CRUISE REPORT

HUDSON 2014030

SCOTIAN SHELF

AZMP TRANSECTS +

Sept 19th – Oct 8th, 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} 56'W - 066^{o} 08'W
Expedition Designation:	HUD2014030 or 18HU14030 (ISDM format)
Chief Scientist:	Dr. Dave Hebert Ocean Ecosystem Science Division Marine Ecology Section Department of Fisheries and Oceans Bedford Institute of Oceanography PO Box 1006 Dartmouth, NS, Canada B2Y 4A2 Dave.Hebert@dfo-mpo.gc.ca
Ship:	CCGS Hudson (call sign - CGDG) Oceanographic research vessel
Ports of Call:	Sept 19th, 2014 - Depart BIO Dartmouth, NS Sept 28th, 2014 – First leg crew exchange and equipment dropped off in Halifax, NS. Sept 30th, 2014 – Jay Barthelotte dropped off in Sydney, NS. Oct 8th, 2014 - Return BIO, Dartmouth, NS
Cruise Dates:	Leg 1: Sept 19th – Sept 28th Leg 2: Sept 28th – Sept 30th Leg 3: Sept 30th – Oct 8th

Mission Summary

Overview

The science party was onboard the CCGS Hudson at 0600 Atlantic time at BIO on Sept. 19th, 2014 to begin the first leg of the mission. Orientation for new participants was conducted before leaving the dock. At 09:00, the departure was delayed due to an issue with one of the engines, but the matter was resolved quickly and the vessel departed from BIO at 10:15. The first leg ended 10 days later at ~0800 on September 28th at BIO. The Hudson then departed from BIO on September 28th at ~1400 to begin the second leg of the mission. The third leg of the mission began after dropping Jay Barthelotte off in Sydney on September 30th, and finished at BIO at ~0800 on the morning of October 8th. During the 20 day mission, the CCGS Hudson logged ~2867 nm and AZMP science staff conducted 187 separate operations at 78 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.

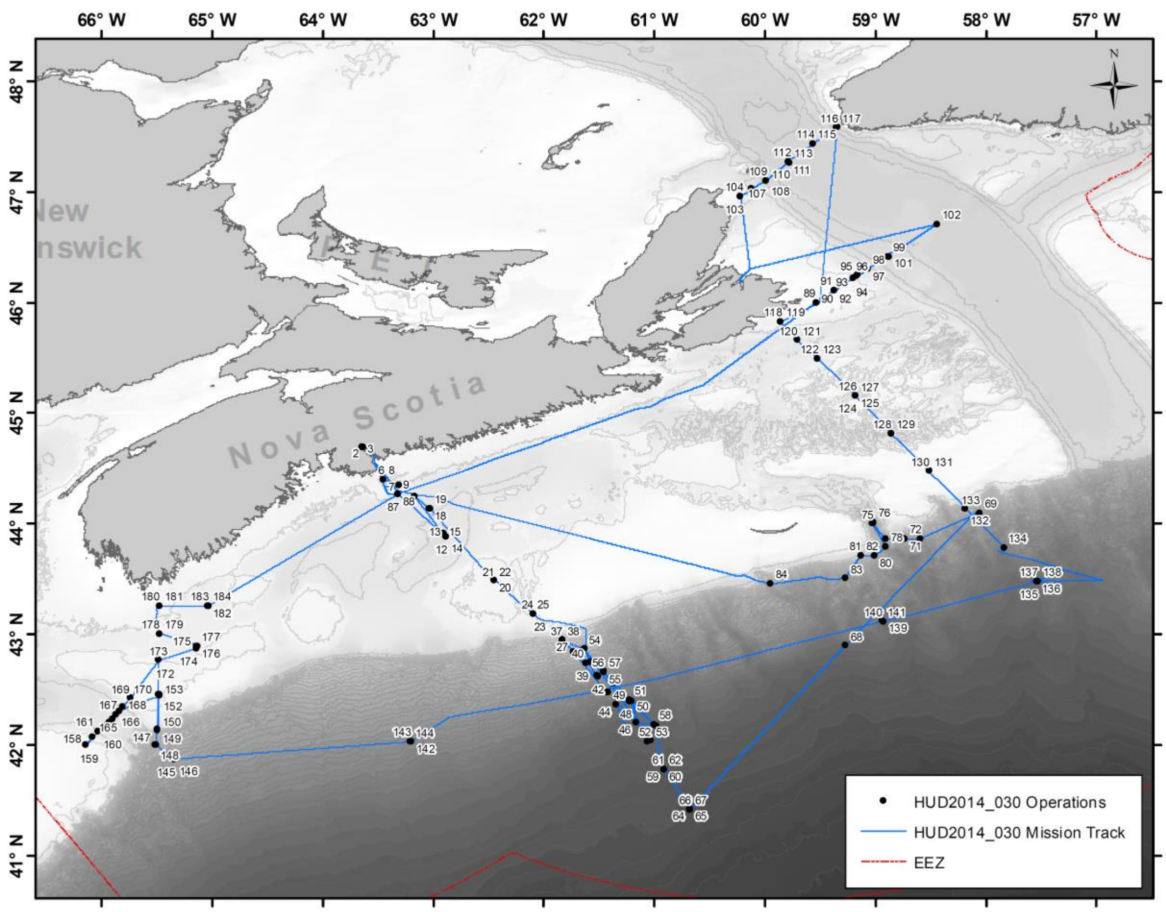


Figure 1. The locations for all 187 events during the HUD2014030 AZMP fall survey. Some overlapping event labels are not visible.

Table 1. Summary of operations during the HUD2014030 AZMP fall survey.

Leg	Operation	# of Operations	Figure
1	CTD	22	2
	Vertical Ring Net	20	16
	Bioness	3	17
	Mooring Deployment	7	22
	Mooring Recovery	15	22
	Mooring Acoustic Release*	4	N/A
	Argo Float Deployments	6	23
	Multi-Net	7	18
2	CTD casts	7	2
	Vertical Net Tows	7	16
	Bioness	1	17
	Mooring Deployment	1	22
	Mooring Recovery	1	22
	Secchi Disk*	1	N/A
3	CTD	39	2
	Vertical Ring Net	35	16
	Bioness	4	17
	Argo Float Deployments	3	23
	Multi-Net	4	18

*A map describing the Secchi deployment location is not included but it was deployed during event 85 at HL_02. Mooring Acoustic Releases were occasionally included as a separate event in ELOG, but because no gear was deployed they were not included in the gear summary figures or tables.

Leg 1

Leg 1 began on September 19th with tests of the CTD, BIONESS and Multi-net in the Bedford Basin. With the exception of a repair to a leaking bottle on the rosette, an adjustment to the Bioness net release and straightening the magnetic read switches on the Multi-net block so cable out could be displayed, Basin tests were successful. After completion of tests and lunch, fire and boat drills were conducted while in the basin. At 13:30, Robert Benjamin was taken ashore after ensuring the event and other logging systems were functioning properly. We then departed Halifax Harbour to begin OTN mooring recovery and deployment operations.

The recovery and deployment of OTN_01 began at 17:00. At 18:00, it was decided that it was too late to recover OTN_02 before dark (~19:15). During the night, HL_01, HL_02 and HL_03 were occupied before returning to OTN_02 for the morning of the 20th. After sunrise, moorings at OTN_02 and OTN_03 were recovered and new moorings deployed. Initially, the plan was to occupy HL_04 to HL_07, skipping HL_06 in order to be ready for mooring recovery for the morning of the 21st. At 20:15 on the 20th, it was discovered that a sword-fisherman was laying line along the same bathymetry as HL_05.5, with the centre of the line crossing the station. A decision was made to skip HL_05.5 and occupy HL_06 instead. It was necessary to steam to the east to avoid the fishing activity. After occupying HL_06, a MicroCAT calibration CTD cast was conducted at HL_07. An APEX float was also deployed at this location.

After some testing of the Hudson's bow thruster, the ship headed to RS_04 for mooring recovery operations. The Hudson arrived on station at 11:00 am on Sept. 21st and science staff began communicating to the release. The mooring was released and took ~½ hour to surface. Subsequent recoveries of RS_03, RS_02 and RS_01 mooring were completed before sunset on the 21st. The Hudson then reversed course and occupied HL_05.5 but progress was slow due to a developing storm. During the early morning hours of the 22nd both HL_06.3 and HL_06.7 were occupied. During recovery at HL_06.7 at 08:00 on the 22nd, the seas were very heavy and tension was lost on the package when it was at 80 m. Conditions were marginal for operations so the ship headed to HL_08, where it was hoped that conditions would improve in the afternoon. Upon arrival at HL_08, conditions had deteriorated to the point that nets could not be deployed. No tasks were planned after the CTD, so a decision was made to hove-to. HL_08 and HL_09 were completed during the night. At 02:15 on Sept 23rd, the underway water system pump was stopped after it blew a gasket. During the night, one of the actuators on the winch room's doors broke.

At 07:30 on the 23rd, the Hudson began the short steam to RS_06 for recovery of the mooring. The Hudson arrived on station at 08:15 but had to wait until repairs on the door actuators were completed. The mooring was released at 08:30. Then, the mooring at RS_05 was recovered and the new mooring at this site was deployed. Due to the length of time for deployment of the mooring, it was too late to deploy the RS_06 mooring; thus, it was decided to occupy HL_10 and be at RS_01 for 05:30 on the 24th.

On the 24th, the ship arrived at RS_01 at 07:15. Moorings were deployed at RS_01, RS_03 and RS_06 during the day. Occupations at HL_11 and HL_12 were completed in the early morning hours of the 25th, including deployment of Argo floats before steaming to ShoHald for an AMAR mooring recovery on the morning of the 26th. On the way to that site, OLC_01 (~3500 m isobath) was occupied to conduct a MicroCAT/CTD calibration cast for the recovered instruments.

At 06:30 on Sept 26th, the AMAR mooring at ShoHald was released and recovered. The AMAR mooring at GulSho was recovered next. The station occupations in the Gully region, including an AMAR mooring recovery at MidGul, were completed next. On the 27th, the AMAR moorings at LC_01, LC_02 and LC_03 were recovered before steaming to BIO for an arrival on the 28th at 08:00. The mooring gear was unloaded and there was a change of cruise personnel. The CCGS Hudson left BIO at 14:00 to begin leg 2 at HL_02.

<u>Leg 2</u>

After occupying HL_02 on September 28th, the Hudson transited to the St. Anns Bank Area of Interest, arriving to begin work on the morning of the 29th. There was a question of the weather conditions and whether moorings could be recovered. When the ship arrived at the mooring site, the spar buoy was missing. It was since discovered on the west coast of Newfoundland, apparently stripped bare of sensors before being set adrift

(November, 2014). The sea conditions precluded searching for the subsurface floats and dragging for the mooring. It is hoped that an opportunity may arise during the spring 2015 AZMP mission to conduct a more thorough search. Nonetheless, the bottom mounted ADCP mooring was recovered and a new one deployed. The remainder of the St. Anns Bank line occupations were completed, including a new station occupied in the Laurentian Channel for the ocean acidification ACCASP program.

Finally, the Hudson steamed to Sydney to drop off Jay Barthelotte by FRC at 08:30 on Sept. 30th; thus, concluding Leg 2 of the mission.

Leg 3

The Hudson began occupying stations on the Cabot Strait Line on Sept. 30th starting at CSL_01. The weather forecast for later in the week showed strong north-easterly winds for several days; thus, upon completion of the Cabot Strait Line at 04:00 on Oct. 1st it was decided occupy the Louisbourg Line stations next because they are core stations. At 12:50 on Oct. 1st, the occupation of LL_01 began. Strong winds limited the transit speed as the Hudson occupied stations on its way to LL_08 and LL_09. There was difficulty detecting the ocean bottom, and at LL_07 the net touched bottom and collected mud; there was no good net sample at LL_07. At LL_08, a false (not known at the time) depth on the LSR of 3200 m was obtained. It was difficult to acquire a good signal due to oceanic noise. The ram was pinned in the up position and Terry Cormier, who is the only person authorized to unpin the ram, was not up yet and preparations for lunch were under way (access to the ram pin is through the officer's pantry). A decision was made to conduct the CTD cast regardless. For a short period, the altimeter locked on the bottom, but before the winch could be stopped, the CTD impacted the ocean floor. Details are provided in the CTD summary section below.

The Hudson began the steam to LL_09 at 16:00 on October 2nd but had to heave-to at 17:30 as it was too rough to steam at night. At dawn on Oct. 3rd, the ship began its steam to LL_09, located about 20 nm to the east. We were informed that a pin hole leak in the top of an interior ballast tank was found during the night. After inspection by the Chief Engineer, the small hole was found to be surrounded by weak metal. It was decided that we did not have to return to BIO immediately but needed to be back by Wednesday October 8th in order to have repairs completed in time for the next mission. It was decided to drop the additional stations on the eastern section of the mission plan (i.e., SPB, EH, BANQ, BP) and complete the Brown's Bank Line core stations before returning to BIO.

Due to weather conditions, a ring net was completed at LL_09 instead of the planned Multi-net. During the CTD cast at LL_09, an electrical short occurred at ~980 db. Randy King thought it might have been an electrical termination issue and re-terminated the cable. In the meantime, an Argo float was deployed. After the termination was completed, electrical issues were discovered when the deck block blew fuses when power was applied to the sea cable. Several electrical re-terminations were completed and the problem was not resolved. It was speculated that the sea cable may be still be damaged but the location could not be determined. After several hours, it was determined that the new pigtail was shorted out. After a new pigtail was used, the CTD cast at LL_09 began at 18:00 on October 3rd. Upon completion of the LL_09 occupation, the ship began steaming to the end of the Brown's Bank Line (BBL_07).

Since some of the planned stations were dropped, including ones for ARGO float deployments, it was decided to occupy a station in the slope water south of Sable Island (SIS_01) and at LHB_07 for float deployments. The Hudson arrived at SIS_01 at 03:00 on Oct 4th and conducted a CTD and Multi-net cast, as well as an ARGO float deployment. Operations at LHB_07 were conducted in the early hours of Oct 5th before steaming to BBL_07.

The Brown's Bank Line and Northeast Channel (aka Peter Smith (PS)) stations were completed in their normal fashion. Between occupying BBL_02 and BBL_01, the RATBA_02 location was occupied on October 6th. Two BIONESS tows were completed for the MEOPAR-Whales group just north of their glider's holding pattern. After completing BBL_01, RL_01 was sampled on Oct. 7th. Finally, the Hudson began a slow steam to HL_02, which was occupied at 03:00 on the 8th, before docking at BIO at 08:00.

During the 20 day mission, ~5.2 full days were directly attributable to field operations (Table 2) and the remaining 14.8 days were attributable to a combination of steaming time, sampling, station keeping and gear preparation/repair. During steaming, the vessel mounted Acoustic Doppler Current Profiler (ADCP) was in operation and was collecting data from September 19th until October 8th.

Underway data (temperature, salinity, fluorescence and the partial pressure of CO_2) were collected via the 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. Also included in the Data Management section is the set up and trial of the NOAA Scientific Computer System (SCS) software which was tested as a means of coordinating, monitoring and logging multiple underway data streams.

Table 2. Break down of operational time by gear type during HUD2014030.

Gear	Time Allocated (hrs)
CTD	~58
Mooring Deployments/Retrievals	~32
Vertical Net Tows	~19
Multi-Net	~10
Bioness	~4
ARGO	~2
Secchi Disk	0.3

Mission Participants

Table 3. List of science staff aboard the HUD2014030 fall AZMP mission.

Name	**Affiliation**	**Duty**	**Leg**	**Shift**
Abbott, Sue	EC-CWS	Bird Watcher	1	Day
Barthelotte, Jay	DFO (MAR – PCSD)	Mooring deployments	1 & 2	Day
Benjamin, Robert	DFO (MAR – PCSD)	Data Manager	2 & 3	Day
Bond, Shelley	DFO (MAR – PCSD)	Data Manager	1	Night
Bregha, Francois	DAL (student of Helmuth Thomas)	Underway and CTD water samples	2 & 3	Night
Caverhill, Carla	DFO (MAR – OESD)	Water samples, Lab Supervisor	All	Day
Cogswell, Andrew	DFO (MAR – OESD)	CTD watch/E-log	All	Night
Cormier, Terry	DFO (MAR – PCSD)	CTD Tech/Ship's Tech	All	Split
Dever, Mathieu	DAL	CTD watch/E-log	All	Day
Fieglar, Angelica	DAL (student of Helmuth Thomas)	Underway and CTD water samples	1	Night
Geshelin, Yuri	DFO (MAR – OESD)	RAPID-WATCH	1	Night
Gould, Jessica	DAL (student of Markus Kienast)	Underway and CTD water samples	All	Day
Hartling, Adam	DFO (MAR – PCSD)	LADCP, VMADCP, TSG, Mooring deployments	1	Day
Hebert, Dave**	DFO (MAR – OESD)	Chief Scientist	All	Day
King, Randy	DFO (MAR – PCSD)	Mooring deployments/CTD Tech	All	Day
Lemay, Jonathan	DAL (student of Helmuth Thomas)	Underway and CTD water samples	2 & 3	Day
Morales Maqueda, Miguel Angel	NOC, Liverpool: RAPID-WATCH	RAPID-WAVE (WATCH)	1	Day
Perry, Timothy	DFO (MAR – OESD)	Water samples, Lab Supervisor	All	Night
Pugh, Jeffrey	NOC, Liverpool: RAPID-WATCH	RAPID-WAVE (WATCH)	1	Day
Ringuette, Marc	DFO (MAR – OESD)	CTD/Net Tows/E-log	All	Day
Spry, Jeffrey	DFO (MAR – OESD)	CTD/Net Tows/E-log	All	Night
Toms, Brad	EC-CWS	Bird Watcher	2&3	Day
Wilson, Erin	DAL (student of Helmuth Thomas)	Underway and CTD water samples	1	Day
Zorz, Jackie	DAL (student of Julie LaRoche)	CTD water samples	All	Day

**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
NOC: National Oceanography Centre

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

1. Obtain fall 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

2. Recover and deploy 3 Ocean Tracking Network (OTN) moorings at inner shelf stations of the Halifax Section (**Contact Dr. Dave Hebert** - http://www.dfo-mpo.gc.ca/science/publications/article/2011/07-19-11-eng.html).
3. Recover and deploy deep water moorings from the slope waters of the Halifax Section and conduct hydrographic profiles and collect water samples at mooring stations. This part of the programme is in collaboration with (and hence partially funded by) the *UK RAPID-WAVE (West Atlantic Variability Experiment)* programme (**Contact Dr. John Loder** - http://noc.ac.uk/science-technology/climate-sea-level/rapid-watch/rapid-wave).
4. 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).
5. Deploy and recover Seahorse mooring near HL_02 (**Contact Dr. Blair Greenan).**
6. Recover 6 Autonomous Multichannel Acoustic Recorders (AMAR) near Logan Canyon, the Gully MPA, Shortland Canyon 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).
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. Recover and deploy mooring(s) at 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).
9. Nutrients and hydrography across the Northeast Channel as part of NERACOOS Cooperative Agreement, (**Contact Dr. Peter Smith/Dr. Dave Hebert** - http://www.neracoos.org/).
10. 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**).
11. 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. Catherine Johnson and Chris Taggart** - http://www.sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=780, http://www.rightwhale.ca/rosewayatba_e.php).
12. Carry out hydrographic, chemical and biological sampling at stations along the Gulf of Maine North Atlantic Time Series section (GNATS). 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/).
13. Collection of DIC, alkalinity and ^{13}C samples in support of research contributing to MEOPAR theme 2.2. (**Contact Dr. Helmuth Thomas** - http://meopar.ca/theme-2-2/).
14. Deployment of APEX and SOLO floats from WHOI and BSH in support of the International ARGO Float Program (**Contact Dr. Denis Gilbert &/or Dr. Igor Yashayaev** - http://www.bio.gc.ca/science/monitoring-monitorage/azomp-pmzao/argo-eng.php).
15. Underway suspended particle sampling (organic biomarkers) and rosette samples collected for isotopic composition of nitrate (**Contact Dr. Markus Kienast**).
16. Water collection from CTD casts at specific stations and specified depths for meta-genomics study (**Contact Dr. Julie Laroche**).
17. Collect water samples at specified locations and depths to fulfil the regional component of a recently funded ACCASP initiative investigating the delineation of ocean acidification and calcium carbonate saturation state of the Atlantic zone (**Contact Dr. Pierre Pepin** - http://www.dfo-mpo.gc.ca/science/oceanography-oceanographie/accasp/index-eng.html.).

18. Deploy Multinet at specified deep slope water stations to support long term monitoring of meso-zooplankton identification and enumeration (**Contact Dr. Erica Head).**

Unplanned

19. Bird and mammal observations were made by CWS observers throughout the mission (**Contact Carina Gjerdrum)**.
20. Zooplankton samples collected for Bucklin genetics study (refer to HUD2013004 – cruise report for details)

Table 4. Status of objectives upon completion of the HUD2014030 mission.

Objective	Status	Comments
1	Complete	All core AZMP stations were sampled in accordance with standard protocols.
2	Complete	All three OTN moorings were successfully recovered and redeployed.
3	Complete	All 6 RAPID moorings were recovered and 4 RAPID moorings were deployed
4	Partially Complete	XHL stations HL_08, HL_09, HL_10, HL_11 and HL_12 were occupied. Stations 13 and 14 were dropped.
5	Dropped	The Seahorse mooring was not received prior to sailing.
6	Complete	All acoustic recorders were retrieved.
7	Complete	All Gully occupations were completed.
8	Partially Complete	The ADCP mooring at St. Anns Bank was retrieved and deployed. We were not able to locate the other mooring at this location and the weather was not conducive for dragging.
9	Complete	All NERACOOS stations and requisite sampling took place
10	Dropped	The combination of weather related delays and ship issues described above precluded sampling stations at the mouth of the Laurentian Channel.
11	Complete	All station occupations in Roseway Basin were completed as planned.
12	Dropped	The combination of weather related delays and ship issues described above precluded sampling GNATS stations.
13	Complete	DIC, alkalinity and $_{13}C$ samples were collected by Dalhousie students in support of research contributing to MEOPAR theme 2.2.
14	Complete (revised)	All APEX and SOLO floats were deployed in slope waters great than 2000 m but at locations differed from those planned due to weather and ship related route changes.
15	Complete	Jessica Gould (Dalhousie University) collected underway samples 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	Partially Complete	Samples were collected for an ACCASP ocean acidification /calcium carbonate saturation project. Nonetheless, many planned sites (specifically at the mouth of the Laurentian Channel) could not be occupied due to route changes.
18	Partially Complete	Due to route change, Multi-net deployments were not possible along slope stations of St. Pierre Bank.
19	Unplanned	Bird and mammal observations were conducted throughout the mission.
20	Unplanned	Zooplankton genetics samples for Bucklin et al.

Summary of Activities

CTD summary

Narrative

As summarized in Table 1, there were a total of 68 CTD casts during the mission (Figure 2 and Table 5) and of these, 66 were successful. Appendix 1 provides the Seasave instrument configuration file (HUD2014030.xmlcon) that details the sensors deployed on the CTD frame from September 19th to October 3rd. After the CTD impacted the bottom during event 134 (described below), the CTD primary T/C T-connector was plugged with sediment. The primary T/C pair (#5081 and #3561 – highlighted in Appendix 1) was replaced with (#2303 and #1874) and a new configuration file was produced (Appendix 2 – HUD2014030a.xmlcon).

The mission did not encounter the volume of CTD technical difficulties experienced during the spring 2014 mission (HUD2014004). The following is a short in depth commentary of CTD operations during the mission.

Upon recovery of the CTD during event 22 at HL_04 (Figure 2), it was observed that one of the bottles (position #10 in the rosette) was leaking. The O-rings were subsequently replaced and the bottle functioned well for the remainder of the mission. On the up-cast of the same CTD, bottles fired at the same depth were done so in quick succession. Upon data download at the end of the cast, it was realized that the SBE35 (high precision thermometer) did not record data for any bottles fired after the 1st bottle at any one depth. In subsequent casts, bottle fires at the same depth were triggered at appropriate intervals (more than 10 seconds between bottle fires) so that a line for the bottle fire was observed in the SBE35 download.

During event 42 (HL_06.7), the CTD was stopped 25 m above the bottom because of heavy seas. Casts at HL_07 (event 30) and OLC_01 (event 068) were used to calibrate SBE 37 MicroCAT C-T recorders used for RAPID mooring operations. As such, the CTD was required to stop at selected intervals on the up-cast for 20 minutes.

At LL_08 (event 134), a combination of human error, rough seas, poor sounding and bad altimeter data resulted in the CTD impacting the bottom (discussed at length in the cruise narrative). It is estimated that approximately 80 m of additional cable was laid down before the problem was detected. On recovery, it was determined that ~20 m of sea cable was damaged and needed to be replaced. The cable was cut and re-terminated. During repairs, the Hudson remained at LL_08. As stated in the first paragraph of this section, the CTD primary T/C T-connector was plugged with sediment. This pair was replaced with another pair (S/Ns 2303 & 1874) and the calibration file was changed for the subsequent cast at LL_09 (136).

The secondary plumbing connection to the oxygen sensor from the pump was disconnected during event 153 (BBL_04) resulting in wildly fluctuating values during the cast. This was fixed prior to the next cast, but no other cast was made at BBL_04. During event 172, large differences between primary and secondary outputs were noticed prior to aborting the cast. Upon retrieval, the primary plumbing was flushed with Triton. The CTD was redeployed at the same location and worked without issue.

For the HUD2014004 report, a number of graphs were created to demonstrate the difference observed between primary and secondary sensors as well as Winkler and salinometer measures. It was a useful means for highlighting outliers prior to final CTD data processing and will be repeated here.

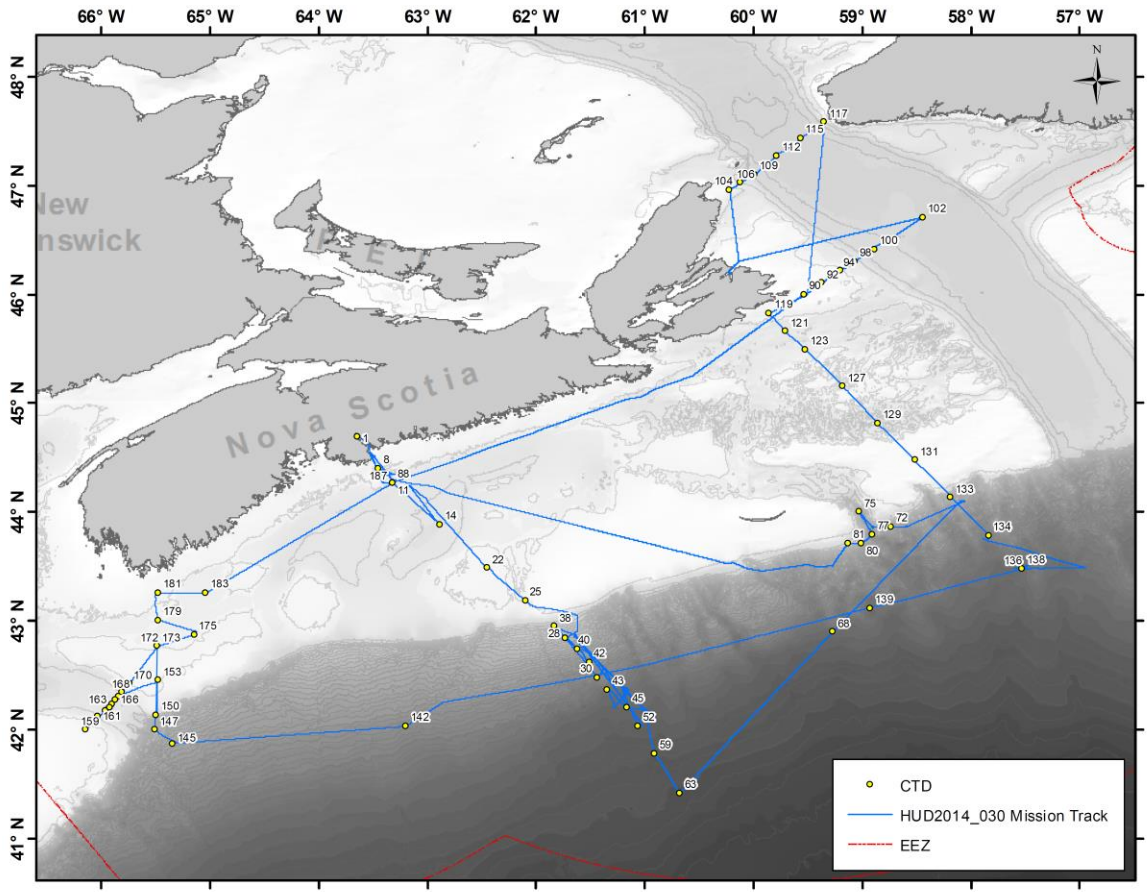


Figure 2. Locations for the 66 successful CTD casts during HUD2014030 AZMP fall survey. Each cast is labelled with the consecutive mission event.

Table 5. CTD casts during the HUD2014030 AZMP fall 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.

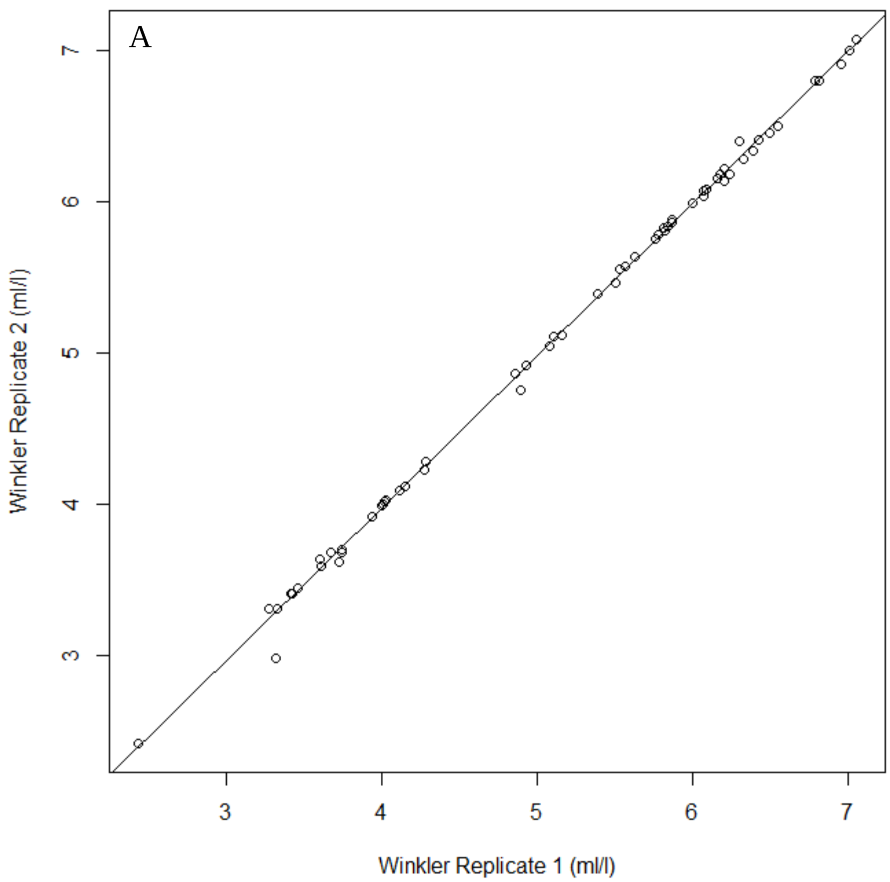
#	Event	Station	Date	Julian Day	Slat (DD)	Slon (DD)	Sounding (m)	LADCP	PAR	pH	MicroCAT	Water Collected	Aborted
1	1	HL_0	9/19/2014	262	44.6918	-63.6413	69		X	X			
2	8	HL_01	9/19/2014	262	44.4001	-63.4499	84		X	X		X	
3	11	HL_02	9/20/2014	263	44.2659	-63.3187	149		X	X		X	
4	14	HL_03	9/20/2014	263	43.8829	-62.8816	266		X	X		X	
5	22	HL_04	9/20/2014	263	43.4806	-62.4494	79		X	X		X	
6	25	HL_05	9/20/2014	263	43.1828	-62.0983	96		X	X		X	
7	28	HL_06	9/21/2014	264	42.8342	-61.7319	1070	X		X		X	
8	30	HL_07	9/21/2014	264	42.4751	-61.4332	2671	X			X	X	
9	38	HL_05.5	9/21/2014	264	42.9439	-61.8343	437			X		X	
10	40	HL_06.3	9/22/2014	265	42.7361	-61.6159	1762	X				X	
11	42	HL_06.7	9/22/2014	265	42.6175	-61.5110	2215	X				X	
12	43	HL_08	9/23/2014	266	42.3630	-61.3413	3264	X				X	
13	45	HL_09	9/23/2014	266	42.1996	-61.1637	3544	X				X	
14	52	HL_10	9/23/2014	266	42.0303	-61.0609	4050	X				X	
15	59	HL_11	9/25/2014	268	41.7754	-60.9054	4300	X				X	
16	63	HL_12	9/25/2014	268	41.4096	-60.6766	4600	X				X	
17	68	OLC_01	9/25/2014	268	42.8935	-59.2645	3550				X		
18	72	SG_23	9/26/2014	269	43.8618	-58.7264	1230	X				X	
19	75	GULD_03	9/26/2014	269	43.9989	-59.0202	405	X		X		X	
20	77	GULD_04	9/27/2014	270	43.7891	-58.9003	2026	X				X	
21	80	SG_28	9/27/2014	270	43.7099	-58.9993	798	X		X		X	
22	81	LC_01	9/27/2014	270	43.7103	-59.1282	256			X			
23	88	HL_02	9/28/2014	271	44.2684	-63.3162	150		X	X		X	
24	90	STAB_01	9/29/2014	272	45.9962	-59.5334	53		X	X		X	
25	92	STAB_02	9/29/2014	272	46.1053	-59.3661	66		X	X		X	
26	94	STAB_03	9/29/2014	272	46.2154	-59.1979	94		X	X		X	
27	98	STAB_04	9/29/2014	272	46.2996	-59.0664	152		X	X		X	
28	100	STAB_05	9/30/2014	273	46.4161	-58.8835	365		X	X		X	
29	102	STAB_06	9/30/2014	273	46.7104	-58.4361	465			X		X	
30	104	CSL_01	9/30/2014	273	46.9599	-60.2176	81		X	X		X	
31	106	CSL_02	9/30/2014	273	47.0252	-60.1154	167		X	X		X	

32	109	CSL_03	9/30/2014	273	47.1018	-59.9896	335		X	X	X	
33	112	CSL_04	9/30/2014	273	47.2713	-59.7816	481			X	X	
34	115	CSL_05	10/1/2014	274	47.4344	-59.5647	471			X	X	
35	117	CSL_06	10/1/2014	274	47.5832	-59.3438	252		X	X	X	
36	119	LL_01	10/1/2014	274	45.8249	-59.8534	48		X	X	X	
37	121	LL_02	10/1/2014	274	45.6586	-59.7054	133		X	X	X	
38	123	LL_03	10/1/2014	274	45.4916	-59.5171	140		X	X	X	
39	127	LL_04	10/1/2014	274	45.1522	-59.1735	104		X	X	X	
40	129	LL_05	10/2/2014	275	44.8128	-58.8521	250		X	X	X	
41	131	LL_06	10/2/2014	275	44.4742	-58.5114	61		X	X	X	
42	133	LL_07	10/2/2014	275	44.1304	-58.1822	599			X	X	
43	134	LL_08	10/2/2014	275	43.7826	-57.8337	2905	X			X	
44	136	LL_09	10/3/2014	276	43.4711	-57.5295	3456	X				X
45	138	LL_09	10/3/2014	276	43.4738	-57.5264	3030	X			X	
46	139	SIS_01	10/4/2014	277	43.1132	-58.9239	3450	X			X	
47	142	LHB_07	10/5/2014	278	42.0262	-63.1944	2800	X			X	
48	145	BBL_07	10/5/2014	278	41.8673	-65.3485	1870	X			X	
49	147	BBL_06	10/5/2014	278	41.9999	-65.5101	1080	X		X	X	
50	150	BBL_05	10/6/2014	279	42.1319	-65.4990	187		X	X	X	
51	153	BBL_04	10/6/2014	279	42.4488	-65.4799	93		X	X	X	
52	154	PS_03	10/6/2014	279	42.3013	-65.8385	214		X	X	X	
53	155	PS_05	10/6/2014	279	42.2326	-65.9037	228		X	X	X	
54	156	PS_07	10/6/2014	279	42.1636	-65.9681	220		X	X	X	
55	157	PS_09	10/6/2014	279	42.0625	-66.0830	94		X	X	X	
56	159	PS_10	10/6/2014	279	41.9920	-66.1415	90		X	X	X	
57	161	PS_08	10/6/2014	279	42.1174	-66.0323	204		X	X	X	
58	163	PS_06	10/6/2014	279	42.1942	-65.9261	223		X	X	X	
59	166	PS_04	10/6/2014	279	42.2685	-65.8686	223		X	X	X	
60	168	PS_02	10/6/2014	279	42.3367	-65.8082	203		X	X	X	
61	170	PS_01	10/6/2014	279	42.4189	-65.7455	99		X	X	X	
62	172	BBL_03	10/7/2014	280	42.7609	-65.4832	97		X	X		X
63	173	BBL_03	10/7/2014	280	42.7604	-65.4830	96		X	X	X	
64	175	RATBA_02	10/7/2014	280	42.8700	-65.1478	132		X	X	X	
65	179	BBL_02	10/7/2014	280	43.0005	-65.4798	109		X	X	X	
66	181	BBL_01	10/7/2014	280	43.2498	-65.4805	63		X	X	X	
67	183	RL_01	10/7/2014	280	43.2497	-65.0403	164		X	X	X	
68	187	HL_02	10/8/2014	281	44.2662	-63.3178	156		X	X	X	

Oxygen

The oxygen data collected by the sensors and Winkler titration will be used to created new calibration coefficients before the final run of the CTD processing. It will be necessary to extract these corrected oxygen values when they are produced so they can be accurately reflected in our data archives.

A linear regression fit of replicate Winkler values (Figures 3A and B) during the mission revealed 2 bad replicate values (629 of Figure 3B=replicate 2/Event 145/BBL_07 at ~250 m, 826 of Figure 3B=replicate 1/Event 179/BBL_02 at ~110 m) that were removed prior to calculating the replicate means. A third replicate difference was also identified as an outlier (83=Event 30/HL_07 at ~2800 m), but it was difficult to tell which replicate was incorrect and it was therefore not removed. The 2 identified inaccurate Winkler replicate values were removed prior to the remaining analysis. The resulting r^2 value upon their removal showed strong relationship between replicates (r^2=0.9994).



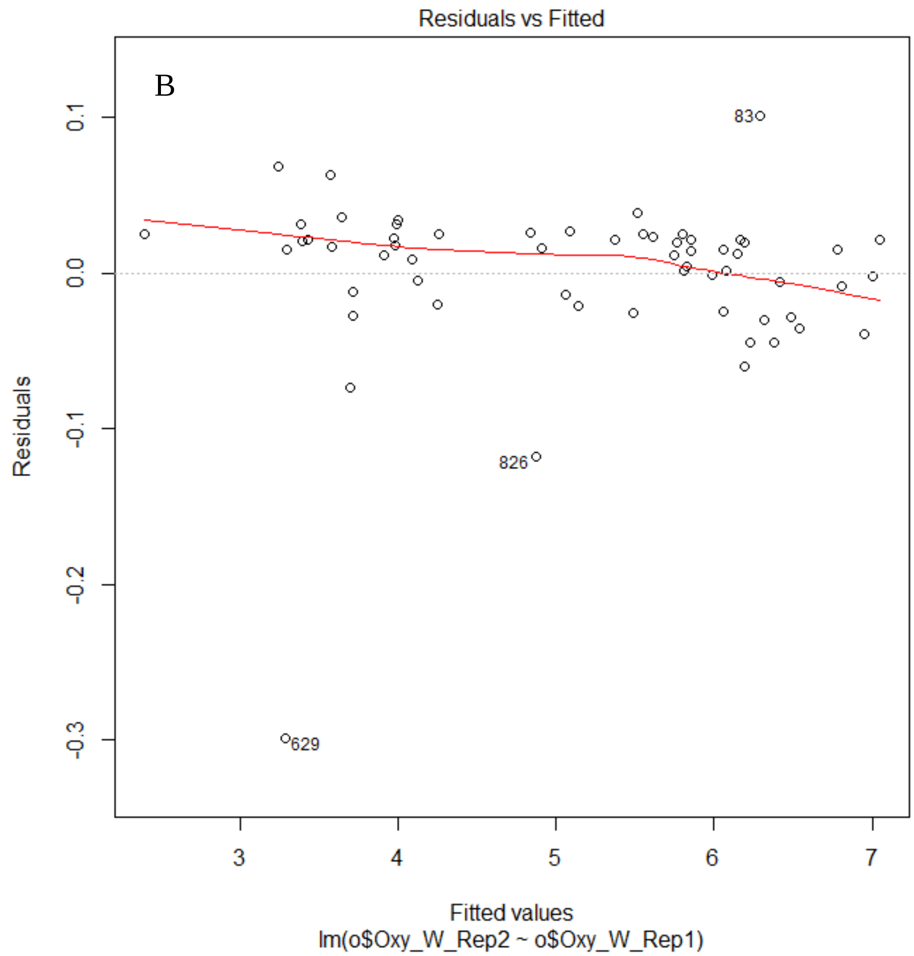


Figure 3. A) The linear relationship between the first and the second Winkler replicates. **B)** The fitted values of the linear regression plotted against the residuals. Note the 3 outliers, 2 of which (629 and 826) were removed from all further analysis.

Interestingly, on average the 1st Winkler replicate value tends to be slightly greater (0.015 ml/l) greater than the 2nd replicate (Figure 4). The reason for this difference is not clear but could potentially point to methodological processes that might influence either 1st or 2nd replicate oxygen concentrations. It might also point to slight changes in sample concentration between the first and second replicate runs. While this difference is likely within the precision of the Winkler titration method, it is systematic and will be investigated further to determine the source.

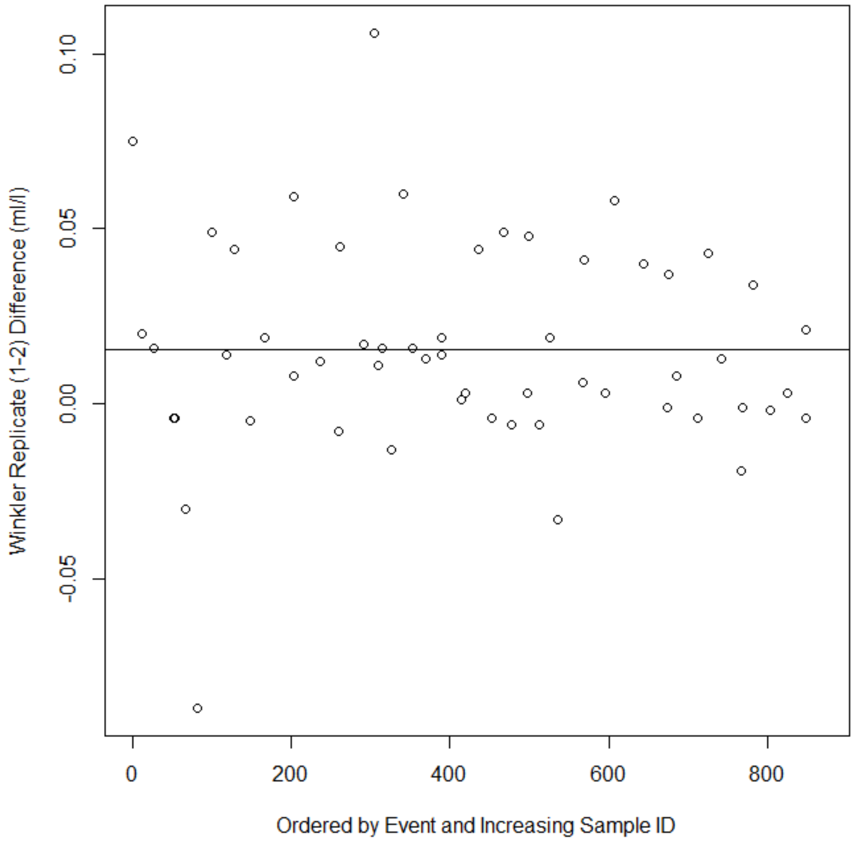


Figure 4 . Difference between Winkler replicates 1 and 2. Horizontal line at mean difference between replicates of 0.015 ml/l.

The next step was to compare the primary and secondary oxygen sensors with the averaged replicate Winkler values. Where only a single replicate was available, the "averaged" value was that of the single replicate. The ultimate goal of this analysis is to generate a linear slope scaling coefficient (Soc) to calibrate both primary and secondary sensor values. This is calculated by a 2 step process. First, a "threshold field" is produced that subtracts the mean difference between the sensor and the average Winkler value for all samples, from the individual sample difference between the sensor and Winkler:

(SBE O2 – Winkler O2) - mean(SBE O2 – Winkler O2)

The next step calculates a new slope term by using the following equation:

NewSoc = mean(previousSoc*([Winkler O2]/[SBE O2]))

Before the Soc can be calculated however, some basic comparisons between the primary and secondary sensors were completed to remove outliers and bad data (Figure 5). This comparison showed a rather large average difference between primary and secondary oxygen sensors throughout mission. In fact, before outliers and bad data were removed, the secondary sensor was on average producing values ~1.23 ml/l greater than the primary sensor (Figure 5). Additionally, there are obvious outliers that seem for the most part to be localized to 2 separate casts. As noted in the previous section, the CTD contacted the bottom during Event 134 at LL_08 (Figure 5 a) and the primary oxygen sensor malfunctioned. During Event 153 at BBL_04 (Figure 5 b), the plumbing coming from the pump and leading to the secondary oxygen sensor was disconnected, also resulting in erroneous oxygen values. A bad Winkler value was also identified at GULD_04 (Event 77) at ~2100 m. All of these values were removed from the analysis before proceeding.

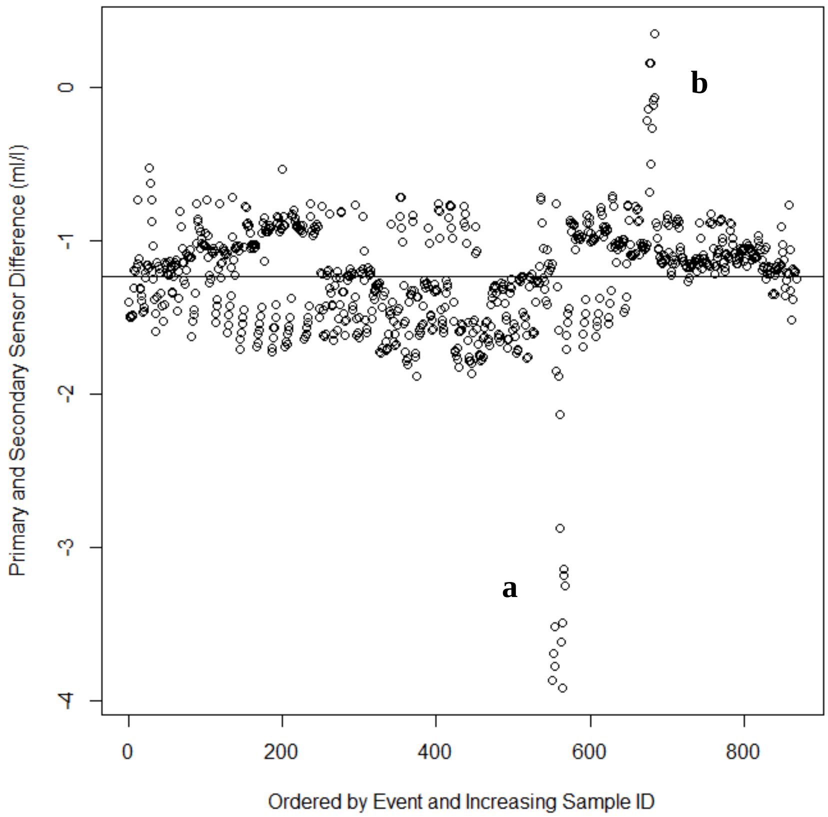


Figure 5. The difference between the primary and secondary sensor values during the mission (mean= -1.23 ml/l). Note that a) Event 134 at LL_08 and b) Event 153 at BBL_04 were removed before proceeding.

Next, the threshold value was calculated and plotted for both the primary and secondary sensors (Figure 6 - A and B). These threshold plots were used to remove outliers and the value selected for both secondary and primary sensors was 0.2. In other words, only the samples where threshold values were within +/- 0.2 ml/l around zero were used in the calculation of Soc. Table 6 shows the previous and revised Soc values for both of the SBE oxygen sensors. The ratio of the new and old Soc values was calculated for each sensor. The Soc ratios for both primary and secondary sensors were 1.0398 and 0.8488. This means that on average, primary sensor oxygen values were 4% less than their corresponding Winkler titration values, while secondary sensor values where 15% greater than their corresponding Winkler titration values.

The new Soc value derived for the secondary sensor (#1588) for this mission is within 4% of the independently derived Soc value for the same sensor used during the HUD2014017 cruise (June 30 - July 15, 2014) (0.045384 vs 0.043679). Both Soc values strongly suggest that sensor #1588 should be returned for factory calibration during the winter months.

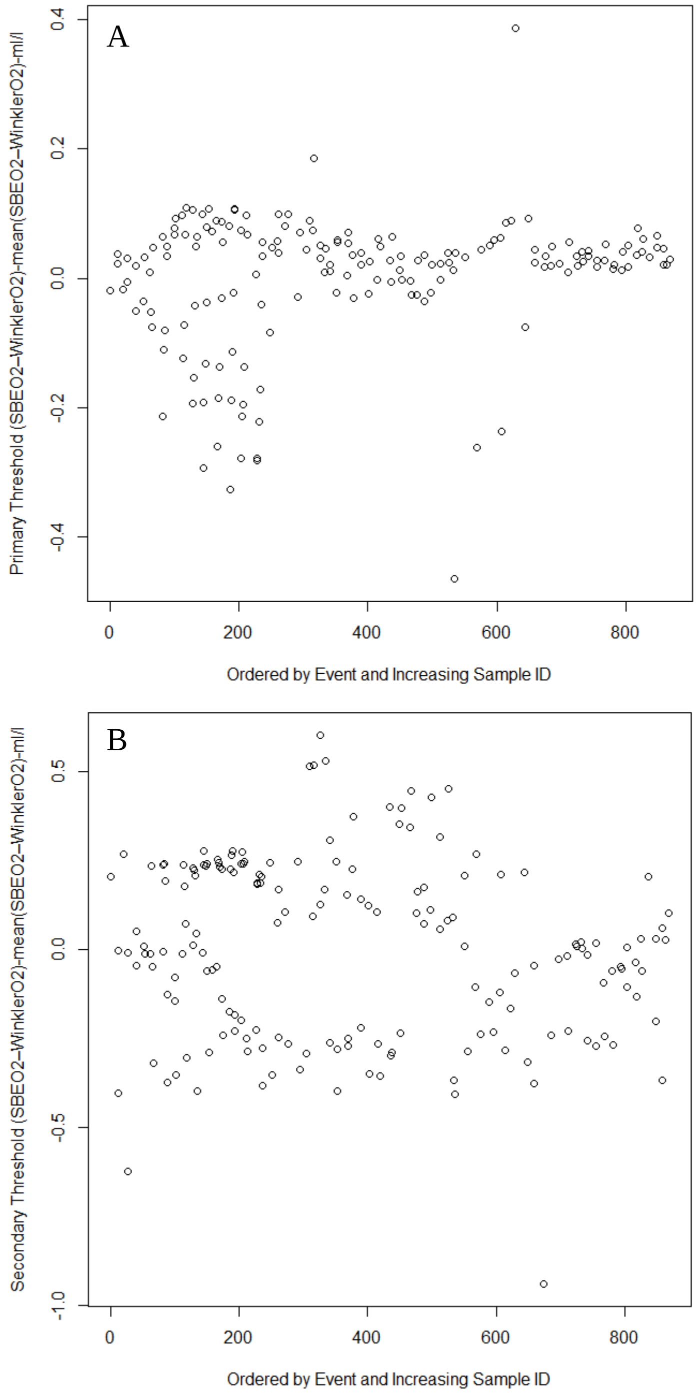


Figure 6. A) The calculated primary threshold values, and **B)** the secondary threshold values.

Table 6. Previous and New Soc values for both SBE oxygen sensors.

	Old Soc	New Soc	Ratio (New:Old)
Primary Sensor #0133	3.9027e-1	4.0582e-1	1.0398
Secondary Sensor #1588	5.3465e-1	4.5384e-1	0.8488

The original primary and secondary sensor values were then multiplied by their corresponding Soc ratios to produce corrected sensor values. This scaling improved the primary and secondary sensor agreement with their corresponding Winkler values (Figures 7 and 8).

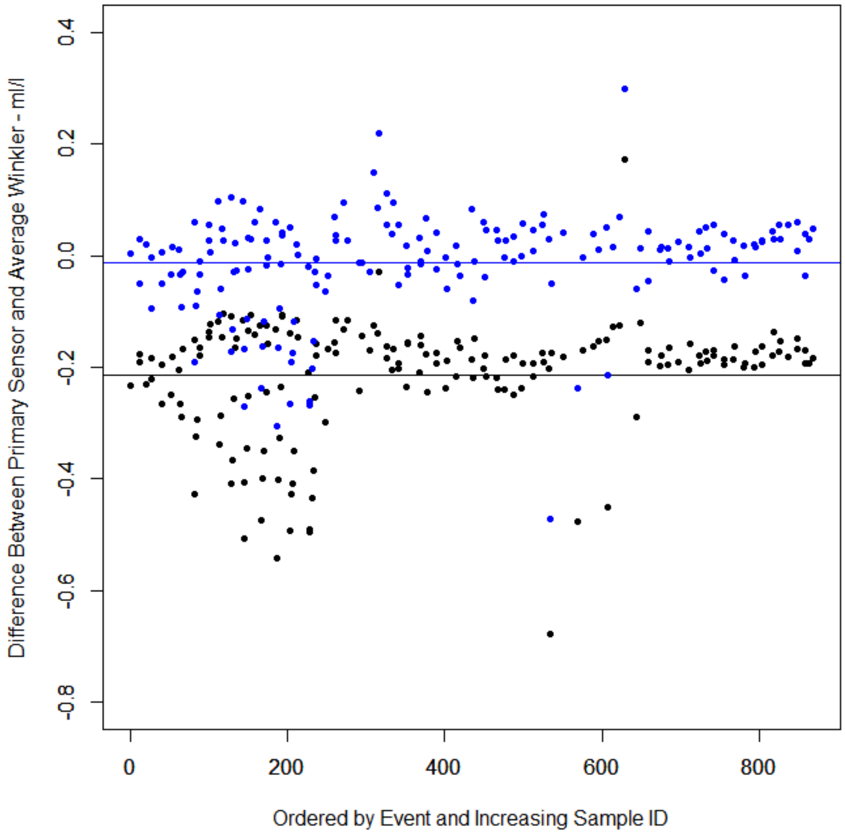


Figure 7. Black dots – uncorrected difference between primary sensor values and corresponding Winkler values (mean=-0.2142). Blue dots – Soc corrected difference between primary sensor values and corresponding Winkler values (mean=-0.0130).

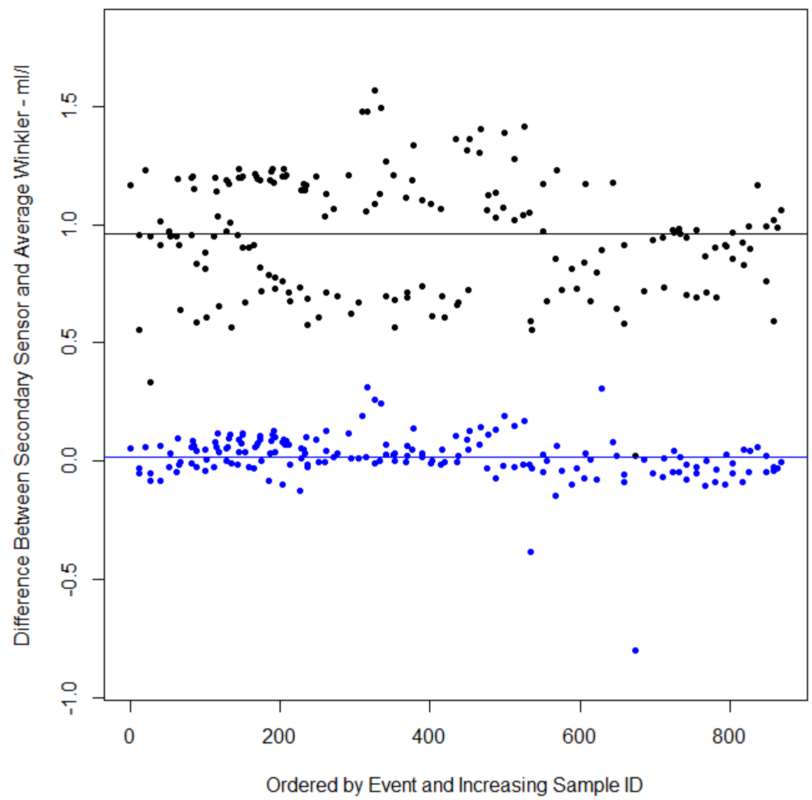


Figure 8. Black dots – uncorrected difference between secondary sensor values and corresponding Winkler values (mean=-0.9601). Blue dots – Soc corrected difference between secondary sensor values and corresponding Winkler values (mean=-0.0195).

Figure 9 shows the marked difference between Soc corrected and uncorrected agreement between the primary and secondary sensors. Prior to Soc Correction, the secondary sensor maintains a value that is on average 1.2 ml/l greater than the primary. After applying the correction, the average difference between the sensors is -0.0006 ml/l. After correction, while there are still some outliers in the data, most of the difference between the primary and secondary sensors appear to be depth dependent.

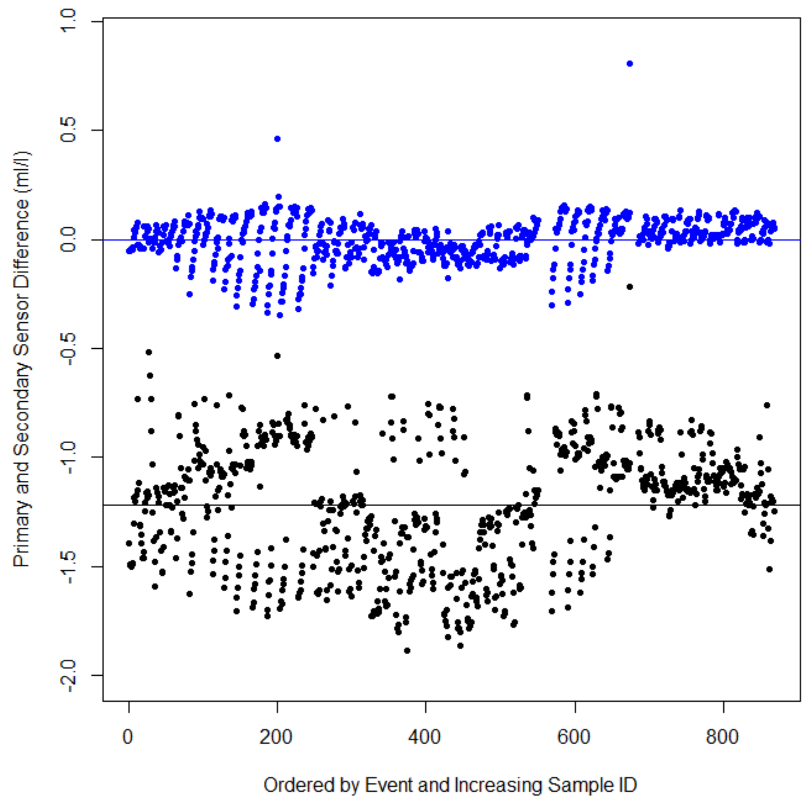


Figure 9. The uncorrected (black dots) and Soc corrected (blue) difference between primary and secondary sensors. (ml/l)

As observed in Figure 9, even with the Soc correction factors applied to both primary and secondary sensors, there appears to be a depth dependent relationship between sensors, likely as a result of the varying influence of pressure on the primary and secondary membranes. This is more easily observed in Figure 10. At 500 m and deeper, this relationship becomes linear as observed in Figure 11 (r^2=0.9437). This means that while the application of the Soc correction has brought the sensor values nearer to the mean Winkler value, the slope of the relationship between depth and corrected oxygen concentration for each sensor is different (Figure 12 - A and B).

As expected, the mean difference between Soc corrected primary sensor values and Winkler values is near 0 (-0.013 ml/l). Nonetheless, when the difference is plotted against depth (Figure 11 - A), there is a clear trend that as depth increases, the Soc corrected primary sensor value is decreasing relative to its associated Winkler value.

The depth relationship between Soc corrected secondary sensor values and associated Winkler values is very different than the primary sensor (Figure 11 - B). For the secondary sensor, the Soc correction also creates a mean difference near 0 (0.019 ml/l); however, there appears to be little pressure related influence on the sensor value in relation to its associated Winkler.

Inherently, the Soc slope correction does a good job adjusting the vast majority of the primary and secondary sensor data to match their associated Winkler values. Nonetheless, because there are so few Winkler samples from water depths greater than

500 m (25%), these samples have a smaller relative contribution to the Soc calculation (Figure 12).

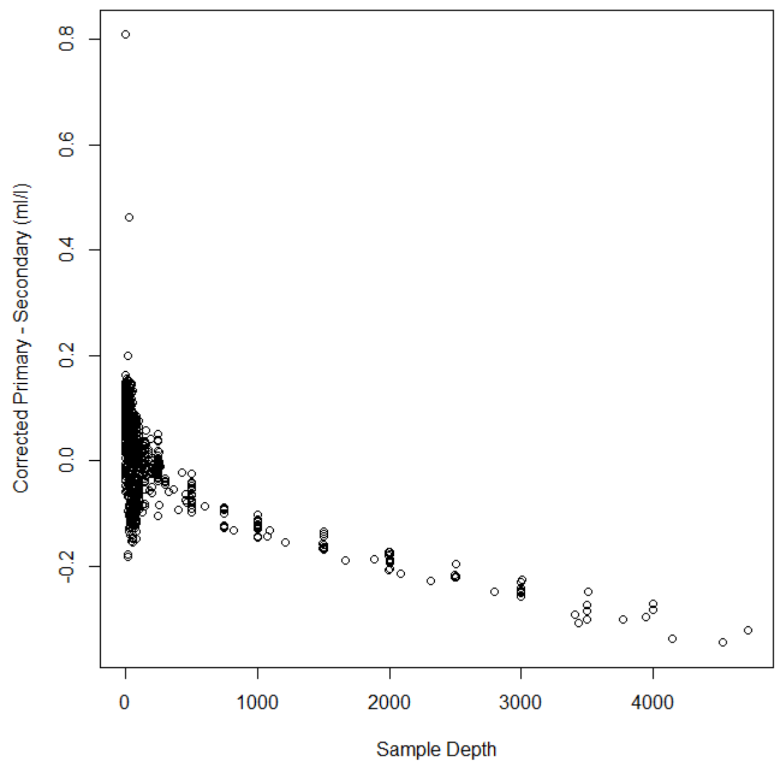


Figure 10. Relationship between corrected primary and secondary sensor values and depth.

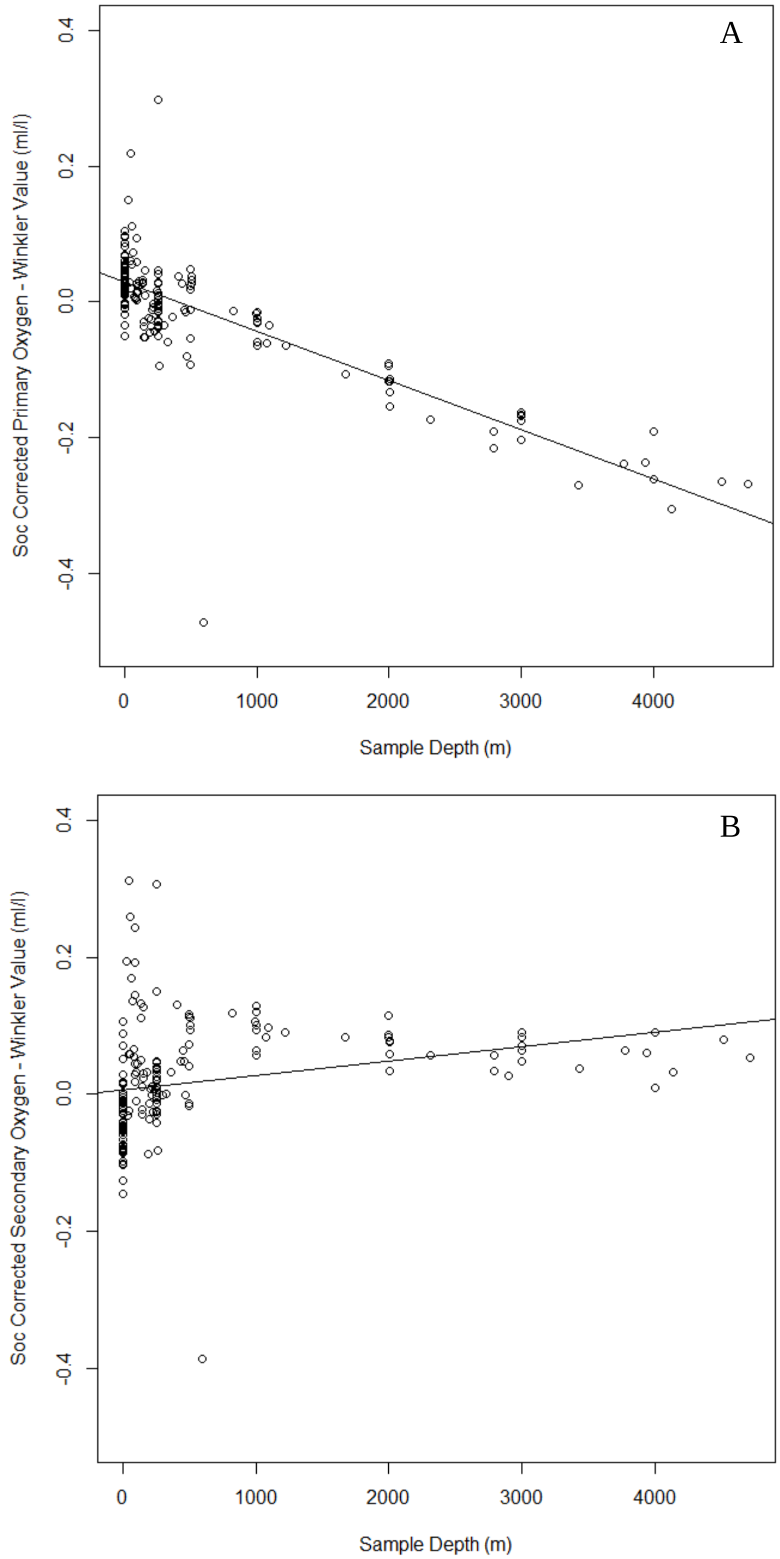


Figure 11. A) The Soc correction works for the majority of the primary sensor data, but does not adjust for the influence of pressure for samples in water greater than 500 m. **B)** The influence of pressure has a less obvious but inverse affect on the secondary sensor, where the sensor value decreases in the first 1000 m relative to the Winkler values, but then slightly increases in water greater than 1000 m.

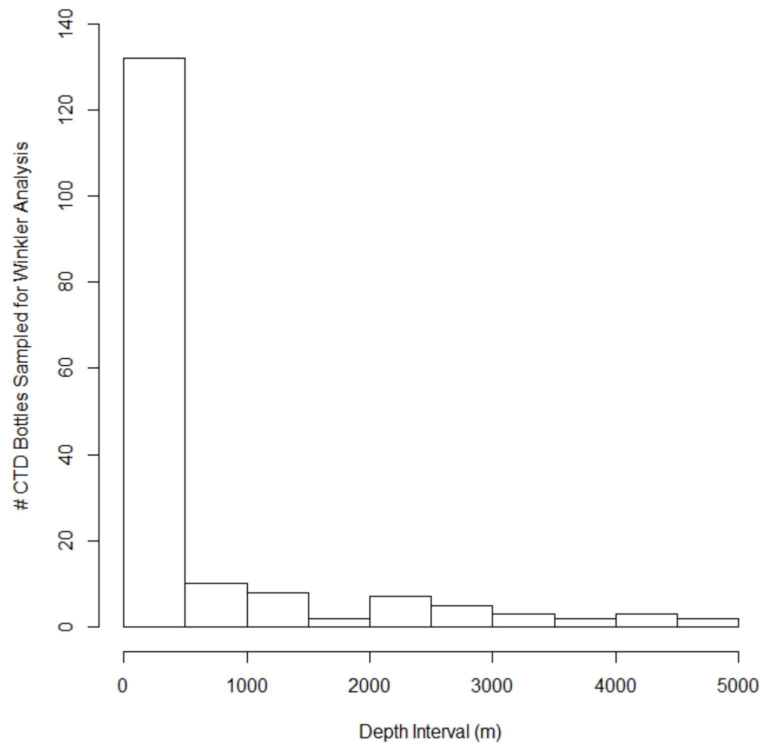


Figure 12. Only 25% of the oxygen samples were taken from CTD bottles fired in water depths greater than 500 m (42 of 174).

While it will not be explored further here, it would be possible to define the depth dependent relationship between depth binned sensor values and their associated Winkler oxygen concentrations. The depth correction could then be applied to bring the oxygen sensors even more in line with their associated Winkler values and hence with each other.

<u>Salinity</u>

(With portions extracted from HUD2014017 Cruise Report)

During Event #135 at LL_08, the CTD struck the bottom. The primary salinity sensor (#3561) was replaced with sensor #1874, and the primary temperature sensor (#5081) was replaced with sensor #2303 prior to the beginning of Event #136 a station LL_09. In general, the uncorrected primary and secondary salinity sensors are in close agreement both before the sensor change and after (Figure 13 - A and B).

For convenience during this section, s1 will refer to the sensor data collected before Event 136 and s2 will refer to all data collected after Event 135. During s2, the tubing connecting the pump to the secondary sensors was not connected during Event 153 at BBL_04 and this also resulted in erroneous values. The revised plots showing the primary and secondary sensor difference during s1 and s2 with these stations removed is shown in Figure 14 - A & B. Further analysis examining the linear relationship between the primary and secondary sensor during s1 revealed 3 additional outliers (Figure 15).

While it would be difficult to determine which sensor is at fault because there are no corresponding salinometer measurements, salinity sensor data at these locations should be used with caution. For s2, the vast majority of residuals are within 0.02 of the regression line. There are no obvious outliers between the primary and secondary sensors during s2.

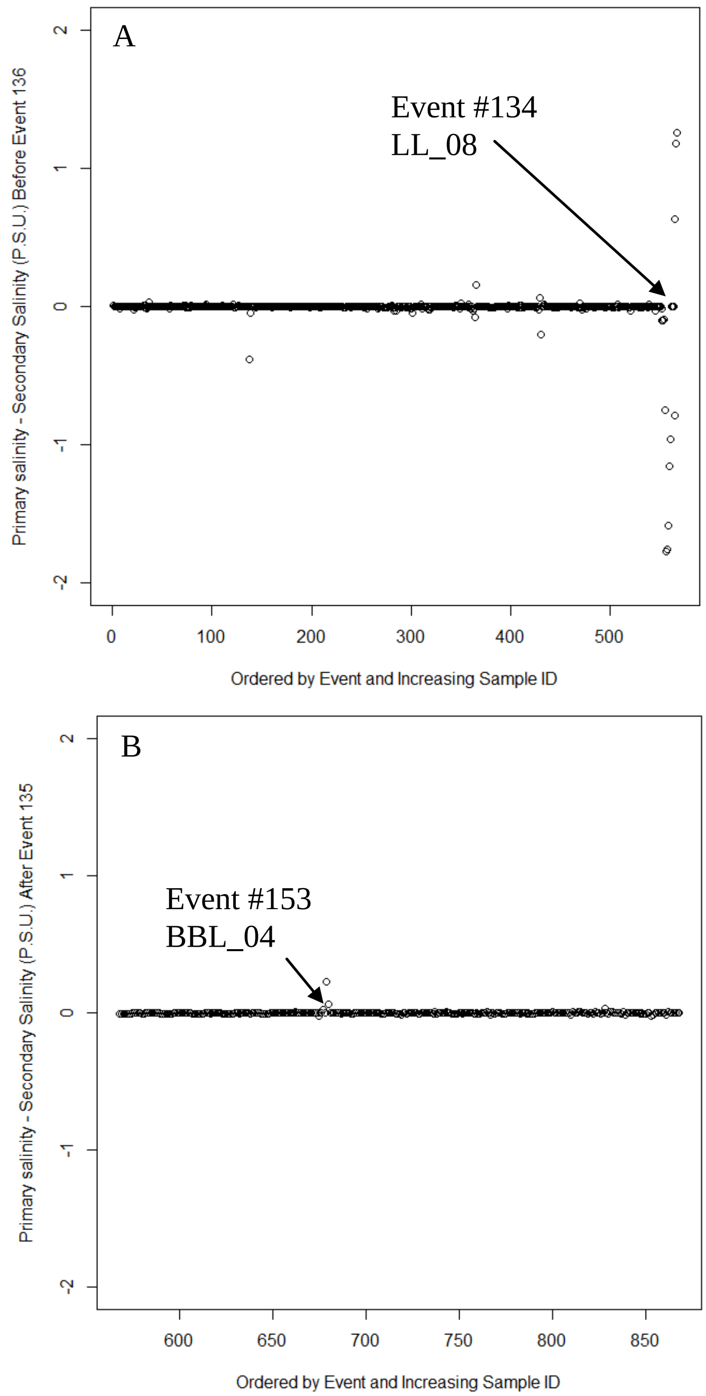


Figure 13. A) There was generally good agreement between the primary (#3561) and secondary (#3562) salinity sensors prior to impacting the bottom during event #134 at LL_08. **B)** Upon replacement with the new primary salinity (#1874) and temperature (#2303) sensors, the agreement between the primary and secondary sensors continued until the end of the mission.

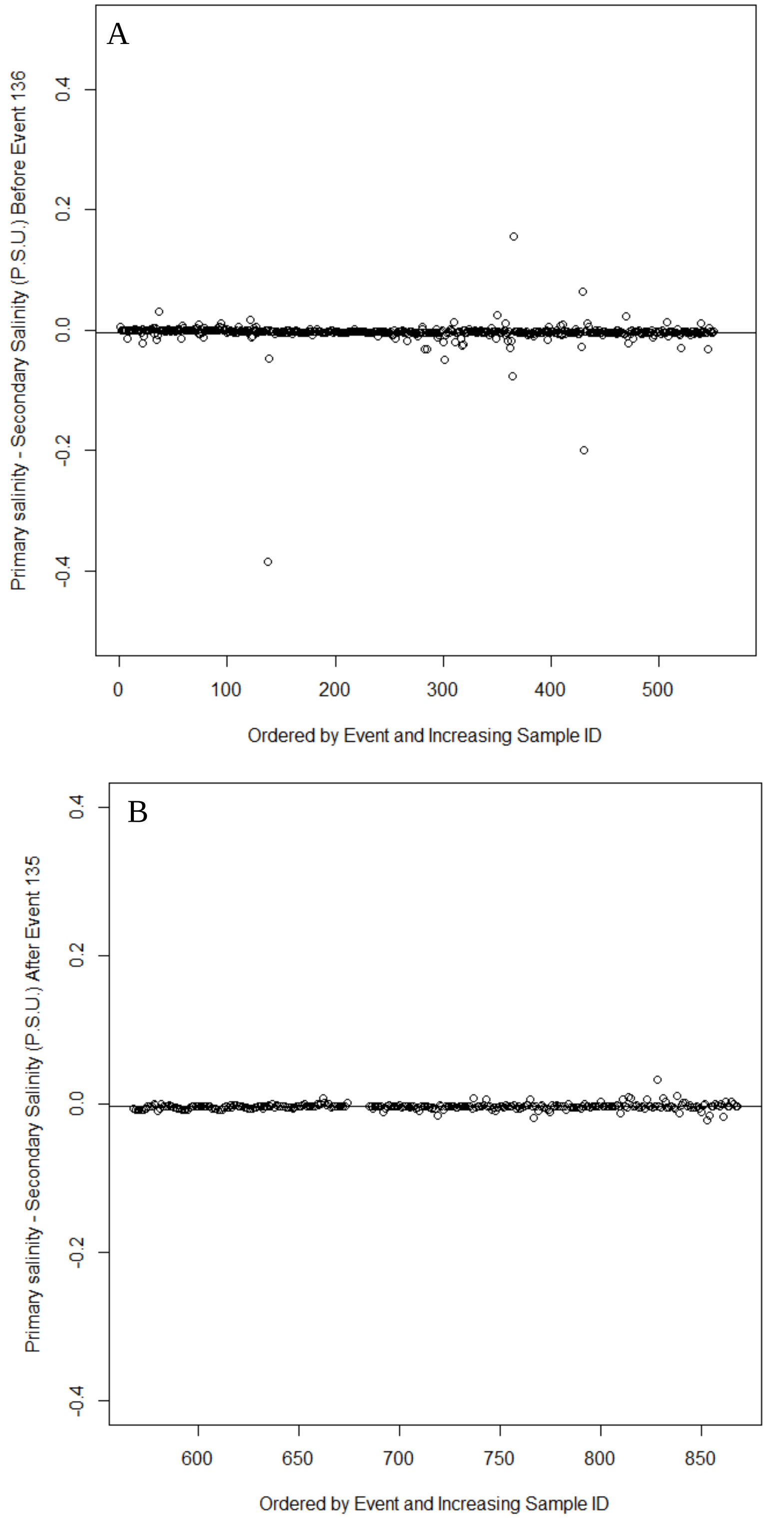


Figure 14. A) The difference between primary and secondary sensors during s1 with Event #134 (LL_08) removed. During s1, the primary salinity sensor (#3561) was on average reporting salinity slightly lower than the secondary (#3562) sensor (-0.0038 P.S.U.). **B)** The difference between primary and secondary sensors during s2 with Event #153 (BBL_04) removed. During s2, the average difference between the primary (#1874) and secondary (#3562) sensors was similar to s1 at -0.0026 P.S.U.

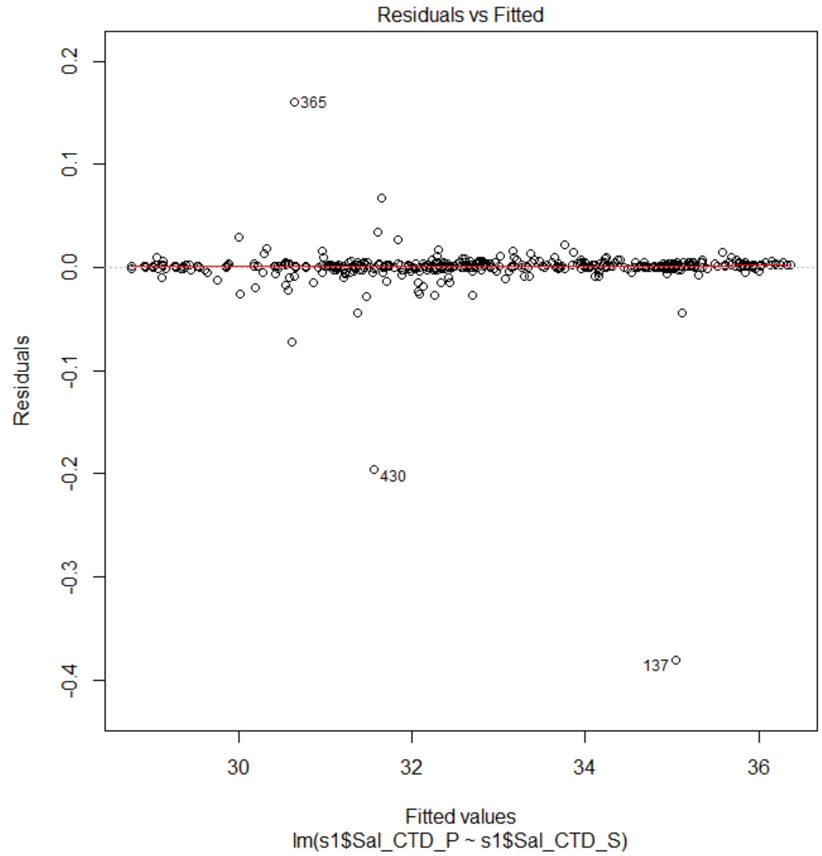


Figure 15. The fitted values of the linear regression between primary and secondary salinity sensors during s1, plotted against their residuals. Note the 3 outliers, suggesting one of the sensors was providing erroneous data. 137=Event 42/HL_06.7/~80 m, 365=Event 100/STAB_05/~20 m, 430=Event 112/CSL_04/~20 m.

Salinometer Calibration

The salinometer outputs the conductivity as a ratio with the standard; therefore, some conversions are done to get the conductivity of the bottle. The standard has a given K15 value:

K15 = conductivity of standard seawater at 15°C and 1atm/conductivity of KCl solution (32.4356g/kg) at 15°C and 1atm

Where K15 = 0.99984 for this particular standard and the conductivity of KCl standard = 4.29140 S/m and can be found in the seawater matlab package (gsw_C3515 function). Knowing K15 and the conductivity of the KCl solution, the conductivity of the standard seawater can be determined. Then, by multiplying by the conductivity ratio from the salinometer, the conductivity of the sample can be determined.

It should be noted that these samples were analyzed with a bath temperature of 24°C rather than the 15°C that the standard conductivity was measured at. The salinometer program accounted for this temperature difference so that the output sample conductivity ratios with the standard are at 15°C.

Now we have the conductivity of the sample at 15°C and at the pressure of the bath in the salinometer; however, this needs to be converted to a conductivity at the temperature and pressure of the CTD. This can be done using some functions from the same matlab package.

First calculate the salinity of the bottle using the conductivity and pressure from the salinometer and a temperature of 15°C.

Salinity_bottle = gsw_SP_from_C(Conductivity_salinometer[mS/cm],T[C],P_bath)

Then re-calculate the conductivity from this salinity value using temperature and pressure from the CTD.

Conductivity_bottle = gsw_C_from_SP(Salinity_bottle,T_CTD,P_CTD) %[mS/cm]

This now gives conductivity values that can be compared to the CTD values. To correct the CTD conductivity a linear regression is done on this equation:

Bottle_conductivity = b1 + b2*CTD_conductivity

to find an intercept, b1, and slope, b2, that will make the CTD conductivity better match the bottle conductivity.

Final calibration of conductivity will be done post-cruise.

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.

pH Sensor

The pH sensor was deployed on the rosette only when the maximum depth was less than or equal to ~1200 m. The CTD casts for which it was deployed are noted in Table 5. The sensor was included during the mission to support a previously mentioned ACCASP initiative investigating the delineation of ocean acidification and calcium carbonate saturation state of the Atlantic zone.

Lowered Acoustic Doppler Current Profiler (LADCP)

Lowered ADCP data was collected during 68 CTD profiles (Table 5). Both upward and downward looking 300 kHz TRDI Workhorse Sentinel ADCPs were installed on the CTD frame.

Starting at event 142 (LHB_07) it was noticed that the slave LADCP was temporarily losing communication with the master LADCP. This resulted in a number of slave LADCP files being uploaded at the end of the cast. Portions of the cast were missed by the slave LADCP for all CTD casts subsequent to event 142. The connection between the slave and master was cleaned after diagnosis but the problem persisted throughout the remainder of the mission.

Secchi Disk

A single Secchi disk deployment (event # 85) took place at station HL_02 on September 28^{th}. The total wire out was 14 m.

Biological Program

Narrative

The "core" biological program conducted as part of cruise HUD2014030, 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 HUD2014030, 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

Overall, the vast majority of ring net, BioNess and Multi-Net deployments were successful. The few problems encountered are described in detail below and in Table 7.

In order to estimate the mesozooplankton community abundance and biomass, a conical ring net of 202µm mesh size with an aperture of 75 cm in diameter (filtering ratio 1:5) equipped with a KC Denmark flow-meter was towed vertically from the bottom to the surface at each station (or from a maximum depth of 1000m – AZMP standard). In total, there were 56 successful vertical ring net tows during the mission (Figure 16). Of these, 7 were 74 µm tows (30 cm diameter and 1:5 filtering ratio) along the shelf stations of the Halifax Line, and 35 were 200 µm tows along the core AZMP sections (CSL, LL, HL and BBL). The 74 µm net tows serve the same purpose of quantifying the community but targets a smaller fraction of the mesozooplankton community (i.e. smaller developmental stages, eggs and nauplii). Regardless of the mesh size, contents of the cod end were preserved in 4% buffered formaldehyde.

The remaining 14 successful ring net tows were conducted at non-core stations throughout the mission (Table 7). During retrieval of the ring net at event 41 at HL_06.7, a large tear in the net was observed and the sample could not be used. Subsequent ring net issues were largely influenced by tidal, current and meteorological conditions at the time of deployment. A total of 4 net tows were redone (events 107, 110, 125 and 165) due to severe wire angles (Table 7).

Ring net samples (200 µm) were also taken for an ongoing University of Connecticut mesozooplankton genetics study during events 126 (LL_04) and 152 (BBL_04) (Table 7).

Excluding the test in Bedford Basin, there were a total of 7 successful Bioness deployments during the mission (Figure 17 and Table 7). The BioNess system generally worked well throughout the mission. An altimeter malfunction during event 113 at CSL_04 and event 184 at RL_01 resulted in BioNess briefly touching bottom. Nonetheless, the integrity of both the net samples and equipment did not seem unduly impacted. During event 184, the camera facing the net mouth malfunctioned and the signal was sporadically lost for extended periods.

Excluding the test in Bedford, there were 10 successful Multi-Net deployments during the mission (Figure 18 and Table 7). Planned deployments did not occur at SPB_10, SPB_11, LL_08 and LL_09 due to unforeseen weather and ship related issues. An additional station (event 277, SIS_01) was created on the transit from the Louisbourg Line to Browns Bank.

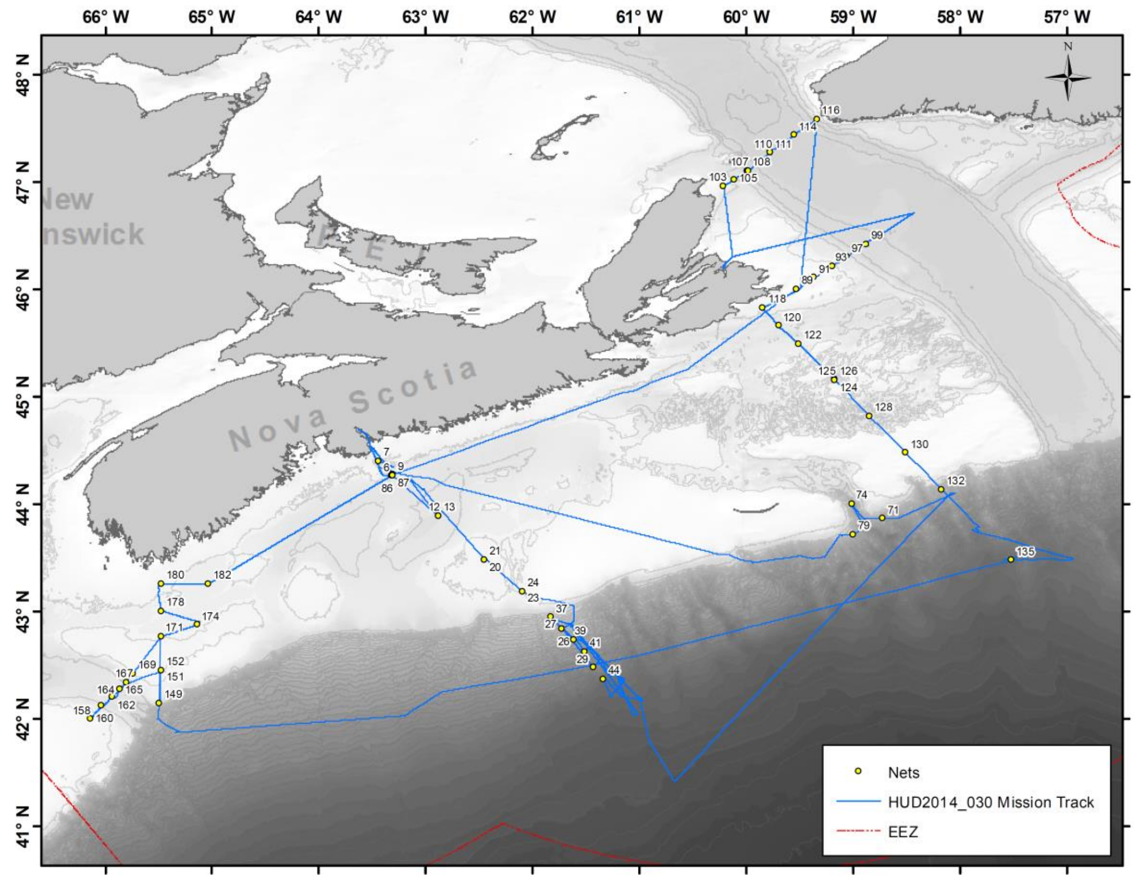


Figure 16. Locations for vertical ring net tows during HUD2014030 AZMP fall survey. Each tow is labelled with the consecutive mission event.

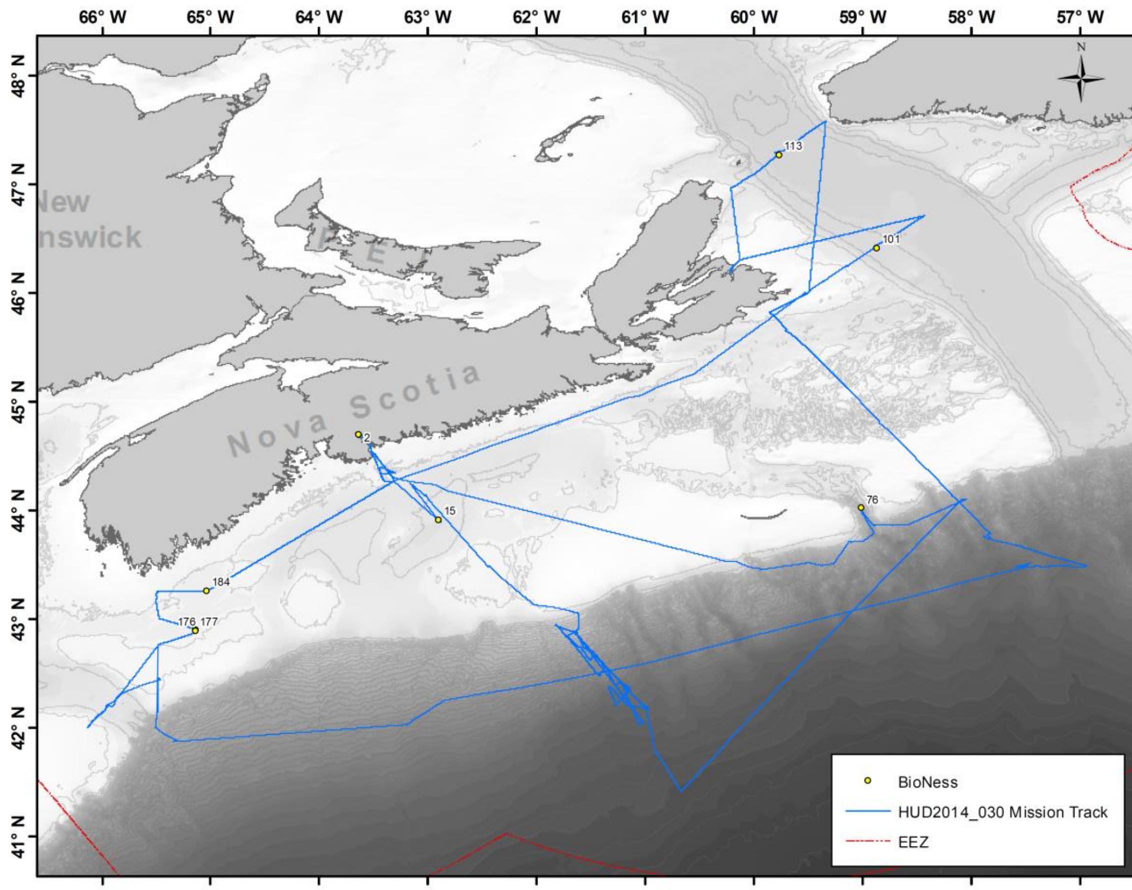


Figure 17. Start locations for BioNess tows during HUD2014030 AZMP fall survey. Each tow is labelled with the consecutive mission event.

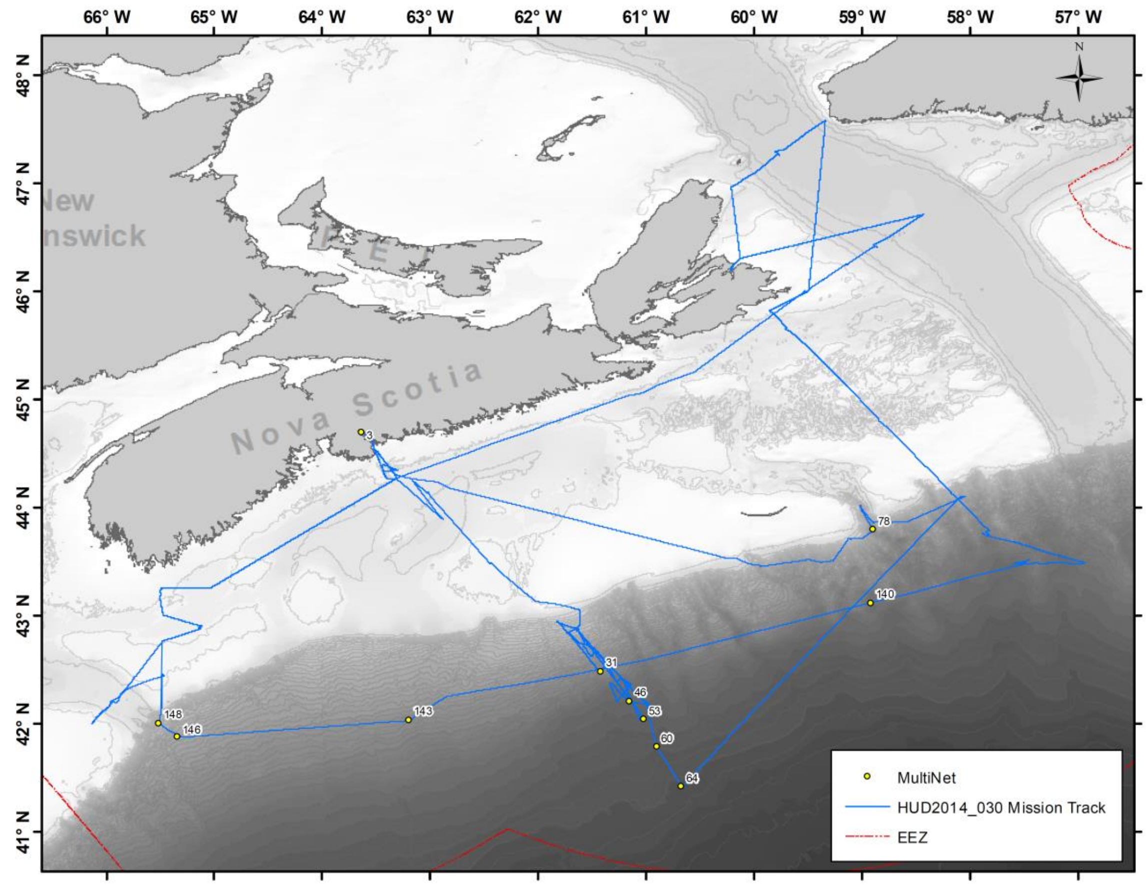


Figure 18. Start locations for MultiNet tows during HUD2014030 AZMP fall survey. Each tow is labelled with the consecutive mission event.

Table 7. Zooplankton collection activities during the HUD2014030 AZMP fall 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	19/09/2014	262	HL_0	Bioness		44.6896	-63.6367	Test	
2	3	19/09/2014	262	HL_0	Multi-net		44.6914	-63.6415	Test	
3	6	19/09/2014	262	HL_01	Ring net	202	44.3995	-63.4498	1	
4	7	19/09/2014	262	HL_01	Ring net	76	44.3999	-63.4500	1	
5	9	20/09/2014	263	HL_02	Ring net	202	44.2665	-63.3166	1	
6	10	20/09/2014	263	HL_02	Ring net	76	44.2659	-63.3187	1	
7	12	20/09/2014	263	HL_03	Ring net	202	43.8838	-62.8832	1	
8	13	20/09/2014	263	HL_03	Ring net	76	43.8829	-62.8821	1	
9	15	20/09/2014	263	HL_03	Bioness		43.9058	-62.9052	1	Net number 1 was thrown away
10	20	20/09/2014	263	HL_04	Ring net	202	43.4797	-62.4516	1	
11	21	20/09/2014	263	HL_04	Ring net	76	43.4802	-62.4533	1	
12	23	20/09/2014	263	HL_05	Ring net	202	43.1844	-62.0981	1	
13	24	20/09/2014	263	HL_05	Ring net	76	43.1844	-62.0978	1	
14	26	21/09/2014	264	HL_06	Ring net	202	42.8316	-61.7321	1	
15	27	21/09/2014	264	HL_06	Ring net	76	42.8324	-61.7332	1	Reply for bottom sent ~700 m instead of 1000 m
16	29	21/09/2014	264	HL_07	Ring net	202	42.4742	-61.4322	1	
17	31	21/09/2014	264	HL_07	Multi-net		42.4762	-61.4260	18	
18	37	21/09/2014	264	HL_05.5	Ring net	202	42.9418	-61.8331	1	
19	39	22/09/2014	265	HL_06.3	Ring net	202	42.7351	-61.6176	1	

20	41	22/09/2014	265	HL_06.7	Ring net	202	42.6183	-61.5127	1	Net tear open 1m^2 at the mouth, no sample
21	44	23/09/2014	266	HL_08	Ring net	202	42.3633	-61.3413	4	
22	46	23/09/2014	266	HL_08	Multi-net		42.1994	-61.1588	18	
23	53	24/09/2014	267	HL_10	Multi-net		42.0331	-61.0295	18	
24	60	25/09/2014	268	HL_11	Multi-net		41.7764	-60.9084	18	
25	64	25/09/2014	268	HL_12	Multi-net		41.4104	-60.6763	18	
26	71	26/09/2014	269	SG_23	Ring net	202	43.8605	-58.7293	7	
27	74	26/09/2014	269	GULD_03	Ring net	202	43.9993	-59.0192	7	last 50 m of tow at 45 degree wire angle
28	76	26/09/2014	269	GULD_03	Bioness		44.0152	-59.0177	7	
29	78	27/09/2014	270	GULD_04	Multi-net		43.7899	-58.8998	18	
30	79	27/09/2014	270	SG_28	Ring net	202	43.7103	-58.9994	7	
31	86	28/09/2014	271	HL_02	Ring net	202	44.2679	-63.3157	1	last 60 m of tow at >50 degree wire angle
32	87	28/09/2014	271	HL_02	Ring net	76	44.2692	-63.3147	1	
33	89	29/09/2014	272	STAB_01	Ring net	202	45.9975	-59.5322	8	
34	91	29/09/2014	272	STAB_02	Ring net	202	46.1065	-59.3670	8	
35	93	29/09/2014	272	STAB_03	Ring net	202	46.2163	-59.1967	8	50 degree wire angle at the surface
36	97	29/09/2014	272	STAB_04	Ring net	202	46.3001	-59.0662	8	
37	99	30/09/2014	273	STAB_05	Ring net	202	46.4160	-58.8839	8	
38	101	30/09/2014	273	STAB_05	Bioness		46.4111	-58.8751	8	The recovery time was

										entered late. Time and position from bridge log
39	103	30/09/2014	273	CSL_01	Ring net	202	46.9583	-60.2172	1	
40	105	30/09/2014	273	CSL_02	Ring net	202	47.0241	-60.1168	1	
41	107	30/09/2014	273	CSL_03	Ring net	202	47.1004	-59.9897	1	Stayed at 300 m for 10 minutes ,wire against hull. 45 degree angle from 120 m to 30 m, >70 degree to surface. Tow aborted.
42	**108**	**30/09/2014**	**273**	**CSL_03**	**Ring net**	**202**	**47.1024**	**-59.9887**	**1**	
43	110	30/09/2014	273	CSL_04	Ring net	202	47.2715	-59.7808	1	Severe angle under the ship for extended period. Tow not good and net replaced prior to next tow.
44	**111**	**30/09/2014**	**273**	**CSL_04**	**Ring net**	**202**	**47.2717**	**-59.7815**	**1**	
45	113	01/10/2014	274	CSL_04	Bioness		47.2642	-59.7743	1	BioNess touched bottom
46	114	01/10/2014	274	CSL_05	Ring net	202	47.4339	-59.5607	1	

47	116	01/10/2014	274	CSL_06	Ring net	202	47.5845	-59.3420	1	
48	118	01/10/2014	274	LL_01	Ring net	202	45.8252	-59.8514	1	
49	120	01/10/2014	274	LL_02	Ring net	202	45.6581	-59.7032	1	
50	122	01/10/2014	274	LL_03	Ring net	202	45.4915	-59.5176	1	
51	124	01/10/2014	274	LL_04	Ring net	202	45.1569	-59.1757	1	
52	125	01/10/2014	274	LL_04	Ring net	202	45.1555	-59.1753	1	Net did not fish properly
53	**126**	**01/10/2014**	**274**	**LL_04**	**Ring net**	**202**	**45.1550**	**-59.1737**	**1**	Genetics
54	128	02/10/2014	275	LL_05	Ring net	202	44.8154	-58.8513	1	
55	130	02/10/2014	275	LL_06	Ring net	202	44.4746	-58.5114	1	
56	132	02/10/2014	275	LL_07	Ring net	202	44.1348	-58.1789	1	Hit the bottom and cod-end half full of mud. Sample on top of mud collected.
57	135	03/10/2014	276	LL_09	Ring net	202	43.4735	-57.5268	1	
58	140	04/10/2014	277	SIS_01	Multi-net		43.1135	-58.9240	18	Extra, deep water Multi-net on transit to Brown's Bank from Louisbourg Line
59	143	05/10/2014	278	LHB_07	Multi-net		42.0250	-63.1999	18	
60	146	05/10/2014	278	BBL_07	Multi-net		41.8682	-65.3438	18	
61	148	05/10/2014	278	BBL_06	Multi-net		41.9999	-65.5143	18	
62	149	05/10/2014	278	BBL_05	Ring net	202	42.1376	-65.4973	1	
63	151	06/10/2014	279	BBL_04	Ring net	202	42.4437	-65.4801	1	
64	152	06/10/2014	279	BBL_04	Ring net	202	42.4497	-65.4822	20	Genetics

										samples for Bucklin et al. (Refer to HUD2014004 cruise report)
65	158	06/10/2014	279	PS_10	Ring net	202	41.9906	-66.1411	9	
66	160	06/10/2014	279	PS_08	Ring net	202	42.1187	-66.0365	9	
67	162	06/10/2014	279	PS_06	Ring net	202	42.1976	-65.9333	9	
68	164	06/10/2014	279	PS_04	Ring net	202	42.2709	-65.8688	9	Cross bow slips
69	**165**	**06/10/2014**	**279**	**PS_04**	**Ring net**	**202**	**42.2680**	**-65.8677**	**9**	**45+ angle on the last 60 m**
70	167	06/10/2014	279	PS_02	Ring net	202	42.3366	-65.8083	9	
71	169	06/10/2014	279	PS_01	Ring net	202	42.4188	-65.7453	9	
72	171	06/10/2014	279	BBL_03	Ring net	202	42.7614	-65.4830	1	
73	174	07/10/2014	280	RATBA_02	Ring net	202	42.8689	-65.1458	11	
74	176	07/10/2014	280	RATBA_02	Bioness		42.8892	-65.1377	11	
75	177	07/10/2014	280	RATBA_02	Bioness		42.8852	-65.1455	11	Bioness touched bottom and cameras not recording.
76	178	07/10/2014	280	BBL_02	Ring net	202	43.0001	-65.4811	1	Time, latitude and longitude taken from GPS log
77	180	07/10/2014	280	BBL_01	Ring net	202	43.2500	-65.4814	1	
78	182	07/10/2014	280	RL_01	Ring net	202	43.2500	-65.0404	11	
79	184	07/10/2014	280	RL_01	Bioness		43.2516	-65.0359	11	Recovery time submitted late

80	185	08/10/2014	281	HL_02	Ring net	202	44.2666	-63.3163	1
81	186	08/10/2014	281	HL_02	Ring net	76	44.2664	-63.3171	1

Dissolved Carbon Sampling

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

The Dalhousie CO_2 group's objective on the AZMP Fall 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.

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 5.5 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.

VINDTA

There were few problems regarding the operation of the VINDTA for the first week of the cruise. The alkalinity detectors regularly gave readings of 0. Angelica Fieglar (Dalhousie University) was able to repair the machine, which ended up being a loose connection. During the second leg, the high temperatures in the lab caused the VINDTA to be non-functional again. Lab temperatures were near 30 C, which is out of the ideal operating temperature range for the VINDTA. If possible, for future AZMP cruises in which the VINDTA is utilized, having the air conditioning system in the GP lab functional would be ideal. As a result of these combined issues, HL 6.3 and 6.7 were not sampled as there were not enough spare bottles during the VINDTA's downtime. Nonetheless, $DI^{13}C$ samples were collected for those stations and will be stored and then analysed in the United States.

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.

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, 228 - 0.2 µm filter samples and 228 – 3 µm filter samples were obtained, which represents 76 samples at 19 stations. The stations chosen to sample were generally from the most offshore and most inshore stations of a transect, along with one or two stations in between. However, 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, 228 samples for flow cytometry were obtained, which represents 76 samples at 19 stations. 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 enrichment cultures are summarized in Table 8.

Table 8. Stations occupied, volume of water required and samples prepared during HUD2014030.

Date Visited	Station (depths sampled in metres)	Volume of Water needed for each depth	Samples Prepared
19-Sept	HL_01 (1,20,40,60)	12L	Flow cytometry and DNA filtration
19-Sept	HL_02 (1,20,40,80)	12L	Flow cytometry and DNA filtration
20-Sept	HL_04 (1,20,40,60)	12L	Flow cytometry and DNA filtration
21-Sept	HL_06 (1,20,80,250)	12L	Flow cytometry and DNA filtration
22-Sept	HL_08 (1,20,100,250)	12L	Flow cytometry and DNA filtration
25-Sept	HL_11 (1,20,80,250)	12L	Flow cytometry and DNA filtration
26-Sept	GULD_04 (1,20,100,250)	12L	Flow cytometry and DNA filtration
29-Sept	STAB_01 (1,10,20,40)	12L	Flow cytometry and DNA filtration
29-Sept	STAB_05 (1,20,80,300)	12L	Flow cytometry and DNA filtration
30-Sept	CSL_01 (1,20,40,60)	12L	Flow cytometry and DNA filtration
30-Sept	CSL_04 (1,20,60,300)	12L	Flow cytometry and DNA filtration
1-Oct	CSL_06 (1,20,60,200)	12L	Flow cytometry and DNA filtration
1-Oct	LL_04 (1,20,80,250)	12L	Flow cytometry and DNA filtration
2-Oct	LL_07 (1,20,80,250)	12L	Flow cytometry and DNA filtration
3-Oct	LL_09 (1,20,80,250)	12L	Flow cytometry, DNA filtration, and enrichment cultures
5-Oct	BBL_07 (1,20,80,250)	12L	Flow cytometry, DNA filtration, and enrichment cultures
5-Oct	BBL_05 (1,20,40,80)	12L	Flow cytometry, DNA filtration, and enrichment cultures
6-Oct	BBL_03 (1,20,40,80)	12L	Flow cytometry and DNA filtration
7-Oct	BBL_01 (1,10,20,40)	12L	Flow cytometry and DNA filtration

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 Halifax Line (HL), and Louisbourg Line (LL) transects, with some filters collected underway between CSL_01 and CSL_04, and from BBL_07 to BBL_01. Approximately 130 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 analysed 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 185 water samples were taken from the CTD Rosette at all depths for eight Halifax Line stations (HL_02, 04, 05, 06, 07, 09, 11, 12), and two Cabot Strait Line stations (CSL_05 and 04). 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
19 September – 7 October, 2014
Canadian Wildlife Service, Environment Canada
Prepared by: Carina Gjerdrum carina.gjerdrum@ec.gc.ca
Observers: Sue Abbott (Leg 1), Brad Toms (Leg 2&3)

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 fall Scotian Shelf AZMP from 19 September – 8 October, 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 300 m-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 1250 km of ocean from 18 Sept – 7 Oct, 2014. A total of 438 birds were observed in transect from 9 families (Table 9). Bird densities averaged 1.2 birds/km^2

(ranging from 0 - 128 birds/km^2). The highest densities of birds were observed at the entrance to Halifax Harbour, in Roseway Basin, the Northeast Channel, Sable Island Bank, on the outskirts of the Gully MPA, and off Sydney, NS (Figure 19A).

Leach's Storm-Petrel was the species most commonly observed, accounting for 23% of the observations (Table 9). They were observed throughout the survey area (Figure 19B). Leach's Storm-Petrels breed in high densities on islands along the eastern shore as well in south western Nova Scotia and are still feeding chicks into October. The related Wilson's Storm-Petrel, which breed in the southern hemisphere, were also observed, although in fewer numbers than the Leach's Storm-Petrel and mainly at the shelf break and in slope waters (Figure 19B). Shearwaters accounted for 26% of the observations, most of which were Great Shearwaters (Table 9). Great Shearwaters also breed in the southern hemisphere but occur on the Scotian Shelf from April through November (Figure 19C). Cory's Shearwaters were observed on the western Scotian Shelf (Figure 19C) where they were presumably migrating towards their wintering grounds along the eastern seaboard of the US.

Gulls and Jaegers accounted for 23% of the observations (Table 9). Herring and Great Black-backed Gulls were the most common and were observed mostly close to shore, although small numbers were also observed on the Sable Bank and Gully MPA (Figure 19D). Phalaropes (Red and Red-necked are difficult to distinguish from one another in their winter plumage, so are grouped together) accounted for 10% of the sightings and all were observed in the northeast channel (Figure 19E). Phalaropes breed in the Arctic, but stage in the Bay of Fundy/Gulf of Maine in large numbers during fall migration. Northern Gannet (3% of the observations; Table 9) were observed off the coast of Cape Breton Island, in Halifax Harbour and in the Roseway Basin (Figure 19F) on their way to wintering grounds off the coast of the southern US and in the Gulf of Mexico. Significantly, a juvenile Red-footed Booby was observed and photographed near the end of the Halifax Line (Figure 19F). This is a species that breeds primarily in the Hawaiian archipelago and the sighting is a first record for Canada.

Marine Mammal Sightings

A total of 137 marine mammals were recorded during the fall AZMP surveys (Table 10; Figure 20). Long-finned Pilot Whales were the most abundant followed by the Bottle-nosed Dolphin and Common Dolphin. Northern Bottlenose Whales were encountered on two occasions, once just west of the Gully MPA and the other in deep water off the Scotian Slope (Figure 20A).

Gully MPA

Only 31 km of surveys were conducted within the Gully MPA (Figure 21). Bird sightings within the MPA included just 3 species; the Great Shearwater, Herring Gull, and Leach's Storm-Petrel (Table 11; Figure 21). The Long-finned Pilot Whale was the only marine mammals observed within the Gully MPA (Table 10; Figure 20A).

Table 9. List of bird species observed during the seabird survey on the fall Scotian Shelf AZMP from 19 Sep – 7 Oct, 2014.

Family	**Species**	**Latin**	**Number observed in transect**	**Total number observed**
Gaviidae	Common Loon	*Gavia immer*	0	2
Procellariidae	Great Shearwater	*Puffinus gravis*	74	110
	Cory's Shearwater	*Calonectris diomedea*	23	42
	Northern Fulmar	*Fulmarus glacialis*	7	9
	Sooty Shearwater	*Puffinus griseus*	4	5
	Manx Shearwater	*Puffinus puffinus*	2	6
	Unidentified Shearwater	*Puffinus* or *Calonectris*	5	11
Hydrobatidae	Leach's Storm-Petrel	*Oceanodroma leucorhoa*	102	225
	Wilson's Storm Petrel	*Oceanites oceanicus*	34	57
	Unidentified Storm-Petrel	Hydrobatidae	16	76
Sulidae	Northern Gannet	*Morus bassanus*	16	32
	Red-footed Booby	*Sula sula*	1	1
Phalacrocoracidae	Double-crested Cormorant	*Phalacrocorax auritus*	1	4
Anatidae	Common Eider	*Somateria mollissima*	2	4
	American Black Duck	*Anas rubripes*	0	1
	Unidentified Duck	All duck genera	0	6
Scolopacidae	Red Phalarope	*Phalaropus fulicaria*	1	1
	Red-necked Phalarope	*Phalaropus lobatus*	0	1
	Unidentified Phalarope	*Phalaropus*	45	418
Laridae	Herring Gull	*Larus argentatus*	81	114
	Great Black-backed Gull	*Larus marinus*	13	38
	Least Tern	*Sterna albifrons*	1	1
	Parasitic Jaeger	*Stercorarius parasiticus*	1	1
	Arctic Tern	*Sterna paradisaea*	0	1
	Long-tailed Jaeger	*Stercorarius longicaudus*	0	1
	Unidentified Jaeger	*Stercorarius* Jaegers	2	3
	Unidentified Gull	Laridae	1	4
Alcidae	Atlantic Puffin	*Fratercula arctica*	6	7
	Unidentified Auk	Alcidae	0	1
Total			**438**	**1182**

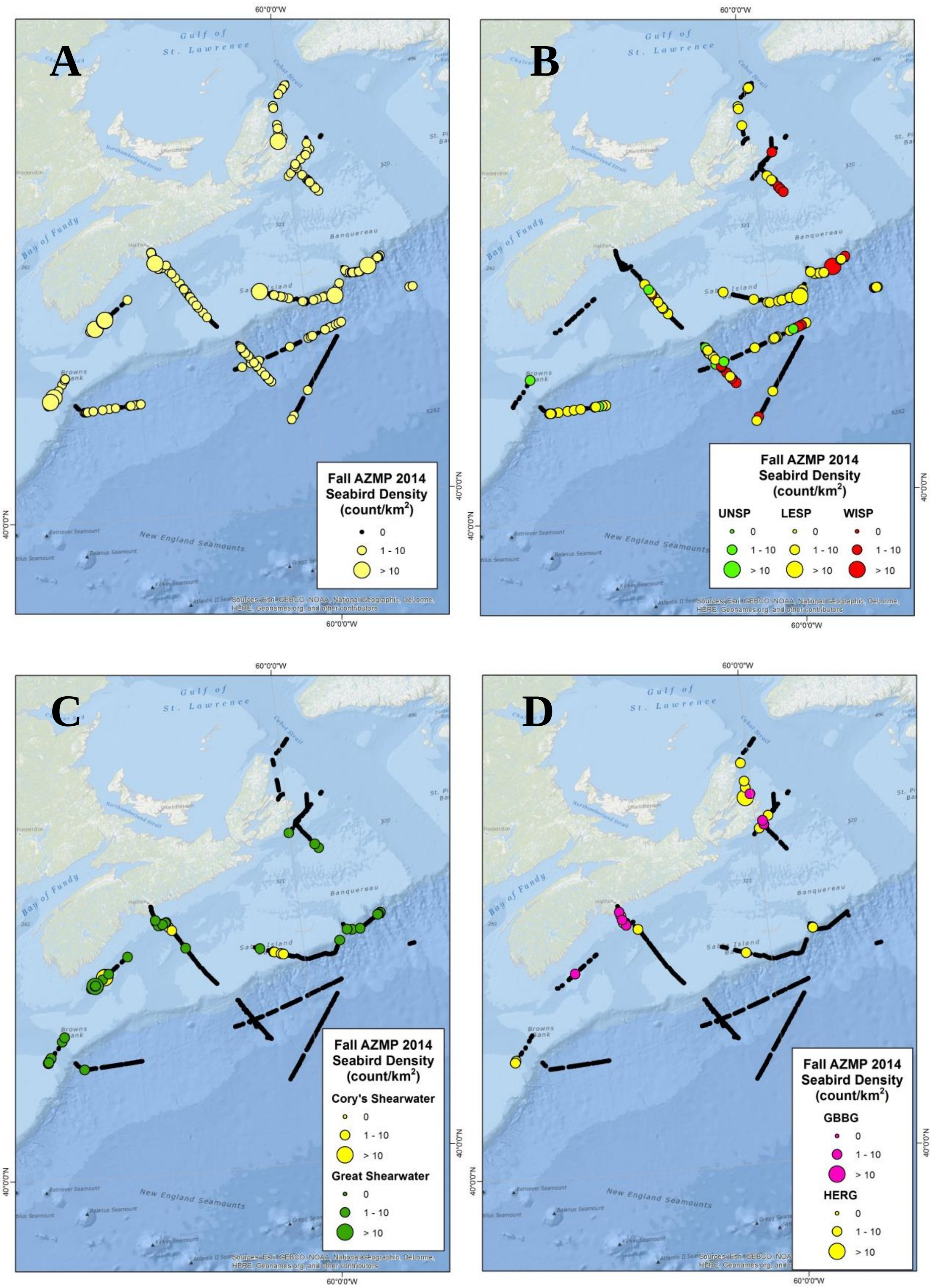
Table 10. List of marine mammals observed during the survey on the fall Scotian Shelf AZMP from 19 Sep – 7 Oct, 2014.

English	Latin	Number Observed
Long-finned Pilot Whale	*Globicephala melas*	84
Bottle-nosed Dolphin	*Tursiops truncatus*	15
Common Dolphin	*Delphinus delphis*	9
Unidentified Dolphins	Delphinidae	8
Northern Bottlenose Whale	*Hyperoodon ampullatus*	7
Humpback Whale	*Megaptera novaeangliae*	5
Atlantic White-sided Dolphin	*Lagenorhynchus acutus*	5
Unidentified Whales and Dolphins	Cetacea	2
Family: Rorquals and Humpback Whales	Balaenopteridae	2
Total		137

Table 11. List of species observed in the Gully MPA on the fall Scotian Shelf AZMP from 19 Sep – 7 Oct, 2014.

Species	**Latin**	**Number observed**
Leach's Storm-Petrel	*Oceanodroma leucorhoa*	5
Great Shearwater	*Puffinus gravis*	3
Herring Gull	*Larus argentatus*	2
Long-finned Pilot Whale	*Globicephala melas*	53
Total		63

Species	**Latin**	**Number observed**
Leach's Storm-Petrel	*Oceanodroma leucorhoa*	5
Great Shearwater	*Puffinus gravis*	3
Herring Gull	*Larus argentatus*	2
Long-finned Pilot Whale	*Globicephala melas*	53
Total		63


A
Fall AZMP 2014
Seabird Density
(count/km2)
0
1 - 10
> 10
B
Fall AZMP 2014
Seabird Density
(count/km2)
UNSP
LESP
WISP
0
1 - 10
> 10
C
Fall AZMP 2014
Seabird Density
(count/km2)
Cory's Shearwater
0
1 - 10
> 10
Great Shearwater
0
1 - 10
> 10
D
Fall AZMP 2014
Seabird Density
(count/km2)
GBBG
0
1 - 10
> 10
HERG
0
1 - 10
> 10
Gulf of St. Lawrence
Bay of Fundy
Banquereau
New England Seamounts
60°0'0"W
40°0'0"N

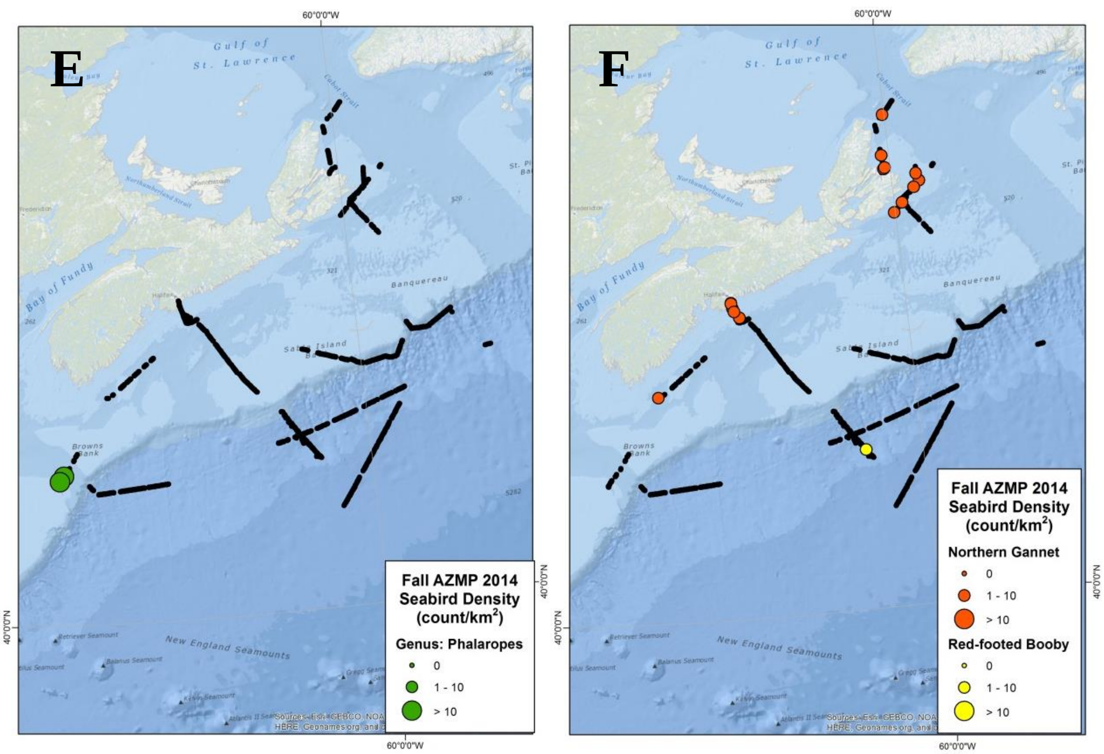


Figure 19. Density of A) total birds; B) Storm-Petrels (UNSP = unidentified Storm-Petrel; LESP = Leach's Storm-Petrel; WISP = Wilson's Storm-Petrel); C) Great Shearwater and Cory's Shearwater; D) Herring Gull (HERG) and Great Black-backed Gull (GBBG); E) phalaropes; and F) Northern Gannet and Red-footed Booby observed during the fall AZMP from 19 Sep – 7 Oct, 2014.

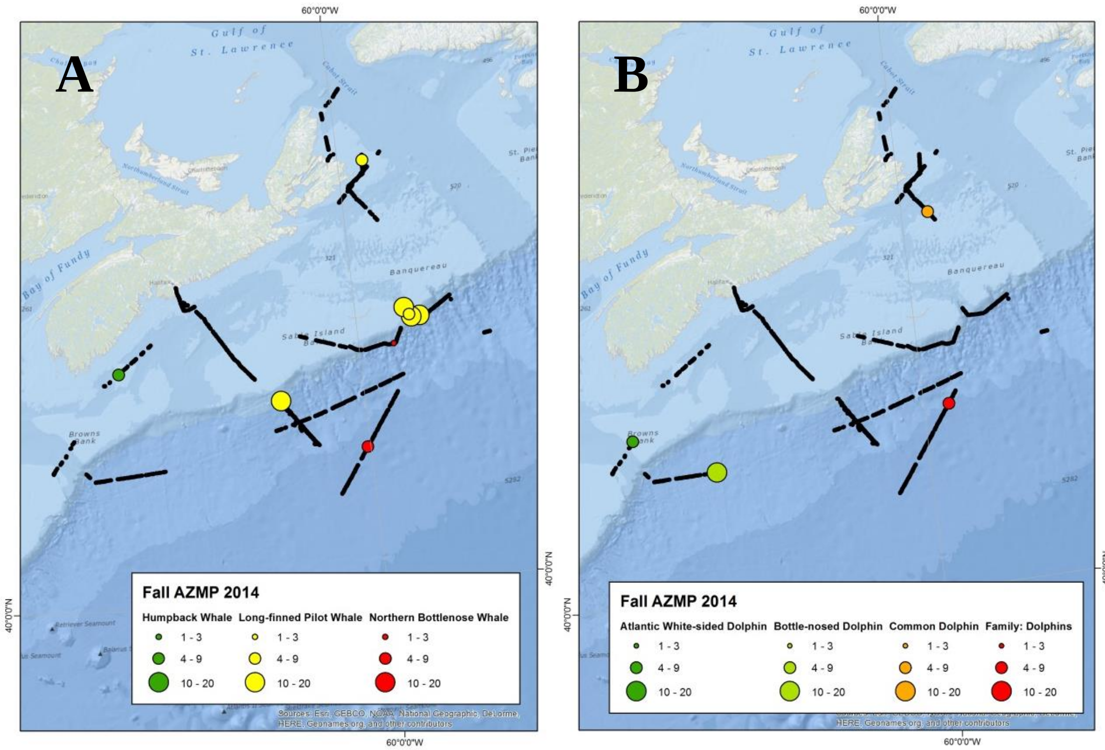


Figure 20. Counts of A) whales and B) dophins observed during the fall AZMP from 19 Sep – 7 Oct, 2014.

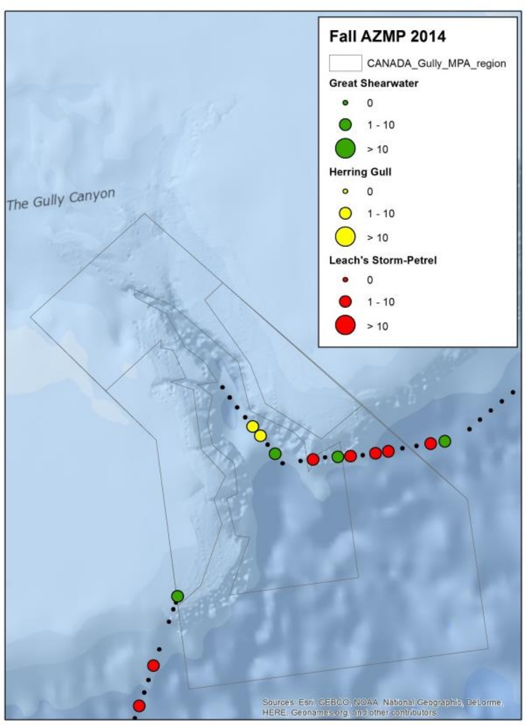


Figure 21. Location of Great Shearwater, Herring Gull and Leach's Storm-Petrel sightings within the Gully MPA during the fall AZMP from 19 Sep – 7 Oct, 2014.

Mooring Operations

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

Narrative

During the 2014 Fall AZMP mission, vessel time was provided to conduct oceanographic mooring operations for ancillary programs. These activities included deployment and recovery operations (Figure 22 and Table 12). With support from the officers and crew of the CCGS Hudson, the mooring technicians conducting these activities were Jay Barthelotte, Adam Hartling and Randy King from Ocean Physics, Program Coordination and Support Division, Science Branch.

Deployment and recovery of OTN moorings (OTN_01, OTN_02 and OTN_03) on the 19th and 20th of September were without incident (Table 12).

The RAPID mooring operations began on September 21st with the successful recovery of RS_04, RS_03, RS_02 and RS_01. On the 23rd of September, RS_05 and RS_06 were also recovered. On September 23rd and 24th, moorings were deployed at RS_01, RS_03, RS_05 and RS_06 without incident. More details are provided in the accompanying RAPID-WAVE report, "CCGS Hudson Fall Cruise 2014, HUD 2014-030 Report on the Recovery and Deployment of RAPID-WAVE Moorings in the Scotian Slope-Rise 19 September – 29 September 2014".

The acoustic moorings were successfully recovered from ShoHald, GulSho, MidGul, LC_01, LC_02 and LC_03 from September 26th to 27th.

During Leg 2 of the mission, the Hudson arrived on the St. Ann's Bank mooring site to discover that the SPAR buoy for the surface mooring (M1863) was not present. Although this mooring was considered 'lost', it was recently discovered on the shores of western NL stripped bare of its associated sensor and missing the beacon light. One can only speculate as to the series of events that ultimately determined its fate. With the exception of M1863, all other mooring recoveries and deployments were successful. NOTSHIPs have been prepared and sent to the Notice to Mariners office in Sydney, NS (as required).

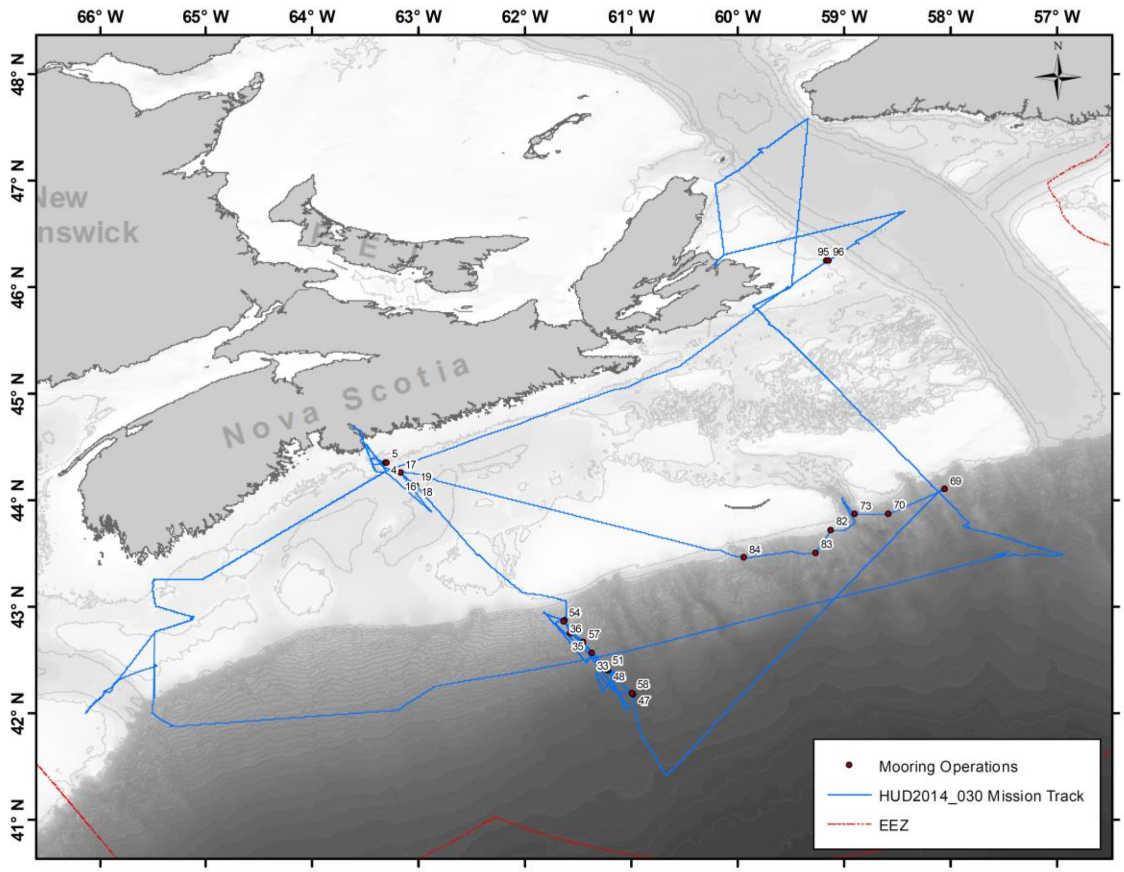


Figure 22. The location for each mooring operation during HUD2014030. Refer to Table 12 for more details.

Table 12. List of mooring operations conducted during HUD2014030. 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
19/09/2014	262	004	Recovered	OTN_01	M1865	44.3436	-63.3097	OTN
19/09/2014	262	005	Deployed	OTN_01	M1890	44.3471	-63.3044	
20/09/2014	263	016	Recovered	OTN_02	M1866	44.2484	-63.1709	
20/09/2014	263	017	Deployed	OTN_02	M1891	44.2486	-63.1701	
20/09/2014	263	018	Recovered	OTN_03	M1867	44.1292	-63.0304	
20/09/2014	263	019	Deployed	OTN_03	M1892	44.1347	-63.0334	
21/09/2014	264	033	Recovered	RS_04	M1837	42.5573	-61.3694	RAPID-WAVE
21/09/2014	264	034	Recovered	RS_03	M1836	42.6559	-61.4579	
21/09/2014	264	035	Recovered	RS_02	M1835	42.7450	-61.5740	
21/09/2014	264	036	Recovered	RS_01	M1834	42.8641	-61.6248	
23/09/2014	266	047	Recovered	RS_06	M1839	42.1647	-60.9839	
23/09/2014	266	048	Recovered	RS_05	M1838	42.3948	-61.2200	
23/09/2014	266	051	Deployed	RS_05	M1888	42.4051	-61.2260	
24/09/2014	267	054	Deployed	RS_01	M1886	42.8546	-61.6392	
24/09/2014	267	057	Deployed	RS_03	M1887	42.6565	-61.4556	
24/09/2014	267	058	Deployed	RS_06	M1889	42.1802	-60.9959	
26/09/2014	269	069	Recovered	ShoHald	M1870	44.0950	-58.0517	Acoustic Moorings
26/09/2014	269	070	Recovered	GulSho	M1869	43.8625	-58.5858	
26/09/2014	269	073	Recovered	MidGul	M1868	43.8612	-58.9062	
27/09/2014	270	082	Recovered	LC_01	M1883	43.7109	-59.1254	
27/09/2014	270	083	Recovered	LC_02	M1884	43.5015	-59.2714	
27/09/2014	270	084	Recovered	LC_03	M1885	43.4523	-59.9451	
29/09/2014	272	095	Recovered	STAB_ADCP	M1864	46.2443	-59.1653	St. Anns Bank*
29/09/2014	272	096	Deployed	STAB_ADCP	M1896	46.2458	-59.1518	

***SPAR buoy at St. Anns Bank was missing (M1863)**

ARGO Float Deployments

Contributions by: Denis Gilbert, Ingrid Peterson, Pelle Robbins and Brigit Klein

Narrative

There were a total of 9 successful ARGO float deployments during HUD2014030 (Figure 23 and Table 13). Prior to the beginning of the mission, the 9 floats (5 Apex – Figure 24, 2 SOLO I and 2 SOLO II – Figure 25) were planned for deployment in the deep water portions of the Halifax, Louisbourg, LaHave Bank and St. Pierre Bank Lines. Weather and ship related delays meant that floats were not deployed at SPB_11 as planned. As a result, an additional station was added during event 141 at SIS_01 (Sable Island Slope) (Figure 23).

The SOLO I and II floats are regularly reporting profiles. Their vertical tracks and horizontal profile information can be found here:

http://argo.whoi.edu/solo2/s7064.html WMO# 4901704
http://argo.whoi.edu/solo2/s7134.html WMO# 4901705
http://argo.whoi.edu/solo1/s1178.html WMO# 4901706
http://argo.whoi.edu/solo1/s1186.html WMO# 4901707

As of November 20, 2014 – only 3 of the five APEX floats had reported metadata netcdf files on the Global Data Assembly Centres (GDACs) due to a decoding problem. Nonetheless, Dr. Brigit Kleign of the Bundesamt für Seeschifffahrt und Hydrographie (BSH - Federal Maritime and Hydrographic Agency, Germany) has confirmed that all 5 floats are transmitting profile data to the ARGOS website.

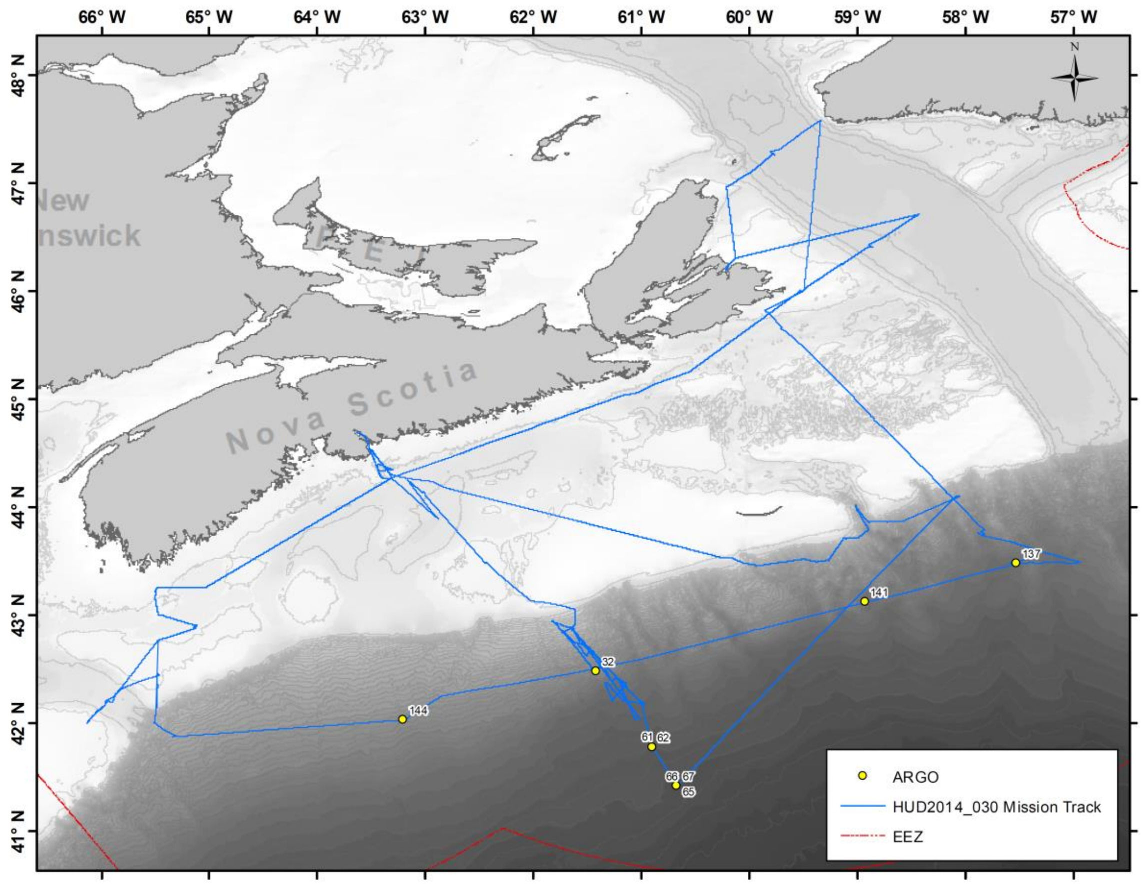


Figure 23. The locations for each Argo float deployment during HUD2014030. Refer to Table 13 for more details.

Table 13. Deployment details for Argo float deployments during HUD2014030. The coordinates provided below are in decimal degrees and represent the ship's position at the time of deployment.

Date	JDay	Event	Station	Float Deployed (UTC)	APEX ID	SOLO ID	SOLO I or II	WMO #	Slat (DD)	Slong (DD)
21/09/2014	264	032	HL_07	1308	7178			6902564	42.4732	-61.4195
25/09/2014	268	061	HL_11	0501		1186	I	4901707	41.7728	-60.9083
25/09/2014	268	062	HL_11	0505		7134	II	4901705	41.7717	-60.9084
25/09/2014	268	065	HL_12	1148	7179			6902565	41.4107	-60.6768
25/09/2014	268	066	HL_12	1152		7064	II	4901704	41.4125	-60.6760
25/09/2014	268	067	HL_12	1154		1178	I	4901706	41.4130	-60.6745
03/10/2014	276	137	LL_09	1408	7177			6902563	43.4729	-57.5328
04/10/2014	277	141	SIS_01	1010	7181			6902567	43.1151	-58.9373
05/10/2014	278	144	LHB_07	0804	7180			6902566	42.0223	-63.2065

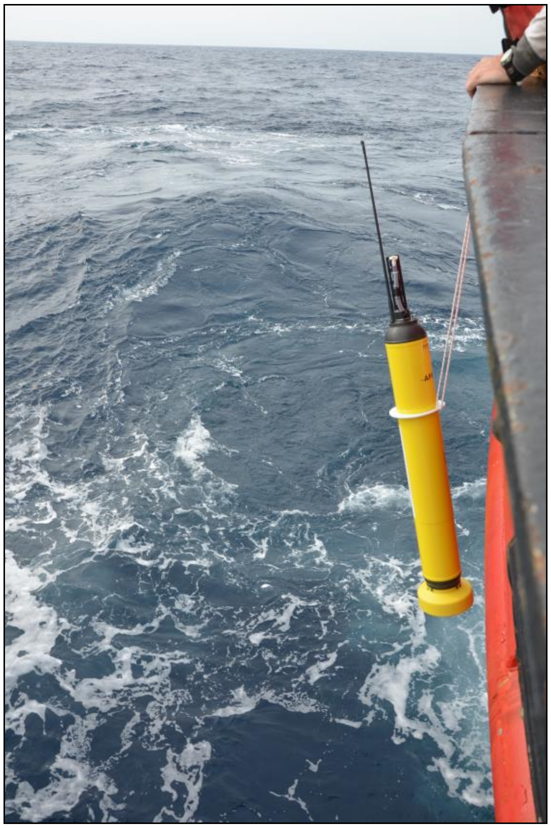


Figure 24. Typical deployment of APEX floats.

Figure 25. Typical deployment of SOLO-I and II floats.

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. Data was collected for the entire mission.

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. Backup position data is supplied by the science Novatel GPS receiver. 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.

A remote computer was used to process the ADCP data every 20min and displayed plots used to verify that the system was functioning.

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 TSG system was run continuously throughout the mission. With the exception of an incident where the pump required replacement (September 23rd), the underway system gathered data continuously throughout the mission. A PCO_2 sensor was placed in line with the TSG and a separate logging system was utilized to capture this data. A TSG and PCO_2 users document has been created and is currently available in the AZOMP managed "Giant Book of Everything" (contact Diana Cardoso for more details).

TSG and PCO_2 underway data was managed the NOAA Scientific Computing Systems (SCS) software. SCS was tested to determine its effectiveness in managing underway data streams reporting at varying sampling rates by integrating by GPS time and location. Initial tests were a success and the incorporation of SCS into AZMP workflow will be discussed at length during the winter months preceding the 2015 spring survey.

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

Please refer to Appendix 3 for a table detailing the data collected during HUD2014030, its current status and location if available.

Data Collection

In addition to standard AZMP manual data collection methods (i.e., Bridge log, various equipment specific deck sheets) **ELOG**, an electronic logbook system for collecting event metadata was again used during HUD2014030. ELOG was accessible via any computer connected to the *science network* on-board the vessel and was well accepted by all. In addition to being configured to collect metadata related to each piece of equipment, additional logbooks were employed to act as an Itinerary and a daily operational log. All logbooks were backed up hourly and at the end of the Mission all logbooks were sent to ODIS for storage.

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

The AZMP Microsoft Access database template was further developed and 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 were entered into the database template. Salinity calculated using the automated spreadsheet were stored in the database template. The GP Lab provided analysis for Oxygen, Chlorophyll and Phaeophytin in the form of CSV files. These CSV files were entered 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.

Hardware

Two Windows 7 computers with REGULUS software installed were used to collect and view positional data. One was setup in the computer room and used by the CTD computer operator. This computer also doubled as the ELOG entry computer.

A laptop was mounted in the winch room with a monitor, keyboard and mouse and used for ELOG entry. Data was stored on the server.

SCS

An additional laptop was used in the forward lab to test the SCS software. Developed by the National Oceanic and Atmospheric Administration (NOAA), SCS is an acronym for Shipboard Computer System. It was developed to record data from a wide variety of shipboard and deployed sensors. During this mission we tested the SCS system by recording data from the TSG and pCO2 sensors in the forward lab with hope to tie these data together with GMT time and position.

APPENDICES

Appendix 1. CTD configuration file – HUD2014030.xmlcon

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 : 69009
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 : 0133
Calibrated on : 18-Dec-13
Equation : Sea-Bird
Soc : 3.90270e-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

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

Serial number : 1588
Calibrated on : 19-Dec-13
Equation : Sea-Bird
Soc : 5.34650e-001
Offset : -5.20400e-001
A : -3.77000e-003
B : 1.79980e-004
C : -2.90470e-006
E : 3.60000e-002
Tau20 : 1.43000e+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 : SPQA5211/PN90310-0002
Calibrated on : 6-Aug-2014/17-Apr-2014

M : -0.77322200
B : -3.53659100
Calibration constant : 4.90000000
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, pH

Serial number : 1137
Calibrated on : 18-Jun-2014
pH slope : 4.6166
pH offset : 2.5380

13) A/D voltage 7, Free

Scan length : 37

Appendix 2. CTD configuration file – HUD2014030a.xmlcon

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 : 2303
Calibrated on : 17-Dec-13
A : 3.68121143e-003
B : 5.99544371e-004
C : 1.56635227e-005
D : 1.96041341e-006
F0 : 3071.921
Slope : 1.00000000
Offset : 0.0000

2) Frequency 1, Conductivity

Serial number : 1874
Calibrated on : 19-Dec-13
G : -4.01267824e+000
H : 5.06066910e-001
I : -9.17933695e-004
J : 7.27049621e-005
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

Serial number : 69009
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 : 0133
Calibrated on : 18-Dec-13
Equation : Sea-Bird
Soc : 3.90270e-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

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

Serial number : 1588
Calibrated on : 19-Dec-13
Equation : Sea-Bird
Soc : 5.34650e-001
Offset : -5.20400e-001
A : -3.77000e-003
B : 1.79980e-004
C : -2.90470e-006
E : 3.60000e-002
Tau20 : 1.43000e+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 : SPQA5211/PN90310-0002
Calibrated on : 6-Aug-2014/17-Apr-2014
M : -0.77322200

B : -3.53659100
Calibration constant : 4.90000000
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, pH

Serial number : 1137
Calibrated on : 18-Jun-2014
pH slope : 4.6166
pH offset : 2.5380

13) A/D voltage 7, Free

Scan length : 37

Appendix 3. Data and meta-data collections during HUD2014030

Data Source	**Responsible Party**	**Data Description**	**File Format(s)**	**Data Volume**	**Data Location**	**Notes**
Thermosalinograph	Adam Hartling/Dave Hebert	Daily files of salinity, temperature and Chl a data collected via forward lab underway system.	.hex, .hdr, .mrk, .XMLCON	94 files/1 folder/13.4 MB	\\dcnsbiona01b\BIODataSvcSrc\2010s\2014\HUD2014030\TSG	TSG_HUD2014030.pdf provides operational details. Routines for processing the data are being developed by Dave Hebert.
CTD – Raw Data	Robert Benjamin/Terry Cormier	Raw primary and secondary temperature, salinity and oxygen data as well as PAR, Chl a, and pH from CTD casts	.BL, .HDR, .HEX, .XMLCON	260 files/1 folder/376 MB	\\dcnsbiona01b\BIODataSvcSrc\2010s\2014\HUD2014030\CTD\2014030HUD	
CTD – Processed Data	Robert Benjamin/Terry Cormier	Processed CTD sensor and bottle data	.Q35, .QAT, .QAT.BAK, .ODF, .IMS, .IGS, .CNV, .txt, .ROS, .BTL,	731 files/9 folders/217 MB	\\dcnsbiona01b\BIODataSvcSrc\2010s\2014\HUD2014030\CTD\2014030HUD	

Lowered ADCP	Adam Hartling	Master and lave lowered ADCP log and data files	.log, .000	100 files/2 folders/118 MB	\\dcnsbiona01b\BIODataSvcSrc\2010s\2014\HUD2014030\LADCP	LADCP_HUD2014030.pdf provides LADCP log sheet
Vessel Mounted ADCP	Adam Harling	Vessel mounted ADCP files	.N1R, N2R, .ENS, .ENR, .ENX, .LOG, .LTA, .NMS, .STA, .txt, .VMO	714 files/1 folder/3.33 GB	\\dcnsbiona01b\BIODataSvcSrc\2010s\2014\HUD2014030\VMADCP	VMADCP_HUD2014030.pdf deployment log sheet
ELOG Logbook	Robert Benjamin	Associated daily log books, ELOG configuration file and QC,d bridge log. Contains the meta-data for the trip	.xls, .txt, .cfg, .log	597 files/4 folders/597 KB	\\dcnsbiona01b\BIODataSvcSrc\2010s\2014\HUD2014030\ELOG	Includes operational details for: CTD, Moorings, BioNess, Vertical Net Tows, Multi-Net, and ARGO floats, as well as any other deployed gear.
ARGO Data	Denis Gilbert	Georeferenced salinity and temperature profiles and track data provided to GDAC's				This data is gathered in the months and years following the mission and are available via the International

						ARGO Project Home Page - http://www.argo.net/
Rosette – Shipboard Laboratory Analysis	Jeff Spry	Chlorophyll, Winkler oxygen, salinities, underway chl a measurement, auto generated BioSum	.xls, .txt	14 files/4 folders/2.84 MB	\\dcnsbiona01b\BIODataSvcSrc\2010s\2014\HUD2014030\JeffSpry	Data has already been ported into AZMP operational database currently in possession of Robert Benjamin.
Rosette/Vertical Net Tows/BioNess/Multi-Net - Shore-side Laboratory Analysis	Jeff Spry/Marc Ringuette	CHN, HPLC, Nutrients and Zooplankton analysis.	.xls	1 file/1 folder/54 KB	\\dcnsbiona01b\BIODataSvcSrc\2010s\2014\HUD2014030\BIOCHEM	As of November 18, 2014 only CHN data had been added. Still awaiting HPLC, Nutrients and Zooplankton. All data (excluding zooplankton data) will be ported into AZMP operational database. Multi-net data is analyzed and stored separately and has not been ported to BioChem for lon

						term storage.
GIS files – Derived from GPS and Operational Data and Meta-data	Robert Benjamin	Daily cruise track and other associated GIS data products	.csv, .tif, .xlsx, .jpg, .mxd, .shp, .shx, .dbf, .prj, .sbn, .sbx	177 files/2 folders/319 MB	\\dcnsbiona01b\BIODataSvcSrc\2010s\2014\HUD2014030\GIS	
MicroCat Calibration	Adam Hartling/Yuri Geshelin	Microcat calibration during CTD profiles	.asc, .cnv, .hex, .xml, .xmlcon	74 files/2 folders/5.64 MB	\\dcnsbiona01b\BIODataSvcSrc\2010s\2014\HUD2014030\Microcat Calibration	Events 030 and 068. "Event 030 HUD2014030 MC Calibration.pdf" and similar file for event 68 provides instrument serial numbers used in cast.
GPS - Navigation Files	Robert Benjamin	Daily Regulus files utilized to create cruise track. Mission Regulus waypoint library	.dbf, .prj, .sbn, .sbx, .shp, .14E	187 files/3 folders, 640 MB	\\dcnsbiona01b\BIODataSvcSrc\2010s\2014\HUD2014030\Navigation	
Underway Data Capture - Scientific Computing System (SCS)	Robert Benjamin	NOAA logging system to integrate various underway data sources	Various	413 files/8 folders/ 2.31 GB	\\dcnsbiona01b\BIODataSvcSrc\2010s\2014\HUD2014030	An SCSMerge.accdb has been created to integrate the PCO2 sampling frequency with

		including TSG, PC02, GPS, Gyro and Meteorological data.				the TSG and NMEA frequencies. There will be discussions this winter about how to proceed with this.
CTD Rosette and Forward Lab Underway System - Ocean Acidification Data	Dr. Helmuth Thomas and Dr. Pierre Pepin	2 independent projects both examining PCO2, total alkalinity, total dissolved carbon and pH				Refined data will be received for archiving at a much later date (next year or later). PI's should be contacted periodically for updates.
Forward Lab Underway System - Suspended Particle Sampling (Organic Biomarkers) and Isotopic Composition of Nitrate	Dr. Markus Kienast	Map the isotopic composition of nitrate in the water column along the AZMP cruise track. Filter underway system for potential organic biomarkers				Meta-data for collections have been provided in the body of this report. PI should be contacted for a copy of the data at a later date.

CWS Bird and Mammal Data	Carina Gjerdrum (CWS)	Georeferenced ID’s and quantities of mammals and birds during transit.				Summary data provided to AZMP PI for inclusion in cruise reports and for permit reporting in MPA.
Mooring Logs	Adam Harling	Logs containing names, locations and descriptions of mooring operations.				These logs require QC and will eventually be submitted to ODIS for long term archiving.
Oceanographic Mooring Data (RAPID-WAVE, OTN, St. Anns Bank)	Dave Hebert	Sensor data (temperature, current, salinity, pressure, etc…).				These data are ultimately downloaded from deployed sensor arrays. These data serve ancillary program requirements and as such, the data has not traditionally been under AZMP purview.
Acoustic Mooring Data	Hilary Murphy-Moors	Whale vocalizations and other marine				These data are ultimately downloaded from acoustic sensors

		acoustic signals.				upon retrieval. These data serve a specific DFO project and as such, have not been under the purview of AZMP.