CRUISE REPORT

HUDSON 2015004

SCOTIAN SHELF

AZMP TRANSECTS +

Apr 17th – Apr 27th, 2015

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CRUISE NARRATIVE

Highlights

Area Designation:	NAFO Regions: 5Ze, 4X, 4W, 4Vs, 4Vn, 3Ps Extent: 41° 51'N - 46° 43'N; 057° 29'W - 066° 10'W
Expedition Designation:	HUD2015004 or 18HU15004 (ISDM format)
Chief Scientist:	Mr. Andrew Cogswell Ocean Ecosystem Science Division Marine Ecology Section Department of Fisheries and Oceans Bedford Institute of Oceanography PO Box 1006 Dartmouth, NS, Canada B2Y 4A2 Andrew.Cogswell@dfo-mpo.gc.ca
Ship:	CCGS Hudson (call sign - CGDG) Oceanographic research vessel
Ports of Call:	Apr 17th, 2015 – Depart BIO Dartmouth, NS Apr 27th, 2015 – Return BIO, Dartmouth, NS
Cruise Dates:	Apr 17th – 27th, 2015

Mission Summary

Overview

The science party was onboard the CCGS Hudson by noon Atlantic time at BIO on Apr. 17th, 2015 to begin the shortened 10 day mission. The ship departed BIO at ~1450 after completing familiarizations and then proceeded to conduct a boat and safety drill in the Basin prior to occupying HL_00 (Compass Buoy Station) to conduct gear tests. Science operations in the Basin began with a CTD test, followed by a BioNess tow. The CTD test revealed a problem with the wireless block and it was exchanged with a spare. The CTD test also showed a problem with the Altimeter. The CTD Technician, did not have a spare cable for the altimeter and was required to take an FRC back to BIO to obtain one.

Once the CTD tech returned to the ship, the altimeter was tested and the Hudson began the steam to the first station occupation at HL_02 in the late evening of the 17th. Upon completion of HL_02, the Hudson travelled west to occupy the Roseway, Browns Bank and Peter Smith Lines, finishing late in the day on the 19th before steaming towards HL_07 of the Halifax Line. Work began at HL_7 at ~1155 on April 20th and proceeded towards the near shore end of the Halifax Line over the next day and a half, completing HL_01 at 0005 on April 22nd. The ship then began the ~21 hour steam towards SG_28 in the Gully MPA, arriving at 2104 on the 22nd. Work in the Gully concluded at SG_23, ~12 hours later on the 23rd at 0919 before beginning the 3.5 hr steam towards the slope end of the Louisbourg Line.

Work began at LL_09 of the Louisbourg Line at 1346 on the 23rd, and concluded ~ 30 hours later at LL_01 at 1959 on the 24th. At this point, the Environment Canada daily ice charts and RadarSat images (provided by Coast Guard) were consulted to determine the most likely scenarios for executing the remainder of the mission. The decision was made on the 24th that the northern Cabot Strait stations were inaccessible due to dense ice (9/10ths) covering most of the transect (Figure 1). The plan was to travel the proposed St. Anns Bank Transect Line as closely as possible towards the Laurentian Channel end (STAB_06), reposition stations as necessary to avoid dense ice flows, and reverse direction and occupy these stations starting with STAB_06 and travelling west towards STAB_01. None of the St. Anns Bank stations were repositioned due to ice, but “rotten” ice and slush was present throughout some of the transit between stations, as was seen earlier on the Louisbourg Line (Figure 2). Beginning at 0323 on April 25th, STAB_06 was occupied and STAB_01 was occupied ~12 hours later, finishing the St. Anns Bank Line at 1532 on April 25th.

After completion of the St. Anns Bank Line, the ship began the ~15 hour steam to: occupy stations in the *Vazella* closure areas, deploy a BioNess at HL_03 that had been dropped earlier in the mission due to weather, occupy HL_02 and conduct CTD casts near some adjacent bathymetric features of interest. The Hudson then departed for BIO, arriving at ~0840 on April 27th.

Over the 10 day mission, the CCGS Hudson logged ~1625 nm and AZMP science staff conducted 142 separate operations at 54 stations (Figure 3). 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.

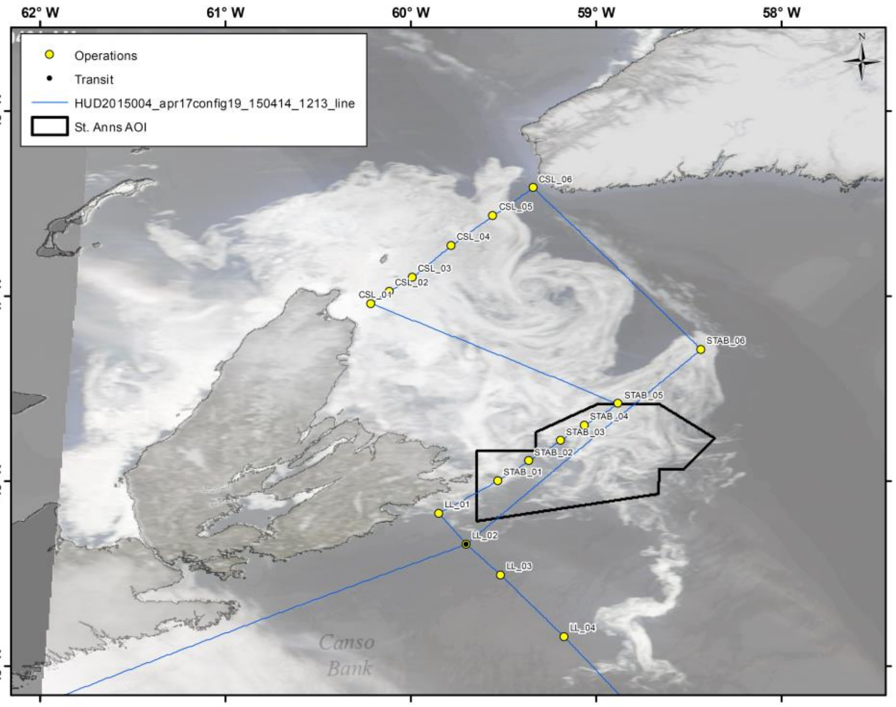


Figure 1. Overlay of proposed mission track over the RADARSAT-2 image of ice conditions in Cabot Strait on April 21st, 2015.

Figure 2. Ice along the Louisbourg line between LL_03 and LL_02 on April 24th, 2015.

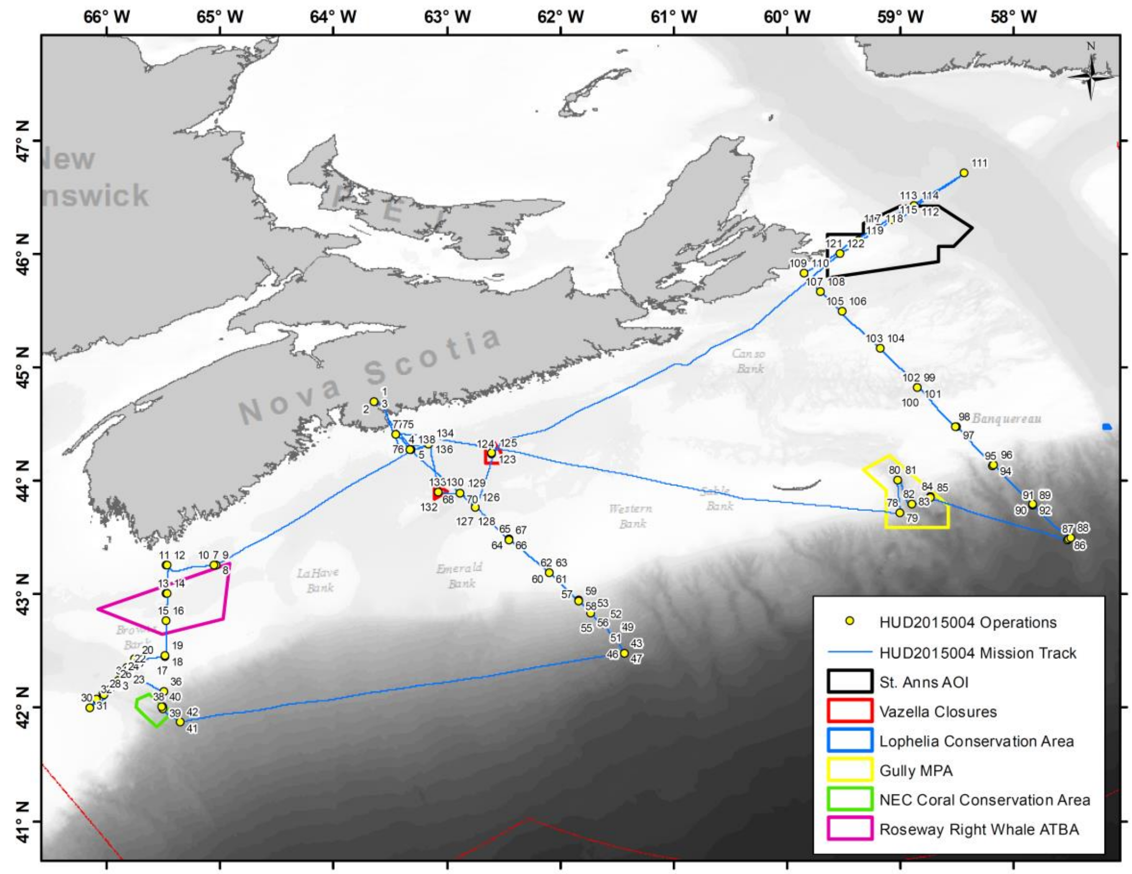


Figure 3. The locations for all 142 events during the HUD2015004 AZMP spring survey. Some overlapping event labels are not visible.

Table 1. Summary of operations during the HUD2015004 AZMP spring survey.

Operation	# of Operations	Figure
CTD	59	4
Vertical Ring Net	71	20
BioNess	8	21
Argo Float Deployments	4	25

Pre-Cruise Narrative

Early correspondence with the ship's Captain, made it clear to the Chief Scientist that the ship was ~2 weeks later than planned entering dry dock over the winter months. On March 19th, the Chief Scientist was contacted by the Captain of the Hudson with an update on the now delayed departure estimate (April 10th – 14th). Despite the Hudson crew working diligently to meet the original start date of the spring AZMP mission (April 7th), remaining repairs (e.g., re-chroming of rams on water tight doors, bringing a third engine online, installing a new life boat, attempting to fix the ARVA crane on the foredeck, installing and testing the starboard quarterdeck crane, Transport Canada safety inspections, etc…) meant that the mission did not depart until 10 days after the intended start date (April 17th), 3 days later than the date estimated in mid-March.

The mission objectives, as provided to Coast Guard Headquarters and the CCGS Hudson in the first “Form B” on January 26th, 2015 were severely impacted by these ship delays and last minute science crew cancellations. The scientific objectives as listed in the initial Form B, and the impacts of these delays and crew cancellations are summarized below and in the Objectives section of this report.

To summarize the impacts: the station occupations of the eXtended Halifax Line (XHL) were cancelled; Autonomous Multichannel Acoustic Recorder (AMAR) mooring deployments partially funded by the National Conservation Plan were shifted to the following Labrador Sea Atlantic Zone Offshore Monitoring Program (AZOMP) mission (which was also delayed by 3 days due to ship crewing issues and mooring coordination efforts); mooring deployments and retrievals planned near and within the St. Anns Bank Area of Interest (AOI) and funded by the National Conservation Plan were postponed until the fall 2015 AZMP mission; ancillary stations (LaHave Basin, Banquereau, Gulf of Maine North Atlantic Time Series) normally occupied to provide additional data for modelling efforts were cancelled; the underway sampling system could not be set up because of injured science staff and was therefore scrapped for the mission – this impacted underway sampling for an ACCASP funded initiative to investigate the delineation of ocean acidification and calcium carbonate saturation state of the Atlantic zone and a Dalhousie project investigating suspended particle sampling for organic biomarkers; the OTN mooring retrievals in the Halifax Harbour Approaches and Nova Scotia Current Mooring deployment were kindly handled by a Dalhousie University Technician from the Ocean Tracking Network (Duncan Bates) during their overlapping mission aboard CCGS Perley.

AZMP worked closely with the Chief Scientist for the AZOMP mission (Igor Yashayaev), divisional management (Kent Smedbol and Blair Greenan) and the Program Coordination and Support Division (Don Belliveau and Neil MacKinnon) to investigate mitigating measures to offset the impacts of the delays and science crew cancellations. Despite the hectic schedule and last minute notice, everyone worked together to minimize the impacts and we greatly appreciate their efforts.

Table 2. Break down of operational time by gear type during HUD2015004.

Gear	Time Allocated (hrs)
CTD	~34
Vertical Net Tows	~21
BioNess	~3
ARGO	~1

Mission Participants

Table 3. List of science staff aboard the HUD2015004 spring AZMP mission.

Name	Affiliation	Duty	Shift
Anstey, Carol	DFO (MAR – OESD)	Laboratory Technician	Day
Benjamin, Robert	DFO (MAR – PCSD)	Data Technician	Day
Burt, Will	DAL	Student (Thomas)	Split
Cogswell, Andrew**	DFO (MAR – OESD)	Chief Scientist/CTD watch/ELOG	Day
Cormier, Terry	DFO (MAR – PCSD)	Electronics Technologist	Day
Gould, Jessica	DAL	Technician (Kienast)	Split
Hebert, Dave	DFO (MAR – OESD)	Moorings/CTD watch/ELOG	Night
Hogan, Holly	EC-CWS	Bird watcher	Day
Lemay, Jonathan	DAL	Student (Thomas)	Day
Perry, Timothy	DFO (MAR – OESD)	Laboratory Technician	Night
Ringuette, Marc	DFO (MAR – OESD)	Biologist/Technician	Day
Spry, Jeffrey	DFO (MAR – OESD)	Biologist/Technician	Night
Wilson, Erin	DAL	Student (Thomas)	Night

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

Objectives

There were 16 defined objectives in the initial Form B submitted to Coast Guard Headquarters on January 26th, 2015 (below). Table 4 describes whether each of the objectives was met along with any relevant supporting commentary. Four stations were added at the end of the trip that may or may not support objectives listed below and are included under the heading "Additional Unplanned". Those objectives highlighted in red were impacted by the ship's late departure and/or last minute science crew cancellations.

Primary

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

Additional

2. 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).
3. Deploy 5 Autonomous Multichannel Acoustic Recorders (AMAR) near Emerald Basin, the Gully MPA, the Stone Fence Lophelia Conservation Area and the St. Anns Bank Area of Interest (AOI) in support of a National Conservation Plan

funded project investigating whale migration patterns (**Contact Dr. Hilary Moors-Murphy** - http://www.mar.dfo-mpo.gc.ca/e0008208).

4. 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).
5. Deploy a total of 5 ADCP/Microcat mooring(s) and a single Thermistor mooring for one year near and within the bounds of the St. Anns Bank AOI in support of project funded through National Conservation Plan (NCP) in an effort to further describe oceanographic conditions within the AOI. Time will be set aside to recover a single ADCP/Microcat mooring deployed last fall and conduct hydrographic profiles and collect water samples at mooring stations (Contact **Dr. Dave Hebert -** http://www.mar.dfo-mpo.gc.ca/e0010385). Time will also be set aside to drag for a Thermistor mooring that was not successfully recovered in the fall of 2014 and to occupy stations within the bounds of the St. Anns Bank AOI.
6. Nutrients and hydrography across the Northeast Channel as part of NERACOOS Cooperative Agreement, (**Contact Dr. Dave Hebert -** http://www.neracoos.org/).
7. Carry out hydrographic, chemical and biological sampling across the mouth of the Laurentian Channel 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**).
8. 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).
9. 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/).
10. Collection of DIC, alkalinity and ^{13}C samples in support of research contributing to MEOPAR theme 2.2. A Dalhousie university student will collect the samples from the CTD rosette (~1L per depth) and will process them shore side (**Contact Dr. Helmuth Thomas -** http://meopar.ca/theme-2-2/).
11. Deployment of ARGO floats in support of the International Argo Float Program (**Contact Dr. Blair Greenan** - http://www.bio.gc.ca/science/monitoring-monitorage/azomp-pmzao/argo-eng.php).
12. Underway suspended particle sampling (organic biomarkers) and rosette samples collected for isotopic composition of nitrate (**Contact Dr. Markus Kienast**).
13. Collect underway water samples at specified locations and depths to fulfill the regional component of an 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).

14. Vertical net tows in support of a project investigating the non-breeding season diet of Dovekie (*Alle alle*) (**Contact Carina Gjerdrum –** carina.gjerdrum@ec.gc.ca**)**.
15. The Nova Scotia Current Mooring (NSCM) at the old OTN_02 site will consist of an ADCP/CTD and will be act as the scaled down 1 year (FY2015/16) continuance of the OTN moorings that were placed on the Halifax line to monitor the physical properties of the Nova Scotia Current. (Contact Dave Hebert).
16. Recover 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).

Unplanned

17. Bird and mammal observations were made by CWS observers throughout the mission (**Contact Carina Gjerdrum)**.
18. Investigate hydrographic, chemical and biological conditions on or near distinct features visible on multibeam bathymetry of the Halifax Approaches.
19. Investigate hydrographic, chemical and biological conditions within each of the *Vazella* closure areas.
20. Vertical ring net tows in support of an ongoing study investigating *C. finmarchicus* egg clutch size.

Table 4. Status of objectives upon completion of the HUD2015004 mission.

Objective	Status	Comments
1	Partially Complete	The Cabot Strait Line could not be occupied due to extensive ice coverage over the majority of stations.
2	Dropped	All XHL stations were dropped due to delays.
3	Dropped	The 5 AMAR deployments were reallocated to the following AZOMP mission.
4	Mostly Complete	A single BioNess, normally scheduled for GULD03 was dropped due to poor weather conditions.
5	Partially Complete	The ADCP mooring operations were postponed until the 2015 fall AZMP mission. All stations were occupied within and near the bounds of the St. Anns Bank AOI.
6	Complete	All NERACOOS stations were occupied and requisite sampling took place.
7	Dropped	Delays precluded sampling stations in LaHave Basin and across the mouth of the Laurentian Channel.
8	Complete	All station occupations in Roseway Basin were completed as planned.
9	Dropped	Delays precluded sampling GNATS stations.
10	Partially Complete	DIC, alkalinity and $_{13}$C samples were collected by Dalhousie students in support of research contributing to MEOPAR theme 2.2.
11	Complete	All floats were deployed in slope waters great than 2000 m at selected locations along the shelf break.
12	Dropped	The underway system was not installed due to delays and lack of scientific staff.
13	Partially Complete	Samples from the CTD rosette were collected for an ACCASP ocean acidification /calcium carbonate saturation project. Due to delays, not all locations could not be occupied.
14	Complete	All planned vertical net tows in support of a Dovekie feeding project were collected. Some locations were added when Dovekies were present.
15	Dropped	The Nova Scotia Current Mooring was not deployed. The mooring deployment

		has been delayed until further notice.
16	Dropped	OTN moorings were recovered by Dalhousie University aboard the CCGS Perley.
17	Unplanned	Bird and mammal observations were conducted throughout the mission.
18	Unplanned	CTD profiles and net tows were conducted over distinct bathymetric features extracted from the Halifax Harbour and approaches multibeam.
19	Unplanned	1 site within the bounds of each of the *Vazella* closure areas was occupied and the CTD, net and BioNess were deployed
20	Unplanned	A number of net tows were collected for the *C. finmarchicus* egg clutch study.

Summary of Activities

CTD summary

<u>Narrative</u>

As summarized in Table 1, there were a total of 59 CTD casts during the mission (Figure 4 and Table 5) and of these, 56 were successful.

Appendix 1 provides the Seasave instrument configuration file (HUD2015004.xmlcon) provided by ODIS and used to process CTD data from April 17th to April 22nd. In the first few days of the trip, there was some confusion about the quality of the pH data as the values being returned were not only out of range but seemed to fluctuate wildly within a cast. A decision was made to replace the pH sensor with the Optode sensor to determine if voltages were still being acquired (Event 12 – BBL_01). It was later determined that the PAR sensor was also providing values out of range and that the likely culprit was that the pH and PAR voltages that run into a single bulk-head connector (JT-6) were not assigned properly in the configuration file provided by ODIS (i.e., voltages 6 and 7 were reversed). A new configuration file was created and all CTD casts up to this point, and from that point on, were re-processed with the new configuration file (HUD2015004_swwitchedphPAR.xmlcon – Appendix 2). While the pH sensor was installed again during Event 79 and used throughout the remainder of the mission, it turns out that the pH sensor (#0743) had not been calibrated since March 6th, 2012 and was providing questionable data regardless. The pH data collected over the mission (and all other data collected on this channel – e.g. Optode) are considered erroneous and will not be archived in BioChem.

The mission encountered few CTD technical difficulties. The following is a short in depth commentary of CTD operations during the mission:

During the first test cast at HL_00 (Event 1), the winch speed, cable out and tension were not visible to the Winch Room or Computer Room and it was as a result of a malfunctioning wireless block output. The block (#1) was replaced (with block #7) prior to the next cast at HL_00 (Event 2) and it functioned without issue for the remainder of the mission. Nonetheless, this cast revealed that the altimeter was not providing an accurate readout due to a faulty cable (19-C). Terry Cormier (CTD Tech) took an FRC back to BIO to retrieve a spare cable and associated gear. The repairs were made upon his return and the altimeter functioned well for the remainder of the mission.

Throughout the mission, O-rings on the bottles were slipping which resulted in leaking bottles and in some occasions, lost samples (Event 25 – 406347 (lost), Event 083 – 406647 (no gases), Event 092 – 406692 (no gases), Event 096 – 406709 (no gases)). It was thought that perhaps the O-rings were not the right size and this will be investigated.

It was observed, starting at Event 104, that the PAR sensor was generating questionable data. While the typical log scale, linear decline in irradiance was obvious, this was punctuated by periodically bad data values. The PAR sensor was removed prior to Event 110 and cleaned. While this temporarily alleviated the issues observed starting at Event 104, the problems re-emerged during Event 116. The PAR sensor and log amplifier connections were cleaned prior to event 120 and the sensor worked well for the remainder of the mission. ODIS has been informed of the data quality issues for the PAR sensors prior to CTD post-processing and long term archiving.

During Event 46 (HL_07), the CTD deck unit through an error code at 2150 m and the cast was aborted to troubleshoot the underwater unit. It appeared as though the error was as a result of a ground fault in the underwater unit. Upon retrieval of the CTD, the deck unit was turned on to cycle through the sensors and the fault seemed to disappear. After troubleshooting, it was determined that the problem lie with the Optode sensor that was put in place of the pH sensor and it was removed and the connection dummied off. The problem did not reoccur throughout the remainder of the mission.

The following is a summary of the primary and secondary sensor issues encountered throughout the mission. Primary oxygen values from Event 32 at PS_09 were not correct on the down cast from ~20 to 40 m depth and should be noted during CTD post processing by ODIS. Primary sensor values (Salinity and Oxygen) were incorrect for the first 100 db of the downcast during Event 096 at LL_07 and this should also be noted for post-processing of CTDs by ODIS. Primary oxygen experienced temporarily high variability on the down cast near the bottom during Event 116 (STAB_04). The primary system was flushed with Triton prior to the next station occupation at STAB_03. During Event 122 at STAB_01, the secondary sensors malfunctioned due to a pump failure; the pump was replaced and functioned well throughout the remainder of the mission. All secondary sensor data acquired on the upcast should be disregarded.

In general, on April 20th it was noticed that the primary and secondary sensors were slightly offset (one slightly higher than the other in the CTD frame (~1 – 2 inches)), which likely resulted in minor differences between primary and secondary sensor values in the upper water column, especially in transition zones where a slight lag was usually visible. This was fixed by the CTD tech in advance of the following AZOMP mission (HUD2015006).

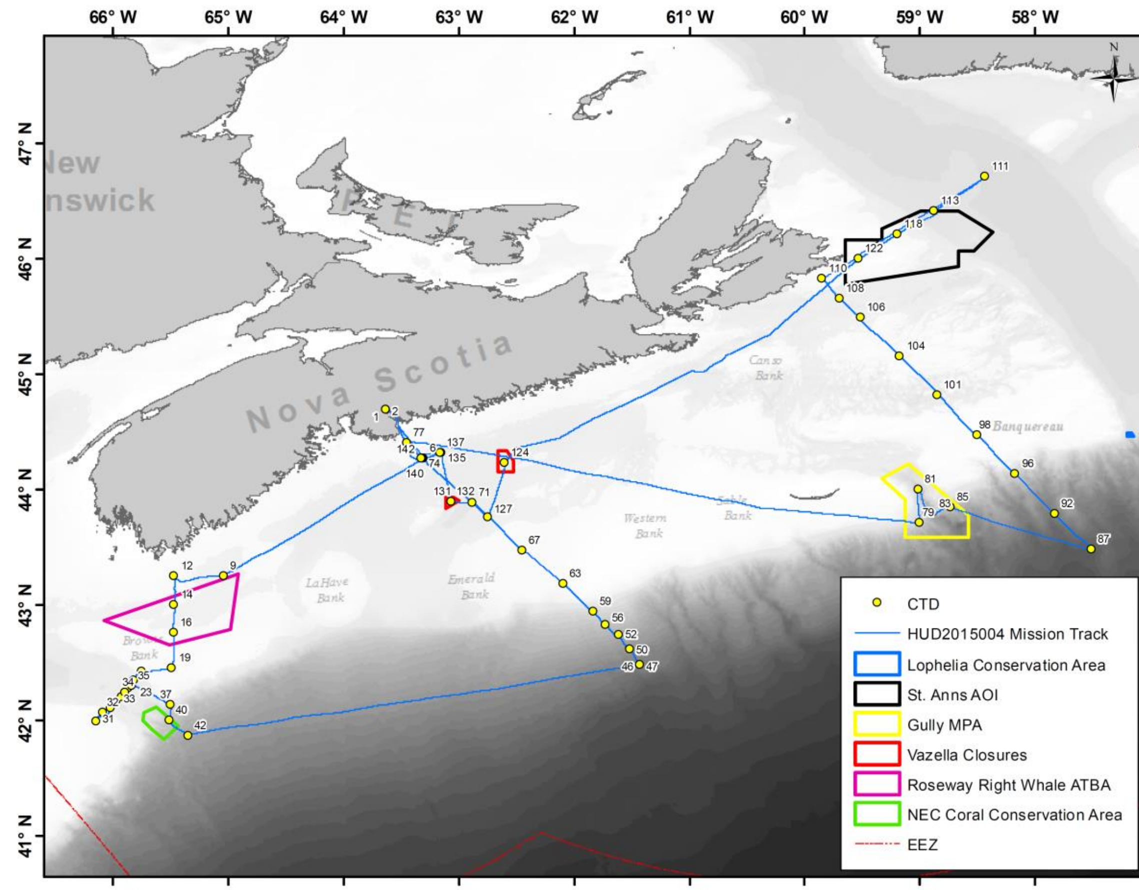


Figure 4. Locations for the 59 CTD casts during HUD2015004 AZMP spring survey. Each cast is labelled with the consecutive mission event.

Table 5. CTD casts during the HUD2015004 AZMP spring survey. The coordinates provided are in decimal degrees and reflect the ship's position at the time of deployment as recorded using the ELOG meta-data logger. Note, that even though pH sensor is attached the data is of poor quality and will not be archived.

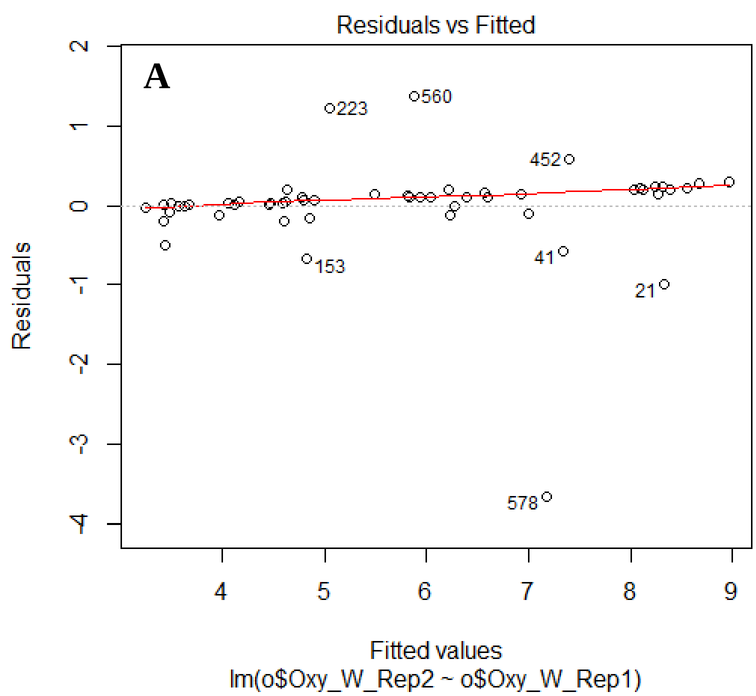
#	Event	Station	Date	Julian Day	Slat (DD)	Slon (DD)	Sounding (m)	PAR	SBE 35	pH	Water Collected	Aborted
1	1	HL_00	17/04/2015	107	44.6937	-63.6399	70	X	X	X		
2	2	HL_00	17/04/2015	107	44.6945	-63.6412	70	X	X	X		
3	6	HL_02	18/04/2015	108	44.2711	-63.3129	160	X	X	X	X	
4	9	RL_01	18/04/2015	108	43.2523	-65.0408	165	X	X	X	X	
5	12	BBL_01	18/04/2015	108	43.2475	-65.4730	61	X	X	X	X	
6	14	BBL_02	18/04/2015	108	42.9973	-65.4725	111	X	X	X	X	
7	16	BBL_03	18/04/2015	108	42.7574	-65.4789	96	X	X		X	
8	19	BBL_04	18/04/2015	108	42.4491	-65.4914	100	X	X		X	
9	21	PS_01	18/04/2015	108	42.4217	-65.7587	99	X	X		X	
10	23	PS_02	19/04/2015	109	42.3449	-65.8237	204	X	X		X	
11	25	PS_04	19/04/2015	109	42.2807	-65.8709	225	X	X		X	
12	27	PS_06	19/04/2015	109	42.1987	-65.9320	222	X	X		X	
13	29	PS_08	19/04/2015	109	42.1056	-66.0238	202	X	X		X	
14	31	PS_10	19/04/2015	109	41.9921	-66.1502	89	X	X		X	
15	32	PS_09	19/04/2015	109	42.0653	-66.0897	90	X	X		X	
16	33	PS_07	19/04/2015	109	42.1633	-65.9715	215	X	X		X	
17	34	PS_05	19/04/2015	109	42.2351	-65.9022	228	X	X		X	
18	35	PS_03	19/04/2015	109	42.2997	-65.8397	206	X	X		X	
19	37	BBL_05	19/04/2015	109	42.1339	-65.5001	182	X	X		X	
20	40	BBL_06	19/04/2015	109	41.9983	-65.5126	1061		X		X	
21	42	BBL_07	20/04/2015	110	41.8659	-65.3519	1842		X		X	
22	46	HL_07	20/04/2015	110	42.4751	-61.4334	2702		X			X
23	47	HL_07	20/04/2015	110	42.4750	-61.4332	2702		X		X	
24	50	HL_06.7	21/04/2015	111	42.6156	-61.5199	2270		X		X	
25	52	HL_06.3	21/04/2015	111	42.7342	-61.6153	1660		X		X	
26	56	HL_06	21/04/2015	111	42.8287	-61.7346	1096		X		X	
27	59	HL_05.5	21/04/2015	111	42.9367	-61.8397	447		X		X	
28	63	HL_05	21/04/2015	111	43.1825	-62.0990	97	X	X		X	
29	67	HL_4	21/04/2015	111	43.4750	-62.4549	84		X		X	
30	71	HL_03	21/04/2015	111	43.8842	-62.8882	262	X	X		X	

31	74	HL_02	22/04/2015	112	44.2674	-63.3228	156	X	X		X	
32	77	HL_01	22/04/2015	112	44.3997	-63.4534	86	X	X		X	
33	79	SG_28	23/04/2015	113	43.7130	-59.0045	838		X	X	X	
34	81	GULD_03	23/04/2015	113	44.0003	-59.0196	450		X	X	X	
35	83	GULD_04	23/04/2015	113	43.7902	-58.8984	2100		X		X	
36	85	SG_23	23/04/2015	113	43.8503	-58.7354	1200		X		X	
37	87	LL_09	23/04/2015	113	43.4769	-57.5191	3597		X		X	
38	92	LL_08	24/04/2015	114	43.7837	-57.8333	2826		X		X	
39	96	LL_7	24/04/2015	114	44.1331	-58.1751	770		X	X	X	
40	98	LL_06	24/04/2015	114	44.4717	-58.5096	65	X	X	X	X	
41	101	LL_05	24/04/2015	114	44.8150	-58.8552	244	X	X	X	X	
42	104	LL_04	24/04/2015	114	45.1580	-59.1762	104	X	X	X	X	
43	106	LL_03	24/04/2015	114	45.4920	-59.5170	132	X	X	X	X	
44	108	LL_02	24/04/2015	114	45.6580	-59.7037	139	X	X	X	X	
45	110	LL_01	24/04/2015	114	45.8254	-59.8506	92	X	X	X	X	
46	111	STAB_06	25/04/2015	115	46.7108	-58.4367	463		X	X	X	
47	113	STAB_05	25/04/2015	115	46.4173	-58.8810	370		X	X	X	
48	116	STAB_04	25/04/2015	115	46.3004	-59.0697	150	X	X	X	X	
49	118	STAB_03	25/04/2015	115	46.2167	-59.1953	90	X	X	X	X	
50	120	STAB_02	25/04/2015	115	46.1085	-59.3663	60	X	X	X	X	
51	122	STAB_01	25/04/2015	115	46.0006	-59.5337	60	X	X	X	X	
52	124	EVC_01	26/04/2015	116	44.2345	-62.6052	163	X	X	X	X	
53	127	HL_03.3	26/04/2015	116	43.7632	-62.7523	200	X	X	X	X	
54	131	SAM_03	26/04/2015	116	43.8934	-63.0731	172	X	X	X		X
55	132	SAM_03	26/04/2015	116	43.8935	-63.0731	172	X	X	X	X	
56	135	HA_03	26/04/2015	116	44.3224	-63.1569	115	X	X	X	X	
57	137	HA_02	27/04/2015	117	44.3200	-63.1650	210	X	X	X	X	
58	140	HL_02	27/04/2015	117	44.2670	-63.3170	156	X	X	X	X	
59	142	HA_01	27/04/2015	117	44.2727	-63.3244	200	X	X	X	X	

Oxygen

The oxygen data collected by the CTD sensors and Winkler titration method will be used to create 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 during the mission (Figures 5A and B) revealed 2 bad replicate 1 values (sample ID – 406481 and 406853), 4 bad replicate 2 values (Sample ID – 406273, 406299, 406411 and 406710) and 1 sample (406830) that had vastly differing replicates and primary/secondary sensor values. The poor replicates and the single ambiguous sample were removed prior to calculating the Winkler replicate means. The resulting r^2 value (comparing the first Winkler replicate to the second) upon erroneous data removal showed strong relationship between replicates (r^2=0.9966 – Figure 5B).



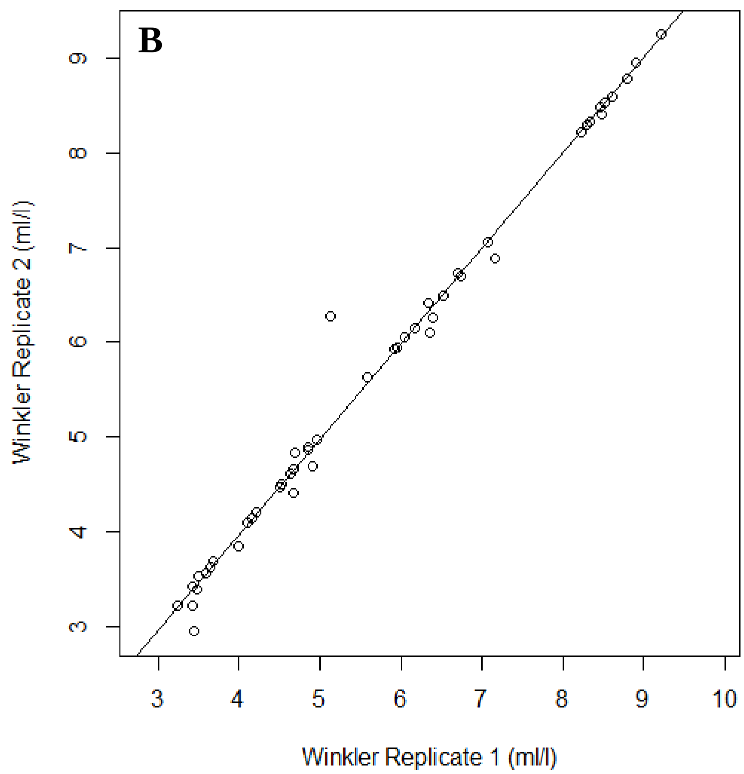


Figure 5. A) The fitted values of the linear regression plotted against the residuals. Note the 7 outliers removed from all further analysis, labelled by row ID. **B)** The linear relationship between the first and the second Winkler replicates with bad replicates removed (r^2=0.9966).

The Winkler replicates from the HUD2015004 mission were more variable than the fall AZMP mission and more outliers were observed. As with the fall mission, on average the 1st Winkler replicate value tends to be greater (0.04 ml/l) than the 2nd replicate (Figure 6). 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.

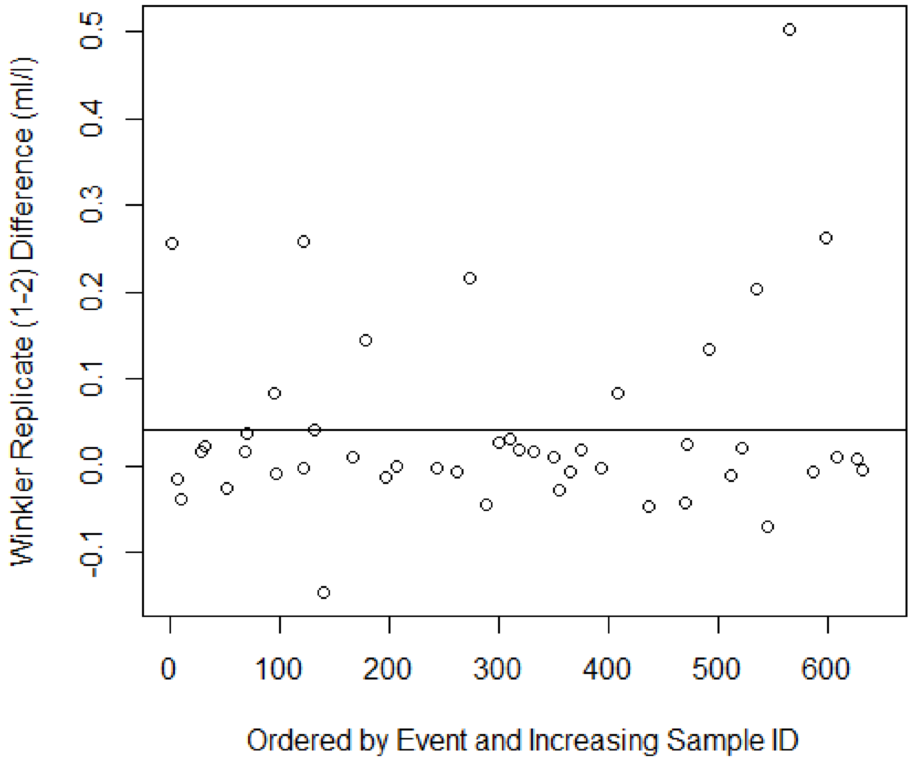


Figure 6. Difference between Winkler replicates 1 and 2. Horizontal line at mean difference between replicates of 0.04 ml/l.

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 sample. The ultimate goal of this analysis is to generate a linear slope scaling coefficient (Soc) to calibrate both primary and secondary sensor values. The Soc values provided below are preliminary and may not match the values generated by ODIS for CTD QC, although it could inform their process.

The adjusted Soc values are 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 7). This comparison showed a minor overall difference between primary and secondary oxygen sensors throughout mission. Some outliers were observed from the secondary oxygen sensor during Event 122 at STAB_01 when the pump failed and required replacement. After these outliers were removed from the dataset, the mean difference between the sensors was ~0.004 ml/l. After outlier removal, there was very good agreement between the primary and secondary sensor values (r^2=0.999).

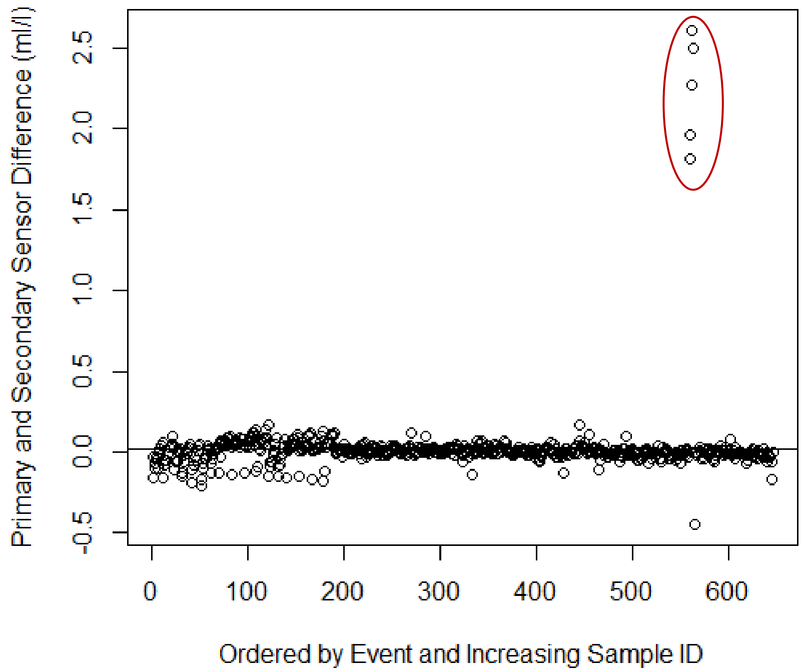


Figure 7. The difference between the primary and secondary sensor values during the mission (mean= 0.004 ml/l). Note that secondary sensor values from STAB_01 were removed before proceeding.

Comparisons between the primary sensor values and the mean Winkler values (Figure 8), showed a number of outliers (Figure 9). Given the very tight agreement between primary and secondary sensor values, it is difficult to say if corresponding erroneous Winkler values are incorrect. For these samples, the average Winkler value was not included in the threshold calculation (Sample ID – 406264, 406281, 406297, 406380, 406531, 406437, 406487, 406805, 406486, 406482, 406397, 406846). After removal of the outliers, the linear fit between primary sensor values and mean Winkler values is r^2=0.998.

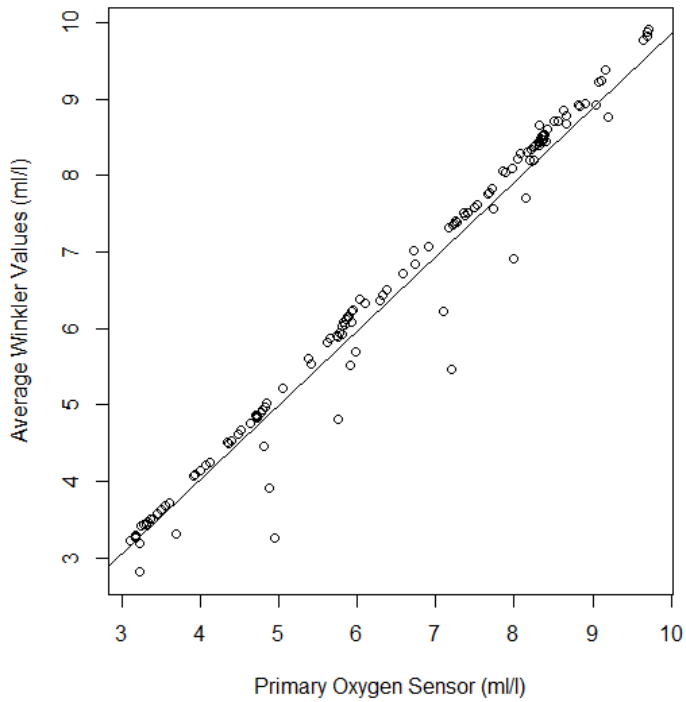


Figure 8. Comparison between primary oxygen sensor values and average Winkler values throughout the mission (not inlcuding STAB_01) before filtering (r^2=0.9735).

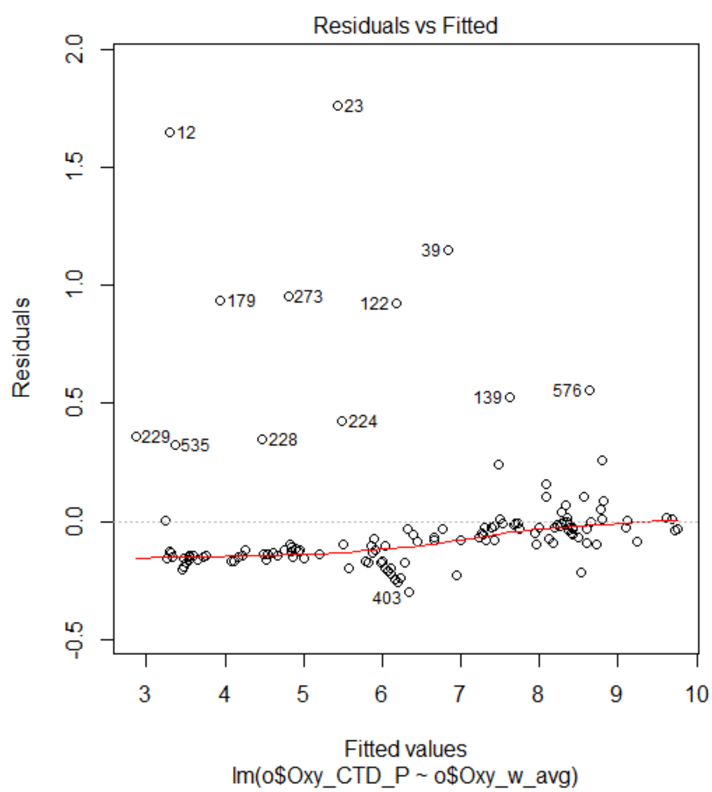
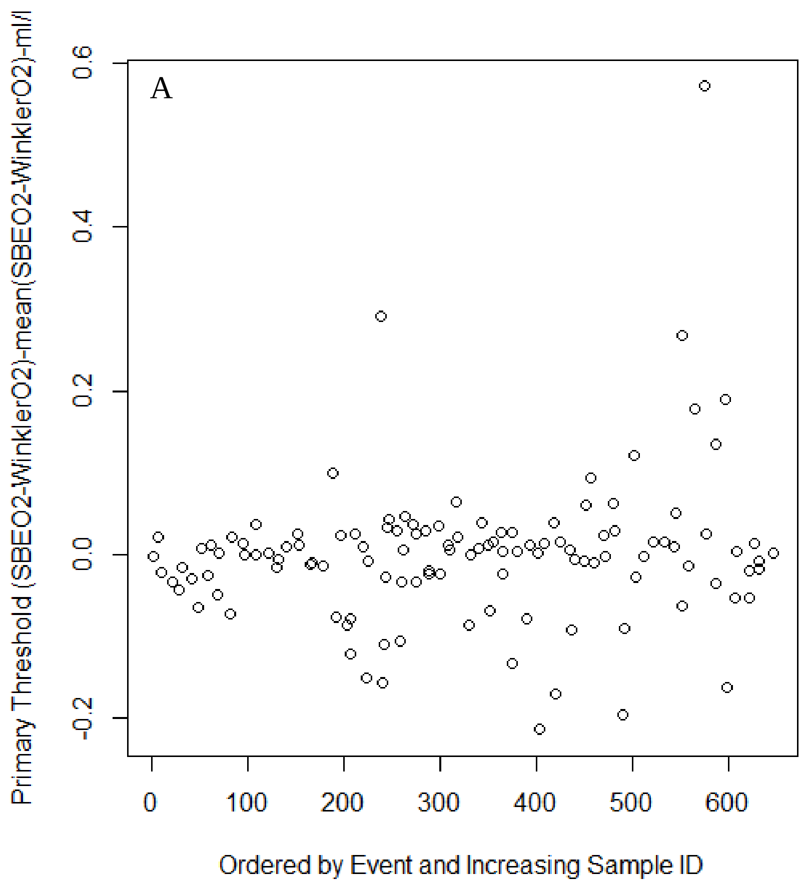


Figure 9. Plotted residuals between primary oxygen sensor values and corresponding averaged Winkler values. These outliers represent poor agreement between the primary sensor and corresponding Winkler values.

The threshold value was calculated and plotted for both the primary and secondary sensors (Figure 10 - 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 (#3026) and secondary (#3030) sensors were 1.0249 and 1.0234. This means that on average, oxygen sensor values were ~2.5% and ~2.3% less than their corresponding Winkler titration values.



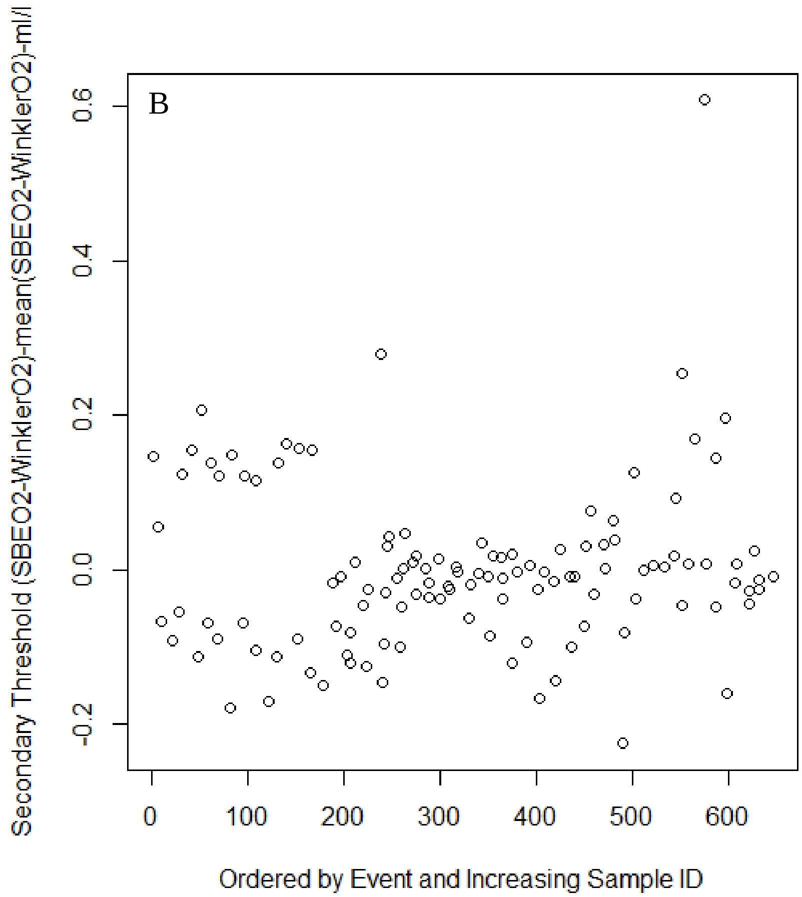


Figure 10. A) The calculated primary threshold values, and **B)** the secondary threshold values.

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

	Old Soc	**New Soc**	**Ratio (New:Old)**
Primary Sensor #3026	4.3050e-1	4.412e-1	1.0249
Secondary Sensor #3030	4.4970e-1	4.602e-1	1.0234

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 11 and 12).

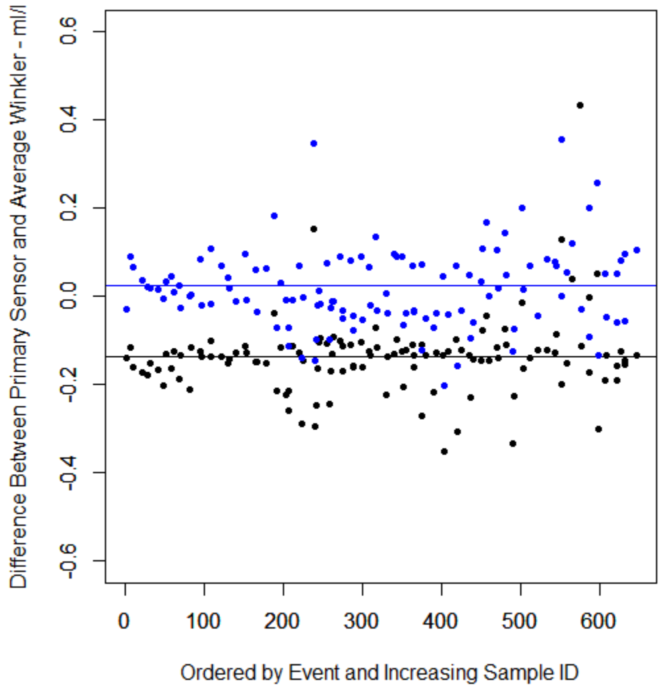


Figure 11. Black dots – uncorrected difference between primary sensor values and corresponding Winkler values (mean = -0.1369). Blue dots – Soc corrected difference between primary sensor values and corresponding Winkler values (mean = 0.0241).

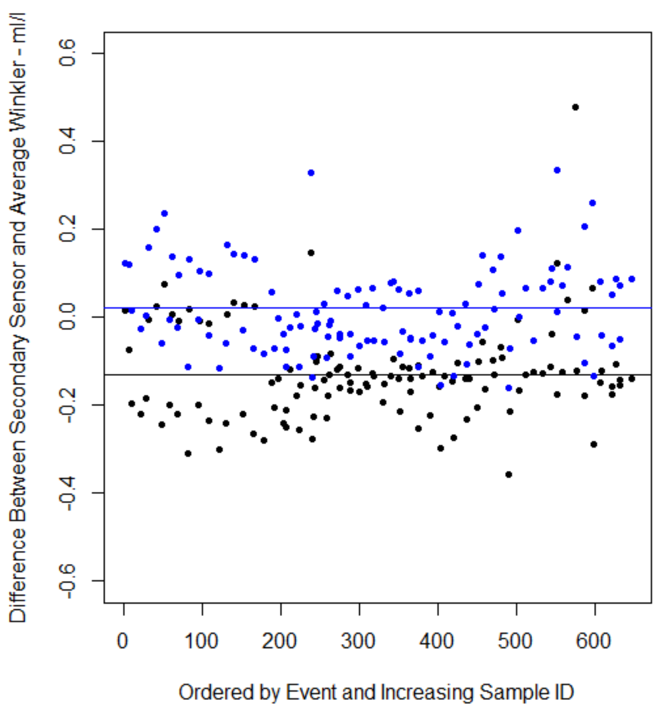


Figure 12. Black dots – uncorrected difference between secondary sensor values and corresponding Winkler values (mean=-0.1303). Blue dots – Soc corrected difference between secondary sensor values and corresponding Winkler values (mean=0.0211).

Figure 13 shows the difference between Soc corrected primary and secondary sensor values (mean difference = 0.0144 ml/l). The Soc correction, while bringing both sensors more in line with corresponding Winkler values, adversely affects the agreement between the primary and secondary sensors. It was also noticed that there is more variability between the corrected primary and secondary sensor values at the beginning of the mission. Discussions with one of the CTD operators suggest that cleaning a small pin hole valve in the secondary tubing early in the mission may have had some impact on this.

As observed in Figure 14, there is a slight depth dependent relationship between sensors below ~1500 m. At depth, the primary oxygen sensor seems to generate values slightly less than the secondary sensor. Note as well a high degree of variability in the difference between primary and secondary sensor values in the upper water column. This is likely due in part to the rapidly transitioning upper water column characteristics but also to a slight vertical offset between the primary and secondary sensor packages on the CTD.

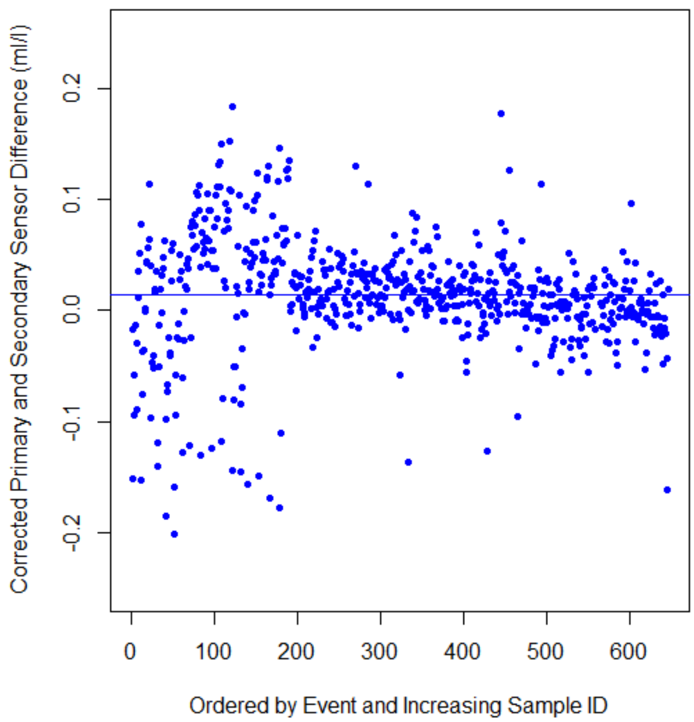


Figure 13. The Soc corrected difference between primary and secondary sensors. (ml/l)

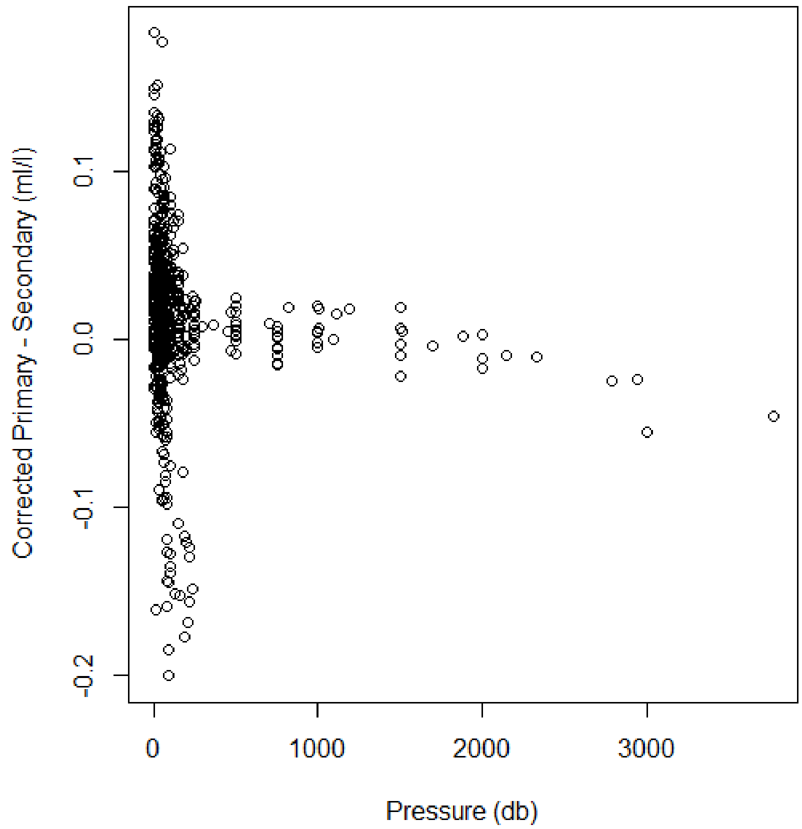


Figure 14. Relationship between corrected primary and secondary sensor values and pressure (db).

Salinity

(With portions extracted from HUD2014017 Cruise Report)

With the exception of secondary conductivity sensor values during Event 122 at STAB_01 (Figure 15), there was generally good agreement between the primary (#4361) and secondary (#3561) sensors throughout the mission. Once these erroneous values were removed, the linear fit was strong ($r^2 = 1$) and the average difference between the primary and secondary was consistent at ~-0.0032 P.S.U. An examination of the linear regression residuals between the primary and secondary sensors (Figure 16) revealed one outlier (-0.0846) from Event 124, Sample ID 406841 at Station EVC_01. Further comparison also showed a strong depth dependent relationship in the variability between primary and secondary sensor differences and depth (Figure 17), likely as a result of a combination of rapidly transitioning upper water column characteristics and a slight vertical offset noticed between the primary and secondary intakes on the CTD frame.

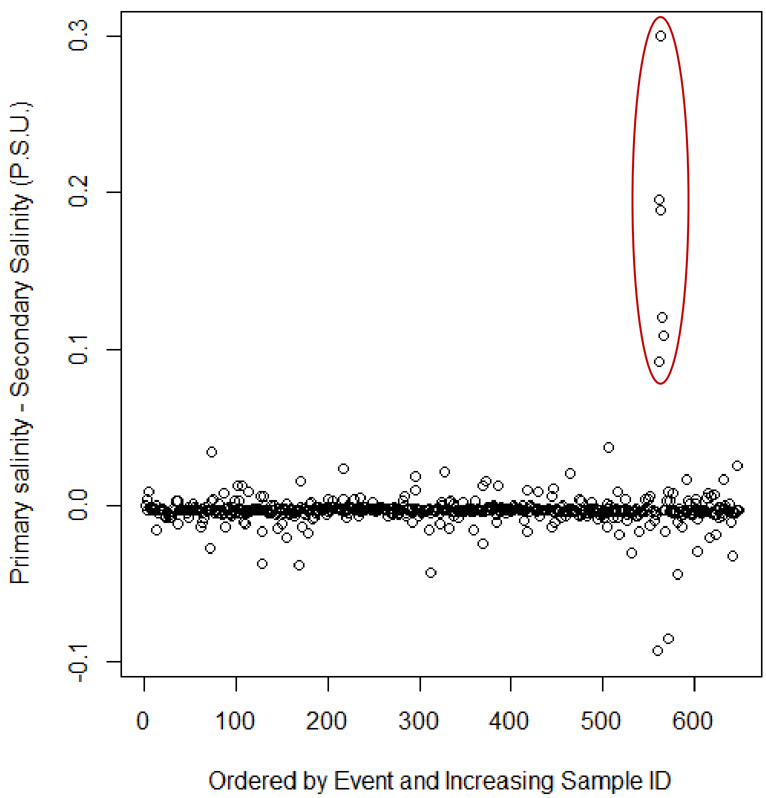


Figure 15. A) There was generally good agreement between the primary (#4361) and secondary (#3561) conductivity sensors throughout the mission. A malfunction of secondary pump caused the large differences observed during Event 122 at STAB_01 (circled in red). These values should be removed before data is archived.

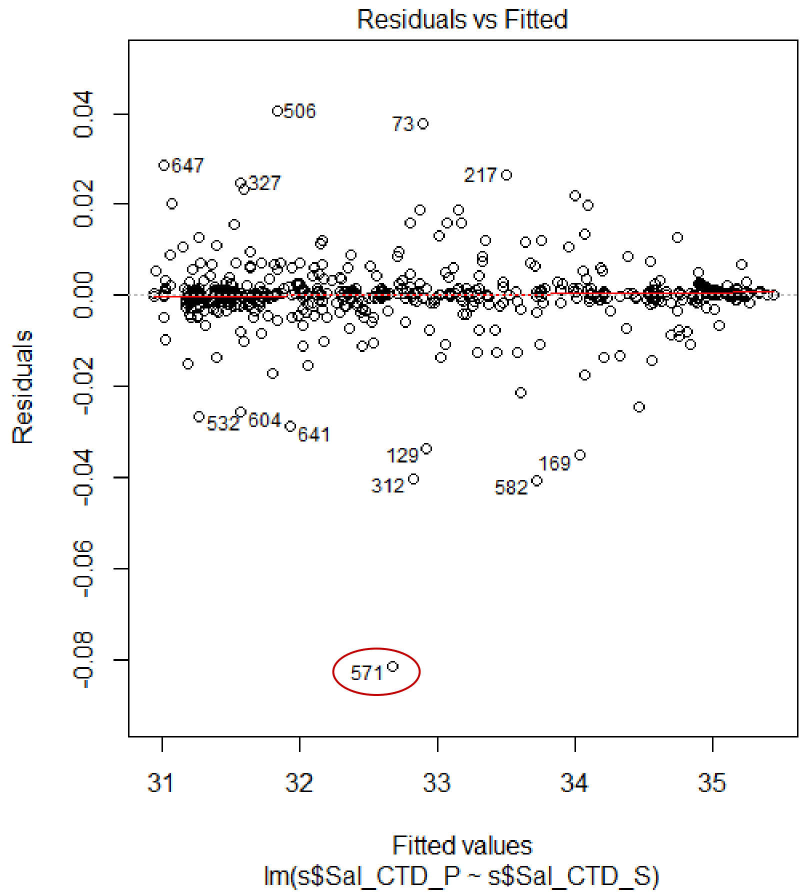


Figure 16. Outlier identified at Station EVC_01, Event 124 and Sample_ID 406841 (circled in red). It is likely that the difference stems from rapidly transitioning upper water column characteristics and a slight vertical offset between the primary and secondary intakes.

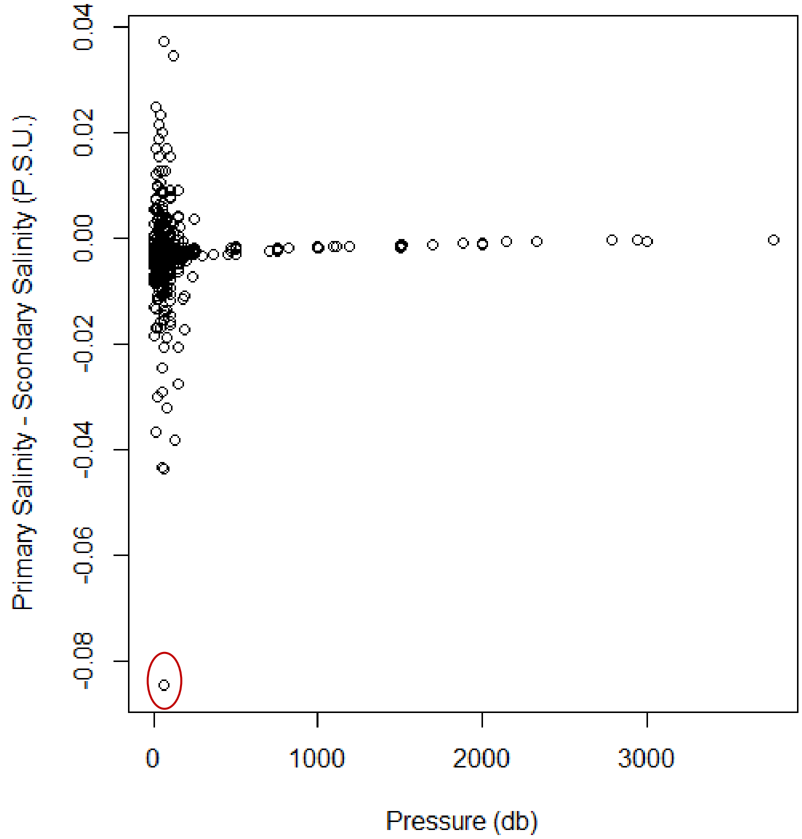


Figure 17. Depth dependent relationship between primary and secodary salinity sensor residual. The agreement between the sensors appears to improve slightly with increasing depth. Note, outlier identified at Station EVC_01, Event 124 and Sample_ID 406841 (circled in red)

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 during CTD post-processing prior to long term archiving of data.

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. It should be noted that the quality of the PAR sensor data was poor during some casts as was noted in the CTD overview above. While it provided a typical linear decline in irradiance when viewed in log scale, the profile was occasionally punctuated by spikes.

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 an ACCASP initiative investigating the delineation of ocean acidification and calcium carbonate saturation state of the Atlantic zone. Unfortunately, as mentioned in the CTD overview, the data acquired was of poor quality because the pH sensor had not been calibrated since March of 2012 and had not been well maintained. It has been recommended to ODIS that the pH sensor data collected during the mission not be included in the long term archive.

Biological Program

Narrative

The "core" biological program conducted as part of cruise HUD2015004, 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 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 HUD2015004, provided by Carina Gjerdrum of the Canadian Wildlife Service.

There was some discussion amongst the AZMP Steering Committee upon conclusion of the mission concerning the future of integrated phytoplankton sampling. Samples are currently collected, but are not analyzed. While this remains one of the core tenants of biological sampling for AZMP, its utility is minimal and a discussion about its future is underway.

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

Remarks/Comments

The vast majority of ring net, BioNess deployments were successful (Figure 18 and 19). 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 202 µm 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 69 successful vertical ring net tows during the mission (Figure 20). Of these, 8 were 76 µm mesh tows (30 cm diameter and 1:5 filtering ratio) along the shelf stations of the Halifax Line, and 29 were 202 µm mesh tows along the core AZMP sections (LL, HL and BBL). As mentioned in previous sections, there were no operations conducted at CSL during this mission due to extensive ice coverage. The 76 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.

Throughout the mission, 7 - 202 µm net tow samples of the top 50 m of the water column were collected for a Dovekie study being led by Carina Gjerdrum of Environment Canada, Canadian Wildlife Service (Event 18 – BBL_04, Event 39 – BBL_06, Event 45 – HL_07, Event 55 – HL_06, Event 62 – HL_05, Event 91 – LL_08, Event 95 – LL_07). 4 - 202 µm net tow samples (Event 8 – RL_01, Event 58 – HL_05.5, Event 89 – LL_08 and Event 100 at LL_05) were also collected for a study investigated egg clutch size in *C. finmarchicus*. The remaining 21 successful ring net tows were conducted at non-core stations throughout the mission (Table 7).

At the conclusion of a 202 µm net tow during Event 64 at HL_04, the sample was accidentally spilled and the tow was repeated. The ring net deployment at HL_03 during event 68 was aborted because the net was stuck under the hull during recover and the winch had to be stopped. Other than severe wire angles (45 – 50 degrees) during the final 30 – 50 m of Event 36 at BBL_05 and Event 103 at LL_04, all other ring net tows were successful (Table 7).

Excluding the test in Bedford Basin, there were a total of 7 successful BioNess deployments during the mission (Figure 21 and Table 7). Unfortunately, it was not possible to conduct a BioNess tow on the Cabot Strait Line due to extensive ice coverage. Poor sea state also precluded us from conducting a BioNess tow in the Gully during this mission.

From the first tests in Bedford Basin, the BioNess video camera blinked rapidly when the being hauled in. It appears as though it was reacting to triggering the net closed. It worked well enough to capture the nets closing but was providing sporadic feed until it completely malfunctioned during Event 102 at LL_05. The camera was replaced with a spare camera after event 125 at EVC_01 and it worked well for the three remaining BioNess tows.

Throughout the mission (starting at Event 10 at RL_01), the operating computer would lose communication with BioNess and the monitor would freeze. During the first instance, the mouse was replaced and the computer restarted and the system functioned well. During Event 125 at EVC_01, there were severe issues with BioNess prior to deployment. The BioNess GUI was freezing when the deck unit and Optical Plankton Counter were started. The computer was rebooted several times and the computer memory cards and cords were all removed and reinstalled. The problem was “fixed” but the issue remains undiagnosed.

After the mission, it was suggested to the AZMP Maritimes Steering Committee that we strongly consider our investment in BioNess. BioNess is in need of an upgrade and refurbishment that could require significant investment and time. Given its limited utility and the fact that it is not part of “core” AZMP operations, its long term use and maintenance is being assessed. Recently, members of PCSD worked with AZMP to acquire an improved computer, updated operating system and found a way to transfer the old software to the new computer. This is a short term stop gap, but will at least allow AZMP to continue BioNess operations for the remainder of the 2015 field season.

Figure 18. Marc Ringuette prepares to deploy a 202 µm ring net tow with the assistance of a CCGS Hudson crew member.

Figure 19. BioNess strapped to the quarterdeck of the CCGS Hudson, awaiting deployment.

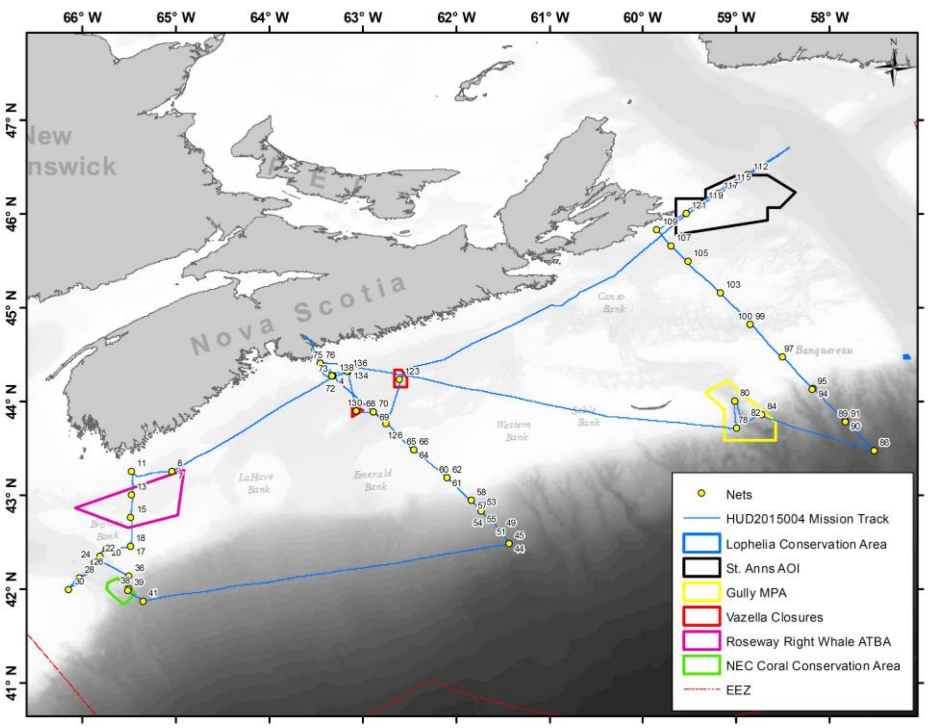


Figure 20. Locations for vertical ring net tows during HUD2015004 AZMP spring survey. Each tow is labelled with the consecutive mission event.

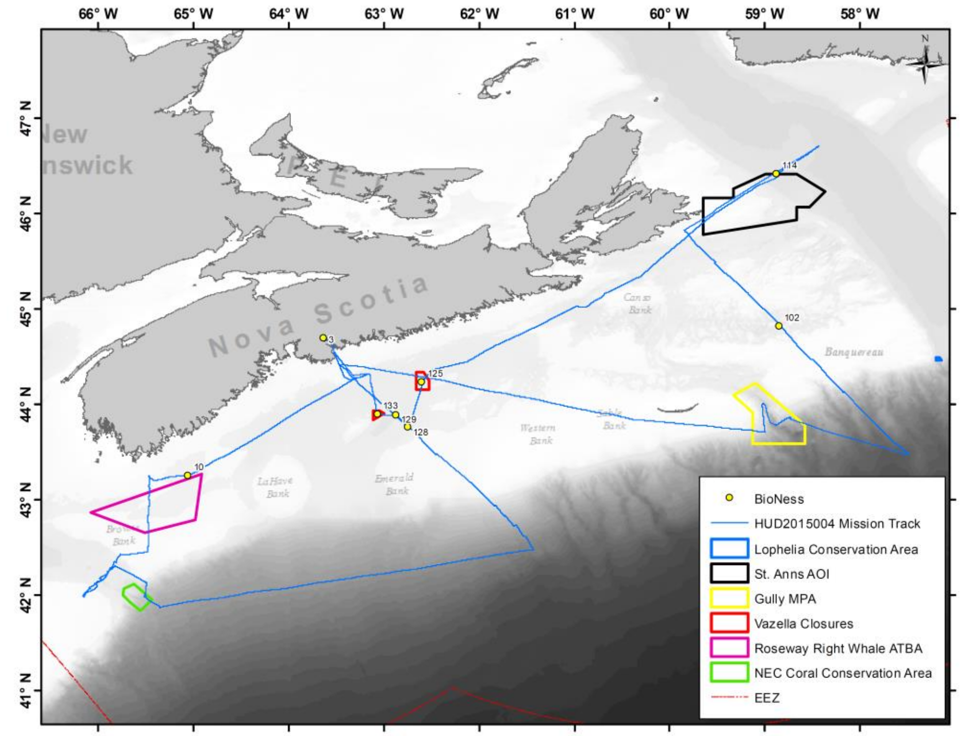


Figure 21. Start locations for BioNess tows during HUD2015004 AZMP spring survey. Each tow is labelled with the consecutive mission event.

Table 7. Zooplankton collection activities during the HUD2015004 AZMP spring survey. The coordinates provided are in decimal degrees and reflect the ship's position at the time of deployment as recorded using the ELOG meta-data logger. Bolded rows represent activities that were re-done.

#	Event	Date	Julian Day	Station	Operation	Mesh Size (µm)	Slat (DD)	SLong (DD)	Objective	Comment
1	3	17/04/2015	107	HL_00	BioNess		44.6958	-63.6391	Test	
2	4	18/04/2015	108	HL_02	RingNet	202	44.2668	-63.3160	1	
3	5	18/04/2015	108	HL_02	RingNet	76	44.2686	-63.3148	1	
4	7	18/04/2015	108	RL_01	RingNet	202	43.2513	-65.0405	8	
5	8	18/04/2015	108	RL_01	RingNet	202	43.2518	-65.0412	20	
6	10	18/04/2015	108	RL_01	BioNess		43.2512	-65.0574	8	
7	11	18/04/2015	108	BBL_01	RingNet	202	43.2465	-65.4773	1	
8	13	18/04/2015	108	BBL_02	RingNet	202	43.0000	-65.4776	1	
9	15	18/04/2015	108	BBL_03	RingNet	202	42.7599	-65.4816	1	
10	17	18/04/2015	108	BBL_04	RingNet	202	42.4492	-65.4858	1	
11	18	18/04/2015	108	BBL_04	RingNet	202	42.4487	-65.4888	14	
12	20	18/04/2015	108	PS_01	RingNet	202	42.4184	-65.7479	6	
13	22	19/04/2015	109	PS_02	RingNet	202	42.3412	-65.8156	6	
14	24	19/04/2015	109	PS_04	RingNet	202	42.2742	-65.8701	6	
15	26	19/04/2015	109	PS_06	RingNet	202	42.1999	-65.9386	6	
16	28	19/04/2015	109	PS_08	RingNet	202	42.1173	-66.0357	6	
17	30	19/04/2015	109	PS_10	RingNet	202	41.9877	-66.1470	6	
18	36	19/04/2015	109	BBL_05	RingNet	202	42.1327	-65.4999	1	Severe wire angle last 30 m
19	38	19/04/2015	109	BBL_06	RingNet	202	41.9999	-65.5093	1	
20	39	19/04/2015	109	BBL_06	RingNet	202	41.9831	-65.5095	14	
21	41	19/04/2015	109	BBL_07	RingNet	202	41.8657	-65.3521	1	
22	44	20/04/2015	110	HL_07	RingNet	202	42.4750	-61.4335	1	
23	45	20/04/2015	110	HL_07	RingNet	202	42.4748	-61.4335	14	

24	49	20/04/2015	110	HL_06.7	RingNet	202	42.6161	-61.5184	1	
25	51	21/04/2015	111	HL_06.3	RingNet	202	42.7276	-61.6231	1	
26	53	21/04/2015	111	HL_06	RingNet	202	42.8319	-61.7331	1	
27	54	21/04/2015	111	HL_06	RingNet	76	42.8280	-61.7332	1	
28	55	21/04/2015	111	HL_06	RingNet	202	42.8279	-61.7338	14	
29	57	21/04/2015	111	HL_05.5	RingNet	202	42.9395	-61.8338	1	
30	58	21/04/2015	111	HL_05.5	RingNet	202	42.9377	-61.8388	20	
31	60	21/04/2015	111	HL_05	RingNet	202	43.1821	-62.0984	1	
32	61	21/04/2015	111	HL_05	RingNet	76	43.1820	-62.0994	1	
33	62	21/04/2015	111	HL_05	RingNet	202	43.1821	-62.1003	14	
34	**64**	**21/04/2015**	**111**	HL_4	**RingNet**	**202**	**43.4788**	**-62.4516**	**1**	**Sampled spilled and another 202 µm tow conducted during Event 66**
35	65	21/04/2015	111	HL_4	RingNet	76	43.4776	-62.4524	1	
36	66	21/04/2015	111	HL_4	RingNet	202	43.4760	-62.4531	1	
37	**68**	**21/04/2015**	**111**	HL_03	**RingNet**	**202**	**43.8833**	**-62.8827**	**1**	**Aborted - net under hull when hauling back and winch stopped**
38	69	21/04/2015	111	HL_03	RingNet	202	43.8831	-62.8837	1	
39	70	21/04/2015	111	HL_03	RingNet	76	43.8827	-62.8857	1	
40	72	22/04/2015	112	HL_02	RingNet	202	44.2666	-63.3165	1	
41	73	22/04/2015	112	HL_02	RingNet	76	44.2669	-63.3194	1	
42	75	22/04/2015	112	HL_01	RingNet	202	44.3996	-63.4504	1	
43	76	22/04/2015	112	HL_01	RingNet	76	44.3999	-63.4518	1	

44	78	23/04/2015	113	SG_28	RingNet	202	43.7095	-59.0018	4	
45	80	23/04/2015	113	GULD_03	RingNet	202	44.0017	-59.0197	4	
46	82	23/04/2015	113	GULD_04	RingNet	202	43.7896	-58.8997	4	
47	84	23/04/2015	113	SG_23	RingNet	202	43.8577	-58.7312	4	
48	86	23/04/2015	113	LL_09	RingNet	202	43.4733	-57.5262	1	
49	89	23/04/2015	113	LL_08	RingNet	202	43.7829	-57.8325	20	
50	90	23/04/2015	113	LL_08	RingNet	202	43.7836	-57.8332	1	
51	91	24/04/2015	114	LL_08	RingNet	202	43.7833	-57.8334	14	
52	94	24/04/2015	114	LL_7	RingNet	202	44.1325	-58.1767	1	
53	95	24/04/2015	114	LL_7	RingNet	202	44.1284	-58.1874	14	
54	97	24/04/2015	114	LL_06	RingNet	202	44.4745	-58.5086	1	
55	99	24/04/2015	114	LL_05	RingNet	202	44.8158	-58.8522	1	
56	100	24/04/2015	114	LL_05	RingNet	202	44.8155	-58.8549	20	
57	102	24/04/2015	114	LL_05	BioNess	202	44.8171	-58.8511	1	Video camera malfunctioned and was replaced at conclusion of tow
58	103	24/04/2015	114	LL_04	RingNet	202	45.1576	-59.1750	1	Severe wire angle last 50 m
59	105	24/04/2015	114	LL_03	RingNet	202	45.4914	-59.5167	1	
60	107	24/04/2015	114	LL_02	RingNet	202	45.6580	-59.7021	1	
61	109	24/04/2015	114	LL_01	RingNet	202	45.8252	-59.8506	1	
62	112	25/04/2015	115	STAB_05	RingNet	202	46.4172	-58.8822	5	
63	114	25/04/2015	115	STAB_05	BioNess		46.4166	-58.8814	5	
64	115	25/04/2015	115	STAB_04	RingNet	202	46.3003	-59.0660	5	
65	117	25/04/2015	115	STAB_03	RingNet	202	46.2169	-59.1948	5	
66	119	25/04/2015	115	STAB_02	RingNet	202	46.1085	-59.3654	5	
67	121	25/04/2015	115	STAB_01	RingNet	202	46.0002	-59.5340	5	

68	123	26/04/2015	116	EVC_01	RingNet	202	44.2345	-62.6053	19	
69	125	26/04/2015	116	EVC_01	BioNess	202	44.2358	-62.6032	19	Severe issues with BioNess prior to deployment (detailed in narrative)
70	126	26/04/2015	116	HL_03.3	RingNet	202	43.7639	-62.7524	1	
71	128	26/04/2015	116	HL_03.3	BioNess	202	43.7620	-62.7499	1	
72	129	26/04/2015	116	HL_03	BioNess	202	43.8828	-62.8808	1	
73	130	26/04/2015	116	SAM_03	RingNet	202	43.8931	-63.0733	19	
74	133	26/04/2015	116	SAM_03	BioNess	202	43.8935	-63.0729	19	
75	134	26/04/2015	116	HA_03	RingNet	202	44.3224	-63.1570	18	
76	136	27/04/2015	117	HA_02	RingNet	202	44.3200	-63.1651	18	
77	138	27/04/2015	117	HL_02	RingNet	202	44.2664	-63.3167	1	
78	139	27/04/2015	117	HL_02	RingNet	76	44.2667	-63.3168	1	
79	141	27/04/2015	117	HA_01	RingNet	202	44.2725	-63.3247	18	

Dissolved Carbon Sampling

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

The Dalhousie CO_2 group's objective on the AZMP Spring 2015 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 3 of the 4 AZMP core transects: Halifax Line (HL), Louisburg Line (LL), and Browns Bank Line (BBL). Cabot Strait Line (CSL) was not collected due to ice formation. This year we decided not sample the HL decimal stations (ie. 3.3, 6.3 ect.), and only sampled up to station 7 (due to time constraints of the cruise). We sampled all BBL and LL stations.

VINDTA

VINDTA operations went smoothly this cruise. The only issue we had was day 1 where a component of the gas line needed replacing. Operation temperature of the VINDTA was not an issue this cruise unlike the last. This is likely the result of repairs done to the water cooling system after the last AZMP cruise, allowing for a larger water flow to better the system's heat sink.

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

Typically a number of suspended particle filters are collected along the cruise track by filtering water from the ship's underway seawater system located in the Forward Lab, however the absence of this pump system prevented the suspended particle sampling during this cruise. Filtering is usually 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, would have been filtered through a pre-combusted 142mm GFF filter placed on a Millipore PVC filter holder. Upon recovery, filters are packed in pre-combusted aluminium foil and frozen immediately at -20°C. Filters are 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 181 water samples were taken from the CTD Rosette at all depths for 5 Halifax Line stations (HL_02, 04, 05, 06, 07), and one St. Anns Bank station (STAB_05). Replicate samples (10 replicate samples from 10 depths) were taken at HL_07 on this cruise. These replicate samples have previously been collected at HL_09 in past AZMP missions; however, we did not reach station HL_09 during this trip. 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. Typically more stations from the Halifax Line would be sampled, as well as some Browns Bank stations, however due to time constraints on this cruise we were unable to sample. In addition, the Cabot Strait stations are of interest, but due to sea ice extent we were unable to take samples from this region.

Pelagic Seabird and Marine Mammal Observations

Seabird Survey Report
18 – 26 April, 2015
Canadian Wildlife Service, Environment Canada
Prepared by: Carina Gjerdrum carina.gjerdrum@ec.gc.ca
Observer: Holly Hogan

Background

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

Methods

Seabird and marine mammal surveys were conducted from the port side of the bridge of the Hudson during the spring Scotian Shelf AZMP from 18 – 26 April, 2015. Surveys were conducted while the ship was moving at speeds greater than 4 knots, looking forward and scanning a 90° arc to one side of the ship. All birds observed on the water within a 300m-wide transect were recorded, and we used the snapshot approach for flying birds (intermittent sampling based on the speed of the ship) to avoid overestimating abundance of birds flying in and out of transect. Distance sampling methods were incorporated to address the variation in bird detectability. Marine mammal observations were also recorded, although surveys were not specifically designed to detect marine mammals. Details of the methods used can be found in the CWS standardized protocol for pelagic seabird surveys from moving platforms[1].

[1]Gjerdrum, C., D.A. Fifield, and S.I. Wilhelm. 2012. Eastern Canada Seabirds at Sea (ECSAS) standardized protocol for pelagic seabird surveys from moving and stationary platforms. Canadian Wildlife Service Technical Report Series. No. 515. Atlantic Region. vi + 36 pp.

Results

Seabird Sightings

We surveyed 906 km of ocean from 18-26 April, 2015. A total of 306 birds were observed in transect (552 birds in total) from 5 families (Table 8). Bird densities averaged 1.2 birds/km^2 (ranging from 0 - 46 birds/km^2). The highest densities of birds (> 10 birds/km2) were observed in the Fundian Channel, western Sable Island Bank, southern Misaine Bank, off eastern Cape Breton Island, and in the slope waters within the Gully MPA (Figure 22a).

Dovekie was the species most commonly observed, accounting for 28% of the observations (Table 1), which were seen primarily on the western Sable Island Bank and in slope waters off the eastern Scotian Shelf (Figure 22b). Dovekie are considered the most abundant seabird species in the north Atlantic, and are present in this area during the non-breeding season (Nov – May). Murre (Common and Thick-billed) are also wintering in this area, and accounted for 19% of the observations. They were observed throughout the survey area but at the highest densities on the eastern Scotian Shelf and Slope (Figure 22c). The bulk of the murre population breeds at locations north of Nova Scotia (NL and Arctic), although small numbers breed in the Bay of Fundy and off Cape Breton Island.

Herring Gulls comprised of 21% of the observations; the highest densities were observed offshore in the Fundian Channel and in slope waters off the eastern Scotian Shelf. Great Black-backed Gulls were observed in smaller numbers but throughout the study area (Figure 22d). Northern Gannet comprised of 10% of the observations and were seen in low densities throughout the study area and in higher densities at the mouth of the Fundian Channel (Figure 22e), presumably moving towards breeding colonies in NL and the Gulf of St. Lawrence. Northern Fulmar are observed in the waters off Nova Scotia throughout the year, but breed in NL and the eastern Arctic. They made up 10% of the sightings and were observed primarily on the eastern Scotian Shelf (Figure 22f). All three Arctic-breeder Jaeger were also sighted.

A total of 10 songbirds were observed on their migration towards breeding locations, including 4 Fox Sparrow (*Passerella iliaca*), 2 American Robin (*Turdus migratorius*) , 2 Ipswich Sparrow (*Passerculus sandwichensis princeps*), 1 Dark-eyed Junco (*Junco hyemalis*), and 1 Veery (*Catharus fuscescens*). It should be noted that the Ipswich Sparrow is listed as a species of Special Concern that nests almost exclusively on Sable Island.

Marine Mammal Sightings

A total of 33 marine mammals were recorded during the surveys (Table 9), none of which occurred in the Gully MPA. Common, White-beaked and unidentified Dolphins were observed in the deeper slope waters (Figure 23a), as were Humpback and Long-finned Pilot Whales (Figure 23b).

Gully MPA

Only the southeastern portion of the Gully MPA was surveyed. No marine mammals and just 21 birds were observed within this area. Bird sightings included Common Murre, Northern Fulmar, Dovekie, Northern Gannet, and an unidentified Gull species (Table 10; Figure 24).

Table 8. List of bird species observed during the seabird survey on the spring Scotian Shelf AZMP, from 18-26 April, 2015.

Family	Species	Latin	Number observed in transect	Total number observed
Procellariidae	Northern Fulmar	*Fulmarus glacialis*	31	103
	Sooty Shearwater	*Puffinus griseus*	1	8
	Manx Shearwater	*Puffinus puffinus*	0	1
Hydrobatidae	Wilson's Storm Petrel	*Oceanites oceanicus*	0	2
Sulidae	Northern Gannet	*Morus bassanus*	32	78
Laridae	Herring Gull	*Larus argentatus*	65	100
	Great Black-backed Gull	*Larus marinus*	6	7
	Black-legged Kittiwake	*Rissa tridactyla*	4	8
	Iceland Gull	*Larus glaucoides*	2	2
	Glaucous Gull	*Larus hyperboreus*	0	1
	Unidentified Gull	*Larus*	1	7
	Pomarine Jaeger	*Stercorarius pomarinus*	2	3
	Parasitic Jaeger	*Stercorarius parasiticus*	2	2
	Unidentified Jaeger	*Stercorarius*	1	1
	Long-tailed Jaeger	*Stercorarius longicaudus*	0	1
Alcidae	Dovekie	*Alle alle*	87	125
	Common Murre	*Uria aalge*	23	25
	Thick-billed Murre	*Uria lomvia*	15	16
	Unidentified Murre	*Uria*	19	27
	Atlantic Puffin	*Fratercula arctica*	7	8
	Unidentified Auk	Alcidae	5	19
	Razorbill	*Alca torda*	1	1
	Murre or Razorbill	*Uria* or *Alca*	2	7
Total			**306**	**552**

Table 9. List of marine mammals observed during the seabird survey on the spring Scotian Shelf AZMP, from 18-26 April, 2015.

Species	**Latin**	**Total number observed**
White-beaked Dolphin	*Lagenorhynchus albirostris*	8
Common Dolphin	*Delphinus delphis*	8
Unidentified Dolphins	Delphinidae	7
Humpback Whale	*Megaptera novaeangliae*	5
Long-finned Pilot Whale	*Globicephala melas*	3
Sei Whale	*Balaenoptera borealis*	2
Total		**33**

Table 10. List of species observed in the Gully Marine Protected Area on 23 April, 2015.

Species	**Latin**	**Number observed in transect**
Common Murre	*Uria aalge*	10
Unidentified Murre	*Uria*	4
Northern Fulmar	*Fulmarus glacialis*	3
Dovekie	*Alle alle*	2
Northern Gannet	*Morus bassanus*	1
Unidentified Gull	*Larus*	1
Total sightings		**21**

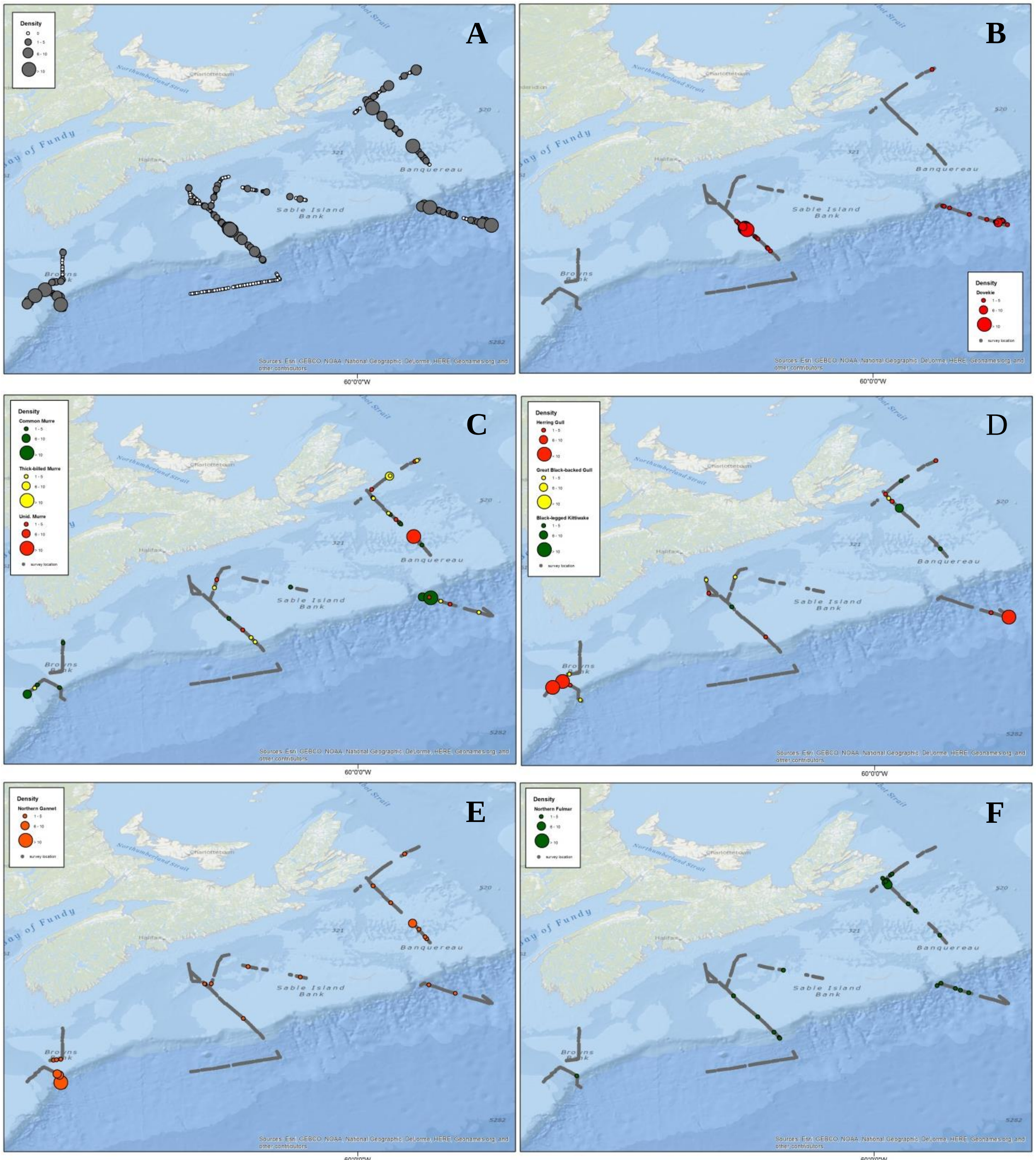


Figure 22. Density of A) total birds; B) Dovekie; C) murres, D) gulls, E) Northern Gannet; and F) Northern Fulmar observed during the spring AZMP, 18-26 April, 2015.

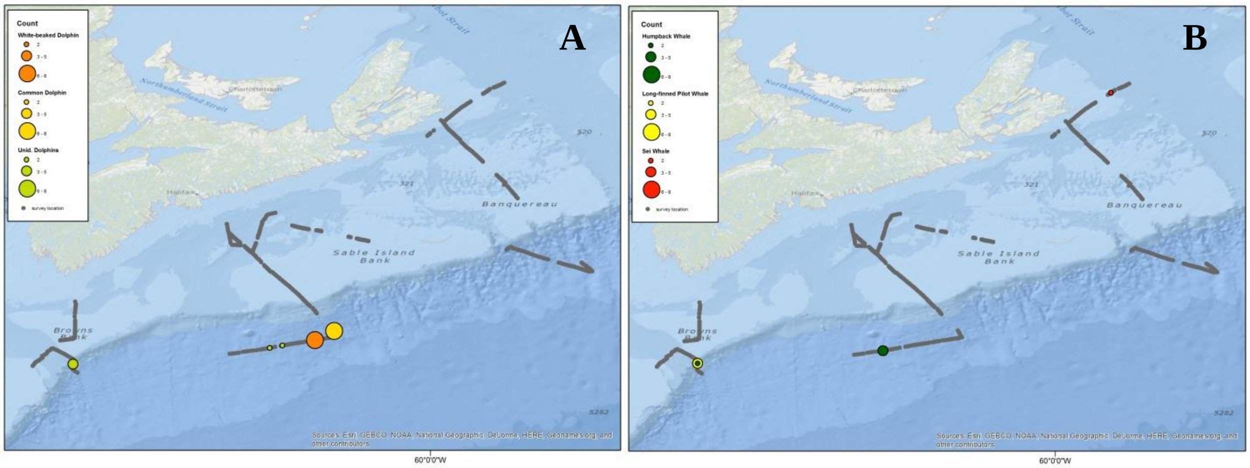


Figure 23. Counts of A) dolphins and B) whales observed during the spring AZMP, 18-26 April, 2015.

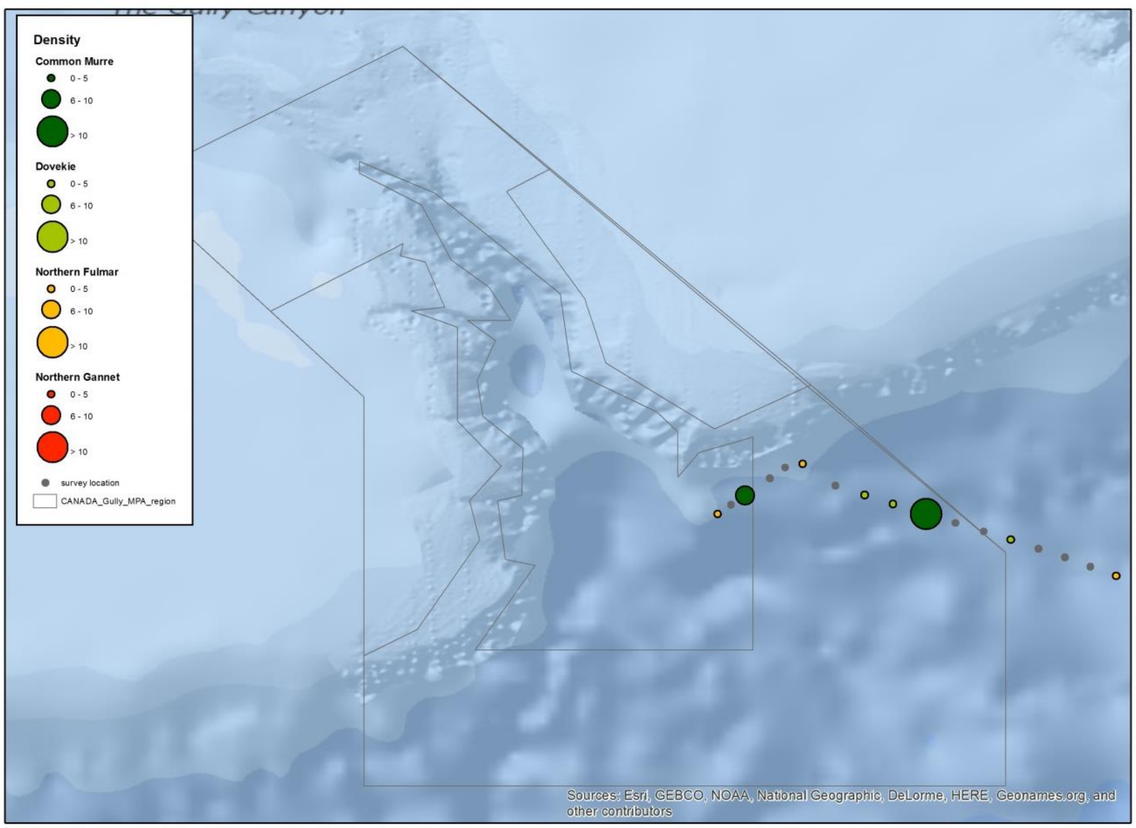


Figure 24. Density of Common Murre, Dovekie, Northern Fulmar and Northern Gannet observed in the Gully Marine Protected Area on 23 April, 2015.

ARGO Float Deployments

Contributions by: Ingrid Peterson

<u>Narrative</u>

There were a total of 4 successful ARGO float deployments during HUD2015004 (Figure 25 and Table 11). Prior to the beginning of the mission, the 4 floats were planned for deployment in the deep water portions of the Halifax Line (HL_07 and HL_11) and Louisbourg Line (LL_08 and LL_09). Ship related delays meant that a float was not deployed at HL_11 as planned. Instead, 2 floats (SN214 and SN194) were deployed at HL_07 on April 20th (Figure 26). The remaining 2 floats were deployed at LL_09 (SN215) and LL_08 (SN216) on April 23rd and 24th respectively.

All floats deployed reported their housekeeping files on the day of their deployment. As of May 14th, 2015 - 3 of the 4 floats continue to transmit profiles. Float SN215 submitted a single profile on the 24th of May and began transmitting housekeeping data every 5 minutes until the unit was deactivated on May 28th. Profile information transmitted by these floats can be found at the following location by using the WMO # in the matrix provided:

http://www.argodatamgt.org/Access-to-data/Description-of-all-floats2

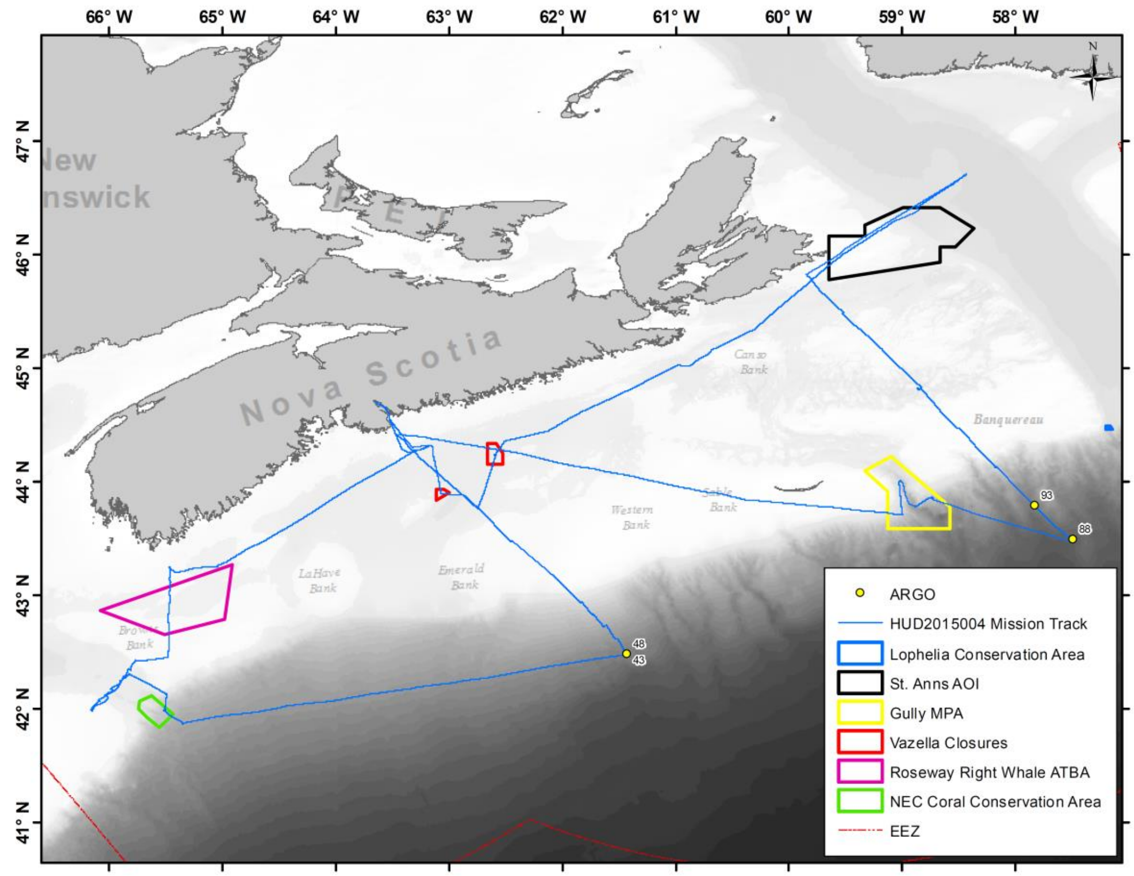


Figure 25. The locations for each Argo float deployment during HUD2015004. Refer to Table 13 for more details.

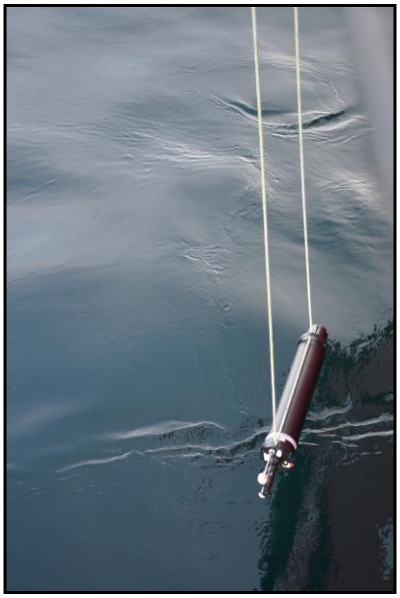


Figure 26. A typical Nova float deployment.

Table 11. Deployment details for Argo float deployments during HUD2015004. 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)	IMEI#	Serial Number	WMO #	Slat (DD)	Slong (DD)
20/04/2015	110	043	HL_07	1456	300234062957330	SN214	4901798	42.4750	-61.4335
20/04/2015	110	048	HL_07	2051	300234062557630	SN194	4901778	42.4749	-61.4341
23/04/2015	113	088	LL_09	2041	300234062952340	SN215	4901799	43.4862	-57.4965
24/04/2015	114	093	LL_08	0230	300234062954320	SN216	4901800	43.7888	-57.8362

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 long term averaged ADCP data every 20min using the CODAS (Common Ocean Data Access System) processing software and displayed contour and depth averaged vector plots used to verify that the system was functioning. The water track and bottom track data were analysed to correct the transducer alignment since this was the first cruise to use the VMADCP after the winter re-fit. As shown in figure below the transducer alignment requires approximately a -3 degree correction. This correction will be applied for the remainder of the cruises this year in the configuration file by adding 3 degrees to the existing EA value of 6694 to give 6997. Please see the configuration file in Appendix 3.

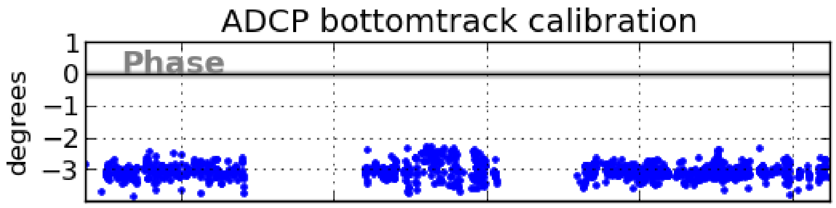


Figure 27. Transducer alignment required ~ -3 degree correction.

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 on station for depth estimation. At CTD stations, the echo sounder system is occasionally 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.

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 4 for a table detailing the data collected during HUD2015004, 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 HUD2015004. ELOG was accessible via any computer connected to the *science network* on-board the vessel. 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.

The underway system in the forward lab was not assembled for this mission due to last minute cancellation of scientific staff prior to sailing. For this reason, the Scientific Computing System (SCS) software and associated operating system were not set up during the mission. It is hoped that both the underway system and SCS software can be properly set up in advance of the fall AZMP mission.

Data Input Template

The AZMP Microsoft Access database template was further developed and utilized extensively during this mission. 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

Extensive changes to the computer room layout were made in advance of this mission by Terry Cormier of PCSD (Figure 28). The CTD computer operator now interfaces with a bank of labelled LCD monitors that contain feeds for the CTD computer, REGULUS computer supplied by NRCAN, ELOG computer, the video camera for the winch room view, a view for the CTD rotation package and the 12.5 and 3.5 KHz sounders (although the sounder was not hooked into the monitor bank for this trip). The computer monitors, mice and keyboards are on KVM switches that allow the operator to change views and computer control without moving to a different "work station". This significantly improved the workflow in the computer room and cleaned up the bench space that was required for data and meta-data documentation during station occupations. This system will now be a permanent fixture in the computer lab.

As during HUD2014030, 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. This year, a member of the ship's crew also made a mount for a keyboard and mouse below the monitor to free up work area for sample extraction and data and meta-data documentation during station occupations.

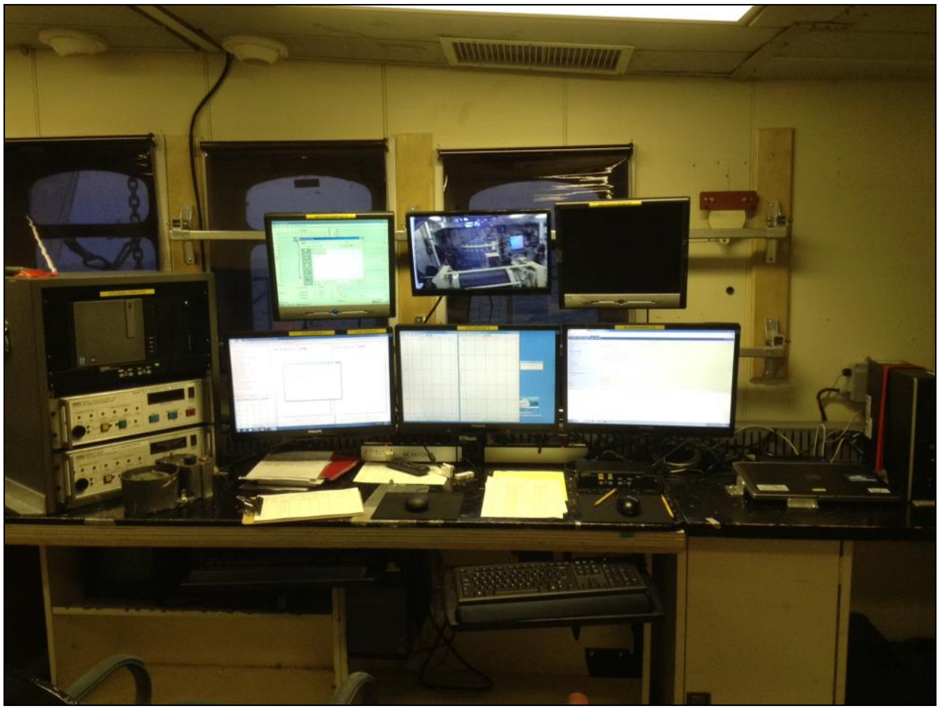


Figure 28. The modified computer room workspace for the CTD operator during HUD2015004.

APPENDICES

Appendix 1. CTD configuration file – HUD2015004.xmlcon

Configuration report for SBE 911plus/917plus CTD

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

1) Frequency 0, Temperature

Serial number : 4807
Calibrated on : 05-Dec-2014
A : 3.68121197e-003
B : 6.00113208e-004
C : 1.52928174e-005
D : 1.66592798e-006
F0 : 2910.609
Slope : 1.00000000
Offset : 0.0000

2) Frequency 1, Conductivity

Serial number : 4361
Calibrated on : 26-Nov-2014
G : -9.70648278e+000
H : 1.33560225e+000
I : -1.18818717e-003
J : 1.44326400e-004
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

Serial number : 69009-0475
Calibrated on : 19-Dec-14

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 : 0.99992289
Offset : 3.14159
AD590M : 1.281640e-002
AD590B : -9.148720e+000

4) Frequency 3, Temperature, 2

Serial number : 5081
Calibrated on : 24-Dec-2014
A : 3.68121204e-003
B : 6.01436527e-004
C : 1.57654409e-005
D : 2.16013383e-006
F0 : 3243.033
Slope : 1.00000000
Offset : 0.0000

5) Frequency 4, Conductivity, 2

Serial number : 3561
Calibrated on : 09-Dec-2014
G : -1.03485230e+001
H : 1.25085848e+000
I : -2.12602640e-003
J : 1.98514753e-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 : 3026
Calibrated on : 09-Dec-2014
Equation : Sea-Bird
Soc : 4.30500e-001
Offset : -5.05200e-001
A : -3.48550e-003
B : 1.81030e-004
C : -2.71480e-006
E : 3.60000e-002
Tau20 : 1.84000e+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 : 3030
Calibrated on : 09-Dec-2014
Equation : Sea-Bird
Soc : 4.49700e-001
Offset : -5.17500e-001
A : -2.87650e-003
B : 1.45360e-004
C : -2.21810e-006
E : 3.60000e-002
Tau20 : 1.81000e+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, Fluorometer, Seapoint Ultraviolet

Serial number : 3668
Calibrated on : 1-Jan-2015
Range : 50.000000
Offset : 0.000000

11) A/D voltage 5, Fluorometer, Seapoint

Serial number : 6210
Calibrated on : 1-Jan-2005
Gain setting : 3 x, 0-50 µg/l
Offset : 0.000

12) A/D voltage 6, 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

13) A/D voltage 7, pH

Serial number : 0743
Calibrated on : 6-Mar-2012
pH slope : 4.6292
pH offset : 2.5140

Scan length : 37

Appendix 2. CTD configuration file – HUD2015004_switchedphPAR.xmlcon

Configuration report for SBE 911plus/917plus CTD

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

1) Frequency 0, Temperature

Serial number : 4807
Calibrated on : 05-Dec-2014
A : 3.68121197e-003
B : 6.00113208e-004
C : 1.52928174e-005
D : 1.66592798e-006
F0 : 2910.609
Slope : 1.00000000
Offset : 0.0000

2) Frequency 1, Conductivity

Serial number : 4361
Calibrated on : 26-Nov-2014
G : -9.70648278e+000
H : 1.33560225e+000
I : -1.18818717e-003
J : 1.44326400e-004
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

Serial number : 69009-0475
Calibrated on : 19-Dec-14

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 : 0.99992289
Offset : 3.14159
AD590M : 1.281640e-002
AD590B : -9.148720e+000

4) Frequency 3, Temperature, 2

Serial number : 5081
Calibrated on : 24-Dec-2014
A : 3.68121204e-003
B : 6.01436527e-004
C : 1.57654409e-005
D : 2.16013383e-006
F0 : 3243.033
Slope : 1.00000000
Offset : 0.0000

5) Frequency 4, Conductivity, 2

Serial number : 3561
Calibrated on : 09-Dec-2014
G : -1.03485230e+001
H : 1.25085848e+000
I : -2.12602640e-003
J : 1.98514753e-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 : 3026
Calibrated on : 09-Dec-2014
Equation : Sea-Bird
Soc : 4.30500e-001
Offset : -5.05200e-001
A : -3.48550e-003
B : 1.81030e-004
C : -2.71480e-006
E : 3.60000e-002
Tau20 : 1.84000e+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 : 3030
Calibrated on : 09-Dec-2014
Equation : Sea-Bird
Soc : 4.49700e-001
Offset : -5.17500e-001
A : -2.87650e-003
B : 1.45360e-004
C : -2.21810e-006
E : 3.60000e-002
Tau20 : 1.81000e+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, Fluorometer, Seapoint Ultraviolet

Serial number : 3668
Calibrated on : 1-Jan-2015
Range : 50.000000
Offset : 0.000000

11) A/D voltage 5, Fluorometer, Seapoint

Serial number : 6210
Calibrated on : 1-Jan-2005
Gain setting : 3 x, 0-50 µg/l
Offset : 0.000

12) A/D voltage 6, pH

Serial number : 0000
Calibrated on : 0000
pH slope : 4.6292
pH offset : 2.5140

13) A/D voltage 7, PAR/Irradiance, Biospherical/Licor

Serial number : 0000
Calibrated on : 0000
M : -0.77322200
B : -3.53691000
Calibration constant : 4.90000000
Multiplier : 1.00000000
Offset : 0.00000000

Scan length : 37

Appendix 3. Vessel mounted ADCP instrument configuration settings during HUD2015004

	Vessel Mounted
Instrument	Ocean Surveyor
Frequency	75
Mode	Narrowband
Beam pattern	concave
Beam angle (deg)	30
Beam configuration	
Vertical alignment (deg)	down
Bin mapping used	Yes
3-beam solution used	Yes
Tilt alignment correction used	No
Coordinates used	Beam
Ambiguity Velocity (cm/s)	
Amplitude Threshold (BT,WT,PR)	30
Correlation Threshold (BT)	220
Correlation Threshold (WT,PR)	180
Error Velocity Threshold (cm/sec) (BT,WT,PR)	1000
Vertical Velocity Threshold (cm/sec) (BT,WT,PR)	1000
False Target Amplitude Threshold	50
Percent good threshold (BT,WT,PR)	50
Bin length (m)	8
Distance to middle of first bin (m)	17
Blanking length (m)	13
Number of bins	100
Number of pings per ensemble	
Time between pings (s)	3
Averaging interval (s) long/short	300/30
Averaging distance first/second	10/1000
Reference layer start bin/end bin	3/10
Reporting interval (s)	1
Temperature sensor	Yes
Pressure sensor	
Salinity sensor	No
transducer misalignment (deg)	66.94
transducer depth (m)	6

Appendix 4. Data and meta-data collections during HUD2015004

Data Source	Responsible Party	Data Description	File Format(s)	Data Volume	Data Location	Notes
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	228 files/1 folder/228 MB	\\dcnsbiona01b\BIODataSvcSrc\2010s\2015\HUD2015004\CTD\2015004HUD\RAW_DATA	pH data was of poor quality and should be removed before long term archival.
CTD – Processed Data	Robert Benjamin/Terry Cormier	Processed CTD sensor and bottle data	.Q35, .QAT, .QAT.BAK, .ODF, .IMS, .IGS, .CNV, .txt, .ROS, .BTL, .HDR	632 files/9 folders/131 MB	\\dcnsbiona01b\BIODataSvcSrc\2010s\2015\HUD2015004\CTD\2015004HUD	
Vessel Mounted ADCP	Adam Harling	Vessel mounted ADCP files	.N1R, N2R, .ENS, .ENR, .ENX, .LOG, .LTA,		\\dcnsbiona01b\BIODataSvcSrc\2010s\2015\HUD2015004\VMADCP	VMADCP_HUD2015004.pdf deployment log sheet. Data not in folder as of May 14, 2015 but has been submitted to

			.NMS, .STA, .txt, .VMO			ODIS by Diana Cardoso on May 1st, 2015.
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	22 files/3 folders/315 KB	\\dcnsbiona01b\BIODataSvcSrc\2010s\2015\HUD2015004\Elog	Includes operational details for: CTD, Moorings, BioNess, Vertical Net Tows, Multi-Net, and ARGO floats, as well as any other deployed gear. QC'd bridge log not in folder as of May 15th , 2015.
ARGO Data	Ingrid Peterson	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,	.xls, .txt	13 files/3 folders/1.75 MB	\\dcnsbiona01b\BIODataSvcSrc\2010s\2015\HUD2015004\ProcessedData	Data has already been ported into AZMP operational

		underway chl a measurement, auto generated BioSum				database currently in possession of Robert Benjamin.
Rosette/Vertical Net Tows/BioNess - Shore-side Laboratory Analysis	Jeff Spry/Marc Ringuette	CHN, HPLC, Nutrients and Zooplankton analysis.	.xls		\\dcnsbiona01b\BIODataSvcSrc\2010s\2015\HUD2015004\BIOCHEM	As of May 15th, 2015 no data has been added to this folder
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	
BioNess files	Jeff Spry	Log files for BioNess deployments	.B15, .T15, .doc	20 files/1 folder, 1.65 MB	\\dcnsbiona01b\BIODataSvcSrc\2010s\2015\HUD2015004\BIONESS\SPRING2015	
GPS - Navigation Files	Robert Benjamin	Daily Regulus files utilized to create cruise track. Mission Regulus waypoint library	.dbf, .prj, .sbn, .sbx, .shp, .14E	49 files/4 folders, 593 MB	\\dcnsbiona01b\BIODataSvcSrc\2010s\2015\HUD2015004\Navigation	
Data Summary Reports	Robert Benjamin	Data summaries for cruise report	.csv	5 files/1 folder, 212 KB	\\dcnsbiona01b\BIODataSvcSrc\2010s\2015\HUD2015004\Reports	
SBE35	Robert Benjamin/Terry Cormier	bottle fire high resolution temperature data	.ASC	54 files/1 folder, 216 KB	\\dcnsbiona01b\BIODataSvcSrc\2010s\2015\HUD2015004\SBE35	

CTD Rosette - 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. PI's should be contacted periodically for updates.
CTD Rosette sampling for study investigating Isotopic Composition of Nitrate	Dr. Markus Kienast	181 water samples for isotopic composition of nitrate				Summary data provided to AZMP PI for inclusion in cruise reports. PI should be contacted directly for data requests
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.