CRUISE REPORT

HUDSON 2014004

SCOTIAN SHELF

AZMP TRANSECTS +

April 4th – April 23rd, 2014

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CRUISE NARRATIVE

Highlights

Area Designation:	NAFO Regions: 5Ze, 4X, 4W, 4Vs, 4Vn, 3Pn, 3Ps Extent: 41^{o} 24'N - 47^{o} 35'N; 056^{o} 08'W - 066^{o} 08'W
Expedition Designation:	HUD2014004 or 18HU14004 (ISDM format)
Chief Scientist:	Mr. Andrew Cogswell Ocean Ecosystem Science Division Marine Ecology Section Department of Fisheries and Oceans Bedford Institute of Oceanography PO Box 1006 Dartmouth, NS, Canada B2Y 4A2 Andrew.Cogswell@dfo-mpo.gc.ca
Ship:	CCGS Hudson (call sign - CGDG) Oceanographic research vessel
Ports of Call:	April 4th, 2014 - Depart BIO Dartmouth, NS April 8th, 2014 – First leg crew and equipment dropped off in Halifax, NS. Storm stayed overnight at BIO dock, departed at ~1300 on April 9th April 23rd, 2014 - Return BIO, Dartmouth, NS
Cruise Dates:	Leg 1: April 4th – April 8th Leg 2: April 9th – April 23rd

Mission Summary

Overview

The first leg of the mission began in Halifax on April 4th, 2014 and ended when first leg science staff disembarked and equipment was unloaded at the BIO pier on April 8th. The Hudson departed from BIO on April 9th at ~1300 to begin the second leg of the mission and finished at the same location at ~0830 on the morning of April 23rd. The CCGS Hudson logged ~2811 nm during the 20 day mission and AZMP science staff conducted 225 separate operations at 91 stations (Figure 1). Table 1 breaks down the operations by sampling gear for each leg of the trip. The table also points to figures which display the deployment locations for each gear type. Each of these figures is accompanied by a table of coordinates detailing each deployment of that gear type.

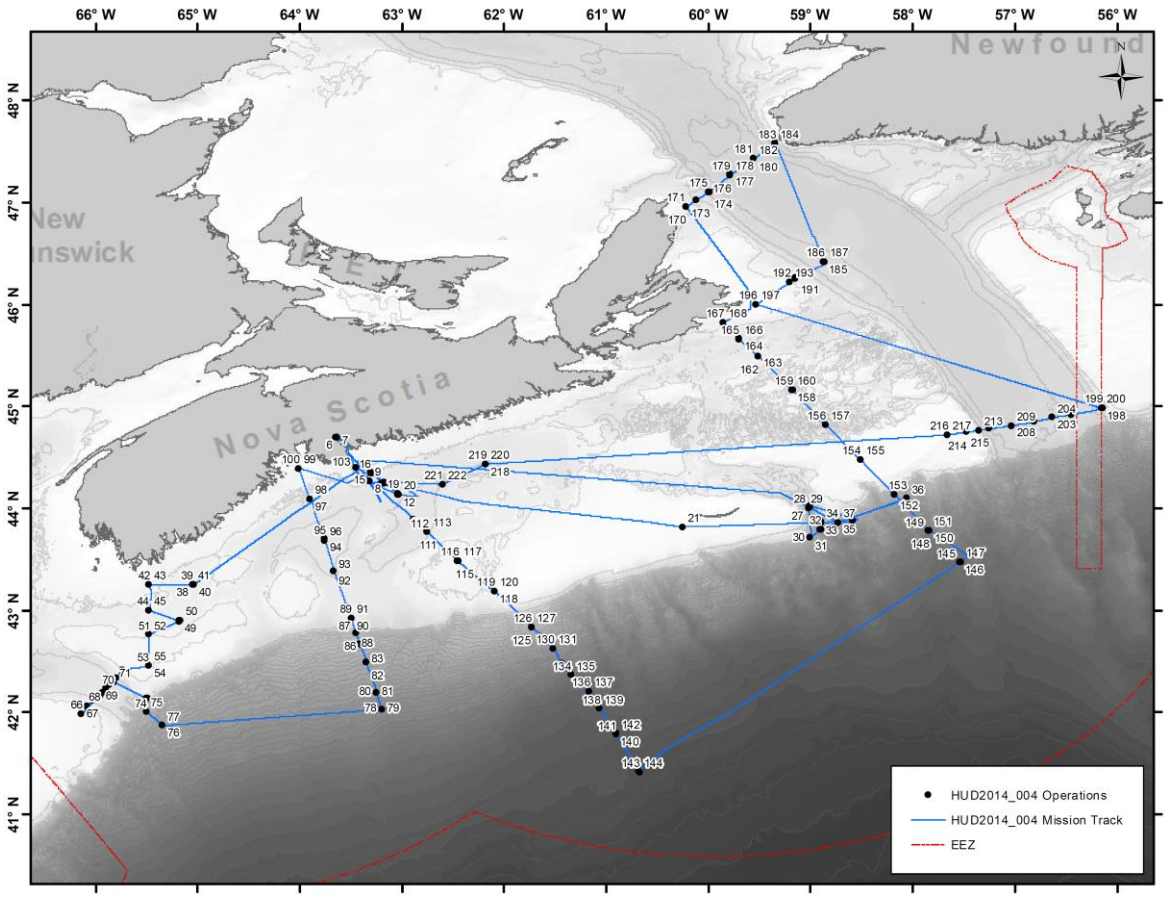


Figure 1. The locations for all 225 events during the HUD2014004 AZMP spring survey. Some overlapping event labels are not visible.

Table 1. Summary of operations during the HUD2014004 AZMP spring survey.

Leg	Operation	# of Operations	Figure
1	CTD	15	9
	Vertical Ring Net	9	10
	Bioness	3	11
	Mooring Recovery	7	14
	Mooring Deployment	3	14
2	CTD casts	81	9
	Vertical Net Tows	92	10
	Bioness	10	11
	Mooring Deployments	2	14
	Argo Float Deployments	3	15

Leg 1

Due to a high concentration of ice in the Cabot Strait in early April (Figure 3) the first and second legs of the mission had to be reconfigured from the plan presented in the Form B (Figure 2). On April 4th, the first leg began by testing gear in Bedford Basin. Considerable technical difficulties were experienced with the CTD which are discussed in next section. In the morning of April 5th, 3 OTN moorings were recovered and another 3 deployed, all within 30 nm of Halifax Harbour. The CCGS Hudson then began to steam towards the Thebaud platform (southwest of Sable Island) to collect water samples before arriving in the Gully MPA and nearby slope to retrieve 4 acoustic moorings and occupy stations for CTD, vertical net tows and Bioness.

Due to heavy ice concentration in the Cabot Strait, Sydney Bight and southern Cape Breton, the Hudson did not sail towards St. Anns Bank to complete mooring deployments and occupy stations. Instead, after completing operations in the Gully MPA, the Hudson began the steam towards Halifax to drop off leg 1 staff. As the Hudson began her approach into Halifax Harbour in the early afternoon of April 8th, the weather began to deteriorate and the Captain made a decision to stay on the BIO jetty until conditions improved in the afternoon of April 9th.

Leg 2

The decision was made by the Chief Scientist (CS) that mooring deployments on St. Anns Bank would wait until later in the trip (end of leg 2) when ice conditions might be more favourable. Instead of working from east to west (as specified in the Form B), the first stations of the second leg were on the western Scotian Shelf (Roseway Basin, Brown's Bank and Northeast Channel) and the ship worked back towards the eastern Scotian Shelf with the hope that ice conditions would improve in Cabot Strait by mid-April. Because of time lost during leg 1 due to repeated gear failure, it was decided by the CS that the Gulf of Maine North Atlantic Time Series (GNATS) stations would be dropped from the mission.

On April 18th, new ice service reports and NOAA satellite imagery obtained by the Captain indicated that ice conditions had improved dramatically in the Cabot Strait (Figures 3 & 4). At this point, the decision was made to occupy the Cabot Strait stations and St. Anns Bank stations prior to mooring deployments in the morning of April 20th. The ship's crew met with science staff prior to mooring deployments to discuss operations. Science staff normally dedicated to the deployment of the moorings were unable to participate during the second leg, thus relatively inexperienced science staff were provided with specific instructions and were able to assist with deployments. Thankfully, with the assistance of the crew, both deployments were successful.

After completing operations at St. Anns Bank, the ship departed for the beginning of the BP line that crosses the mouth of the Laurentian Channel. Upon completing this line on Banquereau early in the morning of April 22nd, the Hudson began the steam back to occupy HL_02 prior to sailing back to BIO. However, because it appeared as though the ship was to arrive earlier than scheduled, 2 additional stations were added: the first at Little Emerald (Figure 1 – 219 to 220) and the second in the centre of the Emerald Vazella Closure (Figure 1 – 221 to 222). The Hudson arrived in Halifax on the morning of April 23rd as scheduled.

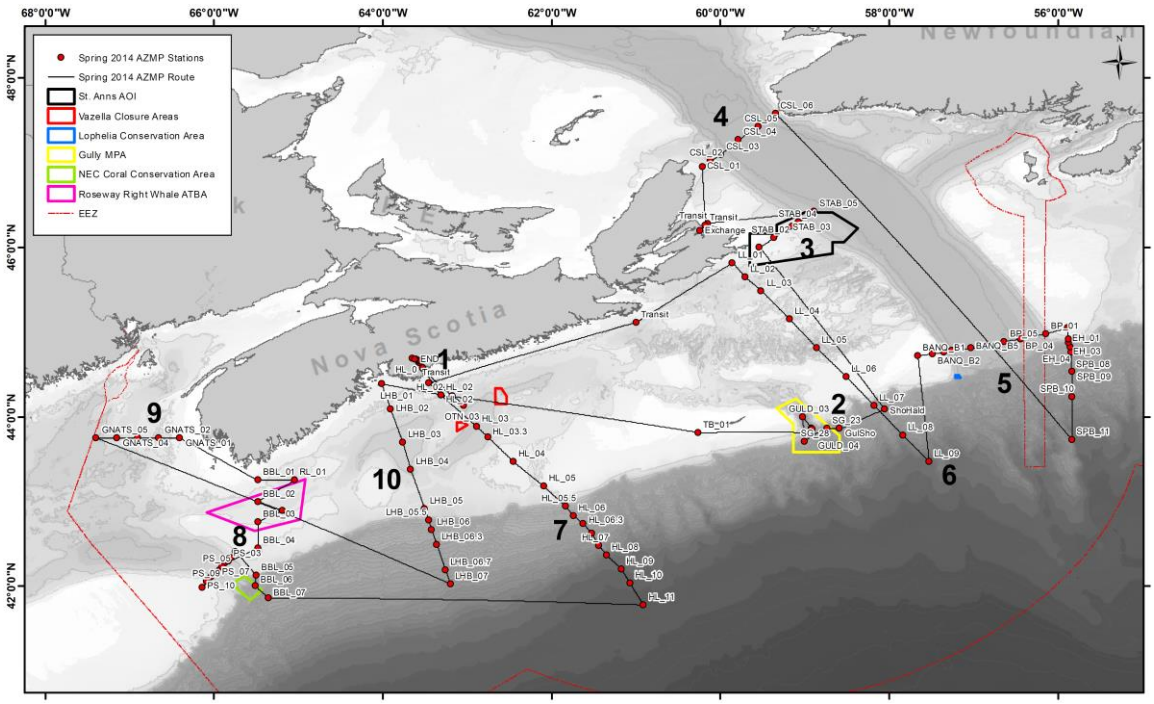


Figure 2. Planned locations as specified in the Form B.

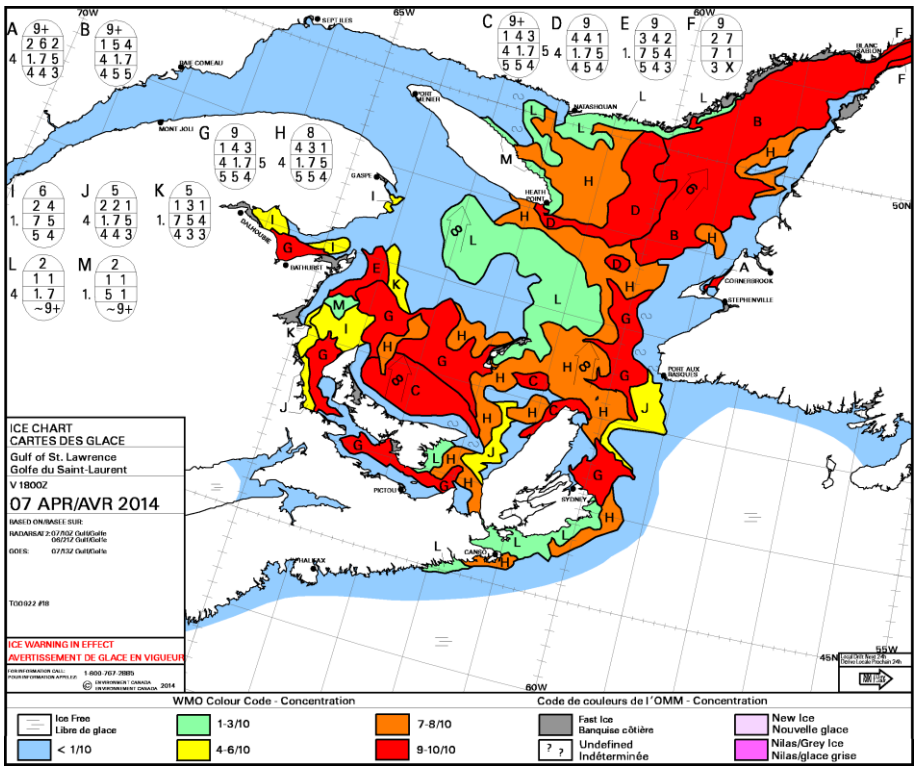


Figure 3. Ice conditions in Gulf of St. Lawrence and Cabot Strait on April 7th.

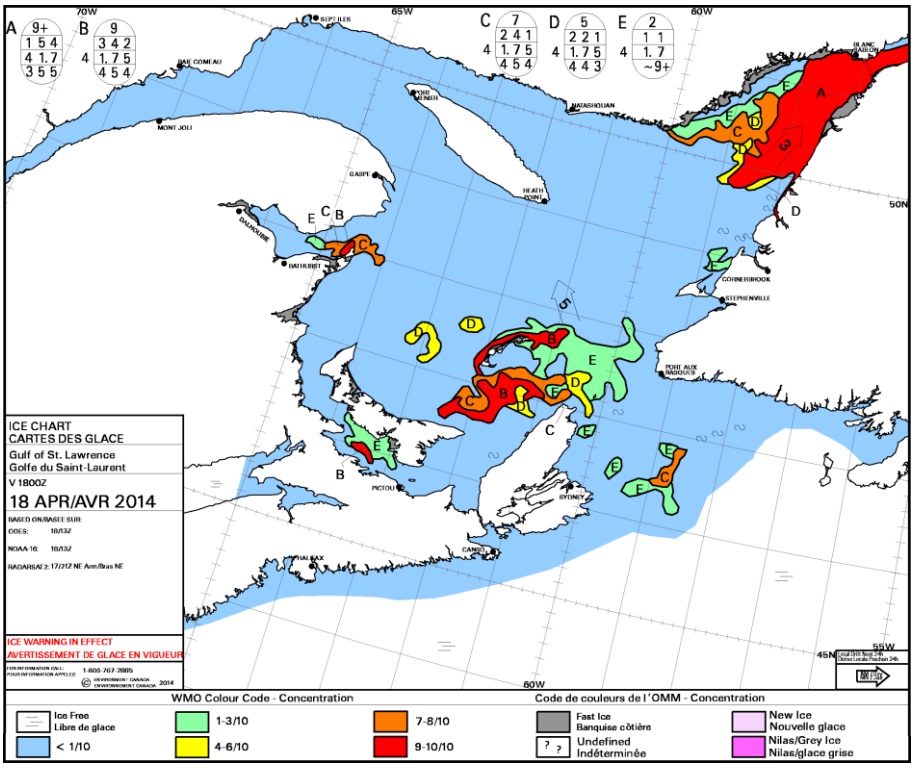


Figure 4. Ice conditions in Gulf of St. Lawrence and Cabot Strait on April 18th.

During the 19 day mission, ~5 days were directly attributable to field operations (Table 2) and the remaining 14 days were attributable to a combination of steaming time, station keeping and gear preparation/repair. During steaming, the vessel mounted Acoustic Doppler Current Profiler (ADCP) was in operation and was collecting data from April 4th until April 17th. The gear was not monitored after the 17th and upon return to BIO it was noticed that the unit had stopped recording data on April 17th.

Underway data (temperature, salinity and fluorescence) were collected via the recently installed Thermosalinograph (TSG) at 5 second intervals throughout the mission. Like other underway sampling gear (VMADCP), this is not included in the operational break down provided in Table 2. Details of the TSG set up and operation during the mission will be provided later in the report.

Table 2. Break down of operational time by gear type during HUD2014004.

Gear	Time Allocated (hrs)
CTD	~59
Vertical Net Tows	~36
Mooring Deployments/Retrievals	~11
Bioness	~ 6
ARGO	~1

Mission Participants

Table 3. List of science staff aboard the HUD2014004 spring AZMP mission.

Name	Affiliation	Responsibility
Abbot, Susan*	EC-CWS	Seabird and Marine Mammal Observer
Barthelotte, Jay*	DFO (MAR – PCSD)	Mooring Technician
Benjamin, Robert	DFO (MAR – PCSD)	Data Management Technician
Caverhill, Carla	DFO (MAR – OESD)	CTD sample collection/Laboratory Technician
Cardoso, Diana*	DFO (MAR – OESD)	Vessel Mounted and Lowered ADCP Operator
Cogswell, Andrew**	DFO (MAR – OESD)	Chief Scientist/CTD Computer Operator/meta-data entry
Cormier, Terry	DFO (MAR – PCSD)	CTD Operator/Ship's Technician
Gould, Jessica	DAL (Markus Kienast)	Underway sampling for organic biomarkers and rosette sampling for isotopic composition of nitrate
Hogan, Holly	EC-CWS	Seabird and Marine Mammal Observer
Lemay, Jonathan	DAL (Helmuth Thomas)	Dissolved inorganic carbon (DIC), total alkalinity, DI ^{13}C and partial pressure of carbon dioxide (pCO_2) collection and analysis
Nudds, Shannon	DFO (MAR – OCS)	CTD Computer Operator/meta-data entry
Perry, Tim	DFO (MAR – OESD)	CTD sample collection/Laboratory Technician
Ringuette, Marc	DFO (MAR – OESD)	Biological Net Tow Operator
Ryan, Robert	DFO (MAR – PCSD)	CTD Operator
Spry, Jeff	DFO (MAR – OESD)	CTD Operator/Biological Net Tow Operator/Laboratory Technician
Wilson, Erin	DAL (Helmuth Thomas)	DIC, total alkalinity, DI ^{13}C and pCO_2 collection and analysis
Wood, Dan*	DFO (MAR – PCSD)	Mooring Technician
Zorz, Jackie	DAL (Julie Laroche)	Water samples for meta-genomics

*Leg one only
**Chief Scientist
DFO: Department of Fisheries and Oceans Canada
MAR-OESD: Maritimes - Ocean Ecosystem Science Division
MAR-PCSD: Maritimes - Program Coordination and Support Division
EC-CWS: Environment Canada - Canadian Wildlife Service
DAL: Dalhousie University

Objectives

There were 18 objectives defined in the Form B submitted prior to sailing (below). Table 4 describes whether each of the objectives was met along with any relevant supporting commentary. Two stations were added during the trip that may or may not support objectives listed below and are included under the heading "Additional Unplanned".

Primary Planned

1. Obtain spring observations of the hydrography and distribution of nutrients, phytoplankton and zooplankton at standard sampling stations along "**core**" Atlantic Zone Monitoring Program sections within the Maritimes Region (**Contact Mr. Andrew Cogswell** - http://www.bio.gc.ca/science/monitoring-monitorage/azmp-pmza-eng.php.).

Additional Planned

2. Conduct Bioness sampling along the Halifax section at HL_03.3 at an area known for a dense scattering layer that causes the *Autonomous Underwater Vehicle, run by the Ocean Tracking Network*, which surveys this line as continuously as possible, to detect a false bottom and return prematurely to the surface (**Contact Dr. Dave Hebert**).
3. Recover and deploy 3 *Ocean Tracking Network (OTN)* moorings at inner shelf stations of the Halifax Section, conduct hydrographic profiles and collect water samples at mooring stations (**Contact Dr. Dave Hebert** - http://www.dfo-mpo.gc.ca/science/publications/article/2011/07-19-11-eng.html).
4. Recover 2 Autonomous Multichannel Acoustic Recorders (AMAR) from the Gully Marine Protected Area (MPA) and 2 more along the eastern Scotian Slope between the Gully MPA and Haldimand Canyon in support of a *SPERA project investigating bottlenose whale migration patterns* and conduct hydrographic profiles and collect water samples at mooring stations (**Contact Dr. Hilary Moors-Murphy** - http://www.mar.dfo-mpo.gc.ca/e0008208).
5. Deploy 2 moorings from St. Anns Bank in support of project funded through *DFO Health of the Oceans Initiative* via the Oceans and Coastal Management Division in an effort to further describe oceanographic conditions within the St. Anns Bank Area of Interest and conduct hydrographic profiles and collect water samples at mooring stations (**Contact Dr. Dave Hebert** - http://www.mar.dfo-mpo.gc.ca/e0010385)
6. Collect nutrients and hydrography across the Northeast Channel as part of *NERACOOS Cooperative Agreement*, (**Contact Dr. Peter Smith** - http://www.neracoos.org/).
7. Carry out hydrographic, chemical and biological sampling at stations in the Gully in support of Gully MPA monitoring initiatives by Oceans (**Contact Dr. Dave Hebert -** http://www.mar.dfo-mpo.gc.ca/Gully-MPA)
8. Carry out hydrographic, chemical and biological sampling across the mouth of the Laurentian Channel, the western shelf break of the Grand Banks and across LaHave Basin. Each of these transects has been proposed to enhance our

understanding of hydrographic phenomenon in these areas in support of current modelling efforts (**Contact Dr. Dave Hebert**).

9. Carry out hydrographic, chemical and biological sampling at the Roseway Line station 1, very near the northeast corner of *an International maritime Organization (IMO) Area To Be Avoided (ATBA)*. This area is known for a seasonally high abundance of the endangered North Atlantic Right Whale (**Contact Dr. Erica Head** - http://www.rightwhale.ca/rosewayatba_e.php, http://www.sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=780).
10. Carry out hydrographic, chemical and biological sampling at stations along the *Gulf of Maine North Atlantic Time Series (GNATS)* section. The GNATS project was eventually funded by NASA (2006 to 2009) but includes physical and biological oceanographic data from 1998 to 2010. The survey was run out of the Bigelow Laboratory for Ocean Science under the direction of Dr. Barney Balch. Data from this survey will enhance our understanding of hydrographic and biological phenomenon in the Gulf of Maine while providing an additional year of data for the GNATS survey (**Contact Dr. Dave Hebert** - http://www.bigelow.org/news/news_2009/gnats-study-shows-evidence-of-climate-change-in-gulf-of-maine/).
11. Collection of DIC, alkalinity and ^{13}C samples in support of research contributing to MEOPAR theme 2.2. Two Dalhousie University students were tasked with collecting the samples from the Rosette (~1L per depth) and processing them (**Contact Dr. Helmuth Thomas -** http://meopar.ca/theme-2-2/).
12. Additional station occupations on the eXtended Halifax Line (XHL) in support of the Atlantic Zone Offshore Monitoring Program (AZOMP) (**Dr. Blair Greenan** - http://www.bio.gc.ca/science/monitoring-monitorage/azomp-pmzao/azomp-pmzao-eng.php).
13. Deployment of ARGO floats (**Contact Dr. Denis Gilbert &/or Dr. Igor Yashayaev** - http://www.bio.gc.ca/science/monitoring-monitorage/azomp-pmzao/argo-eng.php).
14. Methodological comparison of egg production rate measurements of *Calanus finmarchicus* (**Contact Dr. Erica Head/Mr. Marc Ringuette).**
15. Underway suspended particle sampling (organic biomarkers) and rosette samples collected for isotopic composition of nitrate (**Contact Dr. Markus Kienast**).
16. Metagenomics analyses of the microbial community and diversity. Seawater samples will also be obtained and used for enrichment and culturing purposes in hopes of isolating specific strains for further study (**Contact Dr. Julie Laroche**).
17. Ring net sampling in support of research investigating the integration of "genetics and coupled bio-physical modelling of *Centropages typicus* populations on the NW Atlantic continental shelf (**Contact Dr. Erica Head – representing Drs. Blanco-Bercial and Bucklin**).
18. Collect 3-10L samples from CTD cast at 3m at a station near Thebaud Platform and BP1 on St. Pierre Bank for the identification of ultramicrobacteria samples from surface seawater using genomics analyses as part of a larger biodegradation of naturally and chemically dispersed crude oil study (**Contact – Susan Cobanli (COOGER))**.

Additional Unplanned

19. Identify and enumerate birds during the transits between stations and sections.

(**Contact Ms. Carina Gjerdrum –** Environment Canada / Canadian Wildlife Service**)**.

20. The mission was slightly ahead of schedule at the end of the HL_11 occupation. A decision was made to also occupy HL_12.
21. Nearing the conclusion of the mission, it became evident that there would some time available for additional occupations prior to arriving in Halifax. As such, it became apparent that the ship's course would take it near the recently designated Emerald *Vazella* closure area. A single CTD and vertical net tow was collected from the area.
22. Little Emerald (LE) station was occupied when the Hudson was making its final approach towards Halifax on April 22nd.

Table 4. Status of objectives upon completion of the HUD2014004.

Objective	Status	Comments
1	Complete	All core AZMP stations were sampled in accordance with standard protocols.
2	Complete	The last Bioness net did not drop so net 4 becomes 100 m to surface net.
3	Complete	All three OTN moorings were successfully recovered and redeployed.
4	Complete	All four Acoustic AMAR moorings were recovered.
5	Complete	The 2 moorings were deployed on the second leg because of ice near the deployment location during leg 1.
6	Complete	All NERACOOS occupations completed
7	Complete	All Gully occupations completed
8	Partially Complete	The combined St. Pierre Bank and Erica head section could not be occupied because time was not available at the end of the mission.
9	Complete	RL_01 and RATBA_01 stations were both occupied.
10	Dropped	Early in the mission after it became apparent just how much time had been lost repairing gear in Bedford Basin, a decision was made to drop GNATS station occupations.
11	Complete (Revised)	Water samples for DIC and DI ^{13}C and underway measures of pCO_2 were taken by Mr. Jonathan Lemay and Ms. Erin Wilson (Dalhousie University).
12	Complete (Revised)	eXtended Halifax Line stations HL_08, HL_09, HL_10, HL_11 and HL_12 were occupied. The mission was not originally planning to occupy HL_12.
13	Complete (Revised)	Due to time constraints, the Hudson was unable to occupy the originally planned stations at SPB_10 and SPB_11. Instead, through consultation with Denis Gilbert, the ARGO floats were deployed at LL_08 and LL_09. The final float was deployed at the planned location of HL_11.
14	Complete	A number of net tows were collected in addition to AZMP core tows to contribute to on board study examining assessment methodology for determining *C. finmarchicus* egg production rates.
15	Complete	Jessica Gould (Dalhousie University) collected underway samples via the TSG set up for organic biomarker study. She also collected water samples from the rosette at various sites in support of isotopic composition of nitrate study.
16	Complete	Jessica Zorz (Dalhousie University) collected water samples from the rosette at various stations for metagenomics analysis of the microbial community and diversity as well as enrichment and culturing purposes.
17	Complete	Additional ring nets were deployed at the prescribed stations in support of research investigating the integration of "genetics and coupled bio-physical modelling of *Centropages typicus*" populations on the NW Atlantic continental shelf.
18	Complete (Revised)	Water samples were collected near the Thebaud Platform and HL_02 and filtered/stored according to methods provided by COOGER.
19	Complete	The report describing the bird and marine mammal enumeration conducted during the mission has been provided by EC-CWS for this cruise report.
20	Unplanned	CTD and vertical net tow were conducted within the Emerald Vazella Closure.
21	Unplanned	CTD, Bioness and vertical net tow were conducted at Little Emerald.

Summary of Activities

CTD summary

Narrative

As summarized in Table 1, there were a total of 96 CTD casts during the mission (Figure 9 and Table 5) and of these, 88 were complete casts and fully processed. Appendix 1 provides the Seasave instrument configuration file that details the sensors deployed on the rosette frame during HUD2014004.

During the first day of the mission (April 4th), the CTD was plagued with sensor, component and termination failure:

- During the first CTD cast (Event 1) while testing in Bedford Basin (HL_0), the CTD experienced an electrical re-termination and an associated blown fuse in the deck unit.
- During the next CTD cast (Event 3) it was noted that the secondary salinity was consistently ~0.20 P.S.U. higher than the primary measurement. After confirming the coefficients for the salinity sensors were correct, the plumbing was also adjusted to move the primary sensor package outflow away from the secondary intake to cut down on increased variability in the secondary sensor measurements.
- On the next cast (Event 4), the CTD carousel failed and it was also noted that the secondary oxygen and conductivity values were now wildly variable and dramatically different than primary sensor values. In attempt to remedy the issue, the secondary pump was replaced. In addition, the block counter had been installed backwards and this time was also used to reverse it.
- During Event 5, the carousel worked when all bottles were fired at 10 m, but conductivity and oxygen values were still an issue. The secondary oxygen sensor was showing spikey data with low values (3.427 ml/l).
    - Samples for both oxygen and salinity were taken at 10 m from the rosette.
        - The results revealed that the primary oxygen sensor (7.138 ml/l) was fairly near the Winkler measure (duplicate average = 7.370 ml/l) so the secondary sensor was replaced with a spare.
        - The primary salinity measure (30.651 P.S.U.) was within 0.016 P.S.U. of salinometer measurement from the rosette at 10 m (30.635), but the secondary sensor value was ~0.277 P.S.U greater (30.912). Despite the large secondary sensor difference, the decision was made to stick with the current configuration.
        - Finally, a new mission configuration file was created (HUD2014004b.con) that reflected the new oxygen sensor coefficients.
- During Event 6, the CTD experienced another electrical termination failure because of a crimp that did not take. In the future solder should be used instead of crimping to avoid these time consuming malfunctions.

This series of CTD malfunctions began in the morning of Apirl 4th (~0840) and continued until ~1930 the same day. These delays meant that instead of retrieving and deploying

OTN moorings on the 4th, these operations were delayed until sunrise on April 5th. In total, at least 13 hours of mission time was lost to CTD repairs in the first 24 hours.

Throughout the remainder of the mission, the CTD continued to experience technical difficulties:

- The CTD continued to experience primary and secondary salinity differences in the range of ~0.2 P.S.U. until Event 117 at HL_04. Just prior to this CTD cast, the CTD technician had flushed the tubing with Triton-X. During the cast, the secondary and primary salinity difference was reduced to ~0.04 P.S.U. During event 166 at LL_02, all plumbing was changed and the primary secondary tubing was again flushed with Triton-X when a foreign substance (grease?) was found in the plumbing. During Event 173 at CSL_02, it was noted that the primary and secondary salinity difference was now within the margin of error at <0.007 P.S.U.. The difference remained constant at this value for the remainder of the casts during the mission.
    - As a result of these events, it is strongly recommended that the CTD plumbing be soaked in Triton-X, both prior to its first deployment and during any long steams.
- During Event 11 at HL_02, it was noted that the WETstar fluorometer was logging negative noise. Further diagnosis revealed that the sensor had failed and was removed from the CTD.
- Upon recovery of the CTD during Event 47, the CTD deck unit threw an error code and a complete mechanical and electrical re-termination was required.
- Prior to Event 79 a complete re-termination was required due to "bird caging".
- The CTD touched bottom during Event 131 and the sensors failed to capture "real" data on the up cast, as the plumbing was like clogged with silt. Bottles were fired on the up cast and the CTD acquisition data was processed using sensor data captured during the downcast. Upon completion of the cast, the plumbing was flushed and the CTD required a complete re-termination.
- During Event 137 the spooling gear for the CTD winch was adjust upon ascent at ~2800 m by the CTD technician, against the better judgement of the CTD operator. By ~2000 m cable out, this adjustment resulted in a gap on both side of the drum near the flange. To avoid potentially irreparable harm to the cable, the decision was made by the CS to spool back out to just prior to the spool adjustment and make small adjustments during the completion of the up cast. The cast was completed without further incident.
- After reaching the bottom during Event 144, the primary sensor package started returning unusual values on the up cast.
    - Upon retrieval of the CTD the wheel was changed on the block because the Allen screws in the wheel had backed out and one was completely sheared off.
    - Both the primary and secondary plumbing was thoroughly flushed with Triton-X prior to redeployment.
- The secondary salinity sensor did not provide accurate data during Event 165. The plumbing was flushed prior to the next event.
    - Upon retrieval and a plumbing change, a large amount of "foreign" material was found in the plumbing.

- During Event 208 the deck unit threw an error and communication with the CTD was lost. The CTD was aborted, and upon retrieval of the CTD a complete mechanical and electrical re-termination was completed and a 2 amp fuse was replaced in the deck unit.

A number of other smaller issues were encountered during the mission that will not be discussed within the report but could still adversely affect QA/QC of processed CTD data. Most of these problems were addressed prior to CTD processing. During the QA/QC of this data, the meta-data captured by ELOG in the mission logbook should be readily utilized, as it contains all pertinent CTD operational information.

Throughout the mission, the CTD experienced numerous mechanical and electrical re-terminations. Some were clearly caused by workmanship and/or operations issues (e.g., shielding causing abrasion on conducting wire, ground wire becomes separated from crimp, CTD contacting bottom, etc...), but others were more difficult to determine the cause of. It will be important to monitor the frequency of re-terminations on subsequent cruises and to identify other issues that may be increasing re-termination frequency. As a result of the volume and breadth of CTD errors experienced during the mission, science is currently pushing for an early season 2 day "mission" in 2015 just to test all gear prior to the spring AZMP mission to avoid these extensive delays.

During the first leg, beginning at Event 11 at HL_02 on April 4th, the motion sensor package was unable to see either the CTD serial data or the SeaSave serial data, but was able to see the boom and block data. The motion sensor data was not recorded for the first leg of the mission. The problem went undiagnosed until the morning of April 9th (in Bedford Basin) when it was realized, through process of elimination, that the wrong COM ports and baud rates were selected. The COM ports and baud rates listed for each serial feed in the motion sensor manual were partially incorrect. These were fixed and the motion sensor functioned without problems for the remainder of the mission.

During the first few attempts to process CTD data using the Science02 user ID on the primary CTD computer, CTD_DAP threw an error when it could not access a .CNV file required during processing. While this problem was being diagnosed, it was also noted that no true back up was being created on the ship's server in folders S:\ and T:\ but rather on a virtual S and T drives on the computer itself. It was also discovered that many folders were irreversibly read-only and one file type (.CNV) could not be opened and/or copied from one directory to another. As of writing this report, there is no clear reason that either of these should have happened. Flo Hum tested the system prior to departure and no changes were made to the system prior to the errors developing. The decision was made to both capture CTD data and process it using the CTD Tech user ID which did not seem to display these issues. As a consequence, to which the solution has also not been made apparent, this switch to the CTD Tech user ID also caused the calib.txt file to be repeatedly written over during the mission and for unique IGOS.txt file to be created for each processed cast rather than appended into a single file as is usually the case. It was also discovered that a mission header was never created to be included as the default during CTD processing.

Robert Benjamin created the network link to S:\ and T:\ on the ship's server, and other than the IGOS and calib file, processing went regularly and processing and acquisition

files were properly backed up on S and T throughout the remainder of the mission. Upon arrival in Bedford Basin at the end of the mission, processing was run again on the secondary computer to properly generate the IGOS and calib file. The acquisition and processed data were provided to the Ocean Data and Information Section upon our arrival for long term data archiving. To avoid issues like this in the future, some effort should be made by the Chief Scientist and/or CTD computer operators to check key files after data processing to determine if data is being properly processed.

Figures 5, and 6 shows the relationship between the primary oxygen and salinity sensors and their analytical counterparts (Winkler titration and salinometer). The relationships between the primary and secondary oxygen and Winkler titration values are very similar, with only a few obvious outliers. Figure 6 shows the primary oxygen sensor was on average 0.17 ml/l lower than the Winkler titration values throughout most of the mission. Secondary oxygen sensor measures were slightly closer to Winkler values and were on average 0.08 ml/l lower than the Winkler titration values (Figure 6). For both oxygen sensors, there appeared to be a slight trend over the mission towards parity with Winkler measures.

As stated previously in this section, secondary salinity sensor values were ~0.2 P.S.U. less than both primary salinity sensor values and salinometer values from Event 11, until Event 117 when the difference declined to 0.014 P.S.U., and later at Event 173 when the difference declined to less than 0.007 P.S.U. This can be seen in Figure 7 where the primary and secondary salinity sensor values are compared to the salinometer values. There are 2 relationships between the secondary sensor and the salinometer values, 1 before the blockage in the plumbing was removed (pre event 117) and after when secondary values were closer to primary values. This is more evident in Figure 8 where the secondary values are clearly less than the salinometer values until an abrupt improvement at Event 117 and another smaller improvement at Event 173. It should also be noted in Figure 8 that there are at least 2 obvious outliers where primary and secondary values are much different than salinometer values (sample ID numbers: 395759 and 396605). It is clear in these cases, based on the salinity values that surround them, that the salinometer values are incorrect.

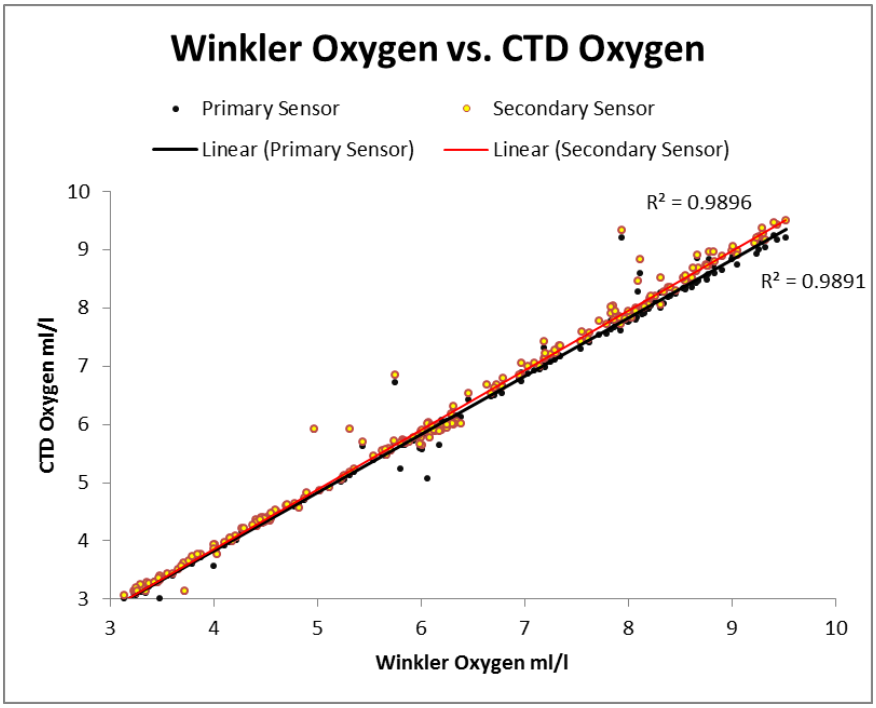


Figure 5. Relationship between Winkler titration oxygen concentration and corresponding primary and secondary CTD censor values throughout the mission.

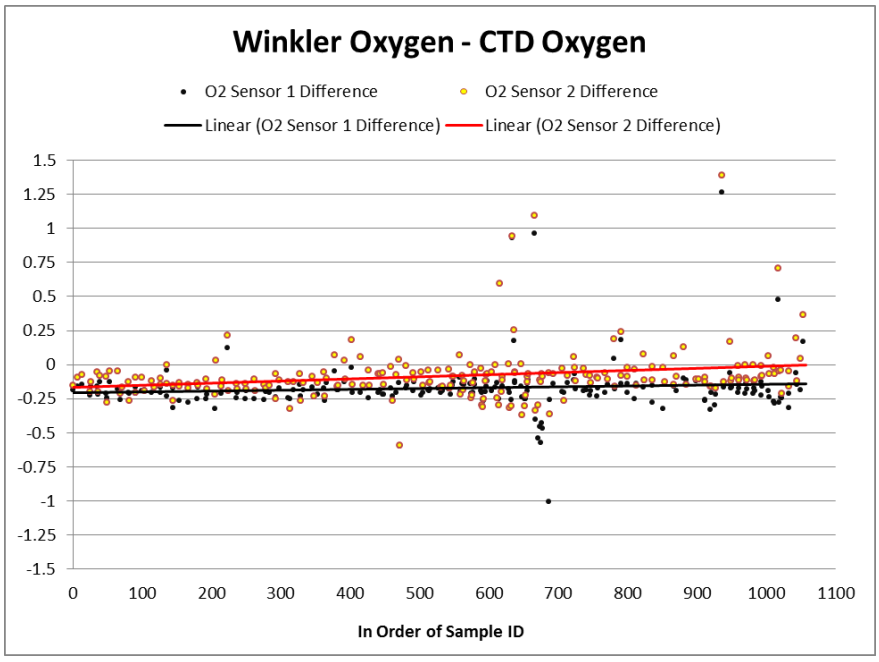


Figure 6. The difference between CTD oxygen concentration values and corresponding Winkler titration oxygen concentration values from the first sample taken to final sample.

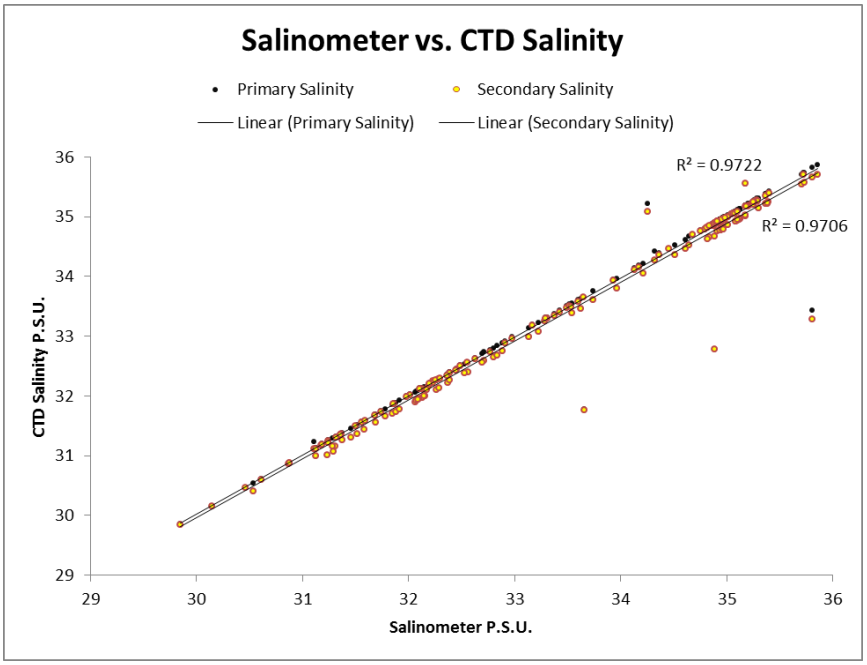


Figure 7. Relationship between salinometer salinity values and corresponding primary and secondary CTD censor values throughout the mission.

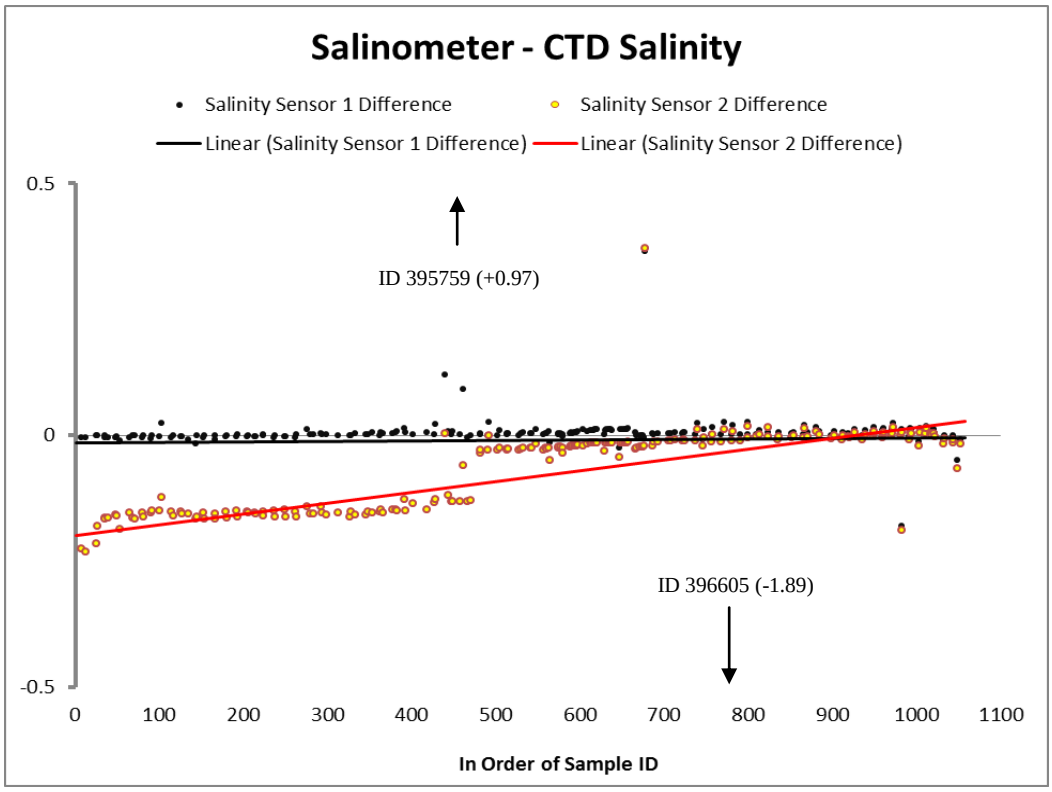


Figure 8. The difference between CTD salinity values and corresponding salinometer salinity values from the first sample taken to the final sample.

Water Samples for Chemical Analyses

Station specific rosette bottle firing depths and water collections for chemical analysis can be found by referring to the CTD deck sheet binder and/or water chemistry sampling document prepared upon the conclusion of the mission and provided to ODIS. Table 5 highlights CTD casts where water collections were made.

Photosynthetically Active Radiation Sensor (PAR)

The Biospherical Instruments PAR (irradiance) sensor was deployed on the rosette only when the maximum depth was ~less than or equal to 300 m. The CTD casts for which it was deployed are noted in Table 5.

Lowered Acoustic Doppler Current Profiler (LADCP)

Lowered ADCP data was collected during 21 CTD profiles (Table 5). Both upward and downward looking 300 kHz TRDI Workhorse Sentinel ADCPs were installed on the CTD frame.

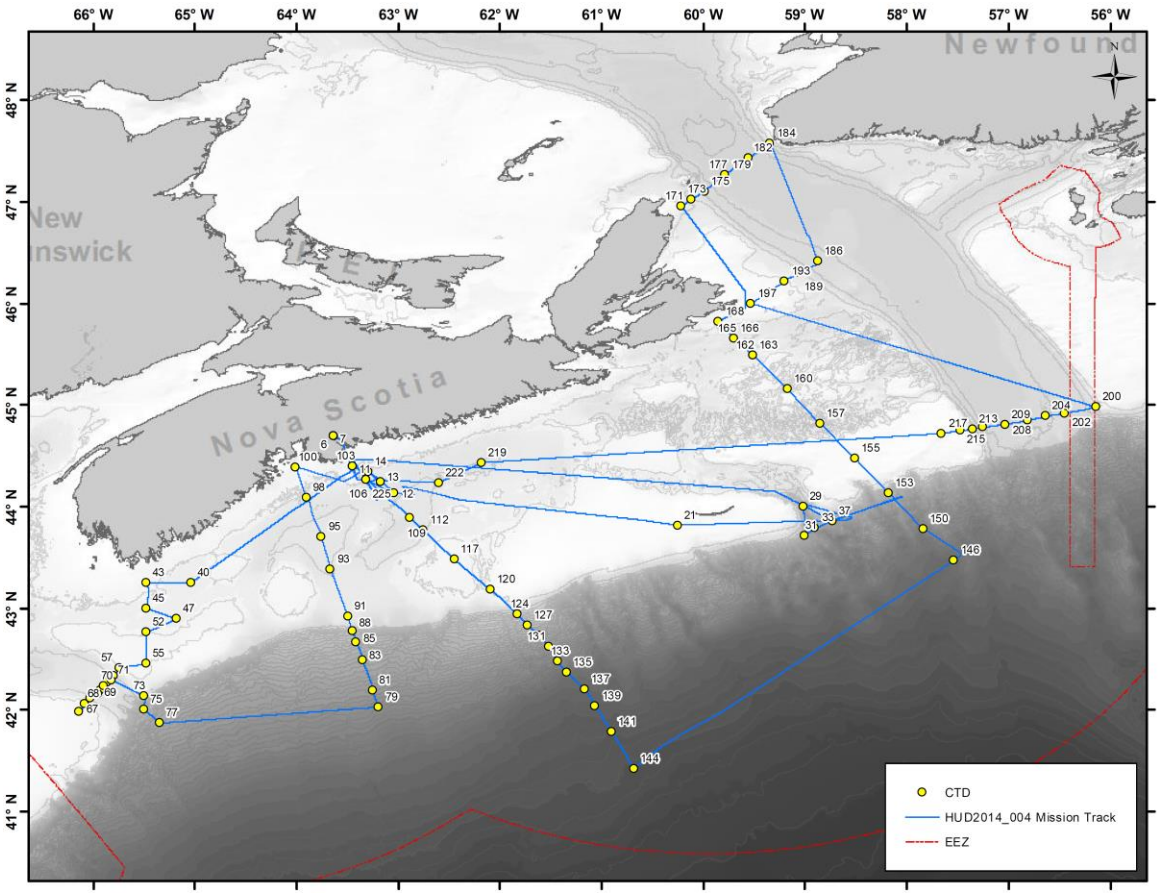


Figure 9. Locations for the 96 CTD casts during HUD2014004 AZMP spring survey. Each cast is labelled with the consecutive mission event.

Table 5. CTD casts during the HUD2014004 AZMP spring survey. The coordinates provided are in decimal degrees and reflect the ship's position at the time of deployment as recorded using the ELOG meta-data logger.

#	Event	Station	Date	Julian Day	Slat (DD)	Slon (DD)	Sounding (m)	LADCP	PAR	Water Collected	Aborted
1	1	HL_0	04/04/2014	94	44.6914	-63.6414	66	X	X		X
2	3	HL_0	04/04/2014	94	44.6906	-63.6405	72		X		X
3	4	HL_0	04/04/2014	94	44.6917	-63.6424	72		X	X	
4	5	HL_0	04/04/2014	94	44.6924	-63.6422	67	X	X		X
5	6	HL_0	04/04/2014	94	44.6927	-63.6416	72		X		X
6	7	HL_0	04/04/2014	94	44.6920	-63.6436	71		X		
7	11	HL_02	05/04/2014	95	44.2667	-63.3168	158		X	X	
8	12	OTN_03	05/04/2014	95	44.1361	-63.0380	170		X		
9	13	OTN_02	05/04/2014	95	44.2418	-63.1748	172		X		
10	14	OTN_01	05/04/2014	95	44.3434	-63.2981	146		X		
11	21	TB_01	06/04/2014	96	43.8149	-60.2549	48		X	X	
12	29	GULD_03	07/04/2014	97	44.0004	-59.0172	450			X	
13	31	SG28	07/04/2014	97	43.7103	-59.0009	876	X		X	
14	33	GULD_04	07/04/2014	97	43.7905	-58.9008	1959	X		X	
15	37	SG_23	07/04/2014	97	43.8603	-58.7304	1169	X		X	
16	40	RL_01	10/04/2014	100	43.2497	-65.0409	166		X	X	
17	43	BBL_01	10/04/2014	100	43.2495	-65.4803	65		X	X	
18	45	BBL_02	10/04/2014	100	42.9997	-65.4813	217		X	X	
19	47	RATBA_01	10/04/2014	100	42.8918	-65.1817	156		X	X	
20	52	BBL_03	10/04/2014	100	42.7582	-65.4807	100		X	X	
21	55	BBL_04	10/04/2014	100	42.4525	-65.4839	103		X	X	
22	57	PS_01	10/04/2014	100	42.4121	-65.7430	100		X	X	
23	59	PS_02	10/04/2014	100	42.3322	-65.8008	201		X	X	
24	61	PS_04	11/04/2014	101	42.2708	-65.8671	224		X	X	
25	63	PS_06	11/04/2014	101	42.1899	-65.9293	223		X	X	
26	65	PS_08	11/04/2014	101	42.1098	-66.0291	200		X	X	

27	67	PS_10	11/04/2014	101	41.9804	-66.1394	91		X	X
28	68	PS_09	11/04/2014	101	42.0603	-66.0839	95		X	X
29	69	PS_07	11/04/2014	101	42.1604	-65.9602	219		X	X
30	70	PS_05	11/04/2014	101	42.2302	-65.9031	235		X	X
31	71	PS_03	11/04/2014	101	42.2903	-65.8280	211		X	X
32	73	BBL_05	11/04/2014	101	42.1330	-65.5007	178		X	X
33	75	BBL_06	11/04/2014	101	42.0000	-65.5096	1087	X		X
34	77	BBL_07	11/04/2014	101	41.8662	-65.3494	1875	X		X
35	79	LHB_07	12/04/2014	102	42.0250	-63.1938	2707	X		X
36	81	LHB_06.7	12/04/2014	102	42.1930	-63.2525	2260	X		X
37	83	LHB_06.3	12/04/2014	102	42.4857	-63.3510	1688	X		X
38	85	LHB_06	12/04/2014	102	42.6657	-63.4150	1083	X		X
39	88	LHB_05.5	13/04/2014	103	42.7747	-63.4511	515			X
40	91	LHB_05	13/04/2014	103	42.9164	-63.4996	165		X	X
41	93	LHB_04	13/04/2014	103	43.3790	-63.6671	205		X	X
42	95	LHB_03	13/04/2014	103	43.6958	-63.7577	241		X	X
43	98	LHB_02	13/04/2014	103	44.0864	-63.9026	146		X	X
44	100	LHB_01	13/04/2014	103	44.3890	-64.0096	39		X	X
45	103	HL_01	13/04/2014	103	44.4002	-63.4503	86		X	X
46	106	HL_02	13/04/2014	103	44.2689	-63.3190	155		X	X
47	109	HL_03	14/04/2014	104	43.8839	-62.8841	264		X	X
48	112	HL_03.3	14/04/2014	104	43.7637	-62.7539	203		X	X
49	117	HL_04	14/04/2014	104	43.4802	-62.4515	86		X	X
50	120	HL_05	14/04/2014	104	43.1826	-62.0984	99		X	X
51	124	HL_05.5	14/04/2014	104	42.9401	-61.8308	452			X
52	127	HL_06	14/04/2014	104	42.8311	-61.7332	1071	X		X
53	129	HL_06.3	14/04/2014	104	42.7336	-61.6177	1652	X		X
54	131	HL_06.7	15/04/2014	105	42.6184	-61.5172	2244	X		X
55	133	HL_07	15/04/2014	105	42.4748	-61.4334	2712	X		X
56	135	HL_08	15/04/2014	105	42.3633	-61.3449	3203	X		X
57	137	HL_09	15/04/2014	105	42.2004	-61.1660	3782	X		X

58	139	HL_10	16/04/2014	106	42.0301	-61.0629	4068	X			X	
59	141	HL_11	16/04/2014	106	41.7779	-60.9045	4498	X			X	
60	144	HL_12	16/04/2014	106	41.4118	-60.6800	4686	X			X	
61	146	LL_09	17/04/2014	107	43.4690	-57.5314	3659	X			X	
62	150	LL_08	18/04/2014	108	43.7809	-57.8358	2855	X			X	
63	153	LL_07	18/04/2014	108	44.1322	-58.1749	750	X			X	
64	155	LL_06	18/04/2014	108	44.4750	-58.5089	65		X		X	
65	157	LL_05	18/04/2014	108	44.8151	-58.8504	264		X		X	
66	160	LL_04	18/04/2014	108	45.1580	-59.1750	104		X		X	
67	162	LL_03	18/04/2014	108	45.4922	-59.5169	133		X			X
68	163	LL_03	18/04/2014	108	45.4918	-59.5163	134		X		X	
69	165	LL_02	18/04/2014	108	45.6592	-59.7004	141		X			X
70	166	LL_02	18/04/2014	108	45.6592	-59.7009	140		X		X	
71	168	LL_01	18/04/2014	108	45.8249	-59.8505	92		X		X	
72	171	CSL_01	19/04/2014	109	46.9582	-60.2164	81		X		X	
73	173	CSL_02	19/04/2014	109	47.0227	-60.1204	181		X		X	
74	175	CSL_03	19/04/2014	109	47.1003	-59.9905	340		X		X	
75	177	CSL_04	19/04/2014	109	47.2692	-59.7860	480					X
76	179	CSL_04	19/04/2014	109	47.2704	-59.7838	475				X	
77	182	CSL_05	19/04/2014	109	47.4319	-59.5576	473				X	
78	184	CSL_06	20/04/2014	110	47.5793	-59.3418	266				X	
79	186	STAB_05	20/04/2014	110	46.4196	-58.8754	392				X	
80	189	STAB_04	20/04/2014	110	46.3001	-59.0697	156		X		X	
81	193	STAB_03	20/04/2014	110	46.2194	-59.1985	88		X		X	
82	195	STAB_02	20/04/2014	110	46.1088	-59.3608	68		X		X	
83	197	STAB_01	20/04/2014	110	45.9986	-59.5289	62		X		X	
84	200	BP_01	21/04/2014	111	44.9793	-56.1395	223		X		X	
85	202	BP_04	21/04/2014	111	44.9196	-56.4388	360				X	
86	204	BP_05	21/04/2014	111	44.8900	-56.6292	413				X	
87	206	BANQ_B6	21/04/2014	111	44.8472	-56.8099	431				X	
88	208	BANQ_B5	21/04/2014	111	44.8088	-57.0251	420					X

89	209	BANQ_B5	21/04/2014	111	44.8094	-57.0275	421		X
90	211	BANQ_B4	21/04/2014	111	44.7800	-57.2510	395		X
91	213	BANQ_B3	21/04/2014	111	44.7617	-57.3480	74	X	X
92	215	BANQ_B2	21/04/2014	111	44.7449	-57.4752	55	X	X
93	217	BANQ_B1	22/04/2014	112	44.7196	-57.6547	33	X	X
94	219	L.Em.	22/04/2014	112	44.4323	-62.1816	220	X	X
95	222	EVC	22/04/2014	112	44.2340	-62.6061	160	X	X
96	225	HL_02	23/04/2014	113	44.2666	-63.3228	154	X	X

Biological Program

Narrative

The "core" biological program conducted as part of cruise HUD2014004, with some modifications, was a continuation of studies began in pre-AZMP years to describe the large-scale (spatial and temporal) variability in plankton biomass, productivity and biogenic carbon inventories on the Scotian Shelf.

The program currently consists of essentially 3 elements:

1. phytoplankton biomass/primary productivity measurements,
2. mesozooplankton community structure, population growth and biomass, and
3. dissolved organic carbon measurements

Table 5 provides a review of the stations where water samples were taken from rosette bottles for elements 1 and 3 above. The mesoplankton sampling program is described below in more detail in a summary provided by M. Ringuette and J. Spry. This is followed by descriptions of "non-core" or ancillary biological sampling that included: dissolved organic carbon measurements conducted by Jonathan Lemay (Dr. Helmuth Thomas) of the Dalhousie University CO_2 group, a description of a meta-genomics sampling undertaken by Jackie Zorz (Dr. Julie Laroche) of Dalhousie University and the description of sampling for a study investigating both organic biomarkers and the isotopic composition of nitrate (Jessica Gould and Dr. Markus Kienast – Dalhousie University). The Biological Program section is concluded with a summary of pelagic seabird and marine mammal observations aboard HUD2014004, provided by Carina Gjerdrum of the Canadian Wildlife Service

The ultimate aim of "core" studies is twofold:

1. to provide a description of the inventories of biogenic carbon, their turnover rates and variability in space and time as part of Ocean Ecosystem Science Division's (OESD) continuing climate studies, and
2. to provide a description of plankton life-cycles and productivity on the Scotian Shelf and its influence or contribution to ecosystems in support of OESD's ecosystem-related research.

Mesozooplankton Sampling

Prepared by: M. Ringuette and J. Spry

Remarks/Comments

With the exception of Event 9 at HL_02 (76 µm) where the shackle near the net ring unclipped and Event 34 at SG_23 (202 µm) where the shackle also unclipped and the net was lost, there were 99 successful vertical ring net tows during the mission (Figure 10). Of these, 8 - 200 µm tows were collected to contribute to an on board study examining

assessment methodology for determining *C. finmarchicus* egg production rates (Objective 18). Another 4 - 200 µm net tows were deployed in support of Objective 17, research investigating the integration of "genetics and coupled bio-physical modelling of *Centropages typicus* populations on the NW Atlantic continental shelf, at stations CSL_01, LL_04, HL_04 and BBL_04. Of the remaining 87 successful tows, 9 were 76 µm tows along the shelf stations of the Halifax Line and 31 were 200 µm tows along the core AZMP sections (CSL, LL, HL and BBL). The remaining 47 tows were conducted at non-core stations throughout the mission. Refer to Table 6 for a station by station description of biological net tow operations.

During the mission, there were a total of 13 Bioness deployments (Figure 11). There were a number of malfunctions, beginning with Event 25, when the pawl engaging diamond screw of the spooling gear completely seized. Starting at Event 41, nets were not always releasing after repeated attempts. Event 48 was redone as Event 49 because nets were not firing properly. This was a problem that was noted throughout the trip and was likely attributable to a malfunctioning chip that controls the turning direction of the stepping motor. This issue was brought to the attention of an Electrical Technician with the Program Coordination and Support Division. Excluding the test in Bedford Basin and the aborted Bioness at Event 48, there were a total of 11 successful or partially successful Bioness tows during the mission (Table 6).

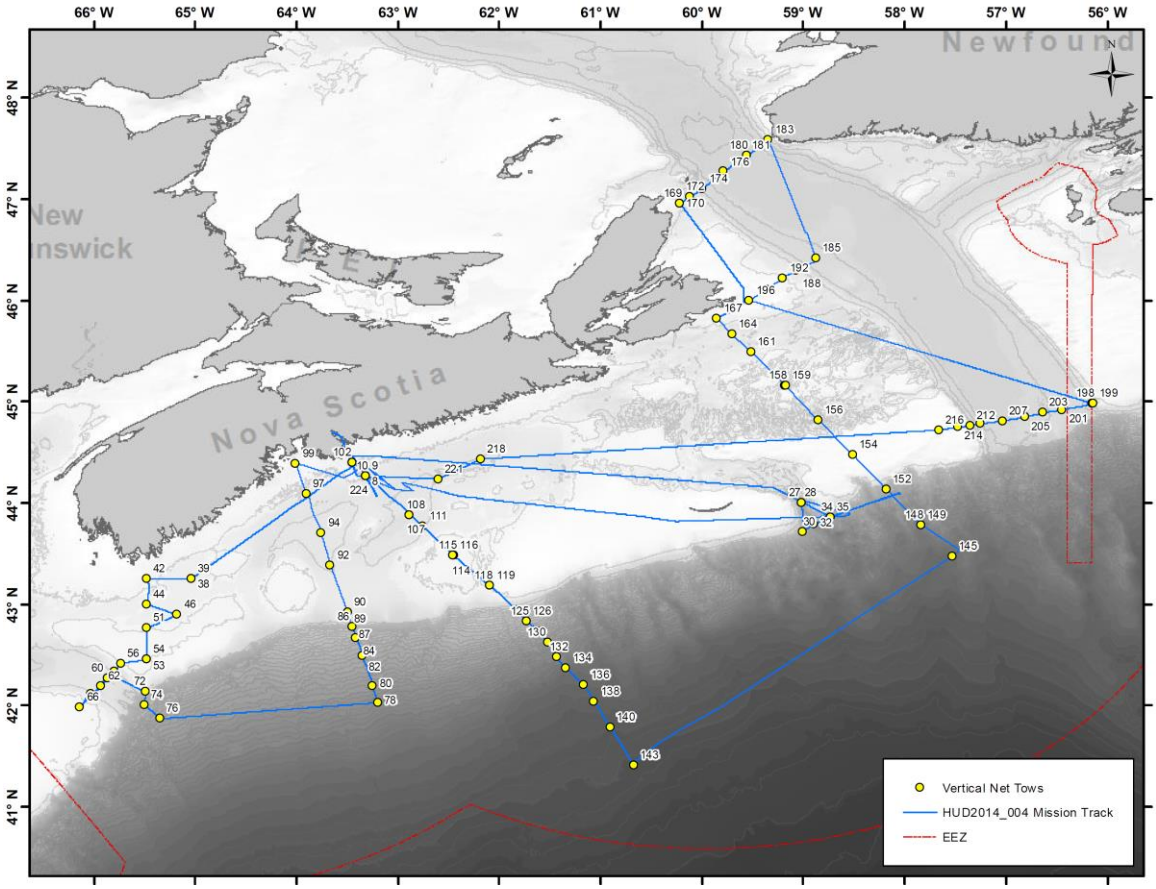


Figure 10. Locations for vertical ring net tows during HUD2014004 AZMP spring survey. Each tow is labelled with the consecutive mission event.

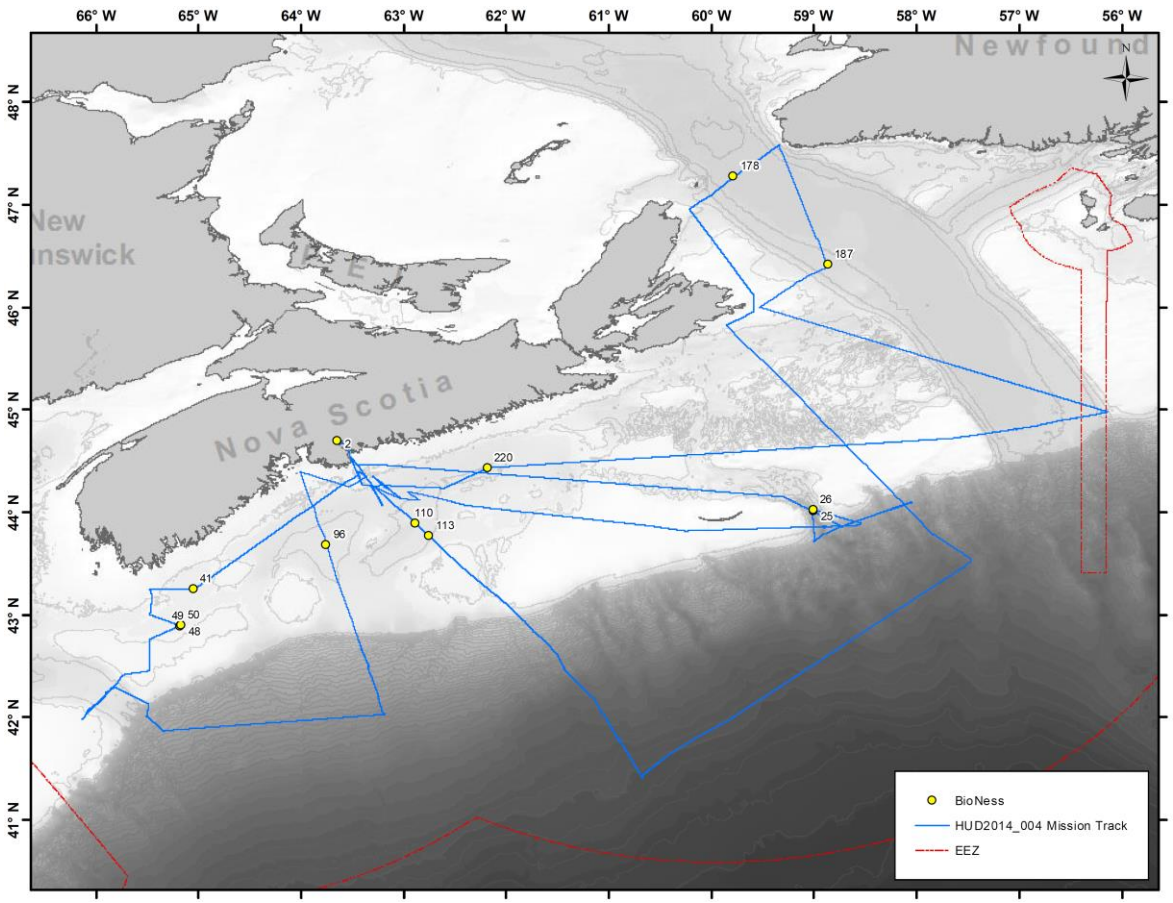


Figure 11. Start locations for Bioness tows during HUD2014004 AZMP spring survey. Each tow is labelled with the consecutive mission event.

Table 6. Zooplankton collection activities during the HUD2014004 AZMP spring survey. The coordinates provided are in decimal degrees and reflect the ship's position at the time of deployment as recorded using the ELOG meta-data logger. Bolded rows represent activities that were re-done.

#	Event	Date	Julian Day	Station	Operation	Mesh Size (µm)	Slat (DD)	SLong (DD)	Objective	Comment
1	2	04/04/2014	94	HL_0	Bioness		44.6973	-63.6455	Test	Test
2	8	05/04/2014	95	HL_02	Ring net	202	44.2666	-63.3175	1	
3	**9**	**05/04/2014**	**95**	**HL_02**	**Ring net**	**76**	**44.2668**	**-63.3172**	**1**	**Shackle at ring unclipped, no sample**
4	10	05/04/2014	95	HL_02	Ring net	76	44.2666	-63.3171	1	
5	**25**	**07/04/2014**	**97**	**GULD_03**	**Bioness**		**44.0121**	**-59.0005**	**7**	**Spooling gear seized**
6	26	07/04/2014	97	GULD_03	Bioness		44.0179	-59.0023	7	
7	27	07/04/2014	97	GULD_03	Ring net	202	44.0005	-59.0187	7	
8	28	07/04/2014	97	GULD_03	Ring net	202	44.0027	-59.0205	18	
9	30	07/04/2014	97	SG28	Ring net	202	43.7101	-59.0001	7	
10	32	07/04/2014	97	GULD_04	Ring net	202	43.7892	-58.8992	7	
11	**34**	**07/04/2014**	**97**	**SG_23**	**Ring net**	**202**	**43.8585**	**-58.7304**	**7**	**Lost net - snap shackle opened**
12	35	07/04/2014	97	SG_23	Ring net	202	43.8597	-58.7283	7	
13	38	10/04/2014	100	RL_01	Ring net	202	43.2496	-65.0407	9	
14	39	10/04/2014	100	RL_01	Ring net	202	43.2498	-65.0412	18	
15	41	10/04/2014	100	RL_01	Bioness		43.2478	-65.0525	9	Nets 4 & 5 did not drop - net 3 was 120 m to surface

16	42	10/04/2014	100	BBL_01	Ring net	202	43.2496	-65.4804	1	
17	44	10/04/2014	100	BBL_02	Ring net	202	42.9989	-65.4802	1	
18	46	10/04/2014	100	RATBA_01	Ring net	202	42.8899	-65.1811	9	
19	**48**	**10/04/2014**	**100**	**RATBA_01**	**Bioness**		**42.8976**	**-65.1703**	**9**	**Nets did not release after net 2 - redone as Event 49**
20	49	10/04/2014	100	RATBA_01	Bioness		42.8866	-65.1872	9	
21	50	10/04/2014	100	RATBA_01	Bioness		42.8954	-65.1756	9	Cod end of net 6 (50 m to surface) broke - no sample
22	51	10/04/2014	100	BBL_03	Ring net	202	42.7588	-65.4817	1	
23	53	10/04/2014	100	BBL_04	Ring net	202	42.4495	-65.4858	1	
24	54	10/04/2014	100	BBL_04	Ring net	202	42.4497	-65.4836	17	
25	56	10/04/2014	100	PS_01	Ring net	202	42.4107	-65.7411	6	
26	58	10/04/2014	100	PS_02	Ring net	202	42.3309	-65.7997	6	
27	60	11/04/2014	101	PS_04	Ring net	202	42.2713	-65.8683	6	
28	62	11/04/2014	101	PS_06	Ring net	202	42.1896	-65.9293	6	
29	64	11/04/2014	101	PS_08	Ring net	202	42.1098	-66.0294	6	Oblique tow in last 100 m - strong current
30	66	11/04/2014	101	PS_10	Ring net	202	41.9801	-66.1404	6	Oblique > 60 degrees
31	72	11/04/2014	101	BBL_05	Ring net	202	42.1340	-65.4963	1	
32	74	11/04/2014	101	BBL_06	Ring net	202	41.9984	-65.5072	1	
33	76	11/04/2014	101	BBL_07	Ring net	202	41.8654	-65.3480	1	
34	78	12/04/2014	102	LHB_07	Ring net	202	42.0272	-63.1961	8	

35	80	12/04/2014	102	LHB_06.7	Ring net	202	42.1891	-63.2498	8	
36	82	12/04/2014	102	LHB_06.3	Ring net	202	42.4845	-63.3510	8	
37	84	12/04/2014	102	LHB_06	Ring net	202	42.6651	-63.4154	8	Ascent < 20 m/min for last 75 m
38	86	13/04/2014	103	LHB_05.5	Ring net	202	42.7733	-63.4522	8	
39	87	13/04/2014	103	LHB_05.5	Ring net	202	42.7740	-63.4509	18	
40	89	13/04/2014	103	LHB_05	Ring net	202	42.9159	-63.5006	8	
41	90	13/04/2014	103	LHB_05	Ring net	202	42.9168	-63.4990	18	
42	92	13/04/2014	103	LHB_04	Ring net	202	43.3793	-63.6672	8	
43	94	13/04/2014	103	LHB_03	Ring net	202	43.6956	-63.7580	8	
44	96	13/04/2014	103	LHB_03	Bioness		43.6833	-63.7573	8	
45	97	13/04/2014	103	LHB_02	Ring net	202	44.0868	-63.9026	8	
46	99	13/04/2014	103	LHB_01	Ring net	202	44.3890	-64.0096	8	
47	101	13/04/2014	103	HL_01	Ring net	202	44.4004	-63.4514	1	
48	102	13/04/2014	103	HL_01	Ring net	76	44.4006	-63.4501	1	
49	104	13/04/2014	103	HL_02	Ring net	202	44.2680	-63.3183	1	
50	105	13/04/2014	103	HL_02	Ring net	76	44.2687	-63.3199	1	
51	107	14/04/2014	104	HL_03	Ring net	202	43.8823	-62.8844	1	
52	108	14/04/2014	104	HL_03	Ring net	76	43.8822	-62.8863	1	
53	110	14/04/2014	104	HL_03	Bioness		43.8856	-62.8854	1	
54	111	14/04/2014	104	HL_03.3	Ring net	202	43.7647	-62.7552	2	
55	113	14/04/2014	104	HL_03.3	Bioness		43.7652	-62.7524	2	
56	114	14/04/2014	104	HL_04	Ring net	202	43.4793	-62.4525	1	
57	115	14/04/2014	104	HL_04	Ring net	76	43.4797	-62.4539	1	
58	116	14/04/2014	104	HL_04	Ring net	202	43.4792	-62.4546	17	
59	118	14/04/2014	104	HL_05	Ring net	202	43.1826	-62.0974	1	
60	119	14/04/2014	104	HL_05	Ring net	76	43.1820	-62.0969	1	
61	121	14/04/2014	104	HL_05.5	Ring net	202	42.9405	-61.8303	1	
62	122	14/04/2014	104	HL_05.5	Ring net	76	42.9398	-61.8287	1	
63	123	14/04/2014	104	HL_05.5	Ring net	202	42.9400	-61.8298	18	

64	125	14/04/2014	104	HL_06	Ring net	202	42.8320	-61.7318	1	
65	126	14/04/2014	104	HL_06	Ring net	76	42.8312	-61.7328	1	
66	128	14/04/2014	104	HL_06.3	Ring net	202	42.7338	-61.6174	1	
67	130	15/04/2014	105	HL_06.7	Ring net	202	42.6196	-61.5193	1	
68	132	15/04/2014	105	HL_07	Ring net	202	42.4749	-61.4327	1	
69	134	15/04/2014	105	HL_08	Ring net	202	42.3634	-61.3403	12	
70	136	15/04/2014	105	HL_09	Ring net	202	42.2009	-61.1628	12	
71	138	16/04/2014	106	HL_10	Ring net	202	42.0305	-61.0632	12	Wire angle 25 - 35 on ascent
72	140	16/04/2014	106	HL_11	Ring net	202	41.7780	-60.9074	12	
73	143	16/04/2014	106	HL_12	Ring net	202	41.4107	-60.6724	12	
74	145	17/04/2014	107	LL_09	Ring net	202	43.4731	-57.5273	1	
75	148	17/04/2014	107	LL_08	Ring net	202	43.7816	-57.8349	1	
76	149	18/04/2014	108	LL_08	Ring net	202	43.7773	-57.8323	18	
77	152	18/04/2014	108	LL_07	Ring net	202	44.1320	-58.1748	1	
78	154	18/04/2014	108	LL_06	Ring net	202	44.4745	-58.5093	1	
79	156	18/04/2014	108	LL_05	Ring net	202	44.8165	-58.8501	1	
80	158	18/04/2014	108	LL_04	Ring net	202	45.1597	-59.1759	1	
81	159	18/04/2014	108	LL_04	Ring net	202	45.1583	-59.1751	17	
82	161	18/04/2014	108	LL_03	Ring net	202	45.4922	-59.5171	1	
83	164	18/04/2014	108	LL_02	Ring net	202	45.6596	-59.7017	1	
84	167	18/04/2014	108	LL_01	Ring net	202	45.8250	-59.8505	1	
85	169	19/04/2014	109	CSL_01	Ring net	202	46.9578	-60.2170	1	
86	170	19/04/2014	109	CSL_01	Ring net	202	46.9584	-60.2176	17	
87	172	19/04/2014	109	CSL_02	Ring net	202	47.0227	-60.1178	1	
88	174	19/04/2014	109	CSL_03	Ring net	202	47.1003	-59.9928	1	
89	176	19/04/2014	109	CSL_04	Ring net	202	47.2728	-59.7827	1	
90	178	19/04/2014	109	CSL_04	Bioness		47.2727	-59.7845	1	
91	180	19/04/2014	109	CSL_05	Ring net	202	47.4329	-59.5583	1	
92	181	19/04/2014	109	CSL_05	Ring net	202	47.4311	-59.5551	18	

93	183	20/04/2014	110	CSL_06	Ring net	202	47.5806	-59.3418	1
94	185	20/04/2014	110	STAB_05	Ring net	202	46.4184	-58.8759	5
95	187	20/04/2014	110	STAB_05	Bioness		46.4166	-58.8645	5
96	188	20/04/2014	110	STAB_04	Ring net	202	46.2992	-59.0695	5
97	192	20/04/2014	110	STAB_03	Ring net	202	46.2200	-59.1993	5
98	194	20/04/2014	110	STAB_02	Ring net	202	46.1084	-59.3584	5
99	196	20/04/2014	110	STAB_01	Ring net	202	45.9998	-59.5304	5
100	198	21/04/2014	111	BP_01	Ring net	202	44.9783	-56.1407	8
101	199	21/04/2014	111	BP_01	Ring net	202	44.9792	-56.1401	18
102	201	21/04/2014	111	BP_04	Ring net	202	44.9197	-56.4389	8
103	203	21/04/2014	111	BP_05	Ring net	202	44.8895	-56.6293	8
104	205	21/04/2014	111	BANQ_B6	Ring net	202	44.8474	-56.8087	8
105	207	21/04/2014	111	BANQ_B5	Ring net	202	44.8093	-57.0269	8
106	210	21/04/2014	111	BANQ_B4	Ring net	202	44.7798	-57.2498	8
107	212	21/04/2014	111	BANQ_B3	Ring net	202	44.7626	-57.3484	8
108	214	21/04/2014	111	BANQ_B2	Ring net	202	44.7449	-57.4740	8
109	216	22/04/2014	112	BANQ_B1	Ring net	202	44.7199	-57.6555	8
110	218	22/04/2014	112	L.Em.	Ring net	202	44.4324	-62.1818	20
111	220	22/04/2014	112	L.Em.	Bioness		44.4330	-62.1815	20
112	221	22/04/2014	112	EVC	Ring net	202	44.2334	-62.6069	21
113	223	23/04/2014	113	HL_02	Ring net	202	44.2661	-63.3176	1
114	224	23/04/2014	113	HL_02	Ring net	76	44.2668	-63.3185	1

Dissolved Carbon Sampling

Prepared by: J. Lemay – Dalhousie University
Supervisor: Dr. Helmuth Thomas

The Dalhousie CO_2 group's objective on the AZMP Spring 2014 cruise was to continue work on piecing together an inter-annual time-series of carbon in the Scotian Shelf region. Standard procedures were followed for gathering water samples throughout the water column at selected stations. This is used to determine and construct depth profiles of dissolved inorganic carbon (DIC) and alkalinity (A_T). $DI^{13}C$ samples were also collected in tandem with DIC/A_T samples. $DI^{13}C$ is stable and not readily incorporated into biology as ^{12}C is, due to ^{13}C being heavier and requiring more energy to incorporate. Therefore, $DI^{13}C$ provides a measure of biological interaction in carbon cycling on the shelf. Additionally, anthropogenic CO_2 is biologically derived (fossil fuels) and also is enriched in ^{12}C. The hope is that $DI^{13}C$ will also provide a measure of human impact on carbon cycling.

The Licor system installed on board the Hudson to measure underway pCO_2 at the surface, utilizing the water intake for the forward lab Thermosalinograph. This was a test, for a system that has not been to sea recently, to determine if surface pCO_2 data could be gathered.

Water samples were collected for DIC and ^{13}C from the 4 AZMP core transects: Halifax Line (HL), Louisburg Line (LL), Cabot Straight Line (CSL), and Browns Bank Line (BBL). The first 7 core stations of the HL were sampled as well as HL_3.3, 5.5, 6.3, 6.7 and stations 8-12 of the eXtended Halifax Line (XHL), with station HL_02 being done 3 times throughout the trip. Water was collected from stations 1-9 on the LL, 1-6 on the CSL, and 1-7 on the BBL. In total ~480 water samples were collected for DIC and TA, as well as 480 samples for $DI^{13}C$; a total of 960 samples. Unlike the fall of 2013, most of the sample processing was done at sea because an extra sampling/laboratory technician allowed for 24 hour/day operations. In fact, only samples collected at HL_6.7, 7 and 8, LL_03 and 4, and CSL_06 were preserved and stored for shore-side analysis.

VINDTA

There were few problems regarding the operation of the VINDTA. A total of ~400 of the 480 samples were run throughout the mission. The Peltier cooler was difficult to stabilize in the GP lab. Temperature varied greatly throughout transects; where it was cold near the shore and much warmer in the Gulf Stream. Additionally, people coming in and out of the lab would occasionally leave the door open, thus altering the temperature of the lab. As a result, the temperature of the cooler would vary throughout the day. The other issue that arose was regarding the electrode in the anode part of the coulometer cell. Upon being replaced, it was noticed that the cell would die within half a day. The old electrode was swapped back in and the issue was resolved. As a result of the cell dying during a station run prematurely, CT data was most likely lost for the bottom 4 depths of

LL1. Alkalinity is still usable however, and the top 4 bottles were run afterwards with a new cell and the values went back to expected and are likely usable.

LICOR

The Licor system never ran properly throughout the cruise. Initially, the issue was the water being drawn in by the pump. Once the pump had been regulated by the clamps on the tubing, the pCO2 values were far too high for what was expected at the surface. At first, it was believed to be the result of the jetty and the ship being tied up. Once the ship departed from BIO, the values remained high. The pump was swapped for a smaller pump and the issue persisted. The system was flushed with nitrogen, but the value kept returning. After calibration the values still returned to 900. The problem(s) with the Licor system was never properly diagnosed during the mission.

Water Collection for Meta-genomics Study

Prepared by: Jackie Zorz – Dalhousie University
Supervisor: Dr. Julie LaRoche

The LaRoche lab is interested in the dynamics of marine microbial community composition and the interactions that a given microbial community has with its environment. Prior to the advancement of genetic techniques, total microbial community composition was difficult to monitor as microbes often had to be able to grow in a lab culture in order to be identified. Now, microbial communities can be analyzed *in situ* without the need for culture growth, via techniques such as 16s/18s rRNA sequencing and metagenomics. This allows for a complete overview of the members of a microbial community (16s/18s rRNA sequencing) and a complete overview of the suite of functions a microbial community has the capacity to perform (metagenomics). The main objective of the LaRoche lab during the AZMP cruise was to obtain water samples for microbial community analysis via 16s/18s sequencing and metagenomics. Other smaller water samples were collected for alternate objectives as well.

One of two distinct sampling methods was conducted at sampling stations depending on the type of samples to be prepared and the amount of water required for those samples. When sampling for metagenomics or rRNA sequencing, 12L of water was needed at each depth. When sampling for only flow cytometry and other minor samples, around 50mL of water was needed at each depth. The volume of water needed at each station and depth is outlined in Table 7, and a brief overview of the sampling protocol for each type of sample collected follows below.

To sample for metagenomics and rRNA sequencing, 4L of water was required for each sample to be filtered for each depth sampled. To generate a depth profile at each location, 4 depths were sampled at each station. To improve the reproducibility and statistical power of our results, samples were collected in triplicate (3x 4L) for a total of 12L of seawater for each depth sampled at each station. Once collected, each 4L sea-water replicate was filtered first on a 3 µm filter to primarily capture large eukaryotic cells, and then on a 0.2 µm filter to capture smaller, mainly prokaryotic cells. The filters were immediately frozen at -80˚C. In some instances where chlorophyll levels were high, only 2L of seawater was filtered through the 0.2 µm filter. The 3 µm filters and 0.2 µm filters will be used for metagenomics study or 16s/18s rRNA sequence analysis once DNA has been extracted in the lab. In total, 276 - 0.2 µm filter samples and 276 – 3 µm filter samples were obtained, which represents 92 samples at 23 stations. The stations chosen for large water volume sampling were generally from the most offshore and most inshore stations of a transect, along with one or two stations in between. Nonetheless, the length of time required to filter the samples from each station often resulted in variations in the number of stations that could be sampled from a given transect. The stations chosen for metagenomics and rRNA sequencing analysis are shown in Table 7 and correspond to the stations where 12L of water was needed at each depth and where "DNA filtration" is included in the samples prepared column.

Water was also collected for flow cytometry at every station visited, as shown in Table 7. These samples were collected in triplicate, fixed with the preservative glutaraldehyde and

frozen at -80˚C. In total, 456 samples for flow cytometry were obtained, which represents 152 samples at 38 stations. At some stations water was also collected from the surface to be used later for epifluorescence microscopy (24 samples in total). For these samples, around 5mL of water was fixed with paraformaldehyde and kept at 4˚C. Lastly, at some stations, ~50mL of water was used for culturing purposes, either from the surface depth or from a depth corresponding to the oxygen minimum zone. Specific nutrients were added to each culture in order to enrich for certain bacteria of interest, mainly nitrogen fixers and sulphur oxidizers. Twenty four enrichment cultures were obtained in total. The stations where water was collected for microscopy and enrichment cultures are summarized in Table 7.

Table 7. Stations visited, volume of water required and samples prepared during HUD2014004.

Date Visited	Station (depths sampled in metres)	Volume of Water needed for each depth	Samples Prepared
5-Apr	HL_02 (1,20,40,80)	12L	Flow cytometry and DNA filtration
6-Apr	TB_01 (1,10,20,40)	12L	Flow cytometry, DNA filtration, microscopy
7-Apr	SG_28 (1,20,100,250)	50mL	Flow cytometry, enrichment cultures
7-Apr	GULD_04 (1,20,100,250)	12L	Flow cytometry, DNA filtration, enrichment cultures
10-Apr	BBL_01 (1,10,20,40)	12L	Flow cytometry, DNA filtration, microscopy, enrichment cultures
10-Apr	BBL_02 (1,20,40,80)	12L	Flow cytometry, DNA filtration, microscopy
10-Apr	BBL_03 (1,20,40,80)	50mL	Flow cytometry
10-Apr	BBL_04 (1,20,40,80)	50mL	Flow cytometry
11-Apr	BBL_05 (1,20,40,80)	12L	Flow cytometry, DNA filtration, microscopy, enrichment cultures
11-Apr	BBL_06 (1,20,40,80)	50mL	Flow cytometry
11-Apr	BBL_07 (1,20,80,250)	12L	Flow cytometry, microscopy, enrichment cultures
12-Apr	LHB_07 (1,20,80,250)	50mL	Flow cytometry
12-Apr	LHB_06.7 (1,20,80,250)	12L	Flow cytometry, DNA filtration, microscopy, enrichment cultures
12-Apr	LHB_06 (1,20,80,250)	12L	Flow cytometry, DNA filtration
12-Apr	LHB_04 (1,20,40,80)	12L	Flow cytometry, DNA filtration
13-Apr	LHB_02 (1,20,40,80)	12L	Flow cytometry, DNA filtration
13-Apr	HL_01 (1,20,40,60)	12L	Flow cytometry, DNA filtration, microscopy
13-Apr	HL_02 (1,20,40,80)	50mL	Flow cytometry
14-Apr	HL_04 (1,20,40,60)	12L	Flow cytometry, DNA filtration, microscopy
14-Apr	HL_05 (1,20,40,80)	50mL	Flow cytometry
14-Apr	HL_05.5 (1,20,80,250)	12L	Flow cytometry, DNA filtration, microscopy
14-Apr	HL_06.3 (1,20,80,250)	50mL	Flow cytometry
15-Apr	HL_08 (1,20,100,250)	12L	Flow cytometry, DNA filtration, microscopy, enrichment cultures

15-Apr	HL_09 (1,80,1000,3500)	50mL	Flow cytometry, microscopy
17-Apr	LL_09 (1,20,80,250)	12L	Flow cytometry, DNA filtration, microscopy
18-Apr	LL_08 (1,20,80,250)	50mL	Flow cytometry
18-Apr	LL_07 (1,20,80,250)	12L	Flow cytometry, DNA filtration
18-Apr	LL_04 (1,20,40,80)	12L	Flow cytometry, DNA filtration
18-Apr	LL_03 (1,20,40,80)	50mL	Flow cytometry, microscopy
18-Apr	LL_01 (1,20,40,80)	50mL	Flow cytometry
19-Apr	CSL_01 (1,20,40,60)	12L	Flow cytometry, DNA filtration, microscopy
19-Apr	CSL_04 (1,20,60,300)	12L	Flow cytometry, DNA filtration, microscopy, culture enrichments
19-Apr	CSL_06 (1,20,60,200)	12L	Flow cytometry, DNA filtration
20-Apr	STAB_05 (1,20,80,300)	12L	Flow cytometry, DNA filtration
20-Apr	STAB_01 (1,10,20,40)	12L	Flow cytometry, DNA filtration, microscopy
21-Apr	BANQ_B6 (1,20,80,250)	50mL	Flow cytometry, microscopy
21-Apr	BANQ_B4 (1,20,40,80)	50mL	Flow cytometry
22-Apr	HL_02 (1,20,40,80)	50mL	Flow cytometry

Suspended Particle Sampling (Organic Biomarkers) and Isotopic Composition of Nitrate

Principle Investigator: Dr. Markus Kienast (Dalhousie University)
Sampling by: Jessica Gould (Dalhousie University)

Suspended Particle Sampling (Organic Biomarkers)

Purpose

The chemical composition of particular organic molecules synthesized by *prymnesiophytes*, i.e. alkenones, is directly related to the environmental conditions the phytoplankton lives in; in particular, sea surface temperatures. In order to establish seasonal variability and explore possible effects of non-thermal factors on the chemical composition of alkenones, this study aims to sample seasonal time series of suspended alkenones along the AZMP cruise track.

Sampling Methods

A total of 37 suspended particle filters were collected along the cruise track from filtering water from the ship's underway seawater system located in the Forward Lab. Filtering was focused along the LaHave Basin Line (LHB), Halifax Line (HL), and Louisbourg Line (LL) transects, with some filters collected underway between Halifax Harbour and TB_01, and from CSL_01 to BP_01. Approximately 75 L of water, on average, was filtered through a pre-combusted 142mm GFF filter placed on a Millipore PVC filter holder. Upon recovery, filters were packed in pre-combusted aluminium foil and frozen immediately at -20°C. Filters will be analyzed for alkenone concentrations, alkenone unsaturation (UK37' index), and eventually for the hydrogen isotopic composition of alkenones.

Isotopic Composition of Nitrate (Water Sampling)

Purpose

To map the isotopic composition of nitrate in the water column along the AZMP cruise track with two main goals:

1. Establish the distribution of nutrient isotope fractionation in the global ocean and evaluate isotope fractionation during nutrient utilization. Specifically, mapping the distribution of nitrate isotopes in the NW Atlantic and establishing fractionation factors during utilization will contribute to our understanding of regional nutrient cycling.
2. Understand how water masses are labelled with specific isotope ratios. Specifically, we want to quantify to what extent, if at all, NW Atlantic waters are modified by shelf processes, for example.

Sampling Methods

A total of 155 water samples were taken from the CTD Rosette at all depths for six Halifax Line stations (HL_03, 04, 05, 06, 07 and 09), two Cabot Strait Line stations (CSL_05 and 04), three Brian Petrie stations (BP_01, 04 and 05), and two Banquereau stations (BANQ_B6 and B5). Water samples were filtered using a Nalgene SFCA filter connected to a 60 ml syringe. The samples for the nitrogen/oxygen isotopic composition of nitrate were filtered into 60 ml Nalgene bottles, and immediately frozen at -20°C.

Pelagic Seabird and Marine Mammal Observations

Seabird Survey Report
4 – 23 April, 2014
Canadian Wildlife Service, Environment Canada
Prepared by: Carina Gjerdrum carina.gjerdrum@ec.gc.ca
Observers: Sue Abbott (Leg 1), Holly Hogan (Legs 1 & 2)

Background

The east coast of Canada supports millions of breeding marine birds as well as migrants from the southern hemisphere and northeastern Atlantic. In 2005, the Canadian Wildlife Service (CWS) of Environment Canada initiated the Eastern Canada Seabirds at Sea (ECSAS) program with the goal of identifying and minimizing the impacts of human activities on birds in the marine environment. Since that time, a scientifically rigorous protocol for collecting data at sea and a sophisticated geodatabase have been developed, relationships with industry and DFO to support offshore seabird observers have been established, and over 100,000 km of ocean track have been surveyed by CWS-trained observers. These data are now being used to identify and address threats to birds in their marine environment. In addition, data are collected on marine mammals, sea turtles, sharks, and other marine organisms when they are encountered.

Methods

Seabird and marine mammal surveys were conducted from the port side of the bridge of the Hudson during the spring Scotian Shelf AZMP from 4 – 23 April, 2014. Surveys were conducted while the ship was moving at speeds greater than 4 knots, looking forward and scanning a 90° arc to one side of the ship. All birds observed on the water within a 300m-wide transect were recorded, and we used the snapshot approach for flying birds (intermittent sampling based on the speed of the ship) to avoid overestimating abundance of birds flying in and out of transect. Distance sampling methods were incorporated to address the variation in bird detectability. Marine mammal observations were also recorded, although surveys were not specifically designed to detect marine mammals. Details of the methods used can be found in the CWS standardized protocol for pelagic seabird surveys from moving platforms[1].

[1]Gjerdrum, C., D.A. Fifield, and S.I. Wilhelm. 2012. Eastern Canada Seabirds at Sea (ECSAS) standardized protocol for pelagic seabird surveys from moving and stationary platforms. Canadian Wildlife Service Technical Report Series. No. 515. Atlantic Region. vi + 37 pp.

Results

Seabird Sightings

We surveyed 1409 km of ocean from 4-23 April, 2014. A total of 540 birds were observed in transect from 7 families (Table 8). Bird densities averaged 1.3 birds/km^2 (ranging from 0 - 100 birds/km^2). The highest densities of birds were observed at the

entrance to Halifax Harbour, in Emerald Basin, the Gully MPA, Banquereau Bank, the western side of Cabot Strait, and in the Laurentian Channel (Figure 12A).

Dovekie was the species most commonly observed, accounting for 31% of the observations (Table 8), which were seen primarily in the Gully MPA (Figure 12B). Dovekie are considered the most abundant seabird species in the north Atlantic, and are present in this area during the non-breeding season (Nov – May). Murre (Common and Thick-billed) are also wintering in this area, and accounted for 19% of the observations. They were observed at the mouth to Halifax Harbour, in Emerald Basin, and on Banquereau Bank (Figure 12C). The bulk of the murre population breeds at locations north of Nova Scotia (NL and Arctic), although small numbers breed in the Bay of Fundy and off Cape Breton Island. Northern Gannet comprised of 12% of the observations and were seen in low densities during surveys of the Eastern Scotian Shelf (Figure 12D). Higher densities were observed in the Cabot Strait where they were presumably moving towards breeding colonies in NL and the Gulf of St. Lawrence. Herring Gulls were observed throughout the study area while Great Black-backed Gull observations were limited to surveys close to shore (Figure 12E). Black-legged Kittiwakes were observed in deeper waters, including the Gully, slope waters south of the Gully, and in the Laurentian Channel (Figure 12E).

Marine Mammal Sightings

Just 15 marine mammals were recorded during the surveys (Table 9), none of which occurred in the Gully MPA. A pod of 6 Northern Bottlenose Whales were encountered approximately 65 km southeast of the Gully (Figure 12F). Five Pilot Whales were observed on the slope waters of the Halifax Line, 2 Gray Seals were observed on the Eastern Scotian Shelf, and 2 Humpback Whales were encountered, one just south of Shortland Canyon and the other on Brown's Bank (Figure 12F).

Gully MPA

No marine mammals and 136 birds were observed within the Gully MPA. Bird sightings included Dovekie, Northern Fulmar, Northern Gannet, Herring and Great Black-backed Gull, and Common and Thick-billed Murre (Table 10; Figure 13A-D).

Table 8. List of bird species observed during the seabird survey on the spring Scotian Shelf AZMP, from 4-23 April, 2014.

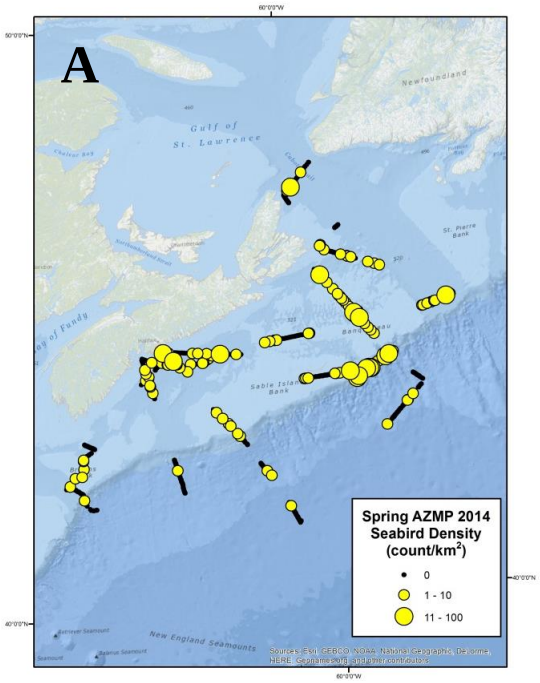
Family	Species	Latin	Number observed in transect	Total number observed
Procellariidae	Northern Fulmar	*Fulmarus glacialis*	20	60
	Sooty Shearwater	*Puffinus griseus*	0	8
Hydrobatidae	Wilson's Storm Petrel	*Oceanites oceanicus*	1	1
	Leach's Storm-Petrel	*Oceanodroma leucorhoa*	1	5
	Unidentified Storm-Petrel	Hydrobatidae	0	9
Anatidae	Common Eider	*Somateria mollissima*	43	46
	White-winged Scoter	*Melanitta fusca*	0	2
Scolopacidae	Unidentified Phalarope	*Phalaropus*	0	39
Sulidae	Northern Gannet	*Morus bassanus*	65	268
Laridae	Herring Gull	*Larus argentatus*	48	114
	Black-legged Kittiwake	*Rissa tridactyla*	20	85
	Great Black-backed Gull	*Larus marinus*	16	60
	Iceland Gull	*Larus glaucoides*	2	4
	Unidentified Gull	*Larus*	0	8
	Ring-billed Gull	Larus delawarensis	0	1
	Glaucous Gull	*Larus hyperboreus*	0	1
	Unidentified Jaeger	*Stercorarius*	0	1
Alcidae	Dovekie	*Alle alle*	166	889
	Common Murre	*Uria aalge*	79	205
	Atlantic Puffin	*Fratercula arctica*	32	127
	Thick-billed Murre	*Uria lomvia*	20	33
	Unidentified Auk	Alcidae	11	201
	Razorbill	*Alca torda*	9	30
	Unidentified Murre	*Uria*	6	83
	Black Guillemot	*Cepphus grylle*	1	2
Total			**540**	**2282**

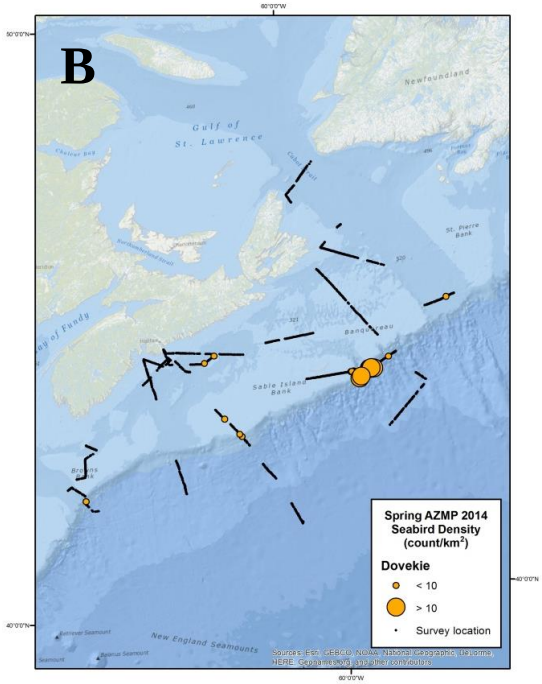
Table 9. List of marine mammals observed during the seabird survey on the spring Scotian Shelf AZMP, from 4-23 April, 2014.

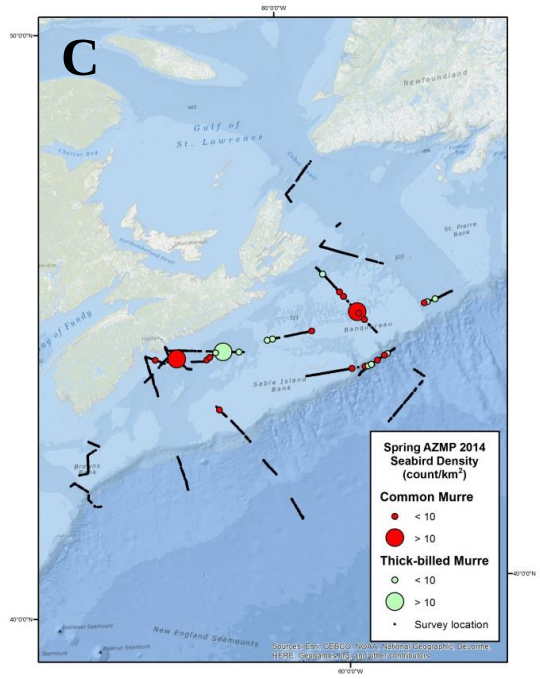
Species	Latin	Total number observed
Northern Bottlenose Whale	*Hyperoodon ampullatus*	6
Genus: Pilot whales	*Globicephala*	5
Gray Seal	*Halichoerus grypus*	2
Humpback Whale	*Megaptera novaeangliae*	2
Total		**15**

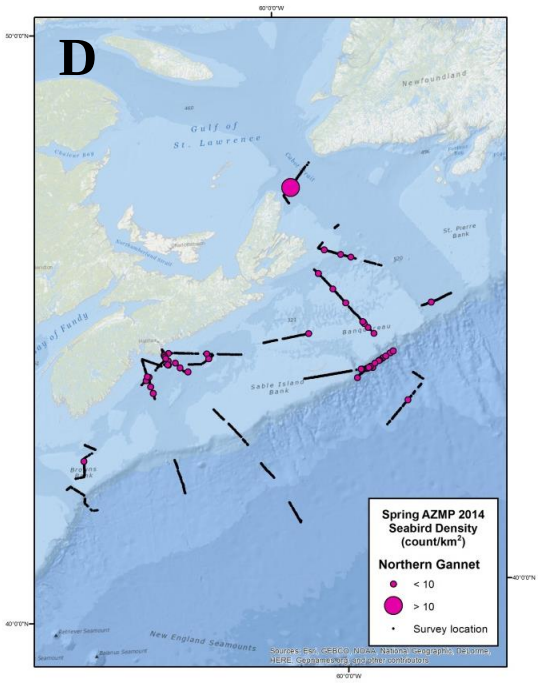
Table 10. List of species observed in the Gully MPA, from 6-7 April, 2014.

Species	Latin	Number observed in transect
Dovekie	*Alle alle*	111
Northern Gannet	*Morus bassanus*	8
Herring Gull	*Larus argentatus*	8
Northern Fulmar	*Fulmarus glacialis*	5
Common Murre	*Uria aalge*	2
Thick-billed Murre	*Uria lomvia*	1
Great Black-backed Gull	*Larus marinus*	1
Total sightings		**136**


A
Spring AZMP 2014
Seabird Density
(count/km²)
0
1 - 10
11 - 100


B
Spring AZMP 2014
Seabird Density
(count/km²)
Dovekie
< 10
> 10
Survey location


C
Spring AZMP 2014
Seabird Density
(count/km²)
Common Murre
< 10
> 10
Thick-billed Murre
< 10
> 10
Survey location


D
Spring AZMP 2014
Seabird Density
(count/km²)
Northern Gannet
< 10
> 10
Survey location

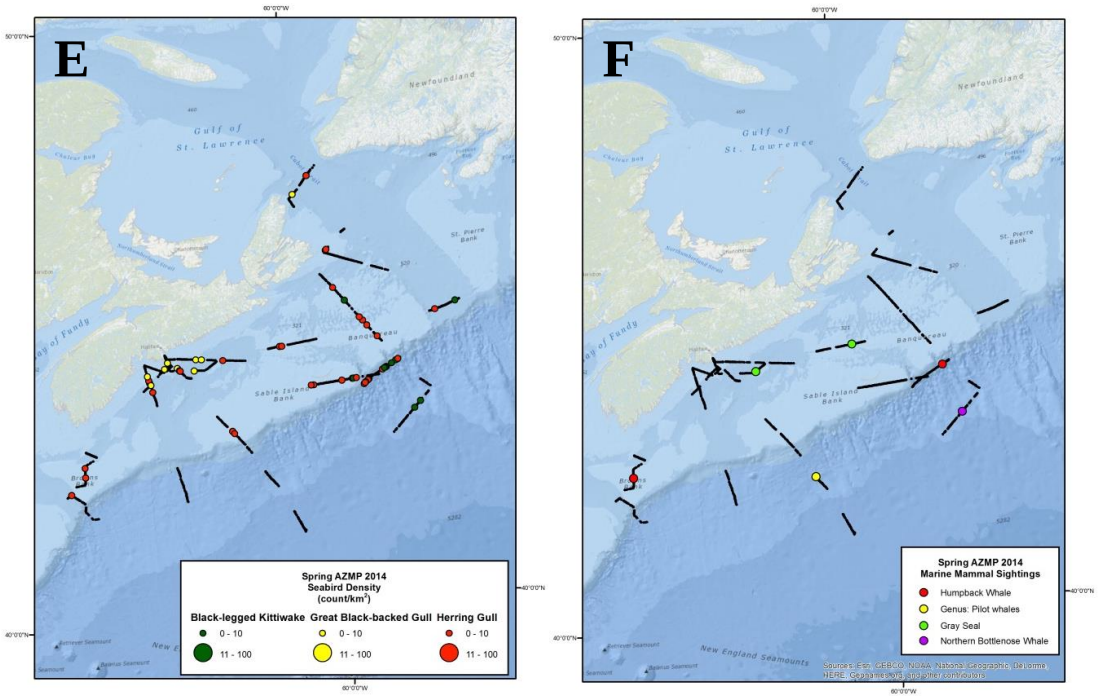


Figure 12. Density of A) total birds; B) Dovekie; C) murres; D) Northern Gannet; E) gulls, and F) marine mammals observed during the spring AZMP, from 4-23 April, 2014.

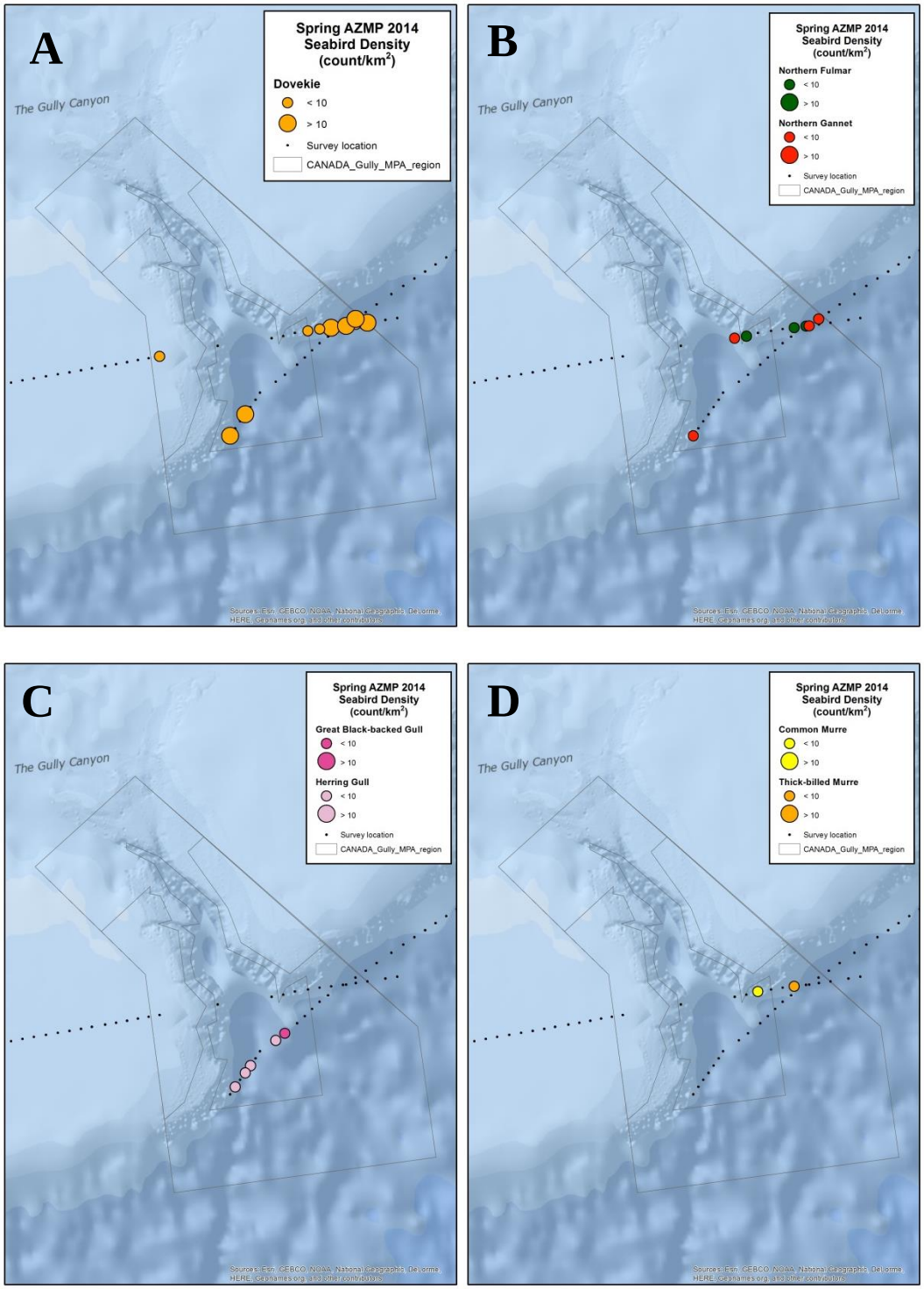


Figure 13. Density of A) Dovekie; B) Northern Fulmar and Northern Gannet; C) Herring and Great Black-backed Gulls; and D) Common and Thick-billed Murres observed in the Gully Marine Protected Area, from 6-7 April, 2014.

Mooring Operations

Prepared by: Jay Barthelotte
Division: Program Coordination and Support (PCSD)

Narrative

During the 2014 Spring AZMP mission, vessel time for other programs was provided to conduct oceanographic mooring operations. These activities included deployment and recovery operations (Figure 14 and Table 11). With support from the officers and crew of the CCGS Hudson, the mooring technicians conducting these activities were Jay Barthelotte and Daniel Wood from Ocean Physics, Program Coordination and Support Division, Science Branch. The heavy ice conditions around the St. Ann's Bank mooring site prevented us from deploying the 2 moorings during Leg 1. In our absence during Leg 2, Shannon Nudds from Ocean Ecosystem Science Division successfully deployed the 2 moorings for the St. Ann's Bank Program.

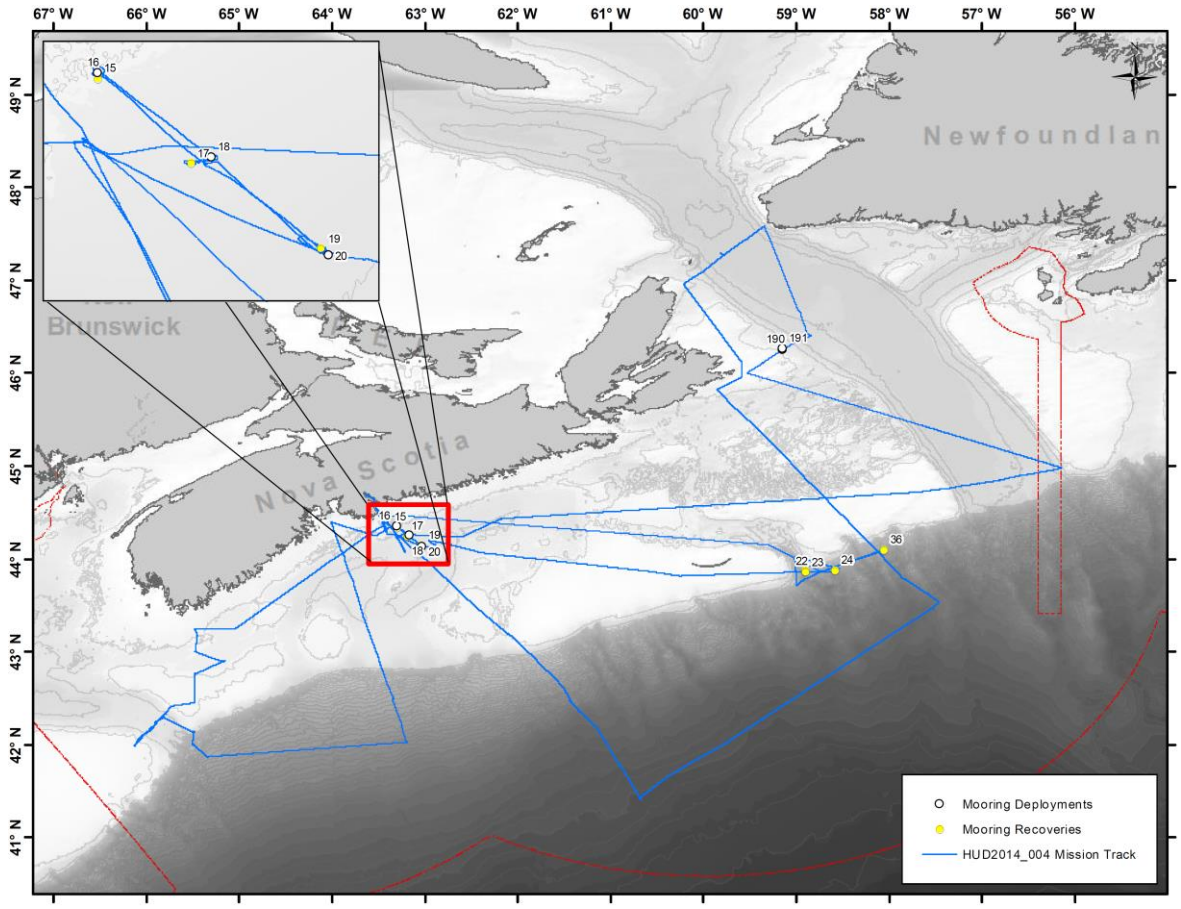


Figure 14. The location for each mooring operation during HUD2014004. Refer to Table 11 for more details.

Table 11. List of mooring operations conducted during HUD2014004. The coordinates provided below are in decimal degrees and represents the ship's position at the time of the operation.

Date	JDay	Event	Operation	Station	Mooring Name	Slat (DD)	SLong (DD)	Program
05/04/2014	95	15	Recovered	OTN_01	M1854	44.3409	-63.3041	OTN
05/04/2014	95	16	Deployed	OTN_01	M1865	44.3475	-63.3041	
05/04/2014	95	17	Recovered	OTN_02	M1855	44.2413	-63.1948	
05/04/2014	95	18	Deployed	OTN_02	M1866	44.2483	-63.1703	
05/04/2014	95	19	Recovered	OTN_03	M1856	44.1414	-63.0423	
05/04/2014	95	20	Deployed	OTN_03	M1867	44.1343	-63.0337	
06/04/2014	96	22	Recovered	MidGul	M1859	43.8653	-58.8967	Acoustic
06/04/2014	96	23	Recovered	JascoSys	M1862	43.8547	-58.8992	
06/04/2014	96	24	Recovered	GulSho	M1860	43.8723	-58.5825	
07/04/2014	97	36	Recovered	ShoHald	M1861	44.0959	-58.0546	
20/04/2014	110	190	Deployed	STAB_MOOR	M1864	46.2462	-59.1508	HOTO
20/04/2014	110	191	Deployed	STAB_MOOR	M1863	46.2574	-59.1430	

ARGO Float Deployments

Contributions by: Denis Gilbert and Ingrid Peterson

Narrative

Three NOVA floats were deployed during the mission; 1 at HL_11 on April 16th and the other two at LL_09 and LL_08 on April 17th and 18th respectively (Figure 15 and Figure 12). Within a few minutes of launching, deployment details were e-mailed to both Denis Gilbert and Ingrid Peterson. Within an hour of the NOVA float deployment at HL_11, an e-mail was received by Ingrid Peterson stating that the csv file for SN 122 was posted on the Joubeh FTP site. This was also the case for the following 2 deployments (SN 120 and 121). By mid-afternoon on April 18th, it had been confirmed that each of the 3 floats deployed during the mission had successfully broadcast their first full profiles (Figure 16)

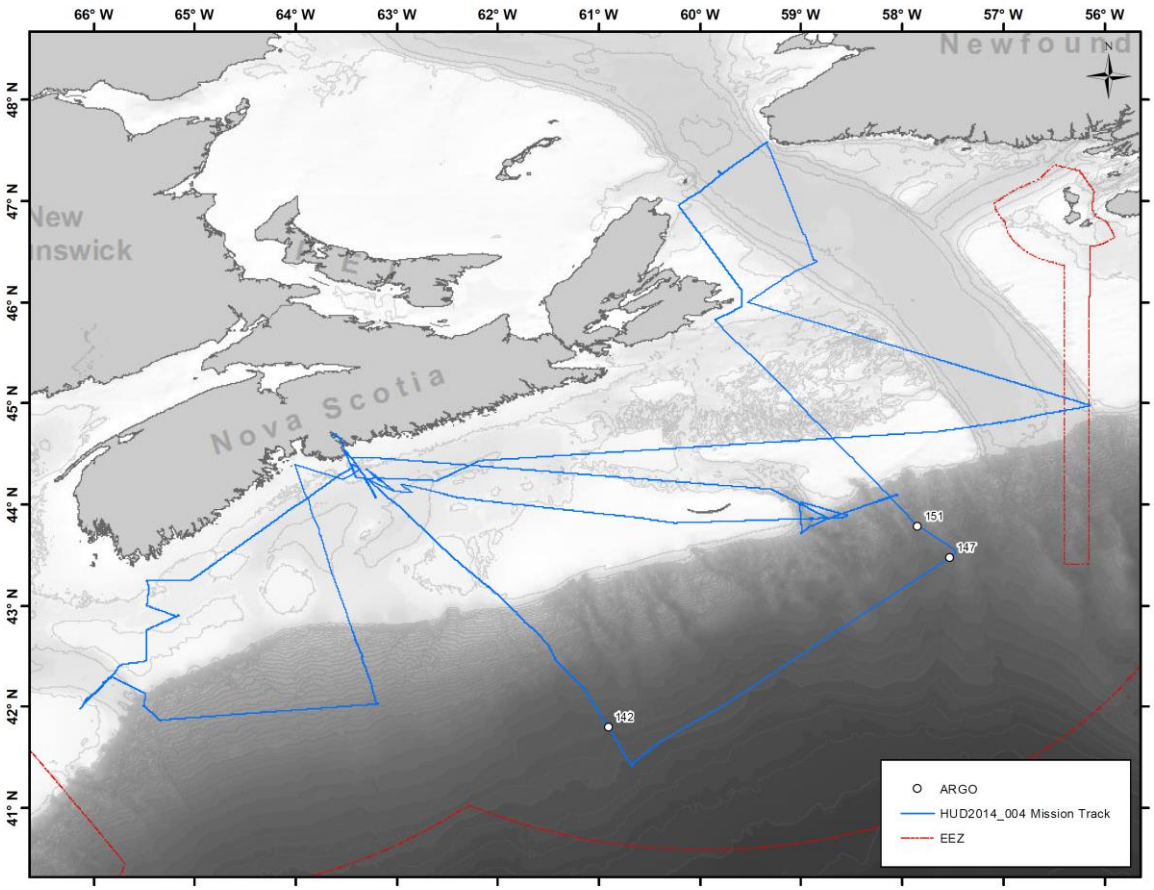


Figure 15. The locations for each NOVA float deployment during HUD2014004. Refer to Table 12 for more details.

Table 12. Deployment details for NOVA float deployments during HUD2014004. The coordinates provided below are in decimal degrees and represent the ship's position at the time of deployment.

Date	JDay	Event	Station	Magnet Removed (UTC)	Float Deployed (UTC)	Plugs Removed	IMEI #	Serial Number	Slat (DD)	Slong (DD)
16/04/14	106	142	HL_11	~131700	132101	Yes	300234060594250	122	41.7881	-60.9046
17/04/14	107	147	LL_09	~200800	201309	Yes	300234060592250	121	43.4725	-57.5316
18/04/14	108	151	LL_08	~032300	032728	Yes	300234060594240	120	43.7814	-57.8401

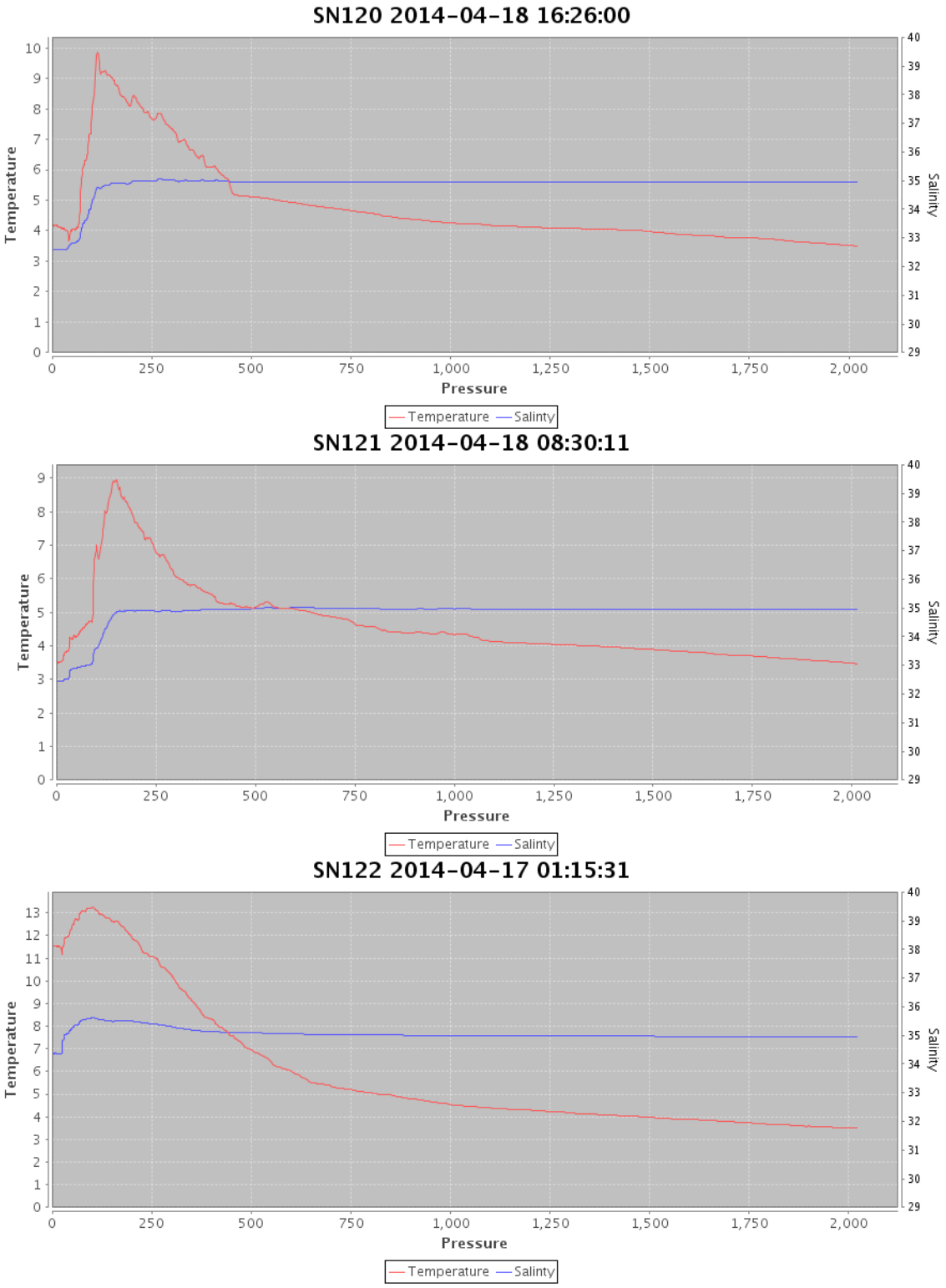


Figure 16. The first profiles for serial numbers 120, 121 and 122 (Table 12).

Underway Sampling

Vessel Acoustic Doppler Current Profiler

Prepared by: Adam Hartling
Division: Program Coordination and Support

Hudson is equipped with a Teledyne RDI Ocean Surveyor II vessel mounted acoustic Doppler current profiler (VMADCP) system consisting of a 75 kHz phased array transducer assembly mounted in a well in the ship's hull and a deck unit and computer located in the forward lab. The VMADCP system was checked regularly for proper operation until ~April 17th. The system malfunctioned not long after it was last checked and did not collect data for the remainder of the mission. Data was collected from the beginning of the mission on April 4th, until it stopped logging data on April 17th.

The transducer assembly is mounted on a ram penetrating the ship's hull that can be lowered if necessary. Transducer remained in the retracted position for the duration of the mission. It was determined during sea acceptance testing that lowering the transducer did not affect the operation of the system. The transducer is located approximately 6m below the waterline.

The system is capable of collecting bottom track data to 1000 m and profile data to 650 m. Setup includes 100-8 m bins. The Ocean Surveyor was set to operate in the narrow band single ping mode with 3 sec ensemble time. Position, heading, pitch and roll data is provided by the ADU5 attitude determination unit at a 1 Hz rate. Ships gyro heading data is connected directly to the OSII deck unit. The Ocean Surveyor also includes a temperature sensor for sound speed calculations. The gyro is the primary heading.

WinADCP software package used monitor profile data in real time. WinADCP is set to display times series of short-term averaged profile and attitude data. VmDas Software package used to deploy OSII and log raw data, VmDas option files, intermediate and processed files. Data back-up on external hard-drive. Data back-up includes only raw data and VmDas option files.

All NMEA strings are logged during data collection. The gyro heading is included in the raw data. Raw data is processed in real time for a short term average of 30 sec and a long term average of 300 sec.

A significant increase in the noise floor is caused by bow thrusters while on station, during high sea states, or during travel at speeds in excess of 12 knots in rough conditions. The increase in noise floor results in a significant decrease in data quality and reduction in profile range.

Navigation and Bathymetry

The navigation system onboard CCGS Hudson consists of differential GPS receiver and navigation software. The receiver is one of many NMEA feeds into a multiplexer that provides all the NMEA strings to a PC on the bridge. The PC running the navigation software, then rebroadcasts the NMEA strings to distribution units in the computer room, which provide many output lines for the working labs. The resulting broadcast navigation strings are ~ 1 Hz. The navigation data are then logged at specified intervals on a PC. For this cruise the navigation was logged approximately every second.

The Knudson 12 kHz sounder was utilized in transit and during mooring activities. At CTD stations, the echo sounder system used for collecting bathymetric data consisted of a 12 KHz Raytheon PTR echo sounder that created an analog trace on a Raytheon Line Scan Recorder in the winch room. The transducer beam width is 15 degrees. The sweep rate of the recorder was adjusted throughout the course of data collection to aid in identifying the bottom signal. One transducer is positioned on a Ram that can be lowered or raised depending on conditions. When the ram is up, the waterline to transducer offset is 6 m. When the ram is down, the offset is 8 m.

Underway Seawater System – Thermosalinograph

The recent acquisition of a new TSG system meant that the plumbing and sensor configuration had to be set up prior to sailing. With help from the ship's crew and staff from PCSD, the system was plumbed and mounted to the table top near the sink in the forward laboratory (Figure 17A). While conducting trials in Bedford Basin, the incoming water pressure was less than 5 PSI and the measurements by probes both in the water bath (temperature & salinity) and near the intake (temperature) both worked well. Throughout the mission, a difference of ~0.2 degrees Celsius was observed between the intake probe and the water bath probe in the Forward Laboratory. This year, the fluorometer was mounted independently but it is hoped that in the future this can mounted in the water bath to reduce the amount of plumbing and the associated fluctuations in flow rates that can result. The Chief Engineer worked with ship's staff to clean the pump and the intake line that were both full of mussels. Once complete the intake pump produced ample water flow (~10-15 PSI) for the duration of the mission.

The addition of the Vortex de-bubbler (Figure 17B) dramatically reduced the amount of air going through the system while the ship was in transit, thus improving the quality of digital data collected. Sensor data and ship's navigation data (latitude and longitude) taken from the ship's NMEA string were collected at 5 second intervals throughout the mission and data acquisition was manually restarted every ~24 hours and periodically backed up. Upon completion of the mission and prior to the next mission, Dr. Dave Hebert created a .bat file that automatically stopped and restarted acquisition every 24 hours. In the fall, data should be automatically backed up to a server or external drive on a regular basis. TSG data acquired during the mission was given to ODIS for archival upon return.

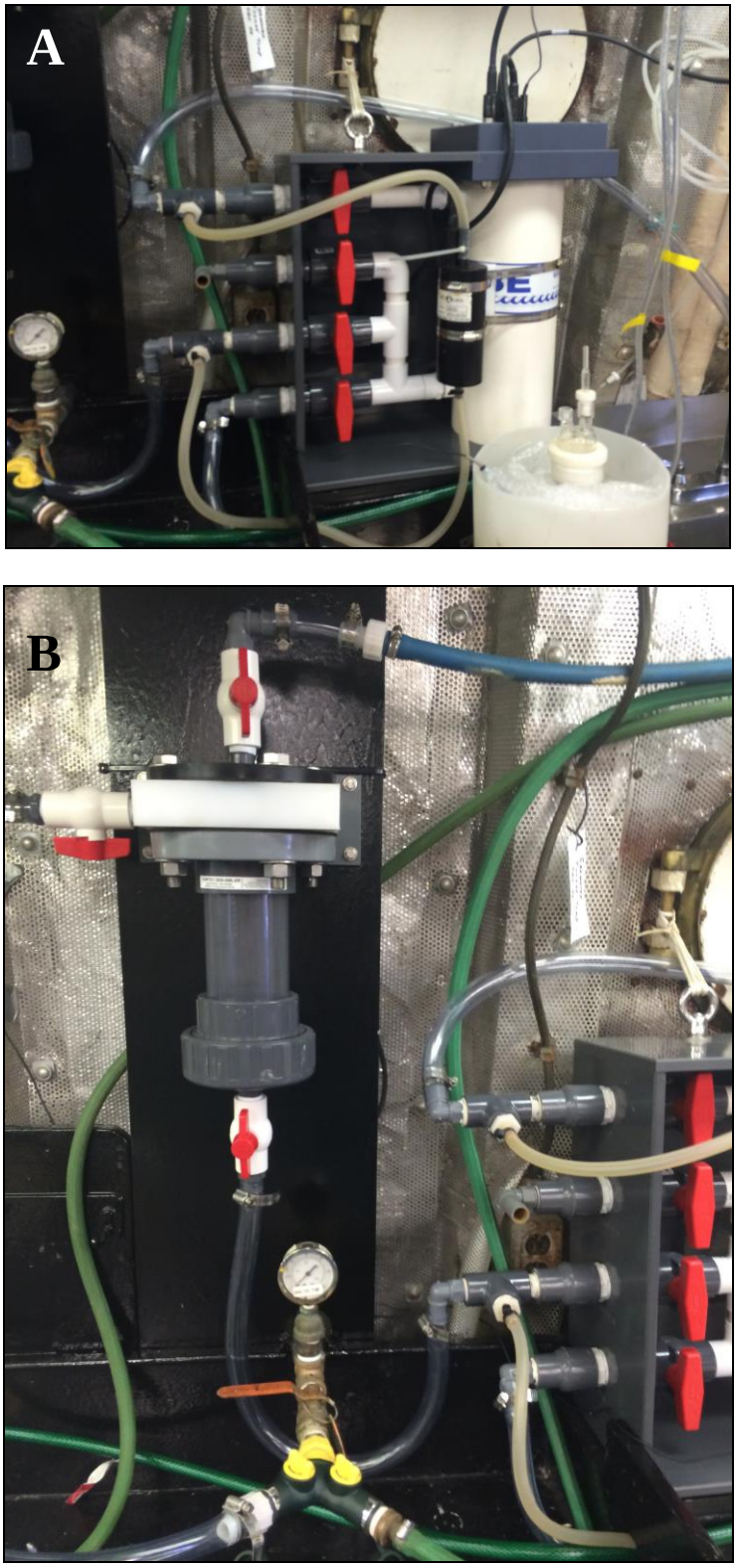


Figure 17. A) The Thermosalinograph and fluorometer plumbing set up, and **B)** The associated Vortex debubbler.

Meterological Measurements

Copied from: Ross Hendry

The officer of the watch enters standard meteorological data into the ship's log book (not the science log book) at regular intervals. On occasion we have transcribed these logged values for local scientific use but there is no standard protocol for doing this.

Since April 2003 Environment Canada (EC) has maintained an AXYS Technologies Inc. Automated Volunteer Observing Station (AVOS) on board Hudson that measures a suite of meteorological variables. Data are stored on an EC-maintained personal computer on board Hudson. Normally these measurements are automatically forwarded at regular intervals onto the Global Telecommunication System (GTS) of the World Meteorological Organization. The GTS data then become available at http://www.sailwx.info/shiptrack/shipposition.phtml?call=CGDG but there are significant data gaps which include the entire period of HUD2009015.

Wind speed and direction are operationally monitored with a Young Model 05103 Wind Monitor, (R. M. Young Company, MI, USA) mounted on the starboard side of the upper platform on Hudson's antenna mast at an estimated elevation of 25 m above sea level. The Wind Monitor is connected to a Young Model 06206 Marine Wind Tracker located on the bridge. The Marine Wind Tracker provides NMEA $WIMWV (Wind Speed and Angle) strings which are captured, time-stamped, and logged at 1-second intervals by the Geological Survey of Canada's (GSC) Survey Suite navigation logging system.

Wind direction reported by the Wind Monitor is the direction relative to the ship's heading from which the wind is blowing, zero degrees when the wind is on the bow and increasing clockwise when viewed from above. The manufacturer of the Model 05103 Wind Monitor notes that the wind direction potentiometer has a 5° dead band between 355 and 360 degrees. In the Hudson installation the NMEA output directions actually show a dead band between approximately 175 and 180 degrees.

Additional information is needed to convert the wind measurements from a ship reference frame to a geographic reference frame. Relative wind direction is converted to geographic direction by adding the ship's heading. Ship's heading information is provided by a Raytheon Marine Standard 20 Gyro Compass System as NMEA $HEHDT (Heading – True) strings. Wind speed and direction in a geographic reference frame are then computed by the vector addition of the wind velocity in the ship reference frame and the ship's velocity. The ship's true course and speed are provided by the Ashtech ADU5 attitude determination and real-time DGPS positioning system as NMEA $GPVTG strings (Track Made Good and Ground Speed). These additional NMEA strings are also captured at 1-second intervals by the Survey Suite system.

Data Management

Prepared by: Robert Benjamin
Division: Program Coordination and Support

Data Collection

In addition to standard AZMP manual data collection methods (Bridge log, various equipment specific deck sheets) **ELOG**, an electronic logbook system for collecting event metadata was tested. Operating through a web interface, ELOG was accessible via any computer connected to the *science network* onboard the vessel. This logbook system was configured to collect positional data, time deployed, on bottom and recovered, as well specific data related to each piece of equipment. Details of each event could be searched, sorted or filtered as needed independently at any computer on the *science network*. The logbooks were backed up hourly.

Nav-Net, an on board ship's data collection system was used to collect all streaming data available during the entire mission. These data include GPS data, sounder data, gyro data, wind and motion data.

Data Input Template

A Microsoft Access database template is being developed and was tested during this mission. While at sea, the database was modified to accept data from the various sources that were available as data was collected. Logbook data from the ELOG system and QAT files from the CTD system can now be easily ingested into the database template. Salinity conductivities can be entered and salinity values calculated and stored in the database template. The GP Lab provided analysis for Oxygen, Chlorophyll and Phaeophytin in the form of CSV files. These CSV files can easily be ingested into the database template. The database template will be further modified to import data that will be post processed such as Nutrients, HPLC and Plankton data.

APPENDICES

Appendix 1. CTD configuration file.

PSA file: C:\CTD_ACQUISITION\Seasave.psa

Date: 05/22/2014

Instrument configuration file:
C:\CTD_ACQUISITION\2014004HUD\ctddata\HUD2014004b.con

Configuration report for SBE 911plus/917plus CTD

Frequency channels suppressed : 0
Voltage words suppressed : 0
Computer interface : RS-232C
Deck unit : SBE11plus Firmware Version >= 5.0
Scans to average : 1
NMEA position data added : Yes
NMEA depth data added : No
NMEA time added : No
NMEA device connected to : deck unit
Surface PAR voltage added : No
Scan time added : No

1) Frequency 0, Temperature

Serial number : 5081
Calibrated on : 14-Dec-13
A : 3.68121203e-003
B : 6.01428889e-004
C : 1.57189532e-005
D : 2.12828552e-006
F0 : 3243.100
Slope : 1.00000000
Offset : 0.0000

2) Frequency 1, Conductivity

Serial number : 3561
Calibrated on : 19-Dec-13
G : -1.03348368e+001
H : 1.24730604e+000
I : -1.28859014e-003
J : 1.43705553e-004
CTcor : 3.2500e-006
CPcor : -9.57000000e-008

Slope : 1.00000000
Offset : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

Serial number : 0475
Calibrated on : 02-Aug-13
C1 : -5.396574e+004
C2 : -1.037259e-001
C3 : 1.543670e-002
D1 : 3.880000e-002
D2 : 0.000000e+000
T1 : 2.985151e+001
T2 : -3.761054e-004
T3 : 3.763920e-006
T4 : 3.187530e-009
T5 : 0.000000e+000
Slope : 0.99985302
Offset : 2.98281
AD590M : 1.281640e-002
AD590B : -9.148720e+000

4) Frequency 3, Temperature, 2

Serial number : 5083
Calibrated on : 14-Dec-13
A : 3.68121206e-003
B : 5.97274727e-004
C : 1.50445052e-005
D : 2.02752890e-006
F0 : 2984.779
Slope : 1.00000000
Offset : 0.0000

5) Frequency 4, Conductivity, 2

Serial number : 3562
Calibrated on : 19-Dec-13
G : -1.02230983e+001
H : 1.24786569e+000
I : -1.11587983e-003
J : 1.31995167e-004
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

6) A/D voltage 0, Altimeter

Serial number : 49559
Calibrated on : 18-Feb-2010
Scale factor : 15.000
Offset : 0.000

7) A/D voltage 1, Fluorometer, Chelsea Aqua 3

Serial number : 88172
Calibrated on : 19-Jan-2010
VB : 0.422400
V1 : 2.133900
Vacetone : 0.453900
Scale factor : 1.000000
Slope : 1.000000
Offset : 0.000000

8) A/D voltage 2, Oxygen, SBE 43

Serial number : 0042
Calibrated on : 19-Dec-13
Equation : Sea-Bird
Soc : 4.18260e-001
Offset : -5.06700e-001
A : -2.95880e-003
B : 2.48920e-004
C : -4.14170e-006
E : 3.60000e-002
Tau20 : 1.65000e+000
D1 : 1.92634e-004
D2 : -4.64803e-002
H1 : -3.30000e-002
H2 : 5.00000e+003
H3 : 1.45000e+003

9) A/D voltage 3, Oxygen, SBE 43, 2

Serial number : 0133
Calibrated on : 19-Dec-13
Equation : Sea-Bird
Soc : 3.90300e-001
Offset : -6.59300e-001
A : -3.72890e-003
B : 2.01120e-004
C : -3.19380e-006
E : 3.60000e-002
Tau20 : 1.34000e+000
D1 : 1.92634e-004

D2 : -4.64803e-002
H1 : -3.30000e-002
H2 : 5.00000e+003
H3 : 1.45000e+003

10) A/D voltage 4, PAR/Irradiance, Biospherical/Licor

Serial number : SPQA5064-/0002-PN90310-CH1
Calibrated on : 20-Mar-2013/17-Apr-1998
M : -0.77322200
B : -3.53659100
Calibration constant : 4.69000000
Multiplier : 1.00000000
Offset : 0.00000000

11) A/D voltage 5, Fluorometer, WET Labs WETstar

Serial number : WSCD-987P
Calibrated on : 18-Aug-2003
Blank output : 0.052
Scale factor : 71.428

12) A/D voltage 6, User Polynomial

Serial number : 372
Calibrated on : 24-Jan-2014
Sensor name : Optode 4330F - O2 D-Phase
A0 : 10.00000000
A1 : 12.00000000
A2 : 0.00000000
A3 : 0.00000000

13) A/D voltage 7, User Polynomial, 2

Serial number : 372
Calibrated on : 24-Jan-2014
Sensor name : Optode 4330F - O2 Temp
A0 : -5.00000000
A1 : 8.00000000
A2 : 0.00000000
A3 : 0.00000000

Scan length : 37