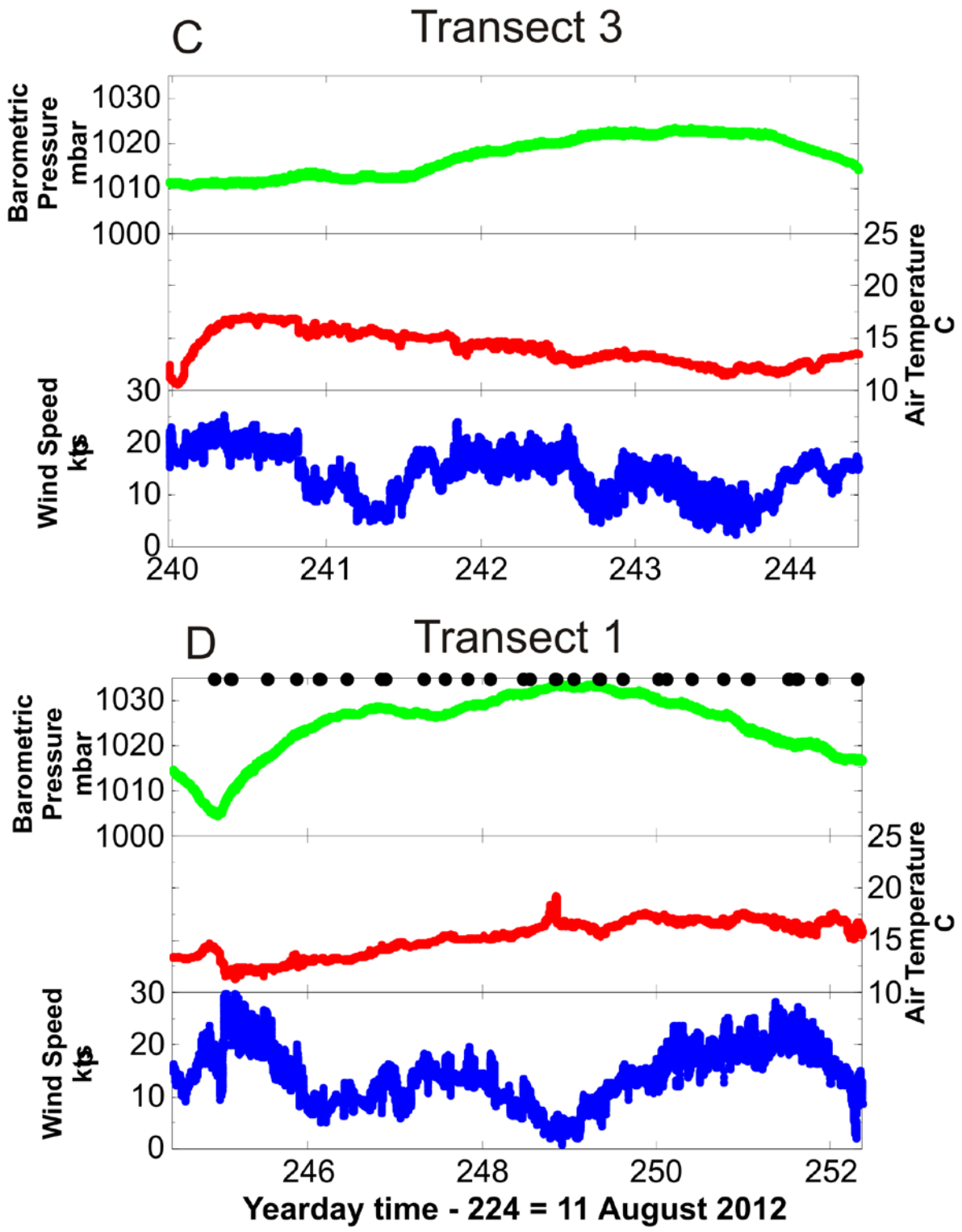
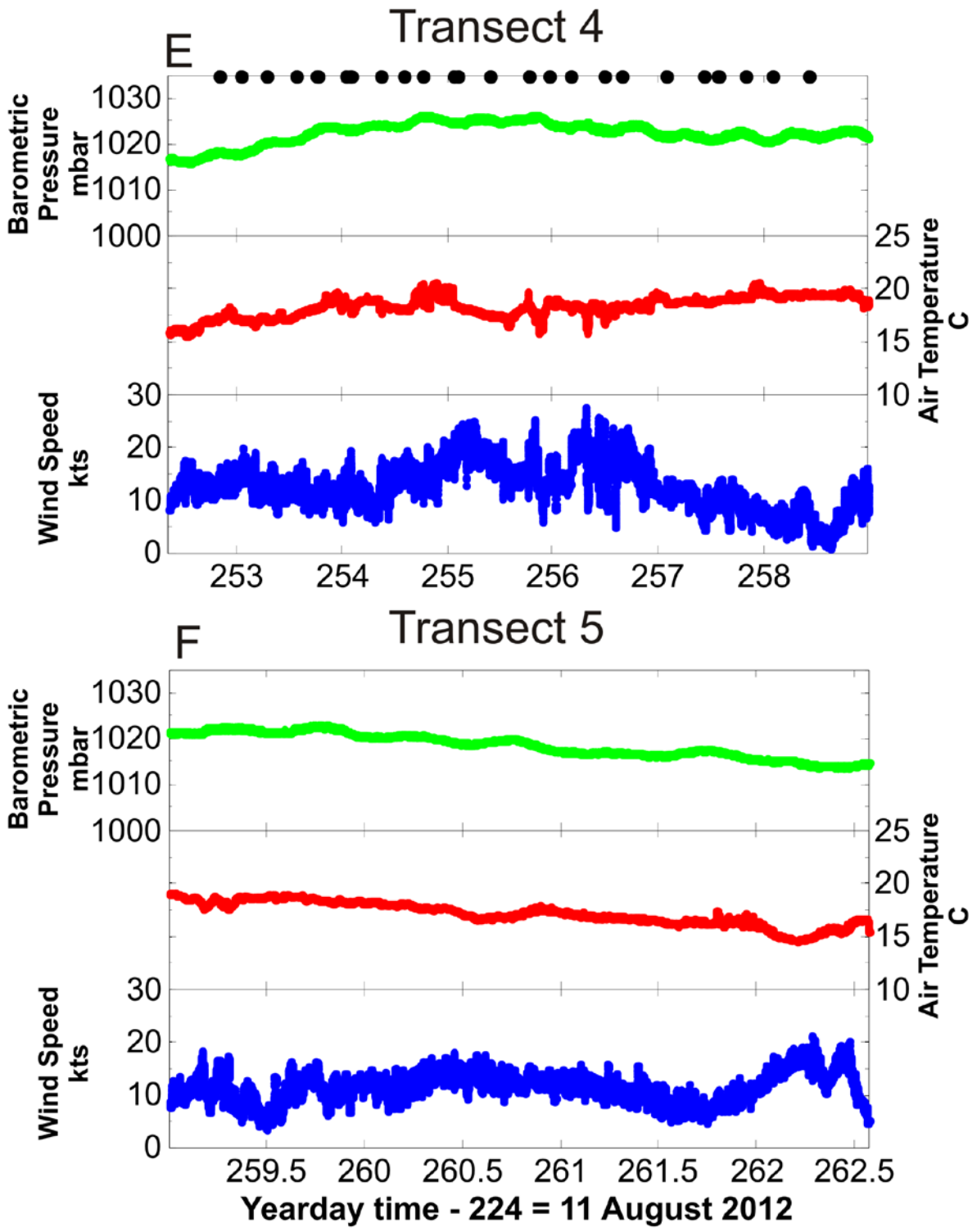


Figure 7.3. New Horizon Cruise 1208 along-track meteorological data: barometric pressure, air temperature, and wind speed measurements made along transects 0 to 5. Principal station work took place along transects 1 to 4. Some data collections were also made along transect 0, 3, and 5. CTD stations are indicated by the filled circle at the top of each plot.


C
Transect 3
Barometric Pressure mbar
1030
1020
1010
1000
25
20
15
10
Air Temperature C
Wind Speed kts
30
20
10
0
240
241
242
243
244
D
Transect 1
Barometric Pressure mbar
1030
1020
1010
1000
25
20
15
10
Air Temperature C
Wind Speed kts
30
20
10
0
246
248
250
252
Yearday time - 224 = 11 August 2012


Transect 4
E
Barometric Pressure mbar
1030
1020
1010
1000
25
20
15
10
Air Temperature C
Wind Speed kts
30
20
10
0
253
254
255
256
257
258
Transect 5
F
Barometric Pressure mbar
1030
1020
1010
1000
25
20
15
10
Air Temperature C
Wind Speed kts
30
20
10
0
259.5
260
260.5
261
261.5
262
262.5
Yearday time - 224 = 11 August 2012

7.3. *CTD*

Peter Wiebe

7.3.1. Introduction

CTD rosette casts were an integral component of the sampling design for the Niskin bottle sampling for the chemistry team. In addition, CTD measurements of environmental conditions provided key correlates of the distribution, abundance, and species composition of pteropods and other sampled zooplankton.

7.3.2. Methods

The CTD rosette had the full 24 10-L Niskin bottle rosette, CTD with dual T/C sensors, a Digiquartz pressure sensor, a SBE43 a DO sensor, a biospherical underwater PAR sensor with surface reference PAR, a Wet Labs C-Star transmissometer (660nm wavelength), a Wet Labs ECO-AFL fluorometer, and an altimeter. A custom sub-frame housed the VPR, which was bolted to a set of rails that allowed the VPR to be removed quickly before deep CTD casts. Only the downcast data were used for the VPR since on the upcast the water passing by the camera had been influenced by the CTD rosette. Chlorophyll was converted to chlorophyll (ug/l) by the equation CHL (µg/l) = Scale Factor * (Output - Dark Counts) where the scale factor = 11, the dark counts = 0.0360, and the output was the sensor output voltage.

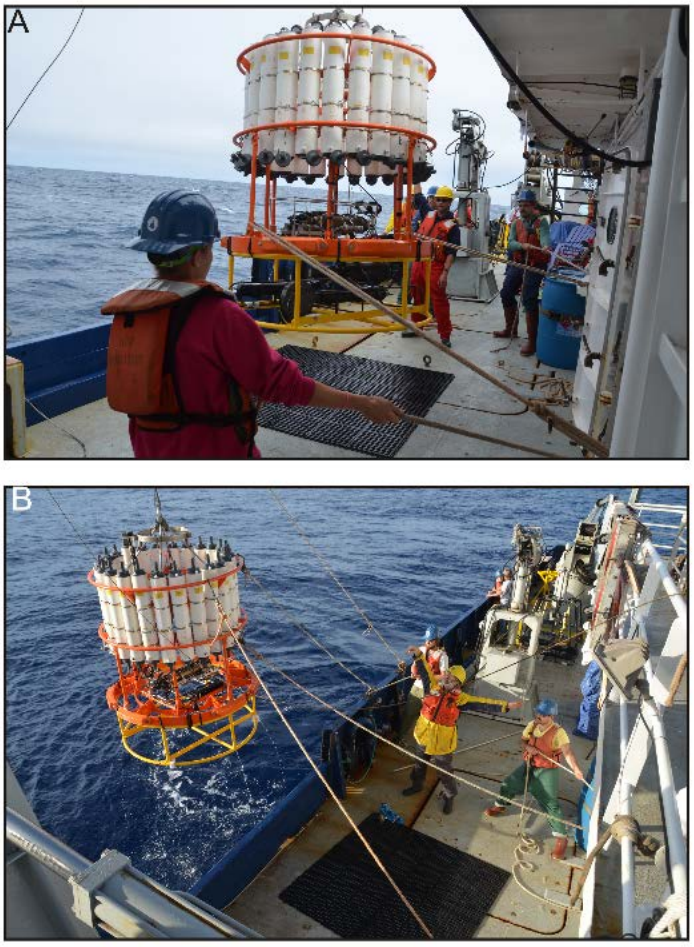


Figure 7.4. Deployment (A - DSC_7364) and recovery (B - DSC_8235) of the CTD on New Horizon cruise 1208. People in A - Kelly Knorr, Nick Tuttle, Dan Schuller, and Sophie Chu. People in B - Nick Tuttle, Jon Calderwood, and Alex Bergan. [Photos: P. Wiebe]

The CTD rosette was deployed from the starboard side J-frame using the Dush-6 oceanographic winch equipped with 0.322" cable. Between casts it was tied down immediately below the block with the J-frame in the retracted position. For deployment, three slip-lines were used that were tied to cleats on the house or on the starboard rail (Figure 7.4 A). Recovery was with snap hooks at the end of the same lines. Three people tended the slip-lines, while the Resident Technician gave instructions to the winch operator and the line tenders for deployment and recovery of the CTD/VPR (Figure 7.4 B).

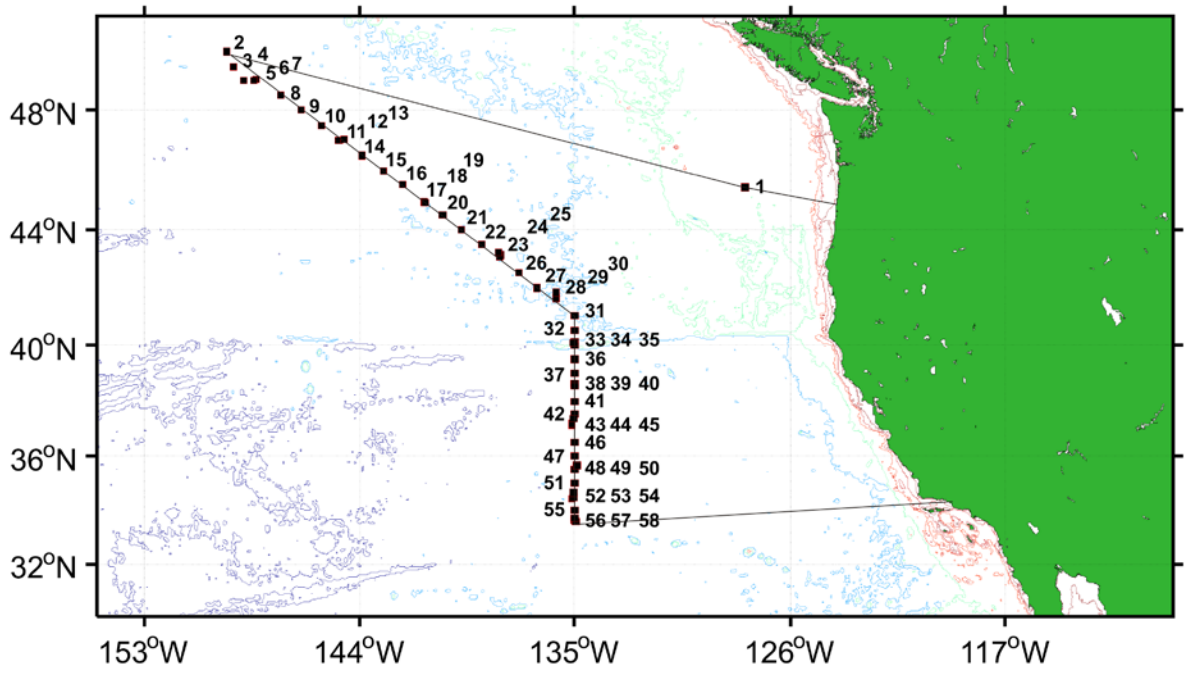


Figure 7.5. NH1208 CTD locations

Table 7.2. Starting times and positions of CTD casts made on New Horizon cruise 1208. * Depth estimated from Etopo2 bathymetry data.

Event #	Transect	Station	Cast #	Time Local	Year-day Time	Latitude	Longitude	Seafloor (m)	Cast Dep (m)
20120811.2332.001	0	0	1	16:31:00	224.6882	45.43516	-127.874	2937	500
20120816.1133.001	1	1	2	03:33:00	229.1479	49.87633	-149.551	4760*	1000
20120816.2121.001	1	2	3	13:21:00	229.5563	49.41437	-149.274	4676	1000
20120816.2252.001	1	2	4	14:46:00	229.6153	49.40985	-149.245	4676	3000
20120831.2204.001	1	3	5	14:03:00	244.5854	48.96786	-148.34	4628*	1000
20120901.0240.001	1	3	6	18:39:00	244.7771	48.94427	-148.44	4510*	3000
20120901.1245.001	1	3	7	04:44:00	245.1972	48.94357	-148.86	4554*	1000
20120901.2050.001	1	4	8	12:49:00	245.534	48.49759	-147.321	4642*	1000
20120902.0319.001	1	5	9	19:18:00	245.8042	47.99848	-146.45	3800	1000
20120902.1044.001	1	6	10	02:43:00	246.1132	47.49504	-145.581	4756*	1000
20120902.2010.001	1	7	11	12:10:00	246.5069	46.99632	-144.86	4769*	1000
20120902.2117.001	1	7	12	13:17:00	246.5535	46.98465	-144.854	4773*	3000
20120903.0747.001	1	7	13	23:46:00	246.9903	47.01615	-144.7	4700	1000
20120903.1330.001	1	8	14	05:30:00	247.2292	46.49904	-143.875	4647*	1000

Event #	Transect	Station	Cast #	Time Local	Year-day Time	Latitude	Longitude	Seafloor (m)	Cast Dep (m)
20120903.1946.001	1	9	15	11:46:00	247.4903	45.99807	-143.032	4563*	1000
20120904.0154.001	1	10	16	17:53:00	247.7451	45.50043	-142.198	4541*	1000
20120904.1059.001	1	11	17	02:59:00	248.1243	44.96157	-141.324	4386*	1000
20120904.1256.001	1	11	18	04:56:00	248.2056	44.93091	-141.323	4278	3000
20120904.2014.001	1	11	19	12:14:00	248.5097	44.90182	-141.244	4923	1000
20120905.0102.001	1	12	20	17:02:00	248.7097	44.49939	-140.551	4076	1000
20120905.0807.001	1	13	21	00:06:00	249.0042	44.0085	-139.756	4321	1000
20120905.1430.001	1	14	22	06:25:00	249.2674	43.49894	-138.933	4154*	1000
20120906.0026.001	1	15	23	16:25:00	249.684	43.10945	-138.101	4100	1000
20120906.0241.001	1	15	24	18:39:00	249.7771	43.0792	-138.116	4100	3000
20120906.0923.002	1	15	12	01:23:00	250.0576	43.18973	-138.163	4151*	1000
20120906.1815.001	1	16	26	10:15:00	250.4271	42.5021	-137.346	4056*	1000
20120907.0107.001	1	17	27	17:06:00	250.7125	42.00293	-136.555	3988	1000
20120907.1225.001	1	18	28	04:25:00	251.184	41.62587	-135.783	4082	1000
20120907.1436.001	1	18	29	06:35:00	251.2743	41.67472	-135.798	3995*	3000
20120907.2111.001	1	18	30	13:11:00	251.5493	41.83053	-135.794	3816	1000
20120908.0659.001	1	19	31	22:58:00	251.9569	41.01328	-135.012	4813	1000
20120908.1152.001	4	20	32	03:51:00	252.1604	40.50293	-135.001	4297	1000
20120908.1955.001	4	21	33	11:54:00	252.4958	40.09313	-135.023	3492	1000
20120909.0053.001	4	21	34	16:52:00	252.7028	39.96881	-135.016	3428	3000
20120909.0644.001	4	21	35	22:44:00	252.9472	40.06652	-135.073	3428	1000
20120909.1331.001	4	22	36	05:31:00	253.2299	39.50191	-135	2815	1000
20120909.1808.001	4	23	37	10:08:00	253.4222	39.0025	-135.002	3305	1000
20120910.0052.001	4	24	38	16:52:00	253.7028	38.61288	-135.009	4692*	1000
20120910.0207.001	4	24	39	17:50:00	253.7431	38.61843	-135.025	4728	3000
20120910.0844.001	4	24	40	00:44:00	254.0306	38.52433	-135.012	4728	1000
20120910.1348.001	4	25	41	05:47:00	254.241	38.00068	-134.999	4591	1000
20120910.1826.001	4	26	42	10:26:00	254.4347	37.50257	-135	4415	1000
20120911.0116.001	4	27	43	17:16:00	254.7194	37.15319	-135.109	4983*	1000
20120911.0222.001	4	27	44	18:21:00	254.7646	37.16863	-135.117	4100	3000
20120911.0943.001	4	27	45	01:43:00	255.0715	37.34219	-135.085	4100	1000
20120911.1818.001	4	28	46	10:18:00	255.4292	36.50461	-135	4996	1000
20120911.2309.001	4	29	47	15:08:00	255.6306	36.00246	-134.999	4255	1000
20120912.0402.001	4	30	48	20:01:00	255.834	35.5061	-135.001	4550	3000
20120912.1133.001	4	30	49	03:33:00	256.1479	35.66538	-134.901	4237	1000
20120912.1534.001	4	30	50	07:33:00	256.3146	35.65409	-134.912	3870	1000
20120913.0158.001	4	31	51	17:58:00	256.7486	35.00282	-134.998	4400	1000
20120913.1023.001	4	32	52	02:22:00	257.0986	34.42517	-135.104	3549	1000
20120913.1334.001	4	32	53	05:34:00	257.2319	34.49025	-135.058	4567	3000
20120913.1955.001	4	32	54	11:55:00	257.4965	34.65324	-135.081	4387	1000
20120914.0153.001	4	33	55	17:53:00	257.7451	34.00055	-135	4128	1000
20120914.1008.001	4	34	56	02:08:00	258.0889	33.61992	-134.995	4078	1000
20120914.1346.001	4	34	57	05:45:00	258.2396	33.58115	-134.976	4161	3000
20120914.2014.001	4	34	58	12:13:00	258.509	33.70854	-135.012	4080	1000

CTD-VPR casts were to 1000m at the regular stations (every ½ degree of latitude), with additional casts to 3000m with the VPR removed at the day-night stations (every 2 degrees of latitude)(Figure 7.5; Table 7.2). When the VPR was attached, the package was deployed on the down-cast with the winch paying out at 30 m/min, while the up-cast was done at a speed of 60 m/min, aside from the last ca. 100m which was at 30 m/min. With the VPR removed for the deep casts, the package was sent down and up at 60 m/min, except in the upper 100 m where the speed was 30 m/min. The 1000m casts took 1.5 hours (time in the water) when stops were made for Niskin bottle sampling during the up-cast and took 1 hour when no water was sampled. The 3000m casts took 2.5 hours.

Note that some additional hydrographic profiles were collected with XBTs supplied by the ship's operator, in association with Reeve net deployments made at test stations. Since CTD casts were not made at test stations, the XBT data were used to inform the choice of Reeve net sampling depths.

7.3.3. Preliminary Results

A subset of the 58 CTD profile data was used to create an interpolated (kriged) view of the temperature, salinity, oxygen, and chlorophyll fields for the two primary transect lines (1 and 4). The casts used for transect 1 were 2, 4, 7, 8, 9, 10, 11, 14, 15, 16, 17, 20, 21, 22, 23, 26, 27, 30, 31; for transect 4, they were: 32, 35, 36, 37, 40, 41, 42, 45, 46, 47, 50, 51, 54, 55, 57. The latitude and longitude positions of each cast were used to create a distance from origin (the first station on a section). These distances were used as the x-axis. The GLOBEC Kriging Software Package – EasyKrig3.0 (Chu, 2004 - ftp://globec.whoi.edu/pub/software/kriging/easy_krig) was used to compute the interpolated fields.

Transect 1 began in the Gulf of Alaska 28 nm shy of 50N; 150W, the intended location of the first station. Temperatures were about 12.1 C at the surface and below a shallow 20 m mixed layer decreased rapidly to about 4 C at 100 and then more gradually to below 3 C at 1000 m (Figure 7.6 A). Surface salinity was 32.5 PSU and it increased slowly to about 32.75 at 100 m and then more rapidly to 33.75 at 160 m (Figure 7.6 B). Below 160 m, salinity increased more gradually to 34.43 PSU at 1000 m. Oxygen was above 6 ml/l at the surface, peaked above 7 ml/l between 40 and 120 m, decreased rapidly to about 2 ml/l at 60 m, and then decreased more gradually to values less than 1 ml/l at 400 m (Figure 7.6 C). These patterns in the profiles of temperature, salinity, and oxygen were evident in transect 1 section plot (Figure 5), but with progression to the southeast along the transect, the water column warmed especially in the upper 400 m, near surface salinities increased, and oxygen values below the subsurface maximum, which declined slightly, increased thus moving the less than 1 ml/l oxygen values down to around 600 m.

In the upper 200 m (Figure 7.7 A), chlorophyll values peaked in a deep chlorophyll layer centered above 50 m in Transect 1. Highest oxygen values were associated with the maximum chlorophyll values Figure 7.7 B) and as the chlorophyll values decreased along the transect, so also did the oxygen values.

The North-to-South Transect 4 was more horizontally uniform in temperature, salinity, and oxygen properties along the section (Figure 7.8) than Transect 1. Surface temperatures gradually increased towards the south (Figure 7.8 A). The 15 C isotherm deepened from about 50 m to 100 m and the 20 C isotherm appeared about halfway along the section and deepened to about 30 m at the most southern station (34). A relatively fresh <33.5 PSU layer present in the upper 150 m persisted between 0 km and 250 km from the start of the section, was interrupted by a short zone of >33.5 salinities, followed by a return to <33.5 salinities, and then ended with surface water >34 PSU (Figure 7.8 B). Oxygen values peaked below the subsurface maximum at about 50 m, declined to less than 0.25 ml/liter at around 800 m (Figure 7.8 C).

In the upper 200 m (Figure 7.7 E), chlorophyll values again peaked in a deep chlorophyll layer, which was centered below 50 m and deepened towards the south in Transect 2. Highest oxygen values were associated with the maximum chlorophyll values and declined as chlorophyll declined (Figure 7.7 H).

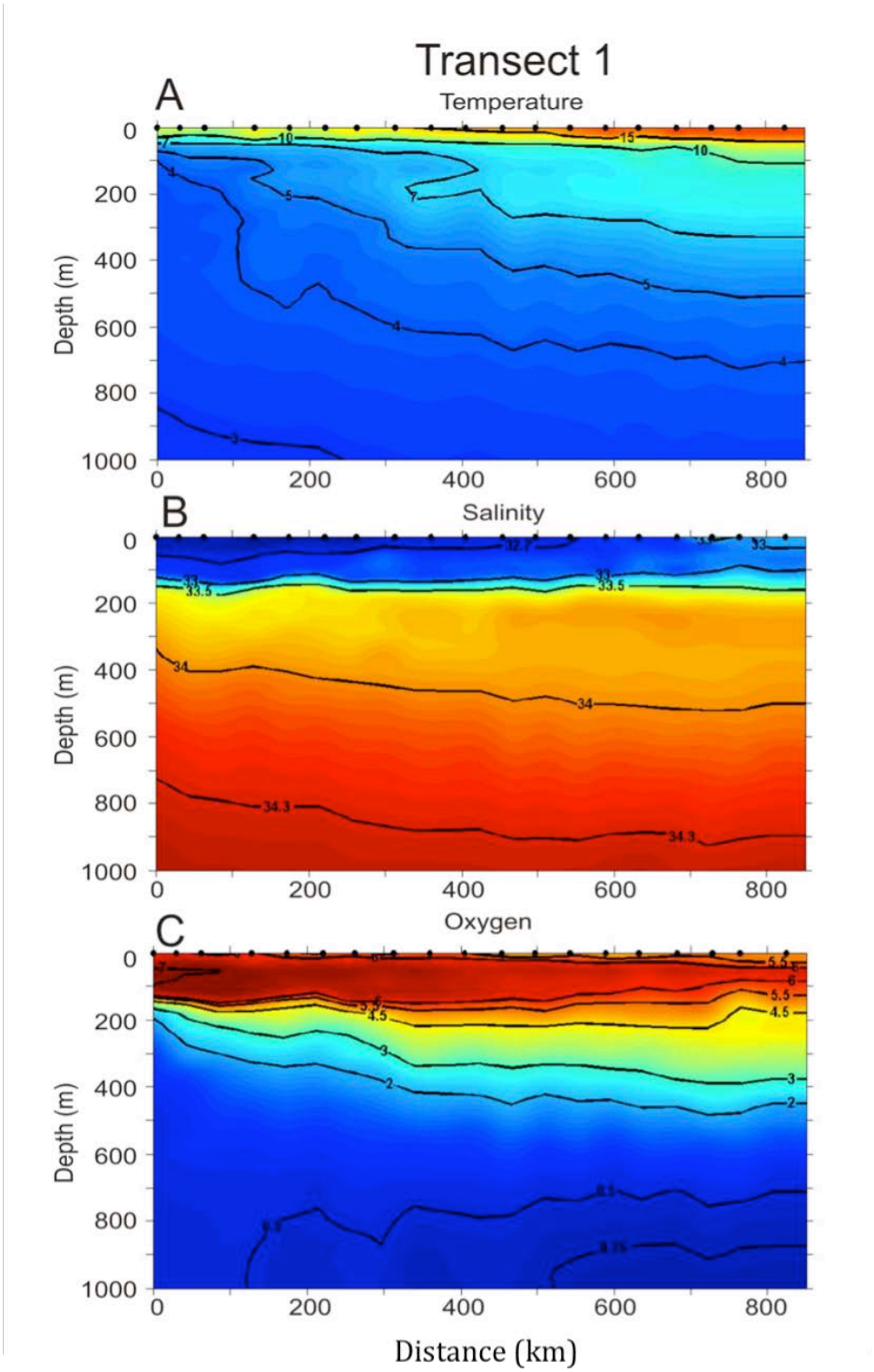


Figure 7.6. Kriged plot of New Horizon Cruise 1208 CTD chlorophyll, oxygen, salinity and temperature data for transect 1 upper 1000 m. CTD stations are indicated by the filled circle at the top of each plot.

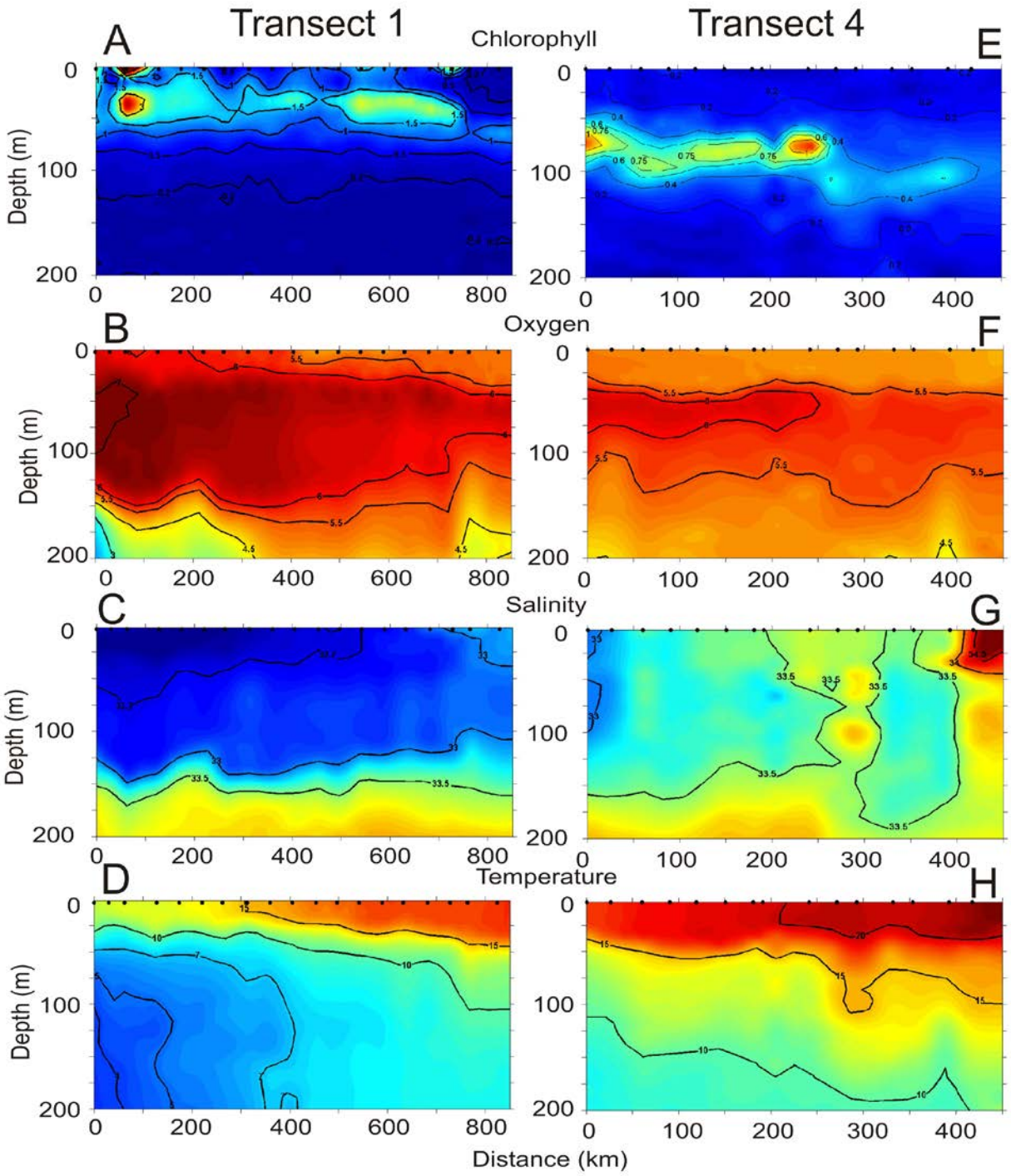


Figure 7.7. Kriged plot of New Horizon Cruise 1208 CTD chlorophyll, oxygen, salinity and temperature data transect 1 and 4 in the upper 200 m. CTD stations are indicated by the filled circle at the top of each plot.

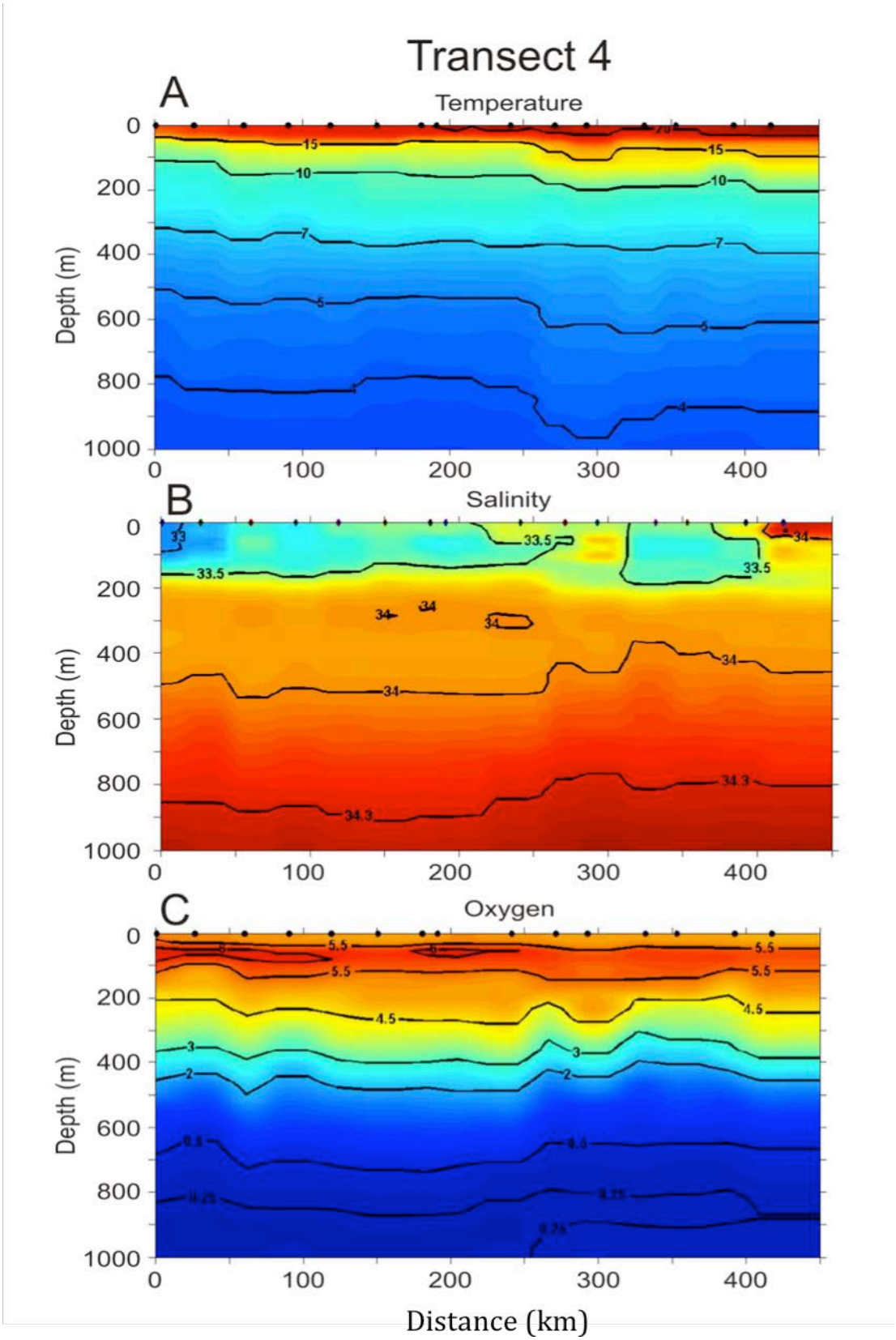


Figure 7.8. Kriged plot of New Horizon Cruise 1208 CTD temperature, salinity, and oxygen data for transect 4 upper 1000 m. CTD stations are indicated by the filled circle at the top of each plot.

8. Chemistry

Zhaohui Aleck Wang, Katherine Hoering, and Sophie Chu

8.1. *Introduction*

Dr. Zhaohui Aleck Wang's group from the Department of Marine Chemistry and Geochemistry at WHOI measured carbonate chemistry parameters including both discrete and underway parameters during the NH1208 cruise on board the R/V *New Horizon*. Measuring these parameters allows us to calculate the calcium carbonate saturation state and the carbonate compensation depth, two important variables that determine the formation of aragonite shells by pteropods. These data will be used to analyze how the distribution, abundance, species composition, shell condition, and vertical migratory behavior of pteropods vary with carbonate chemistry. In addition, the collected carbon data will be very valuable to evaluate the rate of ocean acidification in the N. Pacific Ocean by comparing new data with historical data sets (e.g. CLIVAR P17 data set).

Underway Measurements

Two underway systems were used during the cruise to measure the spatial variability in carbonate chemistry. The automated Multi-parameter Inorganic Carbon Analyzer (MICA) was used to simultaneously measure underway surface sea water pH and DIC. The Automated Flowing pCO_2 Measuring System by General Oceanics, Inc. (GO system) was used to measure air pCO_2 and seawater fCO_2. The CO_2 air-sea flux will also be estimated using these underway measurements and metrological data.

Discrete Samples

Discrete bottles samples were collected at 34 CTD-Rosette stations, among which 22 stations (regular stations) were sampled to 1000m depth, and the rest (day-night stations) were sampled to 3000m. Discrete samples were taken for pH, total dissolved inorganic carbon (DIC), total alkalinity (TA), dissolved oxygen (DO), nutrients, and salinity. These data will be used to resolve the vertical distribution of carbonate chemistry in the sampling area of the North Pacific.

8.2. *Underway Measurements of pCO_2, DIC, and pH using Multi-parameter Inorganic Carbon Analyzer (MICA)*

8.2.1. Methods

Equipment and Analytical Techniques

The automated Multi-parameter Inorganic Carbon Analyzer (MICA) was used to simultaneously measure underway surface sea water DIC and pH.

The technical details and performance evaluation of the MICA can be referred to in Wang et al. (2007). The system has been recently updated to MICA II, which consists of three chambers and a total of four channels: two CO_2 channels (surface sea water fCO_2 and atmospheric pCO_2), DIC channel, and pH channel. All measurements are based on the similar spectrophotometric principle. The system can operate continuously with a sampling frequency of ~7 measurements per hour. The four channels operate and record data independently. The CO_2 channels were not used during this cruise due to mechanic problems with pumps and optical cells.

Spectrophotometric pH measurements are based on the method described in Clayton and Byrne (1993), but use thymol blue as the pH indicator (Zhang and Byrne, 1996; Wang et al., 2007). Indicator thymol blue is directly injected into a stream of underway seawater and absorbances at acid (435 nm), base (596 nm), and a reference wavelength (730 nm) are monitored by a spectrophotometer.

For seawater DIC measurements, Teflon AF 2400 (DuPont) is used as both a CO_2 permeable membrane and a long liquid-core waveguide (LCW) (Wang et al., 2007). Bromocresol purple is used as the indicator in spectrophotometric DIC measurements. During each DIC measurement, the indicator solution is motionless inside the LCW. The seawater is first acidified with 2.5 M HCl to convert all carbonate species of sample water to CO_2. The acidified sample is then pumped to flow outside the LCW. After CO_2 molecules equilibrate with the LCW's internal solution through diffusion, its equilibrium pH is measured by absorbance ratios. DIC is then derived from this equilibrium pH.

For each of the two indicators used, three wavelengths were chosen for measurement of absorbances. Two wavelengths assess the absorbance peaks of the acid and base forms of the indicator, while a third wavelength serves as a reference wavelength. Absorbances vary at the acid and base wavelengths in response to pH changes, but not at the reference wavelength. Absorbance ratios between the acid and base wavelengths are calculated, and used to evaluate CO_2 system parameters. The wavelengths chosen for the pH and DIC channels are listed in Table 8.1.

Table 8.1. Wavelengths used for spectrophotometric determination of inorganic carbon species.

Channel	Indicator	Acid Wavelength	Base Wavelength	Reference Wavelength
pH	Thymol blue	435 nm	596 nm	730 nm
DIC	Bromocresol purple	432 nm	589 nm	730 nm

Two Ocean Optic USB4000 spectrophotometers are used to detect the light signals of the pH and DIC channels. The light assemblies, spectrophotometers, and optical cells are connected through optic fibers. The light assembly of each channel consists of a high-temperature tungsten lamp with blue and short-pass filters in order to achieve an improved balance of spectral intensity between 430 and 730 nm.

The optical cells of the DIC channel are custom-machined from PEEK rods. The center piece of the optical cell has a length of 15 cm. The Teflon AF 2400 LCW is held inside this center piece. The center piece has a sample inlet and outlet, and two optical fibers that connect the optical cell with the light source and spectrophotometer are inserted into the ends of the LCW through two custom-made PEEK connectors. The pH optical cell is also machined from a PEEK rod, but does not require special connectors since no LCW is used.

For DIC measurements, the indicator solution is made of 3 µM bromocresol purple in 1000 µmol kg^{-1} total alkalinity (Na_2CO_3) and 0.2 µM sodium lauryl sulfate solutions. The reference solution is made similarly without indicator. For pH measurements, thymol blue solution is made in Milli-Q water with a concentration of 1.5 mM. The R ratio of the thymol blue solution is adjusted (R~0.77) to minimize the magnitude of indicator-induced pH perturbations. All indicator and reference solutions are stored in gas-impermeable laminated bags.

Indicator and reference solutions are pumped through separate lines into their respective channels by digital peristaltic pumps. Surface seawater is pumped on board by a shipboard pumping system. It first flows through a SBE 49 CTD that records salinity and temperature. Seawater samples are then pumped through two channels for measurements of pH and DIC. Thymol blue is mixed with sea water samples for pH measurement, and the final thymol blue concentration in sample water is ~ 2 µM. Such a low indicator concentration results in insignificant pH perturbation (~0.001 pH units) due to indicator addition.

All channels are thermostated to 25 ± 0.1°C using Peltier devices. All measurements, as well as calibrations, are taken at this temperature.

All units of the system are connected to a custom-made electronic motherboard and controlled by a PC. The interface program runs cycles to operate the MICA continuously. The time required for each measurement cycle depends on the equilibration time (7 minutes for the DIC channel) and flushing time for the indicator/reference solution and samples. Chemical reaction for pH measurements is instantaneous. The following sequence is taken during a measurement cycle:

1. Flush pH reference.
2. Flush reference for seawater DIC.
3. Read and store reference readings.
4. Flush indicator solutions for seawater DIC; mix indicator with seawater samples for pH measurements; acidify DIC samples.
5. DIC equilibration (7 minutes).
6. Read and store measurements.
7. End of one measurement cycle and repeat from the beginning.

During measurements, the seawater samples are continuously flowing through the channels.

Standards

Thymol blue has been previously calibrated for seawater pH measurements (Zhang and Byrne, 1996). DIC was calibrated before the cruise using Certified Reference Material (CRM). During the cruise, CRM was used periodically to check the pre-cruise calibration consistency and re-calibration was performed if necessary.

Data Processing

The absorbance ratio R for each measurement (all parameters) is given as:

$$R = (A_2 - A_{ref})/(A_1 - A_{ref})$$

where A_1 and A_2 are the peak absorbance at acid and base wavelengths, respectively; and A_{ref} is the absorbance at the reference wavelength. For the two parameters measured, R is used to calculate pH via the following equation:

$$pH = \log\left(\frac{R - \varepsilon_{2(HA)}/\varepsilon_{1(HA)}}{\varepsilon_{2(A)}/\varepsilon_{1(HA)} - R \cdot \varepsilon_{1(A)}/\varepsilon_{1(HA)}}\right) - pK_{a2}$$

where $\varepsilon_{1(HA)}$ and $\varepsilon_{2(HA)}$ are the molar absorptivities of the acid form (HA^-) of indicator at two peak-absorbance wavelengths; $\varepsilon_{1(A)}$ and $\varepsilon_{2(A)}$ are the molar absorptivities of the A^{2-} (fully unprotonated) form of indicator at two peak-absorbance wavelengths; and K_{a2} is the second dissociation constant of the indicator used. Molar absorptivities and K_{a2} for all indicators are determined in the laboratory at 25°C before the cruise.

From the above equations, pH can be directly calculated from absorbance ratios. Seawater DIC is calculated by referencing R to their respective standards.

The precisions of all parameters measured, estimated by replicate measurements, are given as follows:

pH	± 0.001

DIC	± 1-3 µmol/kg

Details on the mathematical treatment and calculation procedure can be found in Wang et al. (2007).

8.2.2. Problems and Solutions

The air and seawater pCO_2 channels did not run during this cruise due to mechanical problems of the pumps and optical cells. Both air and seawater pCO_2 were measured by the General Oceanic pCO_2 system (see next section). During the 1st leg of the cruise, the seal of the DIC Teflon AF tubing leaked such that there was problem for CO_2 equilibration. The problem was fixed during the second leg of the cruise. The DIC sample pump occasionally stopped delivering fluids. The issue was resolved by replacing it with a new pump. DIC indicator was remade during the cruise due to a potential mistake in making the old indicator solution.

8.2.3. Preliminary Results

Figure 8.1 shows some of the preliminary data from MICA pH underway measurements along with sea surface temperature and salinity during the cruise. The high resolution pH measurements captured several cross-frontal events when salinity and temperature underwent significant changes.

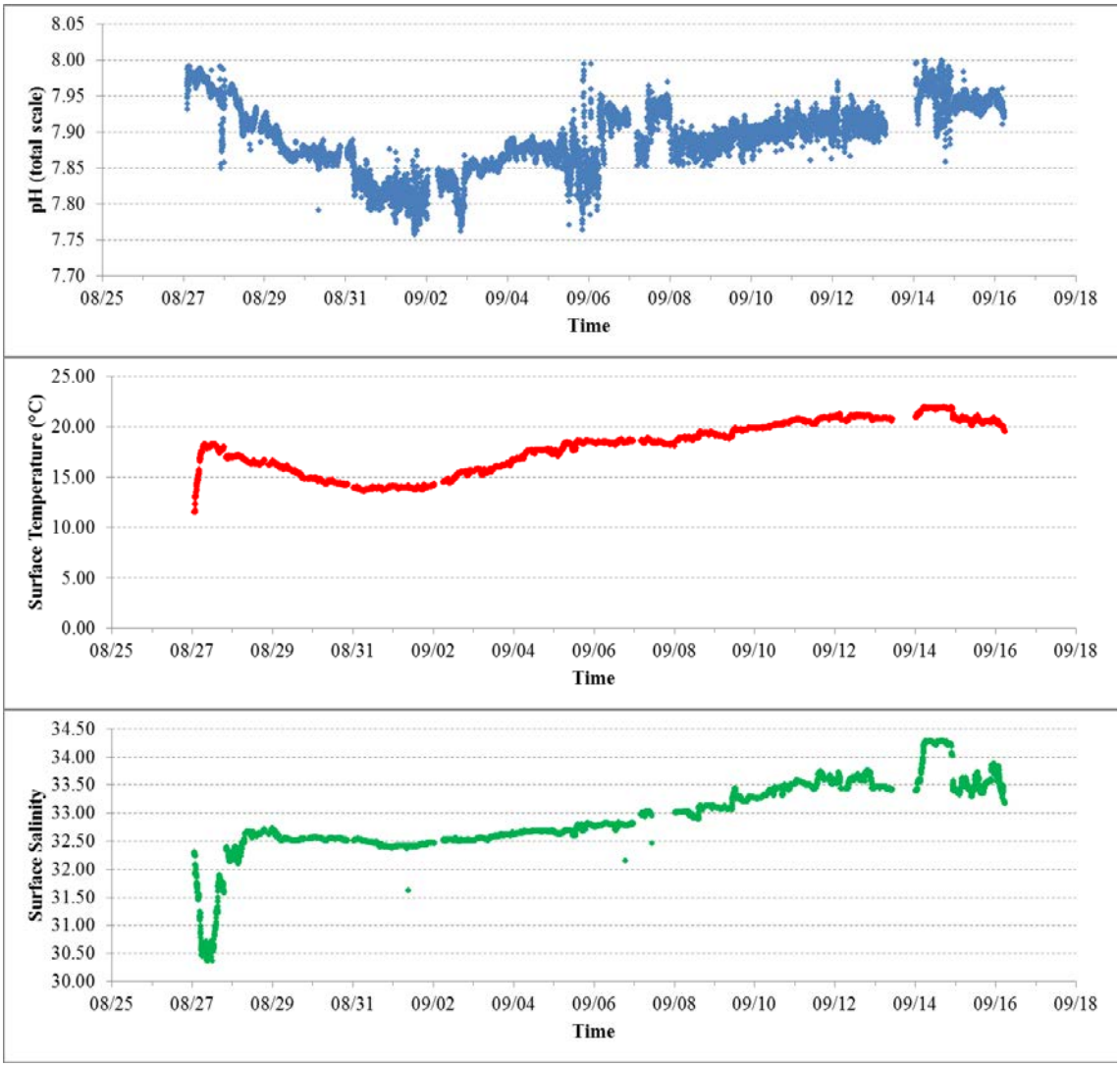


Figure 8.1 Underway MICA measurements of sea surface pH (total scale), temperature, and salinity.

8.2.4. References

Clayton, T.D., and R.H. Byrne. 1993. Spectrophotometric seawater pH measurements: Total hydrogen ion concentration scale calibration of m-cresol purple and at-sea results. Deep-Sea Res., 40: 2315-2329.

Wang, Z. A., Liu, X., Byrne, R. H., Wanninkhof, R. H., Bernstein, R. E., Kaltenbacher, E. A., Patten, J. 2007. Simultaneous spectrophotometric flow-through measurements of multiple inorganic carbon parameters in seawater: at-sea test and comparison. Analytica Chimica Acta, 596: 23-36.

Zhang, H.; Byrne, R. H. 1996. Spectrophotometric pH measurements of surface seawater at in-situ conditions: absorbance and protonation behavior of thymol blue. Mar. Chem., 52, 17-25.

8.3. *Underway Measurements of pCO_2 by the General Oceanic System*

8.3.1. Methods

Equipment and Analytical Technique

The fully automated underway pCO_2 system (model #8050) from General Oceanic's, Inc. (GO system) was used to measure seawater and air pCO_2 for the duration of the cruise. Seawater was pumped directly from the ships underway line at ~1.5 – 3.0 L min^{-1} to a sprinkler-type water-gas equilibrator, where a parcel of head-space air establishes CO_2 equilibrium with the flowing-through seawater. The CO_2 equilibrated air was then passed through a Peltier cooling block and a drying tube to remove the water vapor, and then measured by a LI-COR 6262 Infrared analyzer. Underway water temperature was measured with a Fluke Hart 1523 Reference Thermometer and this temperature will be used in temperature correction.

Air sample was pumped from the foremast of the ship at a rate of ~100 mL/min, passed through the chiller and drying tube and air XCO_2 was then measured by the LI-COR. Air samples were measured five times and seawater was measured 45 times every hour. The following measurement sequence was used:

Sequence Setup

1. STD1Z (ZERO) Once
2. STD2S (SPAN) Once
3. STD2 Two times
4. ATM Five times
5. EQU 45 times
6. Repeat the entire sequence

The precision for the GO system is better than ±1 µmol kg^{-1}.

Standards

The system was calibrated every 2 hours by two air-balanced CO_2 gas standards with XCO_2 (mole fraction of CO_2) of 0 ppm and 1035.2 ppm. These gas standards are traceable to World Meteorological Organization CO_2 standards obtained from NOAA/ESRL in Boulder, Colorado. The gas flow rates were set at the beginning of the cruise to 60mL/min.

Data Processing

The GO system measures XCO_2 (mole fraction of CO_2) in seawater and air. XCO_2 will be first converted to pCO_2 using atmospheric pressure. Final values will be corrected for in-situ temperature and water vapor, and will be reported as the fugacity of CO_2 (fCO_2).

8.3.2. Problems and Solutions

During the 1st leg of the cruise, the seawater regulator broke. It was later replaced before the 2nd leg of the cruise. There were a few other minor interruptions due to software glitches.

8.3.3. Preliminary Results

Figure 8.2 displays surface seawater pCO_2, air XCO_2, and surface temperature during the 2nd leg of the cruise.

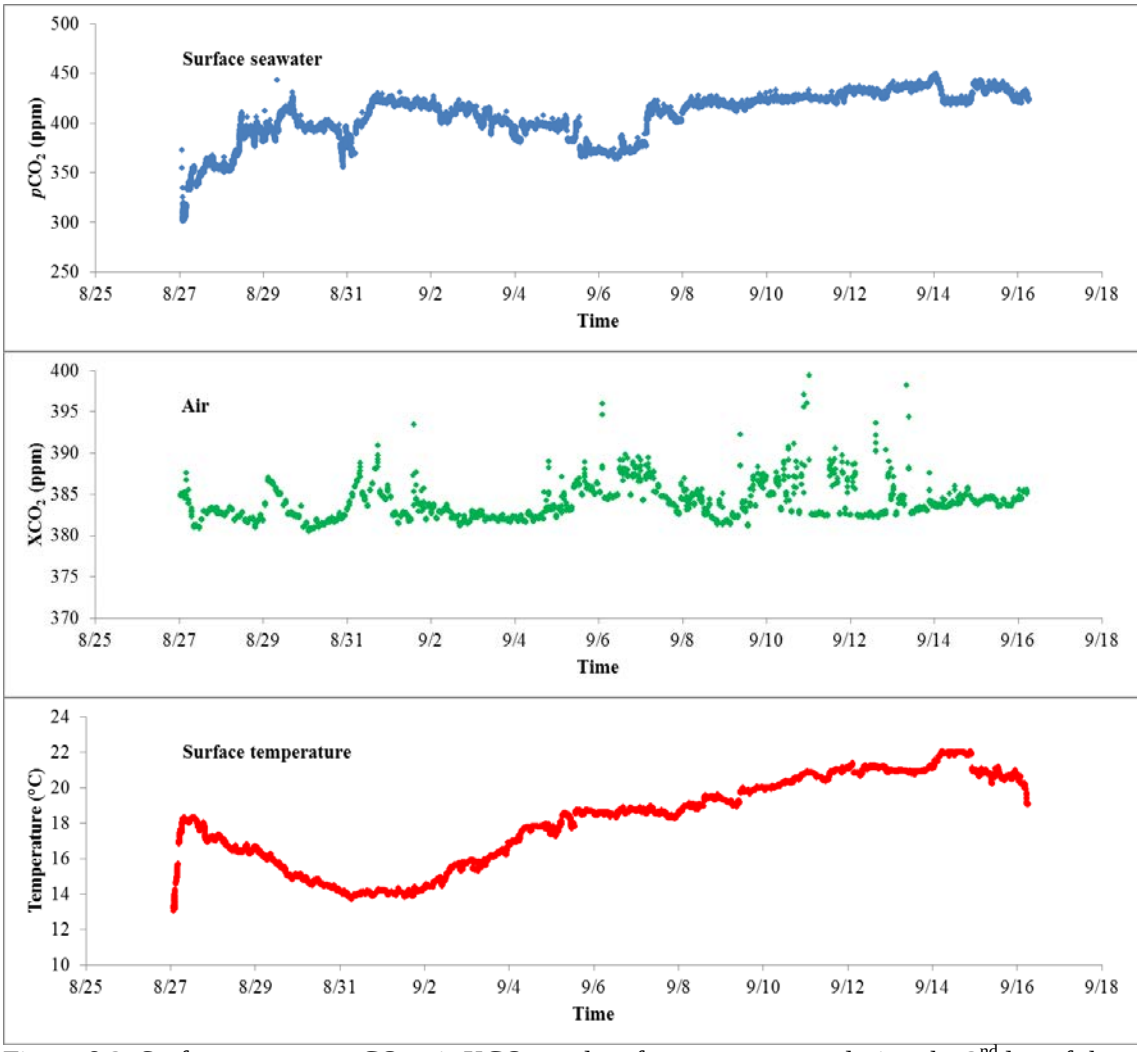


Figure 8.2. Surface seawater pCO_2, air XCO_2, and surface temperature during the 2nd leg of the cruise. Data were measured by the GO pCO_2 system.

8.4. *Discrete pH measurements*

8.4.1. Methods

Summary

Seawater pH was measured during the NH1208 cruise on board R/V *New Horizon* based on the spectrophotometric procedures outlined in SOP 6b of Dickson (2007) and in Clayton and Byrne (1993) using m-cresol purple (mCP) as the indicator. pH on the total scale (pH_T) was calculated using the following equation:

$pH_T = 1245.69/T + 3.8275 - 0.00211(35-S) + \log((R-0.00691)/(2.222-0.1331R))$ (1)

where T is absolute temperature (T = 273.15 + t) of the measurement and S is salinity.

Discrete pH samples were collected for all 34 stations at all sampling depths, and the measurements were completed within 6 hours of sample collection. Duplicate samples were collected at selected depths of each station to evaluate the precision of the measurements.

Principle of pH measurements

Measurements of seawater pH were obtained using m-cresol purple as the indicator. Solution pH in seawater, on the total hydrogen ion concentration ($[H^+]_T$) scale, was calculated from the equation

$$pH_T = -\log_T K_I + \log\frac{R - e_1}{e_2 - Re_3}, \quad (2)$$

where $e_1 = 0.00691$; $e_2 = 2.222$; and $e_3 = 0.1331$. The temperature (T) and salinity (S) dependence of the m-cresol purple equilibrium constant ($_TK_I$) is given as:

$$-\log_T K_I = \frac{1245.69}{T} + 3.8275 + 0.00211(35 - S), \quad (3)$$

and pH_T is related to pH on the free hydrogen ion concentration scale ($pH = -\log[H^+]$) as follows:

$$pH_T = -\log[H^+]_T = -\log[H^+] - \log(1 + \frac{S_T}{K_{HSO_4}}), \quad (4)$$

where S_T is the total sulfate concentration and K_{HSO4} is the HSO_4^- dissociation constant.

Reagents

A stock solution of m-cresol purple (4 mM) was prepared with m-CP sodium salt (Acros Organics) in Milli-Q water. The R ratio (absorbance of the base form (I^{2-}) divided by the absorbance of the acid form (HI^-) of the stock solution) was adjusted to 1.6 with a NaOH solution to minimize pH perturbation as the result of adding indicator to a sample. The dye solution was stored in a borosilicate glass bottle wrapped with aluminum foil to exclude gas exchange and light from the indicator.

Sampling and Measurements

At each station pH samples were taken from Niskin bottles directly to 10 cm cylindrical glass cells via a silicone tubing. After flushing each cell for 20 seconds and ensuring that there was no trapped air, the cell was sealed with PTFE caps. The cells were then dried with paper towels and put into a 24-position metal cell holder that was temperature controlled by flow-through thermostatic water at 25±0.1°C. After the cells had been thermostated for about one hour, the pH measurements started.

For each pH measurement, the exterior of the cell was carefully cleaned with a Kimwipe and then the cell was placed in the thermostated sample compartment of the spectrophotometer (Agilent 8453 UV-VIS). The baseline was recorded at three wavelengths (434, 578 and 700 nm). The cell was then taken out from the spectrophotometer and 20 µL of m-CP was added into the sample with a Gilmont pipette. The cell was briefly shaken to mix the seawater sample and the indicator. The cell was returned to the spectrophotometer and absorbances at the three selected wavelengths were recorded.

The measurements were computer controlled with a macro code for sample information input, data acquisition, and storage. The program also implemented quality controls for baseline stability and measurement precision.

8.4.2. Preliminary Results

Fig. 8.3 shows the preliminary results of pH profiles from selected stations during the cruise.

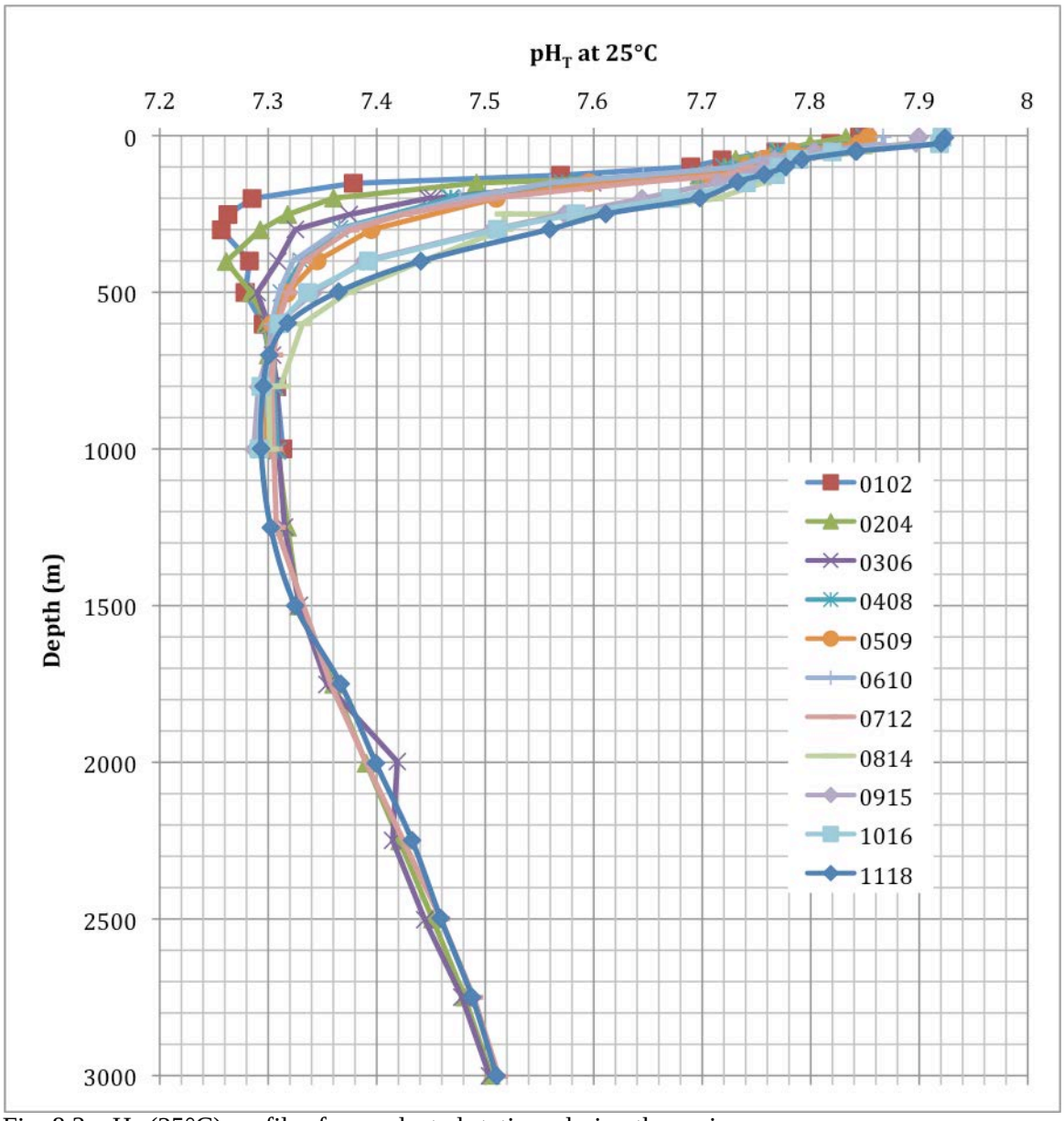


Fig. 8.3. pH_T (25°C) profiles from selected stations during the cruise

8.4.3. Data Processing

Correction for pH perturbation resulting from addition of indicator

The indicator perturbation to seawater samples was evaluated empirically during the cruise and will be further measured after the cruise. A pair of additions of indicator (4 mM m-CP, 20 µL and 40 µL) were made to a series of seawater samples that have the pH range of 7.28 – 7.98 encountered during the cruise. pH difference (ΔpH) to each sample between the two additions will be calculated. The relationship between pH and ΔpH will be used to determine the pH perturbation to each sample.

Temperature consideration

The temperature of the samples was controlled by a circulating water bath which was set to 25°C. As soon as a sample was measured, the temperature of the sample was measured with a Fluke reference temperature probe (traced to NIST standard).

The small temperature difference from 25°C will not add error to measurement due to the inherent properties of m-CP and the CO_2 chemistry. For example, if a sample is measured at 24.9°C, but t = 25°C was assumed to calculate pH based on Eq. 1, this would result in pH = 8.0000. The same sample will have a calculated pH = 7.9985 if using the true t = 24.9°C in Eq. 1. Based on the CO_2 system thermodynamic relationships (Lewis and Wallace, 1998), when pH measurements at 24.9°C are corrected to 25°C, the correction factor is 0.0014. This will result in a corrected pH value (in the example above) of 7.9999 (7.9985 + 0.0014). The difference between the corrected and non-correct pH is only 0.001, which is below the detection limit of the method. When temperature differs by as much as 0.2°C, the error by assuming t = 25°C is less than 0.0002. Therefore no temperature corrections were made to the cruise dataset.

8.4.4. References

Clayton, T. D., and R. H. Byrne. 1993. Spectrophotometric Seawater Ph Measurements - Total Hydrogen-Ion Concentration Scale Calibration of M-Cresol Purple and at-Sea Results. Deep-Sea Res Pt I **40:** 2115-2129.

Dickson, A. G., C. L. Sabine, and J. R. Christian. 2007. Guide to best practices for ocean CO_2 measurements. PICES Special Publication.

Lewis, E., and D. W. R. Wallace. 1998. Program developed for CO_2 system calculations. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy.

8.5. *Discrete Measurements of Dissolved Inorganic Carbon and Total Alkalinity*

8.5.1. Methods

Discrete Dissolved Inorganic Carbon (DIC) and Total Alkalinity (TA) samples were collected for all 34 stations at all sampling depths. A portion of the collected samples was measured during the cruise and the rest were brought back to the lab for analyses. Duplicate samples were collected at random depths of selected stations to evaluate the precision of the measurements.

Sample Collection

DIC and TA samples were collected in 250mL Pyrex borosilicate glass bottles after being filtered with a .45um in-line capsule filter. Each bottle was rinsed three times, filled completely, and then the sample was overflowed by another one and one half bottle volume. Air head space of about one percent of the bottle volume (~3 ml) was left in each sample bottle to allow room for expansion. Each sample was then poisoned with 100uL of saturated mercuric chloride, capped with an Apiezon-L greased stopper, thoroughly mixed, and then tied with a rubber band over the glass stopper.

Dissolved Inorganic Carbon

Dissolved Inorganic Carbon (DIC) is defined as:

$$DIC = CO_3^{2-} + HCO_3^{-} + H_2CO_3.$$

The samples were analyzed using an Apollo SciTech DIC auto-analyzer. The sample was first acidified using 10% phosphoric acid in 10% sodium chloride media to convert all of the carbonate species to CO_2. High purity nitrogen gas was then used to purge the CO_2 from the acidified sample and direct it through a cooling system and a magnesium perchloride plug to remove water vapor. The dried CO_2 gas was then measured with a LI-COR 7000 infrared analyzer.

Certified Reference Material (CRM) from Dr. A. Dickson at Scripps Oceanography was used to calibrate the instrument daily. Four volumes of CRM between 0.4 and 1.2 mL were measured for standardization. The slope and intercept coefficients of area versus volume were determined so that the DIC concentration of the samples, measured at 0.75 mL, could be determined after volume correction. Figure 8.4 shows the calibration curve using CRM.

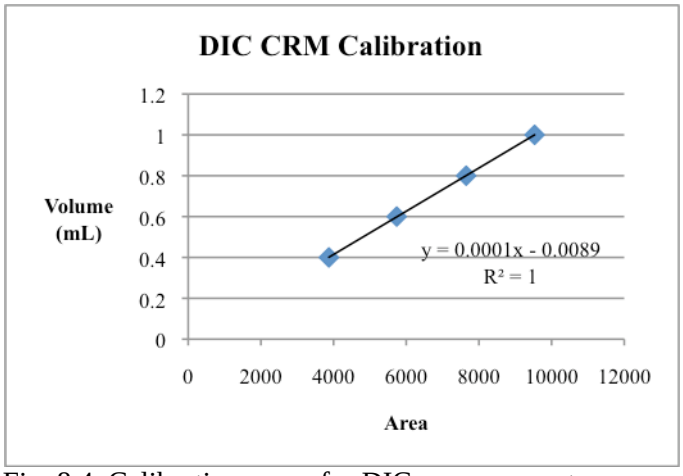


Fig. 8.4. Calibration curve for DIC measurements

A density correction was applied to each sample based on the temperature at which the measurement was made. Each sample was measured at least twice to obtain two parallel readings, the difference which was within 0.1% of each other. The CRM was measured as a sample every 12 hours to check the stability of the instrument. If there was a large shift in the DIC concentration (>2umol/kg), then the instrument was recalibrated. Duplicate samples were also measured to confirm that the field precision was ~0.1%.

8.5.2. Problem and Solutions

Midway through the cruise the instrument would not hold the gas pressure after the program initialized. We found a gas leak from valve 2 and fixed it by tightening the fitting. Soon after this, there were large fluctuations in the data. A salt crystal had built up in one of the gas lines and after this was flushed out the program was fine.

8.5.3. Preliminary Results

Figure 8.5 displays DIC data from selected stations during the cruise.

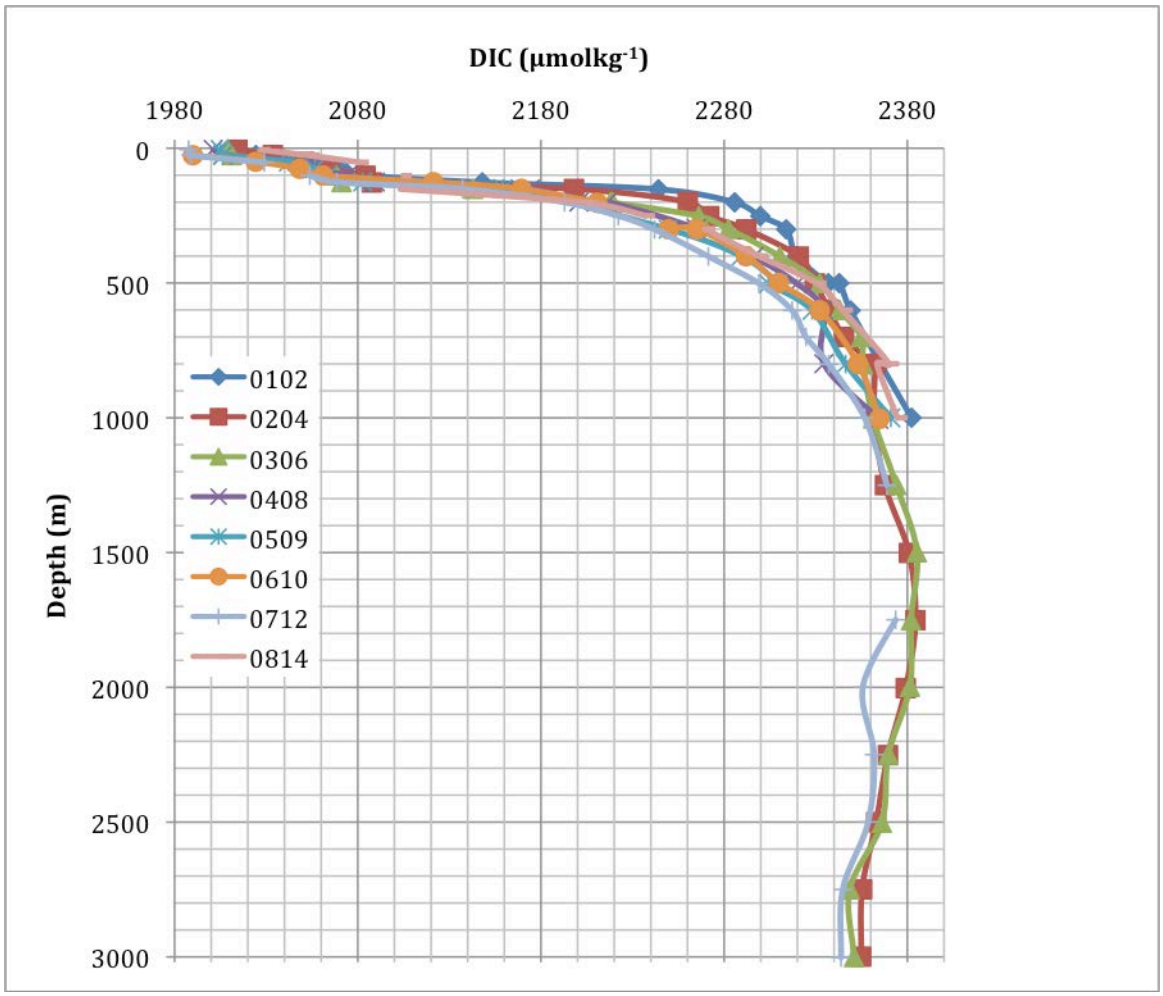


Fig. 8.5. DIC versus depth for selected stations

8.6. *Total Alkalinity*

Total Alkalinity (TA) is vigorously defined by Dickson (1981) as the number of moles of hydrogen ion equivalent to the excess of proton acceptors (bases formed from weak acids with a dissociation constant $K \leq 10–4.5$ at 25°C and zero ionic strength) over proton donors (acids with $K > 10–4.5$) in 1 kilogram of sample:

$$TA = [HCO_3^-] + 2[CO_3^{2-}] + [B(OH)^{4-}] + [OH^-] + [HPO_4^{2-}] + 2[PO_4^{3-}] + [Si(OH)_3O^-] + [NH_3] + [HS^-] + \ldots - [H^+]_F - [HSO_4^-] - [HF] - [H_3PO_4] - \ldots$$

where the brackets represents the total concentrations, $[H^+]_F$ is the free concentration of hydrogen ion, and the dots represent other minor acids and bases (Dickson et al., 2007).

8.6.1. Methods

TA measurements were made with an Apollo SciTech alkalinity auto-titrator, a Ross combination pH electrode, and a pH meter (ORION 3 Star) based on a modified Gran titration method (Wang and Cai, 2004). Input salinity values were used to approximate how much acid would need to lower sample pH to ~3.7. Thereafter, any additional amount of acid added would be a dilution process. A linear relationship could be determined by the amount of acid added and the Gran Factor. This linear relationship could then be used to calculate the amount of acid that would be needed to lower the sample pH to the CO_2 equivalence point (pH = 4.5). The amount of acid needed and its concentration were then used to calculate total alkalinity.

The pH electrode was calibrated using three NBS buffer solutions (pH = 4.01, 7.00, and 10.01) to derive the electrode response's slope used for Gran Factor calculation. This calibration was conducted every 12 hours. CRM was used to calibrate the concentration of hydrochloric acid used (0.9% HCl in 0.7 sodium chloride media solution) for titration every 24 hours.

Each sample was measured at least twice to obtain two parallel readings, the difference which was within 0.1% of each other. Also, for quality control, the CRM was run as a sample at least every 12 hours to check if there was a change between the CRM assigned and measured TA value. A linear interpolation was applied to correct measurements when such a change occurred.

8.6.2. Preliminary Results

Figure 8.6 displays TA data from selected stations during the cruise.

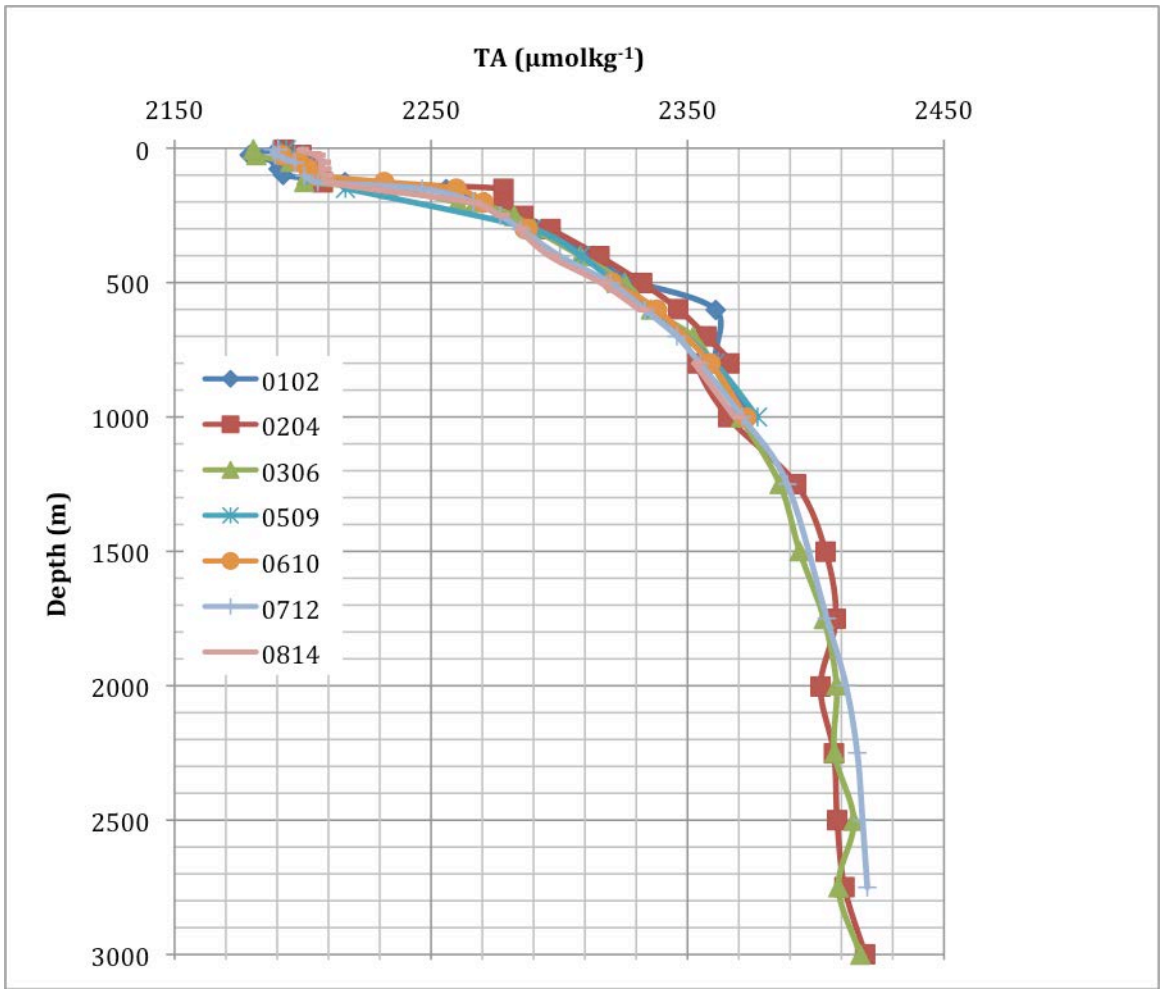


Fig. 8.6. TA versus depth for selected stations

8.6.3. References

Dickson, A. G. 1981. An Exact Definition of Total Alkalinity and a Procedure for the Estimation of Alkalinity and Total Inorganic Carbon from Titration Data. Deep-Sea Res **28:** 609-623.

Dickson, A. G., C. L. Sabine, and J. R. Christian. 2007. Guide to best practices for ocean CO_2 measurements. PICES Special Publication.

Wang, Z. H. A., and W. J. Cai. 2004. Carbon dioxide degassing and inorganic carbon export from a marsh-dominated estuary (the Duplin River): A marsh CO_2 pump. Limnol. Oceanogr. **49:** 341-354.

8.7. *Discrete Salinity Measurements*

8.7.1. Methods

Discrete salinity samples were collected from selected depths at each of the hydrographic stations in order to calibrate CTD salinity measurements. The salinity samples were directly collected from CTD Niskin bottles into 500 ml square borosilicate glass bottles, which were rinsed three times with the sample prior to filling.

An Autosal salinometer (S/N 57-396) was used for all salinity measurements at room temperature (23 - 25°C). The salinity analyses were performed after samples had equilibrated to laboratory temperature, usually within 72 hours after collection. The salinometer was standardized for each group of analyses (usually 5-6 casts and approximately 50 samples) using one fresh vial of standard seawater per group. Salinometer measurements were made manually. PSS-78 salinity (UNESCO, 1981) was calculated for each sample from the measured conductivity ratios. IAPSO Standard Seawater Batch P-152 was used to standardize all measurements.

8.7.2. Problem and Solutions

The first attempt at measuring salinity led to a discovery of a broken o-ring in the machinery responsible for water circulation in the salinometer water bath. The o-ring was replaced and the water circulation resumed. The temperature of the water bath was also an issue as the ship moved from colder to warmer waters. This caused a delay in measurements as the water bath temperature was adjusted and allowed to reach proper temperature.

8.7.3. Preliminary Results

Fig. 8.7 shows the comparison between measured discrete salinity samples and CTD salinity. The tight relationship suggests that the CTD sensor behaved well and both measurements were consistent during the cruise.

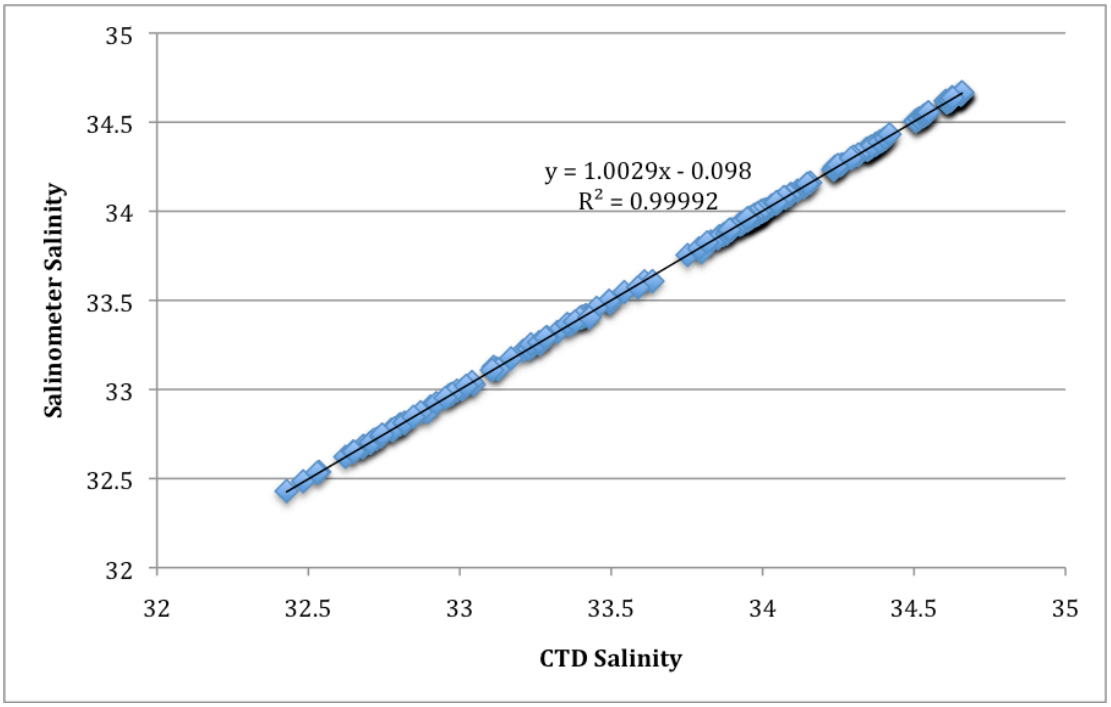


Figure 8.7. Comparison between salinometer and CTD salinity.

8.8. *Discrete Dissolved Oxygen Measurements*

8.8.1. Methods

Discrete dissolved oxygen samples were collected from selected depths at each of the hydrographic stations in order to calibrate CTD dissolved oxygen (DO) measurements. The DO samples were directly collected from CTD Niskin bottles into 150 mL brown glass tincture bottles, which were rinsed three times with the sample prior to filling. One mL of sodium iodide-sodium hydroxide mixture and one mL of manganese chloride was added and mixed to the sample immediately after collection. One mL of sulfuric acid was added right before measurement.

A single dissolved oxygen titrator developed at Woods Hole Oceanographic Institution on loan from Marshall Swartz's group was used for all DO measurements at room temperature (20 - 25°C). It uses the Winkler technique to perform the titration. The DO samples were analyzed after temperature equilibration to the laboratory, usually within 72 hours after collection. The DO system was standardized for each group of analyses (usually 5-6 casts, approximately 30 samples) using sodium thiosulfate standardization. DO measurements were made manually.

8.8.2. Problem and Solutions

The operating software did not have a method set up to measure dissolved oxygen samples below a concentration of 2 mL/L during the 1st leg of the cruise. A low DO method was established after discussion with a technician of the manufacture of the DO instrument before the 2nd leg of the cruise.

8.8.3. Preliminary Results

Fig. 8.8 shows the comparison between discrete dissolved oxygen samples and CTD dissolved oxygen. The tight relationship suggests that the CTD sensor behaved well and both measurements were consistent during the cruise.

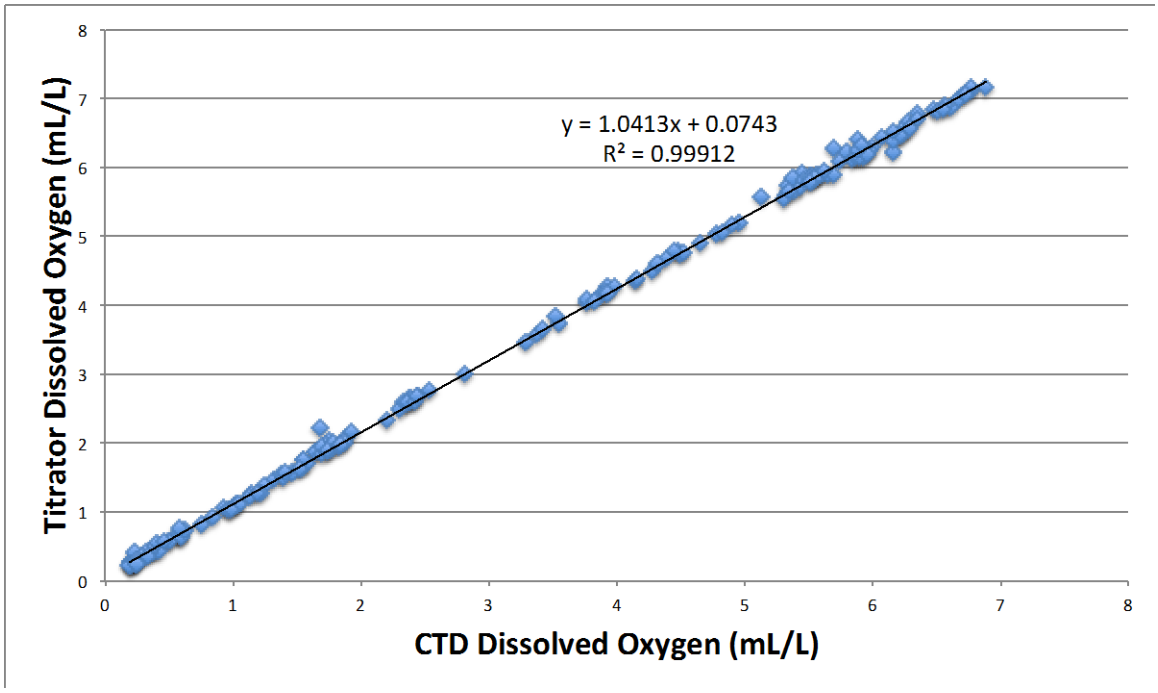


Figure 8.8. Comparison between titrator and CTD DO.

9. Zooplankton Sampling

9.1. *MOCNESS*

Peter Wiebe, Gareth Lawson, Nancy Copley

9.1.1. Introduction

A standard 1-m^2 Multiple Opening/Closing Net and Environmental Sensing System (MOCNESS; Wiebe et al., 1985) was used to collect zooplankton to determine the taxonomic composition of the zooplankton in the study site with a specific focus on the shell bearing thecosomatous pteropods. It was also used to ground truth acoustic data collected with the HTI multi-frequency system and the Edgetech broadband system.

9.1.2. Methods

The MOCNESS was equipped with eight 150-um mesh nets (nets 1-8; borrowed from URI) and one 333-um mesh net (net 0). The system was equipped with the standard SeaBird temperature and conductivity probes (units #535 and #120 respectively). The underwater unit used was #169. The system also had a beta-type strobe-light unit for reducing avoidance of the nets by some zooplankton and possibly small fish. The strobe system has two units each with 12 LED sets (LUXEON Rebel LED) with peak output between 490-520 nm. Seven of the 24 LED sets were no longer working at the start of the sampling. The LEDs are powered by the MOCNESS battery and their pulse width, amplitude, flash rate period, and on/off are controlled by the MOCNESS software. For this cruise the pulse width was 40 ms, the relative amplitude was 99%, and the flash interval was 500 ms. The strobe unit was only used for the first four tows, after which problems with blowing the underwater unit 5A fuse (a symptom typical of strobe unit problems from the past) led us to disconnect it and not use it for the remainder of the tows.

Oblique casts with the MOCNESS were made to 1000m with a ship speed nominally of 2 kts. Generally sampling was from 1000-800, 800-600, 600-400, 400-200, 200-100, 100-50, 50-25, 25-0m, except at test station 1 where sampling took place in the upper 100 m. The downcast started with the winch paying out at 10 m/min then at ca. 50 m the rate was increased to 20 m/min, and at ca. 100m to 30-35 m/min. Between 1500 and 2100 m were paid out to get the MOCNESS to 1000 m depending on ship speed and currents. The up-cast haul-in rate was variable, depending on the vertical velocity and how much wire was out, but was generally ca. 15-20 m/min below 100m and then 10 m/min in the upper 100m to ensure enough water was filtered in the shallow nets. Casts typically lasted three hours (time in the water). Later in the cruise as sample size started to decrease we increased the amount of water filtered to enhance catches (aiming for ca. 1500 m3 in the deep strata) and hence tow duration increased to ca. 3.5 hours.

The MOCNESS tows were done only at the day-night stations, where one daytime and one nighttime tow were performed (Figure 9.1.1). The definitions of day and night used for both the MOCNESS and the VPR (described below in section 9.2) were:

DAY
Start: The MOCNESS needed to be at depth ready to start sampling or the VPR starting its down-cast no earlier than 1 hour after sunrise.
End: The MOCNESS needed to be at depth starting sampling or the VPR finished its downcast sampling by 2 hours before sunset.

NIGHT
Start: The MOCNESS needed to be at depth starting its upcast sampling or the VPR starting its downcast no earlier than 1 hour after sunset.
End: The MOCNESS needed to be at the surface finished sampling or the VPR at depth finished with its downcast sampling by an hour before sunrise.

On this cruise the MOCNESS was deployed from the stern A-frame using 0.680" conducting cable on the Dynacon traction winch. Prior to deployment the MOCNESS was moved under the A-frame and lifted up

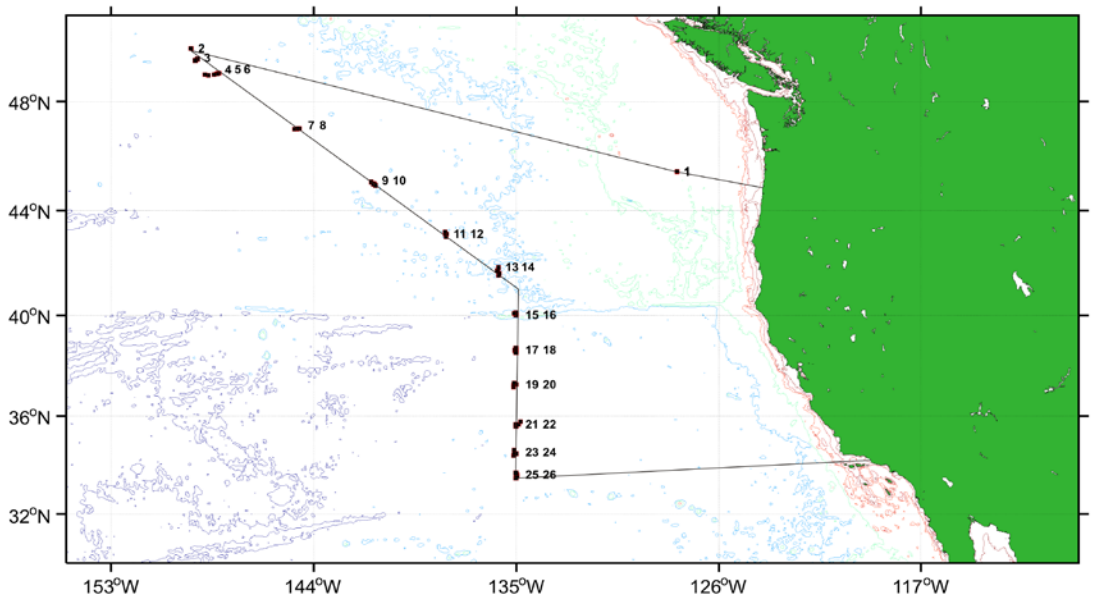


Figure 9.1.1. MOCNESS tow

to an angle of 55 degrees for a system checkout before a tow. Deployment was with two taglines through the U-bolts on the foot. Initially these were tied to cleats on the A-frame, looped through the U-bolts, then back to the same cleats. Because these cleats were up high it was awkward and the lines often slipped off; also this provided no fore-aft stability. During leg II we settled on a system where the lines were tied to a post, looped through the A-frame, then to cleats attached on the deck immediately forward of the A-frame. This worked quite well. During tests and while the system was stood up two additional taglines (short ones) were attached to the upper U-bolts with snap hooks and tied to cleats on the A-frame. These were removed prior to deployment. Recovery was with snap-hooks and lines looped through the same cleats on the deck forward of the A-frame used in deployment.

Between casts the MOCNESS was laid down on deck and often shifted forward to make space for the HammarHead to be deployed. Between casts it was carried by 4 to 6 people forward of the fan tail and ratchet strapped down to the deck. For cocking, a milk crate was placed underneath the bottom I-beam to provide space to loosen the net bar traps and allow the net bars to be moved to the top of the frame where the cables and swaged fittings were loaded into the toggle release mechanism.

Throughout the cruise we had problems with the 150 um nets tangling upon recovery (the 333um net #0 never got tangled). The most successful deployment strategy we identified was to take the ship down to one screw (the starboard side, since this one couldn't be turned off as it was hard to get back on). With the ship at 2 knots, we then picked up the net with the winch/A-frame and moved it back to the last bolt pattern. The cod-ends were pre-arranged in a 3x3 pattern with net 0 aftmost and inboard, with net 1 next to it and slightly farther outboard (to port), then net 2 again slightly farther outboard. This made a row of 3 athwartship, followed by a row with nets 3-5 and then 6-8. The buckers were thrown over the stern in order from 0 through 8. The cod-ends were recovered with the topmost safety line installed. The nets were hosed down with seawater with the system laid down on deck just forward of the stern. As each net

was rinsed down the cod-ends were sequentially removed, placed in numbered buckets with two frozen cooler-packs, and transferred to the wet lab.

Samples were brought into the wet lab where processing took place. First, the sample was poured into a large white tray and a photograph was taken of the entire sample. Dominant species or specimens were noted. The entire sample was carefully viewed to find live pteropods for use in respiration experiments, for genetics/transcriptomics studies, and for examination of the shell structure with an electron microscope. In addition, other species of euphausiids, copepods, fish, salps, gymnosomes, and other specimens of interest were also sorted live for flash freezing for genetics studies or for alcohol preservation for genetic barcoding for species identification. On occasion large fish (7) had their livers and hearts removed and preserved in RNAlater (one was flash frozen). See section 13.2 by Amy Mass. All specimen removals were recorded.

The sample was then split with a Motoda box splitter. One-half of a sample was preserved in 95% ethanol, ¼ was preserved in 5% buffered formalin, and ¼ was preserved in 70% ethanol. For a detailed MOC tow processing protocol, see Appendix 1. On some occasions when the sample was too small to be worth splitting, it was preserved in its entirety in formalin or 95% ethanol.

9.1.3. Preliminary Results

Twenty-six tows were taken on the cruise, all but two successfully. The first one was at Test Station 1 where the MOCNESS flowmeter was calibrated as described below. Sixteen were taken at strategic locations along the 3 primary sampling transect lines (Figure 9.1.1). Appendix #2 gives the positions, depths, and other information for each cast. Appendix #3 indicates pteropods removed and flash frozen for molecular analysis. Appendix #4 summarizes all specimen removals. A pure assemblage of temperate and Arctic/boreal species was present in the MOCNESS samples taken along a good portion of northern portion of transect 1 in the Gulf of Alaska. In the transition zone at the southern end of transect 1 and the northern end of transect 4, a mix of temperate and subtropical species occurred. Mostly tropical/subtropical zooplankton species were caught along the mid- to southern sections of Transect 4.

In situ calibration of the MOCNESS flow meter took place at Test Station 1. The frame angle and water flow are used to calculate the volume of water filtered by each sequentially opened net. The flow meter is mechanical and has a propeller driving a gear shaft that rotates a cylinder with an embedded magnet that moves past an underwater reed switch. With each 360 degrees the magnet passes by the switch causing it to close for a moment, which is recorded as a flow count. Each flow count represents a distance traveled by the flow meter. Quantifying this distance requires calibrating the flow meter. This was done by deploying the MOCNESS to a shallow depth and then towing it horizontally back and forth on a trackline over a prescribed distance. This was done on 11 August, at a station where all of the instruments to be used over the side of the ship were tested to make sure they were operational. To calibrate the flowmeter, the MOCNESS was towed at a depth of approximately 50 m for a distance of about one half a nautical mile from southeast to northwest (340 degrees) and then in the reverse direction (160 degrees) about the same distance in order to eliminate any effect of differential current flow on the calibration (Figure 9.1.2). During the tow, the MOCNESS software logged the data coming from the underwater unit and the GPS latitude and longitude positions. The bridge called down a start and end marks for each half-mile segment and the MOCNESS operator wrote down the flow count number at each of the marks. A Matlab program (mfile) was written to compute the distance for each run and to make a plot of the tow segments superimposed on the total tow (Figure 9.1.2). The calibration coefficient determined on this cruise of 6.3425 m/count (Table 1) closely matches the coefficients determined on two earlier cruises of 6.425 and 6.397 m/count. The average of the tow calibrations is = 6.3882 m/count. This is calibration coefficient that was used on the MOCNESS tows taken this cruise i.e. NH1208.

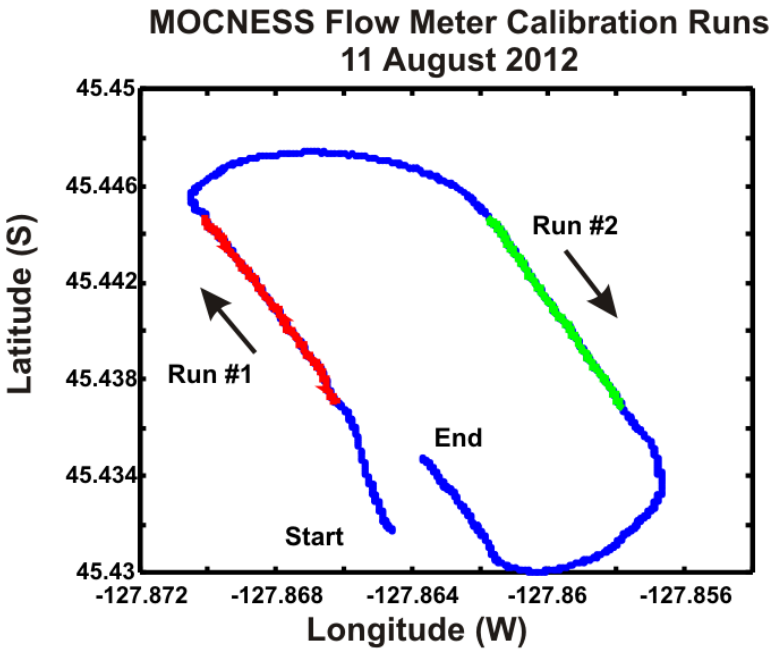


Figure 9.1.2. The R/V New Horizon's trackline in blue while towing the MOCNESS. The red line is first half-mile run for the flowmeter calibration and the green-line marks the second half-mile run.

Table 9.1.1. Measured half-mile runs were carried out on 11 August 2012 as part of MOCNESS tow M_01_001. The MATLAB mfile SW_DIST.m from the SEAWATER toolkit was used to compute the distances based on latitude and longitude.

	Time	Latitude	Longitude	FC	Distance (m)
End of Run#1	224.732049	45.4448	-127.8701	271	918.5
Start of Run#1	224.720625	45.4370	-127.8662	103	
			Run #1 FC	168	
End of Run#2	224.749109	45.4368	-127.8578	539	931.6
Start of Run#2	224.740417	45.4447	-127.8618	409	
			Run #2 FC	130	
		Run # 1 = 918.5/168=5.4673 Run # 2 = 931.6/130 = 7.1662 14.1364/2=6.3167 m/fc			

9.2. *Video Plankton Recorder*

Alexander Bergan

9.2.1. Introduction

The Video Plankton Recorder is an underwater video microscope system designed to record images of plankton ranging in size from less than one half millimeter up to a few centimeters. A strobe light flashing at 20 times per second captures images at this rate. A program called AutoDeck reviews the images at about 15 frames per second and extracts Regions of Interest (ROIs) that may be plankton based on certain parameters such as brightness and sharpness (see Settings for ROI Extraction below).

We used the Video Plankton Recorder (VPR) in order to describe the abundance and vertical distribution of plankton taxa at 34 stations along our study transects. We sampled every station by deploying the VPR attached to the CTD rosette frame generally to 1000 m depth with a total of 46 casts.

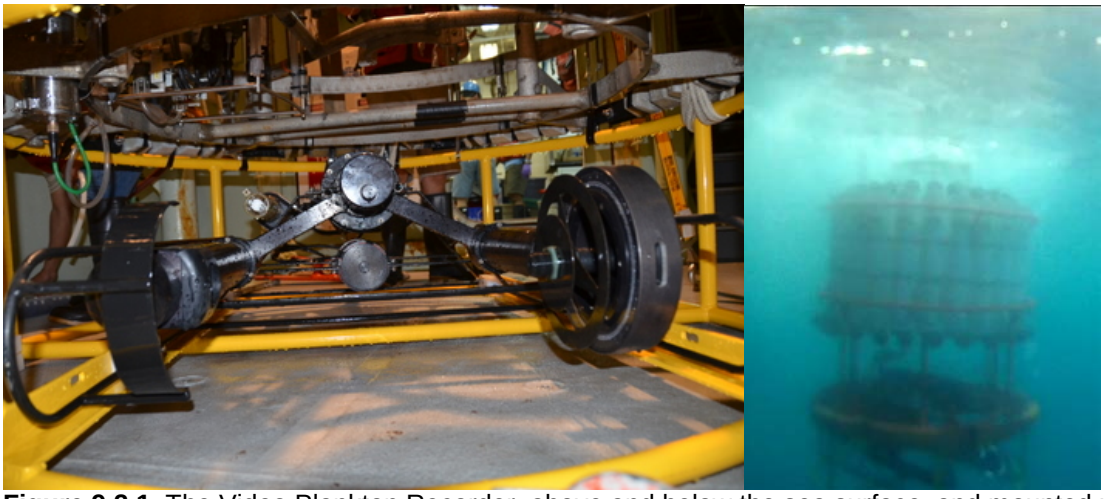


Figure 9.2.1. The Video Plankton Recorder, above and below the sea surface, and mounted under the CTD rosette.

9.2.2. Methods

The VPR was mounted in a specially designed cage attached via hose clamps below the CTD rosette frame (Figure 9.2.1). Four plastic boots clamped to the VPR frame allowed the unit to be bolted to the cage. The VPR remained in its usual frame, which could be slid in and out on rails positioned in such a way that the camera and strobe were unimpeded from below and thus could sample undisturbed water on the downcast. We set the magnification to S1 with an image area of 14 x 14 mm. The hard-drive was removed following each cast and the data downloaded. Since the casts were deep, we only attempted one cast per battery charge and therefore also swapped battery cases on each cast. The VPR was removed from the CTD cage prior to casts greater than 3000 m due to its depth limit of 1000 m.

The VPR was positioned with its long axis parallel to the CTD, such that the CTD's T-S probes were positioned over the open space between the camera and strobe and as such were sampling as undisturbed water as possible. This arrangement also meant that the open-path fluorometer was above the body of the VPR (to one side) and aimed horizontally in the opposite direction from the camera/strobe. In some instances the VPR may have been put in after a 3000m cast backwards.

During ROI extraction in AutoDeck, we identified the continuous downcast, which omitted the period of time from when the CTD frame entered the water, descended to about 10 m to equilibrate the salinity

probes and returned to the surface before it started down again. We also did not extract images from the upcast. With these frames selected, we used AutoDeck to extract using the following settings.

Settings for ROI Extraction:

Segmentation threshold **0; 140** (brightness)

Focus: Sobel: **40**; Standard deviation: **10** (edge detection)

Growth Scale: **300** (extra area around object)

Minimum blob size: **10** (object size)

Minimum join distance: **1** (distance between objects)

Settings were based from the notes of other VPR users and tests employing different ROI extraction settings (Table 9.2.1). The goal was to use AutoDeck to select pictures of pteropods and nice ROIs without having to look at too many blurry images or too much marine snow.

Table 9.2.1. ROI extraction setting test results.

Transect	Station	VPR#	Settings	Seg. Thresh.	Sobel	St. Dev.	#ROIS
0	test 1	1	normal	0-133	40	10	378
0	test 1	1	highest	0-133	40	0	1520
0	test 1	1	high	0-133	40	20	1129
0	test 1	1	low	0-133	60	0	391
0	test 1	1	lowest	0-133	60	20	355
1	1	2	normal	0-140	40	10	644
1	1	2	high	1-133	40	10	1581
1	1	2	low	0-150	40	10	331
1	2	3	normal	0-140	40	10	226
1	2	3	high	0-133	40	10	661
1	2	3	low	0-150	40	10	105
1	3	4	normal	0-140	40	10	291
1	3	4	high	0-133	40	10	785
4	25	33	normal	0-140	40	10	43
4	25	33	high	0-133	40	10	194

ROIs were saved to the external hard drives under the directory NH1208_VPR\VPR#, automatically saved in sub-directories named by year day and hour. Although we thought that we had set the VPR's internal clock to GMT (+7 then +8 to local time), it was actually set in Eastern daylight savings time (+3

and +4 to local time). ROI names were recorded as milliseconds in the day according to the VPR's internal clock. The VPR has an attached CTD, which also records observations by milliseconds into the day, allowing us to match depth, salinity, and temperature to the moment that a ROI was captured. ROIs were checked and those that were identifiable as pteropods and euphausiids were placed into folders. Also, well-focused pictures of interesting subjects were saved to a separate folder containing especially nice ROIs.

9.2.3. Problems and solutions

Maintaining focus of the VPR camera is important in order to obtain the best possible images. The focus of the camera is set at a certain distance for each magnification, but tended to drift over time. The extraction program will only accept a certain level of blurriness before rejecting a ROI, depending on the settings chosen by the user prior to extraction. To maintain the correct focal distance we refocused the camera after each cast by changing the magnification setting (S0 or S2) and then returning to S1.

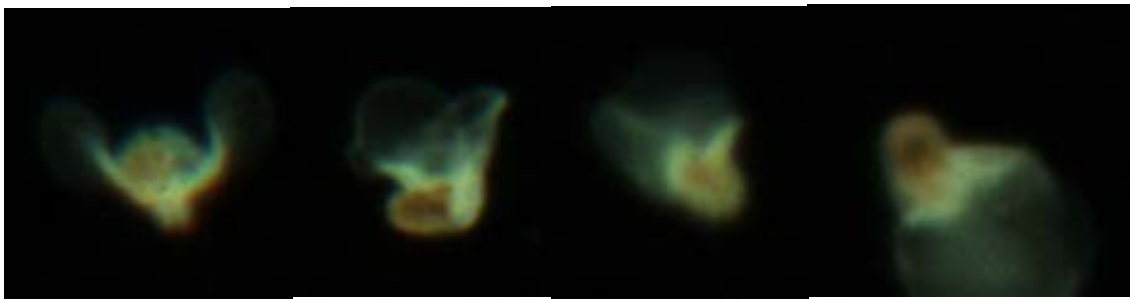
On a few occasions (VPR casts 8 and 23), the VPR hard drive's memory filled up, which takes about 8 casts to 1000 m. It is a good idea to erase files if the free memory is less than 5 GB. On VPR cast 21, many files were created, but they crashed AutoDeck rather than showing frames. We believe that the hard drive got disconnected as one of the pins holding the hard drive in was detached when it arrived on deck. Finally, there was a problem that we couldn't diagnose on cast 30, where the upcast was divided into multiple files. The battery was not too depleted and the hard drive had plenty of free space. We retired that battery and had no further problems.

9.2.4. Preliminary Results

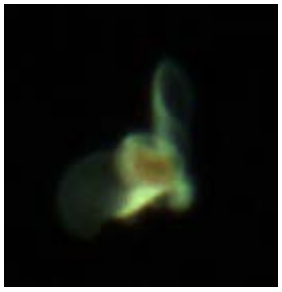
VPR cast information is provided in Table 9.2.2, with table columns as follows:

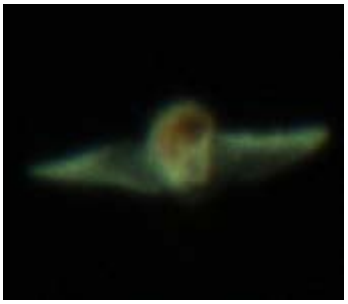
Event : event number as listed in the event log
Transect
Stn: station number
VPR#: cast number
date Local: local date at start of tow
time Local : local time at start of tow
day/ night: whether tow took place in the day or night, dusk or dawn
Lat : decimal latitude at start of cast
Long : decimal longitude at start of cast
Cast Depth : nominal depth of cast; actual depth is usually within 15 meters of nominal
Mag.: magnification setting on the VPR (S0=7x7mm; S1=14x14mm; S2=28x28mm)
Filename: name of video file; suffix is .dat and also .idx
ROI exam: whether each roi in the cast has been manually examined for pteropods
possible pteropods: number of possible pteropods in the cast; tends to be higher than actual number
Total ROIs: number of rois extracted using the settings listed
Notes: comments pertaining to the cast and roi examination

Overall, relatively few ROIs were identified from the VPR cast data as being possible pteropods (0-7 per cast)(Figure 9.2.2). Those few pteropod-like ROIs observed were often at large depths, however (e.g., 270-300m at Station 7), and it will be interesting to compare and integrate the VPR observations with the net sampling results.

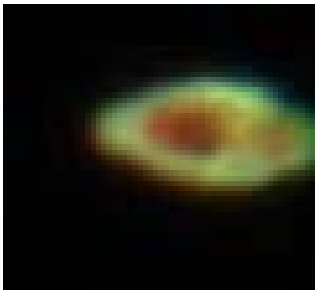


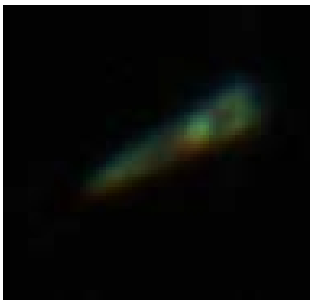
Both day and night casts at station 7 captured likely images of *Limacina sp*. (*helicina*) between 270 and 300 m depth.





Left: *Limacina sp.* (*helicina*) at station 8 residing at 242 m depth on a night cast at station 8.
Right: *Limacina sp*. at station 18, a day cast, found at 283 m.





Other possible pteropods, Left: a juvenile *Clione limacina* at station 6
Right: could be a *Styliola subula* or another cone shaped pteropod at station 31

Figure 9.2.2. Examples of ROIs suggestive of pteropods.

Table 9.2.2. VPR cast information

Event	Tran-sect	Stn	VPR#	date local	time local	day/ night	Lat.	Long.	Cast Depth	Mag.	Filename	ROI exam	possible pteropods	Total ROIs	Notes
20120811.2332.002	0	test 1	1	8/11/2012	16:31	day	45.435	127.874	500	S1	1344725531	√	7	378	Seg thresh 0-133
20120816.1133.002	1	1	2	8/16/2012	3:33	night	49.876	149.551	1000	S1	1345116535	√	1	644	
20120816.2121.002	1	2	3	8/16/2012	13:21	day	49.414	149.274	1000	S1	1345151826	√	1	226	
20120831.2204.002	1	3	4	8/31/2012	14:03	day	48.968	148.340	1000	S1	1346450439	√	1	291	
20120901.1245.002	1	3	5	9/1/2012	4:44	night	48.944	148.860	1000	S1	1346503103	√	0	755	Seg Thresh 0-133
20120901.2050.002	1	4	6	9/1/2012	12:50	day	48.497	147.321	1000	S1	1346532288	√	2	585	Seg Thresh 0-133
20120902.0320.001	1	5	7	9/1/2012	19:20	day	47.998	146.451	1000	S1	1346555797	√	0	292	
20120902.1045.001	1	6	8	9/2/2012	2:45	night	47.495	145.581	1000	S1	1346582311	√	1	196	multiple files on upcast
20120902.2011.001	1	7	9	9/2/2012	12:10	day	46.996	144.860	1000	S1	1346616723	√	5	268	
20120903.0747.002	1	7	10	9/3/2012	11:02	day	47.016	144.700	1000	S1	1346658113	√	6	446	down and upcast extracted
20120903.1331.001	1	8	11	9/3/2012	5:30	night	46.499	143.875	1000	S1	1346678749	√	2	267	
20120903.1947.001	1	9	12	9/3/2012	11:47	day	45.998	143.032	1000	S1	1346701462	√	2	210	
20120904.0154.002	1	10	13	9/3/2012	17:54	day	45.500	142.198	1000	S1	1346723609	√	0	277	
20120904.1100.001	1	11	14	9/4/2012	3:00	night	44.961	141.324	1000	S1	1346756243	√	1	391	
20120904.2015.001	1	11	15	9/4/2012	12:14	day	44.902	141.244	1000	S1	1346789543	√	0	103	
20120905.0106.001	1	12	16	9/4/2012	17:05	day	44.499	140.552	1000	S1	1346806940	√	0	183	
20120905.0808.001	1	13	17	9/5/2012	0:07	night	44.008	139.756	1000	S1	1346832369	√	2	143	
20120905.1430.002	1	14	18	9/5/2012	6:30	day	43.499	138.933	1000	S1	1346855296	√	1	145	
20120906.0026.002	1	15	19	9/5/2012	16:26	day	43.109	138.101	1000	S1	1346890768	√	1	293	Only 1 upcast of yo-yo examined

Event	Tran-sect	Stn	VPR#	date local	time local	day/ night	Lat.	Long.	Cast Depth	Mag.	Filename	ROI exam	possible pteropods	Total ROIs	Notes
20120906.0927.001	1	15	20	9/6/2012	1:27	night	43.190	138.163	1000	S1	1346923483	√	0	110	
20120906.1815.002	1	16	21	9/6/2012	10:15	day	42.502	137.347	1000	S1	corrupted	√	-	none	Bad files
20120907.0107.002	1	17	22	9/6/2012	17:07	day	42.003	136.555	1000	S1	1346979773	√	0	77	
20120907.1225.002	1	18	23	9/7/2012	4:25	night	41.626	135.783	995	S1	1347020638	√	4	61	very bottom and upcast missing
20120907.2112.001	1	18	24	9/7/2012	13:12	day	41.831	135.794	1000	S1	1347052218	√	2	58	
20120908.0659.002	1	19	25	9/7/2012	22:59	night	41.013	135.012	1000	S1	1347087438	√	0	60	
20120908.1153.001	4	20	26	9/8/2012	3:53	night	40.503	135.001	1000	S1	1347105041	√	0	85	
20120908.1956.001	4	21	27	9/8/2012	11:55	day	40.093	135.023	1000	S1	1347134028	√	2	50	
20120909.0645.001	4	21	28	9/8/2012	22:44	night	40.067	135.073	1000	S1	1347172934	√	0	44	
20120909.1331.002	4	22	29	9/9/2012	5:31	night	39.502	135.001	1000	S1	1347197237	√	2	109	
20120909.1809.001	4	23	30	9/9/2012	10:08	day	39.003	135.002	1000	S1	1347214079	√	0	41	multiple files on upcast, Batt B
20120910.0053.001	4	24	31	9/9/2012	16:53	day	38.613	135.009	1000	S1	1347238165	√	0	60	
20120910.0848.001	4	24	32	9/10/2012	0:47	night	38.524	135.013	1000	S1	1347266424	√	1	73	
20120910.1348.002	4	25	33	9/10/2012	5:48	night	38.001	134.999	1000	S1	1347284780	√	0	43	
20120910.1827.001	4	26	34	9/10/2012	10:27	day	37.503	135.000	1000	S1	1347301525	√	1	51	
20120911.0117.001	4	27	35	9/10/2012	17:17	day	37.153	135.109	1000	S1	1347325954	√	0	54	
20120911.0944.001	4	27	36	9/11/2012	1:44	night	37.342	135.085	1000	S1	1347356457	√	0	201	
20120911.1818.002	4	28	37	9/11/2012	10:18	day	36.505	135.000	1000	S1	1347387488	√	1	64	
20120911.2310.001	4	29	38	9/11/2012	15:09	day	36.003	134.999	1000	S1	1347404703	√	1	49	
20120912.1134.001	4	30	39	9/11/2012	3:33	night	35.665	134.901	1000	S1	1347449507	√	0	64	

Event	Tran-sect	Stn	VPR#	date local	time local	day/ night	Lat.	Long.	Cast Depth	Mag.	Filename	ROI exam	possible pteropods	Total ROIs	Notes
20120912.1534.002	4	30	40	9/12/2012	7:34	day	35.654	134.912	1000	S1	1347463984	√	0	60	
20120913.0159.001	4	31	41	9/12/2012	17:58	day	35.003	134.998	1000	S1	1347501453	√	3	53	
20120913.1023.002	4	32	42	9/13/2012	2:23	night	34.425	135.104	1000	S1	1347531765	√	0	36	
20120913.1956.001	4	32	43	9/13/2012	11:55	day	34.653	135.081	1000	S1	1347566080	√	1	55	
20120914.0155.001	4	33	44	9/13/2012	17:54	day	34.001	135.000	1000	S1	1347587577	√	2	57	
20120914.1008.002	4	34	45	9/14/2012	2:08	night	33.620	134.995	1000	S1	1347617293	√	1	174	
20120914.2014.002	4	34	46	9/14/2012	12:14	day	33.709	135.012	1000	S1	1347653516	√	0	139	

9.3. *Multi-frequency acoustics*

Gareth Lawson, Taylor Crockford

9.3.1. Introduction

Quantifying the distribution of any marine organism requires sampling tools able to resolve adequately the scales of variability, which has led biological oceanographers in recent decades to employ a variety of increasingly sophisticated technologies. In particular, high-frequency active acoustic scattering techniques are uniquely suited to the study of zooplankton and fish distributions, as they provide remote and non-intrusive samples at high resolution and to large ranges, allowing patch structure to be quantified in fine detail: a task that is difficult to achieve using traditional net or optical sampling systems alone. Single frequency systems, while useful in this regard, are much less capable of providing insight into the composition of scatterer types present than is a system with multiple frequencies. Multi-frequency systems capitalize on the fact that different kinds of organisms scatter sound differently as the frequency changes, such that measurements of backscattering at multiple frequencies can be used to make inferences about the taxonomic composition of animals present.

On the current cruise, multi-frequency measurements were made near-continuously along-track and while on station. The goals were to characterize the distribution of scattering in relation to changing environmental quantities along the latitudinal gradient of our survey transect; to characterize rates and amplitudes of diel vertical migrations; to provide indices of pelagic animal abundance to be correlated with other datasets; and to assess the feasibility of using acoustics to characterize pteropod distribution and abundance.

9.3.2. Methods

High-frequency acoustic measurements were made using a Hydroacoustic Technology Inc (HTI) multi-frequency echosounder operating at frequencies of 43, 120, 200, and 420 kHz (Fig 9.3.1). Four split-beam transducers at 43 (7 degree full-beamwidth), 120, 200, and 420 (all 3 degree beamwidths) kHz were installed in a towed sled deployed via the ship's moon pool. The sled was built by SIO and was designed according to Terry Hammar's specifications in order to accept the Greene Bomber transducer faceplate, with a new mount for the MUX bottle. Installation was a complicated operation, as it required lowering the sled into the well with a line suspended from the crane, while tending to a safety line and three wire lines. These were then attached to pad-eyes attached to the side of the well and tightened with turnbuckles (by a person suspended in the well via the crane and a bo's'n's chair). The transducers were oriented in the plate such that they were aimed 'forward,' but the orientation of the pad-eyes made the sled turn 45 degrees relative to this. The 250' underwater cable then fed from the MUX bottle and was sistered to the line used to lower the sled in. A sliver of the well top was kept open for the duration of the cruise and this area was roped off. The data cable was spooled at the top of the well, with an end running in to the wetlab and then in to the main lab and the HTI deck unit.

The HTI Model 244 Digital Echo Sounder (DES) deck unit (aka the big red box) was installed in the main lab, along with a Model 242 DES deck unit (aka the little red box) and the control laptop (Fig 9.3.1). The latter was used with a 19" flat-screen monitor to allow easy visualization of the real-time data. A GPS DB-9 feed connected to the laptop via a serial-to-USB converter provides GPS to the HTI Sounder.exe software. The M244 contained the transmit/receive cards and processed the raw data into integrated and target strength data streams, transferred to the control laptop over a local area network (LAN) and using Lantastic networking software. These are displayed and recorded by the HTI software and saved as hourly .INT (integrated data), .RAW (target strength), and .BOT (time and position) files. The raw data are also transferred from the M244 to M242 via a microphone cable, where they are processed and transferred via the LAN to the laptop to be saved as .SMP files. These 'sample' data allow us to later re-process the raw

data using alternative noise profiles, depth strata, etc relative to what was used at-sea for the collection of integrated data, and can be used to look at the data on a ping-by-ping basis.

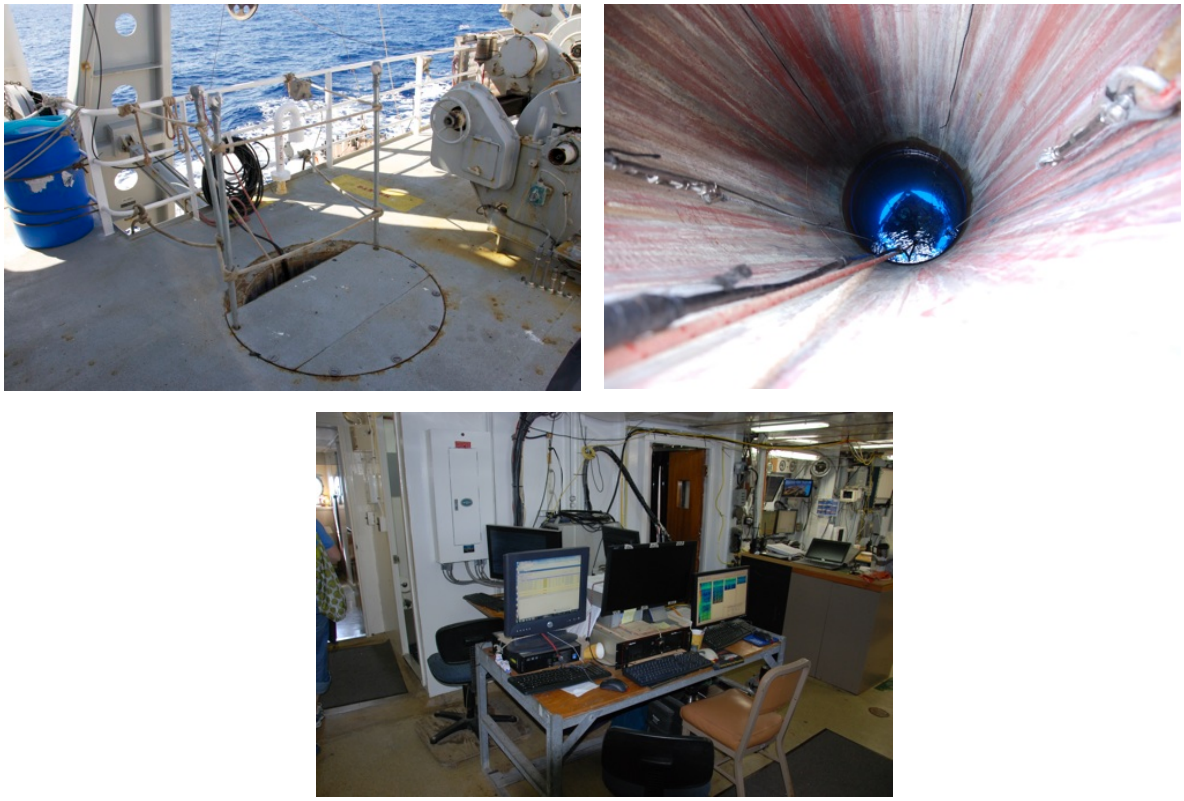


Figure 9.3.1. Clockwise from top left: Top of the New Horizon moon pool; Inside of the moon pool showing the sled housing the HTI transducers; Main lab acoustic data collection station. [Photos: G. Lawson].

Acoustic data were collected continuously over the course of the cruise during both transit and while on station, other than during periods of data transfer (mostly timed to occur during station activities), when the system needed to be shut down to avoid interference with the Edgetech broadband acoustic system, or when trouble-shooting some issue with the multi-frequency echosounder. Data were collected at vessel speeds of up to 10.5 kn. Due to differences in absorption of acoustic energy by seawater, the range limits of the transducers are different. After testing various range settings and associated noise levels, the final configuration involved the 43, 120, 200, and 420 kHz channels looking to 500, 300, 150, and 100m, respectively, with corresponding interval durations to achieve these ranges of 1000, 650, 350, and 250 ms. Integration intervals were set to 0.1 min and depth strata at all frequencies were set to 1m.

The sync out from the HTI fed Wu-Jung's trigger box, which then relayed a logic pulse up to the 01 deck where the ADCP deck unit was located. A fifth 'empty' period with an interval duration of 2000 ms was used to provide the ADCP sufficient time to complete its ping cycle.

The .INT and .BOT files were further post-processed by Taylor Crockford to convert the text files to Matlab format and concatenate the hourly files into daily sections. Echograms for these sections were generated and printed for each cruise day. The daily echograms were combined to provide an image of the backscattering for each transect.

An acoustic log (Appendix 5) was maintained for the duration of the cruise to keep track of configuration file changes, scattering features of interest, and any other salient information.

9.3.3. Problems and Solutions

Noise

The transducers operated reasonably well with respect to noise. Noise levels measured early in the cruise were used throughout in the HTI configuration file. These were higher than on other vessels, partly due perhaps to the ship, but likely mostly due to the transducers being in the moon pool. In even slightly rough seas the 43 kHz and often the 120 kHz were affected by strong streaky noise (both shallow and deep), presumably bubble sweep-down and/or ship's noise. Overall we were reasonably satisfied with the performance of the system in the moon pool though, as it was a very convenient way of collecting data at full transit speed.

Interference

A number of ship's acoustic systems interfered with the HTI frequencies, including the bridge sounder (50 kHz, interfering with the 43 kHz), the Knudsen depth sounder (3.5 and 12 kHz, interfering with the 43 and 120 kHz), and the Doppler speed log (440 kHz, interfering with the 420 kHz). As is the ship's custom, the 50 kHz sounder was secured once the ship left the continental shelf. For the Knudsen, the protocol we settled on was to turn on both the 3.5 and 12 kHz systems at the start of each station to check the water depth and make sure the CTD didn't hit the bottom. Similarly, the bridge preferred to have the speed log on at stations to facilitate deployments/recoveries, and so the speed log was only secured while in transit.

Computer Issues

Occasional problems occurred with the control laptop used for HTI data collection. Every now and then the M244 would reboot itself for no apparent reason. This would manifest itself via a Lantastic error message saying that the server 1017533 was shutting down, the Sounder.exe software would cease the connection to the M244 along with data processing and recording. After the M244 rebooted, the software would automatically reconnect and resume data collection to a new file. Less frequently, also without explanation, the laptop encountered the blue screen of death and the system needed to be restarted. On such occasions, and other instances where the laptop needed to be rebooted, getting the full system communicating was often problematic. The boot-up sequence involves having the laptop on, turning on the M242, then turning on the M244, then restarting the M242. In some instances this process had to be repeated as many as six times to get the M242 and M244 communicating and the samples data logging. The final computer issue involved the GPS. Often when creating a new configuration the GPS feed was inexplicably lost and the GPS had to be plugged into a different port on the serial to USB converter. These are all frustrating but known issues with the HTI system.

9.3.4. Preliminary Results

In the northern portion of the study area, including the transits to/from Newport (i.e., transects 0, 2, 3), the most pervasive acoustic feature was a strong scattering layer present during both day and night at a depth of ca. 20-50m (Figure 9.3.2). This layer was somewhat patchy and absent or weak in some places, but overall was highly persistent. Initial examination of spectra in the layer was inconclusive: sometimes the shape was consistent with large zooplankton, other times with smaller ones (both on the HTI and Edgetech; Figure 9.3.3). Understanding the source(s) of scattering in the layer will take more analysis. This layer is likely the same one observed by Barraclough et al (1969) in the Science paper that marked the beginnings of zooplankton acoustics. They thought the layer was composed of copepods, specifically *Calanus* (now *Neocalanus*) *cristatus*. The magnitude of the scattering relative to the amounts of *Neocalanus* we were catching makes us (qualitatively) a little skeptical of this conclusion.

This shallow layer diminished mid-way along Transect 1 (Figure 9.3.2). Another shallow layer came back farther along Transect 1, but this was weaker at 43 and 120 kHz and perhaps due to smaller plankton (Figure 9.3.3). Scattering along Transect 4 was overall much lower than farther north. A weak signal of scattering between the surface and 50m that underwent a diel vertical migration was evident, with mostly decreasing spectra or similar at 43/120 and then decreasing at the higher frequencies. The salinity was highly variable in the upper 100m, with sharp jumps of up to 0.5 psu. Associated with these layers were often strong scattering layers. Further investigation of the spectra of these acoustic layers will be required, as will a greater understanding than we had during the cruise of what shape of spectrum one would expect from a strong salinity gradient.

Unlike the previous year's cruise to the Atlantic on the Oceanus, the deep scattering layer was not very prevalent. The noise levels on the ship obscured somewhat observations deeper than 300m at 43 kHz, but generally the DSL was not very strong. Along transects 0, 2, and 4, during transit to/from Newport, and along the northern portion of transect 1, the DSL was present at depths of ca. 300m during day. At night one fraction migrated up only to depths of ca. 200m while other fractions migrated to the surface. The DSL started decreasing in magnitude around where the shallow scattering layer ended along transect 1.

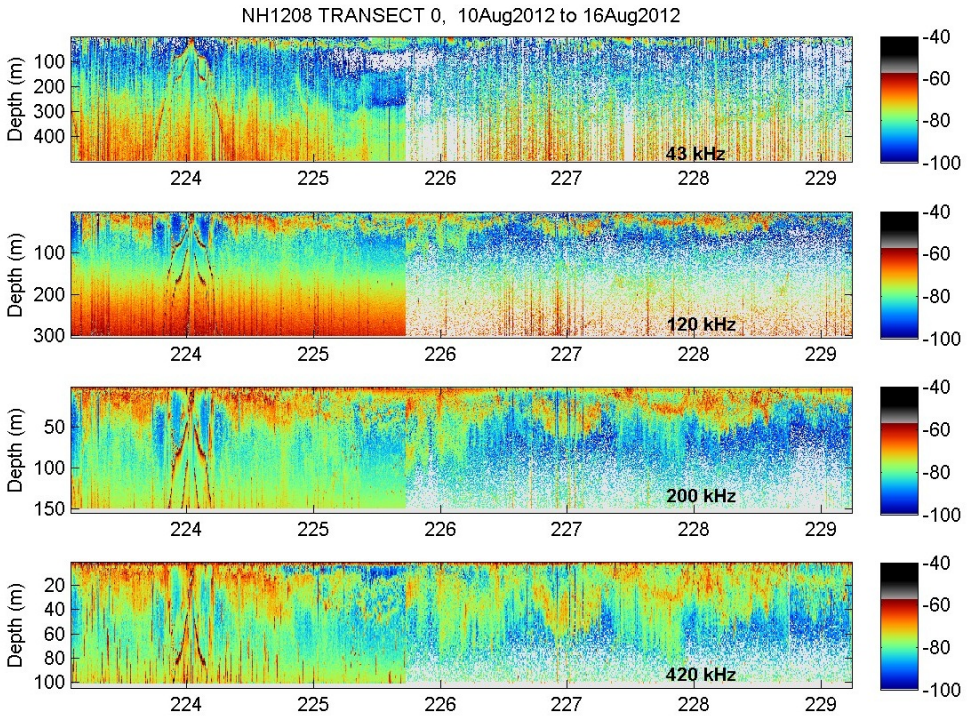


Figure 9.3.2. Transect 0 echogram showing volume backscattering strength (dB) on the color scale relative to depth (m) and time (yearday).

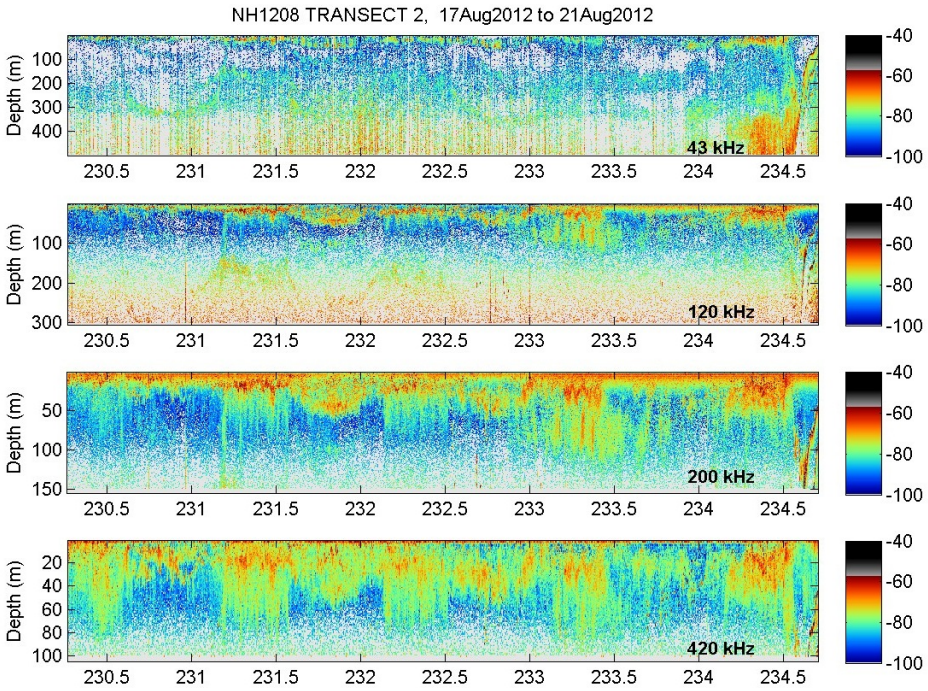


Figure 9.3.2 continued – Transect 2 echogram

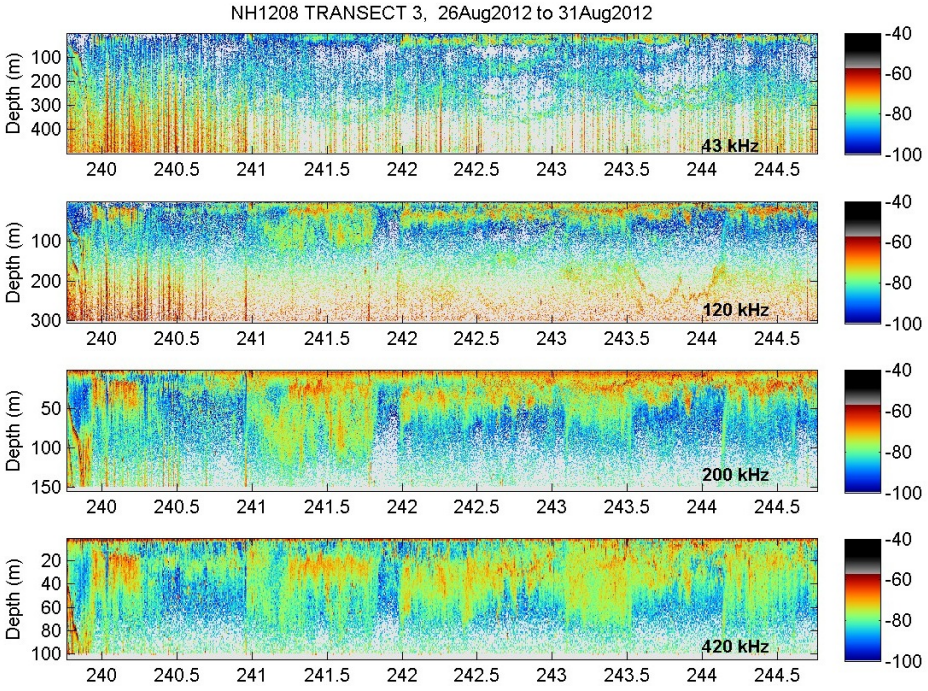


Figure 9.3.2 Continued – Transect 3 echogram

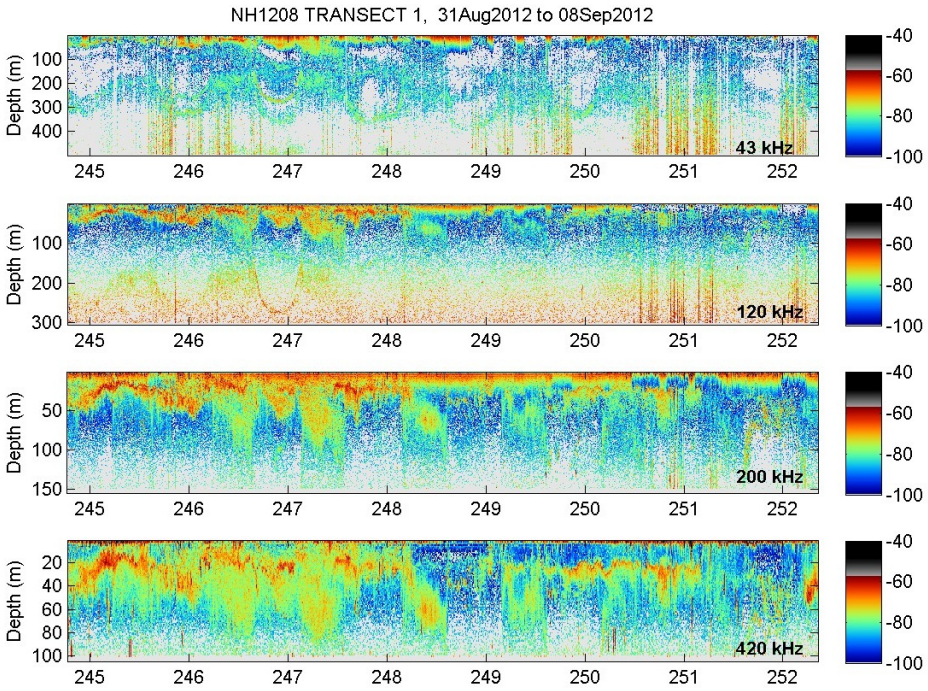


Figure 9.3.2 continued – Transect 1 echogram

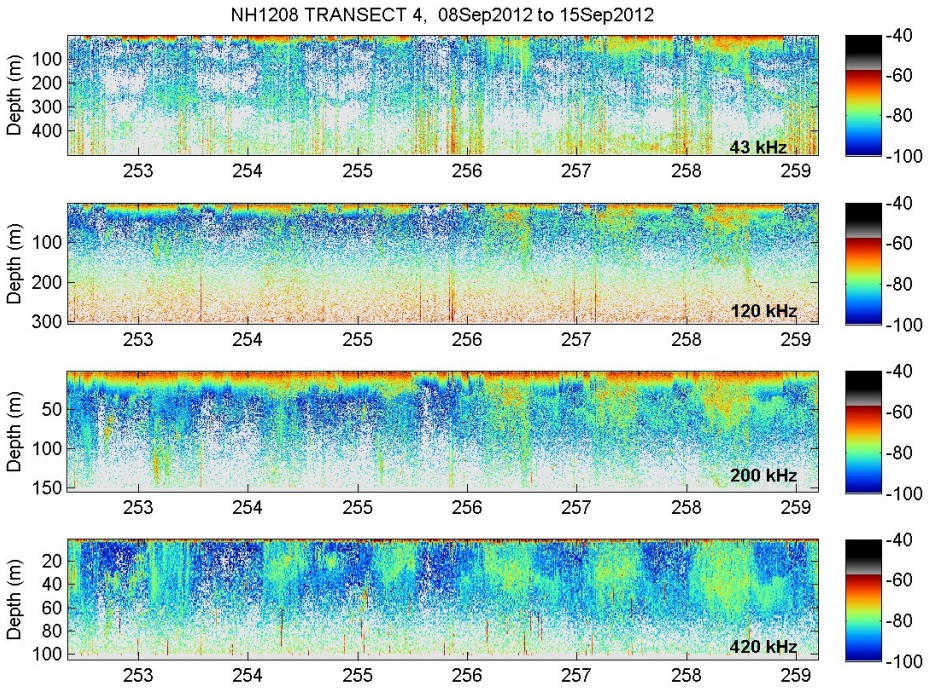


Figure 9.3.2 continued – Transect 4 echogram

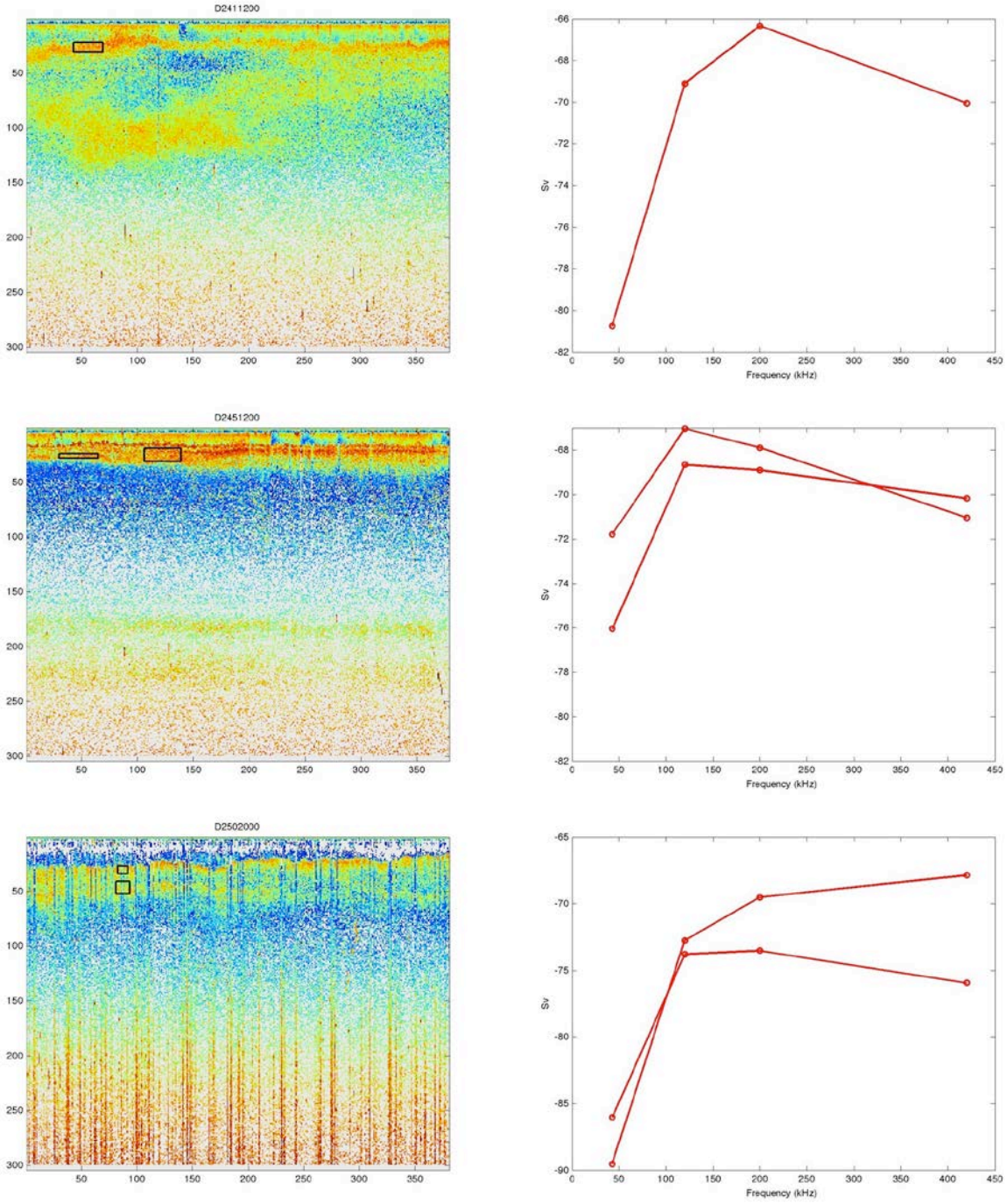


Figure 9.3.3. Selected hourly echograms (120 kHz) showing the different forms of the shallow scattering layer pervasive in much of the northern portion of the study area and associated spectra (calculated for the regions delineated by black boxes).

9.4. *Broadband acoustics*

Gareth Lawson, Tom Bolmer, Andone Lavery

9.4.1. Introduction

A chronic difficultly in the use of acoustics to quantify animal distributions lies in discriminating among the various animals likely to be present and contributing to acoustic scattering measurements. With only one or a limited number of frequencies, the problem of solving for quantities like the abundance of each animal type present is strongly complicated by differences in the scattering characteristics of the different types. For example, at a single frequency, a given level of observed scattering could be accounted for by a large abundance of small and weakly-scattering organisms like copepods, or an orders-of-magnitude smaller number of strong scatterers like gas-bearing siphonophores. Broadband acoustic scattering techniques, of the sort under development by project co-PI Andone Lavery for the past few years, offer the potential for substantial improvements in species discrimination due to the ability to measure scattering relative to frequency (i.e., the scattering spectrum, or acoustic signature) over a broad frequency range. In cases where a single taxon dominates scattering or in mixed assemblages where the scattering spectra of the different animals are sufficiently distinct, the sources of scattering can then be characterized and quantitative estimates of animal abundance and size made.

In recent tests, a newly-developed system has been used to identify and quantify thecosome pteropod abundance and size off the New Jersey continental shelf and verified relative to net samples; similar tests have been conducted for quantification of krill distributions. On the present cruise, broadband data were collected at select stations, with the objective of continuing to develop these broadband techniques for remote identification and characterization of thecosome pteropods and other zooplankton. The intention was also for the broadband system to provide improved species identification capabilities, to supplement the multi-frequency system's underway measurements.

9.4.2. Methods

A heavily-customized downwards-looking broadband acoustic scattering system manufactured by EdgeTech Marine and spanning a near-continuous frequency band of 40-600 kHz was used. This broadband system was limited to a maximum range of 50-150 m (varying with frequency) and so to achieve sampling over a greater depth range was either profiled vertically towed obliquely up and down through the water column (during occasional small-scale acoustic surveys). The system operates at six channels, and the frequency bands and subsystem sharing for the six channels and associated transducers employed during this cruise are shown in Figure 9.4.1.

HammarHead
EdgeTech Broadband Acoustic System

	Subsystem 1		Subsystem 2		Subsystem 3	
System Arrangement	1	4	2	5	3	6
	A1	LOW	MID	A2	HL	HH
	35-70	120-200	220-300	80-120	300-450	450-600
Match Filter Channel	0	5	8	13	16	21
Raw Channel	2	7	10	15	18	23
Ping Sequence	A1,	MID,	HL,	LOW,	A2,	HH
UW Unit IP Adress	192.9.0.101 UserName/Password: Administrator/admin					
Shipboard IP Adress	192.9.0.102 NoUserName/NoPassword					
Trigger Box National Instruments	UserName/Password: Administrator/WHOI					

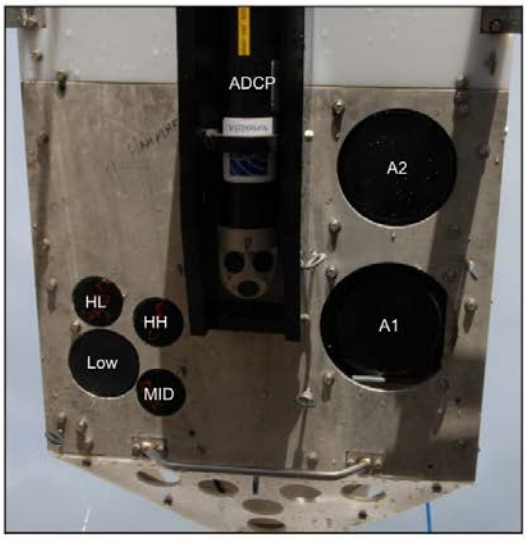


Figure 9.4.1 – Edgetech channel assignments and other settings [Photos: P. Wiebe]

The HammarHead was deployed via the stern A-frame and a portable Sea Mac winch provided by SIO. Deployment required one person on the winch, one on the A-frame, two on slip-lines, and the res tech as deck boss. After some experimentation with tagline arrangement, the final system involved the port side tagline strung in the same way as the MOCNESS: tied to a post just inboard of the A-frame (the post was part of the railing used to keep people away from the A-frame), looped through the U-bolt on the fish, then back to a deck cleat just forward of the A-frame. On the starboard side a cleat was put down just to starboard of the mid-line; the tagline was tied to an eye-bolt (used to attach the cleat to the deck), looped through the U-bolt, then back to the cleat. Recovery involved snaphooks with the lines arranged in the same way as deployment. The HammarHead was deployed at all day-night stations, in most cases with deployments during both daytime and nighttime, sometimes spanning the dusk or dawn transitions. Unlike the previous year's cruise, deployments were not made at the regular stations, due to the lack of groundtruthing information from the nets.

Data collection at the "surface" involved holding the towed body at ca. 10-20m depth, which seemed a comfortable depth in terms of flight characteristics. The portable winch lacked a payout meter and so our rate of payout and haul-in were approximate, based on the person operating the software timing the rate of change in depth. The HTI data were used to identify layers of interest and the HammarHead sent to 10-20m above those layers, then held at constant depth for a few minutes to collect at least 100 pings. Raw data were initially collected over each layer in order to examine whether there was any saturation, and once no saturation was confirmed the raw data collection was shut off as it is bandwidth intensive and having it off allowed the ping rate to be increased to 2 Hz.

HammarHead casts usually lasted ca. one hour with the vessel moving at 2-3 kn. On the one occasion we went up to 5 kn, the winch paid until there was less than a wrap left on the drum and the fish was still

only at 360m. During night when the animals were mostly shallow in distribution, data collection was usually done at the surface with the towed body held at a constant depth, ca. 10-20m, in order to obtain high resolution data of particular scattering layers. During daytime when the scattering usually involved layering at a series of depths, the HTI data were used to identify layers of interest and the HammarHead profiled to 10-20m above those layers, then held at constant depth for 5 minutes to collect a reasonable number of pings. The fish was profiled to as deep as 365m.

After each cast the data were backed up and depth-corrected echograms produced. At some stations where scattering patches of interest were present, spectra were produced. The same acoustic log (Appendix 5) as used for the multi-frequency HTI system was also used for the duration of the cruise to keep track of broadband filenames, depths targeted, ping rates, scattering features of interest, and any other salient information.

9.4.3. Problems and Solutions

Synchronization

Interference between the broadband and multi-frequency systems can be avoided by synchronizing transmissions between the two systems using a National Instruments system and Labview program written by Wu-Jung Lee (a system overall referred to as Wu-Jung's box). This decreases the ping rate of each instrument though, and so in order to collect the highest quality data for the Edgetech, we shut the HTI and ADCP down during all HammarHead deployments. On the few occasions when we ran the Edgetech and HTI simultaneously there didn't appear to be much interference, but rather than risk it we chose not to run them together.

Data Transmission

The Sea Mac portable winch provided to us by SIO came with either 1200 or 1500m of standard UNOLS 0.322" EM 3-wire conducting cable (two different length measurements were made). We requested this length of wire as previous experience with 0.322" suggested we could achieve the necessary bandwidth for the Edgetech system while still having enough wire to target deep depths. We had some initial issues with the 0.322" wire's bandwidth. On deck, and later in the water, we had problems getting data through running the three channels at ranges of 75/75/50m at a ping rate of 1 Hz. The first deck test we had occasional overflows (i.e., dropouts), after which we replaced the slip rings since tests with the mega ohmmeter (aka the meggar) suggested that the wires weren't fully independent and some sleuthing led us to identify the slip rings as the problem. With the new slip rings, the first wet test led to a lot of overflows. On deck afterwards the problem persisted. It wasn't clear whether it was something to do with the wire quality or whether 75/75/50m was just too much data to get through given the speed of the U/W unit's modem (ie about 4 Mbps). Since we don't run the CTD on deck there would also be more data to push through when the system is in the water, perhaps explaining the higher overflow rate seen during the wet test. Reducing the range to 70/70/50m and a ping rate of 1 Hz with the system on deck resulted in no overflows and consistent usage of 41-42% of the capacity of the U/W unit's computer's Ethernet card limit of 10 Mbps. This was the set of ranges we used on OC473, but we believed was slightly less than used on the Endeavor krill cruises. In any case, by this point it seemed that we were perhaps getting overflows because we were exceeding the modem's capacity, not because of any issues with the wire/termination/slip rings/splices/etc. For most of the cruise we were able to collect data with these settings with only very occasional overflows.

Interference

During the first wet test we saw interference on the LOW that might have been 60 Hz noise. The system had been plugged into the ship's "clean" power. We plugged it for the next cast into the UPS used with the CTD deck units (just a regular UPS, not a very large one) and this improved things slightly. We also

had a peculiar problem where the data kept rolling in from the HH but went from showing scattering to showing a noise-like profile, then back to scattering again. This didn't happen for the rest of the cruise.

9.4.4. Preliminary Results

The HammarHead was deployed on 17 casts, at each of the day-night stations where the goal was to do both day and night deployments. At some of the stations we arrived with insufficient time to complete all of the day or night operations before dusk or dawn and so were able to only do day or night HammarHead casts. In some instances the HammarHead was in the water during the dawn or dusk transitions. Depth-corrected echograms showing representative data, often along with spectra, are found for all stations and casts in Appendix 6.

As with the HTI multi-frequency system, the dominant scattering feature for most of the cruise observed with the Edgetech broadband system consisted of shallow scattering layers, mostly quite thin. At a few stations (2,3,7,21), especially early in the cruise where the deep scattering layer was more prominent, we conducted a series of deep casts to the DSL. More typically though the HammarHead was profiled to one or a few shallow depths to ensonify shallow scattering layers. The nature of these layers varied substantially. In some regions they were more intermittent and patchy (e.g., Figure 9.4.2) while in others they were much more regular (e.g., Figure 9.4.3).

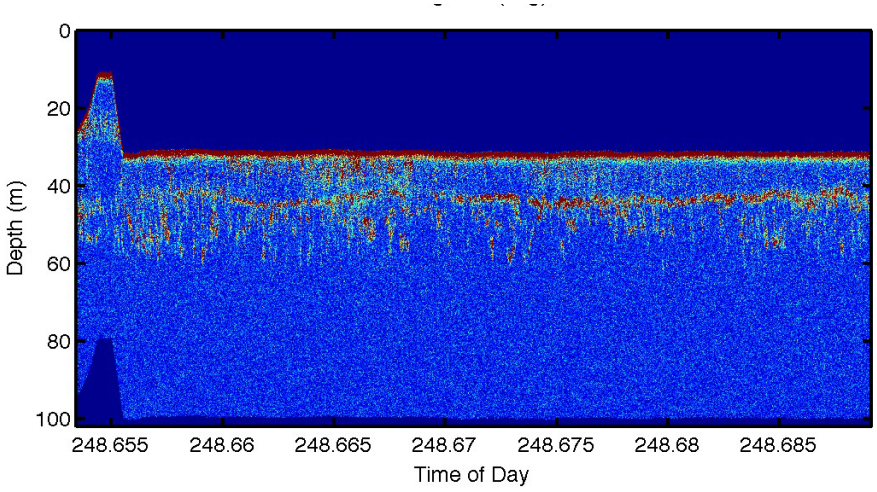


Figure 9.4.2. Edgetech MID data from Station 11, Cast 5.

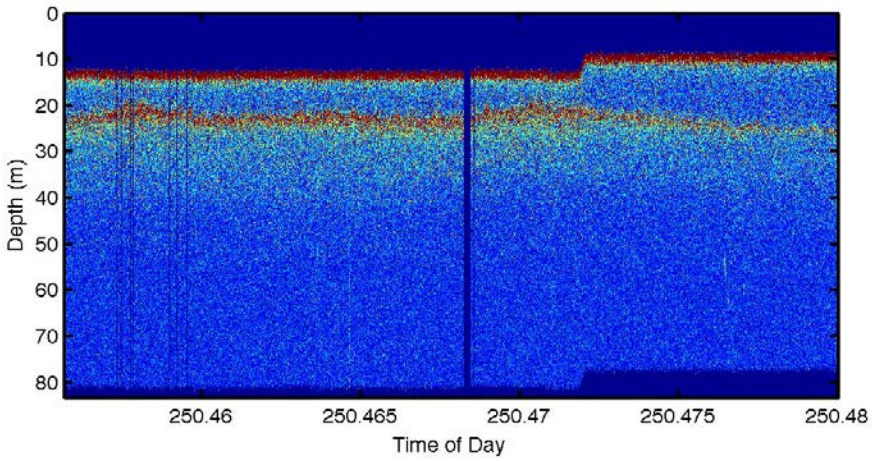


Figure 9.4.3. Edgetech MID data from Station 15, Cast 7

At at least stations 11, 15, and 18, spectra for these layers showed an interesting increasing shape (Figure 9.4.4), with a peak in the HL and then decreasing again in the HH, perhaps suggestive of moderate sized plankton. Pteorpods were abundant in these waters, and further analysis is warranted. On the occasions when we sampled the DSL the spectra were flatter (Figure 9.4.5).

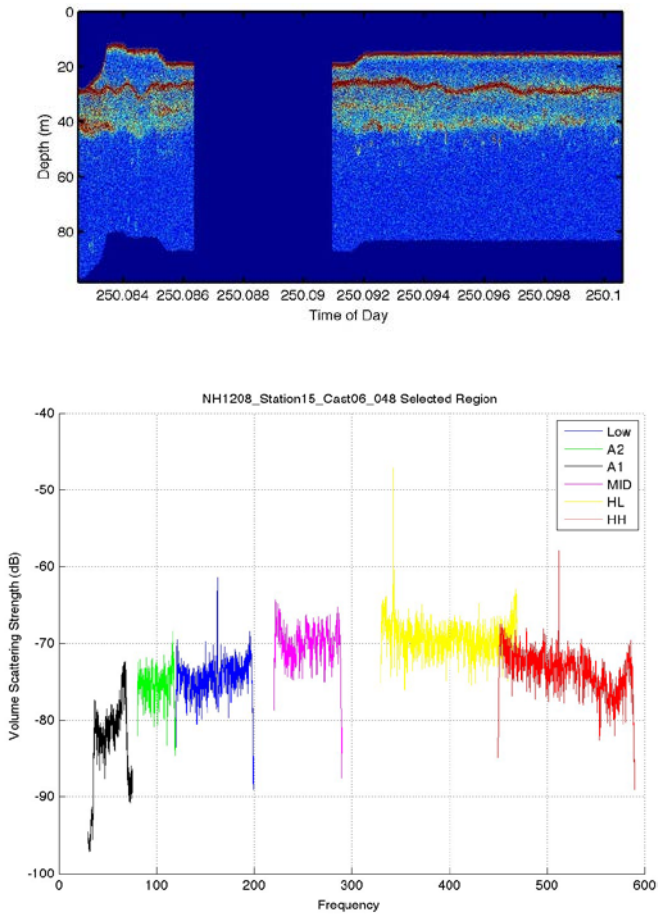


Figure 9.4.4. Spectrum for the shallow scattering layer evident at Station 15, Cast 6

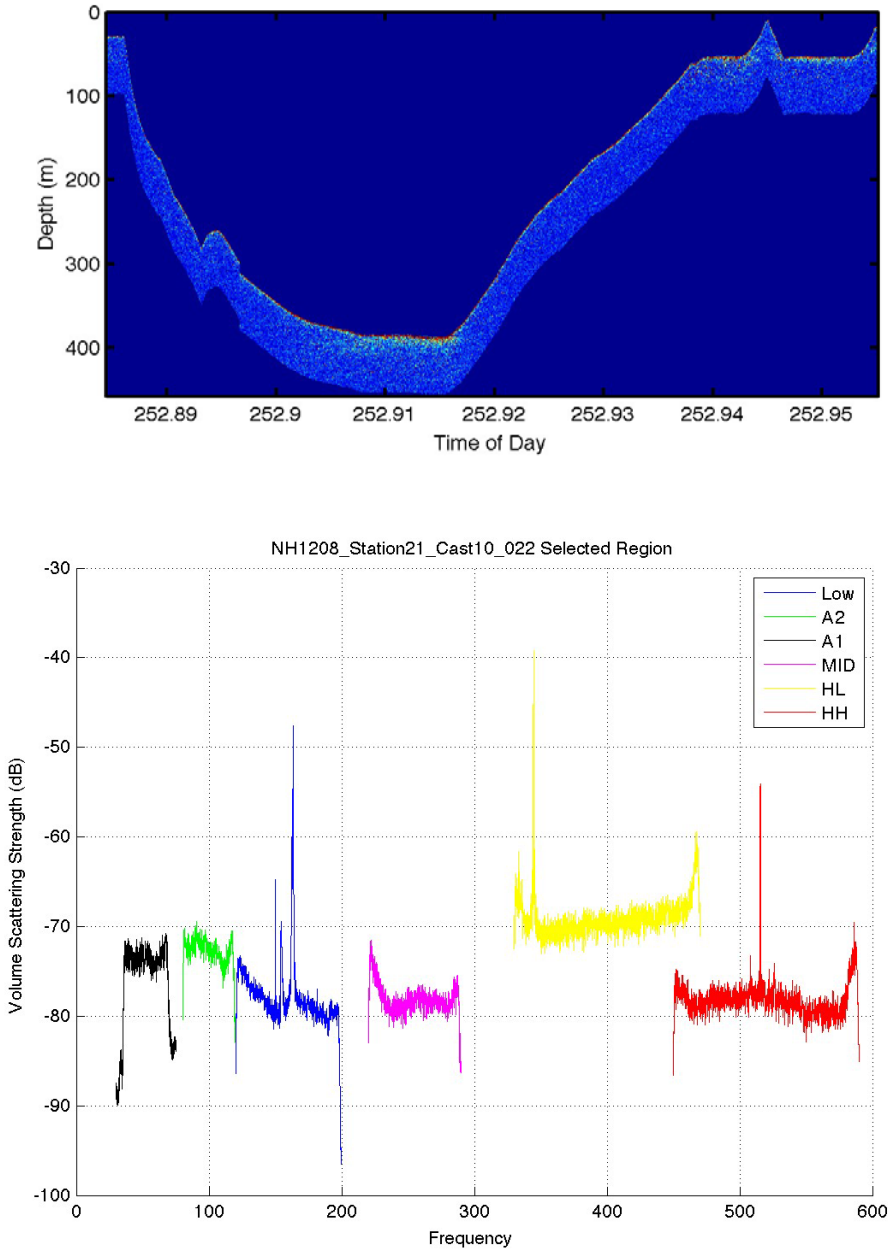
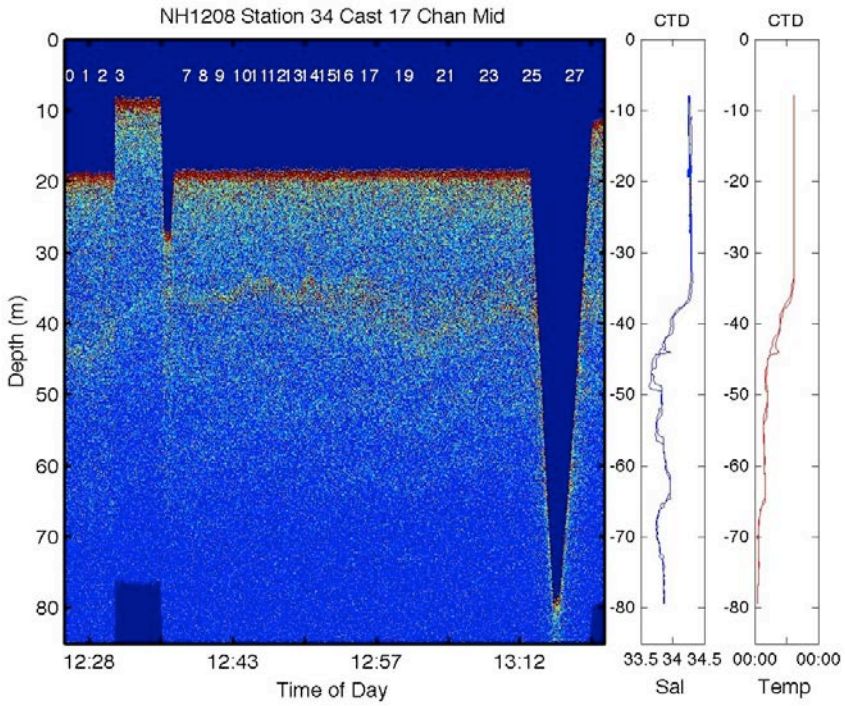


Figure 9.4.5. Spectrum from region of single targets in the DSL observed at Station 21, Cast 10

Towards the end of transect 4 shallow scattering layers were present on the HTI at the same depth as where the CTD was showing large salinity excursions – changes back and forth in salinity of up to 0.5 psu. The MOCNESS and VPR were not showing very many animals in this depth range, leading us to wonder if it was physical in origin. During the last cast of the cruise at Station 34, such a layer was present where the CTD was showing a large change in temperature and salinity (Figure 9.4.6) and Tom and Peter profiled the HammarHead through the layer in order to collect T-S data. They also turned on the HTI to have continuous data during the HammarHead profile.



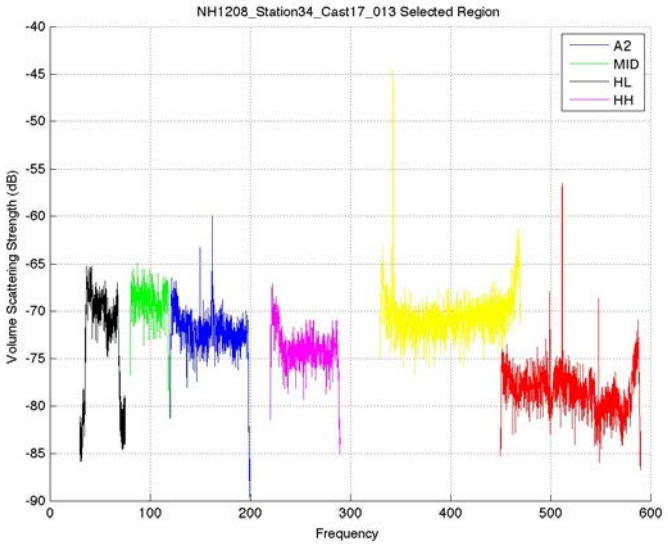


Figure 9.4.6. Profile conducted at Station 34, Cast 17 through a layer associated with a strong salinity gradient. The spectrum was slightly decreasing, except for the HL which was presumably at its noise floor.

9.5. *Reeve Net*

Amy Maas, Leocadio Blanco Bercial

9.5.1. Introduction

The objective of Reeve net sampling was the gentle collection of live specimens to be sampled for physiology and molecular ecology. This was also the source of individuals for shell chemistry, and opportunistic sampling. These net tows were short in duration to minimize handling time, usually lasting for no more than an hour. To maximize collection of diel vertically migrating species, tows generally occurred at the first station after sunset each evening (Table 9.5.1).

Table 9.5.1. Reeve net deployments

Tow	Station	Date	Local Time	Wire out (m)	Downcast (m/min)	Upcast (m/min)	Stops (mwo)	2 m/min ranges	Flow Start	Flow end	Volume filtered (m^3)
1	test 2	8/11/2012	22:07	150	20	5	45	-	0	58107	1549.52
2	test 3	8/12/2012	22:36	100	20	5	40	-	58097	93179	935.52
3	test 4	8/13/2012	23:03	120	20	5	90, 50	-	93237	139859	1243.2533
4	1	8/15/2012	0:07	64	35	5	-	50-30	139870	168211	755.76
5	test 5	8/27/2012	21:38	60	20	5	-	60-20	168211	198130	797.84
6	test 6	8/28/2012	22:00	90	20	5	-	90-40	198150	238301	1070.6933
7	test 7	8/29/2012	22:00	100	20	5	-	60-40	238309	268056	793.25333
8	test 8	8/30/2012	22:30	100	20	5	-	60-40	268057	294237	698.13333
9	3	8/31/2012	23:05	100	20	5	-	60-40	294229	332244	1013.7333
10	6	9/2/2012	1:43	100	20	5	-	50-30	332245	347138	397.14667
11	7	9/2/2012	19:22	100	20	5	-	60-25	347142	393044	1224.0533
12	11	9/4/2012	4:09	120	20	5	-	70-40	393949	436076	1123.3867
13	13	9/4/2012	23:12	90	20	5	-	70-35	436100	475007	1037.52
14	15	9/5/2012	21:09	60	20	5	-	60-30, 30-50, 50-30	475008	517963	1145.4667
15	18	9/6/2012	23:55	65	20	5	-	65-30, 30-50, 50-30	517979	573021	1467.7867
16	19	9/7/2012	22:00	100	20	5	-	70-30	573042	609349	968.18667
17	21	9/8/2012	15:22	280	20	5	-	-	60950	716146	17471.893
18	21	9/8/2012	23:39	250	20	5	-	-	716179	775854	1591.3333
19	24	9/9/2012	20:18	200	20	5	-	60-30	775848	825380	1320.8533
20	27	9/10/2012	20:51	120	20	5	-	90-30	825383	874755	1316.5867
21	27	9/11/2012	3:46	70	20	5	-	70-30	874781	895647	556.42667
22	30	9/11/2012	22:30	150	20	5	-	60-30	895648	946459	1354.96
23	30	9/12/2012	4:39	70	20	5	30, 20	30-20	946465	989517	1148.0533
24	32	9/13/2012	3:34	35	20	5	30, 20	30-20	989510	1023202	898.45333
25	34	9/14/2012	3:20	35	20	5	30, 20	30-20	23210	58785	948.66667
26	test 9	9/14/2012	20:54	35	20	5	30, 20	30-20	58789	84629	689.06667
27	test 10	9/15/2012	12:27	100	20	5	75, 35	-	84660	120228	948.48

9.5.2. Methods and Approach

A 1 m diameter Reeve net with a 333 µm mesh net was deployed over the starboard side via the J-frame and a dedicated winch. A large (~75 lb) weight was attached to the winch and the line was sent down to 5 m. At this point the J-frame was brought in and a bookclamp + zip tie was used to strap the Reeve net to the wire. Attached to the net were a flow meter and an Mk9 depth and temperature logger. After each cast the data were retrieved from the logger and then the instrument was put on standby. If there was no regular station at the time of the Reeve net (i.e., we were at a test station) an XBT was deployed to achieve a sense of the water hydrography.

Reeve net deployments were conducted once or twice per day, at the first station after sunset each day, and generally lasted ca. 1 hour. Ship speed during tows was ~1-2 knots. The downcast was done at ca. 20 m/min and the upcast at 2 or 5 m/min. Typically, the net was towed slowly through some depth(s) chosen either for either scattering on the HTI or high chl-*a* in the CTD data. Alternately the net was held for ca. 5-15 minutes at a depth of interest. Occasionally, when catch numbers had been low, a tow-yo profile was conducted through the water column at 2 m/min. Upon recovery of the net, the flow was documented and the bottom half of the net was then washed down and the code-end detached. The cod-end was immediately taken to the wet lab for examination.

In the wet lab, the top of the cod end was emptied into one of the back-up cod ends. This was done quickly, to reach the bottom of the bucket where most of the pteropods, which tend to sink, were found. Some swimming pteropods as well as krill and other creatures of interest were frequently taken from this top portion. In the bottom 1/5 of the cod-end, buckets of water were individually poured into a white plastic tray for sorting. Individuals of interest were transferred to plastic beakers, which had been kept on ice, at low densities (< 20 individuals) for experimentation. Species identification, if in question, was done using a compound microscope while individuals were still alive. Once the pteropods had been removed the top of the catch was re-examined for euphausiids and used for opportunistic sampling.

9.5.3. Problems and Solutions

Often there were salps or jellies visible in the surface waters. When this was the case, during the top 10 m the Reeve net was deployed and retrieved at great speed to minimize the catch of unwanted gelatinous zooplankton. The backup Reeve net (last year's net), which has a mesh size of 150 µm, has a different zipper orientation; this causes the buckets to not be interchangeable with the 333 µm mesh net. During retrieval and deployment the bucket tended to bounce against the ship's side which caused rips in the bucket at the point of the hard plastic lip. The rips were repaired with thread and superglue and a plastic tube was added as cushion above the lip. Originally lighting was poor in the Ocean Lab, which caused sorting to be difficult. Furthermore, the gooseneck lights were frequently faulty, turning on and off frequently. John Calderwood worked on the lights, cleaning the contacts and this improved things a bit – he suggested that they be fully taken apart and the insulation and contacts checked as they were still occasionally giving a shock and are faulty. Additional lighting was provided by an overlooked overhead light and a handheld light.

9.5.4. Preliminary Results

Pteropods were found in every Reeve net tow, although their diversity and densities varied widely between stations (Table 9.5.2). There were distinct differences between the Atlantic and Pacific distributions of pteropods along the transect. In particular, the cold water species persisted for a longer time, a transition zone with low abundances existed for a number of days and there were both additional and absent species from the distributions. Occasional large blooms of species occurred such as *Corolla spectabalis* at test2 and test5 as well as *Limacina inflata* at station 19.

Table 9.5.2. The presence of species of interest (demarcated with an x), for all the Reeve net tows.

Tow	Station	*Clio balantium*	*Limacina helicina*	*Clio pyramidata*	*Corolla spectabilis*	*Clione limacina*	*Pneumoderma*	*Cliopsis krohni*	*Cavolnia uncinata*	*Cavolinia inflexa*	*Cuvierina columnella*	*Styliola subula*	*Limacina inflata*	*Limacina bulimoides*	*Peraclis reticulata*	*Diacria trispinosa*	*D. quadridentata*	*Hyalocylis striata*	heteropods
1	test 2	x	x	x	x	x	x												
2	test 3		x			x	x												
3	test 4		x	x		x													
4	1		x			x													
5	test 5		x	x	x	x	x												
6	test 6		x	x		x	x												
7	test 7		x	x		x	x												
8	test 8		x	x		x													
9	3		x																
10	6		x	x		x													
11	7		x	x		x													
12	11		x				x												
13	13					x	x												
14	15		x	x	x	x		x											
15	18			x			x	x								x			
16	19						x	x					x						
17	21							x	x				x						x
18	21						x	x		x			x						
19	24								x	x	x		x	x					x
20	27			x						x	x		x	x					x
21	27									x	x		x	x					x
22	30			x			x		x	x		x	x	x	x				x
23	30						x			x	x	x	x	x	x		x	x	x
24	32						x			x	x	x	x	x					x
25	34			x						x		x							
26	test 9			x						x	x						x		
27	test 10									x	x		x	x	x	x		x	x

10. Physiology

Amy Maas

10.1. *Introduction*

To predict the effects of ocean acidification on pteropods, we must understand the physiological mechanisms through which pteropods respond to high CO_2. Our objective was to expose multiple species of pteropods from the North Pacific to conditions mimicking predicted CO_2 levels at the end of the 21st century and to measure their physiological response (oxygen consumption, ammonia excretion) to hypercapnia (high CO_2) in a factorial design with low O_2 (10%) in order to assess synergistic effects. These responses will then be compared with the data collected last year in the Atlantic to determine whether there are basin specific sensitivities to environmental stressors.

10.2. *Methods and Approach*

At sea, animals were captured for physiological experiments using a 1 m diameter, 333 µm mesh Reeve net tow, or a 1-m^2 MOCNESS tow (see above sections). Pteropods were placed in filtered seawater at densities of < 20 individuals L^{-1} (Limacinidae) and <10 individuals L^{-1} (Cavolinidae) and acclimated for

at least 8 hours at 15°C or 10°C in temperature controlled water baths. After acclimation, individuals that were in good condition were put into glass syringe respiration chambers with a known volume of 0.2 µm filtered seawater for at least three hours. The water contained 25 mg each of Streptomycin and Ampicillin L^{-1}, to prevent bacterial growth, and was bubbled with certified gas mixes to achieve normal air saturated (21% O_2, 380 ppm CO_2), high CO_2 (21% O_2, 800 ppm CO_2), low O_2 (10% O_2, 380 ppm CO_2) or low O_2 – high CO_2 (10% O_2, 800 ppm CO_2) conditions.

During each experiment, we simultaneously ran a control syringe to monitor background respiration of microbes. At the conclusion of the experiments, we measured the O_2 level by withdrawing a sample of water from the chamber using a 500 µL airtight Hamilton syringe and injecting it past a Clarke type O_2 electrode (Strathkelvin Instruments, North Lanarkshire, United Kingdom). This electrode was calibrated using air-saturated and N_2 bubbled water and was held in a water-jacketed injection port attached to an independent water bath. A second aliquot of water was drawn from both the experimental and control chambers and frozen in the -80°C freezer (labeled as NH1208 NH_3 # and NH1208 control #). Upon return to land, these samples will be thawed and analyzed for NH_3 excretion (µmol g^{-1} h^{-1} wet mass) using the indophenol blue colorimetric assay (Ivancic and Degobbis 1984). After taking water samples, individual pteropods were blotted dry and frozen in liquid nitrogen so that they can be weighed upon return to land (labeled as labeled as NH1208 NH_3 #, species, treatment).

10.3. *Preliminary Results*

At the end of the cruise we had completed 220 successful respiration experiments on 7 species of pteropod (Table 10.1, Appendix 7).

Table 10.1: Summary of respiration experiments

Species	temp	Treatment					
		380	800	low	H/L	Anti	no-Anti
Limacina helicina	10	8	8	14	9	15	15
Limacina helicina	14	4	4				
Clio pyramidata	10	10	9	16	12		
Clio pyramidata	15	14	6	2	1		
Cuvierina columnella	15	8	5				
Styliola subula	15	6	6				
Cavolinia inflexa	15	8	8	6	7		
Cavolinia uncinata	15	2	2				
Diacria trispinosa	15		3				

11. Zooplankton Molecular Ecology

Leocadio Blanco Bercial and Amy Maas

11.1. *Pteropod DNA Barcoding and Phylogeography of Selected Species*

11.1.1. Introduction

Continuing the efforts started with last year expedition (OC473), during the present cruise, 95 % ethanol preserved samples were taken for molecular research. One of the initial exploratory approaches is the DNA Barcoding (the derivation of short DNA sequences that enables species identification, recognition, and discovery in a particular domain of life) of the pteropod community. This technique provides a means of identifying known species and detecting potentially unknown ones, as well as correcting possible

misidentifications. In addition, Barcoding may allow for the study of the possible relationships (or the absence of them; Maas et al., in press) between the different shell shapes (formae) of pteropods with distinctive genetic lineages. Furthermore, the development of molecular markers like the Barcoding region of the cytochrome-*c* oxydase subunit I (COI) allows phylogeographic studies based on these markers and can yield improved understanding of the marine environment. This approach facilitates the investigation of the presence and effect of barriers to population connectivity and gene flow of marine holoplanktonic species from different ocean basins (Atlantic and Pacific), but also within the ocean basin, between water masses.

11.1.2. Methods

Individuals were identified and picked by eye on white trays from both Reeve and MOCNESS samples when alive. Some small individuals were identified under the stereomicroscope. Afterward they were preserved in 95 % un-denatured ethanol and kept at -20 °C. The ethanol was changed after 24 h. In some cases, due to turbidity or coloration on the sample, more ethanol changes were needed, until the ethanol in the vial remained clear, indicating a proper preservation. For some selected species, high numbers were collected when possible in order to carry out phylogeographic studies based on DNA sequences. For each sample designated for molecular studies, a unique code corresponding to the Census of Marine Zooplankton (www.CMarZ.org) database was assigned, and both the individuals and the extracted DNA will be kept (available by request) at the CMarZ archives located at the Department of Marine Sciences of the University of Connecticut. Additionally, high numbers of each species were preserved in 70 % un-denatured ethanol. This preservation would be useful for the correct preservation of the pteropod shells for electronic microscopy, as well as the tissue for molecular approaches, allowing the joint study of the potentially shell shape changes (formae) and genetic lineages. In this case, more than one changes of the ethanol was done to ensure the complete removal of the excess of water from the tissues, since this ethanol concentration (70 %) is the minimum required for correct preservation.

11.1.3. Sampling results and future work

For gastropods (mostly pteropods, and few specimens of heteropods), the detailed sampling is shown in Appendix 8. In total, 23 different taxa were identified, for a total number of 145 samples, including approximately 1600 individuals. Of those, ~ 1100 corresponded to the species designated for the phylogeographic analysis, which included the six species in which physiology experiments were performed, and *Limacina helicina* (Table 11.1). This species, *L. helicina*, was not found during the OC473 cruise, since it inhabits colder waters than the sampled during last year. On the other hand, *Limacina retroversa*, found last year, is absent in the Pacific Ocean. For Barcoding, the corresponding 660 bp fragment of the COI gene will be amplified using the universal primers LCO-1490 and HCO-2198, following the procedure described in Maas et al. (in press), and compared to the available data on GenBank (http://www.ncbi.nlm.nih.gov/genbank/) and other local data available from CMarZ. For the phylogeographic approach, the same COI region, together with other target markers (like the mitochondrial Cytochrome *b*, SNPs, etc) would be studied.

A total number of seventy samples from 10 species of pteropods were preserved in 70 % ethanol, accounting for more than 1600 individuals (Appendix 9). Both samples from the reeve net and from the MOCNESS tows were used for this purpose. The future work will include the study of the relationships between shell shapes (forma) and genetic lineages.

Table 11.1. Number of individuals preserved at each station that included a Reeve net from the species selected for phylogeography. Horizontal lines indicate boundaries between transects.

St	*Cavolinia inflexa*	*Clio pyramidata*	*Cuvierina columnella*	*Diacria trispinosa*	*Limacina helicina*	*Limacina inflata*	*Styliola subula*
Test 2		1			30		
Test 3					12		
Test 4		25			32		
Test 5		4			30		
Test 6					51		
Test 7		50			50		
Test 8		1			50		
01					42		
03					26		
06		13			50		
07		20			50		
11					7		
15		1			11		
18		12		1			
19						200	
21						150	
24			5			2	
27		18	6			65	
30	23	6	3			60	9
32	4		3			34	2
34	9						
Test 9	1		2				

11.2. *Genomics and Gene Expression of Pteropoda and Euphausiacea*

11.2.1. Introduction

Next Generation sequencing technologies are in rapid development nowadays, increasing their use in gene expression, community analysis, phylogenomics, and molecular ecology studies. Despite their technological advantages in obtaining enormous amounts of data in a fast and relatively cheap way, the sample preservation requires more care than the previous methods, especially if the aim of the study involves mRNA (transcriptomics – gene expression). Thus, the available stock of suitable samples for these analyses is reduced. During the NH1208 cruise, key species of euphausiids from the North Pacific Ocean ecosystems were targeted in order to obtain samples whose quality would allow later analysis on Next-Gen platforms. For Pteropoda, the main goal was C*lio pyramidata*, since this species is distributed both in depth and surface water, in the North Atlantic and North Pacific oceans, being thus subject to a wide range of environmental conditions. On the Euphausiacea side, of special interest were the vertical distribution of non-migratory species (for example, *Stylocheiron* spp.) in the water column, and the potential relationship of this pattern to oxygen level.

11.2.2. Methods

Flash freezing of live individuals in liquid nitrogen was the preservation and storage method. The species targeted were the different species of Euphausiacea and Pteropoda. For pteropods, single individuals or a number of them (depending on the size and availability of individuals) were preserved. Single euphausiids were included in each cryovial after being photographed under an image system attached to a stereomicroscope. The pictures taken will allow for the identification of life-stage and measurement of every single individual. The selection and preservation of the individuals was carried out immediately after the capture, and only on live individuals with active behavior.

11.2.3. Preliminary Results

For pteropods, ten samples of *Clio pyramidata* from samples mostly from the surface layers (0 – 100 m depth) were collected and flash frozen. Another twelve samples of *Limacina helicina* and two samples of *Limacina inflata* were also preserved with this method (Table 11.2).

Table 11.2. Flash-frozen samples of Pteropoda. Horizontal line indicates transect boundaries

Vial #	St	Date	Time	Gear Type	Net	Species	N	Collector
1	2	8/16/2012	1400	M-01-03	7	*Limacina helicina*	3	AEM
2	2	8/16/2012	1400	M-01-03	7	*Limacina helicina*	3	AEM
3	2	8/16/2012	1430	M-01-03	8	*Limacina helicina*	2	AEM
5	7	9/2/2012		M-01-07	8	*Clio pyramidata*	1	AEM
6	7	9/2/2012		M-01-07	8	*Limacina helicina*	3	AEM
7	7	9/2/2012		M-01-07	8	*Limacina helicina*	3	AEM
8	7	9/2/2012		M-01-07	8	*Limacina helicina*	3	AEM
9	11	9/4/2012	1400	M-01-10	5	*Limacina helicina*	2	GL
10	11	9/4/2012	1400	M-01-10	8	*Limacina helicina*	5	GL
11	11	9/4/2012	1400	M-01-10	8	*Limacina helicina*	4	GL
12	13	9/4/2012	0:18 5th	Reeve	13	*Limacina helicina*	2	AEM
13	15	9/5/2012		M-01-12	?	*Limacina helicina*	1	AEM
14	15	9/5/2012	2:38	M-01-12	7	*Limacina helicina*	4	AEM
15	18	9/7/2012	7:16	M-01-13	7	*Clio pyramidata*	1	GL
16	18	9/7/2012	1300	M-01-14	4	*Clio pyramidata*	1	GL
17	21	9/8/2012	17:15	Reeve	17	*Limacina inflata*	lots	AEM
20	27	9/10/2012	22:22	Reeve	20	*Clio pyramidata*	4	AEM
21	27	9/11/2012	2:31	M-01-20	6	*Clio pyramidata*	4	AEM
22	27	9/11/2012	2:40	M-01-20	8	*Clio pyramidata*	1	AEM
23	27	9/11/2012	2:40	M-01-20	8	*Clio pyramidata*	1	AEM
24	27	9/11/2012	2:45	M-01-20	8	*Limacina inflata*	lots	AEM
25	32	9/13/2012	3:09	M-01-23	8	*Clio pyramidata*	1	AEM
26	32	9/13/2012	3:09	M-01-23	8	*Clio pyramidata*	1	AEM
27	34	9/13/2012	3:09	M-01-25	6	*Clio pyramidata*	1	AEM

For other taxa, during the first stations, high densities of *Neocalanus cristatus* (CIV and CV) were found in surface waters, and a sample of 10 individuals was cryo-preserved at station 1. In total from all stations, 119 individuals from sixteen species of euphausiids were identified and preserved (Table 11.3). In the first stations the samples were strongly dominated by *Thysanoessa longipes* and *Euphausia pacifica*, meanwhile species diversity increased towards the southern stations. *Stylocheiron* species were

only abundant at the last two stations of transect four. Most samples were taken from the Reeve net (surface layer), since most of the time the deep samples from the MOCNESS were dead, or at least non-active. Some exceptions were eventually present from deep tows (individuals from *Bentheuphausia amblyops*, *Thysanoessa longipes*, and *Nematoscelis difficilis*). In case of doubt between sister species (*Thysanoessa longipes*/*gregaria*, for example), since keeping the individual in good shape prevailed over a very accurate identification, barcoding would allow the later identification of the species preserved in liquid nitrogen if needed. These samples will be suitable for a wide spectrum of different analysis, from transcriptomics to genomics and phylogenomics.

11.3. *DNA Barcoding and Phylogeography of non-Pteropods*

11.3.1. Introduction

During the cruise, other taxa from the Reeve nets, apart from pteropods or gastropods in general, were sampled and preserved in 95 % ethanol. They consisted mostly of euphausiids, since having an idea (even a non-quantitative and qualitative-biased on) of the community could help in the future when working on the flash-frozen samples (Section 11.2). Other taxa targeted were copepods of the Megacalanidae family, which were collected in the deep layers of the MOCNESS tows, as well as any interesting individual or individuals of interest for anybody.

11.3.2. Methods

Individuals were identified and picked by eye on white trays from both Reeve and MOCNESS samples when alive, and immediately transferred into 95 % ethanol. Individuals were then identified under the stereomicroscope. Afterward they were preserved kept at -20 °C. The ethanol was changed after 24 h. In some cases, due to turbidity or coloration on the sample, more ethanol changes were needed, until the ethanol in the vial remained clear, indicating a proper preservation. For some selected species, high numbers were collected when possible in order to carry out phylogeographic studies based on DNA sequences. For each sample designated for molecular studies, a unique code corresponding to the Census of Marine Zooplankton (www.CMarZ.org) database was assigned, and both the individuals and the extracted DNA will be kept (available by request) at the CMarZ archives located at the Department of Marine Sciences of the University of Connecticut.

11.3.3. Results

Most of the euphausiid samples came from the test stations, since during the stations involving other sampling flash-freezing was prioritized over ethanol-preserving. In total, 98 samples were preserved, including two fish larvae, a deep amphipod, a planktonic nemertean, two *Poeobius meseres* (polychaete), 26 samples of copepods and 67 samples of 19 species of euphausiids (Appendix 10). Of all these samples, one of the highlights was the eight *Megacalanus* sp., since these individuals will be included in an ongoing revision of the family Megacalanidae (Bradford-Grieve and Blanco-Bercial, *in prep.*) to be published in the near future.

Table 11.3. Number of flash frozen samples of Euphausiacea from the selected taxa per station and gear system and cast numbet. Horizontal lines indicate boundaries between transects.

St	Net	*B. amblyops*	*E. gibbosa*	*E. mutica*	*E. pacifica*	*E. recurva*	*E. pseudogibba*	*N. flexipes*	*N. difficilis*
1	Reeve 04				5				
3	Reeve 09				4				
6	Reeve 10				5				
7	Reeve 11								
11	M1-09-2								1
13	Reeve 14								1
14	Reeve 14					1			
15	Reeve 14				1	2		7	
	M1-12-1	1							
	M1-12-2								
	M1-12-4								1
	M1-12-5								2
18	Reeve 15				1	2		2	
	M1-13-2	1							
19	Reeve 16				1	1		1	
21	M1-16-2	1							
	Reeve 18					3		2	1
24	Reeve 19					2		1	
27	Reeve 20			2		2		2	
30	Reeve 22			1		1	1	1	
	Reeve 23		1	1		2		2	
32	Reeve 24								
34	Reeve 25								
	Total	3	1	4	17	16	1	18	6

St	Net	*S. affine*	*S. longicorne*	*T. oculatus*	*T. gregaria*	*T. longipes*	*Thysanoessa* sp.	*T. aequalis*	*T. obtusifrons*
1	Reeve 04					3			
3	Reeve 09			2		4			
6	Reeve 10					2			
7	Reeve 11			1		1			
11	M1-09-2					1			
13	Reeve 14								
14	Reeve 14								
15	Reeve 14								
	M1-12-1					1			
	M1-12-2					1			
	M1-12-4					1			
	M1-12-5								
18	Reeve 15								
	M1-13-2								
19	Reeve 16					2			
21	M1-16-2								
	Reeve 18						4		
24	Reeve 19		2				1		
27	Reeve 20				3				
30	Reeve 22								1
	Reeve 23							1	
32	Reeve 24	8							
34	Reeve 25	13							
	Total	21	2	3	3	16	5	1	1

12. Shell Boron

Liza Roger

12.1. *Introduction*

Seawater pH is being modified due to the process of ocean acidification, which is driven by increasing CO_2. Determining the relationship between changing environmental conditions and the composition of marine calcifiers can be key to understanding their likely response to climate change. The boron concentrations and isotopic compositions of marine carbonate skeletons (eg. foraminifers, coccoliths, corals) have been shown to be pH-dependent, and can thus be used as a proxy for seawater pH. No gastropods skeletons (external or internal) have been studied with regards to boron systematics and pteropod shells least of all.

Pteropods shells represent more than 20% of the total $CaCO_3$ flux in certain regions. They comprise a significant component of planktonic calcifiers, which may be sensitive to the potential effects of ocean acidification. The calibration of the mass spectrometer and other chemical analytical instruments using carbonate ion chemistry measurements determined from ambient seawater by A. Wang and his chemistry team will be essential to the significance of our results.

This field trip in collaboration with WHOI contributes to a project aiming to determine the boron systematics (B/Ca, $\delta^{11}B$) of pteropod shells and their potential as archives of seawater pH (L. Roger's Ph.D project at the University of Western Australia). We hope to determine which boron ionic species (borate or boric acid) pteropods incorporate to their calcium carbonate skeleton (aragonite shell) and what levels are incorporated. The preferential incorporation of borate ions would allow us to recreate ambient seawater pH and its variations during the life-cycle of the specimens sampled. We also hope to identify differences between thecosome species, between formae, and between migratory and non-migratory species.

12.2. *Methods*

Pteropod shells were collected from plankton net tows (Reeve Net and MOCNESS).

- The Reeve net (150 µm mesh) was towed every night between the surface and typically 100 m (maximum depth sampled 200 m) for a duration between 30 to 60 minutes. The plankton samples were sorted and pteropods picked out.
- The MOCNESS was towed at each day/night station (1 tow during daylight and 1 tow during night time). The MOCNESS samples specific depths. Only pteropods from net 0 (0 m to – 1000 m) were used for boron work, to maintain the integrity of the other samples (nets 1-8).

The pteropod shells (whether originating from the Reeve net tows or MOCNESS tows) were rinsed in fresh Nano-filtered-H_2O and delicately cleaned. When possible, the animal was removed from the shell. Some animals were placed in 95% ethanol after extraction for DNA/RNA analysis. The fragile nature of the shells, their intricate shape and the rocking of the ship due to the swell did not allow every animal to be extracted from the shell. The shell morphology of pteropods is very varied and the extraction of the animal can prove very difficult. The easiest species here, in terms of animal extraction, are the cone-like *Clio pyramidata, Hyalocylis striata,* and the oddly (but very practically)-shaped *Cavolinia inflexa*. *Limacina helicina* shells and *Cavolinia uncinata* were not extracted because of their intricate shell-shapes; this process will take place back at the laboratory.

Once cleaned and rinsed (with or without the animal inside), the shells were placed in plastic petri dishes to dry overnight in a fume-hood in the lab-van situated on the O2 deck of the vessel. The dry shells were placed in plastic vials the next day, labeled, and stored securely.

The clean nature (contamination free) of the samples was essential. The lab-van was a secluded zone where passage and chemical agents were minimal. Work surfaces were cleaned and protected whenever pteropod shells were handled and glass was avoided to prevent boron contamination; this was especially important because borax (i.e., sodium tetraborate) was used to buffer formalin-preserved MOCNESS samples and thus was present in the main lab.

12.3. *Preliminary Results*

A total of 1481 shells were sampled for later boron analysis (Table 12.1); 4 different genera of thecosome pteropods: 2 Families (Limacinidae and Cavolinidae) and 1 Subfamily (Cavolininae). These 4 genera can be divided into 6 different species and/or formae:

Order: Thecosomata
Suborder: Euthecosomata
Family: Limacinidae
Genus: Limacina
Subgenus: *Limacina*
L. (L.) helicina helicina form *acuta*
L. (L.) helicina helicina forma *pacifica*
Genus: *Hyalocylis*
Hyalocylis striata
Genus: *Clio*
Clio pyramidata forma *lanceolata*
Subfamily: Cavolininae
Genus: *Cavolinia*
C. inflexa
C. unicnata

Table 12.1: Cruise NH1208 thecosome pteropod species sampled for later chemical composition analysis and corresponding sample counts.

SPECIES	COUNT
Cavolinia inflexa	**109**
Cavolinia uncinata	**21**
Clio pyramidata* forma *lanceolata	**133**
Hyalocylis striata	**4**
Limacina helicina helicina* forma *acuta	**848**
Limacina helicina helicina* forma *pacific	**339**
***Limacina helicina helicina* sp. (*)**	**27**
TOTAL	**1481**

(*)Certain *Limacina* specimens weren't identified with certainty or were identified as a cross/mix of *L. (L.) helicina helicina* forma *acuta* with forma *pacifica* as described by McGowan (1963). The identifications will be perfected later in the laboratory.

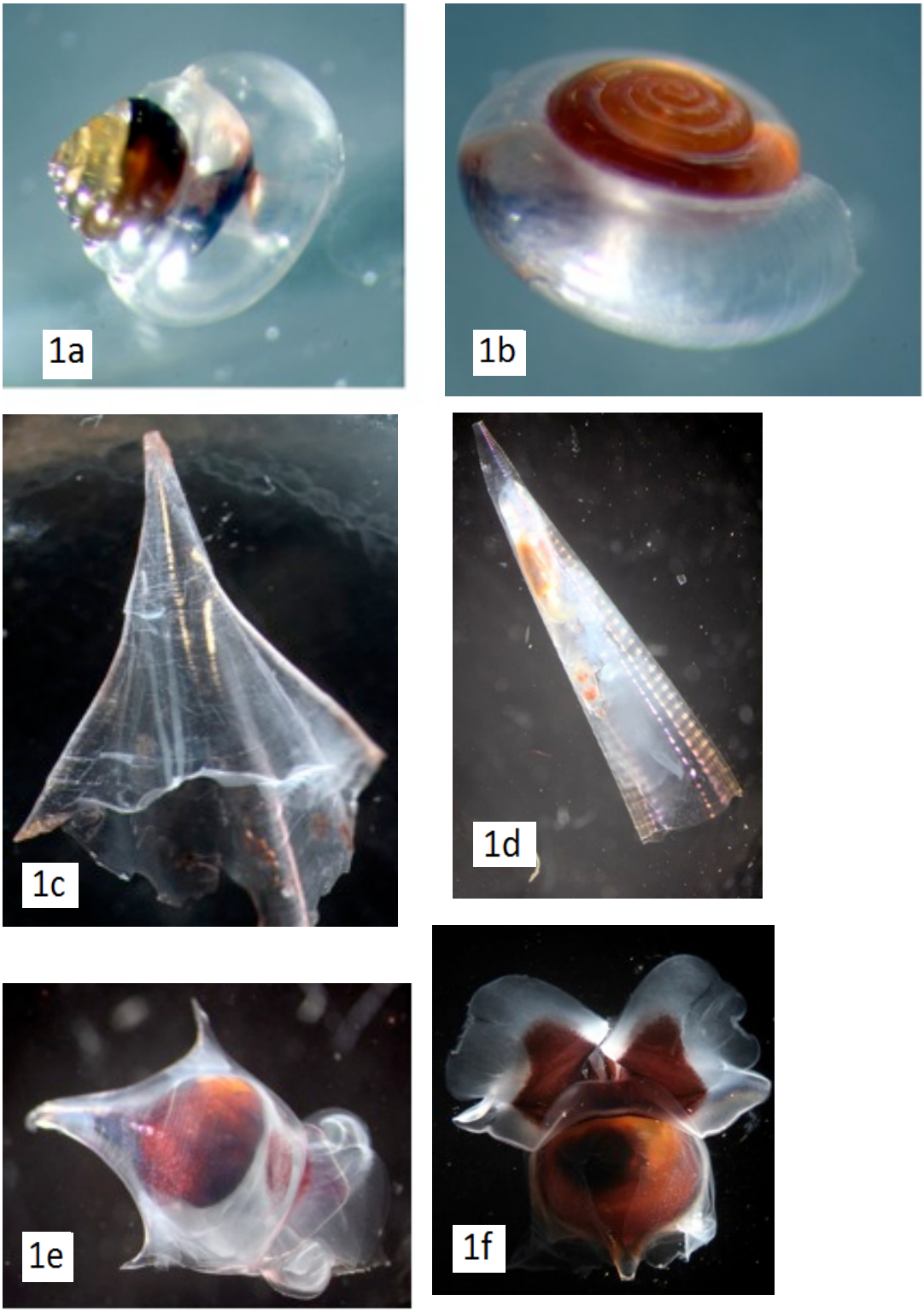


Figure 12.1: Microscope photographs of 5 species of thecosome pteropods sampled for shell chemical analysis: 1a – *Limacina helicina helicina* forma *acuta*. 1b – *Limacina helicina helicina* forma *pacifica*. 1c – *Clio pyramidata* forma *lanceolata*. 1d – *Hyalocylis striata*. 1e – *Cavolinia inflexa*. 1f – *Cavolinia uncinata*.

Future plans for the sampled animals include:

- The abundance of both forma *acuta* (Figure 1a & 1b) and forma *pacifica* of *Limacina helicina helicina* (848 and 339 specimens respectively) will allow the comparison of various bulk samples and the comparison between forma even though *Limacina helicina* sp. shells are very small.

- The cone-like shape of *Clio pyramidata* (Figure 12.1c) and *Hyalocylis striata* (Figure 12.1d) will allow us to use these shells for laser ablation inductively coupled plasma mass spectrometry (LAICPMS). Laser analysis along the growth of the shells should identify potential changes in shell chemical composition over time/growth. The variation in shell chemical composition represents the changes in the chemical environment (seawater chemistry) of the animal.

- If Boron (preferential incorporation of borate ions over boric acid) is detected in the composition of the shells, the results will be compared between species, within species between formae and between migratory species (vertical migration) and non-migratory species.

- Juveniles were collected when possible. Comparison between adults and juveniles will also be possible using a mass spectrometer, but laser work will be impossible because of the very small size of the juveniles (*Clio pyramidata* forma *lanceolata* and *Cavolinia inflexa* – Figure 12.1e).

- Some *Cavolinia uncinata* (Figure 12.1f) specimens (21) were dried after a fragment of wing was preserved in 95% ethanol for genetics. *Cavolinia uncinata* was the largest species encountered during this cruise (11 mm in length) and we are confident that their chemical analysis will be successful.

The assemblages of pteropod species were different from one station to another (Figure 12.2). The different percentages (especially for transect 0 and 3) allow us to make a preliminary observation regarding geographical assemblages of thecosome pteropods.

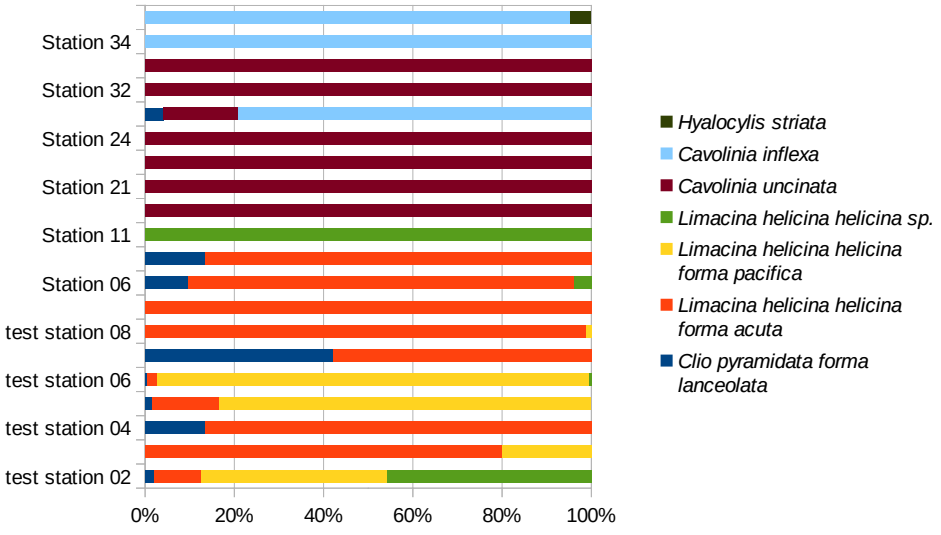


Figure 12.2: stacked percentages of each species dried for later boron analysis per station. The missing stations were not sampled for chemical analysis.

13. Opportunistic Sampling

A number of other samples were collected for various collaborators interested in our geographical area of operation and/or in using our cruise as a ship of opportunity.

13.1. *Mercury Contamination Sampling*

Amy Maas

13.1.1. Introduction and Methods

Zooplankton and mesopelagic fish samples were taken at the request of Dr. Carl Lamborg (WHOI) with the intention of examining their mercury content. The protocol involved filtering the Reeve net sample through a 3 mm and a 150 µm sieve. The large individuals captured by the 3 mm sieve were discarded and the remaining size class was put into a plastic jar and frozen (-20°C) and returned to WHOI.

Table 13.1.1. Date, gear and type of sample for the methyl mercury study.

Date	Gear	Type
8-11-2012	Reeve 1	Fish
8-16-2012	Reeve 4	Zooplankton
8-16-2012	Reeve 4	Fish
8-27-2012	Reeve 5	Zooplankton
8-28-2012	Reeve 6	Zooplankton
8-28-2012	Reeve 6	Fish
8-29-2012	Reeve 7	Zooplankton
9-1-2012	Moc 6 N 2	Fish
9-7-2012	Reeve 16	Zooplankton
9-10-2012	Reeve 20	Zooplankton
9-11-2012	Moc 20 N 0	Fish
9-14-2012	Reeve 25	Zooplankton

13.1.2. Results

In total, 7 zooplankton samples and 5 fish samples were frozen for methyl mercury (Table 13.1.1). Post-cruise the samples were shipped back to WHOI overnight with ice packs.

13.2. *Meso-pelagic Fish Liver/Heart Sampling*

Amy Maas & Leocadio Blanco Bercial

13.2.1. Introduction and Methods

Fish liver samples were taken at the request of Dr. John Stegeman (WHOI). The protocol involved excising liver from freshly killed (live) or very recently dead fish. Dissecting tools were first rinsed in ethanol, the fish was cut from anus to operculum then along the operculum edge. The muscle was pulled back and care was taken to avoid puncturing the gall bladder. Pieces of liver were excised from fish and placed into 15 mL Falcon tubes containing 5 mL RNAlater. The heart was similarly placed into RNAlater (same vial). These samples were stored refrigerated in the walk-in. The fish was wrapped in aluminum foil then placed in the -20°C freezer.

Table 13.2.1. Location and gear data for the fish samples obtained during the cruise.

DateSt.	Gear	Net (depth)	St.
8-16-12	MOC-02	0 (0 - 1000 m)	1
8-16-12	MOC-03	4 (200 - 400 m)	2
9-4-12	MOC-09	2 (600 - 800 m)	11
9-11-12	MOC-21	0 (0 - 1000 m)	30

13.2.2. Results

In total, four fish dissections occurred (Table 13.2.1). Post-cruise, these fish samples were shipped back to WHOI overnight with icepacks.

13.3. *Salps*

Liza Roger for N. Henschke (Ph.D candidate at the University of News South Whales, SYD - Australia)

A large quantity of big salps was found at Station 21. Specimens from 3 different species were collected and preserved in formalin (borax buffer), 70%, 95% ethanol and dry frozen. These samples will be sent to

the University of New South Whale, Sydney, Australia. They will contribute to a study on large salp fecundity and body composition (protein, carbohydrates, lipids, C:N ratio).

Contact: Natasha Henschke
natashahenschke@gmail.com
University of New South Whales
Sydney, NSW Australia

14. R2R Event Logger

Nancy Copley

A detailed event log is an important part of every oceanographic cruise. Not only can it be used during the cruise to keep track of casts, equipment and to diagnose problems, but it also aids in data management after the cruise has ended.

Traditionally, event logs begin in hand-written form and are transcribed to electronic form (such as an Excel spreadsheet). Instead, these steps were bypassed with a beta version of Elog, an open source browser-based event logger from the NSF program "Rolling Deck to Repository" (R2R) [http://www.whoi.edu/page.do?pid=35716] (Figure 14.1). Events could be entered to Elog from any computer that was connected to the ship's intranet, either wired or wireless. This made it possible for event starts and stops to be entered from the deck as well as from the main lab or just about anywhere on the ship (Fig. 14.2).

Prior to the cruise, the headings were custom assigned with, for example, the addition of transect and local time. The list of instruments and names of cruise participants was created and edited in the configuration file (Fig. 14.3). Another feature of the event logger is the ability to select a single instrument for viewing as well as sub-selecting an action (start, stop, etc.) which made it easy to determine the next cast number for each instrument.

There were 668 events logged during the cruise.

The R2R event logger was also used on the first OAPS cruise, Oceanus 473, August 2011 so many of the science party were familiar with its use. An event could be queued up with all the information except for the local time prior to the event. Once it occurred, the local time would be added and the event submitted. At that moment, the position and UTC time were automatically updated. This was fine as long as the event was entered promptly. If it was added later, the UTC time, position, and event number were off and were manually edited.

This year, the event submission worked much faster than last year, requiring about 2 seconds rather than around 10 seconds. One person (Copley) was in charge of checking the log to make corrections in locked fields (event number, UTC time, etc) and to check for consistency such as end events following start events. The full event log is in Appendix 11.

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ELOG

List | New | Edit | Delete | Reply | Duplicate | Find | Help

Summary | Threaded

-- Author -- -- Instrument -- -- Action -- 645 Entries

Goto page 1, 2, 3 ... 31, 32, 33 Next

Event	dateTimeUTC	timeLocal	timeZone	Instrument	Action	Transect	Station	Cast	depthCast	Latitude	Longitude	Seafloor	Author	Comment
20120808.1905.001	20120808.1905	10:04	-9	Ship	other	NaN	NaN	NaN		44.626283	-124.049282		nCopley	test from remote computer;local time is 2 hours off
20120809.0235.001	20120809.0235	19:33	-7	Ship	changeTimezone	NaN	NaN	NaN		44.626283	-124.049258		nCopley	changed config file to timezone=-7 from timezone=-9
20120809.2300.001	20120809.2300	16:00	-7	Ship	startCruise	0	NaN	0		44.626358	-124.049292		nCopley	
20120810.0223.001	20120810.0223	19:22	-7	Hull_HTI	start	0	NaN	1		44.733203	-124.696980		gLawson	
20120810.1509.001	20120810.1509	08:09	-7	Hull_HTI	end	0	NaN	1		44.626267	-124.049272		gLawson	
20120810.1511.001	20120810.1511	08:10	-7	Ship	other	0	NaN	NaN		44.626268	-124.049267		gLawson	Arrived back in port for evaporator repair
20120811.0130.001	20120811.0130	18:29	-7	Ship	other	0	NaN	0		44.627003	-124.050512		nCopley	restart of cruise
20120811.0216.001	20120811.0216	19:15	-7	Hull_HTI	start	0	NaN	2		44.617185	-124.176532		gLawson	
20120811.0505.001	20120811.0505	10:05	-7	GO pCO2	start	0	NaN	NaN		44.743985	-124.748230		aWang	UTC 5:05 on 11aug2012. changed 20120811.2222 to 20120811.0505, changed lat/lon with uway log
20120811.2030.001	20120811.2030	13:30	-7	Ship	startStation	0	Test 1	NaN		45.4229	-127.8559		nCopley	actual start of Test station was 13:30 from 02:24. Changed utc, event#, etc., lat/lon from uway log
20120811.2059.002	20120811.2059	14:00	-7	MOCNESS	start	0	Test 1	1	50	45.431775	-127.864553		nCopley	
20120811.2219.001	20120811.2219	15:19	-7	MOCNESS	end	0	Test 1	1	50	45.434432	-127.863468		nCopley	
20120811.2332.001	20120811.2332	16:31	-7	CTD911	start	0	Test 1	1	500	45.435163	-127.874497		kHoering	
20120811.2332.002	20120811.2332	16:31	-7	VPR	deploy	0	Test 1	1	500	45.435163	-127.874497		nCopley	added event late; utc/latlon ok
20120811.2340.001	20120811.2340	16:36	-7	Echosounder12	start	0	Test 1	NaN		45.433855	-127.876337	2937	kHoering	
20120811.2345.001	20120811.2345	16:45	-7	Echosounder12	end	0	Test 1	NaN		45.4329	-127.8770	2937	nCopley	entered later; time/position approximate
20120812.0052.001	20120812.0052	17:52	-7	CTD911	end	0	Test 1	1	500	45.4279	-127.8959		kHoering	this was added later; corrected utc, etc. from 12th @utc 2331 to 12th @ 0052; added lat/long from uway log
20120812.0052.002	20120812.0052	17:52	-7	VPR	recover	0	Test 1	1	500	45.4279	-127.8959		nCopley	entered late; utc/latlon ok
20120812.0122.001	20120812.0122	18:21	-7	Hammarhead	start	0	Test 1	1		45.434650	-127.908942		nCopley	
20120812.0124.001	20120812.0124	18:24	-7	Hull_HTI	end	0	Test 1	2		45.435883	-127.909988		nCopley	

Goto page 1, 2, 3 ... 31, 32, 33 Next

ELOG V2.9.5-2411

Figure 14.1. The Elog browser window.

Figure 14.2. Chief Scientist Gareth Lawson logging a successful CTD cast on deck with a ruggedized Ipad on loan from R2R.

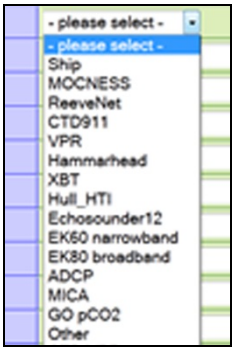


Figure 14.3. The Elog instrument list for this cruise.

15. Blog

Gareth Lawson

15.1. *Introduction*

'The Charismatic Microfauna Blog' was maintained by the science team during the cruise as an outreach effort. The goal of this blog was to give real-time updates from the field to describe in a conversational and engaging, but professional, tone for the public our work on pteropods, including where we were, what we were doing, and why, as well as information on life at sea and oceanographic research more generally.

15.2. *Methods*

All scientists were encouraged to participate in writing a post or two. Because of the interdisciplinary nature of the science performed, this resulted in a wide range of topics including pteropod physiology, chemistry, biology, and so on. Other posts were written to introduce readers about life on a research vessel, these ranged from a tour of the engine room, to discussions about the food onboard, and more. A total of 32 posts were completed during this cruise. All posts contained media such as photographs, movies, and preliminary figures. Because of the shipboard internet, the posts could be uploaded directly from the ship.

The blog host utilized was www.blogger.com. The site has the capacity to track the number of views on the blog, what country the viewers are from, and where they found the blog link. To show where we were at any given time, the blog included a link to the SIO beta Shiptrack website which featured a map showing our cruise track, current information on winds, vessel speed, etc, as well as the pitch and roll data for the whole cruise (Figure 15.1).

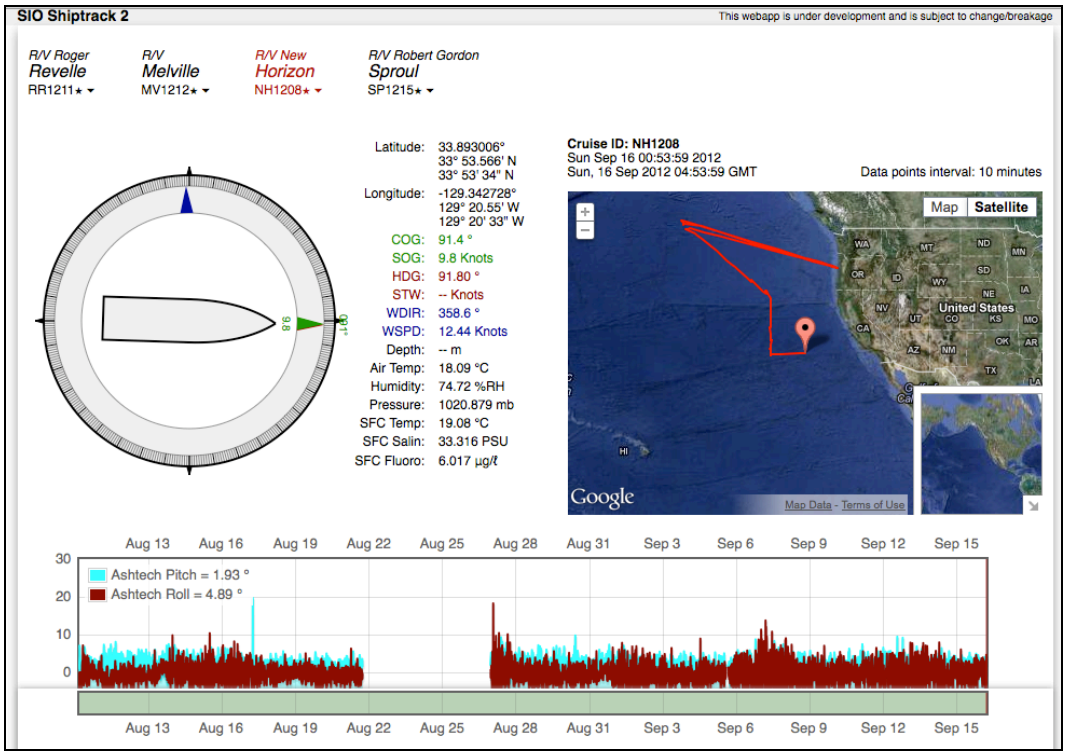


Figure 15.1. SIO shiptrack site linked to the blog, allowing viewers to follow along our cruise track.

The blog link was posted on the WHOI site's online expeditions. It was also linked to the SIO Marine Operations website, along with a nice photograph of pteropods (Fig 15.2). Initially we received much

more traffic from the latter link. We therefore asked Ken Kostel at WHOI to promote the site more heavily. Ken used a photograph of Amy Maas as the picture of the day and put a link to the site in the 'News and Highlights' section of the homepage. We then started to get a lot more traffic from WHOI. The site was also linked to the WHOI Facebook page and by the WHOI Media Relations twitter. This publicity likely increased the number of readers.

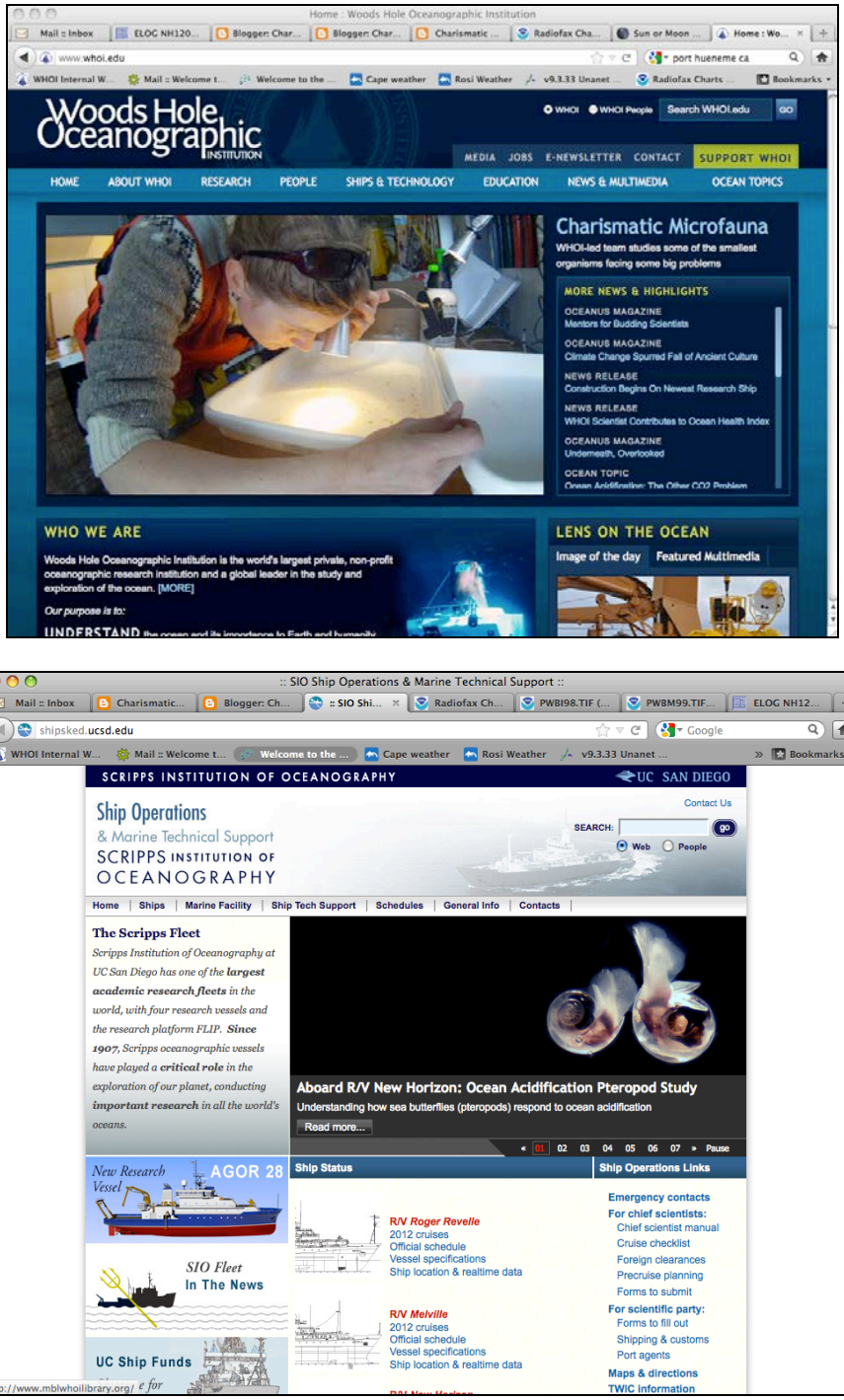


Figure 15.2. Screenshots of the blog links from the WHOI and SIO websites.

15.3. *Problems and Solutions*

One minor issue was that the posts were quite difficult to format. Font, text size, and captions were inconsistent among posts and posters, which did not look as professional as we would have hoped.

15.4. *Preliminary Results*

Thanks to tracking software on the blog site, we were able to tell how many people have been checking in. Over the cruise, there were over 5,000 views on the blog page (Figure 15.3). While the majority of the viewers were from the United States, our audience had some international representation with more than 10 views from each of the Philippines, France, Canada, the UK, Australia, Russia, Italy, and more.

Figure 15.3. Blog views over the course of the cruise.

16. Cruise Participants

Science Party Personnel:
Dr. Gareth Lawson, Woods Hole Oceanographic Institution
Dr. Peter Wiebe, Woods Hole Oceanographic Institution
Dr. Zhaohui 'Aleck' Wang, Woods Hole Oceanographic Institution
Dr. Amy Maas, Woods Hole Oceanographic Institution
Ms. Nancy Copley, Woods Hole Oceanographic Institution
Ms. Katherine Hoering, Woods Hole Oceanographic Institution
Mr. Alex Bergan, Woods Hole Oceanographic Institution
Dr. Leocadio Bercial, University of Connecticut
Ms. Liza Roger, University of Western Australia
Ms. Sophie Chu, Woods Hole Oceanographic Institution
Ms. Kelly Knorr, University of Rhode Island
Mr. Robert 'Nick' Tuttle
Mr. Robert Levine, Cornell University (Leg I)
Mr. Kevin Manganini, Woods Hole Oceanographic Institution (Leg I)
Ms. Britta Voss, Woods Hole Oceanographic Institution (Leg I)
Mr. Tom Bolmer, Woods Hole Oceanographic Institution (Leg II)
Ms. Taylor Crockford, Woods Hole Oceanographic Institution (Leg II)
Mr. Elliott Roberts (Leg II)

Research Technicians:

Ms. Meghan Donohue, Scripps Institution of Oceanography (Leg II)
Mr. Daniel Schuller, Scripps Institution of Oceanography (Leg I)
Mr. Jon Calderwood, Scripps Institution of Oceanography

Crew:
Captain Ian Lawrence
Mr. Tom Schuller, Chief Engineer
Mr. René Buck, Chief Mate
Mr. Jack Purdy, Third Mate
Mr. Ed Lagrasso, Cook
Mr. Oscar Buan, Cook
Mr. Geoff Quillin, A/B
Mr. Dave Weaver, Bo's'n, A/B
Mr. Jon Barnes, A/B
Mr. Willie Brown, Assistant Engineer
Mr. Jonathan Garcia, Wiper
Mr. William 'Chumly' Bouvier, Oiler

NH1208 Leg II Science Party. From left to right: Gareth Lawson, Peter Wiebe, Taylor Crockford, Liza Roger, Amy Maas, Leo Blanco Bercial, Nancy Copley, Aleck Wang, Nick Tuttle, Katherine Hoering, Sophie Chu, Alex Bergan, Tom Bolmer, Elliott Roberts, Meghan Donohue, Kelly Knorr. [Photo: John Calderwood]

Leg I – Watch Schedule

BIOLOGY

Day Watch 0800 – 2000	**Night Watch 2000 – 0800**
Watch Leader: Lawson	Watch Leader: Wiebe
Copley	Blanco Bercial
Bergan	Levine
Manganini	Roger

CHEMISTRY

Day Watch 0200 – 1400	**Night Watch 1400 – 0200**
Watch Leader: Hoering	Watch Leader: Wang
Voss	Chu
Tuttle	Knorr

RES TECHS

0000 – 1200	**1200 – 0000**
Calderwood	Schuller

Leg II – Watch Schedule

BIOLOGY

Day Watch 0800 – 2000	**Night Watch 2000 – 0800**
Watch Leader: Lawson	Watch Leader: Wiebe
Copley	Blanco Bercial
Bergan	Bolmer
Crockford	Roger

CHEMISTRY

Day Watch 0200 – 1400	**Night Watch 1400 – 0200**
Watch Leader: Hoering	Watch Leader: Wang
Knorr	Chu
Tuttle	Roberts

RES TECHS

0000 – 1200	**1200 – 0000**
Calderwood	Donohue

Appendix 1 - Notes on Processing the MOCNESS Samples

Before nets are on deck

- Jar labels: Before the tow comes on deck, fill out labels for the jar caps and the inside of the jars. There are various templates for the labels such as "labels_24UPXerox_MOC_NH1208.doc". The cap labels are printed on 24up label paper and the internal labels are printed on waterproof paper (e.g. Rite in the Rain). Leave the start time (and date if in question) blank until the MOCNESS enters the water, then add that information, put label in and on the jars. Spell out month if day<13 eg. 8 Sep 2012. Double check that the station and tow# are correct.
- Entirely cover top labels with 2" clear tape to protect them as they aren't waterproof.

Once nets are on deck

From cod end to tray

- When MOC is almost to surface, bring pails and ice packs to deck.
- Wash down the net from the outside with sea water,
- Place cod end into pail, move rubber bands down, and unclasp buckle. Remove net, inspect net for plankton. If plankton is still in the net, reattach and hose down again.
- Once net is off cod end, put two ice packs into pail and carry to processing area inside ship.
- Put the buckets in priority of processing starting with cod end 1. (1-8 then 0)
- Rinse funnel inside cod end with filtered seawater (fCH_2O) and set aside.
- Tip cod end over pail to allow excess water to flow out of cod end. Don't drip all over the floor
- Rinse animals off mesh with fCH_2O
- Pour sample into large white inspection tray, rinse sides and bottom of cod end. Be sure the small heavy plankton (pteropods) are not left behind. Use a squirt bottle with filtered sea water to rinse down the cod end multiple times if necessary. Try to avoid pouring over buckles.
- Put formalin label into tray and take a photo, trying to get it mid-slosh.

- Quickly examine tray (use a light if possible) to identify very abundant, large or target organisms; record on “Taxonomic Composition” data sheet.
- Remove specimens as allowed, being very sure to record removals. If a record is not made, then abundance and distribution data will be incorrect. Record on “Specimen Removals” data sheet.
- Preferentially remove any jellies and put in the formalin jar because they will dissolve in ethanol. Record number of jellies pulled out.

From tray to splitter and jars

- Carefully pour sample from tray to sieve over sink. Use a sieve with same or smaller mesh size than the nets. If the sample volume is small enough it can sometimes go straight into the splitter.
- Using fCH_2O (preferably from a spigot in the sink), concentrate the sample to one side of the sieve. Then using a fCH_2O squeeze bottle, wash the sample into the box splitter. Be sure not to put too much liquid into the splitter or it will overflow when tipped to the divided half (it has a pouring hole in it) but use enough to ensure a proper split. Rock the splitter back and forth until equal portions are in the two sections. Carefully pour the first split into the sieve. Concentrate with fCH_2O, then rinse in the sink with 95% ethanol to remove some of the water and start the dehydration process. Place a funnel over the jar and with a 95% ethanol squeeze bottle; rinse the sample into a jar. Top off to neck of jar with 95% ethanol. You don’t have to fill all the way if you plan on replenishing the ethanol in 24 hours – ½ to 2/3 full is enough.)
- Tip the remaining half sample back into undivided section of the splitter and split again.

Formalin split:

- Pour this ¼ fraction straight into sample jar, take to hood. Add full strength formalin to create a 5% solution:
    - pint (500 ml) jar: 25 ml formalin
    - quart (1 liter) jar: 50 ml formalin
- Add borate buffer per pint to the sample by spooning the measured borate into a small 330 micron sieve held over the sample and sift the buffer into the sample. **Note: Too

much buffer coats the specimens and renders the sample useless for most purposes; clumps of buffer do not dissolve which is why we sieve.

  - Pint (500 ml) jar: ½ teaspoon
  - Quart (1 liter) jar: 1 teaspoon

- Top off to neck of jar with fCH_2O, cap, and gently swirl the jar, dry outside of jar and put into sample box. Check pH after 24 hrs to 1 week (?).
- The last fraction (1/4) is put into 70% ethanol: hold splitter over sieve and rinse all inside surfaces with fCH_2O. Concentrate sample with fCH_2O, rinse with 70% ethanol in sink, then put funnel onto jar, rinse sample into jar, top off, cap, dry jar and store in sample box. Repeat for each net except net 0.
- Put all of net 0 into formalin. This will frequently require a quart jar as opposed to the typical pint jar for most other samples. If removing specimens for other projects, net 0 is best to take from so as to not affect other net proportions.
- When all samples are in jars, rinse all processing equipment. Blast the sieves upside down to remove hidden sample, if any. Rinse items with fresh water, especially metal sieves to reduce rusting.
- Secure ethanol (nozzles up to avoid slow drips) and formalin dispensers, and close hood.
- Cod ends need to be cleaned after each tow. Take two at a time out on deck and rinse the inside with seawater from hose. Run your hand over the mesh to dislodge stuck plankton. Don't blast mesh from outside as this is apt to unglue the mesh from the cod end.
- Replace the funnels into cod ends.
- Empty pails (leave them upside down for a while on deck), stack and store inside when dried a bit.
- Put ice packs into two relatively dry buckets and put back in freezer.
- Put sample boxes away but handy enough to check pH and change ethanol after 24 hours.
- Dry off work table, put away pipettes, dishes, beakers, etc.

24 hours later:

Replace ethanol:

- Put special cap with mesh in its center onto an ethanol sample.

- Pour ethanol through mesh into waste container.
- Remove cap, rinse with appropriate ethanol squeeze bottle.
- Fill jar with ethanol and replace cap, dry outside of jar
- Put a check mark on the cap and store in box

Check formalin:

- Open jar in hood, dip a small piece of pH paper into sample liquid.
- If pH is below 8 add a small amount of sifted borate buffer, swirl, recheck pH, cap, store jar.

Appendix 2 - Summary of MOCNESS Tows

Station	Tow	Month local	Day local	Time Start end (Yearday .time)	Lat. (N) start end	Long.(W) start end	Net: depth_open-depth_closed	Volume filtered
test 1	1	8	11	224.7123	45.4318	-127.8646	net 0: 0 - 48	5211
				224.7685	45.4347	-127.8636	net 1: 48 - 24	390
				Day Tow / Flow Calibration			net 2: 24 - 0	445
1	2	8	16	229.0399	49.8634	-149.4318	net 0: 0 – 712-0	1003+?
				229.0698	49.8638	-149.4705	UW failed at 712 m	
				229.1229	49.8780	-149.5364	Back on surface	
				Night Tow				
2	3	8	16	229.3934	49.4920	-149.1628	net 0: 0 - 1018	2382
				229.5182	49.4313	-149.2629	net 1: 1000 - 805	ND*
							net 2: 805 - 602	ND*
				Day Tow / Flow problem			net 3: 598- 400	2127
							net 4: 400 - 200	1090
							net 5: 200 - 100	919
							net 6: 100 – 50	326
							net 7: 50 - 27	167
							net 8: 27 - 0	523
3	4	8	31	244.4609	48.9956	-148.2275	net 0: 0 – 412-0	1223+?
				244.4787	48.9924	-148.2457	UW failed at 712 m	
				244.5646	48.9746	-148.3353	Back on surface	
				Day Tow				
3	5	8	31	244.6512	48.9468	-148.3307	net 0: 0 - 1008	1041+
				244.7547	48.9440	-148.4284	net 1: 999 - 802	724
							net 2: 802 - 598	1109
				Day Tow			net 3: 598 - 399	1155
							net 4: 399 - 199	1383
							net 5: 199 - 98	530
							net 6: 98 - 52	304
							net 7: 52 - 26	228
							net 8: 26 - 0	268
3	6	9	1	245.0304	48.9128	-148.6815	net 0: 0 - 1011	3838
				245.1616	48.9411	-148.8384	net 1: 1001 - 800	1007
							net 2: 800 - 400	2296
				Night Tow			net 3: 400 - 100	1222
							net 4: 405 - 200	792
						No Net 8	net 5: 200 - 100	626
							net 6: 100 - 50	309

Station	Tow	Month local	Day local	Time Start end (Yearday .time)	Lat. (N) start end	Long.(W) start end	Net: depth_open-depth_closed	Volume filtered
							net 7: 50 - 23	421
7	7	9	2	246.3754	46.9989	-144.7368	net 0: 0 - 1012	2373
				246.4881	46.9975	-144.8549	net 1: 1001 - 796	1196
							net 2: 796 - 600	1047
				Day Tow			net 3: 600 - 405	1095
							net 4: 405 - 200	1333
							net 5: 200 - 100	772
							net 6: 100 - 51	411
							net 7: 51 - 27	260
							net 8: 27 - 0	273
7	8	9	2	246.8598	47.0215	-144.6109	net 0: 0 - 1018	2455
				246.9748	47.0231	-144.7012	net 1: 999 - 785	1137
							net 2: 785 - 600	1076
				Night Tow			net 3: 600 - 493	501
							net 4: 493- 300	944
							net 5: 300 - 99	1299
							net 6: 99 - 51	610
							net 7: 51 - 24	302
							net 8: 24 - 6	469
11	9	9	3	247.9810	45.0506	-141.4537	net 0: 0 - 1014	4203
				248.1096	44.9727	-141.3325	net 1: 1000 - 799	1362
							net 2: 799 - 599	1127
				Night Tow			net 3:599 - 399	1158
							net 4:399 - 200	1288
							net 5: 200 - 99	625
							net 6: 99 - 51	416
							net 7: 51 - 25	321
							net 8: 25 - 0	317
11	10	9	4	248.3848	44.9646	-141.3447	net 0: 0 - 1012	2990
				248.4989	44.9079	-141.2514	net 1: 1000 - 800	1112
							net 2: 800 - 600	1195
				Day Tow			net 3: 600 - 402	1340
							net 4: 402 - 202	1231
							net 5: 202 - 100	665
							net 6: 100 - 52	476
							net 7: 52 - 26	272
							net 8: 26 - 0	285

Station	Tow	Month local	Day local	Time Start end (Yearday .time)	Lat. (N) start end	Long.(W) start end	Net: depth_open-depth_closed	Volume filtered
15	11	9	5	249.5398	43.0036	-138.1338	net 0: 0 - 1011	3333
				249.6680	43.1020	-138.1010	net 1: 1000 - 801	1117
							net 2: 801 - 601	1646
				Day Tow			net 3: 601 - 400	1127
							net 4: 405 - 201	1308
							net 5: 201 - 103	699
							net 6: 103 - 52	460
							net 7: 52 - 25	484
							net 8: 25 - 0	534
15	12	9	5	249.9273	43.0952	-138.1589	net 0: 0 - 1014	2880
				250.0474	43.1852	-138.1610	net 1: 999 - 799	1063
							net 2: 799 - 700	796
				Night Tow			net 3: 700 - 398	1645
							net 4: 398 - 185	944
							net 5: 185 - 101	745
							net 6: 101 - 52	536
							net 7: 52 - 25	428
							net 8: 25 - 0	467
18	13	9	7	251.0594	41.5330	-135.7863	net 0: 0 - 1024	2885
				251.1733	41.6162	-135.7843	net 1: 993 - 808	930
							net 2: 808- 600	823
				Night Tow			net 3: 600 - 400	1152
							net 4: 400 - 200	947
							net 5: 200 - 100	744
							net 6: 100 - 51	486
							net 7: 51 - 26	255
							net 8: 26 - 0	314
18	14	9	7	251.4066	41.7197	-135.8227	net 0: 0 - 1012	2695
				251.5317	41.8181	-135.7980	net 1: 999 - 799	1169
							net 2: 799 - 600	1019
				Day Tow			net 3: 600 - 400	1382
							net 4: 400 - 200	1314
							net 5: 200 - 102	697
							net 6: 102- 50	592
							net 7: 50 - 27	409
							net 8: 27 - 0	363
21	15	9	8	252.3658	40.0044	-135.0007	net 0: 0 - 1012	2365
				252.4843	40.0846	-135.0193	net 1: 999 - 802	1022

Station	Tow	Month local	Day local	Time Start end (Yearday .time)	Lat. (N) start end	Long.(W) start end	Net: depth_open-depth_closed	Volume filtered
							net 2: 802 - 602	1197
				Day Tow			net 3: 602 - 401	1273
							net 4: 401 - 201	1248
							net 5: 201 - 99	958
							net 6: 99 - 52	559
							net 7: 52 - 26	587
							net 8: 26 - 0	335
21	16	9	8	252.8198	39.9834	-135.0297	net 0: 0 - 1015	2701
				252.9359	40.0625	-135.0667	net 1: 1001 - 800	949
							net 2: 797 - 600	1033
				Night Tow			net 3: 600 - 399	1099
							net 4: 399 - 200	1401
							net 5: 200 - 99	935
							net 6: 99 - 50	499
							net 7: 50 - 25	376
							net 8: 25 - 0	403
24	17	9	9	253.5646	38.7115	-135.0097	net 0: 0 - 1012	3384
				253.6870	38.6212	-135.0063	net 1: 1000 - 802	1217
							net 2: 802 - 601	1195
				Day Tow			net 3: 601 - 400	1422
							net 4: 405 - 200	1202
							net 5: 200 - 102	741
							net 6: 102- 51	536
							net 7: 51 - 25	251
							net 8: 25 - 0	311
24	18	9	9	253.9013	38.6237	-135.0626	net 0: 0 - 1012	3072
				254.0178	38.5317	-135.0156	net 1: 999- 800	1294
							net 2: 800 - 600	992
				Night Tow			net 3: 600 - 401	1169
							net 4: 401 - 203	1557
							net 5: 203 - 102	626
							net 6: 102 - 52	562
							net 7: 52 - 26	364
							net 8: 26 - 0	288
27	19	9	10	254.5655	37.2594	-135.0084	net 0: 0 - 1011	3890
				254.7100	37.1545	-135.1007	net 1: 1001- 801	1819
							net 2: 801 - 601	1486
				Day Tow			net 3: 601 - 402	1445
							net 4: 402 - 202	1507

Station	Tow	Month local	Day local	Time Start end (Yearday .time)	Lat. (N) start end	Long.(W) start end	Net: depth_open-depth_closed	Volume filtered
							net 5: 202- 99	974
		Note: delayed NR 5to6 @ 75m					net 6: 99 - 52	449
		Net 5 = 861 +283*0.4 = 974					net 7: 52 - 26	437
		Net 6 = 279 +283*0.6 = 449					net 8: 26 - 0	525
27	20	9	10	254.9181	37.2305	-135.1288	net 0: 0 - 1013	3520
				255.0619	37.3367	-135.0866	net 1: 1002- 801	1729
							net 2: 801 - 600	1362
				Night Tow			net 3: 600 - 401	1069
							net 4: 401 - 201	1653
							net 5: 201 - 100	1121
							net 6: 100 - 52	696
							net 7: 52 - 25	305
							net 8: 25 - 0	456
30	21	9	11	255.9979	35.5852	-135.0034	net 0: 0 - 1015	3387
				256.1379	35.6621	-135.0156	net 1: 1000- 789	1856
							net 2: 789 - 601	1148
				Night Tow			net 3: 601 - 401	1722
							net 4: 401 - 201	1505
							net 5: 201 - 99	722
							net 6: 99 - 51	425
							net 7: 51 - 26	288
							net 8: 26 - 0	505
30	22	9	12	256.3717	35.6829	-134.9076	net 0: 0 - 1010	4252
				256.5239	35.7880	-134.8236	net 1: 1000- 802	1717
							net 2: 802 - 603	1455
				Day Tow			net 3: 603 - 401	2136
							net 4: 401 - 201	1353
							net 5: 201 - 98	647
							net 6: 98 - 51	507
							net 7: 51 - 25	333
							net 8: 25 - 0	288
32	23	9	12	256.9514	34.4969	-135.0014	net 0: 0 - 1053	2750
				257.0888	34.4281	-135.0992	net 1: 1001- 801	1413
							net 2: 801 - 601	1594
				Night Tow			net 3: 601 - 401	1426
							net 4: 401 - 204	1415
							net 5: 204 - 111	748
							net 6: 111 - 51	691
							net 7: 51 - 25	468

Station	Tow	Month local	Day local	Time Start end (Yearday .time)	Lat. (N) start end	Long.(W) start end	Net: depth_open-depth_closed	Volume filtered
							net 8: 25 - 0	690
32	24	9	13	257.3496	34.5261	-135.0731	net 0: 0 - 1011	3052
				257.4882	34.6452	-135.0817	net 1 1000 - 801	1583
							net 2: 801 - 602	1288
				Day Tow			net 3: 602 - 401	1548
							net 4: 401 - 202	2073
							net 5: 202 - 102	1147
							net 6: 102 - 50	540
							net 7: 50 - 25	206
							net 8: 25 - 0	236
34	25	9	13	257.9332	33.4988	-135.0010	net 0: 0 - 1014	3142
				258.0821	33.6143	-134.9961	net 1: 995- 786	1333
							net 2: 786 - 601	1337
				Night Tow			net 3: 601 - 400	1660
							net 4: 400 - 201	1392
							net 5: 201 - 101	1258
							net 6: 101 - 52	721
							net 7: 52 - 25	417
							net 8: 26 - 0	410
34	26	9	14	258.3543	33.5889	-134.9791	net 0: 0 - 1012	3081
				258.5006	33.7006	-135.0110	net 1: 1001- 800	1488
							net 2: 800 - 600	1303
				Day Tow			net 3: 600 - 401	1490
							net 4: 401 - 200	1876
							net 5: 200- 102	1319
							net 6: 102 - 51	654
							net 7: 51 - 27	602
							net 8: 27 - 0	576

* Flowmeter reedswitch failed; Volume estimated based on average net angle and GPS distance traveled.

Appendix 3 - Flash-Frozen Pteropods Removed from MOCNESS Samples for Molecular Analyses

id#	date	station	tow#	NET	Species*	Count	Time pres'd	Collector	Note
1	8/16/12	2	M3	7	L. helicina	3	1400	AEM	
2	8/16/12	2	M3	7	L. helicina	3	1400	AEM	
3	8/16/12	2	M3	8	L. helicina	2	1430	AEM	
4									
5	9/2/12	7	M7	8	C. pyramidata	1		AEM	not labled properly
6	9/2/12	7	M7	8	L. helicina	3		AEM	not labled properly
7	9/2/12	7	M7	8	L. helicina	3		AEM	not labled properly
8	9/2/12	7	M7	8	L. helicina	3		AEM	not labled properly
9	9/4/12	11	M10	5	L. helicina	2	1400	GL	
10	9/4/12	11	M10	8	L. helicina	5	1400	GL	some still swimming happily
11	9/4/12	11	M10	8	L. helicina	4	1400	GL	some still swimming happily
12	9/4/12	13	R13		L. helicina	2	0:18 5th	AEM	
13	9/5/12	15	M12	4	L. helicina	1		AEM	
14	9/5/12	15	M12	7	L. helicina	4	2:38	AEM	
15	9/7/12	18	M13	7	C. pyramidata	1	7:16	GL	labled as N8, not dead, not happy
16	9/7/12	18	M14	4	C. pyramidata	1	13:00	GL	
17	9/8/12	21	R17		L. inflata	lots	17:15	AEM	
18	9/9/12	22	M16	8	C. pyramidata	2	23:30		
19	9/9/12	22	M16	8	C. uncinata	~20	23:30		
20	9/10/12	27	R20		C. pyramidata	4	22:22	AEM	
21	9/11/12	27	M20	6	C. pyramidata	4	2:31	AEM	
22	9/11/12	27	M20	8	C. pyramidata	1	2:40	AEM	HUGE!
23	9/11/12	27	M20	8	C. pyramidata	1	2:40	AEM	
24	9/11/12	27	M20	8	L. inflata	lots	2:45	AEM	
25	9/13/12	32	M23	8	C. pyramidata	1	3:09	AEM	
26	9/13/12	32	M23	8	C. pyramidata	1	3:09	AEM	
27	9/13/12	34	M25	6	C. pyramidata	1	3:09	AEM	

Appendix 4 - All Specimens Removed From MOCNESS Samples

tow type	date	station	tow	NET	Species*	Count	Time preserved	Preservation	Collector's name	sample code
					(ok if not known; give shape if possible- cone, snail, etc.)					
MOCNESS		Test 1	1	3	Limacina helicina	1	16:04	95%	Amy	
	11-Aug-12	1	2	0	Limacina helicina	1		95%	Amy	Ga56.13
	16-Aug-12	1	2	0	Euphausia pacifica	3		95%	Leo	
	16-Aug-12	1	2	0	Thysanoessa longipes	5		95%	Leo	
	16-Aug-12	1	2	0	Tessarabrachion oculatus	2		95%	Leo	
	16-Aug-12	1	2	0	Stylocheiron maximum	1		95%	Leo	
	16-Aug-12	1	2	0	Neocalanus cristatus	3		95%	Leo	
	16-Aug-12	1	2	0	Paraeuchaeta sp.	11		95%	Leo	
	16-Aug-12	1	2	0	Euchirella sp.	2		95%	Leo	
	16-Aug-12	1	2	0	Nemertean worm	2		95%	Leo	Ne04.2
	16-Aug-12	2	3	7	Limacina helicina	6		liq.N2		
	16-Aug-12	2	3	8	Limacina helicina	2	1430	liq.N2	Amy	
	2-Sep-12	7	7	8	Limacina helicina	9	~2 hrs after tow end	liq.N2		
	2-Sep-12	7	7	8	Limacina helicina	1	~2 hrs after tow end	70%	Alex	
	2-Sep-12	7	7	8	Clio pyramidata	1	~2 hrs after tow end	liq.N2	Amy	
	2-Sep-12	8	7	2	Poeobius (polychaete)	1	j	95%	Amy	
	2-Sep-12	11	9	1	Pneumoderma sp. (gymnosome)	1		95%	Amy	
	2-Sep-12	11	9	1	Poeobius (polychaete)	2		95%	Amy	
	2-Sep-12	11	9	1	Megacalanus sp. (male)	2		95%	Leo	
	2-Sep-12	11	9	1	Megacalanus sp.	1		95%	Leo	

tow type	date	station	tow	NET	Species*	Count	Time preserved	Preservation	Collector's name	sample code
					(female)					
	2-Sep-12	11	9	1	fish for Stegeman	1		frozen, RNAlater	Amy	
	4-Sep-12	11	10	5	Limacina helicina	2	~1400??	liq.N2		
	4-Sep-12	11	10	5	Limacina helicina	1	~1400??	70%		
	4-Sep-12	11	10	8	Limacina helicina	5	~1400??	liq.N2		
	4-Sep-12	11	10	8	Limacina helicina	4	~1400??	liq.N2		
	5-Sep-12	15	11	0	Limacina helicina	2	1700	70%	Amy/Leo	
	5-Sep-12	15	11	0	Cliopsis kroni (gymnosone)	2	1700	70%	Amy/Leo	
	5-Sep-12	15	11	0	Clio pyramidata	1	1700	70%	Amy/Leo	
	5-Sep-12	15	11	7	Cliopsis kroni (gymnosone)	3	~1630	95%	Amy/Leo	
	5-Sep-12	15	11	8	Cliopsis kroni (gymnosone)	4	~1630	95%	Amy/Leo	
	5-Sep-12	15	12	1	Bentheuphausia amblyops	1		liq.N2	Nancy	
	5-Sep-12	15	12	1	Thysanoessa longipes	1		liq.N2	Leo	
	5-Sep-12	15	12	2	Thysanoessa longipes	1		liq.N2	Leo	
	5-Sep-12	15	12	2	Pneumoderma sp. (gymnosome)	7		95%	Amy	
	5-Sep-12	15	12	2	fish for Stegeman (large)	1		frozen, RNAlater	Amy	
	5-Sep-12	15	12	4	Thysanoessa longipes	1		liq.N2	Leo	
	5-Sep-12	15	12	4	Limacina helicina	1		liq.N2	Nancy	
	5-Sep-12	15	12	4	Nematoscelis difficilis	1		liq.N2	Leo	
	5-Sep-12	15	12	5	Nematoscelis difficilis	2		liq.N2	Leo	
	5-Sep-12	15	12	7	Limacina helicina	4		liq.N2	Nancy	

tow type	date	station	tow	NET	Species*	Count	Time preserved	Preservation	Collector's name	sample code
	5-Sep-12	15	12	7	Limacina helicina	4		70%	Nancy	
	5-Sep-12	15	12	8	Limacina helicina	6		70%	Amy	
	5-Sep-12	15	12	8	Clio pyramidata	3		70%	Nancy	
	7-Sep-12	18	13	0	Cavolinia uncinata	1		95%	Leo	
	7-Sep-12	18	13	0	Cavolinia uncinata	1		70%	Leo	
	7-Sep-12	18	13	0	Clio pyramidata	3		Respiration Expt.	Amy	
	7-Sep-12	18	13	3	Bentheuphausia amblyops	1		liq.N2	Leo	
	7-Sep-12	18	13	3	Megacalanus sp.	1		95%	Leo	
	7-Sep-12	18	13	4	Cavolinia uncinata	3		95%	Gareth	Ga29.12
	7-Sep-12	18	13	7	Clio pyramidata	5		95%	Leo	
	7-Sep-12	18	13	7	Clio pyramidata	4		70%	Leo	
	7-Sep-12	18	M13	7	C. pyramidata	1	7:16	liq.N2	Gareth	labled as N8, not dead, not happy
	7-Sep-12	18	13	8	Clio pyramidata	4		95%	Leo	
	7-Sep-12	18	13	8	Clio pyramidata	5		70%	Leo	
	7-Sep-12	18	14	2	Clio pyramidata	1		70%	Alex	
	7-Sep-12	18	14	2	Megacalanus sp. (female)	1		95%	Leo	
	7-Sep-12	18	14	4	Clio pyramidata	1		liq.N2	Alex	
	7-Sep-12	18	14	4	Clio pyramidata	3		70%	Alex	
	7-Sep-12	18	14	6	Clio pyramidata	4		70%	Alex	
	7-Sep-12	18	14	6	Cavolinia uncinata	2		70%	Alex	
	7-Sep-12	18	14	7	Cavolinia uncinata	4		70%	Alex	
	8-Sep-12	21	15	0	Cavolinia uncinata	3		95%	Amy	
	8-Sep-12	21	15	0	Cavolinia uncinata	4		dry	Amy	
	8-Sep-12	21	15	1	Bentheuphausia	1		95%	Nancy	Eu05.4

tow type	date	station	tow	NET	Species*	Count	Time preserved	Preservation	Collector's name	sample code
					amblyops					
	8-Sep-12	21	15	7	Cavolinia uncinata	1		70%	Nancy	
	9-Sep-12	22	16	0	Pneumoderma sp. (gymnosome)	2	2340	95%	Amy	
	9-Sep-12	22	16	0	Cavolinia uncinata	4	2340	dry	Liza	
	9-Sep-12	22	16	2	Bentheuphausia amblyops	1	2300	liq.N2	Leo	
	9-Sep-12	22	16	4	Limacina inflata	1	2320	70%	Amy	
	9-Sep-12	22	16	6	Cavolinia uncinata	1	2330	70%	Amy	
	9-Sep-12	22	16	8	Clio pyramidata	2	2330	liq.N2	Amy	T#18
	9-Sep-12	22	16	8	Cavolinia uncinata	~20	2330	liq.N2	Amy	T#19
	9-Sep-12	24	17	4	Clio pyramidata	5	~1715	70%	Alex	
	9-Sep-12	24	17	7	Cavolinia uncinata	1	~1730	70%	Alex	
	9-Sep-12	24	18	3	Clionidae sp. (C. limacina?)	1		95%	Amy	Ga
	9-Sep-12	24	18	4	Megacalanus sp. (female)	1	1814	95%	Leo	Co429.7
	9-Sep-12	24	18	6	Pneumoderma sp. (gymnosome)	1		95%	Amy	Photos
	9-Sep-12	24	18	6	Cavolinia uncinata	1		70%	Amy	
	9-Sep-12	24	18	8	unknown purple gastropods	2		95%	Amy	Photos; Ga110.2
	10-Sep-12	27	19	0	Pneumoderma sp. (gymnosome)	1	1730	70%	Amy	
	10-Sep-12	27	19	6	Cavolinia uncinata	2	1730	70%	Nancy	
	10-Sep-12	27	19	7	Cavolinia uncinata	3	1730	70%	Nancy	
	11-Sep-12	27	20	0	fish, mesopelagic	1	0150	frozen	Amy for Lombard	
	11-Sep-12	27	20	1	Pneumoderma sp. (gymnosome)	2		95%	Amy	Ga113.21

tow type	date	station	tow	NET	Species*	Count	Time preserved	Preservation	Collector's name	sample code
	11-Sep-12	27	20	2	Megacalanus sp.	1		95%	Leo	Co429.8
	11-Sep-12	27	20	3	Clione limacina	1	0215	95%	Amy	Ga04.29
	11-Sep-12	27	20	5	Clio pyramidata	1	0221	70%	Leo	
	11-Sep-12	27	20	5	Leptocephalus (eel larva, large)	chunk		95%	Leo/Amy	
	11-Sep-12	27	20	6	Cavolinia uncinata	2	0216	70%	Leo/Amy	
	11-Sep-12	27	20	6	Clio pyramidata	4	0230	liq.N2	Amy	
	11-Sep-12	27	20	8	Clio pyramidata	2	0240	liq.N2	Amy	
	11-Sep-12	27	20	8	Limacina inflata	20	0245	liq.N2	Amy	
	11-Sep-12	30	21	0	fish	1		frozen, RNAlater	Amy for Stegeman	
	11-Sep-12	30	21	0	Cavolinia inflexa	3		Resp. Expt.; 95%	Amy	Ga37.13
	11-Sep-12	30	21	0	Clio pyramidata	1		Resp. Expt.; 95%	Amy	
	11-Sep-12	30	21	0	Cuvierina columnella	2		95%	Amy	Ga06.20
	11-Sep-12	30	21	6	Cavolinia inflexa	1	0417	70%	Amy	
	11-Sep-12	30	21	6	Clio pyramidata	2	0417	70%	Amy	
	11-Sep-12	30	21	6	Styliola subula	1	0417	70%	Amy	
	11-Sep-12	30	21	7	Diacria quadridentata	1		70%	Amy	photos
	11-Sep-12	30	21	7	Cavolinia inflexa	4		70%	Amy	
	11-Sep-12	30	21	7	Clio pyramidata	1		70%	Amy	
	12-Sep-12	30	22	0	Cavolinia uncinata	1	<~1400	70%	Nancy	
	12-Sep-12	30	22	0	Cavolinia inflexa	2	<~1400	70%	Nancy	
	12-Sep-12	30	22	4	Cuvierina columnella	1	<~1300	70%	Nancy	
	12-Sep-12	30	22	4	Cavolinia inflexa	3	<~1300	70%	Nancy	
	12-Sep-12	30	22	6	Styliola subula	2	<~1330	70%	Nancy	

tow type	date	station	tow	NET	Species*	Count	Time preserved	Preservation	Collector's name	sample code
	12-Sep-12	30	22	6	Diacria quadridentata	1	<~1330	70%	Nancy	
	12-Sep-12	30	22	7	Diacria quadridentata	4	<~1330	70%	Nancy	
	12-Sep-12	32	23	0	Cavolinia uncinata	1		95%	Amy	
	12-Sep-12	32	23	0	Pneumoderma sp. (gymnosome)	1		95%	Amy	
	12-Sep-12	32	23	0	Clio pyramidata	2		95%	Amy	
	12-Sep-12	32	23	0	Megacalanus sp.	1		95%	Leo	
	12-Sep-12	32	23	2	Pneumoderma sp. (gymnosome)	1		95%	Amy	
	12-Sep-12	32	23	5	Clio pyramidata	1		70%	Amy	
	12-Sep-12	32	23	7	Pneumoderma sp. (gymnosome)	1		95%	Amy	
	12-Sep-12	32	23	7	Cavolinia inflexa	1		70%	Amy	
	12-Sep-12	32	23	8	Clio pyramidata	1		liq.N2	Amy	
	12-Sep-12	32	23	8	Clio pyramidata	1		liq.N2	Amy	
	12-Sep-12	32	23	8	Clio pyramidata	12		70%	Amy	
	13-Sep-12	32	24	0	Cavolinia uncinata	1		dry	Nancy for Liza	
	13-Sep-12	32	24	0	Cavolinia uncinata	1		70%	Nancy	
	13-Sep-12	32	24	4	Clio pyramidata	3		70%	Nancy	
	13-Sep-12	32	24	4	Clio pyramidata	1		liq.N2	Nancy	
	13-Sep-12	32	24	4	Cavolinia inflexa	1		70%	Nancy	
	13-Sep-12	32	24	4	Cuvierina columnella	2		70%	Nancy	

Appendix 5 - Acoustic Log (HTI and HammarHead)

NOTE: This log is in GMT.
This log was used for both the HTI and HammarHead Acoustic instruments. All starts and stops and all adjustments for these devices are in this log. It is mostly in an "as is" format.

August 10, 2012

0216 First day on cruise NH1208. I have just synchronized the acoustic log, Edgetech control, and HTI computers to GMT. The HTI had collected a few files earlier yesterday and today with the computer in Eastern time. These were some noise tests done prior to the sled being deployed in the moon pool and then once it was in the well. I also collected a couple of files as we head to our first station before re-setting the time.

Current HTI acoustic file is D2230213. Haven't yet done noise profiles so this is with no thresholds. Looks pretty noisy, with some big spikes. Also some interference on the 420 kHz, likely due to a speed log. I have yet to check in with the bridge about securing acoustic devices. The ADCP is presently off. Configuration file is RunChirp-NewHorizon-MoonPool-500m-NoNoiseThresholds-8-9-12.cfg.

0223 Just realized I hadn't entered the start of HTI data into the e-log.

0236 Bridge was running their depth sounder (28/50 kHz) which they have now shut off. Not much difference on the HTI.

1506 Shut down HTI because we're back in Newport to get the evaporators fixed.

August 11, 2012

0213 New HTI file D2240213. Evaporators are fixed and we're heading back out to sea. Same config with no thresholds: RunChirp-NewHorizon-MoonPool-500m-NoNoiseThresholds-8-9-12.cfg.

2336 Power out, HTI shut off

2357 Power back on (breaker tripped because we had too many things on the clean power) and the HTI is running again, file D2242357. Knudsen (12kHz) is on for the CTD cast and we can see it at 43 and 120 kHz.

August 12, 2012
0023 HTI just gave blue screen of death. Rebooting.

0035 Restarted HTI, took two tries to reboot the M242. File D2250035. RunChirp-NewHorizon-MoonPool-500m-NoNoiseThresholds-8-9-12.cfg.

0123 Edgetech in the water under files station_test1_. Raw collection on, Ranges set to 75/75/50. High amount of over flow so we will restart with no raw. Fish at 23M, speed 4kts.

0128 New Edgetech file station_test1_noraw_ with same ranges and raw collection off

0132 Ship's speed log turned off

0134 Edgetech being let out to 100m at 10MPM

0146 Edgetech being brought up at 10MPM to 15M for recovery

0201 Edgetech shutdown for recovery

0243 HTI back on. File D2250243. RunChirp-NewHorizon-MoonPool-500m-NoNoiseThresholds-8-9-12.cfg.

0425 Walking by I saw the HTI was off. Seems that one of the connections on the power adapter had come loose and the battery had run down. Rebooted and now collecting data again. File D2250424.

1514 HTI big red rebooted and so I'm starting a new file…little red took two reboots. File D2251524. Very clean data today as it's nice and calm. Good day for some noise tests.

1529 Coming up onto Brown Bear Seamount and the 43 kHz is tripping over itself.

1925 HTI stopped for noise test

1933 HTI noise test. First file D2251928 is bad – interval was 6 seconds. Correct start file D2251932. runchirp-newhorizon-moonpool-500-20logrnoise-8-3-12.cfg.

1936 Noise test restarted because of wrong config file. File N2251936. runchirp-newhorizon-moonpool-500-20logrnoise-8-12-12.cfg.

1943 Noise test second file N2251943. runchirp-newhorizon-moonpool-500-40logrnoise-8-12-12.cfg

1948 HTI resumed D2251948. RunChirp-NewHorizon-MoonPool-500m-NoNoiseThresholds-8-9-12.cfg.

2022 Noise profiles look pretty good, quite similar to Oceanus. The 43 kHz suffers from frequent streaky pings when we're using the 0.1 min integration intervals and so the noise profiles aren't very smooth. Redoing to see if we can get a better 43 profile. File N2252021. runchirp-newhorizon-moonpool-500-20logrnoise-8-12-12.cfg.

2024 Lost GPS on last file, no longer seeing COM3. Switched GPS to COM4. Restarted data collection file D2252026, config RunChirp-NewHorizon-MoonPool-500m-NoNoiseThresholds-8-9-12.cfg

2035 New noise profile at 43 doesn't look much better so used first one but increased the smoothing factor to 15 from its default 10.

2041 New data file D2252041. New configuration file with noise threshold included runchirp-newhorizon-moonpool-500-8-12-12.cfg

2115 ADCP is being turned on – unsynchronized – to check for noise. ADCP in narrowband mode.

2137 HTI crashed, restarted

2149 New file D2252148 with the 120 and 43 in passive to look for interference from the ADCP. Ping by ping data not collected.

2157 New file D2252157 with ping by ping.

2214 New file D2252214, 43 and 120 are still in passive mode. Now attempting to synchronize the ADCP.

2230 New config file RunChip-NewHorizon-MoonPool-500m-1000ms-8-12-12.cfg has a 5th dead period for synching with the ADCP

2231 Test with 43 and 120 on passive. File D2252231. Sync had been on wrong channel previously.

2238 43 and 120 are now on Active. File D2252238. Config RunChip-NewHorizon-MoonPool-500m-1000ms-8-12-12.cfg. ADCP seems to be synchronized.

2245 ADCP was synchronized but still seemed to be cross talk with 120khz so duration of dead period increased to 2000ms.

2255 Realized that the cfg we were just using was the no thresholds one. Redid things so that the noise thresholds are now included. File is D2252255, config is RunChip-NewHorizon-MoonPool-500m-2000ms-8-12-12.cfg. Everything seems to be working with the sync, ADCP is firing about as often as it should (its ping time is rounded to the nearest second making it a little hard to tell exactly). We are still getting what is likely interference on the 120 though…hard to conceive that it's the ADCP given that it's nominally 75kHz and there's 3 seconds after the ADCP fires before.

August 13, 2012

0135 We were seeing the apparent ADCP interference on the 120 very regularly and at a relatively constant range and so I turned off the ADCP. The noise persisted so it doesn't appear to be ADCP. We'll keep running the sync anyhow.

August 14, 2012

0242 Acoustic data have been coming in fine for the past long while. There has been a lot of noise on the 43 and 120 as it's a littler rougher today than yesterday. A minute ago the system got hung up because of an error saying that there was no room on S:/ for a file named something like GPS.tmp. Rebooted. File D2270241. Not getting samples so rebooted again. File D2270246. Config is RunChip-NewHorizon-MoonPool-500m-2000ms-8-12-12.cfg. ADCP data I think kept coming in because the M244 was sending out a trigger.

0921 Blue Screen of Death on the HTI. Shut everything down, restarted laptop, then took two attempts to get a connection to sounder and had to re-establish connection to S drive. Stopped trigger for ADCP.

0939 Sounder running and recording again. File D2270939. Config is RunChip-NewHorizon-MoonPool-500m-2000ms-8-12-12.cfg. Restarted trigger for ADCP.

1903 Samples data weren't logging, so restarted little red box. Now getting samples data fine. File D2271905.

August 15, 2012

1014 Noticed that computer interface was no longer updating, although big red continues to pass through the channels. Most recent file on display in program is timed at 0400, however samples folder continues to show current files being made, most recent is R2281010. Decided to restart software. Program appears to be frozen.

1019 When restarting the software, transceivers continued and the computer was unable to connect. We are restarting the whole system.

1023 Restarted but no samples data weren't logging so restarted little red. Tried to reconnect to sonar and unable so whole system being restarted again. ADCP is now off as well when the trigger was disabled.

1046 Tried rebooting a few times, still no luck. Big red is not producing chirp. Various combinations of resetting the whole system and reconnecting the S: drive have been tried, still no luck.

1129 Still no luck getting any connection to the sonar. Big red is not making any chirp. We've tried directly connecting big red to the computer and changing network cables. I've also tried moving positions on the switch, directly connecting big red to laptop, running big without little, turning off all power, including unplugging the whole system, various combinations of startup order between the system and the laptop.

Also tried working off of the VPR laptop, LANtastic was unable to map to the drives on the sounder. Direct and through switch, both little and big.

1244 ADCP back on standalone

2116 Chris Odum at HTI sent us a copy they had made of the C-drive on the M244 chip. I copied all the files over to the M244 (except for spool.net, a file associated with Lantastic that was in use and couldn't be modified). Restarted the M244 and it's now working, made a happy chirp, connected to the laptop, and is collecting data fine.

2118 First reboot no samples so restarted M242. Took many reboots but we're finally getting samples data. File D2282131. Config is RunChip-NewHorizon-MoonPool-500m-2000ms-8-12-12.cfg. Restarted trigger for ADCP.

August 17, 2012

0210 HammarHead has been in the water for about 10 minutes. Smooth deployment. At first boot up the CTD was indicating 62PSI but the depth estimate was 0.0m. After I started pinging the depth estimate came up as 32m. We deployed heading into the wind (ie towards the south) but that was taking us away from the station so we made a slow turn with the fish at constant depth and we're now heading back towards station at 3 kt. Bridge just turned off the speed log (440 kHz).

0215 Just turned off the HTI and ADCP. We had been seeing interference on the A1 but now that's gone. File is NH1208_station01_cast02_*, in directory D:/NH1208/Station_2/Cast02. Pulses/ranges are:

A1L_10002_11002_500us_00.spf (master; 70m)
MA2_20002_12002_500us_00.spf (delay of 333ms; 70m)
H_30002_31002_500us_00.spf (delay of 666ms; 50m)

We are getting occasional overflows, with raw data collection on.

0223 New file, changed ranges to 65/65/50m. Overflows stopped.

0225 Signal looks ok. Some suggestion of interference (spikes) on A1. LOW is showing banding, looks a lot like 60 Hz noise. MID, HL, HH showing nice scattering plankton like in interesting patches (vertical circulation cells?).

0232 No evidence of saturation on any channels. Restarting with no RAW.

0234 Still at 65/65/50m. Increased ping rate to 2 Hz. Initial bolus of 292 overflows but then settled out ok at 31% of the 10 Mbps capacity. Increased range to 100/100/50m at 2 Hz and we're using 40% capacity.

0237 Noise on the A1 and A2 might be the engines as it looks pretty rhythmic. Will try paying out a little.

0240 Kevin is starting to pay out. The winch doesn't have a payout meter nor a speed meter making things a little tricky. He's got it at 'half speed' which seems to be about 20m/min (of depth, not wire out).

0244 Fish is at 85m and the noise on the A1/A2 is lessened so it is likely engine noise. The 60Hz noise seems also a little lessened. Fish is at 110m and the water column is completely empty. Pitch and roll are ok. Some weak boomerangs on A1 and A2 but not much. Other frequencies are clear as day.

0250 Stopped winch, fish at 168m. Some weak targets, strongest on A1/A2. Will hold here for a few pings.

0256 Sending down again, around 20m/min (vertical).

0258 Stopped at 210m. Interesting thin layer, seems plankton-like.

0302 Paying out again. There had been a layer at 300m on the HTI 43kHz that we'll aim for.

0305 221m depth above a nice layer on the MID.

0308 Paying out again. Coming into a nice fishy layer.

0314 Stopped at 285m above the layer. Will collect a few 100 pings.

0316 Collecting a little raw data to check for saturation. Nothing. Back to 2 Hz and NO RAW.

0322 Hauling it in. Initially came up at >20m/min, slowed to hopefully 20.

0406 Fish is at 21m. Will hold at this depth for a while. Some very nice dense plankton patches in 0-10m range.

0426 Powered down Edgetech

0427 Power back on Edgetech on UPS

0430 Noise on low is slightly reduced. Initially it was much lower, now just slightly lower. Also slightly better on HL and HH. Certainly no worse than before on any channels.

0454 Fish is still at 21m. Still getting some very nice plankton-like scattering. There's a layer at ca. 20m range that is undulating, a bit like an internal wave. Also some shallower (0-10m) more vertical patches, looks a little like Langmuir cells. Would be nice to have these patches just a little farther away but I'd rather not bring the fish up much shallower.

0529 Shut down.

0614 HTI restarted. File name D2300614, config file RunChip-NewHorizon-MoonPool-500m-2000ms-8-12-12.cfg. ADCP restarted.

0840 Samples was not growing, restarted little red. Received an "unable to stop processing error" so reset little and big.

0905 After MANY resets, finally started collecting ping by ping. File D2300905, config file RunChip-NewHorizon-MoonPool-500m-2000ms-8-12-12.cfg.

0909 Changed bottom tracking to P5 instead of BNC Output on final restart so first few minutes, ADCP was being triggered on P1.

Saturday August 18, 2012

0252 We had to end science because of a blown generator and are presently returning to Newport OR. The HTI computer just had the blue screen of death. Rebooting. First try didn't get samples data so rebooted and then again…finally worked on sixth try. File D2310309.

1444: PHW Came into main lab at 0630 and found HTI with blue screen of death. Rebooted computer, turned off little red and big red and then worked to get the system running again. Turned on little red, then big red, then little red off and on again. Tried to start the DES, but could not connect. Went to Lantastic and reset the connections "s", "t", and "i", then tried to connect again. Was successful. Checked to see if samples were being written and they were. Last processed file written was D2311400, last samples file written was R23111443, time on last files 1401. Restarted files are D2311443 and R2311443.

0129 HTI computer was off, power adapter not working.

0137 Restarted on second try. File D2320137. config file RunChip-NewHorizon-MoonPool-500m-2000ms-8-12-12.cfg.

Sunday August 26, 2012

2342 Back at sea after 5 days of being in port for repairs to the generator. Just cleared the Newport harbor, and started up the HTI. File D23912340. Config is RunChip-NewHorizon-MoonPool-500m-2000ms-8-12-12.cfg.
0443 Blue screen of death. Did the reboot sequence. NH1208/D2400449 at 0448. Failed to acquire data. Re-rebooting the small box. NH1208/D2400451 and many others failed. More than an hour, nothing alive. At the end NH1208/D2400556 worked.

21:39 Note Edgetech data collection computer instrument is not on GMT time. But has Jan 2007 and about 4 hours fast, 343Z 31 Jan 2007. Gareth resetting time on the CPU. Was this off the last leg?

Tuesday August 28, 2012

1955 Stopped collecting HTI data so that we can back up the past many days' worth of data. ADCP is therefore off too.

2135 Finished backup. Taylor started HTI and thus ADCP as well. No problems at startup.

8/30/12 0706
Blue screen of death on HTI. Shut down computer etc. Restarted system. Peter re-mapped S & T drives before turning littler red on/off. (reset lantastic)

0715 HTI up and running again. Raw data being collected under the Samples. Only had to restart little red once. Did close software once using end task (by accident).

Thursday August 30, 2012 – YD 243

2210 Blue screen of death on the HTI computer. Rebooting.

2223 Took 3 reboots but finally started collecting samples data. File D2432224. Config is RunChip-NewHorizon-MoonPool-500m-2000ms-8-12-12.cfg.

Saturday Sept 1, 2012 – YD245

05:55 Hammerhead in and JSTAR started
Making about 2 ½ knots now but going to about 3-4 knot. HTI stopped. Doppler speed log stopped.

06:04 start recoding 15M depth 1Hz
06:08 from 1 mag to 50 meg files about file 126. Had set the max file size to 1 meg during deck tests.

06:11 start down to about 200M file 127
06:18 at 190 M file 132 was 165

0621 stop at 200m file 134
0628 starting up file 137

0638 stop recording at file 143 to come in. Got a few overflows, especially towards the end of the cast.
0639 HTI starting up again. File D2450640.

Monday Sept 3 2012, YD 247

0014 HH in water for cast #3 at station #7.

0017 Start new file NH1208_Station07_Cast04_*.

0019 Shut down HTI and ADCP. So far have constant OF=97 and OF=0. Layer at 10m range with fish at ca. 15-20m. Seems like mixed scattering, wide band of high scattering at low frequencies, narrow layer of high scattering at high frequencies.

0027 Starting down on tow-yo towards 240m.

0037 Fish at 240m depth, just came into layer. Started new file #012. Scattering highest at low frequencies, some nice single targets. Will collect a few minutes of data and then turn off the raw.

0039 Fish is kiting up a little, will send it down a bit further. Now have 39 OF.

0047 No evidence of saturation so will turn off RAW.

0048 File #018 turned off RAW, increased ping rate to 2 Hz (from 1) and delays to 0, 133, 333 (from 0, 333, 666).

0054 Collected a good number of pings in this layer so sending it deeper. File 020.

0100 Fish now at 323m depth above another layer, more diffuse targets up to 70m range. Started a new file #024. Still have RAW off, 2 Hz.

0102 Getting quite a lot of interference on the A1. Not sure why as the fish is far aft of us and all of the ship's acoustics are off…

0104 Decreased to 1 Hz (RAW off still) to see if we get less interference…at first got a bunch of interference but then went away and now we seem pretty clean…

0107 Interference is intermittent but less at 1 Hz.

0111 Getting a bunch of interference again on A1

0112 New file (028) coming back up, will target surface layer.

0130 fish now at 15 m and holding steady. Came up at about 20 m / min.

0135 Turning RAW back on to look for saturation. File 035.

0138 Turning off RAW. File 036, back up at 2 Hz.

0147 Nice layer at 5-10m range, fish is at 14m (don't want to come shallower). Highest scattering at HH. HL is showing virtually nothing. A1 has a lot of noise, presumably the ship (I think this is the same as what I was calling interference when the fish was at depth – unlike the HTI where the ship's engine spikes occupy the whole ping, these are more intermittent with range within each ping). Some noise on the A2 too.

0210 The 5-10 m layer going deeper, to 10-13m after about 5 minutes, then gradually back up, split into two layers briefly. After 15 min, layer was back up to 5-10 m – internal wave.

0258 Stopped file to recover.

0319 Turned HTI back on. File D2470319. Config is RunChip-NewHorizon-MoonPool-500m-2000ms-8-12-12.cfg.

Monday Sept 4 2012, YD 248

09:40 UTC
John C. and I noted in the JSF data that the time is only coming in at 1 sample every 2 seconds for the GPRMC data. This was in the GPS data test I sent in to And one a few days ago but none of us noted this until I started wonder why the time was stepping by 2 seconds only no matter whether we were sampling the JSTAR at 1 or 2 Hz. Neither should see the seconds stepping in numbers at 2 each change.
This is a dump of a file from the HammarHead at Station07 Cast 04
File number, ping number, day of year, hour minute seconds
037 151 000 000000
037 152 247 014102
037 153 247 014102
037 154 247 014104
037 155 247 014104
037 156 247 014107
037 157 247 014107
037 158 247 014108
037 159 247 014108
037 160 247 014110
The sampling was going at 2 Hz for this. The data is in the file but times will need a further look at.
Tom

1535 HH in the water for cast # 5.

1537 HTI shut down. ADCP too.

1540 File 000. Fish at 25m, bringing it up to 15m to check out layers.

1543 Brought fish up to 10m. Layer on HTI quite thick, to 40m, highest at low frequency, not evident in HH so probably bubbles under ship.

1546 file 004 fish back at 30m to look at the layer at 40m. Very thin o nHTI, interesting structure on HH.

1548 Checked for saturation, looks good.

1549 Turned off RAW. File 007. Increased ping rate to 2 Hz.

1553 on the A1 channel we're getting a faint trace at 30m, and the fish is at 30m depth. Interesting because we had baffled the topside of the fish against this kind of backwards projection. Quite faint though. Maybe it's because the surface is flat and calm, so a better reflector.

1556 No OF. Looking good. Noise spikes now on A1, weren't there at deployment. Deployed at 2 kt, brought it up to 3 kt.

1558 Just realized Doppler speed log is still on. Bridge turned it off.

1607 This layer is very interesting in structure, toroidal shape, lots of nice highs at 20-25m range with more continuous layer above. Will keep fish here as this is plankton-like, HTI is showing very little deeper and what's there is faint until the DSL at 300m.

1629 Will get set up for recovery.

1631 Turned HTI (and ADCP) back on. File D2481631. Config is RunChip-NewHorizon-MoonPool-500m-2000ms-8-12-12.cfg. So far no sign of interference in HH data.

1632 Shut down HH for recovery.

Wednesday Sept 5 2012, YD 249

10:58 Z The .mat unpacked data collected at 2 Hz did not have GPS time/position data associated with each ping, so John changed the GPS data rate to the JSTAR (and all other instruments) from 2 seconds to ½ seconds. He only gets the data for re-transmit at 1 every 1 seconds so presumably every second update is a repeat. This should have the time in the JSTAR data closer to the right time. Tom

16:12 Z start JSTAR in deck mode to check change in GPS feed. Unplugged CTD for test.

16:30Z Tested with both 1 and 2 Hz sampling rates and saw times incrementing right in the header data. Tom

1805Z Looked at some spectra from the HTI data in the shallow high scattering layer we've been seeing to compare the magnitude of scattering to the Edgetech spectra Tom has been generating. At 120-200 the layer is ca. -70dB, which is very similar to the Edgetech, suggesting that the right calibrations are being applied in the matlab Edgetech processing code. The 420 kHz data were low though, similar to the 43 kHz, which seemed suspicious. I therefore tried collecting a short HTI file (D2491800) with the 420 transmit set to 21 dB, in case the transmit switches are stuck again. Config file was RunChip-NewHorizon-MoonPool-500m-420xmit21dB-2000ms-8-12-12.cfg. Then set back to the original config RunChip-NewHorizon-MoonPool-500m-2000ms-8-12-12.cfg.

1825Z Spectra with the 420 at 21dB looked similarish to 27dB but not very conclusive. Will collect a longer file to make a better test.

1831 Gareth stopped normal HTI collection and changed configuration to test power switches. Now using RunChip-NewHorizon-MoonPool-500m-420xmit21dB-2000ms-8-12-12.cfg. Will run for about 30 minutes. Last little test did not run for long enough to find any conclusive evidence. File is D2491832.

1935 Going back to original HTI config RunChip-NewHorizon-MoonPool-500m-2000ms-8-12-12.cfg. File D2491935.

September 6, 2012 – YD250

0120 Just realized that the HTI is still using the 21 dB transmit at 420kHz configuration. Restarting with RunChip-NewHorizon-MoonPool-500m-2000ms-8-12-12.cfg.

0156 HH in water for Station 15, Cast 06.

0158 File NH1208_Station15_Cast06_000 just started. Speed log was on, just shut down.

0201 HTI/ADCP shut down.

0209 No saturation so shutting off RAW and increasing to 2 Hz. Forgot to stop recording so did this during file 033. File #034 is no raw. Very nice layer at ca. 10-15m range, then a more episodic layer at 25-30m with some dense patches. Between those two plankton-like layers there is a middle layer of more fishy single targets, highest at A1.

0223 Noise coming in on A1.

0224 Ended data collection, file #064 (or so).

Thursday ,September 6

10:52 Hammerhead in H2O, HTI off at 2501000
10:56 start
11:07 start record 2 Hz on #006
11:22 come up 3 meters file #012
11:31 stop recording at #017
11:31 start HTI at 2501133

Friday, Sept 7

13:48 HTI off 2511300
Started JSTAR
1350 JSTAR net on
1352 star recording 1 Hz #000
Speed log on but asked bridge to turn it off
1356 noted speed log off, asked to maintain 2 knots speed.
1359 stop to go to 2 Hz at file #004
1400 no raw recording, file #005
1415 stop recording at #012
Start HTI #2511417

2229 Start next HH Station 16 Cast 09.

2232 start recording NH1208_Station16_Cast09_000

2235 Stop HTI/ADCP. Fish at 20m. Very weak layer at 20m range. Stronger on HTI, very weak on ET. Quite a lot of ship's noise on A1 and A2.

2241 Stopped file (004). No saturation. Turning off raw and increasing to 2 Hz.

2242 New file 005.

2253 Paying out to get to next layer (fainter). Fish at 54m, layer below, strongest on MID.

2259 Collected at least 100 pings inthis layer, bringing it shallow for recovery.

2302 New HTI file, D2512302. ADCP back on too.

2303 Stopped hauling in at 29m because nice scattering.

2304 Hauling in again for recovery.

2305 Stopped data file, shutting down.

0150 blue screen of death. Faulted at raw file – R2520138

02112 after 6 restarts of little red hti started again at raw file – R2520213

Saturday, September 8 2012, YD 252

2110 At day-night station 21, doing a HammarHead cast (#10). Note that prior to a few tows ago the cable had been pinched next to the A-frame during a MOC cast resulting in a slight kink at ca. 15-20mwo. This does not appear to have affected the bandwidth. Not much showing on HTI. Doppler speed log is off.

2113 Shut down HTI/ADCP.

2118 Not much on the go at the surface (30m fish depth) so paying out to head for deeper layers. Ship speed requested at 4-6 kt so that we can get south of station, ready to tow north with the MOC. Water column empty!

2137 Got to 250m and down to last wrap up drum so stopped winch and slowing down ship to 3 kt to get the fish to sink. Some weak targets on A1, not much else. Not much noise on A1 for once.

2143 No saturation so turning off RAW and increasing ping rate. File 017 last one with RAW.

2144 File 018, RAW off 2 Hz.

2146 Fish at 319m depth, lots of nice targets as near DSL. Good scattering on 4 lowest channels.

2154 Depth leveling out near 365m. Just above nice dense part of DSL. Very pretty on A1 and A2 especially. Very few specks on HL, more on HH.

ca. 2210 Coming up on speed (to 5kt) to get ourselves into position for later MOC. Hauling in on winch too.

2219 Just noticed we have 146 OF – not sure from when.

2235 Fish at 54m depth, some interesting scattering on LOW and MID 10-35m range, less strong on HH. Will park here for a bit. File 042.

2240 hauling in on winch again, file 043.

2243 Got to 12m but nothing shallow so going deep for a few minutes more.

2245 Fish at 52m depth, will hold here. File 046.

2252 File 049, starting to haul in. Will bring to 20m then stop for recovery.

2255 Fish at 20m, file 050. Shutting down.

2320 Just rememberted to turn HTI back on. File D2522321. RunChip-NewHorizon-MoonPool-500m-2000ms-8-12-12.cfg.

0055 3,000m ctd cast. At some point around 1,200m there was a discrepancy in depth so the ship had to turn the boat's echo sounder on.

0156 ship echo sounder turned off.

Sunday, September 9

09:10 Hammerhead in
09:10 HTI off 2530900
09:13 JSTAR pinging at 53 meters deep #000
09:16 going to 90 #001
09:20 stop; and go to 2 Hz
09:22 on 2 Hz at 93m #005
09:30 going up to 70 #008
09:31 at 70 #009
09:38 going up to 10 #012
09:40 stop at 10 #013
09:42 SOG 2.4 Kt
09:49 stop recording and shutdown
09:50 HTI 2530951 started again

Monday, September 10, Day 254

09:56Z Hammerhead on, HTI off 2540900
09:59Z #001 at 71 m
10:06Z going to 2 Hz
10:07Z at 2Hz #004 2 Kt
10:12Z up to 50 #006
10:13Z at 49m #006
10:18z going to 10m #009
10:19Z at 9m #010
10:23Z HTI was locked with 2 programs running Peter killed them
10:24Z stop at #012(?)
10:25Z Jstar off

10:54 HTI started again at 2541055

Tuesday, September 11, day 255

10:55 Hammerhead in Station 27 Cast 13
10:56 HTI off 2551000

10:58 JSTAR recording #000
10:59 at 60m going up to 50 #000
11:01 at 49 #001
11:01 stop record at #001 for 1 to 2 Hz
11:03 at 2 Hz #003 49 m
11:06 no GPS restarting it all
11:11 restarted JSTAR have GPS now
11:14 running at 2Hz #005
11:23 coming up to 10m #008
11:24 at 9m #09
11:31 stop JSTAR #011???
11:32 start HTI 2551133

13:11 Looking at the JSTAR data, it looks like the A1 and Low channels were not recorded. They will not translate. Tom

Wednesday, September 12, 2012

13:42 boot JSTAR
13:43 HTI off at 2561300
Station 30 Cast 14
13:46 had to restart all since no GPS
13:48 start recording at #000 14meters
13:52 speed log off
13:54 stop recording and going to 2Hz #002
13:55 at 2Hz #003
14:04 going to 60m #006
14:05 at 62m #007
14:12 going to 100m #010
14:13 at 100m #011
14:17 HTI on at 2561418
14:21 at 93 meters #015 Winch creep? Ship going faster? Flying differently?
14:22 HTI off 2561418
14:30 coming up to 15m #019
14:32 at 13m #020
15:05 changing heading of the ship #035
15:08 on course for recovery
15:08 stop recording at #037
15:09 HTI on 2561511
19:00 Blue screen of death
19:05 HTI computer restarted
19:11 started recording on 2561913

2223 Just noticed that the HTI config file was the RunChip-NewHorizon-MoonPool-500m-420xmit21dB-2000ms-8-12-12.cfg. Not sure when this happened. Set it back to the 27dB config and restarted. File D2562224. RunChip-NewHorizon-MoonPool-500m-2000ms-9-5-12.cfg.

Thursday September 13
08:44Z Looking at the HammarHead data from Cast 14 I can not translate the HL and HH channels. Replaying the cast shows these channels don't have data to replay. I note that for HL and HH that the

Pulse file is H_00000_31002_500us_00.spf and the how to notes show it should be H_30002_31003_500us_00.spf Is this perhaps the problem? The 1Hz/Raw data can be played back. I have reset the pulse file for HL and HH for Cast 15.
Tom

1231 HammarHead in
1233 HTI off 2571200
1233 start JSTAR
Station 32 Cast 15
1235 at 35 recording
1236 at 30 #000
1239 Chan 18 & 21 raw show blank out
1243 Noted HTI working still, off at 2571200, now off, #005
1251 staying on 1Hz since HL and HH seem pretty boring
1251 going up to 15m #009
1252 stop at 14m #010
1302 stop recording to change files to 2 meg from 50 for files to send ashore #17
1304 stop recording to go back to 50 meg files #28
1305 Langamuir cell features to bottom of mixed layer? #29 35 meter mixed layer depth based on last CTD
1309 HTI on 2571311
1312 HTI off 2571311
1315 HTI was still going, now stopped!
1317 stop recording
1317 JSTAR off
1318 HTI on 2571320

2105 HammarHead in at station 32, cast 16. Deployed heading into wind (to north, same heading as during the previous CTD operation).

2106 Started recording, file NH1208_Station32_cast16_001.

2107 Shut HTI/ADCP off.

2108 Fish at 18m depth, now coming about to make progress towards station (will tow with swell towards ca. SW). Very little scattering showing.

2114 On course now to 210 (HH compass says 160!).

2118 76m depth. Very little on the go. One weak layer at 30m range. Will head deeper towards it.

2120 Sto1226 start loggin #0 18.8 mpped with fish at 94m, just above layer.

2125 Collected 100 pings in this layer (which looks from the HTI much like the thin strong layers we've been wondering might be due to salinity gradients). Now headed back up to 20m for recovery.

2128 Shut down for recovery.

2142 HH on deck, restarted HTI. D2572142. Config is RunChip-NewHorizon-MoonPool-500m-2000ms-9-5-12.cfg.

Friday, September 14

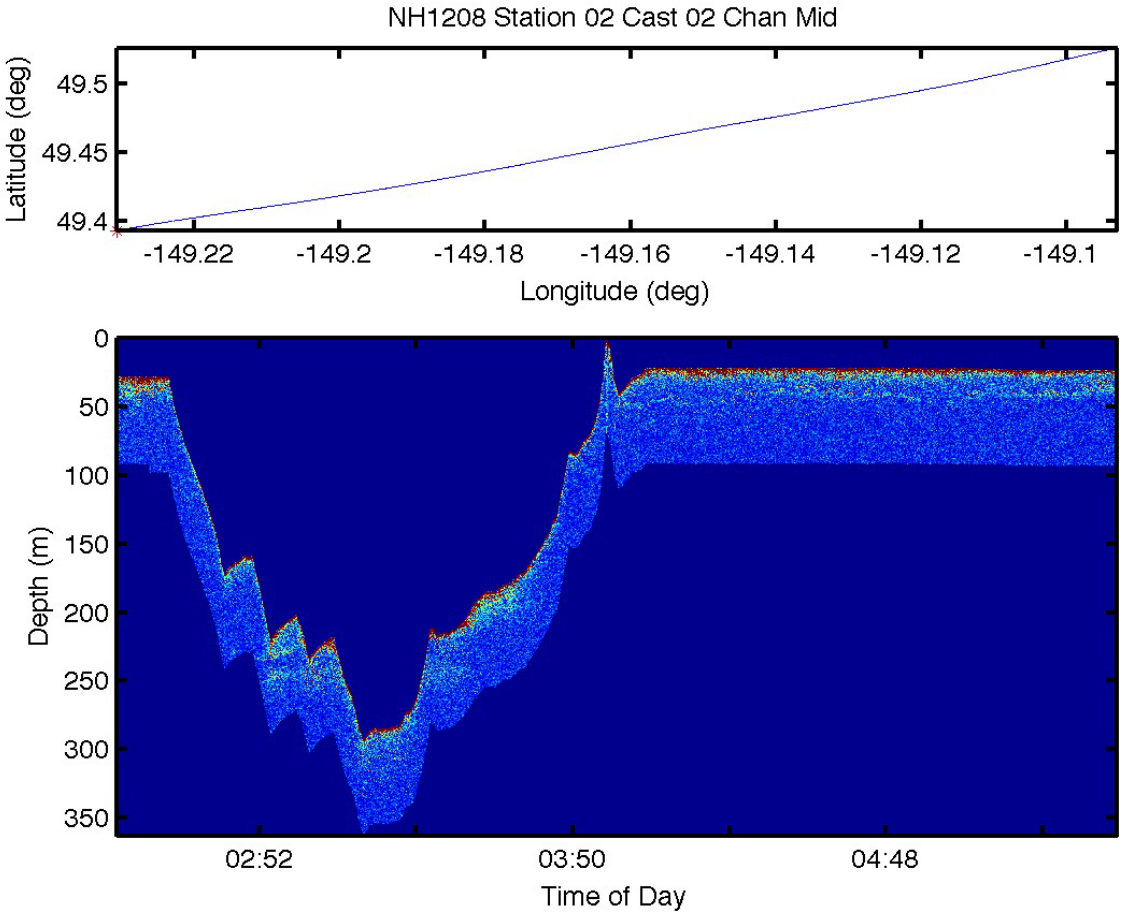
HammarHead Station 34 Cast 17
1223 HammarHead in water
1244 up to 18m #010 since were trying for 20 and over shot it.
1253 stop recording to go to 2Hz #015
1256 at 2Hz #017
1256 stop since had wrong Hz First trigger 1 Hz still
1257 Now at 2Hz at 18m #018
1306 start HTI 2581308 #022
1315 going down to 70m #026
1317 down to 76 #027
1317 coming up to 10 #027
1319 stop at 11m #028
1320 stop JSTAR

Saturday, September 15

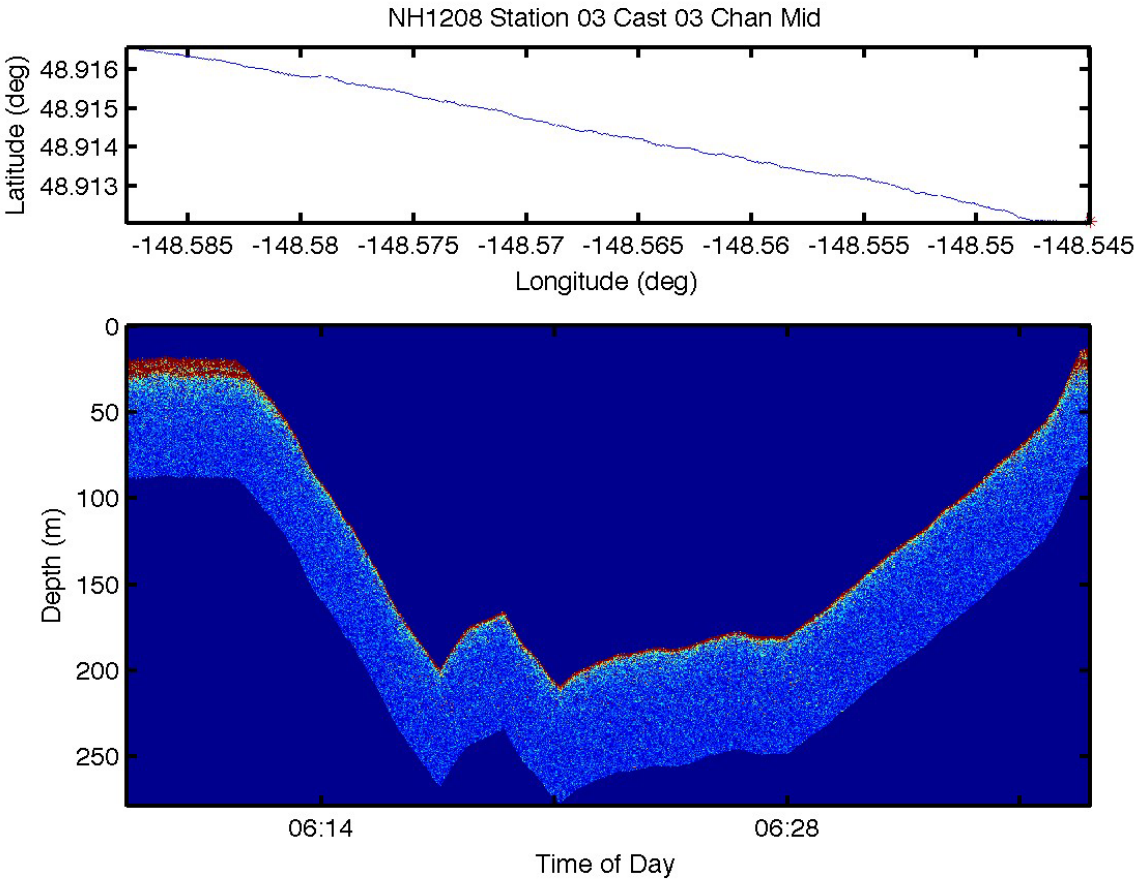
1740 restarted HTI computer because laptop was not recognizing backup hard drive when connected. Took 2 restarts

Appendix 6 - HammarHead Cast Echograms and Spectra

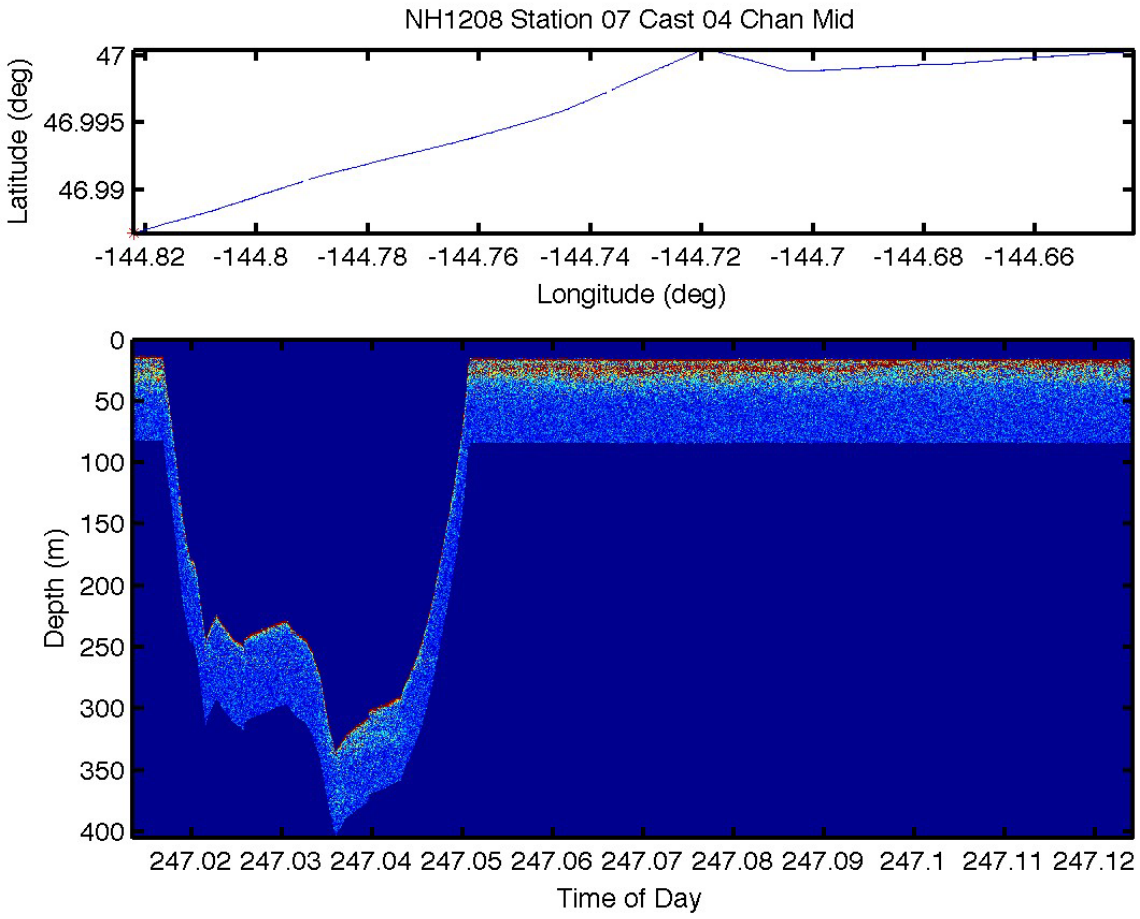
Station 02 Cast 02

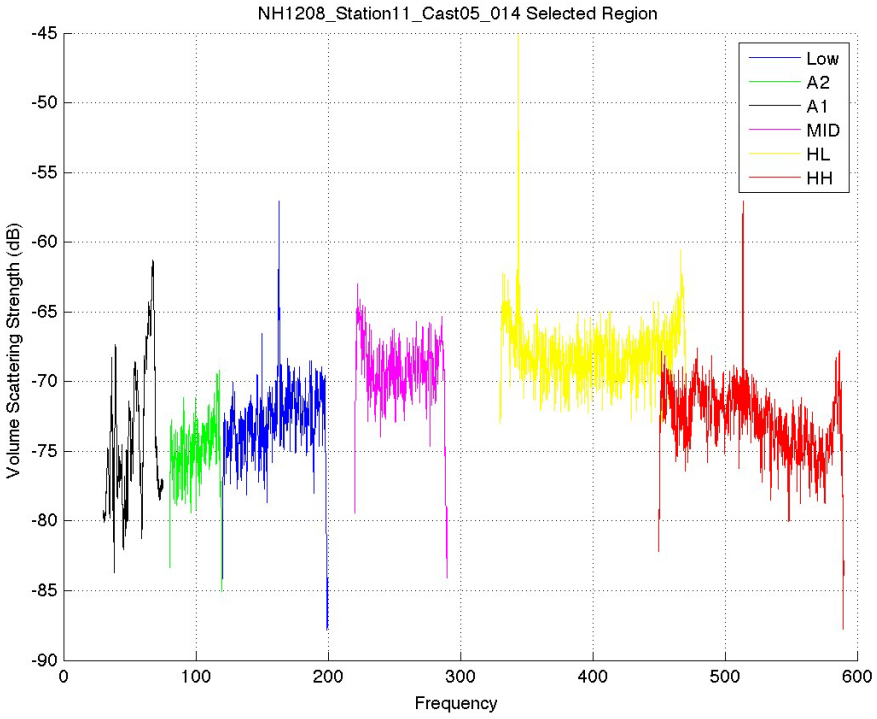


Station 03 Cast 03

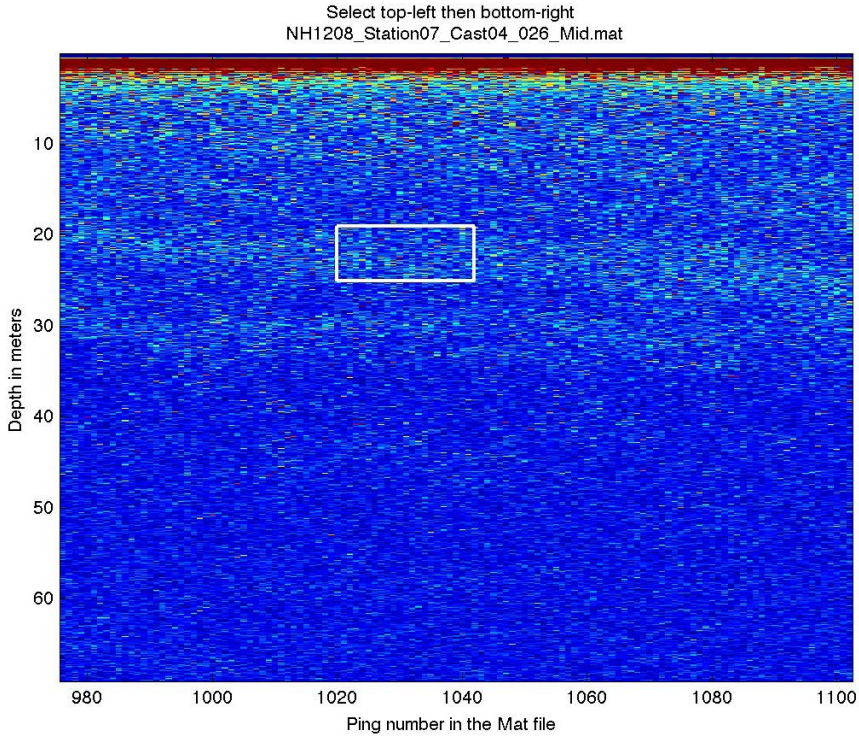


Station 07 Cast 04



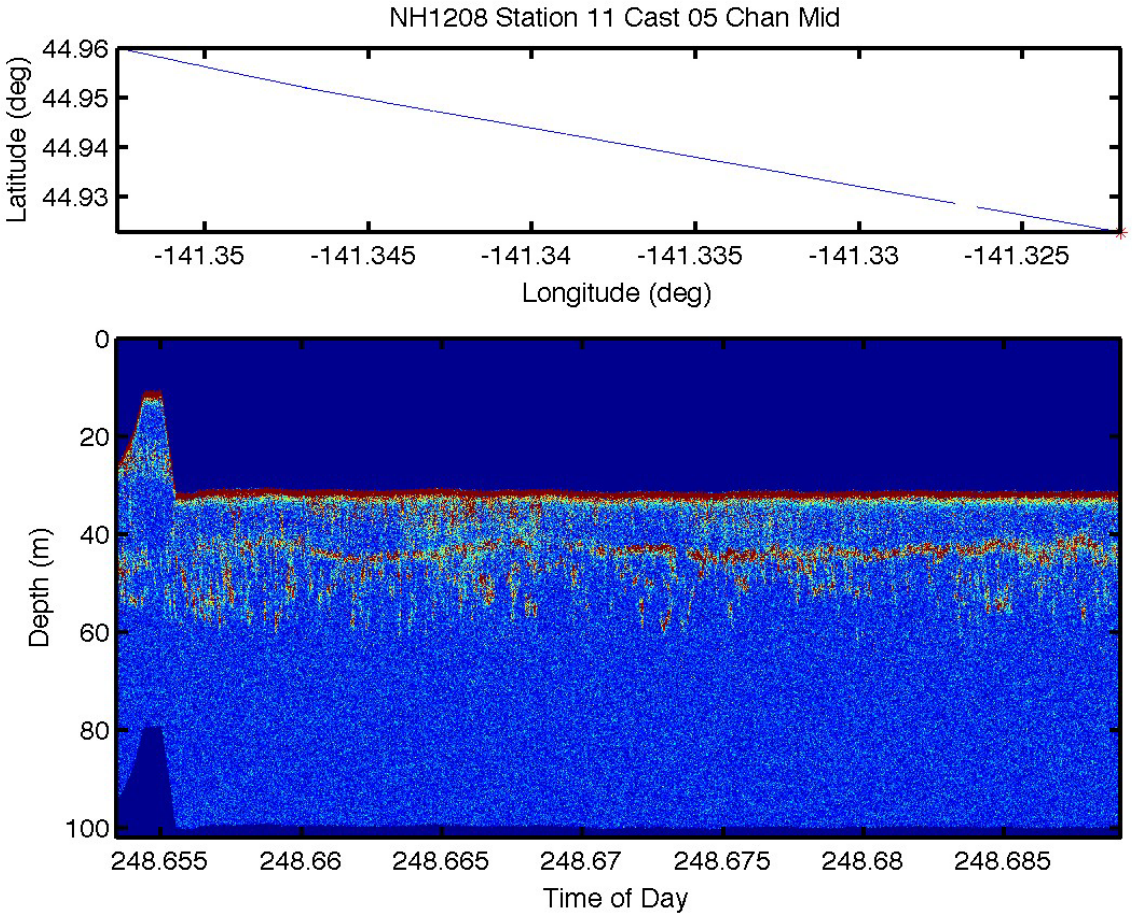


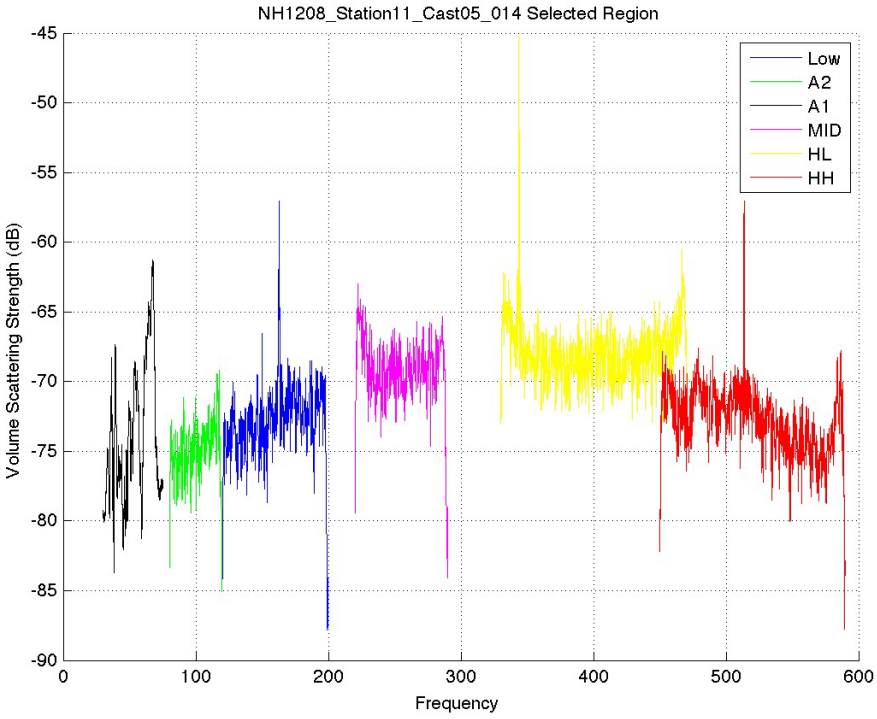
Spectra of all 6 channels



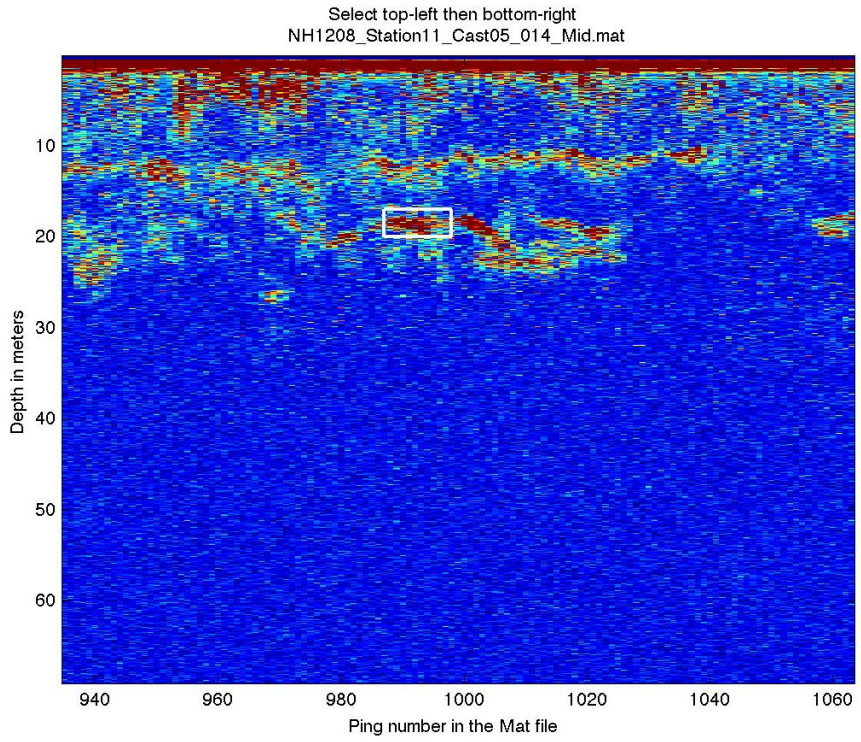
Location where spectra were calculated

Station 11 Cast 05



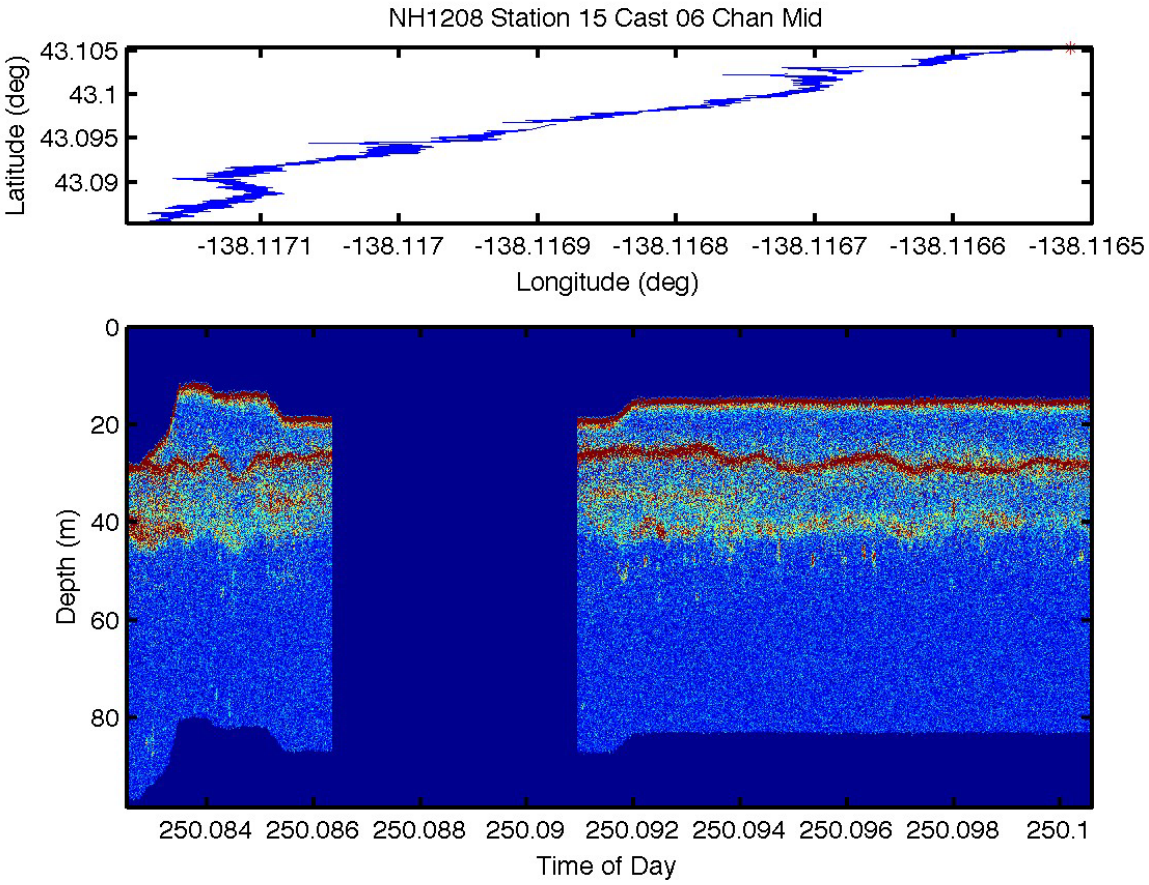


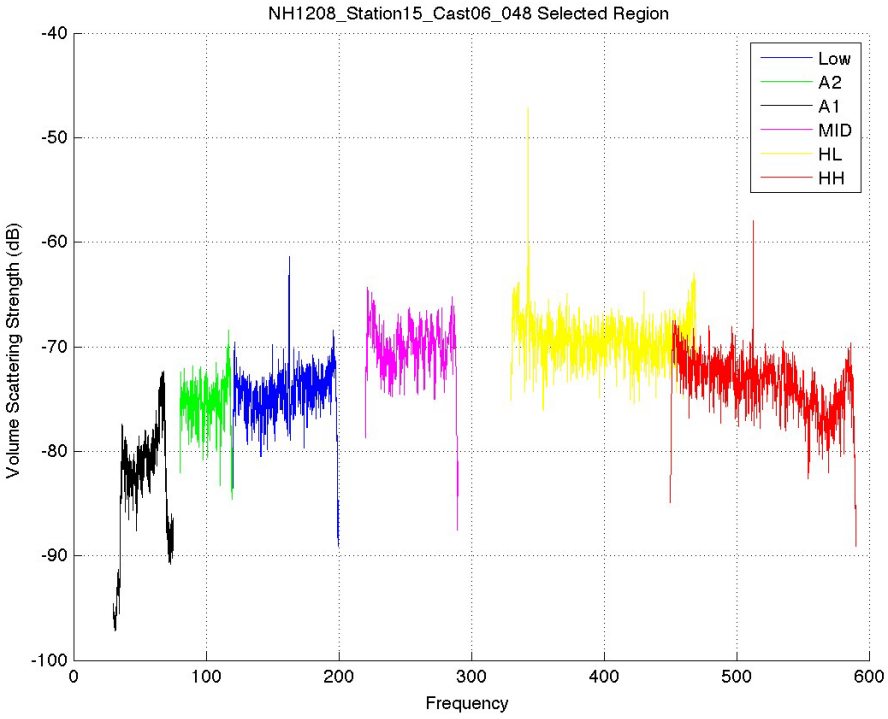
Spectra of all 6 channels



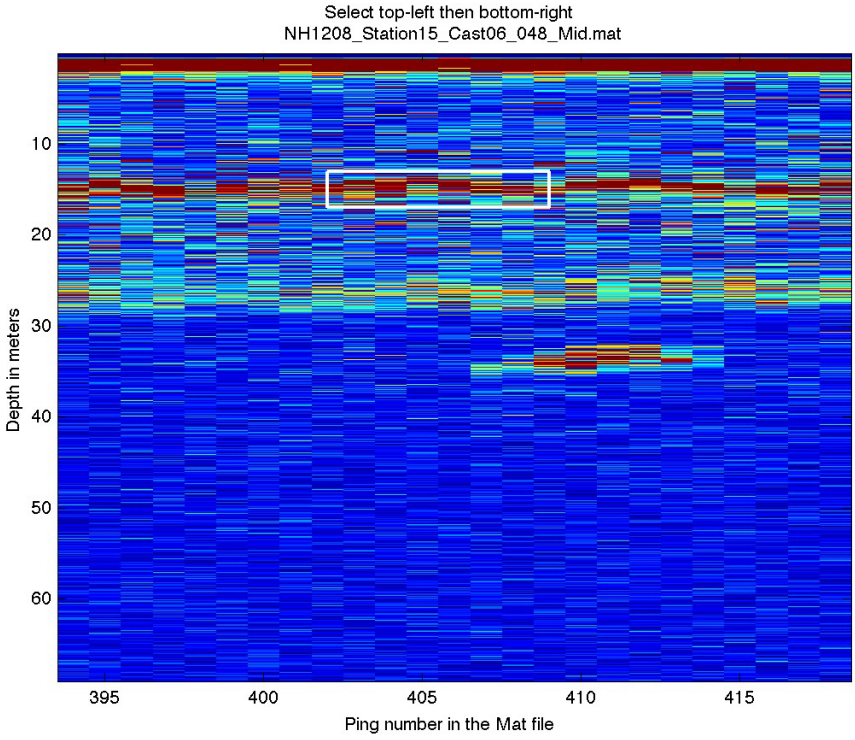
Location where spectra were calculated

Station 15 Cast 06



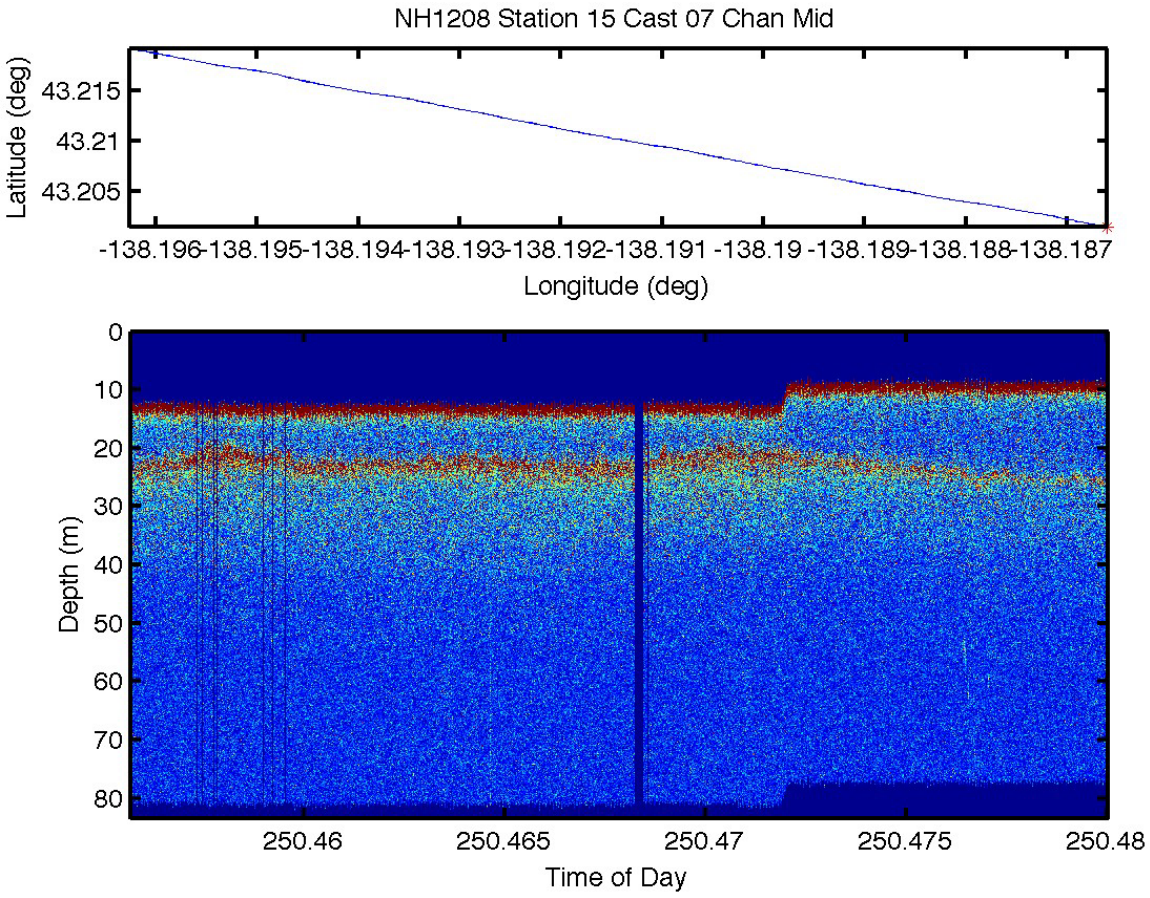


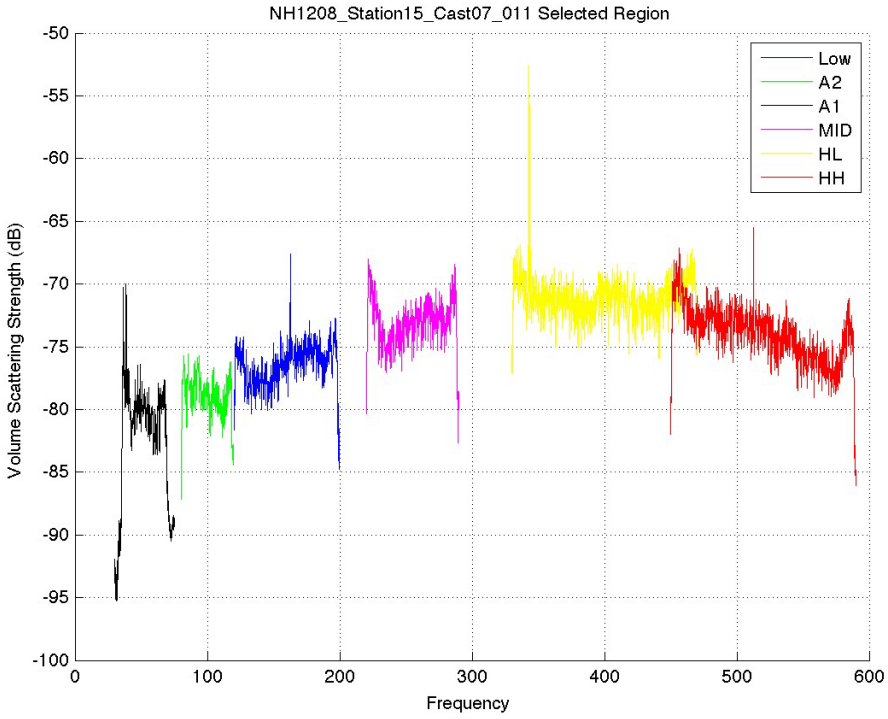
Spectra of all 6 channels



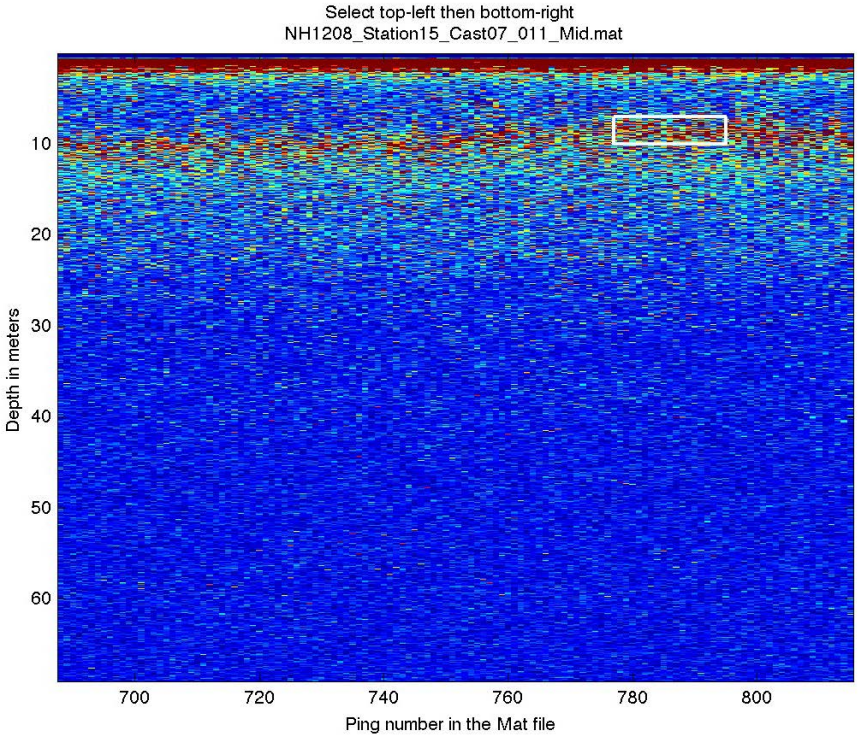
Location where spectra were calculated

Station 15 Cast 07



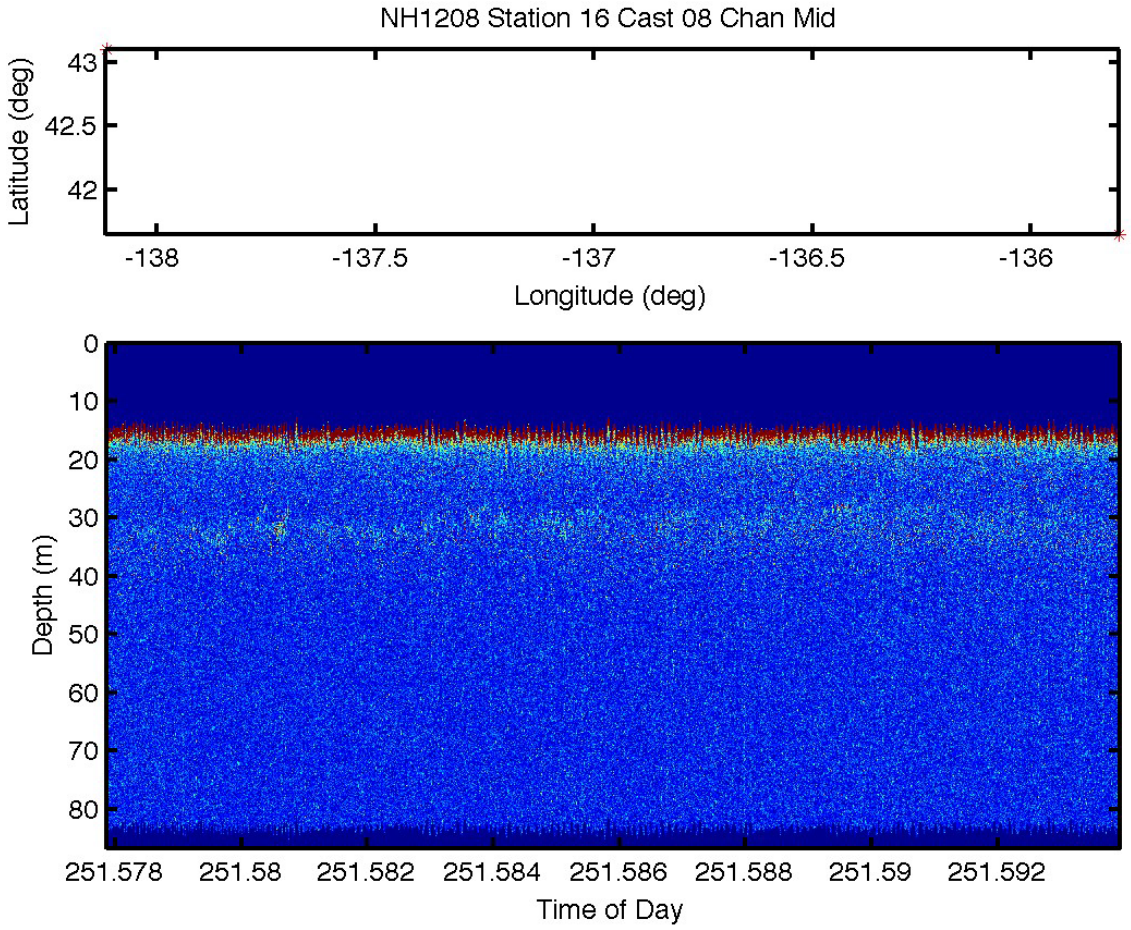


Spectra of all 6 channels

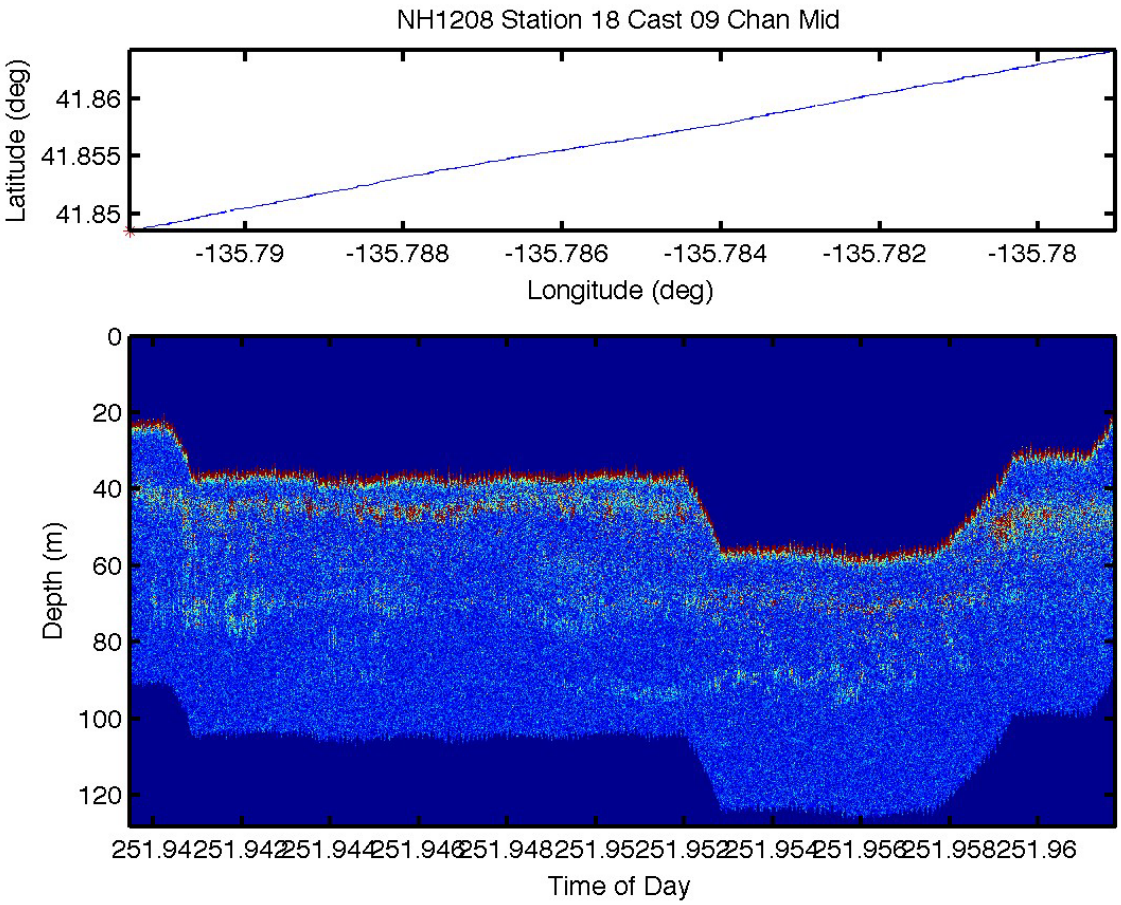


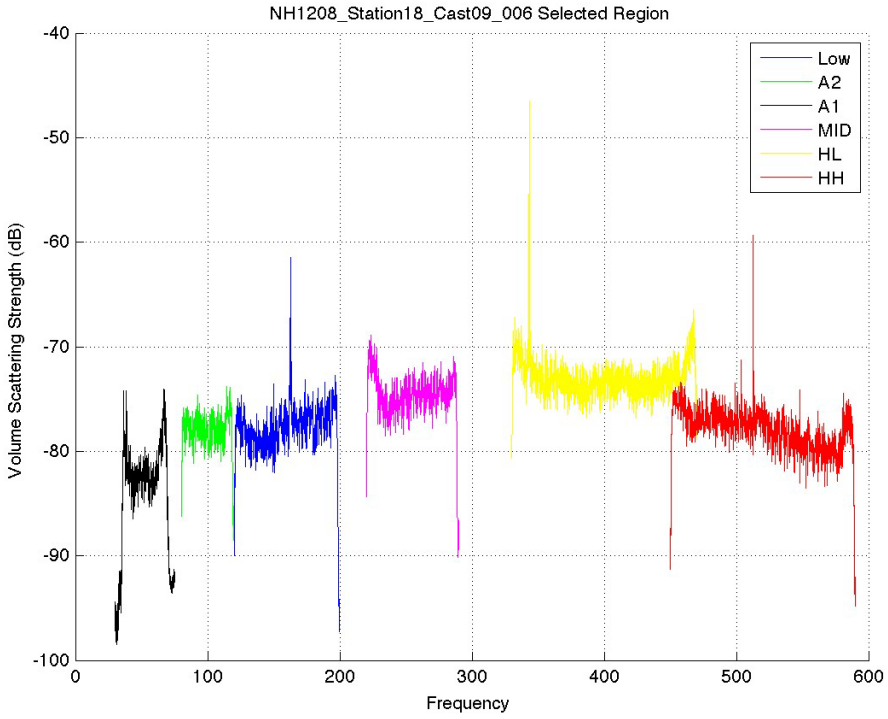
Location where spectra were calculated

Station 16 Cast 08

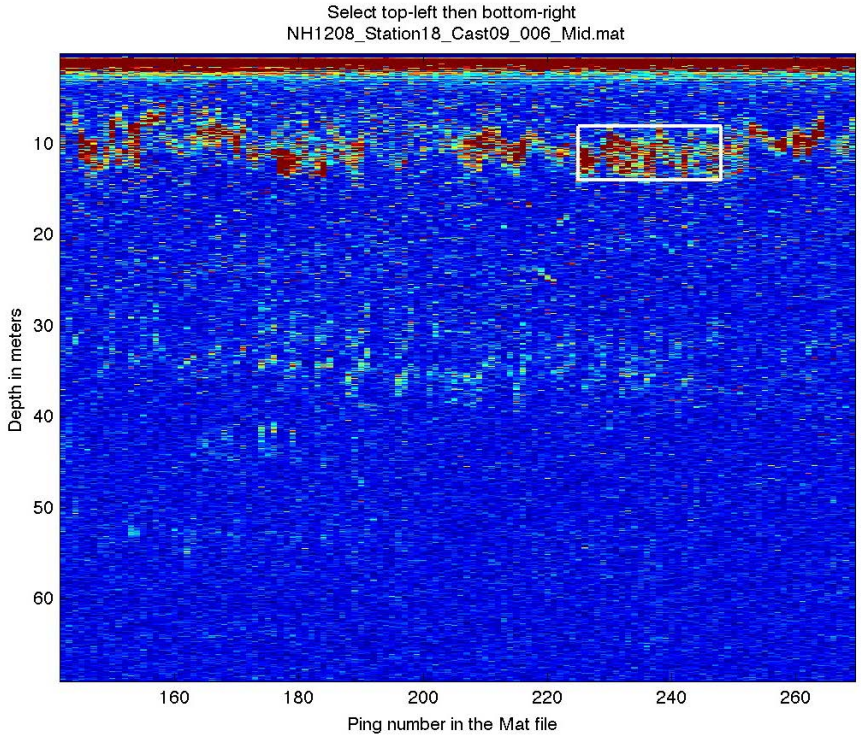


Station 18 Cast 09



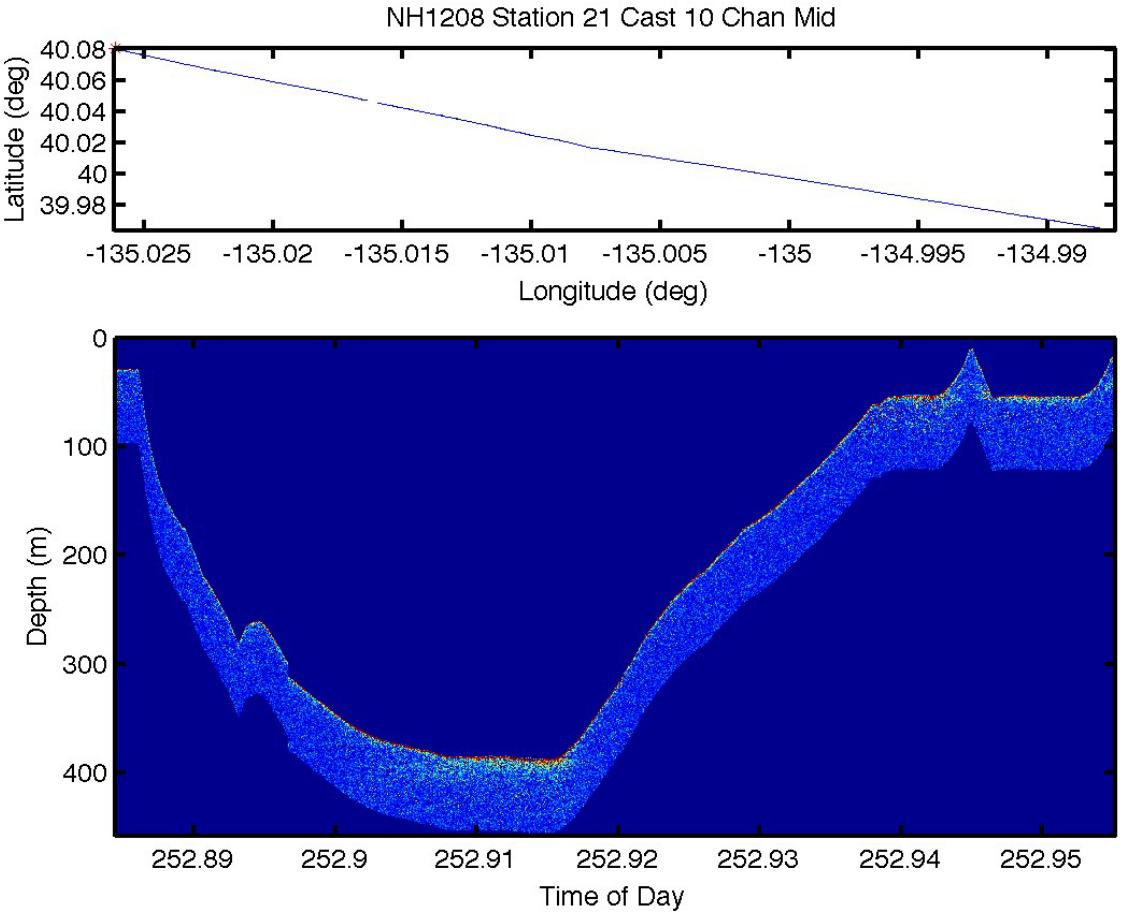


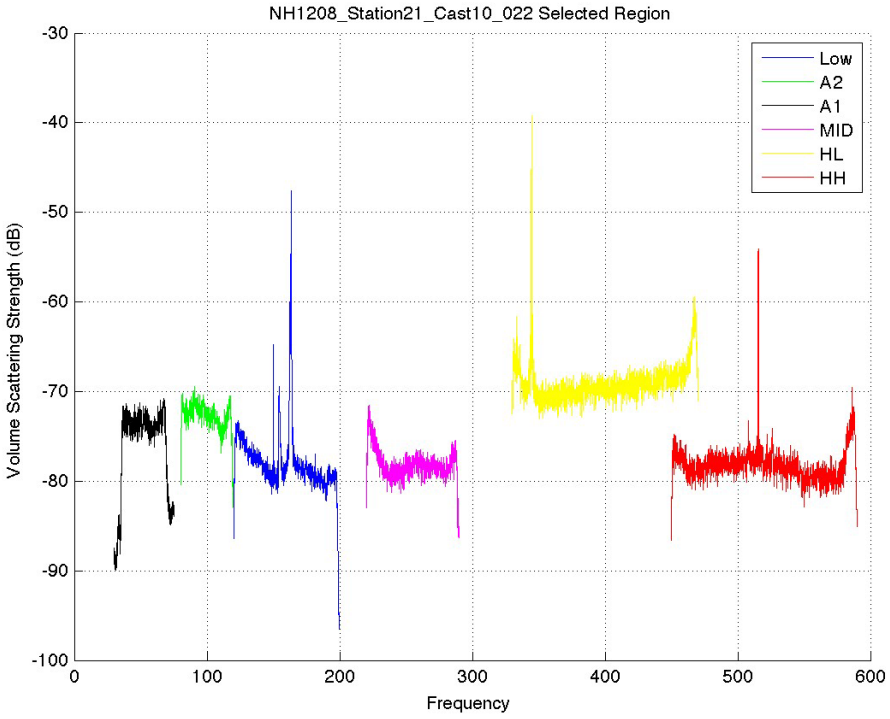
Spectra of all 6 channels



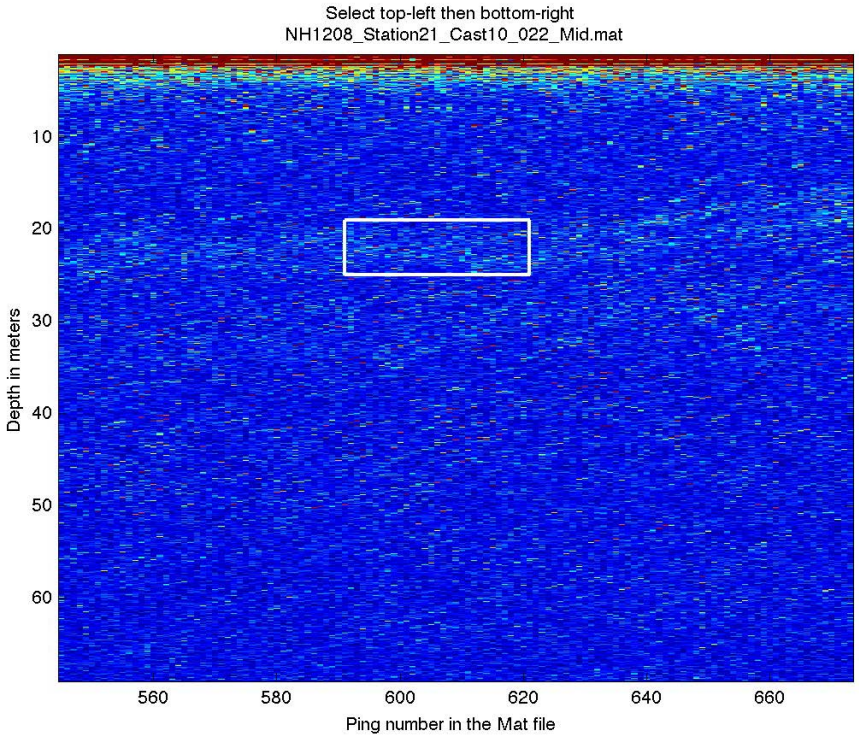
Location where spectra were calculated

Station 21 Cast 10



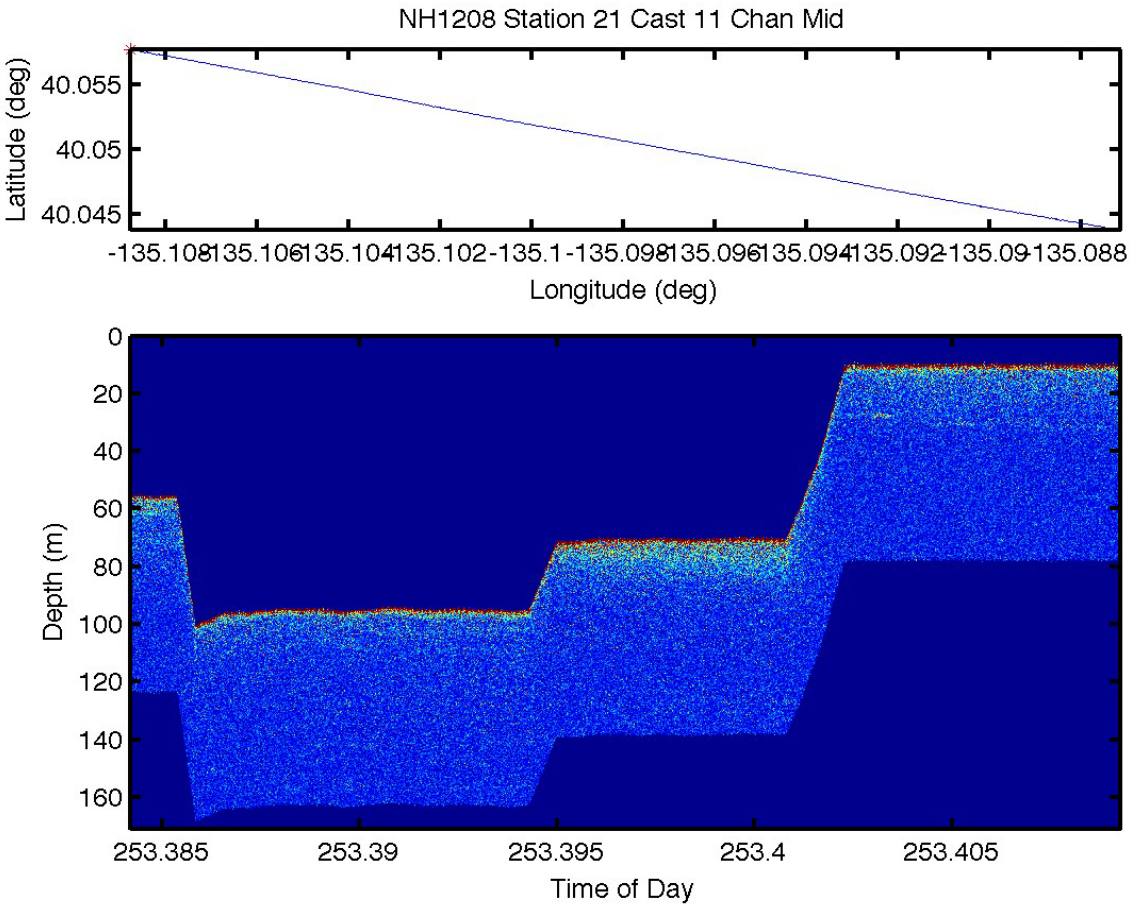


Spectra of all 6 channels

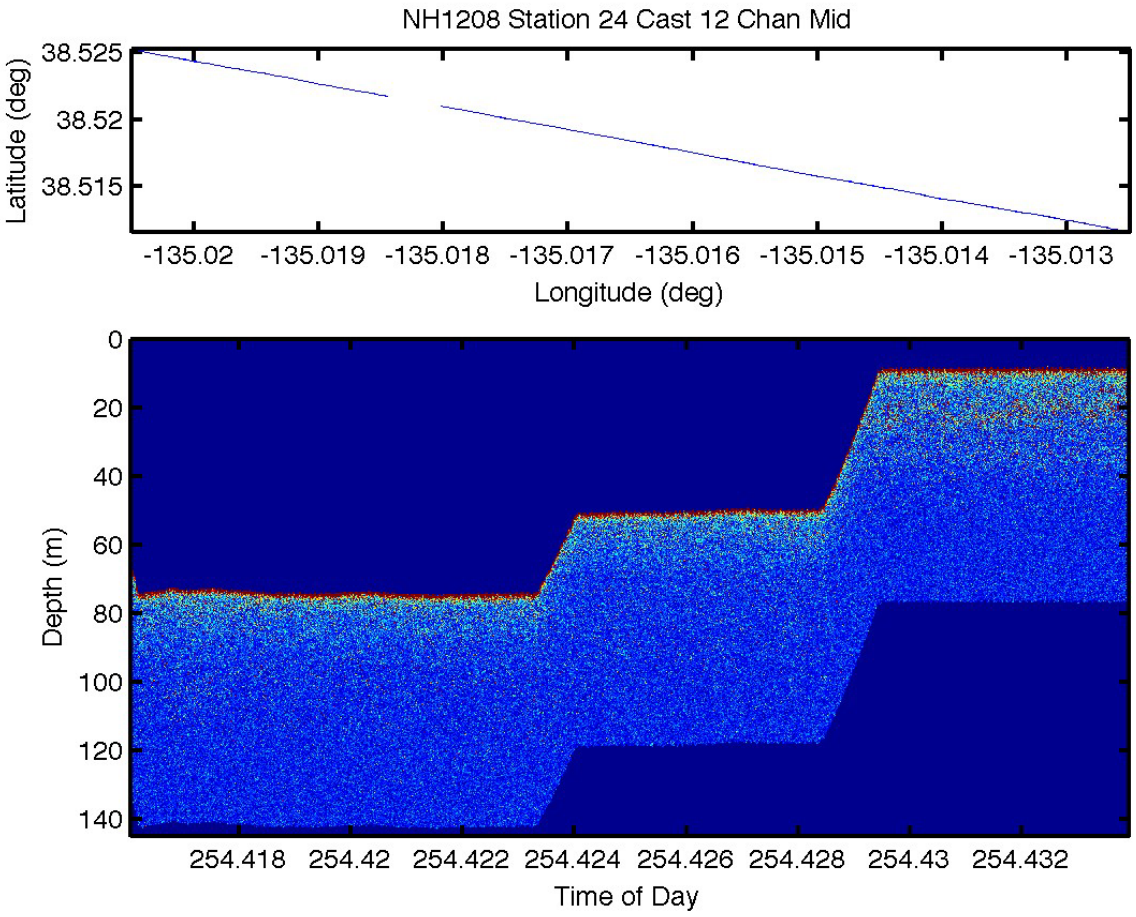


Location where spectra were calculated

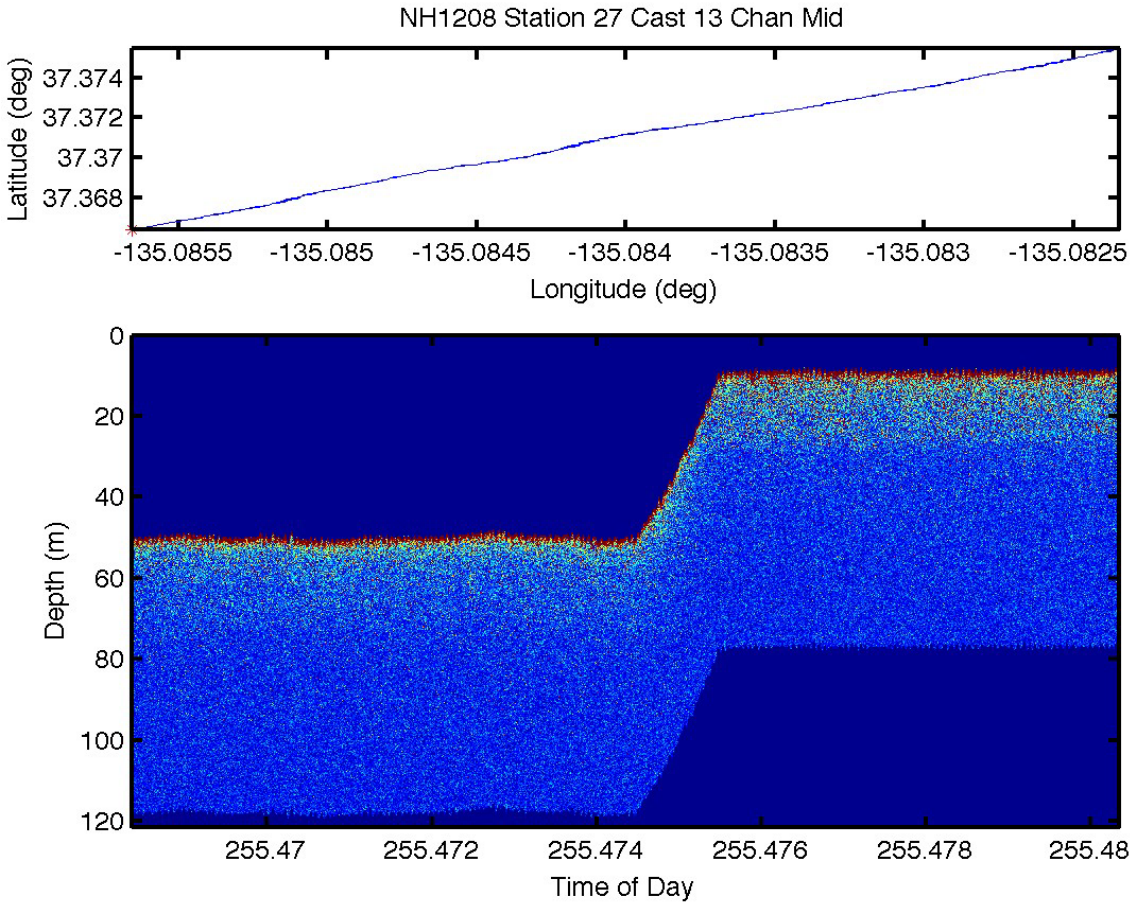
Station 21 Cast 11



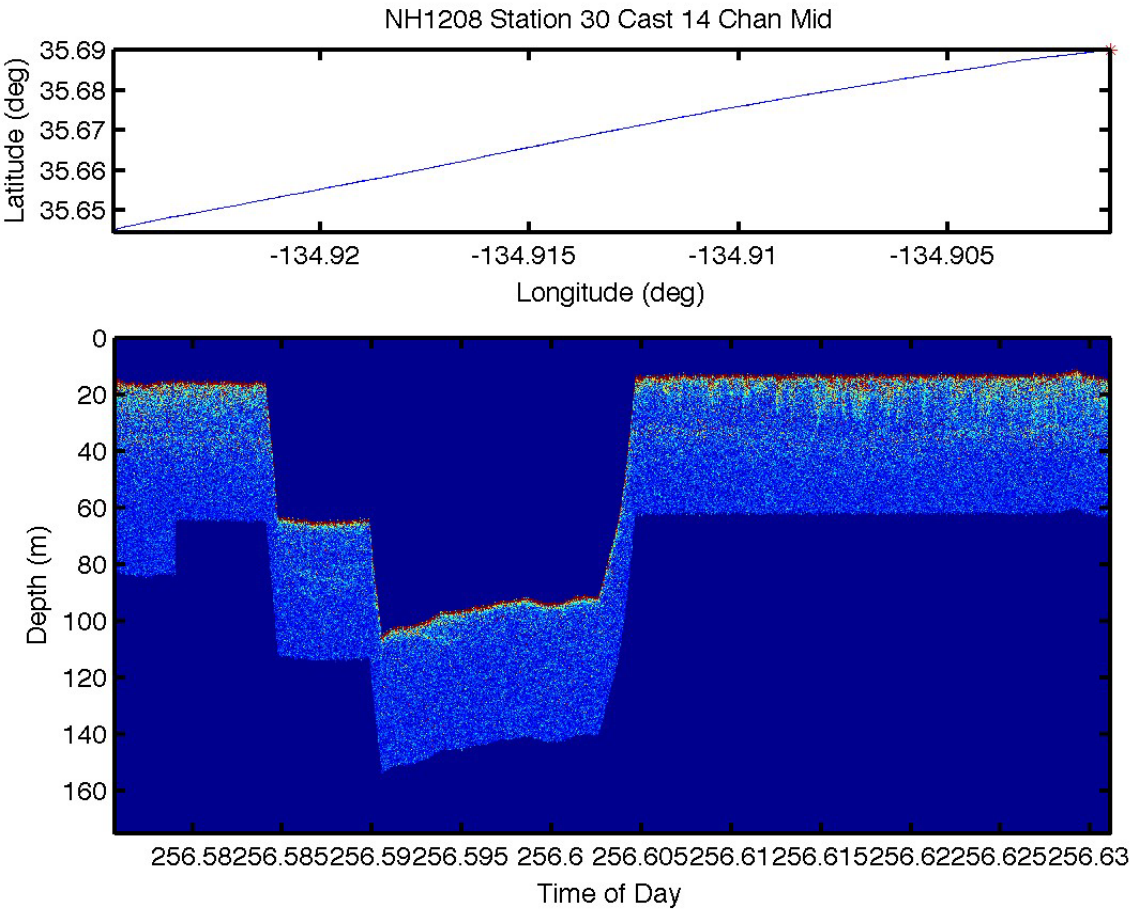
Station 24 Cast 12

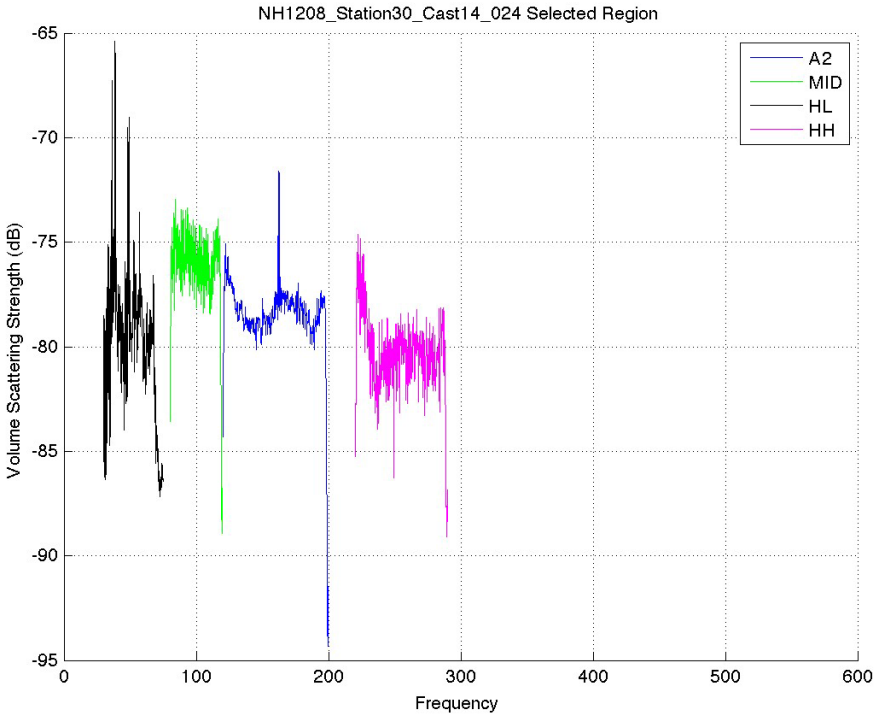


Station 27 Cast 13

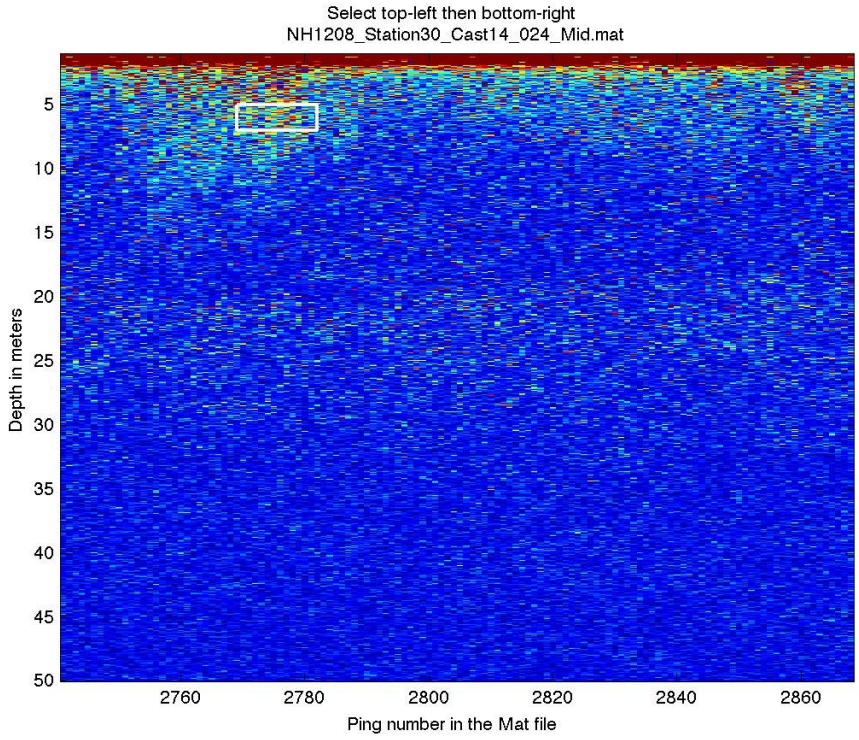


Station 30 Cast 14



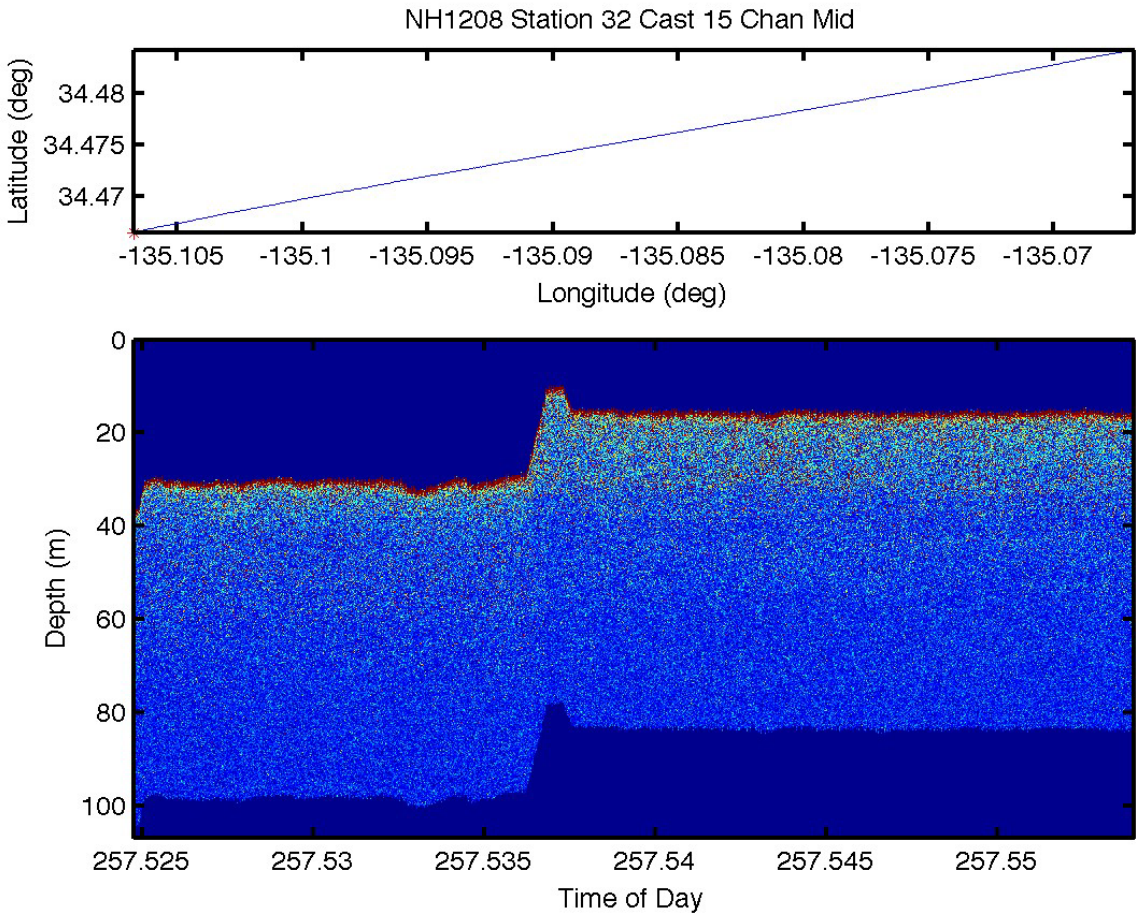


Spectra of 4 channels. HL and HH were not recorded.

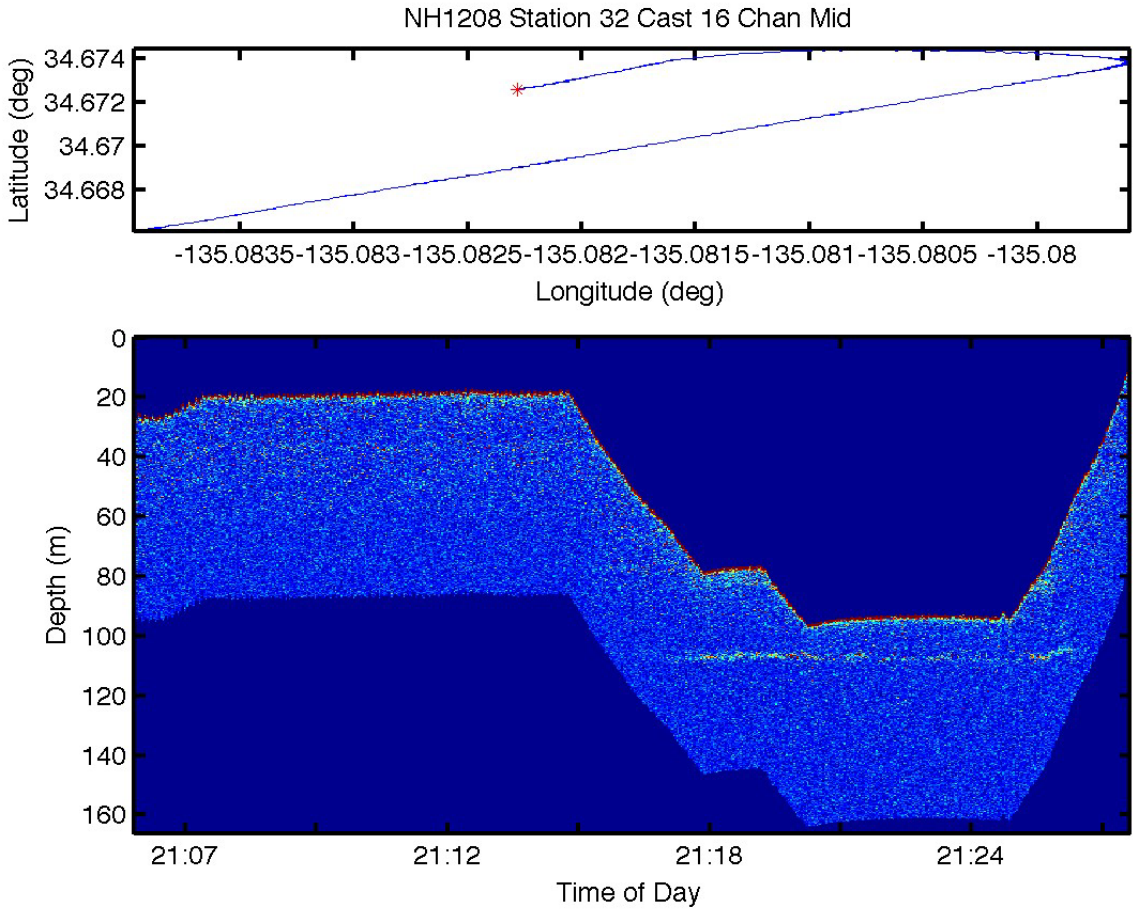


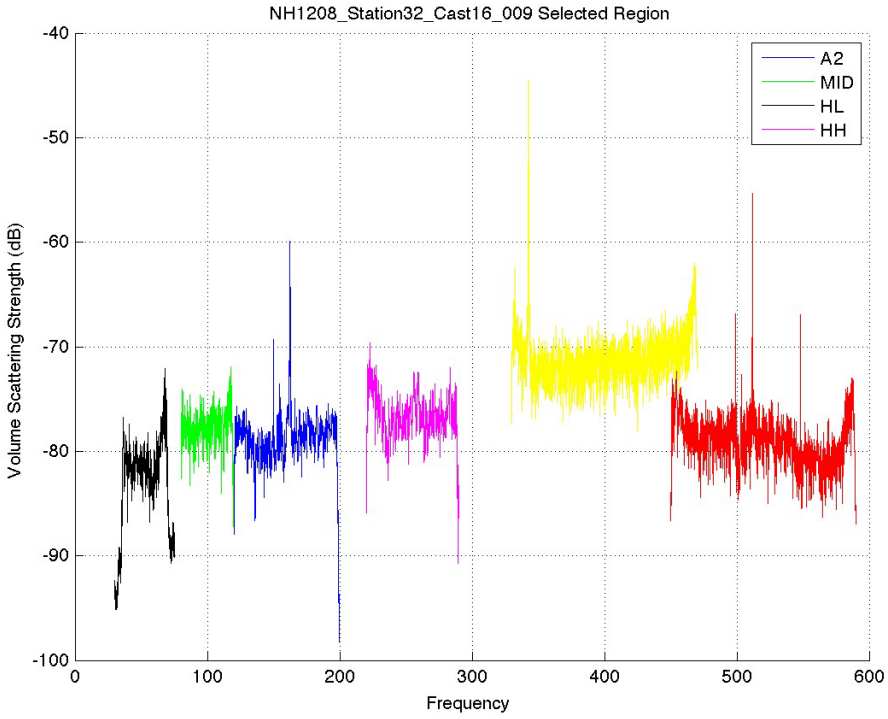
Location where spectra were calculated

Station 32 Cast 15

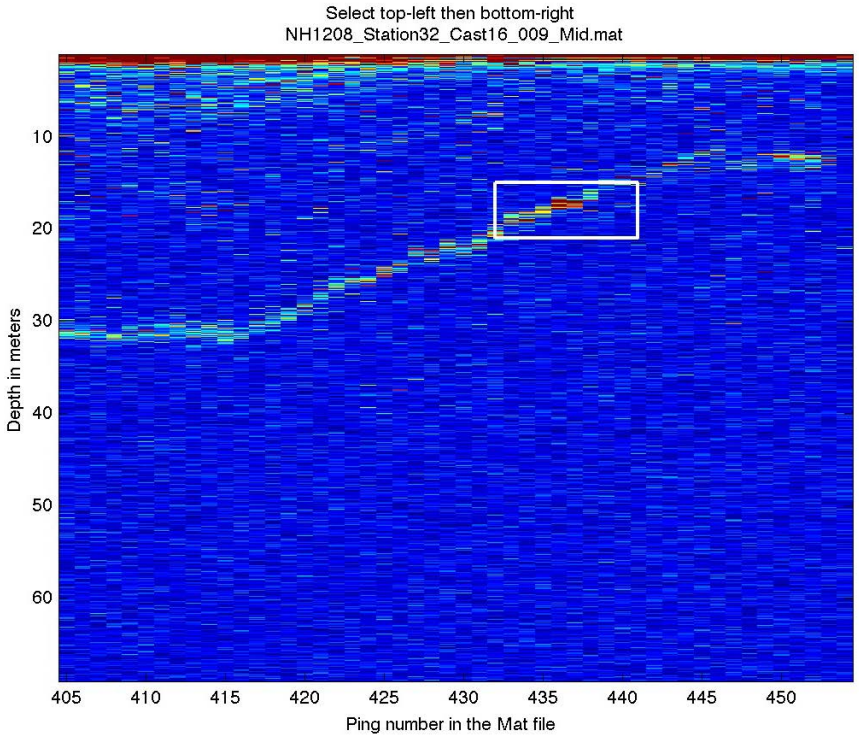


Station 32 Cast 16



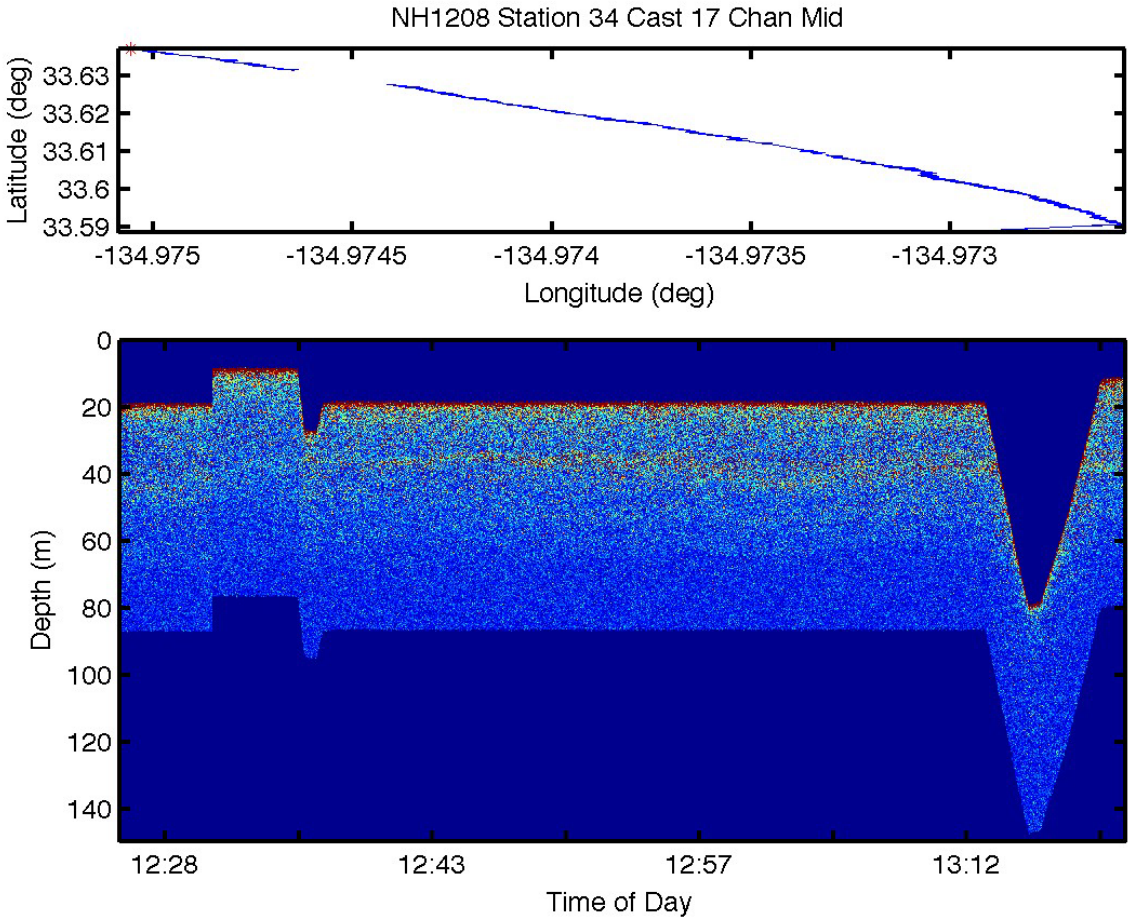


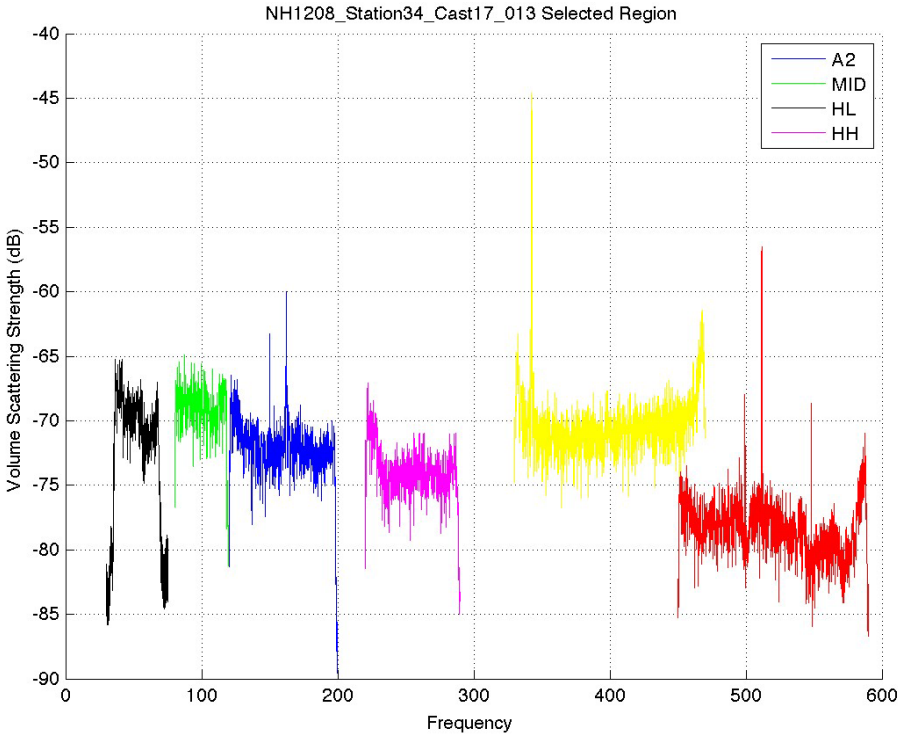
Spectra of all 6 channels



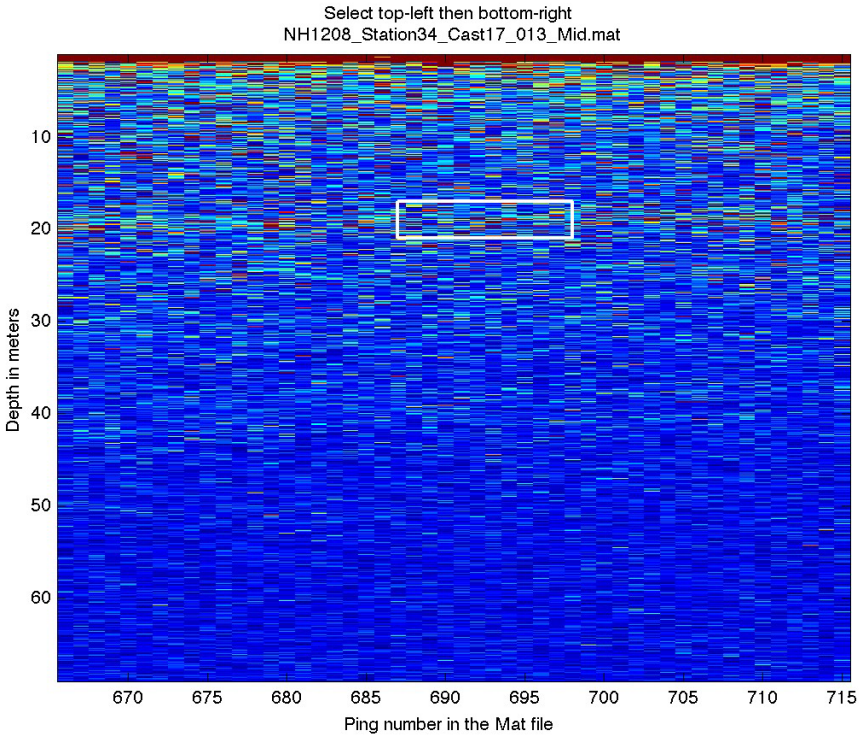
Location where spectra were calculated

Station 34 Cast 17





Spectra of all 6 channels



Location where spectra were calculated

Appendix 7 - Table of Successful Respiration Experiment Details

ID #	Species	Treatment	Temp (°C)	Capture	Volume (ml)	Water Batch	Time (hr)	O_2 consumed (µmol)
1	*Limacina helicina*	ANTI	10 C	Reeve 8/11	13	1	12.78333	35.52206
2	*Limacina helicina*	ANTI	10 C	Reeve 8/11	15	1	12.93333	21.28901
3	*Limacina helicina*	ANTI	10 C	Reeve 8/11	13	1	13.1	32.31205
4	*Limacina helicina*	ANTI	10 C	Reeve 8/11	13	1	13.25	31.40356
5	*Limacina helicina*	NO-anti	10 C	Reeve 8/11	15	1	13.98333	40.30679
6	*Limacina helicina*	NO-anti	10 C	Reeve 8/11	15	1	14.08333	33.25083
7	*Limacina helicina*	NO-anti	10 C	Reeve 8/11	13	1	14.23333	56.23569
9	*Limacina helicina*	ANTI	10 C	Reeve 8/11	13	1	14.56667	29.04148
14	*Limacina helicina*	NO-anti	10 C	Reeve 8/11	13	1	15.21667	4.754445
15	*Limacina helicina*	NO-anti	10 C	Reeve 8/11	15	1	15.4	45.00067
16	*Limacina helicina*	NO-anti	10 C	Reeve 8/11	13	1	15.53333	37.15735
17	*Clio pyramidata*	380	10 C	Reeve 8/11	20	1	7.983333	48.51351
18	*Clio pyramidata*	380	10 C	Reeve 8/11	20	1	8.383333	73.13366
19	*Clio pyramidata*	380	10 C	Reeve 8/11	18	1	8.966667	15.83805
20	*Clio pyramidata*	380	10 C	Reeve 8/11	18	1	8.5500	34.97697
21	*Clio pyramidata*	800	10 C	Reeve 8/11	18	1	9.2500	59.05202
22	*Clio pyramidata*	800	10 C	Reeve 8/11	18	1	9.5667	14.62673
23	*Clio pyramidata*	800	10 C	Reeve 8/11	20	1	9.4167	34.67414
24	*Limacina helicina*	380	10 C	Reeve 8/12	10	1	11.6167	16.61405
25	*Limacina helicina*	380	10 C	Reeve 8/12	10	1	11.7833	14.86202
26	*Limacina helicina*	380	10 C	Reeve 8/12	10	1	11.9500	24.83045
27	*Limacina helicina*	380	10 C	Reeve 8/12	10	1	12.1167	18.00358
28	*Limacina helicina*	800	10 C	Reeve 8/12	10	1	15.16667	5.83002
29	*Limacina helicina*	800	10 C	Reeve 8/12	8	1	15.46667	12.95896
30	*Limacina helicina*	800	10 C	Reeve 8/12	10	1	15.63333	16.13073
31	*Limacina helicina*	800	10 C	Reeve 8/12	8	1	15.76667	16.64425
32	*Limacina helicina*	380	10 C	Reeve 8/12	8	1	15.93333	2.084308
33	*Limacina helicina*	380	10 C	Reeve 8/12	8	1	16.06667	4.500896
34	*Limacina helicina*	380	10 C	Reeve 8/12	10	1	16.2	14.31829
35	*Limacina helicina*	380	10 C	Reeve 8/12	10	1	16.38333	3.685297
36	*Limacina helicina*	800	10 C	Reeve 8/12	10	1	16.5	16.64425
37	*Limacina helicina*	800	10 C	Reeve 8/12	8	1	16.66667	6.977899
38	*Limacina helicina*	800	10 C	Reeve 8/12	8	1	16.8	9.877806
39	*Limacina helicina*	800	10 C	Reeve 8/12	10	1	16.96667	27.66994
40	*Clio pyramidata*	380	10 C	Reeve 8/13	20	1	7.95	74.79961
41	*Clio pyramidata*	380	10 C	Reeve 8/13	20	1	8.066667	50.3176
42	*Clio pyramidata*	380	10 C	Reeve 8/13	20	1	8.25	46.40401
43	*Clio pyramidata*	800	10 C	Reeve 8/13	20	1	8.516667	60.23399

ID #	Species	Treatment	Temp (°C)	Capture	Volume (ml)	Water Batch	Time (hr)	O_2 consumed (umol)
44	*Clio pyramidata*	800	10 C	Reeve 8/13	20	1	8.716667	39.90097
45	*Clio pyramidata*	800	10 C	Reeve 8/13	20	1	8.866667	40.22465
46	*Clio pyramidata*	380	10 C	Reeve 8/13	18	1	9.133333	83.50956
47	*Clio pyramidata*	380	10 C	Reeve 8/13	20	1	9.316667	47.87528
48	*Clio pyramidata*	380	10 C	Reeve 8/13	19	1	9.516667	88.80615
49	*Clio pyramidata*	800	10 C	Reeve 8/13	20	1	9.716667	45.5801
50	*Clio pyramidata*	800	10 C	Reeve 8/13	20	1	9.866667	57.52685
51	*Clio pyramidata*	800	10 C	Reeve 8/13	20	1	10.03333	26.63008
53	*Limacina helicina*	HL	10 C	Reeve 8/27	15	2	9.383333	12.98941
54	*Limacina helicina*	HL	10 C	Reeve 8/27	15	2	9.5	9.069625
57	*Limacina helicina*	low	10 C	Reeve 8/27	15	2	10.16667	6.3963
58	*Limacina helicina*	low	10 C	Reeve 8/27	15	2	10.3	13.15342
60	*Limacina helicina*	HL	10 C	Reeve 8/28	15	3	7.833333	5.084239
61	*Limacina helicina*	HL	10 C	Reeve 8/28	15	3	10.98333	19.77933
62	*Limacina helicina*	HL	10 C	Reeve 8/28	15	3	11.23333	18.46727
63	*Limacina helicina*	HL	10 C	Reeve 8/28	15	3	11.38333	4.821826
64	*Limacina helicina*	low	10 C	Reeve 8/28	15	3	11.71667	6.3963
65	*Limacina helicina*	low	10 C	Reeve 8/28	15	3	11.86667	18.82808
66	*Limacina helicina*	low	10 C	Reeve 8/28	15	3	12.1	9.725656
67	*Limacina helicina*	low	10 C	Reeve 8/28	15	3	12.3	11.15252
68	*Limacina helicina*	HL	10 C	Reeve 8/28	15	3	12.51667	20.66497
69	*Limacina helicina*	HL	10 C	Reeve 8/28	15	3	12.71667	25.22438
70	*Limacina helicina*	HL	10 C	Reeve 8/28	15	3	12.86667	27.38928
71	*Limacina helicina*	HL	10 C	Reeve 8/28	15	3	13.01667	21.91143
72	*Limacina helicina*	low	10 C	Reeve 8/28	15	3	13.35	5.904277
75	*Limacina helicina*	low	10 C	Reeve 8/28	15	3	14.88333	5.248246
76	*Clio pyramidata*	low	10 C	Reeve 8/29	20	3	4.533333	1.894289
77	*Clio pyramidata*	low	10 C	Reeve 8/29	20	3	4.65	25.10138
78	*Clio pyramidata*	low	10 C	Reeve 8/29	20	3	4.866667	20.70597
79	*Clio pyramidata*	HL	10 C	Reeve 8/29	20	3	5.15	19.45131
81	*Clio pyramidata*	HL	10 C	Reeve 8/29	20	3	5.55	12.33338
82	*Clio pyramidata*	low	10 C	Reeve 8/29	20	3	5.916667	17.28641
84	*Clio pyramidata*	low	10 C	Reeve 8/29	20	3	6.066667	37.29535
86	*Clio pyramidata*	HL	10 C	Reeve 8/29	20	3	6.316667	29.9314
89	*Clio pyramidata*	low	10 C	Reeve 8/29	20	3	6.733333	22.43625
90	*Clio pyramidata*	low	10 C	Reeve 8/29	20	3	6.466667	22.43625
91	*Clio pyramidata*	HL	10 C	Reeve 8/29	20	3	6.783333	35.68807
92	*Clio pyramidata*	HL	10 C	Reeve 8/29	20	3	6.95	27.48769
93	*Clio pyramidata*	HL	10 C	Reeve 8/29	20	3	7.15	18.95929
94	*Limacina helicina*	NO-anti	10 C	Reeve 8/30	15	3	10.25	6.280883

ID #	Species	Treatment	Temp (°C)	Capture	Volume (ml)	Water Batch	Time (hr)	O_2 consumed (umol)
95	*Limacina helicina*	NO-anti	10 C	Reeve 8/30	15	3	10.35	10.5604
96	*Limacina helicina*	NO-anti	10 C	Reeve 8/30	15	3	12	6.841549
97	*Limacina helicina*	ANTI	10 C	Reeve 8/30	15	3	12.13333	10.63847
98	*Limacina helicina*	ANTI	10 C	Reeve 8/30	15	3	12.28333	5.173744
99	*Limacina helicina*	ANTI	10 C	Reeve 8/30	15	3	12.45	1.298759
100	*Limacina helicina*	NO-anti	10 C	Reeve 8/30	15	3	12.86667	5.152453
101	*Limacina helicina*	NO-anti	10 C	Reeve 8/30	15	3	13.03333	17.01161
102	*Limacina helicina*	NO-anti	10 C	Reeve 8/30	15	3	13.23333	9.62359
103	*Limacina helicina*	ANTI	10 C	Reeve 8/30	15	3	13.63333	3.285931
104	*Limacina helicina*	ANTI	10 C	Reeve 8/30	15	3	13.8	4.925348
105	*Limacina helicina*	ANTI	10 C	Reeve 8/30	15	3	13.91667	19.59493
107	*Limacina helicina*	ANTI	10 C	Reeve 8/31	15	3	9.966667	12.12175
108	*Limacina helicina*	ANTI	10 C	Reeve 8/31	15	3	10.11667	8.977759
109	*Limacina helicina*	NO-anti	10 C	Reeve 8/31	15	3	10.38333	12.40563
110	*Limacina helicina*	NO-anti	10 C	Reeve 8/31	15	3	10.51667	4.34339
111	*Limacina helicina*	NO-anti	10 C	Reeve 8/31	15	3	10.66667	7.778359
112	*Limacina helicina*	ANTI	10 C	Reeve 8/31	15	3	10.96667	7.29576
113	*Limacina helicina*	ANTI	10 C	Reeve 8/31	15	3	11.21667	7.863523
114	*Clio pyramidata*	HL	10 C	Reeve 9/2	20	3	3.766667	5.021796
117	*Clio pyramidata*	HL	10 C	Reeve 9/2	20	3	4.2	10.10327
119	*Clio pyramidata*	low	10 C	Reeve 9/2	20	3	4.55	12.56728
120	*Clio pyramidata*	low	10 C	Reeve 9/2	20	3	4.733333	2.438427
121	*Clio pyramidata*	low	10 C	Reeve 9/2	20	3	4.866667	36.37178
122	*Limacina helicina*	HL	10 C	Reeve 9/2	15	3	5.166667	5.703873
123	*Limacina helicina*	HL	10 C	Reeve 9/2	15	3	0.666667	6.437107
124	*Limacina helicina*	HL	10 C	Reeve 9/2	15	3	5.5	1.730772
125	*Limacina helicina*	HL	10 C	Reeve 9/2	15	3	5.616667	2.515161
126	*Limacina helicina*	low	10 C	Reeve 9/2	15	3	6	8.346924
130	*Clio pyramidata*	800	14 C	Reeve 9/2 #2	20	3	9.266667	4.977307
131	*Clio pyramidata*	800	14 C	Reeve 9/2 #2	20	3	9.633333	5.50822
132	*Clio pyramidata*	800	14 C	Reeve 9/2 #2	20	3	9.816667	14.94022
133	*Clio pyramidata*	800	14 C	Reeve 9/2 #2	20	3	10.03333	25.55018
134	*Clio pyramidata*	380	14 C	Reeve 9/2 #2	20	3	10.25	3.011271
135	*Clio pyramidata*	380	14 C	Reeve 9/2 #2	20	3	10.41667	19.10456
137	*Clio pyramidata*	380	14 C	Reeve 9/2 #2	20	3	10.7	3.80764
138	*Limacina helicina*	800	14 C	Reeve 9/2 #2	15	3	10.83333	6.536863
139	*Limacina helicina*	800	14 C	Reeve 9/2 #2	15	3	10.98333	1.659102
140	*Limacina helicina*	800	14 C	Reeve 9/2 #2	15	3	11.11667	5.806858
141	*Limacina helicina*	800	14 C	Reeve 9/2 #2	15	3	11.3	3.351387
146	*Limacina helicina*	380	14 C	Reeve 9/2 #2	15	3	11.56667	2.720928

ID #	Species	Treatment	Temp (°C)	Capture	Volume (ml)	Water Batch	Time (hr)	O_2 consumed (umol)
147	*Limacina helicina*	380	14 C	Reeve 9/2 #2	15	3	11.68333	5.607766
148	*Limacina helicina*	380	14 C	Reeve 9/2 #2	15	3	11.81667	4.686964
149	*Limacina helicina*	380	14 C	Reeve 9/2 #2	15	3	11.95	5.607766
150	*Clio pyramidata*	800	14 C	Moc 9/6	10	4	4.6	13.49744
151	*Clio pyramidata*	800	14 C	Reeve 9/5	15	4	4.766667	9.078632
152	*Clio pyramidata*	800	14 C	Reeve 9/5	15	4	4.95	49.8441
153	*Clio pyramidata*	380	14 C	Reeve 9/5	15	4	5.183333	9.89812
154	*Clio pyramidata*	380	14 C	Moc 9/6	20	4	5.333333	31.01197
155	*Clio pyramidata*	380	14 C	Moc 9/6	15	4	5.516667	25.03453
156	*Clio pyramidata*	low	10 C	Reeve 9/6	20	4	3.966667	20.3545
157	*Clio pyramidata*	low	10 C	Reeve 9/6	20	4	4.083333	17.07757
158	*Clio pyramidata*	low	10 C	Reeve 9/6	15	4	4.05	9.599816
159	*Clio pyramidata*	HL	10 C	Reeve 9/6	20	4	4	19.2285
161	*Clio pyramidata*	HL	10 C	Reeve 9/6	20	4	4.083333	10.79799
163	*Clio pyramidata*	low	10 C	Reeve 9/6	20	4	4.2	23.44376
164	*Clio pyramidata*	HL	10 C	Reeve 9/6	20	4	5.8	2.049885
165	*Clio pyramidata*	HL	10 C	Reeve 9/6	15	4	4.2	7.838647
166	*Clio pyramidata*	low	10 C	Reeve 9/7	20	4	3.916667	3.926541
167	*Clio pyramidata*	low	10 C	Reeve 9/7	20	4	4.033333	9.022383
169	*Cavolinia uncinata*	380	10 C	Reeve 9/8 #2	20	4	4.466667	196.0383
170	*Cavolinia uncinata*	380	10 C	Reeve 9/8 #2	20	4	4.65	58.11858
171	*Cavolinia uncinata*	800	10 C	Reeve 9/8 #2	20	4	4.716667	120.4019
172	*Cavolinia uncinata*	800	10 C	Reeve 9/9	20	4	4.866667	103.0717
174	*Cuvierina columnella*	800	15 C	Reeve 9/9	20	4	8.816667	7.255591
175	*Cuvierina columnella*	800	15 C	Reeve 9/9	20	4	8.183333	7.597444
177	*Cuvierina columnella*	380	15 C	Reeve 9/9	18	4	8.55	4.384026
178	*Cuvierina columnella*	380	15 C	Reeve 9/9	18	4	8.566667	1.403067
179	*Cuvierina columnella*	380	15 C	Reeve 9/9	20	4	8.566667	2.428626
181	*Clio pyramidata*	380	15 C	Reeve 9/10	15	4	8.4	6.505891
182	*Clio pyramidata*	380	15 C	Reeve 9/10	15	4	8.316667	14.25781
183	*Clio pyramidata*	380	15 C	Reeve 9/10	15	4	8.3	5.503622
184	*Clio pyramidata*	380	15 C	Reeve 9/10	15	4	8.333333	10.65591
185	*Clio pyramidata*	380	15 C	Reeve 9/10	15	4	8.283333	8.181559
186	*Clio pyramidata*	380	15 C	Reeve 9/10	15	4	8.35	15.07216
187	*Cuvierina columnella*	800	15 C	Reeve 9/11	20	4	3.083333	15.91782
188	*Cuvierina columnella*	800	15 C	Reeve 9/11	20	4	2.8	26.97409
189	*Clio pyramidata*	800	15 C	Reeve 9/11	20	4	3.2	12.78573
190	*Clio pyramidata*	800	15 C	Reeve 9/11	20	4	3.483333	15.51065

ID #	Species	Treatment	Temp (°C)	Capture	Volume (ml)	Water Batch	Time (hr)	O_2 consumed (umol)
191	*Cuvierina columnella*	380	15 C	Reeve 9/11	20	4	2.633333	4.70494
192	*Cuvierina columnella*	380	15 C	Reeve 9/11	20	4	2.583333	45.10889
193	*Clio pyramidata*	380	15 C	Reeve 9/11	20	4	3.233333	21.53992
194	*Clio pyramidata*	380	15 C	Reeve 9/11	20	4	3.283333	8.244201
195	*Clio pyramidata*	380	15 C	Reeve 9/12	19	4	7.283333	31.45
196	*Cuvierina columnella*	380	15 C	Reeve 9/12	20	4	7.383333	55.28333
197	*Clio pyramidata*	380	15 C	Reeve 9/12	20	4	7.55	32.05
198	*Clio pyramidata*	800	15 C	Reeve 9/12	20	4	7.666667	39.7
199	*Clio pyramidata*	800	15 C	Reeve 9/12	20	4	7.883333	31
201	*Cavolinia inflexa*	800	15 C	Reeve 9/12	20	4	7.7	19.7
202	*Cavolinia inflexa*	800	15 C	Reeve 9/12	20	4	7.833333	19.66667
203	*Cavolinia inflexa*	800	15 C	Reeve 9/12	20	4	7.966667	31.65
204	*Cavolinia inflexa*	800	15 C	Reeve 9/12	20	4	8.166667	22.75
205	*Cavolinia inflexa*	380	15 C	Reeve 9/12	20	4	8.25	19.2
206	*Cavolinia inflexa*	380	15 C	Reeve 9/12	20	4	8.316667	14.7
207	*Cavolinia inflexa*	380	15 C	Reeve 9/12	20	4	8.5	22.5
208	*Cavolinia inflexa*	380	15 C	Reeve 9/12	20	4	8.6	24.4
209	*Clio pyramidata*	380	15 C	M 9/12	20	4	5.566667	40.36667
210	*Clio pyramidata*	380	15 C	Reeve 9/13	20	4	5.65	19.25
211	*Cuvierina columnella*	380	15 C	Reeve 9/13	20	4	5.166667	45.35
212	*Cuvierina columnella*	380	15 C	Reeve 9/13	20	4	5.3	10.83333
213	*Clio pyramidata*	800	15 C	Moc 9/12	20	4	5.933333	22.65
215	*Clio pyramidata*	800	15 C	Reeve 9/13	20	4	6.216667	36.8
218	*Cavolinia inflexa*	380	15 C	Reeve 9/13	20	4	6.783333	8.966667
219	*Cavolinia inflexa*	380	15 C	Reeve 9/13	20	4	6.95	23.26667
220	*Cavolinia inflexa*	380	15 C	Reeve 9/13	20	4	7.116667	14.26667
222	*Diacria trispinosa*	800	15 C	Reeve 9/13	20	4	7.483333	15.63333
223	*Cavolinia inflexa*	800	15 C	Reeve 9/13	20	4	7.6	14.2
224	*Cavolinia inflexa*	800	15 C	Reeve 9/13	20	4	7.766667	15.43333
225	*Cavolinia inflexa*	800	15 C	Reeve 9/13	20	4	7.85	19.1
226	*Clio pyramidata*	HL	15 C	Reeve 9/14	20	4	3.116667	8.933333
227	*Cavolinia inflexa*	HL	15 C	Reeve 9/14	20	4	3.2	6
229	*Cavolinia inflexa*	HL	15 C	Reeve 9/14	20	4	3.25	12.65
230	*Clio pyramidata*	low	15 C	Reeve 9/14	20	4	3.133333	4.9
231	*Clio pyramidata*	low	15 C	Reeve 9/14	20	4	3.116667	5.216667
232	*Cavolinia inflexa*	low	15 C	Reeve 9/14	20	4	3.133333	7.05
233	*Cavolinia inflexa*	low	15 C	Reeve 9/14	20	4	3.133333	5.733333
234	*Cavolinia inflexa*	low	15 C	Reeve 9/14	20	4	3.2	8.2
235	*Cavolinia inflexa*	low	15 C	Reeve 9/14	20	4	3.233333	9.1

ID #	Species	Treatment	Temp (°C)	Capture	Volume (ml)	Water Batch	Time (hr)	O_2 consumed (umol)
236	*Cavolinia inflexa*	low	15 C	Reeve 9/14	20	4	3.216667	6.1
237	*Cavolinia inflexa*	low	15 C	Reeve 9/14	20	4	3.15	9.6
238	*Cavolinia inflexa*	HL	15 C	Reeve 9/14	20	4	3.116667	7.4
239	*Cavolinia inflexa*	HL	15 C	Reeve 9/14	20	4	3.3	3.85
240	*Cavolinia inflexa*	HL	15 C	Reeve 9/14	20	4	3.25	6.65
241	*Cavolinia inflexa*	HL	15 C	Reeve 9/14	20	4	3.35	8.65
242	*Styliola subula*	800	15 C	Reeve 9/14	15	4	7.066667	26.6
243	*Styliola subula*	800	15 C	Reeve 9/14	15	4	7.183333	20.61667
244	*Styliola subula*	800	15 C	Reeve 9/14	15	4	7.916667	17.58333
245	*Styliola subula*	800	15 C	Reeve 9/14	15	4	8.033333	5.85
246	*Styliola subula*	380	15 C	Reeve 9/14	15	4	8.133333	10.55
248	*Styliola subula*	380	15 C	Reeve 9/14	15	4	8.45	11.95
249	*Styliola subula*	380	15 C	Reeve 9/14	15	4	8.6	2.3
250	*Styliola subula*	800	15 C	Reeve 9/14	15	4	8.966667	7.116667
251	*Styliola subula*	800	15 C	Reeve 9/14	15	4	9.083333	6.95
253	*Styliola subula*	380	15 C	Reeve 9/14	15	4	9.266667	21.5
254	*Styliola subula*	380	15 C	Reeve 9/14	15	4	9.483333	16.8
255	*Styliola subula*	380	15 C	Reeve 9/14	15	4	9.65	15.1
256	*Cuvierina columnella*	800	15 C	Reeve 9/15	20	4	3.283333	10.15
257	*Diacria trispinosa*	800	15 C	Reeve 9/15	20	4	4.116667	17.45
258	*Diacria trispinosa*	800	15 C	Reeve 9/15	20	4	4.266667	5.1
259	*Cavolinia inflexa*	800	15 C	Reeve 9/15	20	4	4.466667	8.033333
260	*Clio pyramidata*	380	15 C	Reeve 9/14 #2	20	4	3.3	13.6
261	*Clio pyramidata*	380	15 C	Reeve 9/14 #2	20	4	3.433333	10.34167
262	*Cavolinia inflexa*	380	15 C	Reeve 9/14 #2	20	4	3.65	9.166667

Appendix 8 - Table of Pteropods Preserved for Genetic Analyses

Station	Date	Taxa	Species #	Vial #	Individual #	N	Latitude	Longitude	Gear Type	Net	Depth
Test 2	11-Aug-12	*Clio balantium*	Ga58	6		1	45.576 N	128.453 W	Reeve	1	0-140 m
		Clio pyramidata	Ga01	25		1	45.576 N	128.453 W	Reeve	1	0-140 m
		Clione limacina	Ga04	17		14	45.576 N	128.453 W	Reeve	1	0-140 m
		Corolla sp.	Ga64	2		22	45.576 N	128.453 W	Reeve	1	0-140 m
		Limacina helicina	Ga56	09		30	45.576 N	128.453 W	Reeve	1	0-140 m
		Pneumoderma sp.	Ga113	6		2	45.576 N	128.453 W	Reeve	1	0-140 m
Test 3	12-Aug-12	*Limacina helicina*	Ga56	10		12	46.620 N	133.522 W	Reeve	2	0-100 m
		Pneumoderma sp.	Ga113	7		2	46.620 N	133.522 W	Reeve	2	0-100 m
Test 4	13-Aug-12	*Clio pyramidata*	Ga01	26		25	47.659 N	138.467 W	Reeve	3	0-100 m
		Clione limacina	Ga04	18		9	47.659 N	138.467 W	Reeve	3	0-100 m
		Limacina helicina	Ga56	11		32	47.659 N	138.467 W	Reeve	3	0-100 m
Test 5	27-Aug-12	*Clio pyramidata*	Ga01	27		4	45.680 N	129.805 W	Reeve	5	0-60 m
		Clione limacina	Ga04	20		5	45.680 N	129.805 W	Reeve	5	0-60 m
		Corolla sp.	Ga64	3		20	45.680 N	129.805 W	Reeve	5	0-60 m
		Limacina helicina	Ga56	14		30	45.680 N	129.805 W	Reeve	5	0-60 m
		Pneumoderma sp.	Ga113	8		2	45.680 N	129.805 W	Reeve	5	0-60 m
Test 6	28-Aug-12	*Clione limacina*	Ga04	21		25	46.622 N	134.927 W	Reeve	6	0-75 m
		Limacina helicina	Ga56	15		51	46.622 N	134.927 W	Reeve	6	0-75 m
		Pneumoderma sp.	Ga113	9		2	46.622 N	134.927 W	Reeve	6	0-75 m
		Pneumoderma sp.	Ga113	9		2	46.622 N	134.927 W	Reeve	6	0-75 m
Test 7	29-Aug-12	*Clio pyramidata*	Ga01	28		50	47.577 N	140.186 W	Reeve	7	0-90 m
		Clione limacina	Ga04	22		1	47.577 N	140.186 W	Reeve	7	0-90 m
		Limacina helicina	Ga56	16		50	47.577 N	140.186 W	Reeve	7	0-90 m
		Pneumoderma sp.	Ga113	10		3	47.577 N	140.186 W	Reeve	7	0-90 m
Test 8	30-Aug-12	*Clio pyramidata*	Ga01	29		1	48.543 N	145.622 W	Reeve	8	0-100 m
		Clione limacina	Ga04	23		40	48.543 N	145.622 W	Reeve	8	0-100 m
		Limacina helicina	Ga56	17		50	48.543 N	145.622 W	Reeve	8	0-100 m
01	15-Aug-12	*Clione limacina*	Ga04	19		1	49.879 N	149.413 W	Reeve	4	0-60 m
01		*Limacina helicina*	Ga56	12		41	49.879 N	149.413 W	Reeve	4	0-60 m

Station	Date	Taxa	Species #	Vial #	Individual #	N	Latitude	Longitude	Gear Type	Net	Depth
01	16-Aug-12	*Limacina helicina*	Ga56	13		1	49.860 N	149.438 W	M-01-002	0	0-712 m
03	31-Aug-12	*Clio polita*	Ga112	2		1	49.000 N	148.227 W	M-01-004	0	0-1000 m
		Limacina helicina	Ga56	18		26	48.915 N	148.697 W	Reeve	9	0-100 m
06	02-Sep-12	*Clio pyramidata*	Ga01	30		13	47.501 N	145.583 W	Reeve	10	0-100 m
		Clione limacina	Ga04	24		19	47.501 N	145.583 W	Reeve	10	0-100 m
		Limacina helicina	Ga56	19		50	47.501 N	145.583 W	Reeve	10	0-100 m
07	02-Sep-12	*Clio polita*	Ga112	3		1	47.000 N	144.737 W	M-01-007	8	0-25 m
		Clio pyramidata	Ga01	31		20	47.002 N	144.617 W	Reeve	11	0-100 m
		Clione limacina	Ga04	25		50	47.002 N	144.617 W	Reeve	11	0-100 m
		Limacina helicina	Ga56	20		50	47.002 N	144.617 W	Reeve	11	0-100 m
11	04-Sep-12	*Limacina helicina*	Ga56	21		7	44.946 N	141.319 W	Reeve	12	0-80 m
		Pneumoderma sp.	Ga113	11		3	44.946 N	141.319 W	Reeve	12	0-80 m
		Pneumoderma sp.	Ga113	12		7	45.046 N	141.447 W	M-01-009	1	999-798 m
13	05-Sep-12	*Clione limacina*	Ga04	26		1	44.001 N	139.472 W	Reeve	13	0-100 m
13	05-Sep-12	*Pneumoderma* sp.	Ga113	13		2	44.001 N	139.472 W	Reeve	13	0-100 m
15	05-Sep-12	*Clio pyramidata*	Ga01	32		1	43.083 N	138.139 W	Reeve	14	0-60 m
		Clione limacina	Ga04	27		1	43.083 N	138.139 W	Reeve	14	0-100 m
		Corolla sp.	Ga64	4		2	43.083 N	138.139 W	Reeve	14	0-60 m
		Limacina helicina	Ga56	22		11	43.083 N	138.139 W	Reeve	14	0-60 m
		Cliopsis krohni	Ga114	1		12	43.003 N	138.134 W	Reeve	14	0-100
	06-Sep-12	*Cliopsis krohni*	Ga114	4		2	43.003 N	138.134 W	M-01-011	0	1000-0 m
		Cliopsis krohni	Ga114	3		4	43.003 N	138.134 W	M-01-011	8	25-0 m
		Cliopsis krohni	Ga114	2		3	43.003 N	138.134 W	M-01-011	7	50-25 m
18	06-Sep-12	*Clio pyramidata*	Ga01	33		3	41.500 N	135.771 W	Reeve	15	65-0 m
		Cliopsis krohni	Ga114	5		5	41.500 N	135.771 W	Reeve	15	65-0 m
		Diacria trispinosa	Ga02	23		1	41.500 N	135.771 W	Reeve	15	65-0 m
		Pneumoderma sp.	Ga113	14		1	41.500 N	135.771 W	Reeve	15	65-0 m
		Pneumoderma sp.	Ga113	15		1	41.500 N	135.771 W	Reeve	15	65-0 m
	07-Sep-12	*Cavolinia uncinata*	Ga29	12		2	41.533 N	135.786 W	M-01-013	4	200-400 m
		Cavolinia uncinata	Ga29	13		1	41.533 N	135.786 W	M-01-013	0	0-1000 m

Station	Date	Taxa	Species #	Vial #	Individual #	N	Latitude	Longitude	Gear Type	Net	Depth
		Clio pyramidata	Ga01	34		5	41.533 N	135.786 W	M-01-013	7	50-25 m
		Clio pyramidata	Ga01	35		4	41.533 N	135.786 W	M-01-013	8	25-0 m
19	07-Sep-12	*Cliopsis krohni*	Ga114	6		12	41.003 N	135.000 W	Reeve	16	0-100 m
		Limacina inflata	Ga11	16		200	41.003 N	135.000 W	Reeve	16	0-100 m
		Pneumoderma sp.	Ga113	16		30	41.003 N	135.000 W	Reeve	16	0-100 m
21	08-Sep-12	*Atlanta* sp.	Ga109	3		5	39.949 N	134.986 W	Reeve	17	0-250 m
		Cavolinia uncinata	Ga29	14	3	1	40.003 N	135.000 W	M-01-015	0	0-1000 m
		Cavolinia uncinata	Ga29	14	2	1	40.003 N	135.000 W	M-01-015	0	0-1000 m
		Cavolinia uncinata	Ga29	14	1	1	40.003 N	135.000 W	M-01-015	0	0-1000 m
		Cliopsis krohni	Ga114	7		2	39.949 N	134.986 W	Reeve	17	0-250 m
		Limacina inflata	Ga11	17		100	39.949 N	134.986 W	Reeve	17	0-250 m
	09-Sep-12	*Atlanta* sp.	Ga109	4		3	40.062 N	135.091 W	Reeve	18	0-200 m
		Cavolinia uncinata	Ga29	15		1	40.062 N	135.091 W	Reeve	18	0-200 m
		Cavoliniid juveniles	Ga115	1		13	40.062 N	135.091 W	Reeve	18	0-200 m
		Cavoliniid juveniles	Ga115	2		3	40.062 N	135.091 W	Reeve	18	0-200 m
		Cliopsis krohni	Ga114	8		4	40.062 N	135.091 W	Reeve	18	0-200 m
		Limacina inflata	Ga11	18		50	40.062 N	135.091 W	Reeve	18	0-200 m
		Pneumoderma sp.	Ga113	18		1	40.062 N	135.091 W	Reeve	18	0-200 m
23	09-Sep-12	*Pneumoderma* sp.	Ga113	17		2	39.994 N	135.036 W	M-01-016	0	0-1000 m
24	09-Sep-12	*Atlanta* sp.	Ga109	5		5	38.629 N	135.046 W	Reeve	19	0-200 m
		Cavoliniid juveniles	Ga115	3		18	38.629 N	135.046 W	Reeve	19	0-200 m
		Clione limacina	Ga04	28		1	38.623 N	135.062 W	M-01-018	3	600-400 m
		Cuvierina columnella	Ga06	17		5	38.629 N	135.046 W	Reeve	19	0-200 m
		Gastropoda	Ga110	2		2	38.623 N	135.062 W	M-01-018	8	25-0 m
		Limacina bulimoides	Ga12	12		4	38.629 N	135.046 W	Reeve	19	0-200 m
		Limacina inflata	Ga11	19		2	38.629 N	135.046 W	Reeve	19	0-200 m
		Pneumoderma sp.	Ga113	19		1	38.623 N	135.062 W	M-01-018	6	100-50 m
27	10-Sep-12	*Atlanta* sp.	Ga109	6		2	37.204 N	135.128 W	Reeve	20	0-200 m
		Cavoliniid juveniles	Ga115	4		1	37.204 N	135.128 W	Reeve	20	0-200 m
		Clio pyramidata	Ga01	36		18	37.204 N	135.128 W	Reeve	20	0-200 m

Station	Date	Taxa	Species #	Vial #	Individual #	N	Latitude	Longitude	Gear Type	Net	Depth
		Clione limacina	Ga04	29		1	37.231 N	135.129 W	M-01-020	3	600-400 m
		Cuvierina columnella	Ga06	18		1	37.204 N	135.128 W	Reeve	20	0-200 m
		Limacina bulimoides	Ga12	13		5	37.204 N	135.128 W	Reeve	20	0-200 m
		Limacina inflata	Ga11	20		15	37.204 N	135.128 W	Reeve	20	0-200 m
		Pneumoderma sp.	Ga113	20		1	37.260 N	135.008 W	M-01-019	0	1000-0 m
		Pneumoderma sp.	Ga113	21		1	37.231 N	135.129 W	M-01-020	1	800-1000 m
	11-Sep-12	*Atlanta* sp.	Ga109	7		5	37.382 N	135.081 W	Reeve	21	0-70 m
		Cavoliniid juveniles	Ga115	5		2	37.382 N	135.081 W	Reeve	21	0-70 m
		Cuvierina columnella	Ga06	19		5	37.382 N	135.081 W	Reeve	21	0-70 m
		Limacina bulimoides	Ga12	14		5	37.382 N	135.081 W	Reeve	21	0-70 m
		Limacina inflata	Ga11	21		50	37.382 N	135.081 W	Reeve	21	0-70 m
30	11-Sep-12	*Atlanta* sp.	Ga109	8		5	35.552 N	135.009 W	Reeve	22	0-150 m
		Atlanta sp.	Ga109	9		1	35.552 N	135.009 W	Reeve	22	0-150 m
		Cavolinia inflexa	Ga37	13		3	35.585 N	135.003 W	M-01-21	0	0-1000 m
		Cavolinia uncinata	Ga29	16		1	35.552 N	135.009 W	Reeve	22	0-150 m
		Cavoliniid juveniles	Ga115	6		4	35.552 N	135.009 W	Reeve	22	0-150 m
		Clio pyramidata	Ga01	37		6	35.552 N	135.009 W	Reeve	22	0-150 m
		Cuvierina columnella	Ga06	20		2	35.585 N	135.003 W	M-01-21	0	0-1000 m
		Limacina bulimoides	Ga12	15		19	35.552 N	135.009 W	Reeve	22	0-150 m
		Limacina inflata	Ga11	22		40	35.552 N	135.009 W	Reeve	22	0-150 m
		Peracle reticulata	Ga47	11		1	35.552 N	135.009 W	Reeve	22	0-150 m
		Pneumoderma sp.	Ga113	22		1	35.552 N	135.009 W	Reeve	22	0-150 m
		Styliola subula	Ga13	18		3	35.552 N	135.009 W	Reeve	22	0-150 m
	12-Sep-12	*Atlanta* sp.	Ga109	10		16	35.670 N	134.903 W	Reeve	23	0-70 m
		Cavolinia inflexa	Ga37	12		20	35.670 N	134.903 W	Reeve	23	0-70 m
		Cavoliniid juveniles	Ga115	8		7	35.670 N	134.903 W	Reeve	23	0-70 m
		Cavoliniid juveniles	Ga115	7		1	35.670 N	134.903 W	Reeve	23	0-70 m
		Cuvierina columnella	Ga06	21		1	35.670 N	134.903 W	Reeve	23	0-70 m
		Diacria quatridentata	Ga07	12		3	35.670 N	134.903 W	Reeve	23	0-70 m
		Hyalocilis striata	Ga09	16		3	35.670 N	134.903 W	Reeve	23	0-70 m

Station	Date	Taxa	Species #	Vial #	Individual #	N	Latitude	Longitude	Gear Type	Net	Depth
		Limacina bulimoides	Ga12	16		80	35.670 N	134.903 W	Reeve	23	0-70 m
		Limacina inflata	Ga11	23		20	35.670 N	134.903 W	Reeve	23	0-70 m
		Limacina spp.	Ga116	1		8	35.670 N	134.903 W	Reeve	23	0-70 m
		Peracle reticulata	Ga47	12		1	35.670 N	134.903 W	Reeve	23	0-70 m
		Pneumoderma sp.	Ga113	23		1	35.670 N	134.903 W	Reeve	23	0-70 m
		Styliola subula	Ga13	19		6	35.670 N	134.903 W	Reeve	23	0-70 m
32	12-Sep-12	*Cavolinia uncinata*	Ga29	17	2	1	34.501 N	135.000 W	M-01-023	0	0-1000 m
		Cavolinia uncinata	Ga29	17	1	1	34.501 N	135.000 W	M-01-023	0	0-1000 m
		Pneumoderma sp.	Ga113	25		1	34.501 N	135.000 W	M-01-023	2	600-800 m
		Pneumoderma sp.	Ga113	24		1	34.501 N	135.000 W	M-01-023	0	0-1000 m
		Pneumoderma sp.	Ga113	26		1	34.501 N	135.000 W	M-01-023	7	50-25 m
	13-Sep-12	*Atlanta* sp.	Ga109	11		8	34.443 N	135.111 W	Reeve	23	0-70 m
		Cavolinia inflexa	Ga37	14		4	34.443 N	135.111 W	Reeve	23	0-70 m
		Cuvierina columnella	Ga06	22		3	34.443 N	135.111 W	Reeve	23	0-70 m
		Limacina bulimoides	Ga12	17		21	34.443 N	135.111 W	Reeve	23	0-70 m
		Limacina inflata	Ga11	24		34	34.443 N	135.111 W	Reeve	23	0-70 m
		Paedoclione	Ga117	1		1	34.443 N	135.111 W	Reeve	24	0-30 m
		Pneumoderma sp.	Ga113	27		1	34.443 N	135.111 W	Reeve	24	0-30 m
32	13-Sep-12	*Styliola subula*	Ga13	20		2	34.443 N	135.111 W	Reeve	23	0-70 m
34	13-Sep-12	*Cavolinia inflexa*	Ga37	15		6	33.505 N	135.000 W	M-01-025	0	0-1000 m
		Pneumoderma sp.	Ga113	28	1	1	33.505 N	135.000 W	M-01-025	7	50-25 m
		Pneumoderma sp.	Ga113	28	2	1	33.505 N	135.000 W	M-01-025	7	50-25 m
	14-Sep-12	*Cavolinia inflexa*	Ga37	16		3	33.629 N	134.986 W	Reeve	25	0-35 m
Test 9	14-Sep-12	*Cavolinia inflexa*	Ga37	17		1	33.751	133.582 W	Reeve	26	0-35 m
		Cuvierina columnella	Ga06	23		2	33.751	133.582 W	Reeve	26	0-35 m
		Diacria quatridentata	Ga07	13		1	33.751	133.582 W	Reeve	26	0-35 m

Appendix 9 - Pteropods Preserved in 70% Ethanol

Station	Date	Gear Type	Net	Species	N
test 1	11-Aug-2012	Reeve	1	*Limacina helicina*	6
test 3	12-Aug-2012	Reeve	2	*Limacina helicina*	39
test 4	16-Aug-2012	Reeve	4	*Limacina helicina*	12
test 5	28-Aug-2012	Reeve	5	*Limacina helicina*	27
test 6	28-Aug-2012	Reeve	6	*Limacina helicina*	50
test 7	29-Aug-2012	Reeve	7	*Limacina helicina*	27
				Clio pyramidata	25
				Limacina helicina	25
test 8	30-Aug-2012	Reeve	8	*Limacina helicina*	34
3	31-Aug-2012	Reeve	9	*Limacina helicina*	14
6	2-Sep-2012	Reeve	10	*Limacina helicina*	21
7	2-Sep-2012	Reeve	11	*Limacina helicina*	80
				Clio pyramidata	30
7	3-Sep-2012	M-01-07	8	*Clio polita*?	shell fragments
11	4-Sep-2012	M-01-10	5	*Limacina helicina*	1
15	5-Sep-2012	M-01-11	0	*Limacina helicina*	2
				Clio pyramidata	1
			8	*Limacina helicina*	6
18	7-Sep-2012	M-01-13	0	*Clio pyramidata*	4
				Cavolinia uncinata	1
			7	*Clio pyramidata*	4
			8	*Clio pyramidata*	3
		M-01-14	2	*Clio pyramidata*	1
			4	*Clio pyramidata*	2
				Clio pyramidata	1
			6	*Cavolinia uncinata*	2
				Clio pyramidata	4
			7	*Cavolinia uncinata*	4
		Reeve	16	*Limacina inflata*	1000
21	8-Sep-2012	M-01-15	7	*Cavolinia uncinata*	1
		M-01-16	4	*Cavolinia uncinata*	1
			6	*Cavolinia uncinata*	1
		Reeve	17	*Limacina inflata*	100
24	9-Sep-2012	M-01-17	4	*Clio pyramidata*	5
			7	*Cavolinia uncinata*	1
		Reeve	19	*Cuvierina columnella*	2
	10-Sep-2012	M-01-18	6	*Cavolinia uncinata*	1
27	10-Sep-2012	M-01-19	6	*Cavolinia uncinata*	2
			7	*Cavolinia uncinata*	3
		M-01-20	5	*Clio pyramidata*	1
			6	*Cavolinia uncinata*	2

Station	Date	Gear Type	Net	Species	N
30	12-Sep-2012	M-01-21	6	*Cavolinia inflexa*	1
				Clio pyramidata	2
				Styliola subula	1
			7	*Cavolinia inflexa*	4
				Clio pyramidata	1
				Diacria quatridentata	1
		M-01-22	0	*Cavolinia uncinata*	1
				Cavolinia inflexa	2
			4	*Cuvierina columnella*	1
				Cavolinia inflexa	3
			6	*Diacria quatridentata*	1
				Styliola subula	2
			7	*Diacria quatridentata*	4
32	13-Sep-2012	M-01-23	5	*Clio pyramidata*	1
			7	*Cavolinia inflexa*	1
			8	*Cavolinia inflexa*	12
		M-01-24	0	*Cavolinia uncinata*	1
			4	*Cuvierina columnella*	2
				Cavolinia inflexa	1
				Clio pyramidata	3
34	14-Sep-2012	M-01-25	5	*Cavolinia inflexa*	1
				Clio pyramidata	7
				Styliola subula	8
				Diacria trispinosa	1
			7	*Diacria trispinosa*	1
		M-01-26	0	*Cuvierina columnella*	1
			4	*Cavolinia inflexa*	5
				Clio pyramidata	4
				Styliola subula	10

Appendix 10 - Table of Animals Other Than Pteropods Preserved for Genetic Analysis

Station	Date	Taxa	Species #	Vial #	Latitude	Longitude	CMarZ group	N	Gear Type	Net	Depth
Test 2	11-Aug-12	*Euchirella rostrata*	Co076	4	45.576 N	128.453 W	Copepoda	2	Reeve	1	0-140 m
		Neocalanus cristatus	Co227	4	45.576 N	128.453 W	Copepoda	2	Reeve	1	0-140 m
		Nematobrachion flexipes	Eu01	9	45.576 N	128.453 W	Euphausiacea	1	Reeve	1	0-140 m
		Thysanoessa longipes	Eu15	3	45.576 N	128.453 W	Euphausiacea	1	Reeve	1	0-140 m
		Nematoscelis difficilis	Eu22	5	45.576 N	128.453 W	Euphausiacea	2	Reeve	1	0-140 m
		Euphausia pacifica	Eu27	2	45.576 N	128.453 W	Euphausiacea	21	Reeve	1	0-140 m
Test 3	12-Aug-12	*Neocalanus cristatus*	Co227	5	46.620 N	133.522 W	Copepoda	9	Reeve	2	0-100 m
		Thysanoessa gregaria	Eu03	6	46.620 N	133.522 W	Euphausiacea	3	Reeve	2	0-100 m
		Thysanoessa longipes	Eu15	4	46.620 N	133.522 W	Euphausiacea	30	Reeve	2	0-100 m
		Nematoscelis difficilis	Eu22	6	46.620 N	133.522 W	Euphausiacea	2	Reeve	2	0-100 m
		Euphausia pacifica	Eu27	3	46.620 N	133.522 W	Euphausiacea	3	Reeve	2	0-100 m
Test 4	13-Aug-12	*Metridia lucens*	Co221	4	47.659 N	138.467 W	Copepoda	10	Reeve	3	0-100 m
		Neocalanus cristatus	Co227	6	47.659 N	138.467 W	Copepoda	30	Reeve	3	0-100 m
		Thysanoessa longipes	Eu15	5	47.659 N	138.467 W	Euphausiacea	29	Reeve	3	0-100 m
		Tessarabrachion oculatus	Eu24	3	47.659 N	138.467 W	Euphausiacea	13	Reeve	3	0-100 m
		Euphausia pacifica	Eu27	4	47.659 N	138.467 W	Euphausiacea	18	Reeve	3	0-100 m
		Stylocheiron maximum	Eu39	5	47.659 N	138.467 W	Euphausiacea	4	Reeve	3	0-100 m
		Thysanoessa spp.	Eu55	2	47.659 N	138.467 W	Euphausiacea	30	Reeve	3	0-100 m
01	15-Aug-12	*Candacia columbiae*	Co443	1	49.879 N	149.413 W	Copepoda	6	Reeve	3	0-60 m
		Tessarabrachion oculatus	Eu24	4	49.879 N	149.413 W	Euphausiacea	1	Reeve	3	0-100 m
		Euphausia pacifica	Eu27	5	49.879 N	149.413 W	Euphausiacea	23	Reeve	3	0-100 m
		Thysanoessa spp.	Eu55	3	49.879 N	149.413 W	Euphausiacea	7	Reeve	3	0-100 m
	16-Aug-12	*Neocalanus cristatus*	Co227	7	49.860 N	149.438 W	Copepoda	3	M-01-002	0	0-712 m
		Pareuchaeta sp.	Co319	2	49.860 N	149.438 W	Copepoda	11	M-01-002	0	0-712 m
		Calanoid copepod	Co442	1	49.860 N	149.438 W	Copepoda	2	M-01-002	0	0-712 m
		Thysanoessa longipes	Eu15	6	49.860 N	149.438 W	Euphausiacea	5	M-01-002	0	0-712 m
		Tessarabrachion oculatus	Eu24	5	49.860 N	149.438 W	Euphausiacea	2	M-01-002	0	0-712 m
		Euphausia pacifica	Eu27	6	49.860 N	149.438 W	Euphausiacea	3	M-01-002	0	0-712 m
		Stylocheiron maximum	Eu39	6	49.860 N	149.438 W	Euphausiacea	1	M-01-002	0	0-712 m
		nemertine worm	Ne04	2	49.860 N	149.438 W	Nemertea	2	M-01-002	0	0-712 m
Test 5	27-Aug-12	*Neocalanus cristatus*	Co227	8	45.680 N	129.805 W	Copepoda	64	Reeve	5	0-60 m
		Euchirella sp.	Co444	1	45.680 N	129.805 W	Copepoda	1	Reeve	5	0-60 m
		Thysanoessa longipes	Eu15	7	45.680 N	129.805 W	Euphausiacea	23	Reeve	5	0-60 m
		Euphausia pacifica	Eu27	7	45.680 N	129.805 W	Euphausiacea	8	Reeve	5	0-60 m
Test 6	28-Aug-12	*Neocalanus cristatus*	Co227	9	46.622 N	134.927 W	Copepoda	100	Reeve	6	0-75 m
		Euphausia pacifica	Eu27	8	46.622 N	134.927 W	Euphausiacea	70	Reeve	6	0-75 m

Station	Date	Taxa	Species #	Vial #	Latitude	Longitude	CMarZ group	N	Gear Type	Net	Depth
		Thysanoessa spp.	Eu55	4	46.622 N	134.927 W	Euphausiacea	30	Reeve	6	0-75 m
Test 7	29-Aug-12	*Metridia lucens*	Co221	5	47.577 N	140.186 W	Copepoda	200	Reeve	7	0-90 m
		Neocalanus cristatus	Co227	10	47.577 N	140.186 W	Copepoda	50	Reeve	7	0-90 m
		Thysanoessa longipes	Eu15	8	47.577 N	140.186 W	Euphausiacea	14	Reeve	7	0-90 m
		Tessarabrachion oculatus	Eu24	6	47.577 N	140.186 W	Euphausiacea	5	Reeve	7	0-90 m
		Euphausia pacifica	Eu27	9	47.577 N	140.186 W	Euphausiacea	59	Reeve	7	0-90 m
		Stylocheiron maximum	Eu39	7	47.577 N	140.186 W	Euphausiacea	3	Reeve	7	0-90 m
		Thysanoessa spp.	Eu55	5	47.577 N	140.186 W	Euphausiacea	30	Reeve	7	0-90 m
Test 8	30-Aug-12	*Neocalanus cristatus*	Co227	11	48.543 N	145.622 W	Copepoda	117	Reeve	8	0-100 m
		Candacia columbiae	Co443	2	48.543 N	145.622 W	Copepoda	5	Reeve	8	0-100 m
		Thysanoessa longipes	Eu15	9	48.543 N	145.622 W	Euphausiacea	13	Reeve	8	0-100 m
		Tessarabrachion oculatus	Eu24	7	48.543 N	145.622 W	Euphausiacea	11	Reeve	8	0-100 m
		Euphausia pacifica	Eu27	10	48.543 N	145.622 W	Euphausiacea	16	Reeve	8	0-100 m
07	03-Sep-12	*Poeobius meseres*	Po11	01	47.021 N	144.611 W	Polychaeta	2	M-01-008	2	800-600 m
11	04-Sep-12	*Megacalanus* sp.	Co429	3	45.046 N	141.447 W	Copepoda	2	M-01-009	2	797-599 m
		Megacalanus sp.	Co429	4	45.046 N	141.447 W	Copepoda	1	M-01-009	3	598-399 m
		Nematoscelis difficilis	Eu22	7	44.946 N	141.319 W	Euphausiacea	1	Reeve	12	0-80 m
		Poeobius meseres	Po11	02	45.046 N	141.447 W	Polychaeta	1	M-01-009	2	797-599 m
13	05-Sep-12	*Nematoscelis difficilis*	Eu22	8	44.001 N	139.472 W	Euphausiacea	1	Reeve	13	0-80 m
18	06-Sep-12	*Nematobrachion flexipes*	Eu01	10	41.500 N	135.771 W	Euphausiacea	3	Reeve	15	0-65 m
		Euphausia pacifica	Eu27	11	41.500 N	135.771 W	Euphausiacea	1	Reeve	15	0-65 m
		Euphausia recurva	Eu65	2	41.500 N	135.771 W	Euphausiacea	9	Reeve	15	0-65 m
	07-Sep-12	*Megacalanus* sp.	Co429	5	41.533 N	135.786 W	Copepoda	1	M-01-013	3	399-600 m
		Megacalanus sp.	Co429	6	41.720 N	135.823 W	Copepoda	1	M-01-014	2	600-800 m
21	08-Sep-12	*Bentheuphausia amblyops*	Eu05	4	40.003 N	135.000 W	Euphausiacea	1	M-01-015	1	1000-800 m
	09-Sep-12	*Thysanoessa gregaria*	Eu03	7	40.062 N	135.091 W	Euphausiacea	15	Reeve	18	0-200 m
		Nematoscelis difficilis	Eu22	9	40.062 N	135.091 W	Euphausiacea	4	Reeve	18	0-200 m
		Euphausia pacifica	Eu27	12	40.062 N	135.091 W	Euphausiacea	1	Reeve	18	0-200 m
		Stylocheiron longicornis	Eu36	8	40.062 N	135.091 W	Euphausiacea	3	Reeve	18	0-200 m
		Euphausia gibboides	Eu44	7	40.062 N	135.091 W	Euphausiacea	4	Reeve	18	0-200 m
		Euphausia recurva	Eu65	3	40.062 N	135.091 W	Euphausiacea	2	Reeve	18	0-200 m
		Thysanopoda acutifrons	Eu71	1	40.062 N	135.091 W	Euphausiacea	4	Reeve	18	0-200 m
24	09-Sep-12	*Megacalanus* sp.	Co429	7	38.623 N	135.062 W	Copepoda	1	M-01-018	4	400-200 m
		Thysanoessa gregaria	Eu03	8	38.629 N	135.046 W	Euphausiacea	3	Reeve	19	0-200 m
		Euphausia mutica	Eu19	3	38.629 N	135.046 W	Euphausiacea	1	Reeve	19	0-200 m
		Stylocheiron longicorne	Eu36	9	38.629 N	135.046 W	Euphausiacea	9	Reeve	19	0-200 m
		Euphausia recurva	Eu65	4	38.629 N	135.046 W	Euphausiacea	11	Reeve	19	0-200 m

Station	Date	Taxa	Species #	Vial #	Latitude	Longitude	CMarZ group	N	Gear Type	Net	Depth
		Euphausia paragibba	Eu72	1	38.629 N	135.046 W	Euphausiacea	2	Reeve	19	0-200 m
27	10-Sep-12	*Megacalanus* sp.	Co429	8	37.231 N	135.129 W	Copepoda	1	M-01-020	2	600-800 m
		Thysanoessa gregaria	Eu03	9	37.204 N	135.128 W	Euphausiacea	3	Reeve	20	0-200 m
		Euphausia mutica	Eu19	4	37.204 N	135.128 W	Euphausiacea	9	Reeve	20	0-200 m
		Euphausia recurva	Eu65	5	37.204 N	135.128 W	Euphausiacea	2	Reeve	20	0-200 m
		Euphausia paragibba	Eu72	2	37.204 N	135.128 W	Euphausiacea	4	Reeve	20	0-200 m
		Leptocephalus larvae	Ve48	1	37.231 N	135.129 W	Vertebrata	1	M-01-020	5	200-100 m
30	11-Sep-12	*Gaussia princeps*	Co118	10	35.552 N	135.009 W	Copepoda	1	Reeve	22	0-150 m
		Stylocheiron abbreviatum	Eu11	10	35.552 N	135.009 W	Euphausiacea	14	Reeve	22	0-150 m
		Euphausia mutica	Eu19	5	35.552 N	135.009 W	Euphausiacea	1	Reeve	22	0-150 m
		Euphausia hemigibba	Eu45	2	35.552 N	135.009 W	Euphausiacea	1	Reeve	22	0-150 m
		Nematoscelis tenella	Eu50	3	35.552 N	135.009 W	Euphausiacea	1	Reeve	22	0-150 m
		Euphausia recurva	Eu65	6	35.552 N	135.009 W	Euphausiacea	11	Reeve	22	0-150 m
		Pedunculated eyes fish larvae	Ve49	1	35.552 N	135.009 W	Vertebrata	2	Reeve	22	0-150 m
32	12-Sep-12	*Megacalanus* sp.	Co429	9	34.501 N	135.000 W	Copepoda	1	M-01-023	0	0-1000 m
	13-Sep-12	*Euphausia mutica*	Eu19	6	34.443 N	135.111 W	Euphausiacea	2	Reeve	24	0-60 m
		Stylocheiron affine	Eu51	2	34.443 N	135.111 W	Euphausiacea	10	Reeve	24	0-60 m
		Euphausia recurva	Eu65	7	34.443 N	135.111 W	Euphausiacea	11	Reeve	24	0-60 m
34	13-Sep-12	*Megacalanus* sp.	Co429	10	33.505 N	135.000 W	Copepoda	1	M-01-025	3	600-400 m
	14-Sep-12	Amphipod	Am78	1	33.589 N	134.979 W	Euphausiacea	1	M-01-026	3	600-400 m
		Bentheuphausia amblyops	Eu05	5	33.589 N	134.979 W	Euphausiacea	1	M-01-026	2	800-600 m
		Nematoscelis atlantica	Eu14	10	33.629 N	134.986 W	Euphausiacea	1	Reeve	25	0-35 m
		Stylocheiron affine	Eu51	3	33.629 N	134.986 W	Euphausiacea	50	Reeve	25	0-35 m
		Stylocheiron affine	Eu51	4	33.629 N	134.986 W	Euphausiacea	2	Reeve	25	0-35 m
		Euphausia recurva	Eu65	8	33.629 N	134.986 W	Euphausiacea	10	Reeve	25	0-35 m

Appendix 11 - Event Log

Event	Instrument	Action	T	Stn	Cast	Time Local	Date GMT	Time GMT	Time Zone	Latitude	Longitude	Sea floor (m)	Cast Depth (m)	PI name	Comment
20120809.2300.001	Ship	start Cruise	0		0	1600	9-Aug-2012	2300	-7	44.626358	-124.049292				
20120810.0223.001	Hull HTI	start	0			1922	10-Aug-2012	0223	-7	44.733203	-124.696980			G.Lawson	
20120810.1509.001	Hull HTI	end	0			0809	10-Aug-2012	1509	-7	44.626267	-124.049272			G.Lawson	
20120810.1511.001	Ship	other	0			0810	10-Aug-2012	1511	-7	44.626268	-124.049267				Arrived back in port for evaporator repair
20120811.0130.001	Ship	other	0		0	1829	11-Aug-2012	0130	-7	44.627003	-124.050512				restart of cruise
20120811.0216.001	Hull HTI	start	0			1915	11-Aug-2012	0216	-7	44.617185	-124.176532			G.Lawson	
20120811.0505.001	GO pCO2	start	0			2205	11-Aug-2012	0505	-7	44.743985	-124.748230			A.Wang	UTC 5:05 on 11aug2012. changed 20120811.2222 to 20120811.0505, changed lat/lon with uway log
20120811.2030.001	Ship	start Station	0	Test 1		1330	11-Aug-2012	2030	-7	45.422900	-127.855900				actual start of Test station was 13:30 from 02:24. Changed utc, event#, etc., lat/lon from uway log
20120811.2059.002	MOCNESS	start	0	Test 1	1	1400	11-Aug-2012	2059	-7	45.431775	-127.864553		50	P.Wiebe	
20120811.2219.001	MOCNESS	end	0	Test 1	1	1519	11-Aug-2012	2219	-7	45.434432	-127.863468		50	P.Wiebe	
20120811.2332.001	CTD911	start	0	Test 1	1	1631	11-Aug-2012	2332	-7	45.435163	-127.874497		500	A.Wang	
20120811.2332.002	VPR	start	0	Test 1	1	1631	11-Aug-2012	2337	-7	45.435163	-127.874497		500	G.Lawson	added event late; utc/latlon ok
20120811.2340.001	Echosounder	start	0	Test 1		1636	11-Aug-2012	2340	-7	45.433855	-127.876337	2937			
20120811.2345.001	Echosounder	end	0	Test 1		1645	11-Aug-2012	2345	-7	45.432900	-127.877000	2937			entered later; time/position approximate
20120812.0052.001	CTD911	end	0	Test 1	1	1752	12-Aug-2012	0052	-7	45.427900	-127.895900		500	A.Wang	this was added later; corrected utc, etc. from 12th @utc 2331 to 12th @ 0052; added lat/long from uway log
20120812.0052.002	VPR	end	0	Test 1	1	1752	12-Aug-2012	0052	-7	45.427900	-127.895900		500	G.Lawson	entered late; utc/latlon ok
20120812.0122.001	HammarHead	start	0	Test 1	1	1821	12-Aug-2012	0122	-7	45.434658	-127.908942			G.Lawson	
20120812.0124.001	Hull HTI	end	0	Test 1		1824	12-Aug-2012	0124	-7	45.435883	-127.909988			G.Lawson	
20120812.0216.001	HammarHead	end	0	Test 1	1	1914	12-Aug-2012	0216	-7	45.477257	-127.945107			G.Lawson	
20120812.0222.001	Ship	end Station	0	Test 1		1921	12-Aug-2012	0222	-7	45.479742	-127.948522				
20120812.0247.001	Hull HTI	start	0			1943	12-Aug-2012	0247	-7	45.496953	-128.016697			G.Lawson	

20120812.0500.001	Ship	start Station	0	Test 2		2200	12-Aug-2012	0500	-7	45.576160	-128.450758				11 aug. 2012 local time 2200. entered late (21:26). corrected utc time, etc., lat/lon from uway log
20120812.0507.001	ReeveNet	start	0	Test 2	1	2207	12-Aug-2012	0507	-7	45.575665	-128.453218		150 mwo	G.Lawson	140m depth on TD logger
20120812.0556.001	ReeveNet	end	0	Test 2	1	2256	12-Aug-2012	0556	-7	45.570737	-128.468822		150 mwo	G.Lawson	140m depth on TD logger
20120812.0600.001	Ship	end Station	0	Test 2		2300	12-Aug-2012	0600	-7	45.570000	-128.469600				occured local 11 aug, 2300. corrected utc, etc.from 20120812.2127.001 to 20120812.0600.001 and lat/lon frm uway log
20120812.2122.001	ADCP	start	0			1415	12-Aug-2012	2122	-7	46.252152	-131.746038			G.Lawson	
20120813.0135.001	MICA	start	0			1832	13-Aug-2012	0135	-7	46.453188	-132.682117			A.Wang	Only pH Channel is running
20120813.0524.001	Ship	start Station	0	Test 3		2224	13-Aug-2012	0524	-7	46.626177	-133.516980				
20120813.0536.001	ReeveNet	start	0	Test 3	2	2235	13-Aug-2012	0536	-7	46.620313	-133.522212		100 mwo	G.Lawson	
20120813.0617.001	ReeveNet	end	0	Test 3	2	2314	13-Aug-2012	0617	-7	46.611633	-133.532277		100 mwo	G.Lawson	
20120813.0619.001	Ship	end Station	0	Test 3		2319	13-Aug-2012	0619	-7	46.611287	-133.535820				
20120814.0234.001	Hull HTI	end	0			1932	14-Aug-2012	0234	-7	47.512235	-137.734272			G.Lawson	system crashed
20120814.0241.001	Hull HTI	start	0			1941	14-Aug-2012	0241	-7	47.517860	-137.760682			G.Lawson	restart after system crash
20120814.0600.001	Ship	start Station	0	Test 4		2300	14-Aug-2012	0620	-7	47.659600	-138.466100				test sta. 4 start and end not entered on time. corrected lat/lon/utc, etc.; Changed 20120815.2021.001 to 20120814.0600.001
20120814.0603.001	ReeveNet	start	0	Test 4	3	2303	14-Aug-2012	0603	-7	47.659212	-138.466735		120 mwo	G.Lawson	~95m on TD logger
20120814.0653.001	ReeveNet	end	0	Test 4	3	2352	14-Aug-2012	0653	-7	47.664188	-138.454097		120 mwo	G.Lawson	~95m on TD logger
20120814.0659.001	Ship	end Station	0	Test 4		2359	14-Aug-2012	0659	-7	47.666800	-138.448600				test sta. 4 start and end not entered on time. corrected lat/lon/utc, etc.; Changed 20120815.2022.001 to 20120814.0659.001
20120814.0800.001	Ship	Change Time zone	0			0000	14-Aug-2012	08:00:0+	-8	47.398700	-137.193600				time zone changed from -7 to -8 on 8/13 at midnight; entered late; lat/lon corrected; 20120815.0309.001 changed to 20120814.0800.001

20120815.1014.001	Hull HTI	end	0			0214	15-Aug-2012	1014	-8	48.889986	-144.468625			G.Lawson	Put in late, updated lat/lon; Changed 20120815.1226.001 to 20120815.1014.001
20120815.2329.001	Hull HTI	start	0			1530	15-Aug-2012	2329	-8	49.863798	-149.315680			G.Lawson	Entered ~10 late: Changed local time from 07:30 on 16th to 15:30 on 15th; Changed 20120816.0730.001 to 20120815.2329.001
20120816.0527.001	XBT	release	0		1	2128	16-Aug-2012	0527	-8	49.776495	-148.870743			G.Lawson	XBT - near station 1
20120816.0757.001	Ship	start Transect	1	1		2357	16-Aug-2012	0757	-8	49.882990	-149.413108				
20120816.0757.002	Ship	start Station	1	1		2357	16-Aug-2012	0757	-8	49.882990	-149.413108				
20120816.0807.001	ReeveNet	start	1	1	4	0007	16-Aug-2012	0807	-8	49.879678	-149.413400		64 mwo	G.Lawson	changed timezone from -7 to -8
20120816.0830.001	ReeveNet	end	1	1	4	0030	16-Aug-2012	0830	-8	49.873185	-149.413722		64 mwo	G.Lawson	changed timezone from -7 to -8
20120816.0905.001	MOCNESS	start	1	1	2	0057	16-Aug-2012	0905	-8	49.860742	-149.438258		1000	P.Wiebe	bad tow: uw unit and flowmeter both failed. Only n0 sampled.
20120816.1027.001	Echosounder	start	1	1		0225	16-Aug-2012	1027	-8	49.874348	-149.511482				
20120816.1027.002	Echosounder	end	1	1		0227	16-Aug-2012	1027	-8	49.874358	-149.511657				
20120816.1057.001	MOCNESS	end	1	1	2	0257	16-Aug-2012	1057	-8	49.878050	-149.536405		1000	P.Wiebe	
20120816.1121.001	Echosounder	start	1	1		0321	16-Aug-2012	1121	-8	49.876298	-149.551505				
20120816.1124.001	Echosounder	end	1	1		0324	16-Aug-2012	1124	-8	49.876153	-149.551525				
20120816.1133.001	CTD911	start	1	1	2	0333	16-Aug-2012	1134	-8	49.876330	-149.551145		1000	A.Wang	
20120816.1133.002	VPR	start	1	1	2	0333	16-Aug-2012	1134	-8	49.876330	-149.551145		1000	G.Lawson	entered late; utc/latlon ok
20120816.1256.001	CTD911	end	1	1	2	0452	16-Aug-2012	1256	-8	49.875647	-149.541137		1000	A.Wang	
20120816.1256.002	VPR	end	1	1	2	0452	16-Aug-2012	1256	-8	49.875647	-149.541137		1000	G.Lawson	added late; utc/latlon ok
20120816.1257.001	Ship	end Station	1	1		0456	16-Aug-2012	1257	-8	49.875752	-149.540537				
20120816.1557.001	Ship	start Station	1	2		0756	16-Aug-2012	1557	-8	49.521683	-149.126067				
20120816.1618.001	MOCNESS	start	1	2	3.x	0818	16-Aug-2012	1618	-8	49.510700	-149.128700		25	P.Wiebe	aborted: angle=0; changed uw unit; added late; corrected utc (1618) ; lat/lon corrected
20120816.1626.001	MOCNESS	abort	1	2	3.x	0826	16-Aug-2012	1626	-8	49.506000	-149.132400		25	P.Wiebe	corrected utc & lat/lon; Changed 20120816.1617.001 to 20120816.1626.001
20120816.1727.001	MOCNESS	start	1	2	3	0925	16-Aug-2012	1727	-8	49.491617	-149.163710		1000	P.Wiebe	

20120816.2029.001	MOCNESS	end	1	2	3	1228	16-Aug-2012	2029	-8	49.430070	-149.264372		1000	P.Wiebe	
20120816.2111.001	Echosounder	start	1	2		1308	16-Aug-2012	2111	-8	49.414083	-149.277385				
20120816.2112.001	Echosounder	end	1	2		1312	16-Aug-2012	2112	-8	49.413960	-149.277170				
20120816.2121.001	CTD911	start	1	2	3	1321	16-Aug-2012	2121	-8	49.414367	-149.273772		1000	A.Wang	
20120816.2121.002	VPR	start	1	2	3	1321	16-Aug-2012	2121	-8	49.414367	-149.273772		1000	G.Lawson	added late; utc/latlon ok
20120816.2227.001	CTD911	end	1	2	3	1427	16-Aug-2012	2228	-8	49.413567	-149.252862		1000	A.Wang	
20120816.2227.002	VPR	end	1	2	3	1427	16-Aug-2012	2228	-8	49.413567	-149.252862		1000	G.Lawson	added late; utc/latlon ok
20120816.2252.001	CTD911	start	1	2	4	1446	16-Aug-2012	2252	-8	49.409852	-149.244650	4676	3000	A.Wang	3000 ctd
20120816.2329.001	Echosounder	start	1	2		1528	16-Aug-2012	2329	-8	49.406633	-149.237118	4676	3000		
20120817.0211.001	HammarHead	start	1	2	2	1811	17-Aug-2012	0211	-8	49.384487	-149.243190			G.Lawson	Fish actually went in about 10 minutes ago
20120817.0211.002	ADCP	end	1	2		1811	17-Aug-2012	0211	-8	49.384020	-149.244180			G.Lawson	added late; corrected utc from 17.1714 to 17.0211 ; corrected lat/lon
20120817.0211.003	Hull HTI	end	1	2		1811	17-Aug-2012	0211	-8	49.384020	-149.244180			G.Lawson	Stopped when we started the HammarHead cast. UTC changed from 0618 to 0211. lat/lon corrected
20120817.0213.001	CTD911	end	1	2	4	1735	17-Aug-2012	0213	-8	49.385533	-149.241093	4676	3000	A.Wang	is local time correct for this entry? it was probably queued up and not reset upon submit
20120817.0215.001	Echosounder	end	1	2		1815	17-Aug-2012	0215	-8	49.386678	-149.239163	4676	3000		
20120817.0544.001	HammarHead	end	1	2	2	2143	17-Aug-2012	0544	-8	49.534345	-149.084620			G.Lawson	
20120817.0604.001	Ship	end Station	1	2		2203	17-Aug-2012	0604	-8	49.538573	-149.034997				a bit late
20120817.0604.002	Ship	end Transect	1	2		2204	17-Aug-2012	0604	-8	49.538358	-149.032997				
20120817.0605.001	Ship	other	1	2		2204	17-Aug-2012	0605	-8	49.538027	-149.029112				abort cruise: heading for Newport; generator down
20120817.0619.001	Hull HTI	start	2			2218	17-Aug-2012	0619	-8	49.532340	-148.974532			G.Lawson	
20120817.0620.001	ADCP	start	2			2220	17-Aug-2012	0620	-8	49.531903	-148.970365			G.Lawson	forgot to add end of this cast
20120818.1452.001	Hull HTI	end	2			0601	18-Aug-2012	1452	-8	48.121902	-141.084888			G.Lawson	
20120818.1453.001	Hull HTI	start	2			0643	18-Aug-2012	1453	-8	48.121583	-141.083275			G.Lawson	
20120819.0134.001	Hull HTI	end	2			1734	19-Aug-2012	0134	-8	47.601418	-138.708510			G.Lawson	changed time local to match time utc
20120819.0138.001	Hull HTI	start	2			1737	19-Aug-2012	0138	-8	47.597415	-138.691502			G.Lawson	
20120819.0905.001	Ship	Change	2			0104	19-Aug-2012	0905	-8	47.247728	-136.956012				time zone changed from -8 to -7

		Time zone													on 8/19 at 1 am
20120821.1653.001	Hull HTI	end	2			0953	21-Aug-2012	1653	-7	44.626392	-124.048202			G.Lawson	changed utc from 17:53:48 to 16:53:48
20120821.1655.001	Ship	other	2			0954	21-Aug-2012	1655	-7	44.626365	-124.048232				Return to NOAA dock, Newport; changed utc from 17:53:48 to 16:53:48
20120825.1520.001	Ship	other				0800	25-Aug-2012	1520	-7	44.626365	-124.048232				depart NOAA dock; change time 1517 to 1500
20120825.1521.001	Ship	other				0820	25-Aug-2012	1521	-7	44.625733	-124.045025				arrive OSU dock
20120826.2301.001	Ship	other	3			1600	26-Aug-2012	2301	-7	44.625733	-124.045025				restart cruise - yet again! manually added lat/lon (same as previous event)
20120826.2301.002	Ship	start Transect	3			1600	26-Aug-2012	2301	-7	44.625733	-124.045025				entered late. corrected utc, etc.
20120826.2339.001	Hull HTI	start	3			1637	26-Aug-2012	2339	-7	44.603453	-124.098163			G.Lawson	added lat/lon from uway data log
20120827.0027.001	ADCP	start	3			1726	27-Aug-2012	0027	-7	44.631023	-124.255033			G.Lawson	chnged utc to 0027; added lat/lon from uway data log
20120827.0119.001	GO pCO2	start	3			1817	27-Aug-2012	0119	-7	44.663848	-124.427128			A.Wang	added lat/lon from uway data log
20120827.0159.001	MICA	start	3			1858	27-Aug-2012	0200	-7	44.685580	-124.548563			A.Wang	added lat/lon from uway data log
20120827.1714.001	Ship	other	3			1013	27-Aug-2012	1714	-7	45.251613	-127.519683				test for lat/lon fix by N. Cohen
20120828.0418.001	XBT	release	3	Test 5	2	2120	28-Aug-2012	0418	-7	45.673062	-129.781503			G.Lawson	
20120828.0431.001	Ship	start Station	3	Test 5		2131	28-Aug-2012	0431	-7	45.677545	-129.809380				
20120828.0437.001	ReeveNet	start	3	Test 5	5	2132	28-Aug-2012	0437	-7	45.679880	-129.805650		60 mwo	G.Lawson	
20120828.0506.001	ReeveNet	end	3	Test 5	5	2206	28-Aug-2012	0506	-7	45.685068	-129.794592		60 mwo	G.Lawson	
20120828.0509.001	Ship	end Station	3	Test 5		2209	28-Aug-2012	0509	-7	45.685742	-129.791175				
20120828.1958.001	Hull HTI	end	3			1256	28-Aug-2012	1958	-7	46.264908	-133.003453			G.Lawson	stopped collection to backup data
20120828.2000.001	ADCP	end	3			1259	28-Aug-2012	2000	-7	46.266658	-133.011790			G.Lawson	
20120828.2122.001	Hull HTI	start	3			1422	28-Aug-2012	2122	-7	46.325245	-133.310338			G.Lawson	finished data backup
20120828.2124.001	ADCP	start	3			1424	28-Aug-2012	2124	-7	46.326400	-133.316958			G.Lawson	
20120829.0425.001	XBT	release	3	Test 6	3	2126	29-Aug-2012	0425	-7	46.603743	-134.823043			G.Lawson	
20120829.0500.001	Ship	start Station	3	Test 6		2200	29-Aug-2012	0500	-7	46.622378	-134.927343				Entered late; latlon, utc, etc. fixed; Chged 20120829.0536.001 to 20120829.0500.001

20120829.0500.002	ReeveNet	start	3	Test 6	6	2200	29-Aug-2012	0500	-7	46.622378	-134.927343		90 mwo	G.Lawson	
20120829.0531.001	ReeveNet	end	3	Test 6	6	2230	29-Aug-2012	0531	-7	46.624572	-134.942703		90 mwo	G.Lawson	
20120829.0541.001	Ship	end Station	3	Test 6		2240	29-Aug-2012	0541	-7	46.628498	-134.950012				
20120829.0900.001	Ship	change Time zone	3			0200	29-Aug-2012	0900	-7	46.753671	-135.643653				entered late; changed latlon utc, etc.
20120830.0527.001	XBT	release	3		4	2127	30-Aug-2012	0527	-8	47.558412	-140.079320			G.Lawson	
20120830.0555.001	Ship	start Station	3	Test 7		2154	30-Aug-2012	0555	-8	47.576492	-140.183658				
20120830.0557.001	ReeveNet	start	3	Test 7	7	2200	30-Aug-2012	0557	-8	47.577323	-140.186085		100 mwo	G.Lawson	
20120830.0633.001	ReeveNet	end	3	Test 7	7	2234	30-Aug-2012	0633	-8	47.582500	-140.199672		100 mwo	G.Lawson	
20120830.0636.001	Ship	end Station	3	Test 7		2235	30-Aug-2012	0636	-8	47.583350	-140.200487				
20120831.0557.001	XBT	release	3		5	2156	31-Aug-2012	0557	-8	48.528262	-145.524832			G.Lawson	bad probe: surface temp was 14 but recorded as 5.
20120831.0602.001	XBT	release	3	Test 8	6	2201	31-Aug-2012	0602	-8	48.531912	-145.545128			G.Lawson	
20120831.0619.001	Ship	start Station	3	Test 8		2230	31-Aug-2012	0619	-8	48.544033	-145.611157				
20120831.0630.001	ReeveNet	start	3	Test 8	8	2230	31-Aug-2012	0630	-8	48.542765	-145.622335		100 mwo	G.Lawson	
20120831.0702.001	ReeveNet	end	3	Test 8	8	2300	31-Aug-2012	0702	-8	48.536947	-145.613065		100 mwo	G.Lawson	
20120831.0703.001	Ship	end Station	3	Test 8		2303	31-Aug-2012	0703	-8	48.536802	-145.612880				
20120831.1723.001	Echosounder	start	3			0922	31-Aug-2012	1723	-8	48.955170	-147.948792				
20120831.1726.001	Echosounder	end	3			0926	31-Aug-2012	1726	-8	48.957098	-147.960732				
20120831.1831.001	Ship	start Station	1	3		1030	31-Aug-2012	1831	-8	48.998495	-148.203800				
20120831.1902.001	MOCNESS	start	1	3	4	1103	31-Aug-2012	1902	-8	48.995570	-148.227203		~1000 m; ~1500 mwo	P.Wiebe	
20120831.2134.001	MOCNESS	abort	1	3	4	1333	31-Aug-2012	2134	-8	48.974587	-148.335253		~1000 m; ~1500 mwo	P.Wiebe	lost communication with uw unit
20120831.2139.001	Echosounder	start	1	3		1338	31-Aug-2012	2139	-8	48.973083	-148.338453				
20120831.2141.001	Echosounder	end	1	3		1341	31-Aug-2012	2141	-8	48.972363	-148.339975				

20120831.2204.001	CTD911	start	1	3	5	1403	31-Aug-2012	2204	-8	48.967862	-148.340275		1000	A.Wang	
20120831.2204.002	VPR	start	1	3	4	1403	31-Aug-2012	2204	-8	48.967862	-148.340275		1000	G.Lawson	added late; utc/latlon ok
20120831.2307.001	CTD911	end	1	3	5	1507	31-Aug-2012	2307	-8	48.959700	-148.325660		1000	A.Wang	
20120831.2307.002	VPR	end	1	3	4	1507	31-Aug-2012	2307	-8	48.959700	-148.325660		1000	G.Lawson	added late; utc/latlon ok
20120831.2343.001	MOCNESS	start	1	3	5	1537	31-Aug-2012	2343	-8	48.943348	-148.332788		1000	P.Wiebe	entered a little late
20120901.0206.001	MOCNESS	end	1	3	5	1806	1-Sep-2012	0206	-8	48.944045	-148.428493		1000	P.Wiebe	added late; corrected utc to 9/1 @ 0206; lat/lon corrected
20120901.0240.001	CTD911	start	1	3	6	1839	1-Sep-2012	0240	-8	48.944268	-148.439815		3000	A.Wang	
20120901.0245.001	Echosounder	start	1	3		1844	1-Sep-2012	0245	-8	48.943073	-148.441517	3600 - 4700			
20120901.0248.001	Echosounder	end	1	3		1847	1-Sep-2012	0248	-8	48.942955	-148.442358				
20120901.0518.001	CTD911	end	1	3	6	2118	1-Sep-2012	0518	-8	48.925158	-148.494847		3000	A.Wang	
20120901.0553.001	HammarHead	start	1	3	3	2151	1-Sep-2012	0553	-8	48.912750	-148.524073		240	G.Lawson	
20120901.0559.001	Hull HTI	end	1	3		2158	1-Sep-2012	0559	-8	48.911900	-148.530567			G.Lawson	
20120901.0641.001	Hull HTI	start	1	3		2241	1-Sep-2012	0641	-8	48.916738	-148.590698			G.Lawson	
20120901.0653.001	HammarHead	end	1	3	3	2250	1-Sep-2012	0653	-8	48.916745	-148.598738		240	G.Lawson	
20120901.0708.001	ReeveNet	start	1	3	9	2305	1-Sep-2012	0708	-8	48.915042	-148.607412		100 mwo	G.Lawson	
20120901.0742.001	ReeveNet	end	1	3	9	2340	1-Sep-2012	0742	-8	48.911522	-148.625958		100 mwo	G.Lawson	
20120901.0843.001	MOCNESS	start	1	3	6	0039	1-Sep-2012	0843	-8	48.912867	-148.681227		1000	P.Wiebe	
20120901.1154.001	MOCNESS	end	1	3	6	0354	1-Sep-2012	1154	-8	48.941297	-148.839793		1000	P.Wiebe	
20120901.1155.001	Echosounder	start	1	3		0355	1-Sep-2012	1155	-8	48.941405	-148.840378				
20120901.1156.001	Echosounder	end	1	3		0356	1-Sep-2012	1156	-8	48.941505	-148.841065				
20120901.1245.001	CTD911	start	1	3	7	0444	1-Sep-2012	1245	-8	48.943572	-148.860302		1000	A.Wang	
20120901.1245.002	VPR	start	1	3	5	0444	1-Sep-2012	1245	-8	48.943572	-148.860302		1000	G.Lawson	added late; utc/latlon ok
20120901.1344.001	CTD911	end	1	3	7	0544	1-Sep-2012	1344	-8	48.938303	-148.864258		1000	A.Wang	
20120901.1344.002	VPR	end	1	3	5	0544	1-Sep-2012	1344	-8	48.938303	-148.864258		1000	G.Lawson	added late; utc/latlon ok
20120901.1352.001	Ship	end Station	1	3		0552	1-Sep-2012	1352	-8	48.938647	-148.872442				
20120901.2041.001	Ship	start Station	1	4		1240	1-Sep-2012	2041	-8	48.499323	-147.319947				

20120901.2041.002	Echosounder	start	1	4		1241	1-Sep-2012	2041	-8	48.499068	-147.319907				
20120901.2042.001	Echosounder	end	1	4		1242	1-Sep-2012	2042	-8	48.498592	-147.320382				
20120901.2050.001	CTD911	start	1	4	8	1249	1-Sep-2012	2050	-8	48.497585	-147.320673		1000	A.Wang	
20120901.2050.002	VPR	start	1	4	6	1250	1-Sep-2012	2051	-8	48.497488	-147.320707		1000	G.Lawson	
20120901.2221.001	CTD911	end	1	4	8	1419	1-Sep-2012	2221	-8	48.483195	-147.327152		1000	A.Wang	
20120901.2222.001	VPR	end	1	4	6	1421	1-Sep-2012	2222	-8	48.483118	-147.327188		1000	G.Lawson	
20120901.2223.001	Ship	end Station	1	4		1422	1-Sep-2012	2223	-8	48.483038	-147.327320				
20120902.0314.001	Ship	start Station	1	5		1911	2-Sep-2012	0314	-8	47.999048	-146.449247		1000		
20120902.0315.001	Echosounder	start	1	5		1914	2-Sep-2012	0315	-8	47.998980	-146.449463	3800 m	1000		
20120902.0319.001	CTD911	start	1	5	9	1918	2-Sep-2012	0319	-8	47.998483	-146.450355	3800	1000	A.Wang	
20120902.0320.001	VPR	start	1	5	7	1920	2-Sep-2012	0320	-8	47.998360	-146.450728	3800	1000	G.Lawson	
20120902.0321.001	Echosounder	end	1	5		1921	2-Sep-2012	0321	-8	47.998235	-146.450987	3800	1000		
20120902.0440.001	CTD911	end	1	5	9	2039	2-Sep-2012	0440	-8	47.992022	-146.468058	3800	1000	A.Wang	
20120902.0440.002	VPR	end	1	5	7	2040	2-Sep-2012	0440	-8	47.992020	-146.468198	3800	1000	G.Lawson	
20120902.0444.001	Ship	end Station	1	5		2042	2-Sep-2012	0444	-8	47.991622	-146.472440		1000		
20120902.0943.001	Ship	start Station	1	6		0142	2-Sep-2012	0943	-8	47.500532	-145.582900				
20120902.0953.001	ReeveNet	start	1	6	10	0150	2-Sep-2012	0953	-8	47.498698	-145.581197		100 mwo	G.Lawson	
20120902.1025.001	ReeveNet	end	1	6	10	0225	2-Sep-2012	1026	-8	47.496242	-145.581800		100 mwo	G.Lawson	
20120902.1029.001	Echosounder	start	1	6		0229	2-Sep-2012	1029	-8	47.496255	-145.581123				
20120902.1030.001	Echosounder	end	1	6		0230	2-Sep-2012	1030	-8	47.496325	-145.580888				
20120902.1044.001	CTD911	start	1	6	10	0243	2-Sep-2012	1044	-8	47.495038	-145.580760		1000	A.Wang	
20120902.1045.001	VPR	start	1	6	8	0245	2-Sep-2012	1045	-8	47.494925	-145.580747		1000	G.Lawson	
20120902.1208.001	CTD911	end	1	6	10	0408	2-Sep-2012	1208	-8	47.486463	-145.573950		1000	A.Wang	
20120902.1209.001	VPR	end	1	6	8	0408	2-Sep-2012	1209	-8	47.486398	-145.573830		1000	G.Lawson	when it came up it was not flashing...
20120902.1211.001	Ship	end Station	1	6		0411	2-Sep-2012	1211	-8	47.485978	-145.573462				
20120902.1644.001	Ship	start Station	1	7		0844	2-Sep-2012	1644	-8	46.999373	-144.726150				
20120902.1652.001	Echosounder	start	1	7		0851	2-Sep-2012	1652	-8	46.999133	-144.731625				

20120902.1653.001	Echosounder	end	1	7		0853	2-Sep-2012	1653	-8	46.999090	-144.732438				
20120902.1659.001	MOCNESS	start	1	7	7	0859	2-Sep-2012	1659	-8	46.998910	-144.736543		1000	P.Wiebe	
20120902.1943.001	MOCNESS	end	1	7	7	1142	2-Sep-2012	1943	-8	46.997495	-144.855445		1000	P.Wiebe	
20120902.1956.001	Echosounder	start	1	7		1156	2-Sep-2012	1956	-8	46.997562	-144.862947				
20120902.1958.001	Echosounder	end	1	7		1157	2-Sep-2012	1958	-8	46.997610	-144.862780				
20120902.2010.001	CTD911	start	1	7	11	1210	2-Sep-2012	2010	-8	46.996322	-144.859612		1000	A.Wang	
20120902.2011.001	VPR	start	1	7	9	1210	2-Sep-2012	2011	-8	46.996187	-144.859550		1000	G.Lawson	
20120902.2110.001	CTD911	end	1	7	11	1310	2-Sep-2012	2110	-8	46.986275	-144.854227		1000	A.Wang	
20120902.2110.002	VPR	end	1	7	9	1310	2-Sep-2012	2110	-8	46.986207	-144.854233		1000	G.Lawson	
20120902.2117.001	CTD911	start	1	7	12	1317	2-Sep-2012	2117	-8	46.984650	-144.854102		3000	A.Wang	
20120902.2351.001	CTD911	end	1	7	12	1550	2-Sep-2012	2351	-8	46.982163	-144.840302		3000	A.Wang	
20120903.0011.001	HammarHead	start	1	7	4	1611	3-Sep-2012	0011	-8	46.985813	-144.829887		15	G.Lawson	
20120903.0019.001	Hull HTI	end	1	7		1619	3-Sep-2012	0019	-8	46.986720	-144.822275			G.Lawson	
20120903.0029.001	ADCP	end	1			1629	3-Sep-2012	0030	-8	46.988082	-144.810855			G.Lawson	This ended a few minutes earlier, at the same time as the HTI cast end
20120903.0311.001	HammarHead	end	1	7	4	1910	3-Sep-2012	0311	-8	47.001008	-144.627663		15	G.Lawson	
20120903.0319.001	Hull HTI	start	1	7		1918	3-Sep-2012	0319	-8	47.001427	-144.618420			G.Lawson	
20120903.0319.002	ADCP	start	1	7		1919	3-Sep-2012	0319	-8	47.001503	-144.618075			G.Lawson	
20120903.0321.001	ReeveNet	start	1	7	11	1930	3-Sep-2012	0322	-8	47.001820	-144.617233		100 mwo	G.Lawson	
20120903.0358.001	ReeveNet	end	1	7	11	2000	3-Sep-2012	0358	-8	47.010390	-144.603398		100 mwo	G.Lawson	
20120903.0438.001	MOCNESS	start	1	7	8	2038	3-Sep-2012	0438	-8	47.021723	-144.611452		1000	P.Wiebe	
20120903.0723.001	MOCNESS	end	1	7	8	2323	3-Sep-2012	0723	-8	47.022905	-144.701458		1000	P.Wiebe	
20120903.0735.001	Echosounder	start	1	7		2334	3-Sep-2012	0735	-8	47.019183	-144.706282	4700	1000		
20120903.0747.001	CTD911	start	1	7	13	2346	3-Sep-2012	0747	-8	47.016152	-144.700220	4700	1000	A.Wang	
20120903.0747.002	VPR	start	1	7	10	2346	3-Sep-2012	0747	-8	47.016152	-144.700220		1000	G.Lawson	added late; corrected utc, lat/lon
20120903.0748.001	Echosounder	end	1	7		2348	3-Sep-2012	0748	-8	47.016005	-144.699498	4700	1000		
20120903.0844.001	CTD911	end	1	7	13	0043	3-Sep-2012	0844	-8	47.010297	-144.684092	4700	1000	A.Wang	
20120903.0844.002	VPR	end	1	7	10	0043	3-Sep-2012	0844	-8	47.010297	-144.684092		1000	G.Lawson	added late; corrected utc, lat/lon
20120903.0851.001	Ship	end	1	7		0050	3-Sep-2012	0851	-8	47.005515	-144.683812				

		Station													
20120903.1324.001	Ship	start Station	1	8		0523	3-Sep-2012	1324	-8	46.500168	-143.874588				
20120903.1324.002	Echosounder	start	1	8		0524	3-Sep-2012	1324	-8	46.500030	-143.874647				
20120903.1325.001	Echosounder	end	1	8		0525	3-Sep-2012	1325	-8	46.499808	-143.874748				
20120903.1330.001	CTD911	start	1	8	14	0530	3-Sep-2012	1330	-8	46.499043	-143.874715		1000	A.Wang	
20120903.1331.001	VPR	start	1	8	11	0530	3-Sep-2012	1331	-8	46.499037	-143.874627		1000	G.Lawson	
20120903.1450.001	CTD911	end	1	8	14	0648	3-Sep-2012	1450	-8	46.486472	-143.867193		1000	A.Wang	
20120903.1450.002	VPR	end	1	8	11	0650	3-Sep-2012	1450	-8	46.486383	-143.867160		1000	G.Lawson	
20120903.1452.001	Ship	end Station	1	8		0652	3-Sep-2012	1453	-8	46.485485	-143.867030				
20120903.1939.001	Ship	start Station	1	9		1139	3-Sep-2012	1939	-8	46.000433	-143.033382				
20120903.1940.001	Echosounder	start	1	9		1140	3-Sep-2012	1940	-8	46.000187	-143.033375	4579			
20120903.1940.002	Echosounder	end	1	9		1140	3-Sep-2012	1941	-8	45.999977	-143.033485	4579			
20120903.1946.001	CTD911	start	1	9	15	1146	3-Sep-2012	1947	-8	45.998067	-143.032157		1000	A.Wang	
20120903.1947.001	VPR	start	1	9	12	1147	3-Sep-2012	1947	-8	45.997958	-143.031955		1000	G.Lawson	
20120903.2114.001	CTD911	end	1	9	15	1314	3-Sep-2012	2114	-8	45.986248	-143.013258		1000	A.Wang	
20120903.2114.002	VPR	end	1	9	12	1314	3-Sep-2012	2114	-8	45.986207	-143.013222		1000	G.Lawson	
20120903.2115.001	Ship	end Station	1	9		1315	3-Sep-2012	2115	-8	45.986103	-143.013135				
20120904.0150.001	Ship	start Station	1	10		1750	4-Sep-2012	0151	-8	45.501427	-142.198888		1000		
20120904.0152.001	Echosounder	start	1	10		1751	4-Sep-2012	0152	-8	45.500757	-142.198548	4554			
20120904.0154.001	CTD911	start	1	10	16	1753	4-Sep-2012	0154	-8	45.500430	-142.198448		1000	A.Wang	
20120904.0154.002	VPR	start	1	10	13	1754	4-Sep-2012	0154	-8	45.500393	-142.198427		1000	G.Lawson	
20120904.0203.001	Echosounder	end	1	10		1803	4-Sep-2012	0203	-8	45.499190	-142.196973	4554			
20120904.0307.001	CTD911	end	1	10	16	1907	4-Sep-2012	0307	-8	45.491957	-142.186097		1000	A.Wang	
20120904.0307.002	VPR	end	1	10	13	1907	4-Sep-2012	0307	-8	45.491928	-142.186028		1000	G.Lawson	
20120904.0321.001	Ship	end Station	1	10		1921	4-Sep-2012	0321	-8	45.478885	-142.170223		1000		
20120904.0725.001	Ship	start Station	1	11		2325	4-Sep-2012	0725	-8	45.053535	-141.459551				entered late: local date=9/3/12 but utc was 9/4: corrected utc & latlon
20120904.0742.001	MOCNESS	start	1	11	9	2341	4-Sep-2012	0742	-8	45.046307	-141.446702		1000	P.Wiebe	

20120904.1038.001	MOCNESS	end	1	11	9	0238	4-Sep-2012	1038	-8	44.972290	-141.331992		1000	P.Wiebe	
20120904.1039.001	Echosounder	start	1	11		0239	4-Sep-2012	1039	-8	44.971572	-141.331198	3723			
20120904.1040.001	Echosounder	end	1	11		0240	4-Sep-2012	1040	-8	44.970875	-141.330405	3723			
20120904.1059.001	CTD911	start	1	11	17	0259	4-Sep-2012	1059	-8	44.961567	-141.324290		1000	A.Wang	
20120904.1100.001	VPR	start	1	11	14	0300	4-Sep-2012	1100	-8	44.961447	-141.324295		1000	G.Lawson	
20120904.1156.001	CTD911	end	1	11	17	0356	4-Sep-2012	1156	-8	44.949918	-141.318677		1000	A.Wang	
20120904.1157.001	VPR	end	1	11	14	0357	4-Sep-2012	1157	-8	44.949880	-141.318665		1000	G.Lawson	
20120904.1210.001	ReeveNet	start	1	11	12	0409	4-Sep-2012	1210	-8	44.946485	-141.319402		120 mwo	G.Lawson	
20120904.1246.001	ReeveNet	end	1	11	12	0446	4-Sep-2012	1246	-8	44.933628	-141.322977		120 mwo	G.Lawson	
20120904.1246.002	Echosounder	start	1	11		0446	4-Sep-2012	1246	-8	44.933472	-141.323018	4278			
20120904.1251.001	Echosounder	end	1	11		0451	4-Sep-2012	1251	-8	44.931813	-141.323435	4278			
20120904.1256.001	CTD911	start	1	11	18	0456	4-Sep-2012	1256	-8	44.930907	-141.323157	4278	3000	A.Wang	
20120904.1522.001	CTD911	end	1	11	18	0722	4-Sep-2012	1522	-8	44.914192	-141.314295	4278	3000	A.Wang	
20120904.1531.001	HammarHead	start	1	11	5	0731	4-Sep-2012	1532	-8	44.917515	-141.317148		30	G.Lawson	
20120904.1538.001	Hull HTI	end	1	11		0738	4-Sep-2012	1538	-8	44.921435	-141.320688			G.Lawson	
20120904.1539.001	ADCP	end	1	11		0738	4-Sep-2012	1539	-8	44.921705	-141.320932			G.Lawson	
20120904.1648.001	HammarHead	end	1	11	5	0848	4-Sep-2012	1648	-8	44.969403	-141.359032		30	G.Lawson	
20120904.1712.001	MOCNESS	start	1	11	10	0912	4-Sep-2012	1712	-8	44.964960	-141.345310		1000	P.Wiebe	
20120904.1958.001	MOCNESS	end	1	11	10	1158	4-Sep-2012	1958	-8	44.907695	-141.251050		1000	P.Wiebe	
20120904.2009.001	Echosounder	start	1	11		1209	4-Sep-2012	2009	-8	44.902890	-141.243982	4923			
20120904.2010.001	Echosounder	end	1	11		1210	4-Sep-2012	2010	-8	44.902385	-141.243403	4923			
20120904.2014.001	CTD911	start	1	11	19	1214	4-Sep-2012	2014	-8	44.901818	-141.243840	4923	1000	A.Wang	
20120904.2015.001	VPR	start	1	11	15	1214	4-Sep-2012	2015	-8	44.901818	-141.243845		1000	G.Lawson	
20120904.2107.001	CTD911	end	1	11	19	1307	4-Sep-2012	2107	-8	44.900915	-141.245858	4923	1000	A.Wang	
20120904.2107.002	VPR	end	1	11	15	1307	4-Sep-2012	2107	-8	44.900912	-141.245852		1000	G.Lawson	
20120904.2125.001	Ship	end Station	1	11		1315	4-Sep-2012	2125	-8	44.880703	-141.209052				
20120905.0059.001	Ship	start Station	1	12		1658	5-Sep-2012	0059	-8	44.500577	-140.551955				
20120905.0059.002	Echosounder	start	1	12		1659	5-Sep-2012	0100	-8	44.500248	-140.551388	4076	1000		

20120905.0102.001	CTD911	start	1	12	20	1702	5-Sep-2012	0102	-8	44.499392	-140.551403	4076	1000	A.Wang	
20120905.0106.001	VPR	start	1	12	16	1705	5-Sep-2012	0106	-8	44.498723	-140.551650	4076	1000	G.Lawson	
20120905.0213.001	CTD911	end	1	12	20	1811	5-Sep-2012	0213	-8	44.489597	-140.547600	4076	1000	A.Wang	
20120905.0213.002	VPR	end	1	12	16	1813	5-Sep-2012	0213	-8	44.489538	-140.547578	4076	1000	G.Lawson	
20120905.0217.001	Ship	end Station	1	12	20	1816	5-Sep-2012	0217	-8	44.488752	-140.547868		1000		
20120905.0647.001	Ship	start Station	1	13		2247	5-Sep-2012	0647	-8	44.034688	-139.795961				time utc, latlon, etc changed to match time local
20120905.0713.001	ReeveNet	start	1	13	13	2312	5-Sep-2012	0713	-8	44.000878	-139.742362		90 mwo	G.Lawson	
20120905.0801.001	ReeveNet	end	1	13	13	0000	5-Sep-2012	0801	-8	44.008002	-139.755042		90 mwo	G.Lawson	
20120905.0807.001	CTD911	start	1	13	21	0006	5-Sep-2012	0807	-8	44.008497	-139.755893	4321	1000	A.Wang	
20120905.0808.001	VPR	start	1	13	17	0007	5-Sep-2012	0808	-8	44.008485	-139.756070	4321	1000	G.Lawson	
20120905.0822.001	Echosounder	end	1	13		0021	5-Sep-2012	0822	-8	44.008553	-139.757678	4321	1000		the sounder was on between stn 12 and 13 all the time.
20120905.0928.001	CTD911	end	1	13	21	0130	5-Sep-2012	0928	-8	44.011807	-139.763240	4321	1000	A.Wang	
20120905.0928.002	VPR	end	1	13	17	0128	5-Sep-2012	0928	-8	44.011867	-139.763400	4321	1000	G.Lawson	
20120905.0934.001	Ship	end Station	1	13	21	0133	5-Sep-2012	0934	-8	44.013500	-139.765578				
20120905.1425.001	Ship	start Station	1	14		0624	5-Sep-2012	1425	-8	43.498225	-138.934705				
20120905.1425.002	Echosounder	start	1	14		0625	5-Sep-2012	1426	-8	43.498263	-138.933980	4683			
20120905.1430.001	CTD911	start	1	14	22	0625	5-Sep-2012	1430	-8	43.498935	-138.933332		1000	A.Wang	
20120905.1430.002	VPR	start	1	14	18	0630	5-Sep-2012	1430	-8	43.499007	-138.933318		1000	G.Lawson	
20120905.1434.001	Echosounder	end	1	14		0634	5-Sep-2012	1434	-8	43.499108	-138.932983	4683			
20120905.1547.001	CTD911	end	1	14	22	0747	5-Sep-2012	1547	-8	43.499450	-138.939170		1000	A.Wang	
20120905.1548.001	VPR	end	1	14	18	0748	5-Sep-2012	1548	-8	43.499480	-138.939233		1000	G.Lawson	
20120905.1548.002	Ship	end Station	1	14		0748	5-Sep-2012	1548	-8	43.499525	-138.939252				
20120905.2047.001	Ship	start Station	1	15		1247	5-Sep-2012	2047	-8	42.999867	-138.132190				
20120905.2056.001	MOCNESS	start	1	15	11	1255	5-Sep-2012	2056	-8	43.003288	-138.133652			P.Wiebe	
20120905.2355.001	Echosounder	start	1	15		1552	5-Sep-2012	2355	-8	43.098553	-138.102585	4100			
20120905.2359.001	Echosounder	end	1	15		1559	5-Sep-2012	2359	-8	43.100728	-138.101610	4100			

20120906.0002.001	MOCNESS	end	1	15	11	1602	6-Sep-2012	0002	-8	43.102273	-138.100920			P.Wiebe	Event was entered much later. Local time based on the MOC data sheet; utc/latlon corrected
20120906.0026.001	CTD911	start	1	15	23	1625	6-Sep-2012	0026	-8	43.109453	-138.101368	4100	1000	A.Wang	
20120906.0026.002	VPR	start	1	15	19	1626	6-Sep-2012	0026	-8	43.109497	-138.101442	4100	1000	G.Lawson	
20120906.0134.001	CTD911	end	1	15	23	1734	6-Sep-2012	0134	-8	43.115842	-138.117558	4100	1000	A.Wang	
20120906.0134.002	VPR	end	1	15	19	1734	6-Sep-2012	0134	-8	43.115938	-138.117610	4100	1000	G.Lawson	
20120906.0154.001	HammarHead	start	1	15	6	1753	6-Sep-2012	0154	-8	43.108608	-138.116242			G.Lawson	
20120906.0202.001	Hull HTI	end	1	15		1802	6-Sep-2012	0202	-8	43.102620	-138.116690			G.Lawson	Seem to have forgotten to put a start to this cast.
20120906.0205.001	ADCP	end	1	15		1804	6-Sep-2012	0205	-8	43.100638	-138.116705			G.Lawson	Forgot to put a start to this cast.
20120906.0226.001	Hull HTI	start	1	15		1826	6-Sep-2012	0226	-8	43.083968	-138.117185			G.Lawson	
20120906.0227.001	ADCP	start	1	15		1826	6-Sep-2012	0227	-8	43.083483	-138.117168			G.Lawson	
20120906.0238.001	HammarHead	end	1	15	6	1838	6-Sep-2012	0238	-8	43.078722	-138.115642			G.Lawson	
20120906.0241.001	CTD911	start	1	15	24	1839	6-Sep-2012	0241	-8	43.079197	-138.115770	4100	3000	A.Wang	
20120906.0503.001	CTD911	end	1	15	24	2102	6-Sep-2012	0503	-8	43.082802	-138.136608	4100	3000	A.Wang	
20120906.0509.001	ReeveNet	start	1	15	14	2109	6-Sep-2012	0509	-8	43.082605	-138.139095		60 mwo	G.Lawson	
20120906.0600.001	ReeveNet	end	1	15	14	2200	6-Sep-2012	0600	-8	43.089373	-138.154885		60 mwo	G.Lawson	Forgot this event. Cast was about 50 minutes (end=2200 on 9/5); utc/latlon corrected
20120906.0618.001	MOCNESS	start	1	15	12	2217	6-Sep-2012	0618	-8	43.096472	-138.159383			P.Wiebe	
20120906.0908.001	MOCNESS	end	1	15	12	0110	6-Sep-2012	0908	-8	43.185245	-138.160987	4100	1000	P.Wiebe	corrected utc and lat/lon
20120906.0923.002	CTD911	start	1	15	25	0123	6-Sep-2012	0923	-8	43.189725	-138.162505		1000	A.Wang	VPR only; test bottle 15 for misfire
20120906.0927.001	VPR	start	1	15	20	0127	6-Sep-2012	0927	-8	43.189550	-138.163428	4100	1000	G.Lawson	
20120906.1025.001	CTD911	end	1	15	25	0225	6-Sep-2012	1025	-8	43.189225	-138.178603	4100	1000	A.Wang	
20120906.1026.001	VPR	end	1	15	20	0226	6-Sep-2012	1026	-8	43.189273	-138.178683	4100	1000	G.Lawson	
20120906.1046.001	Hull HTI	end	1	15		0245	6-Sep-2012	1046	-8	43.197035	-138.184003			G.Lawson	
20120906.1056.001	HammarHead	start	1	15	7	0255	6-Sep-2012	1056	-8	43.201650	-138.186643			G.Lawson	missed start but was shortly after it came out for the 1st time; this is ok
20120906.1133.001	HammarHead	end	1	15	7	0332	6-Sep-2012	1133	-8	43.220172	-138.196818			G.Lawson	
20120906.1137.001	Hull HTI	start	1	15		0337	6-Sep-2012	1137	-8	43.222417	-138.197995			G.Lawson	
20120906.1140.001	Ship	end Station	1	15		0340	6-Sep-2012	1141	-8	43.224450	-138.198928				

20120906.1810.001	Ship	start Station	1	16		1009	6-Sep-2012	1810	-8	42.500295	-137.345068				
20120906.1810.002	Echosounder	start	1	16		1010	6-Sep-2012	1810	-8	42.500558	-137.345335	4142			
20120906.1812.001	Echosounder	end	1	16		1011	6-Sep-2012	1812	-8	42.501138	-137.345658	4142	4142		
20120906.1815.001	CTD911	start	1	16	26	1015	6-Sep-2012	1815	-8	42.502100	-137.346460		1000	A.Wang	
20120906.1815.002	VPR	start	1	16	21	1015	6-Sep-2012	1816	-8	42.502228	-137.346637		1000	G.Lawson	
20120906.1943.001	CTD911	end	1	16	26	1143	6-Sep-2012	1943	-8	42.526198	-137.369572		1000	A.Wang	
20120906.1943.002	VPR	end	1	16	21	1143	6-Sep-2012	1943	-8	42.526325	-137.369560		1000	G.Lawson	strobe not flashing upon recovery
20120906.1949.001	Ship	end Station	1	16		1150	6-Sep-2012	1949	-8	42.529337	-137.367190				
20120907.0100.001	Echosounder	start	1	17		1700	7-Sep-2012	0101	-8	42.000752	-136.555803	3988	1000		
20120907.0103.001	Ship	start Station	1	17		1702	7-Sep-2012	0103	-8	42.001955	-136.554900				
20120907.0107.001	CTD911	start	1	17	27	1706	7-Sep-2012	0107	-8	42.002932	-136.555305	3988	1000	A.Wang	
20120907.0107.002	VPR	start	1	17	22	1707	7-Sep-2012	0108	-8	42.003382	-136.555232	3988	1000	G.Lawson	
20120907.0115.001	Echosounder	end	1	17		1714	7-Sep-2012	0115	-8	42.005720	-136.555658	3988	1000		
20120907.0223.001	CTD911	end	1	17	27	1823	7-Sep-2012	0223	-8	42.019597	-136.559737	3988	1000	A.Wang	
20120907.0224.001	VPR	end	1	17	22	1824	7-Sep-2012	0224	-8	42.019735	-136.559705	3988	1000	G.Lawson	
20120907.0239.001	Ship	end Station	1	17		1828	7-Sep-2012	0239	-8	42.028612	-136.555900				
20120907.0746.001	Ship	start Station	1	18		2345	7-Sep-2012	0746	-8	41.500230	-135.773108				
20120907.0748.001	ReeveNet	start	1	18	15	2355	7-Sep-2012	0748	-8	41.500410	-135.771387		65 mwo	G.Lawson	
20120907.0849.001	ReeveNet	end	1	18	15	0043	7-Sep-2012	0849	-8	41.515480	-135.787070		65 mwo	G.Lawson	
20120907.0925.001	MOCNESS	start	1	18	13	0125	7-Sep-2012	0925	-8	41.533405	-135.786268			P.Wiebe	
20120907.1210.001	MOCNESS	end	1	18	13	0409	7-Sep-2012	1210	-8	41.616883	-135.784117			P.Wiebe	net 5 ripped 12+" along seam
20120907.1219.001	Echosounder	start	1	18		0419	7-Sep-2012	1219	-8	41.622902	-135.783140	4082			
20120907.1220.001	Echosounder	end	1	18		0420	7-Sep-2012	1220	-8	41.623458	-135.783050	4082			
20120907.1225.001	CTD911	start	1	18	28	0425	7-Sep-2012	1225	-8	41.625867	-135.783038	4082	1000	A.Wang	
20120907.1225.002	VPR	start	1	18	23	0425	7-Sep-2012	1225	-8	41.625982	-135.783080	4082	1000	G.Lawson	
20120907.1325.001	CTD911	end	1	18	28	0525	7-Sep-2012	1325	-8	41.639370	-135.796995	4082	1000	A.Wang	
20120907.1325.002	VPR	end	1	18	23	0525	7-Sep-2012	1326	-8	41.639450	-135.796993	4082	1000	G.Lawson	

20120907.1346.001	HammarHead	start	1	18	8	0545	7-Sep-2012	1346	-8	41.648620	-135.796802			G.Lawson	
20120907.1348.001	Hull HTI	end	1	18		0548	7-Sep-2012	1348	-8	41.649862	-135.796792			G.Lawson	
20120907.1415.001	HammarHead	end	1	18	8	0615	7-Sep-2012	1415	-8	41.665848	-135.797085			G.Lawson	
20120907.1416.001	Hull HTI	start	1	18		0616	7-Sep-2012	1416	-8	41.665985	-135.797100			G.Lawson	
20120907.1433.001	Echosounder	start	1	18		0633	7-Sep-2012	1433	-8	41.674022	-135.797568	4076			
20120907.1434.001	Echosounder	end	1	18		0633	7-Sep-2012	1434	-8	41.674215	-135.797785	4076			
20120907.1436.001	CTD911	start	1	18	29	0635	7-Sep-2012	1436	-8	41.674717	-135.797965		3000	A.Wang	
20120907.1522.001	Echosounder	start	1	18		0722	7-Sep-2012	1522	-8	41.683140	-135.805378	3235			
20120907.1524.001	Echosounder	end	1	18		0724	7-Sep-2012	1524	-8	41.683182	-135.805623	3235			
20120907.1712.001	CTD911	end	1	18	29	0912	7-Sep-2012	1712	-8	41.704625	-135.822043		3000	A.Wang	
20120907.1745.001	MOCNESS	start	1	18	14	0944	7-Sep-2012	1745	-8	41.719827	-135.822622		1000	P.Wiebe	
20120907.2045.001	MOCNESS	end	1	18	14	1245	7-Sep-2012	2045	-8	41.818310	-135.797853		1000	P.Wiebe	net 8 totally ripped down seam; some sample in codend
20120907.2105.001	Echosounder	start	1	18		1305	7-Sep-2012	2105	-8	41.829185	-135.793892	3816			
20120907.2106.001	Echosounder	end	1	18		1306	7-Sep-2012	2106	-8	41.829408	-135.793847	3816			
20120907.2111.001	CTD911	start	1	18	30	1311	7-Sep-2012	2111	-8	41.830532	-135.794202	3816	1000	A.Wang	
20120907.2112.001	VPR	start	1	18	24	1312	7-Sep-2012	2112	-8	41.830697	-135.794067	3816	1000	G.Lawson	
20120907.2209.001	CTD911	end	1	18	30	1409	7-Sep-2012	2209	-8	41.839703	-135.796598	3816	1000	A.Wang	
20120907.2209.002	VPR	end	1	18	24	1409	7-Sep-2012	2209	-8	41.839740	-135.796610	3816	1000	G.Lawson	
20120907.2227.001	HammarHead	start	1	18	9	1427	7-Sep-2012	2227	-8	41.845665	-135.793642			G.Lawson	
20120907.2234.001	Hull HTI	end	1	18		1433	7-Sep-2012	2234	-8	41.849200	-135.790937			G.Lawson	
20120907.2234.002	ADCP	end	1	18		1434	7-Sep-2012	2234	-8	41.849355	-135.790757			G.Lawson	
20120907.2305.001	Hull HTI	start	1	18		1505	7-Sep-2012	2305	-8	41.864437	-135.778755			G.Lawson	
20120907.2305.002	ADCP	start	1	18		1505	7-Sep-2012	2305	-8	41.864542	-135.778672			G.Lawson	
20120907.2315.001	HammarHead	end	1	18	9	1515	7-Sep-2012	2315	-8	41.869038	-135.774836			G.Lawson	added late; end time estimated at 15:15 local; utc/latlon corrected
20120907.2322.001	Ship	end Station	1	18		1521	7-Sep-2012	2322	-8	41.871617	-135.773048				
20120908.0601.001	Ship	start Station	1	19		2201	8-Sep-2012	0601	-8	41.002045	-135.000688				
20120908.0604.001	ReeveNet	start	1	19	16	2200	8-Sep-2012	0604	-8	41.002512	-135.000310		100	G.Lawson	

													mwo		
20120908.0645.001	ReeveNet	end	1	19	16	2245	8-Sep-2012	0645	-8	41.012182	-135.006265		100 mwo	G.Lawson	
20120908.0659.001	CTD911	start	1	19	31	2258	8-Sep-2012	0659	-8	41.013277	-135.011605	4813	1000	A.Wang	
20120908.0659.002	VPR	start	1	19	25	2259	8-Sep-2012	0659	-8	41.013452	-135.011937	4813	1000	G.Lawson	
20120908.0703.001	Echosounder	start	1	19		2303	8-Sep-2012	0703	-8	41.014365	-135.013343	4813	1000		
20120908.0710.001	Echosounder	end	1	19		2310	8-Sep-2012	0710	-8	41.015895	-135.015623	4813	1000		
20120908.0822.001	CTD911	end	1	19	31	0022	8-Sep-2012	0822	-8	41.028713	-135.032105	4813	1000	A.Wang	
20120908.0822.002	VPR	end	1	19	25	0022	8-Sep-2012	0822	-8	41.028847	-135.032177	4813	1000	G.Lawson	
20120908.0828.001	Ship	end Station	1	19		0027	8-Sep-2012	0828	-8	41.032610	-135.032917				
20120908.0829.001	Ship	end Transect	1			0028	8-Sep-2012	0829	-8	41.030768	-135.032782				end of station 19, end of transect 1
20120908.0829.002	Ship	start Transect	4			0029	8-Sep-2012	0829	-8	41.029842	-135.032725				
20120908.1145.001	Ship	start Station	4	20		0345	8-Sep-2012	1145	-8	40.501723	-134.999467				
20120908.1148.001	Echosounder	start	4	20		0348	8-Sep-2012	1148	-8	40.502028	-135.000385	4297			
20120908.1149.001	Echosounder	end	4	20		0349	8-Sep-2012	1149	-8	40.502415	-135.000272	4297			
20120908.1152.001	CTD911	start	4	20	32	0351	8-Sep-2012	1152	-8	40.502927	-135.000713	4297	1000	A.Wang	
20120908.1153.001	VPR	start	4	20	26	0353	8-Sep-2012	1153	-8	40.503028	-135.000832	4297	1000	G.Lawson	
20120908.1314.001	CTD911	end	4	20	32	0514	8-Sep-2012	1315	-8	40.508735	-135.011977	4297	1000	A.Wang	
20120908.1315.001	VPR	end	4	20	26	0515	8-Sep-2012	1315	-8	40.508808	-135.011917	4297	1000	G.Lawson	
20120908.1315.002	Ship	end Station	4	20		0515	8-Sep-2012	1315	-8	40.508953	-135.011838				
20120908.1628.001	Ship	start Station	4	21		0828	8-Sep-2012	1628	-8	39.999583	-135.001205				
20120908.1643.001	MOCNESS	start	4	21	15	0842	8-Sep-2012	1643	-8	40.002870	-135.000445			P.Wiebe	
20120908.1938.001	MOCNESS	end	4	21	15	1138	8-Sep-2012	1938	-8	40.085320	-135.019542			P.Wiebe	
20120908.1949.001	Echosounder	start	4	21		1149	8-Sep-2012	1949	-8	40.092093	-135.022165	3492			
20120908.1950.001	Echosounder	end	4	21		1149	8-Sep-2012	1950	-8	40.092372	-135.022387	3492			
20120908.1955.001	CTD911	start	4	21	33	1154	8-Sep-2012	1955	-8	40.093130	-135.023318	3492	1000	A.Wang	
20120908.1956.001	VPR	start	4	21	27	1155	8-Sep-2012	1956	-8	40.093177	-135.023422	3492	1000	G.Lawson	
20120908.2053.001	CTD911	end	4	21	33	1252	8-Sep-2012	2053	-8	40.091023	-135.031280	3492	1000	A.Wang	

20120908.2053.002	VPR	end	4	21	27	1253	8-Sep-2012	2053	-8	40.091002	-135.031355	3492	1000	G.Lawson	
20120908.2108.001	HammarHead	start	4	21	10	1308	8-Sep-2012	2108	-8	40.084767	-135.027322			G.Lawson	
20120908.2114.001	Hull HTI	end	4	21		1313	8-Sep-2012	2114	-8	40.080937	-135.026065			G.Lawson	
20120908.2114.002	ADCP	end	4	21		1314	8-Sep-2012	2114	-8	40.080700	-135.026025			G.Lawson	
20120908.2300.001	HammarHead	end	4	21	10	1500	8-Sep-2012	2300	-8	39.957831	-134.985218			G.Lawson	Actually happened at 1500; utc/latlon corrected
20120908.2321.001	Hull HTI	start	4	21		1521	8-Sep-2012	2321	-8	39.948887	-134.985520			G.Lawson	
20120908.2321.002	ADCP	start	4	21		1521	8-Sep-2012	2321	-8	39.948940	-134.985597			G.Lawson	
20120908.2323.001	ReeveNet	start	4	21	17	1522	8-Sep-2012	2323	-8	39.949102	-134.985845		280 mwo	G.Lawson	
20120909.0040.001	ReeveNet	end	4	21	17	1632	9-Sep-2012	0040	-8	39.967347	-135.013765		280 mwo	G.Lawson	
20120909.0053.001	CTD911	start	4	21	34	1652	9-Sep-2012	0053	-8	39.968805	-135.016248	3428	3000	A.Wang	
20120909.0056.001	Echosounder	start	4	21	34	1655	9-Sep-2012	0056	-8	39.968832	-135.016375	3428	3000		
20120909.0156.001	Echosounder	end	4	21	34	1756	9-Sep-2012	0156	-8	39.967938	-135.022248	3428	3000		
20120909.0316.001	CTD911	end	4	21	34	1916	9-Sep-2012	0316	-8	39.974282	-135.025605	3428	3000	A.Wang	
20120909.0340.001	MOCNESS	start	4	23	16	1940	9-Sep-2012	0340	-8	39.983550	-135.029817			P.Wiebe	39 59.013N -135 1.789W; time-utc changed from 0404 to 0340; latlon, etc. corrected
20120909.0628.001	MOCNESS	end	4	23	16	2210	9-Sep-2012	0628	-8	40.062982	-135.067047			P.Wiebe	
20120909.0644.001	CTD911	start	4	21	35	2244	9-Sep-2012	0644	-8	40.066522	-135.072518	3428	1000	A.Wang	
20120909.0645.001	VPR	start	4	21	28	2244	9-Sep-2012	0645	-8	40.066512	-135.072655	3428	1000	G.Lawson	
20120909.0742.001	CTD911	end	4	21	35	2342	9-Sep-2012	0742	-8	40.062067	-135.087825	3428	1000	A.Wang	
20120909.0742.002	VPR	end	4	21	28	2342	9-Sep-2012	0742	-8	40.062057	-135.087905	3428	1000	G.Lawson	
20120909.0752.001	ReeveNet	start	4	21	18	2339	9-Sep-2012	0752	-8	40.061543	-135.091470		250 mwo	G.Lawson	
20120909.0852.001	ReeveNet	end	4	21	18	0051	9-Sep-2012	0852	-8	40.061138	-135.111785		250 mwo	G.Lawson	
20120909.0905.001	Hull HTI	end	4	21		0110	9-Sep-2012	0905	-8	40.060755	-135.114033			G.Lawson	late entry; changed local from 2310 to 0110; changed utc from 20120909.1005 to 20120909.0905; chgd latlon
20120909.0905.002	ADCP	end	4	21		0110	9-Sep-2012	0905	-8	40.060755	-135.114033			G.Lawson	added late; utc/latlon ok
20120909.0912.001	HammarHead	start	4	21	11	0112	9-Sep-2012	0912	-8	40.058000	-135.109260			G.Lawson	
20120909.1002.001	HammarHead	end	4	22	11	0201	9-Sep-2012	1002	-8	40.038448	-135.078322			G.Lawson	

20120909.1002.001	Hull HTI	start	4	21		0202	9-Sep-2012	1002	-8	40.038680	-135.078647			G.Lawson	late entry; changed local from 2150 to 02:02, chgd utc from 120909.1006 to 20120909.1002; corrected latlon
20120909.1002.002	ADCP	start	4	21		0150	9-Sep-2012	1002	-8	40.038680	-135.078647			G.Lawson	added late; utc/latlon ok
20120909.1003.001	Ship	end Station	4	21		0203	9-Sep-2012	1003	-8	40.037802	-135.077343				
20120909.1325.001	Ship	start Station	4	22		0524	9-Sep-2012	1325	-8	39.501037	-134.999750				
20120909.1325.002	Echosounder	start	4	22		0525	9-Sep-2012	1325	-8	39.501082	-134.999880	2815			
20120909.1327.001	Echosounder	end	4	22		0527	9-Sep-2012	1327	-8	39.501485	-134.999903	2815			
20120909.1331.001	CTD911	start	4	22	36	0531	9-Sep-2012	1331	-8	39.501907	-135.000477	2815	1000	A.Wang	
20120909.1331.002	VPR	start	4	22	29	0531	9-Sep-2012	1331	-8	39.501945	-135.000502	2815	1000	G.Lawson	
20120909.1448.001	CTD911	end	4	22	36	0648	9-Sep-2012	1448	-8	39.508475	-135.006375	2815	1000	A.Wang	
20120909.1449.001	VPR	end	4	22	29	0649	9-Sep-2012	1449	-8	39.508532	-135.006428	2815	1000	G.Lawson	
20120909.1449.002	Ship	end Station	4	22		0649	9-Sep-2012	1449	-8	39.508677	-135.006438				
20120909.1803.001	Ship	start Station	4	23		1003	9-Sep-2012	1803	-8	39.000608	-135.000680				
20120909.1803.002	Echosounder	start	4	23		1003	9-Sep-2012	1803	-8	39.000695	-135.000690	3305			
20120909.1804.001	Echosounder	end	4	23		1004	9-Sep-2012	1805	-8	39.001247	-135.000680	3305			
20120909.1808.001	CTD911	start	4	23	37	1008	9-Sep-2012	1808	-8	39.002502	-135.002145	3305	1000	A.Wang	
20120909.1809.001	VPR	start	4	23	30	1008	9-Sep-2012	1809	-8	39.002588	-135.002222	3305	1000	G.Lawson	
20120909.1931.001	CTD911	end	4	23	37	1131	9-Sep-2012	1931	-8	39.007557	-135.017818	3305	1000	A.Wang	
20120909.1931.002	VPR	end	4	23	30	1131	9-Sep-2012	1931	-8	39.007617	-135.017885	3305	1000	G.Lawson	
20120909.1934.001	Ship	end Station	4	23		1133	9-Sep-2012	1934	-8	39.008595	-135.018982				
20120909.2126.001	Ship	start Station	4	24		1325	9-Sep-2012	2126	-8	38.715387	-135.009810				
20120909.2133.001	MOCNESS	start	4	24	17	1332	9-Sep-2012	2133	-8	38.710922	-135.009700			P.Wiebe	
20120910.0051.001	MOCNESS	end	4	24	17	0851	10-Sep-2012	0051	-8	38.612720	-135.009382			P.Wiebe	no local time entered; added later
20120910.0052.001	CTD911	start	4	24	38	1652	10-Sep-2012	0052	-8	38.612880	-135.009480		1000	A.Wang	
20120910.0053.001	VPR	start	4	24	31	1653	10-Sep-2012	0053	-8	38.612982	-135.009488		1000	G.Lawson	
20120910.0148.001	CTD911	end	4	24	38	1748	10-Sep-2012	0148	-8	38.615867	-135.021827		1000	A.Wang	
20120910.0149.001	VPR	end	4	24	31	1748	10-Sep-2012	0149	-8	38.615848	-135.021863		1000	G.Lawson	

20120910.0154.001	Echosounder	start	4	24		1752	10-Sep-2012	0154	-8	38.616643	-135.022442				
20120910.0205.001	Echosounder	end	4	24		1804	10-Sep-2012	0205	-8	38.618117	-135.024308	4728			
20120910.0207.001	CTD911	start	4	24	39	1750	10-Sep-2012	0150	-8	38.618432	-135.024905	4728	3000	A.Wang	input late; use 17:50 local time
20120910.0412.001	CTD911	end	4	24	39	2011	10-Sep-2012	0412	-8	38.627472	-135.041980	4728	3000	A.Wang	
20120910.0419.001	ReeveNet	start	4	24	19	2018	10-Sep-2012	0419	-8	38.628662	-135.046152		200 mwo	G.Lawson	
20120910.0523.001	ReeveNet	end	4	24	19	2123	10-Sep-2012	0523	-8	38.630818	-135.065793		200 mwo	G.Lawson	
20120910.0538.001	MOCNESS	start	4	24	18	2137	10-Sep-2012	0538	-8	38.623285	-135.062332			P.Wiebe	
20120910.0839.001	MOCNESS	end	4	24	18	0039	10-Sep-2012	0839	-8	38.523373	-135.010218			P.Wiebe	
20120910.0844.001	CTD911	start	4	24	40	0044	10-Sep-2012	0844	-8	38.524328	-135.012067	4728	1000	A.Wang	
20120910.0848.001	VPR	start	4	24	32	0047	10-Sep-2012	0848	-8	38.524332	-135.012928	4728	1000	G.Lawson	
20120910.0946.001	CTD911	end	4	24	40	0146	10-Sep-2012	0946	-8	38.528872	-135.024283	4728	1000	A.Wang	
20120910.0947.001	VPR	end	4	24	32	0147	10-Sep-2012	0947	-8	38.529190	-135.024463	4728	1000	G.Lawson	
20120910.0956.001	HammarHead	start	4	24	12	0156	10-Sep-2012	0956	-8	38.526337	-135.021330			G.Lawson	
20120910.0957.001	Hull HTI	end	4	24		0156	10-Sep-2012	0957	-8	38.526182	-135.021178			G.Lawson	
20120910.1026.001	HammarHead	end				0225	10-Sep-2012	1026	-8	38.510995	-135.012082			G.Lawson	Turn Hammerhead off to recover it
20120910.1037.001	HammarHead	end	4	24	12	0237	10-Sep-2012	1037	-8	38.502770	-135.006515			G.Lawson	
20120910.1038.001	Ship	end Station	4	24		0237	10-Sep-2012	1038	-8	38.502437	-135.006253				
20120910.1055.001	Hull HTI	start	4			0254	10-Sep-2012	1055	-8	38.464042	-135.004615			G.Lawson	
20120910.1342.001	Ship	start Station	4	25		0542	10-Sep-2012	1342	-8	37.998880	-134.999843				
20120910.1343.001	Echosounder	start	4	25		0542	10-Sep-2012	1343	-8	37.999000	-134.999388	4591			
20120910.1343.002	Echosounder	end	4	25		0543	10-Sep-2012	1343	-8	37.999260	-134.999098	4591			
20120910.1348.001	CTD911	start	4	25	41	0547	10-Sep-2012	1348	-8	38.000677	-134.999350	4591	1000	A.Wang	
20120910.1348.002	VPR	start	4	25	33	0548	10-Sep-2012	1348	-8	38.000758	-134.999353	4591	1000	G.Lawson	
20120910.1504.001	CTD911	end	4	25	41	0704	10-Sep-2012	1504	-8	38.012283	-135.006183	4591	1000	A.Wang	
20120910.1505.001	VPR	end	4	25	33	0705	10-Sep-2012	1505	-8	38.012337	-135.006198	4591	1000	G.Lawson	
20120910.1505.002	Ship	end Station	4	25		0705	10-Sep-2012	1505	-8	38.012458	-135.006283				
20120910.1821.001	Ship	start Station	4	26		1020	10-Sep-2012	1821	-8	37.501012	-134.999068				
20120910.1822.001	Echosounder	start	4	26		1022	10-Sep-2012	1822	-8	37.501463	-134.999672	4415			

20120910.1825.001	Echosounder	end	4	26		1024	10-Sep-2012	1825	-8	37.502150	-135.000008	4415			
20120910.1826.001	CTD911	start	4	26	42	1026	10-Sep-2012	1826	-8	37.502568	-135.000308	4415	1000	A.Wang	
20120910.1827.001	VPR	start	4	26	34	1027	10-Sep-2012	1827	-8	37.502823	-135.000458	4415	1000	G.Lawson	
20120910.1950.001	CTD911	end	4	26	42	1150	10-Sep-2012	1950	-8	37.513537	-135.011922	4415	1000	A.Wang	
20120910.1950.002	VPR	end	4	26	34	1150	10-Sep-2012	1951	-8	37.513577	-135.011977	4415	1000	G.Lawson	
20120910.1951.001	Ship	end Station	4	26		1151	10-Sep-2012	1951	-8	37.513642	-135.012073				
20120910.2126.001	Ship	start Station	4	27		1326	10-Sep-2012	2126	-8	37.265740	-135.007020				
20120910.2133.001	MOCNESS	start	4	27	19	1333	10-Sep-2012	2133	-8	37.259517	-135.008333		1000	P.Wiebe	
20120911.0100.001	MOCNESS	end	4	27	19	1700	11-Sep-2012	0100	-8	37.155268	-135.099827		1000	P.Wiebe	entered late; ended around 16:30?; utc corrected to 1700 local; need to correct latlon
20120911.0116.001	CTD911	start	4	27	43	1716	11-Sep-2012	0117	-8	37.153185	-135.108782		1000	A.Wang	
20120911.0117.001	VPR	start	4	27	35	1717	11-Sep-2012	0117	-8	37.153375	-135.108957		1000	G.Lawson	
20120911.0212.001	CTD911	end	4	27	43	1811	11-Sep-2012	0212	-8	37.166038	-135.116048		1000	A.Wang	
20120911.0212.002	VPR	end	4	27	35	1812	11-Sep-2012	0212	-8	37.166165	-135.116088		1000	G.Lawson	
20120911.0222.001	CTD911	start	4	27	44	1821	11-Sep-2012	0222	-8	37.168628	-135.116545	4100	3000	A.Wang	
20120911.0223.001	Echosounder	start	4	27	44	1823	11-Sep-2012	0223	-8	37.168708	-135.116525	4100	3000		
20120911.0225.001	Echosounder	end	4	27	44	1825	11-Sep-2012	0225	-8	37.169333	-135.116738	4100	3000		
20120911.0447.001	CTD911	end	4	27	44	2047	11-Sep-2012	0447	-8	37.202570	-135.128013	4100	3000	A.Wang	
20120911.0451.001	ReeveNet	start	4	27	20	2051	11-Sep-2012	0451	-8	37.204420	-135.127957		120 mwo	G.Lawson	
20120911.0545.001	ReeveNet	end	4	27	20	2145	11-Sep-2012	0545	-8	37.221490	-135.131488		120 mwo	G.Lawson	
20120911.0602.001	MOCNESS	start	4	27	20	2145	11-Sep-2012	0602	-8	37.230947	-135.128588		1000	P.Wiebe	
20120911.0937.001	MOCNESS	end	4	27	20	0136	11-Sep-2012	0937	-8	37.340937	-135.085092		1000	P.Wiebe	
20120911.0943.001	CTD911	start	4	27	45	0143	11-Sep-2012	0943	-8	37.342193	-135.084867	4100	1000	A.Wang	
20120911.0944.001	VPR	start	4	27	36	0144	11-Sep-2012	0944	-8	37.342278	-135.084947	4100	1000	G.Lawson	
20120911.1039.001	CTD911	end	4	27	45	0239	11-Sep-2012	1039	-8	37.350482	-135.090325	4100	1000	A.Wang	
20120911.1040.001	VPR	end	4	27	36	0239	11-Sep-2012	1040	-8	37.350533	-135.090387	4100	1000	G.Lawson	
20120911.1055.001	HammarHead	start	4	27	13	0253	11-Sep-2012	1055	-8	37.356217	-135.089340			G.Lawson	
20120911.1056.001	Hull HTI	end	4	27		0256	11-Sep-2012	1056	-8	37.357153	-135.088915			G.Lawson	

20120911.1132.001	HammarHead	end				0332	11-Sep-2012	1132	-8	37.376132	-135.082158			G.Lawson	stop recording and shut down
20120911.1133.001	Hull HTI	start				0332	11-Sep-2012	1133	-8	37.376470	-135.082073			G.Lawson	restart #2551133
20120911.1140.001	HammarHead	end	4	27	13	0340	11-Sep-2012	1140	-8	37.379898	-135.081167			G.Lawson	
20120911.1148.001	ReeveNet	start	4	27	21	0346	11-Sep-2012	1148	-8	37.381803	-135.081468		70 mwo	G.Lawson	
20120911.1224.001	ReeveNet	end	4	27	21	0420	11-Sep-2012	1224	-8	37.394412	-135.081545		70 mwo	G.Lawson	
20120911.1226.001	Ship	end Station	4	27		0425	11-Sep-2012	1226	-8	37.395852	-135.081252				
20120911.1812.001	Ship	start Station	4	28		1012	11-Sep-2012	1812	-8	36.502053	-135.001345				
20120911.1813.001	Echosounder	start	4	28		1012	11-Sep-2012	1813	-8	36.502277	-135.001257	4996			
20120911.1817.001	Echosounder	end	4	28		1017	11-Sep-2012	1817	-8	36.504377	-135.000122	4996			
20120911.1818.001	CTD911	start	4	28	46	1018	11-Sep-2012	1818	-8	36.504612	-135.000035	4996	1000	A.Wang	
20120911.1818.002	VPR	start	4	28	37	1018	11-Sep-2012	1819	-8	36.504672	-135.000028	4996	1000	G.Lawson	
20120911.1943.001	CTD911	end	4	28	46	1143	11-Sep-2012	1943	-8	36.522495	-134.996020	4996	1000	A.Wang	
20120911.1943.002	VPR	end	4	28	37	1143	11-Sep-2012	1943	-8	36.522550	-134.996008	4996	1000	G.Lawson	
20120911.1944.001	Ship	end Station	4	28		1144	11-Sep-2012	1944	-8	36.522628	-134.996003				
20120911.2300.001	Ship	start Station	4	29	47	1500	11-Sep-2012	2300	-8	36.001138	-135.000407				entered late; changed latlon, utc, etc.
20120911.2309.001	CTD911	start	4	29	47	1508	11-Sep-2012	2309	-8	36.002460	-134.998880	4255	1000	A.Wang	
20120911.2310.001	VPR	start	4	29	38	1509	11-Sep-2012	2310	-8	36.002588	-134.998913	4255	1000	G.Lawson	
20120911.2314.001	Echosounder	start	4	29		1514	11-Sep-2012	2314	-8	36.003422	-134.999137	4255	1000		
20120911.2319.001	Echosounder	end	4	29		1519	11-Sep-2012	2319	-8	36.004208	-134.999093	4255	1000		
20120912.0023.001	CTD911	end	4	29	47	1623	12-Sep-2012	0023	-8	36.019700	-134.996443	4255	1000	A.Wang	
20120912.0024.001	VPR	end	4	29	38	1624	12-Sep-2012	0024	-8	36.019875	-134.996575	4255	1000	G.Lawson	
20120912.0027.001	Ship	end Station	4	29	47	1627	12-Sep-2012	0027	-8	36.020850	-134.996793				
20120912.0401.001	Ship	start Station	4	30	48	2000	12-Sep-2012	0401	-8	35.505773	-135.001120	4550			
20120912.0402.001	CTD911	start	4	30	48	2001	12-Sep-2012	0402	-8	35.506100	-135.001047	4550	3000	A.Wang	
20120912.0411.001	Echosounder	start	4	30		2010	12-Sep-2012	0411	-8	35.509068	-135.000042	4550			
20120912.0433.001	Echosounder	end	4	30		2033	12-Sep-2012	0433	-8	35.515992	-135.000903	4550			
20120912.0626.001	CTD911	end	4	30	48	2226	12-Sep-2012	0626	-8	35.548975	-135.008005	4550	3000	A.Wang	

20120912.0634.001	ReeveNet	start	4	30	22	2233	12-Sep-2012	0634	-8	35.552268	-135.008588		150 mwo	G.Lawson	
20120912.0727.001	ReeveNet	end	4	30	22	2325	12-Sep-2012	0727	-8	35.570575	-135.011512		150 mwo	G.Lawson	
20120912.0757.001	MOCNESS	start	4	30	21	2356	12-Sep-2012	0757	-8	35.585470	-135.003108		1000	P.Wiebe	
20120912.1119.001	MOCNESS	end	4	30	21	0318	12-Sep-2012	1119	-8	35.662482	-134.903600		1000	P.Wiebe	
20120912.1127.001	Echosounder	start	4	30		0327	12-Sep-2012	1128	-8	35.665155	-134.900373	4237			
20120912.1128.001	Echosounder	end	4	30		0328	12-Sep-2012	1128	-8	35.665197	-134.900290	4237			
20120912.1133.001	CTD911	start	4	30	49	0333	12-Sep-2012	1133	-8	35.665378	-134.900572	4237	1000	A.Wang	
20120912.1134.001	VPR	start	4	30	39	0333	12-Sep-2012	1134	-8	35.665378	-134.900585	4237	1000	G.Lawson	
20120912.1229.001	CTD911	end	4	30	49	0428	12-Sep-2012	1229	-8	35.668438	-134.902345	4237	1000	A.Wang	
20120912.1229.002	VPR	end	4	30	39	0429	12-Sep-2012	1229	-8	35.668442	-134.902337	4237	1000	G.Lawson	
20120912.1240.001	ReeveNet	start	4	30	23	0439	12-Sep-2012	1240	-8	35.670385	-134.902968		70 mwo	G.Lawson	
20120912.1329.001	ReeveNet	end	4	30	23	0527	12-Sep-2012	1329	-8	35.682767	-134.905605		70 mwo	G.Lawson	
20120912.1342.001	HammarHead	start	4	30	14	0540	12-Sep-2012	1342	-8	35.689450	-134.902507			G.Lawson	
20120912.1343.001	Hull HTI	end	4	30		0543	12-Sep-2012	1343	-8	35.690540	-134.901927			G.Lawson	file:2561300
20120912.1509.001	HammarHead	end	4	30	14	0709	12-Sep-2012	1509	-8	35.645108	-134.923068			G.Lawson	
20120912.1509.002	Hull HTI	start	4	30		0709	12-Sep-2012	1509	-8	35.645170	-134.922910			G.Lawson	file:2561511
20120912.1514.001	Echosounder	start	4	30		0714	12-Sep-2012	1514	-8	35.646207	-134.920478	3870			
20120912.1516.001	Echosounder	end	4	30		0716	12-Sep-2012	1516	-8	35.646882	-134.919203	3870			
20120912.1534.001	CTD911	start	4	30	50	0733	12-Sep-2012	1534	-8	35.654088	-134.912108	3870	1000	A.Wang	
20120912.1534.002	VPR	start	4	30	40	0734	12-Sep-2012	1534	-8	35.654162	-134.912042	3870	1000	G.Lawson	
20120912.1634.001	CTD911	end	4	30	50	0834	12-Sep-2012	1634	-8	35.671307	-134.910573	3870	1000	A.Wang	
20120912.1634.002	VPR	end	4	30	40	0834	12-Sep-2012	1634	-8	35.671375	-134.910545	3870	1000	G.Lawson	
20120912.1654.001	MOCNESS	start	4	30	22	0853	12-Sep-2012	1654	-8	35.682388	-134.907803		1000	P.Wiebe	
20120912.2041.001	MOCNESS	end	4	30	22	1241	12-Sep-2012	2041	-8	35.790080	-134.820415		1000	P.Wiebe	
20120912.2044.001	Ship	end Station	4	30		1243	12-Sep-2012	2044	-8	35.790900	-134.819257				
20120913.0155.001	Ship	start Station	4	31		1755	13-Sep-2012	0155	-8	35.001440	-134.998318				
20120913.0158.001	CTD911	start	4	31	51	1758	13-Sep-2012	0158	-8	35.002818	-134.998073	4400	1000	A.Wang	
20120913.0159.001	VPR	start	4	31	41	1758	13-Sep-2012	0159	-8	35.002983	-134.998088	4400	1000	G.Lawson	

20120913.0202.001	Echosounder	start	4	31		1802	13-Sep-2012	0202	-8	35.003592	-134.998407	4400			
20120913.0207.001	Echosounder	end	4	31		1807	13-Sep-2012	0207	-8	35.004998	-134.998575	4400			
20120913.0310.001	CTD911	end	4	31	51	1910	13-Sep-2012	0310	-8	35.019247	-134.999362	4400	1000	A.Wang	
20120913.0311.001	VPR	end	4	31	41	1911	13-Sep-2012	0311	-8	35.019340	-134.999350	4400	1000	G.Lawson	
20120913.0640.001	Ship	start Station	4	32		2239	13-Sep-2012	0640	-8	34.500787	-134.999110				
20120913.0640.002	MOCNESS	start	4	32	23	2240	13-Sep-2012	0640	-8	34.500613	-134.998950			P.Wiebe	
20120913.1007.001	MOCNESS	end	4	32	23	0207	13-Sep-2012	1007	-8	34.427833	-135.099452			P.Wiebe	
20120913.1014.001	Echosounder	start	4	32		0214	13-Sep-2012	1014	-8	34.424257	-135.102373				
20120913.1016.001	Echosounder	end	4	32		0216	13-Sep-2012	1016	-8	34.423152	-135.103595				
20120913.1023.001	CTD911	start	4	32	52	0222	13-Sep-2012	1023	-8	34.425167	-135.104260	3549	1000	A.Wang	
20120913.1023.002	VPR	start	4	32	42	0223	13-Sep-2012	1023	-8	34.425277	-135.104312	3549	1000	G.Lawson	
20120913.1122.001	CTD911	end	4	32	52	0322	13-Sep-2012	1122	-8	34.438253	-135.110085	3549	1000	A.Wang	
20120913.1123.001	VPR	end	4	32	42	0323	13-Sep-2012	1123	-8	34.438328	-135.110088	3549	1000	G.Lawson	
20120913.1135.001	ReeveNet	start	4	32	24	0334	13-Sep-2012	1135	-8	34.443055	-135.110820		35 mwo	G.Lawson	
20120913.1215.001	ReeveNet	end	4	32	24	0404	13-Sep-2012	1215	-8	34.458008	-135.112948		35 mwo	G.Lawson	
20120913.1231.001	HammarHead	start	4	32	15	0415	13-Sep-2012	1231	-8	34.464698	-135.110190			G.Lawson	
20120913.1233.001	Hull HTI	end	4	32		0432	13-Sep-2012	1233	-8	34.465515	-135.108832			G.Lawson	file:2571200
20120913.1319.001	Hull HTI	start	4	32		0519	13-Sep-2012	1319	-8	34.484958	-135.065287			G.Lawson	
20120913.1319.002	HammarHead	end	4	32	15	0519	13-Sep-2012	1319	-8	34.485080	-135.065078			G.Lawson	
20120913.1329.001	Echosounder	start	4	32		0529	13-Sep-2012	1329	-8	34.488180	-135.058462	4567			
20120913.1330.001	Echosounder	end	4	32		0530	13-Sep-2012	1330	-8	34.488668	-135.057930	4567			
20120913.1334.001	CTD911	start	4	32	53	0534	13-Sep-2012	1334	-8	34.490247	-135.057945	4567	3000	A.Wang	
20120913.1604.001	CTD911	end	4	32	53	0804	13-Sep-2012	1604	-8	34.514340	-135.072582	4567	3000	A.Wang	
20120913.1750.001	MOCNESS	start	4	32	24	0823	13-Sep-2012	1623	-8	34.526040	-135.073063		1000	P.Wiebe	entered late; latlon, utc corrected
20120913.1945.001	MOCNESS	end	4	32	24	1145	13-Sep-2012	1945	-8	34.647433	-135.081497		1000	P.Wiebe	
20120913.1951.001	Echosounder	start	4	32		1151	13-Sep-2012	1951	-8	34.651745	-135.081133	4387			
20120913.1952.001	Echosounder	start	4	32		1152	13-Sep-2012	1952	-8	34.652445	-135.081087	4387			
20120913.1955.001	CTD911	start	4	32	54	1155	13-Sep-2012	1955	-8	34.653243	-135.081225	4387	1000	A.Wang	

20120913.1956.001	VPR	start	4	32	43	1155	13-Sep-2012	1956	-8	34.653363	-135.081262	4387	1000	G.Lawson	
20120913.2054.001	CTD911	end	4	32	54	1253	13-Sep-2012	2054	-8	34.666393	-135.085103	4387	1000	A.Wang	
20120913.2054.002	VPR	end	4	32	43	1254	13-Sep-2012	2054	-8	34.666517	-135.085107	4387	1000	G.Lawson	
20120913.2102.001	HammarHead	start	4	32	16	1301	13-Sep-2012	2102	-8	34.670320	-135.083493			G.Lawson	
20120913.2107.001	Hull HTI	end	4	32		1307	13-Sep-2012	2107	-8	34.673260	-135.081923			G.Lawson	
20120913.2133.001	HammarHead	end	4	32	16	1333	13-Sep-2012	2133	-8	34.662922	-135.085670			G.Lawson	
20120913.2138.001	Ship	end Station	4	32		1338	13-Sep-2012	2138	-8	34.659300	-135.087500				
20120913.2142.001	Hull HTI	start	4	32		1341	13-Sep-2012	2142	-8	34.653658	-135.087123			G.Lawson	
20120914.0149.001	Ship	start Station	4	33		1748	14-Sep-2012	0149	-8	33.999828	-135.000108				
20120914.0153.001	CTD911	start	4	33	55	1753	14-Sep-2012	0153	-8	34.000553	-134.999922	4128	1000	A.Wang	
20120914.0155.001	VPR	start	4	33	44	1754	14-Sep-2012	0155	-8	34.000698	-135.000055	4128	1000	G.Lawson	
20120914.0155.002	Echosounder	start	4	33		1755	14-Sep-2012	0155	-8	34.000717	-135.000102	4128			
20120914.0200.001	Echosounder	end	4	33		1759	14-Sep-2012	0200	-8	34.000825	-135.000773	4128			
20120914.0304.001	CTD911	end	4	33	55	1904	14-Sep-2012	0304	-8	34.006683	-135.007355	4128	1000	A.Wang	
20120914.0304.002	VPR	end	4	33	44	1904	14-Sep-2012	0304	-8	34.006702	-135.007367	4128	1000	G.Lawson	
20120914.0308.001	Ship	end Station	4	33		1908	14-Sep-2012	0308	-8	34.007503	-135.007072				
20120914.0624.001	Ship	start Station	4	34		2224	14-Sep-2012	0624	-8	33.499408	-135.001057				
20120914.0635.001	MOCNESS	start	4	34	25	2224	14-Sep-2012	0635	-8	33.505167	-134.999702			P.Wiebe	
20120914.0958.001	MOCNESS	end	4	34	25	0146	14-Sep-2012	0958	-8	33.614768	-134.996095			P.Wiebe	
20120914.1004.001	Echosounder	start	4	34		0204	14-Sep-2012	1004	-8	33.618865	-134.995902	4078			
20120914.1005.001	Echosounder	end	4	34		0205	14-Sep-2012	1005	-8	33.619220	-134.995775	4078			
20120914.1008.001	CTD911	start	4	34	56	0208	14-Sep-2012	1008	-8	33.619918	-134.995095	4078	1000	A.Wang	
20120914.1008.002	VPR	start	4	34	56	0208	14-Sep-2012	1009	-8	33.619955	-134.995045	4078	1000	G.Lawson	
20120914.1112.001	CTD911	end	4	34	56	0312	14-Sep-2012	1112	-8	33.627225	-134.987650	4078	1000	A.Wang	
20120914.1112.002	VPR	end	4	34	56	0312	14-Sep-2012	1112	-8	33.627265	-134.987638	4078	1000	G.Lawson	
20120914.1123.001	ReeveNet	start	4	34	25	0320	14-Sep-2012	1123	-8	33.629480	-134.986033		35 mwo	G.Lawson	
20120914.1209.001	ReeveNet	end	4	34	25	0407	14-Sep-2012	1209	-8	33.642267	-134.977923		35 mwo	G.Lawson	
20120914.1225.001	Hull HTI	other				0424	14-Sep-2012	1225	-8	33.638000	-134.975103			G.Lawson	Stop for Hammar Head 2581200

20120914.1225.002	HammarHead	start				0425	14-Sep-2012	1225	-8	33.637695	-134.975088			G.Lawson	Boot JSTAR
20120914.1314.001	Hull HTI	start				0513	14-Sep-2012	1314	-8	33.593997	-134.972663			G.Lawson	HTI back on at 1306Z # 2581308
20120914.1321.001	HammarHead	end	4	34	17	0520	14-Sep-2012	1321	-8	33.588140	-134.973135			G.Lawson	
20120914.1331.001	Echosounder	start	4	34		0531	14-Sep-2012	1331	-8	33.581230	-134.974758				
20120914.1332.001	Echosounder	end	4	34		0532	14-Sep-2012	1332	-8	33.580945	-134.974857				
20120914.1346.001	CTD911	start	4	34	57	0545	14-Sep-2012	1346	-8	33.581148	-134.975597	4161	3000	A.Wang	
20120914.1609.001	CTD911	end	4	34	57	0809	14-Sep-2012	1609	-8	33.579377	-134.979420	4161	3000	A.Wang	
20120914.1629.001	MOCNESS	start	4	34	26	0829	14-Sep-2012	1629	-8	33.588738	-134.979065			P.Wiebe	
20120914.2001.001	MOCNESS	end	4	34	26	1201	14-Sep-2012	2001	-8	33.701480	-135.011302			P.Wiebe	
20120914.2008.001	Echosounder	start	4	34		1208	14-Sep-2012	2008	-8	33.706220	-135.012590	4080			
20120914.2010.001	Echosounder	end	4	34		1210	14-Sep-2012	2010	-8	33.707292	-135.012777	4080			
20120914.2014.001	CTD911	start	4	34	58	1213	14-Sep-2012	2014	-8	33.708538	-135.012447	4080	1000	A.Wang	
20120914.2014.002	VPR	start	4	34	46	1214	14-Sep-2012	2014	-8	33.708598	-135.012467	4080	1000	G.Lawson	
20120914.2117.001	CTD911	end	4	34	58	1317	14-Sep-2012	2117	-8	33.722285	-135.015368	4080	1000	A.Wang	
20120914.2117.002	VPR	end	4	34	46	1317	14-Sep-2012	2117	-8	33.722338	-135.015377	4080	1000	G.Lawson	
20120914.2120.001	Ship	end Station	4	34		1320	14-Sep-2012	2121	-8	33.723827	-135.014888				
20120914.2120.002	Ship	end Transect	4			1320	14-Sep-2012	2121	-8	33.723827	-135.014888				entered late; corrected latlon, utc etc.
20120914.2120.003	Ship	start Transect	5			1320	14-Sep-2012	2121	-8	33.723827	-135.014888				entered late; corrected latlon, utc etc.
20120915.0450.001	Ship	start Station	5	Test 9		2050	15-Sep-2012	0450	-8	33.748228	-133.595668				entered late; corrected utc, latlon, etc. start STM when reeve net went in.
20120915.0454.001	ReeveNet	start	5	Test 9	26	2054	15-Sep-2012	0454	-8	33.748530	-133.582545		35 mwo	G.Lawson	
20120915.0552.001	ReeveNet	end	5	Test 9	26	2150	15-Sep-2012	0552	-8	33.760957	-133.595258		35 mwo	G.Lawson	
20120915.0608.001	Ship	end Station	5	Test 9		2208	15-Sep-2012	0608	-8	33.764048	-133.567755				
20120915.0609.001	XBT	release	5	Test 9	7	2208	15-Sep-2012	0609	-8	33.764058	-133.565447			G.Lawson	
20120915.0819.001	XBT	release	5	Test 10	8	0018	15-Sep-2012	0819	-8	33.772777	-133.172073			G.Lawson	
20120915.0825.001	Ship	start Station	5	Test 10	27	0019	15-Sep-2012	0825	-8	33.774073	-133.171958				
20120915.0827.001	ReeveNet	start	5	Test 10	27	0025	15-Sep-2012	0827	-8	33.774770	-133.171807		100 mwo	G.Lawson	

20120915.0906.001	ReeveNet	end	5	Test 10	27	0105	15-Sep-2012	0906	-8	33.787222	-133.174518		100 mwo	G.Lawson	
20120915.0910.001	Ship	end Station	5	Test 10		0109	15-Sep-2012	0910	-8	33.788637	-133.174895				
20120915.1741.001	Hull HTI	end	5			1740	16-Sep-2012	0141	-8	33.817853	-131.519815			G.Lawson	rebooting computer was not recognizing backup HD
20120915.1821.001	Hull HTI	start	5			1821	16-Sep-2012	0221	-8	33.818798	-131.391417			G.Lawson	startup after restart file R2591829
20120917.0900.001	Ship	change Time zone	5			0100	17-Sep-2012	0900	-8	34.053553	-123.934696				entered late; corrected latlon, utc etc.
20120917.1853.001	MICA	end	5			1153	17-Sep-2012	1853	-7	34.100777	-122.237123			A.Wang	
20120917.1854.001	Hull HTI	end	5			1154	17-Sep-2012	1854	-7	34.100962	-122.233878			G.Lawson	
20120918.1517.001	Ship	end Transect	5			0816	18-Sep-2012	1517	-7	34.147722	-119.208422				
20120918.1500.002	Ship	end Cruise				0800	18-Sep-2012	1500	-7	34.147712	-119.208418				entered 15 min. late; times corrected