# CRUISE REPORT

# HUDSON 2015030

# SCOTIAN SHELF

# AZMP TRANSECTS +

# Sep 20th – Oct 11th, 2015

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# CRUISE NARRATIVE

## *Highlights*

| | |
|---|---|
| Area Designation: | NAFO Regions: 5Y, 5Ze, 4X, 4W, 4Vs, 4Vn, 3Ps, 3Pn<br>Extent: 40$^o$ 40'N - 47$^o$ 35'N; 055$^o$ 34'W - 070$^o$ 23'W |
| Expedition Designation: | HUD2015030 or 18HU15030 (ISDM format) |
| Chief Scientist: | Dr. Dave Hebert<br>Ocean Ecosystem Science Division<br>Marine Ecosystem Section<br>Department of Fisheries and Oceans<br>Bedford Institute of Oceanography<br>PO Box 1006<br>Dartmouth, NS, Canada B2Y 4A2<br>Dave.Hebert@dfo-mpo.gc.ca |
| Ship: | CCGS Hudson (call sign - CGDG)<br>oceanographic research vessel |
| Ports of Call: | Sep 20$^{th}$, 2015 – Depart BIO, Dartmouth, NS<br>Sep 25$^{th}$, 2015 – Arrive/Depart, Sydney Harbour, NS<br>Oct 11$^{th}$, 2015 – Return BIO, Dartmouth, NS |
| Cruise Dates: | Sep 20$^{th}$ – Oct 11$^{th}$, 2015 |

## *Mission Summary*

### <u>Overview</u>

The CCGS Hudson left BIO at 1000LT on September 20$^{th}$ and conducted boat and fire drills in Bedford Basin. A test CTD cast was conducted after lunch at 1300LT. There were issues with server drive mounts after the CTD data acquisition (DAQ) computer had to be rebooted. The BIONESS was tested; there was an issue with the camera when a net was triggered. The ship started up the harbour at 1400LT.

Later on September 20$^{th}$, we arrived near HL_02 to look for the spar buoy used with the CARIOCO buoy. We searched at the location where we thought it was deployed and also at the position last obtained from the CARIOCO buoy. There was no sign of it and we headed to HL_02, arriving at 1730LT. After occupying the station, we headed to SG_28 at 1930LT.

On the 21st, after arriving at SG_28, tests of all of acoustic releases were conducted. The winds were 35 kts, gusting to 40 kts, so it was decided not to do nets at this station. The winds were still high at GULD_04 but a ring net cast was done. Given the winds and sea state, there was no BIONESS done at GULD_03.

On the 22nd, we headed to deploy the AMAR mooring M1908 at the Stone Fence site. The winds and seas were too rough initially, but did die down in the afternoon. The weather forecast showed that conditions in Cabot Strait would be OK for the next couple of days before deteriorating prior to the time scheduled to do the St. Anns Bank work. We arrived at the mooring site (M1908) at 1230LT. It was decided to wait at this site and then head to St. Anns Bank to do that work next. At 1300LT, we started prepping for the mooring work. The M1908 mooring was deployed at 1441LT. After the anchor reached the bottom, a mcal to determine the location was performed. Then, we headed to the southern-most St. Anns Bank mooring with the plans to be there at 0600 on the 23rd.

The mooring M1902 was successfully deployed at 0700LT on September 23rd. We headed to M1896 mooring site to recover the bottom mounted ADCP/microcat. It was successfully recovered at 0900LT. Next, we spent time trying to find the subsurface floats of the thermistor chain. The surface buoy detached from the mooring last year and weather was not good to try to recover it last fall. We determined that we could only see down 18 feet so it would be unlikely we would see the floats. A chain was hung at a depth of 20 feet between two vertical lines separated by 20 feet. We swiped back and forth between the two known fixes of the mooring and had no luck on hitting it. We stopped dragging for the lost mooring at lunchtime. We deployed moorings M1898 and M1899 nearby, starting at 1230LT and ending at 1340LT. We headed past the end of the St. Anns Bank Line near the Laurentian Channel to deploy M1903 at 1525LT. At 1735LT, the ship was called on SAR for four men in a lifeboat about 70 nm almost east of our position. At 1915LT, we were called off of SAR and headed back to occupy STAB_06 of the St. Anns Bank Line. A BIONESS tow was done at STAB_05. We finished the STAB Line at 0830LT on the 24th. We deployed the mooing (M1901) between LL_01 and LL_02 at 1000LT. Then, we deployed the mooring (M1900) between STAB_02 and STAB_03 at 1300LT. Due to generous sailing speeds (~12 kts) we were ahead of the scheduled disembarkment of the science party in Sydney, so we diverted to the Cabot Strait Line (CSL) prior to dropping people off.

Due to high winds, no BIONESS tow was conducted on the CSL. At 1040LT on September 25th, the CSL was completed and we headed to Sydney. We dropped off Jay Barthelotte, Adam Hartling, Isabeau Pratte and Chantelle Layton as planned at 1400LT. As well, Qian Huang, who was sea sick for most of the trip, also departed. At 1545LT, we departed the harbour and arrived at LL_01 at 1900LT.

During September 26, with good weather and seas, we occupied the stations on the Louisbourg Line including the BIONESS at LL_05. At LL_08, two ARGO floats (APEX 7502 and APEX 7504) were deployed at 19:50LT. At LL_09, another APEX float (7505) was deployed at 01:33LT on September 27th. We proceeded to SF_01 to do a ring net and CTD cast as well as deploy APEX float 7503. During the CTD cast (Event 86), the package was stopped at approximately 2900 m and lowered 10 m to correct the poor spooling of the cable. Then, we headed to SPB_11. Since it was daylight during the transit, we conducted a search survey for a Dalhousie University AUV that resembles a scaled sailboat between SF_01 and SPB_10. We received a position at 0800Z of the AUV to the west of SPB_11 at the eastern side of the French EEZ. We conducted a search from 1100 to 1500LT with no sign of the AUV. After completing the search, we received a position at the end of the search that indicated that the AUV was to the southwest of the search pattern.

We arrived at SPB_11 at 1600LT on the 27$^{th}$. In addition to a net and CTD cast, SOLO float 7263 was deployed at 1930LT. Instead of using the HIAB crane (because it takes longer to unfold), the larger crane was used. There is less control on it and somehow the D-ring holding the harness of the float box jumped out of the hook. We hoped that the harness will fall off the box and the float released. Later, we received reports that the float was reporting data.

At SPB_10 (Event 91), a ring net had disappeared upon recovery. At 02:11LT on Sept 28$^{th}$, SOLO float 7257 was deployed using the line to lower the box and harness. At 0700LT, as the CTD was ascending during Event 95 at SPB_09, gaps in the CTD wire on the drum were noticed. The winch was stopped at 1460 m, 1430 m, 946 m, 823m, 493 m and 165 m to correct spooling. The cast was reversed approximately 5 m each time. Upon retrieval of the CTD, a decision was made to head to deeper water to spool the cable better. It was (and still is) not clear how deep we needed to get to correct the issue.

We conducted a CTD without firing bottles at a water depth of 3500 m. This station was designated LF_35. At 1230LT, we started to spool the wire back onto the drum. The bad rap on the drum could not be reached and a decision was made to fix it at HL_14, our deepest station at ~ 5000 m. The boatswain filled the gaps in the cable with marlin. He also made sure that the level wind was adjusted correctly. At 1400LT, the CTD was recovered and we headed for SPB_08, 52 nm away. The SPB/EH line was completed at 0500LT on September 29$^{th}$. The BP and BANQ lines were completed next before heading to HL_14.

At 0200LT on October 1$^{st}$, we arrived at HL_14, spooled out 5040 m of wire and found no gaps present. The wire was spooled back on the drum without incident. During October 2$^{nd}$ and 3$^{rd}$, we continued to occupy Halifax Line stations. ARGO floats were deployed at HL_09 (7299) and HL_07 (7506). It was determined that the pH and PAR sensor were not working properly. It was determined that the Y-cable was bad. There was no spare cable or components to make one. The winds were high, 30-35 kts, so we could not do a BIONESS at either HL_03.3 or HL_03. At 1030LT on October 4$^{th}$, we finished HL_01 and started for YL_01. We decided to do the work in the Gulf of Maine next, since Hurricane Joaquin was travelling eastward south of the Scotian Shelf at this time.

We started YL_01 at 0100LT on October 5$^{th}$. At 2245LT, we were sitting west of YL_09 waiting for a cruise ship to depart the traffic lane from Portland. We waited about 1 hour. We need to move YL_09 about 1 nm west to well clear of the traffic area. Also, we need to move the station YL_04 closer to mooring M. After completing the Yarmouth Line, the Portsmouth Line was occupied during October 6$^{th}$. The Browns Bank Line was started at BBL_07 at 0920LT on October 7$^{th}$. At the 1710LT, the PS Line was started at PS_03 after doing BBL_05. The PS Line was completed at 0830LT on the 8th. After completing BBL_03, at 1400LT the ship was designated SAR West. At 2050LT, we occupied the RL_01, RATBA_01 and RATBA_02 stations which all included a BIONESS tow at them. We finished RATBA_02 at 0321LT on October 9th and headed to LHB_08.

At LHB_08, there was an issue of spooling of the CTD wire at 840 m. It appears that a foreign object was wrapped on the winch with about 1200 m of cable out. This resulted in the issue of spooling. Regardless, there appeared to be gaps at deeper locations. We had to send the CTD back down to 1700 m and there still was a problem of gaps. Marlin was placed in the gaps to get good wraps. The plan was to fix the problems at the next station, where the depth (2700 m) is about the same as LHB_08. At LHB_07, marlin was placed in the gaps near the bottom of the cast and the wire spooled on well for the rest of the way up.

On October 10th, we continued to occupy stations along the LHB Line. Winds had increased to 30 kts from the northwest making transit slow. At LHB_05 (Event 269), a net was torn on deployment. Winds and seas were marginal for net tows. At LHB_04, a bridle and ring from the torn net was used for the new net. Since we have not traditionally conducted BIONESS tows on LHB, a decision was made to drop the tow to save time in case we needed it later.

We finished LHB_01 at 0130LT on October 11th. We headed to HL_03 to complete a BIONESS tow that we were unable to conduct earlier in the mission. Once on station, the BIONESS was deployed first to accommodate the schedule of the operator. Sue Abbott spotted a blue whale while the ship occupied HL_03. The HL_02 occupation began at 1030LT on the return transit to BIO. The Hudson arrived at BIO at 1345LT on October 11th.

Over the 21 day mission, the CCGS Hudson logged ~3478 nm and AZMP science staff conducted 287 separate operations at 122 stations (Figure 1). Table 1 breaks down the operations by sampling gear for each leg of the trip. The table also points to figures that display the deployment locations for each gear type. Each of these figures is accompanied by a table of coordinates detailing each deployment of that gear type.

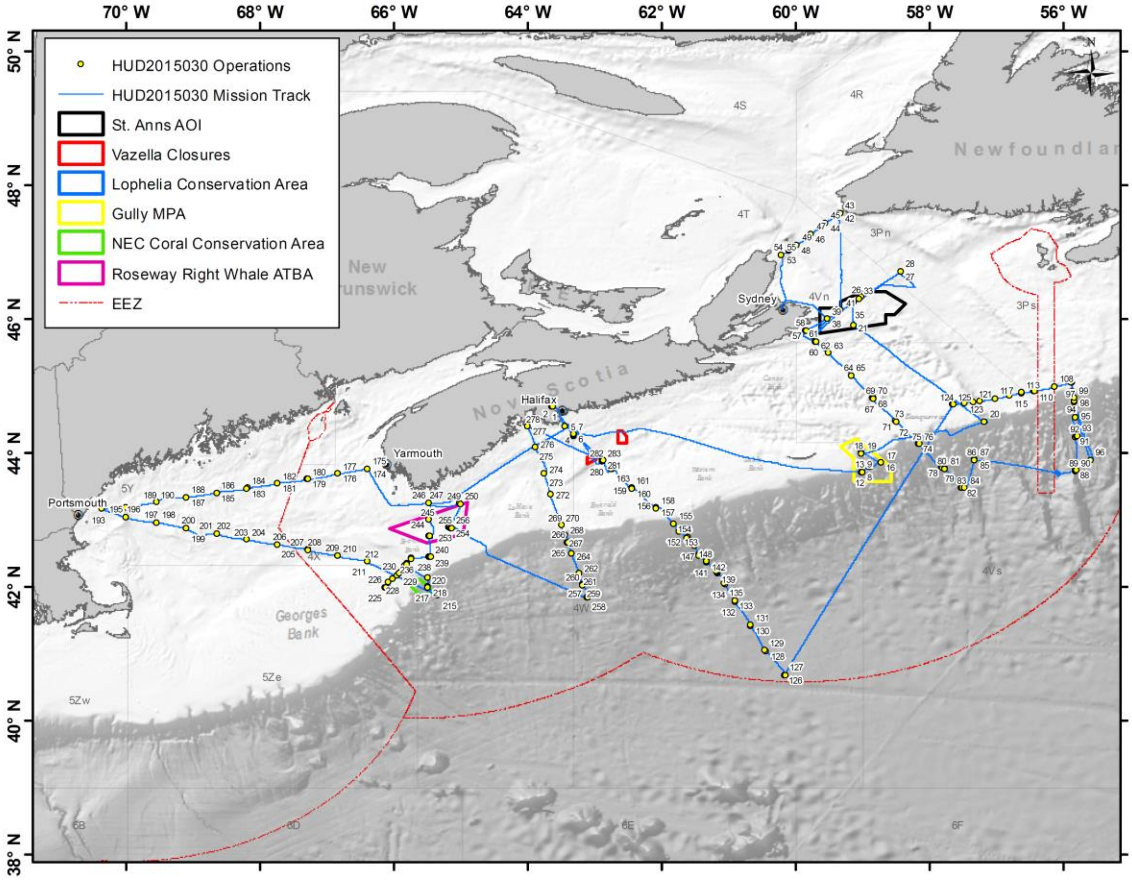



**Figure 1.** The locations for all 287 events during the HUD2015030 AZMP fall survey. Some overlapping event labels are not visible.

**Table 1.** Summary of operations during the HUD2015030 AZMP fall survey.

| Leg | Operation | # of Operations | Figure |
|---|---|---|---|
| 1 | CTD | 18 | 2 |
| | Vertical Ring Net Tows | 21 | 16 |
| | BioNess | 2 | 17 |
| | Mooring Release Tests | 5 | 22 |
| | Mooring Deployment | 7 | 22 |
| | Mooring Recovery | 1 | 22 |
| 2 | CTD | 98 | 2 |
| | Vertical Ring Net Tows | 120 | 16 |
| | BioNess | 6 | 17 |
| | Argo Float Deployments | 8 | 23 |

**Table 2.** Break down of operational time by gear type during HUD2015030.

| Gear | Time Allocated (hrs) |
|---|---|
| CTD | ~85 |
| Vertical Net Tows | ~53 |
| BioNess | ~2.5 |
| ARGO | ~1 |
| Moorings | ~10 |

## Mission Participants

**Table 3.** List of science staff aboard the HUD2015030 Fall AZMP mission.

| Name | Affiliation | Duty | Leg | Shift |
|---|---|---|---|---|
| Abbott, Sue | EC-CWS | Bird Watcher | both | Day |
| Anstey, Carol | DFO (MAR – OESD) | Laboratory Technician | both | Night |
| Barthelotte, Jay | DFO (MAR – PCSD) | Mooring Team | 1 | Day |
| Benjamin, Robert | DFO (MAR – PCSD) | Data Technician | both | Day |
| Britten, Greg | DAL | Student (Thomas) | both | Split |
| Cormier, Terry | DFO (MAR – PCSD) | Electronics Technologist | both | Day |
| DeGrace, Dylan | DAL | CTD watch/ELOG | both | Day |
| Dever, Mathieu | DAL | CTD watch/ELOG | both | Night |
| Hartling, Adam | DFO (MAR – PCSD) | Mooring Team | 1 | Day |
| Hebert, Dave** | DFO (MAR – OESD) | Moorings/CTD watch/ELOG | both | Day |
| Huang, Qian | DAL | Student (Thomas) | 1 | Split |
| Layton, Chantelle | DAL | Student (Kelley) | 1 | Day |
| Perry, Timothy | DFO (MAR – OESD) | Laboratory Technician | both | Day |
| Pratte, Isabeau | EC-CWS | Bird Watcher | 1 | Day |
| Spry, Jeffrey | DFO (MAR – OESD) | Biologist/Technician | both | Night |
| Thamer, Peter | DFO (MAR – OESD) | Laboratory Technician | both | Day |
| Wilson, Erin | DAL | Student (Kienast) | both | Split |
| Sun, Xiaohong | Shandong University | Visiting Scientist (Azetsu-Scott) | both | Split |

**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 15 defined objectives in the Form B submitted to Coast Guard Headquarters on August 4th, 2015 (below). Table 4 describes whether each of these objectives, along with 1 not defined in the Form B and 2 unexpected objectives, were met along with any relevant supporting commentary.

*Primary*

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

*Additional*

2. 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 1 Autonomous Multichannel Acoustic Recorder (AMAR) near the Stone Fence Lophelia Conservation Area in support of a National Conservation Plan and Species at Risk funded project investigating whale migration patterns (**Contact Dr. Hilary Moors-Murphy -** http://www.dfo-mpo.gc.ca/science/coe-cde/cemam/teams-equipes/moors-murphy/moors-eng.html)
4. Carry out hydrographic, chemical and biological sampling at stations in the Gully in support of Gully MPA monitoring initiatives by Oceans and Coastal Management Division (**Contact Dr. Dave Hebert -** http://www.inter.dfo-mpo.gc.ca/Maritimes/Oceans/OCMD/Gully/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, and drag for a thermistor mooring that was not successfully recovered in the fall of 2014. (Contact **Dr. Dave Hebert** - http://www.inter.dfo-mpo.gc.ca/Maritimes/Oceans/OCMD/Marine-Protection/Areas-Interest).
6. Nutrients and hydrography across the Northeast Channel as part of NERACOOS Cooperative Agreement, (**Contact Dr. Dave Hebert** - http://www.neracoos.org/).
7. Conduct 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 (including Bioness) at RATBA_01, RATBA_02 and 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. Biological collections are in support of the MEOPAR WHaLES project (**Contact Dr. Catherine Johnson, Chris Taggart and Kimberly Davies** - http://www.sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=780, http://www.inter.dfo-mpo.gc.ca/Maritimes/SABS/popec/sara/Roseway, http://meopar.ca/research/project/whale-whales-habitat-and-listening-experiment).
9. Carry out hydrographic, chemical and biological sampling at stations along the Yarmouth Line (YL) and Plymouth Line (PL) in anticipation of potentially funded projects resulting from 2 recent LOI's to NERACOOS. (**Contact Dr. Dave Hebert** - http://www.ocean-partners.org/sites/ocean-partners.org/files/public/attachments/295_Bigelow_climate_ecosystem_changes.pdf).
10. Collection of DIC, alkalinity and $^{13}C$ samples in support of research contributing to MEOPAR theme 2.2. Dalhousie University students 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.meds-sdmm.dfo-mpo.gc.ca/isdm-gdsi/argo/index-eng.html).
12. Underway suspended particle sampling (organic biomarkers) and rosette samples collected for isotopic composition of nitrate (**Contact Dr. Markus Kienast -**

http://oceanbiogeochem-atdal.org/).

13. Collect underway and CTD water samples at specified locations and depths to fulfill the regional component of an Aquatic Climate Change Adaptation Services Program (ACCASP) initiative investigating the delineation of ocean acidification and calcium carbonate saturation state of the Atlantic zone (**Contact Dr. Pierre Pepin and Kumiko Azetsu-Scott -** 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. Deploy SPAR and Carioca buoys near HL_02 in support of carbon cycling monitoring program for MEOPAR (**Contact Dr. Helmuth Thomas -** http://meopar.ca/theme-2-2/).

*Not Specified in Form B*

16. Bird and mammal observations were made by CWS observers throughout the mission (**Contact Carina Gjerdrum)**.

*Unplanned*

17. Vertical ring net tows investigating the impact of Ocean Acidification on *C. finmarchicus* populations (**Contact Xiaohong Sun**).
18. Collect duplicate 4L water samples at pre-defined stations and depths to characterize microbial communities with special interests in the nitrogen cycle (DNA & RNA, flow cytometry). As well, water samples were sorted using flow cytometry to isolate and grow diazotrophs previously detected at some AZMP stations in the past. (**Contact Dr. Julie LaRoche – mailto:julie.laroche@dal.ca?subject=HUD2015030 Cruise Report)**

**Table 4.** Status of objectives upon completion of the HUD2015030 mission.

| Objective | Status | Comments |
|---|---|---|
| **1** | Complete | |
| **2** | Complete | XHL stations HL_08 to HL_14 were occupied on October 1st and 2nd. |
| **3** | Complete | A single AMAR Mooring (M1908) was deployed within the Lophelia Conservation Area at Stone Fence on September 22nd. |
| **4** | Mostly Complete | A single BioNess, normally scheduled for GULD03 was dropped due to poor weather conditions but all other operations were completed. |
| **5** | Complete | All 5 planned ADCP/Microcat moorings and a single Thermistor mooring were deployed at the proposed locations. Dragging for a Thermistor mooring lost in the fall of 2015 was not successful. |
| **6** | Complete | All NERACOOS stations were occupied and requisite sampling took place. |
| **7** | Complete | All stations were occupied across the Laurentian Channel and across LaHave Basin. |
| **8** | Complete | All station occupations in Roseway Basin were completed as planned (RL_01, RATBA_01 and RATBA_02) |
| **9** | Complete (modified) | All planned stations were occupied along the YL and PL lines from October 5th to October 7th. The planned station at YL_10 was relocated to ~4 nm to the northeast of the planned location because the original location was too shallow for the ship to safely occupy. For next year, YL_09 should be moved about 1 |

| | | |
|---|---|---|
| | | nm west to well clear of the traffic area. Also, YL_04 should be moved closer to mooring M. |
| **10** | 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 8 floats were deployed in slope waters great than 2000 m at selected locations along the Eastern Scotian Shelf break. |
| **12** | Complete | The $pCO_2$ system was not available for this mission but otherwise the underway system collected data throughout the mission. |
| **13** | Complete | Samples from the CTD rosette were collected for an ACCASP ocean acidification /calcium carbonate saturation project. |
| **14** | Complete | All planned vertical net tows in support of a Dovekie feeding project were collected (In total, 11 nets were deployed to collect samples for this project) |
| **15** | Dropped | The SPAR and Carioca buoys near HL_02 were not deployed by AZMP. |
| **16** | Complete | Bird and mammal observations were conducted throughout the mission. |
| **17** | Unplanned | 12 Net tows were conducted at various locations to support this project. |
| **18** | Unplanned | Water samples collected at stations and depths specified and samples provided to Principal Investigator. |

# SUMMARY OF ACTIVITIES

## *CTD Summary*

### Narrative

As summarized in Table 1, there were a total of 116 CTD casts during the mission (Figure 2 and Table 5).

There were issues during the test CTD cast in Bedford Basin. The data acquisition computer had to be rebooted and issues on mounting the server hard disks. It has been proposed that we have our own back-up disks and server. At first, the software doesn't seem to copy the data over to the processing directory. At GULD_04 (Event 15), the temperature, salinity and especially oxygen on the primary were poor above 150 m. Below that depth, they were slightly noisy. There was an offset between the primary and secondary salinity. The sensors were cleaned and flushed after the cast. The bleed valve on the tubing was plugged. During SG_23 (Event 17), the primary oxygen sensor varied more than usual over the first 550 m. After Event 19, when disconnecting the oxygen sensor from the cable, one of the pins broke off. It was wet and corroded. The primary oxygen sensor #3026 was replaced by sensor #0042. Again, at CSL_03, there were issues with the primary sensors for the first 100 m of the cast. The bleed valve was plugged again. Appendix 1A is the Seasave instrument configuration file (HUD2015030_1.xmlcon) provided by ODIS and used to process CTD data collected from September 20$^{th}$ to September 22$^{nd}$ (Events 1 through 19) using the primary oxygen sensor serial #3026. Appendix 1B provides the modified configuration file (HUD2015030_2.xmlcon) that was used to process all subsequent CTD data from September 23$^{rd}$ to October 11$^{th}$ (Events 28 through 287) using primary oxygen sensor serial # 0042.

The water budget had a depth of 4400 m at SPB_11 (Event 89) but the depth at the station was 3260 m. Therefore, an extra bottle was fired at the bottom. There might be some confusion in station names, etc. In 2013, there was a SPB_10A at 3500 m, SPB_11 at 4400 m and a SPB_12 sampled. This should be checked prior to next year.

At SPB_10 (Event 92), the bottle depth at 40 m was missed and that bottle was fired at 30 m depth. There were issues on spooling the cable on the winch at SPB_09 (Event 95). We headed to 3500 m water depth to spool the cable on correctly. At that station, LF_35 (Event 96), it was determined that the mistake is deeper and would have to be fixed at HL_14. At SPB_08 (Event 98), the water depth was less than 1000 m, so two bottles were fired at the bottom.

At HL_14 (Event 127), there was a jump in the primary oxygen sensor at 4000 m. It was normal on the upcast. At both HL_09 (Event 138) and HL_08 (Event 142), bottle 16 did not close. At HL_09, bottle 19 did not close. At HL_06.7 (Event 148), a second surface bottle was fired in case bottle 19 did not close. At HL_06 (Event 153), an extra surface bottle was fired.

With the shallower stations on the Halifax Line, the pH sensor was jumpy and providing incorrect values at depth. At HL_5.5 (Event 155), the pH sensor was reading below 6.6. Likewise, when the PAR sensor was attached, it was providing unrealistic values. When scanning an earlier cast at HL_02 (Event 7), it was also found to be bad. At HL_04 (Event 161), the pH was constant at 7.2 with occasional spikes (low values) and PAR values were not realistic. The CTD technician cleaned the connectors prior to the cast so we suspect it was an issue with the cable. A spare cable could not be located or constructed. It was decided to put the optode on this channel and leave it on for the remainder of the cruise. It is strongly recommended that the pH and PAR data not be carried forward for CTD archiving and/or the BioChem archives from this mission. The Ocean Data and Information Section (ODIS) has been notified.

At YL_03 (Event 180), the primary sensors were plugged again. At YL_05 (Event 184), we tried the PAR/pH sensors again with a clean cable and connectors taped. There was no difference. Later, the CTD Tech took the cable apart and it was rotten inside of the PAR part. At YL_10 (Event 194) and PL_01 (Event 196) there were problems with the primary sensors again. The plumbing was cleaned again.

At LHB_08 (Event 258), there was an issue of cable spooling at 840 m. The CTD, after the bottles had already been fired for deeper depths, was sent back down to 1700 m. The samples in those bottles could be compromised.

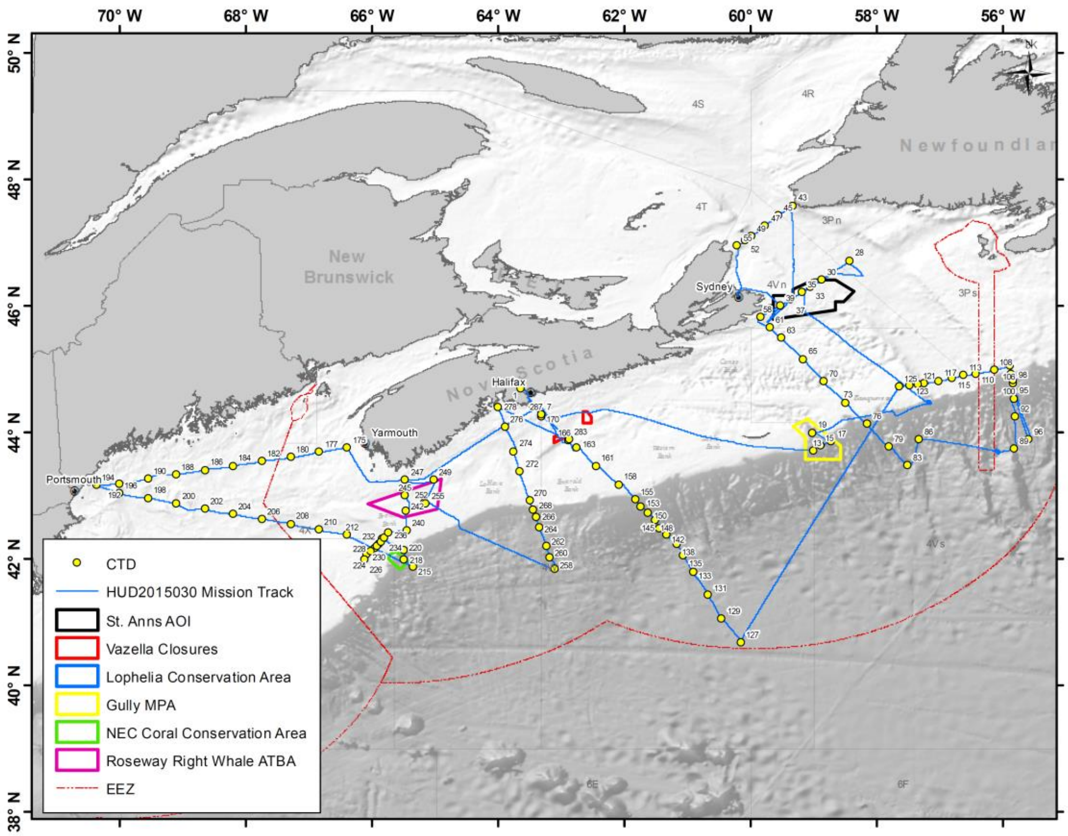



**Figure 2.** Locations for the 118 CTD casts during HUD2015030 AZMP fall survey. Each cast is labelled with the consecutive mission event.

**Table 5.** CTD casts during the HUD2015030 AZMP fall survey. The coordinates provided are in decimal degrees and reflect the ship's position at the time of deployment as recorded using the ELOG meta-data logger. Note that even though the PAR and pH sensors are attached, these data are of poor quality and will/should not be archived.

| # | Event | Station | Date | Slat (DD) | Slon (DD) | Sounding (m) | PAR | SBE 35 | pH | Water Collected | Aborted |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 1 | HL_00 | 20/09/2015 | 44.6939 | -63.6408 | 75 | X | X | X | | |
| **2** | 7 | HL_02 | 20/09/2015 | 44.2725 | -63.3238 | 182 | X | X | X | X | |
| **3** | 13 | SG_28 | 21/09/2015 | 43.7088 | -59.0035 | | | X | X | X | |
| **4** | 15 | GULD_04 | 21/09/2015 | 43.7854 | -58.8990 | 2200 | | X | | X | |
| **5** | 17 | SG_23 | 22/09/2015 | 43.8511 | -58.7199 | 1396 | | X | | X | |
| **6** | 19 | GULD_03 | 22/09/2015 | 43.9906 | -59.0187 | 460 | | X | X | X | |
| **7** | 28 | STAB_06 | 24/09/2015 | 46.7126 | -58.4380 | 482 | | X | X | X | |
| **8** | 30 | STAB_05 | 24/09/2015 | 46.4162 | -58.8739 | 390 | X | X | X | X | |
| **9** | 33 | STAB_04 | 24/09/2015 | 46.2972 | -59.0609 | 160 | X | X | X | X | |
| **10** | 35 | STAB_03 | 24/09/2015 | 46.2146 | -59.1927 | 95 | X | X | X | X | |
| **11** | 37 | STAB_02 | 24/09/2015 | 46.1079 | -59.3622 | 67 | X | X | X | X | |
| **12** | 39 | STAB_01 | 24/09/2015 | 45.9990 | -59.5338 | 57 | X | X | X | X | |
| **13** | 43 | CSL_06 | 25/09/2015 | 47.5834 | -59.3388 | 260 | X | X | X | X | |
| **14** | 45 | CSL_05 | 25/09/2015 | 47.4307 | -59.5608 | 475 | | X | X | X | |
| **15** | 47 | CSL_04 | 25/09/2015 | 47.2692 | -59.7710 | 480 | | X | X | X | |
| **16** | 49 | CSL-03 | 25/09/2015 | 47.1002 | -59.9858 | 340 | X | X | X | X | |
| **17** | 52 | CSL-02 | 25/09/2015 | 47.0299 | -60.0900 | 283 | X | X | X | X | |
| **18** | 55 | CSL-01 | 25/09/2015 | 46.9530 | -60.2138 | 80 | X | X | X | X | |
| **19** | 58 | LL_01 | 25/09/2015 | 45.8245 | -59.8483 | 91 | X | X | X | X | |
| **20** | 61 | LL_02 | 26/09/2015 | 45.6579 | -59.7016 | 140 | X | X | X | X | |
| **21** | 63 | LL_03 | 26/09/2015 | 45.4887 | -59.5114 | 170 | X | X | X | X | |
| **22** | 65 | LL_04 | 26/09/2015 | 45.1559 | -59.1721 | 105 | X | X | X | X | |
| **23** | 70 | LL_05 | 26/09/2015 | 44.8072 | -58.8488 | 264 | X | X | X | X | |
| **24** | 73 | LL_06 | 26/09/2015 | 44.4682 | -58.4976 | 66 | X | X | X | X | |
| **25** | 76 | LL_07 | 26/09/2015 | 44.1270 | -58.1545 | 849 | | X | X | X | |
| **26** | 79 | LL_08 | 26/09/2015 | 43.7744 | -57.8088 | 2880 | | X | | X | |
| **27** | 83 | LL_09 | 27/09/2015 | 43.4741 | -57.5093 | 3700 | | X | | X | |
| **28** | 86 | SF_01 | 27/09/2015 | 43.8898 | -57.3290 | 3100 | | X | | X | |
| **29** | 89 | SPB_11 | 27/09/2015 | 43.7324 | -55.8215 | 3302 | | X | | X | |
| **30** | 92 | SPB_10 | 28/09/2015 | 44.2425 | -55.8108 | 2957 | | X | | X | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **31** | 95 | SPB_09 | 28/09/2015 | 44.5337 | -55.8228 | 2147 | | X | | X |
| **32** | 96 | LF_35 | 28/09/2015 | 43.8848 | -55.5998 | 3536 | | X | | |
| **33** | 98 | SPB_08 | 28/09/2015 | 44.7767 | -55.8354 | 1035 | | X | | X |
| **34** | 100 | EH_04 | 29/09/2015 | 44.8239 | -55.8409 | 792 | | X | X | X |
| **35** | 102 | EH_03 | 29/09/2015 | 44.8827 | -55.8683 | 285 | | X | X | X |
| **36** | 104 | EH_02 | 29/09/2015 | 44.9232 | -55.8675 | 202 | X | X | X | X |
| **37** | 106 | EH_01 | 29/09/2015 | 45.0546 | -55.8823 | 83 | X | X | X | X |
| **38** | 108 | BP_01 | 29/09/2015 | 44.9838 | -56.1373 | 228 | X | X | X | X |
| **39** | 110 | BP_04 | 29/09/2015 | 44.9239 | -56.4359 | 390 | | X | X | X |
| **40** | 113 | BP_05 | 29/09/2015 | 44.8962 | -56.6300 | 408 | | X | X | X |
| **41** | 115 | BANQ_B6 | 29/09/2015 | 44.8481 | -56.8069 | 417 | | X | X | X |
| **42** | 117 | BANQ_B5 | 29/09/2015 | 44.8114 | -57.0249 | 423 | | X | X | X |
| **43** | 119 | BANQ_B4 | 29/09/2015 | 44.7778 | -57.2536 | 394 | | X | X | X |
| **44** | 121 | BANQ_B3 | 30/09/2015 | 44.7616 | -57.3485 | 69 | | X | X | X |
| **45** | 123 | BANQ_B2 | 30/09/2015 | 44.7457 | -57.4731 | 57 | | X | X | X |
| **46** | 125 | BANQ_B1 | 30/09/2015 | 44.7186 | -57.6522 | 37 | X | X | X | X |
| **47** | 127 | HL_14 | 01/10/2015 | 40.6725 | -60.1591 | 4900 | | X | | X |
| **48** | 129 | HL_13 | 01/10/2015 | 41.0490 | -60.4611 | 4789 | | X | | X |
| **49** | 131 | HL_12 | 01/10/2015 | 41.4208 | -60.6731 | 4586 | | X | | X |
| **50** | 133 | HL_11 | 02/10/2015 | 41.7849 | -60.9135 | 4403 | | X | | X |
| **51** | 135 | HL_10 | 02/10/2015 | 42.0438 | -61.0654 | 4050 | | X | | X |
| **52** | 138 | HL_09 | 02/10/2015 | 42.2234 | -61.1699 | 3834 | | X | | X |
| **53** | 142 | HL_08 | 02/10/2015 | 42.3720 | -61.3372 | 3383 | | X | | X |
| **54** | 145 | HL_07 | 03/10/2015 | 42.4765 | -61.4449 | 2750 | | X | | X |
| **55** | 148 | HL_06.7 | 03/10/2015 | 42.6082 | -61.5228 | 2330 | | X | | X |
| **56** | 150 | HL_06.3 | 03/10/2015 | 42.7224 | -61.6281 | 1720 | | X | | X |
| **57** | 153 | HL_06 | 03/10/2015 | 42.8206 | -61.7416 | 1146 | | X | X | X |
| **58** | 155 | HL_05.5 | 03/10/2015 | 42.9350 | -61.8302 | 481 | | X | X | X |
| **59** | 158 | HL_05 | 03/10/2015 | 43.1730 | -62.0909 | 102 | X | X | X | X |
| **60** | 161 | HL_04 | 03/10/2015 | 43.4663 | -62.4543 | 80 | X | X | X | X |
| **61** | 163 | HL_03.3 | 04/10/2015 | 43.7573 | -62.7573 | 203 | X | X | X | X |
| **62** | 166 | HL_03 | 04/10/2015 | 43.8699 | -62.8963 | 265 | X | X | X | X |
| **63** | 170 | HL_02 | 04/10/2015 | 44.2532 | -63.3189 | 148 | X | X | X | X |
| **64** | 173 | HL_01 | 04/10/2015 | 44.3948 | -63.4494 | 80 | X | X | X | X |
| **65** | 175 | YL_01 | 05/10/2015 | 43.7567 | -66.4012 | 72 | | X | | X |
| **66** | 177 | YL_02 | 05/10/2015 | 43.6849 | -66.8442 | 124 | | X | | X |
| **67** | 180 | YL_03 | 05/10/2015 | 43.6017 | -67.2965 | 184 | | X | | X |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **68** | 182 | YL_04 | 05/10/2015 | 43.5372 | -67.7489 | 237 | | X | | X |
| **69** | 184 | YL_05 | 05/10/2015 | 43.4669 | -68.2072 | 175 | X | X | X | X |
| **70** | 186 | YL_06 | 05/10/2015 | 43.4015 | -68.6572 | 140 | | X | | X |
| **71** | 188 | YL_07 | 05/10/2015 | 43.3300 | -69.1092 | 140 | | X | | X |
| **72** | 190 | YL_08 | 05/10/2015 | 43.2595 | -69.5611 | 167 | | X | | X |
| **73** | 192 | YL_09 | 06/10/2015 | 43.1860 | -70.0104 | 84 | | X | | X |
| **74** | 194 | YL_10 | 06/10/2015 | 43.1596 | -70.3780 | 74 | | X | | X |
| **75** | 196 | PL_01 | 06/10/2015 | 43.0329 | -70.0142 | 130 | | X | | X |
| **76** | 198 | PL_02 | 06/10/2015 | 42.9584 | -69.5559 | 176 | | X | | X |
| **77** | 200 | PL_03 | 06/10/2015 | 42.8695 | -69.1045 | 184 | | X | | X |
| **78** | 202 | PL_04 | 06/10/2015 | 42.7865 | -68.6598 | 195 | | X | | X |
| **79** | 204 | PL_05 | 06/10/2015 | 42.7011 | -68.2093 | 181 | | X | | X |
| **80** | 206 | PL_06 | 06/10/2015 | 42.6249 | -67.7574 | 197 | | X | | X |
| **81** | 208 | PL_07 | 07/10/2015 | 42.5497 | -67.2889 | 296 | | X | | X |
| **82** | 210 | PL_08 | 07/10/2015 | 42.4564 | -66.8480 | 325 | | X | | X |
| **83** | 212 | PL_09 | 07/10/2015 | 42.3707 | -66.4059 | 264 | | X | | X |
| **84** | 215 | BBL_07 | 07/10/2015 | 41.8673 | -65.3531 | 1862 | | X | | X |
| **85** | 218 | BBL_06 | 07/10/2015 | 41.9827 | -65.4958 | 1206 | | X | | X |
| **86** | 220 | BBL_05 | 07/10/2015 | 42.1326 | -65.5058 | 177 | | X | | X |
| **87** | 221 | PS_03 | 07/10/2015 | 42.3047 | -65.8449 | 209 | | X | | X |
| **88** | 222 | PS_05 | 07/10/2015 | 42.2335 | -65.9025 | 231 | | X | | X |
| **89** | 223 | PS_07 | 08/10/2015 | 42.1643 | -65.9675 | 218 | | X | | X |
| **90** | 224 | PS_09 | 08/10/2015 | 42.0637 | -66.0858 | 97 | | X | | X |
| **91** | 226 | PS_10 | 08/10/2015 | 41.9849 | -66.1295 | 88 | | X | | X |
| **92** | 228 | PS_08 | 08/10/2015 | 42.1095 | -66.0283 | 198 | | X | | X |
| **93** | 230 | PS_06 | 08/10/2015 | 42.1944 | -65.9290 | 221 | | X | | X |
| **94** | 232 | PS_04 | 08/10/2015 | 42.2711 | -65.8677 | 222 | | X | | X |
| **95** | 234 | PS_02 | 08/10/2015 | 42.3369 | -65.8127 | 201 | | X | | X |
| **96** | 236 | PS_01 | 08/10/2015 | 42.4182 | -65.7403 | 95 | | X | | X |
| **97** | 240 | BBL_04 | 08/10/2015 | 42.4374 | -65.4596 | 97 | | X | | X |
| **98** | 242 | BBL_03 | 08/10/2015 | 42.7515 | -65.4744 | 95 | | X | | X |
| **99** | 245 | BBL_02 | 08/10/2015 | 42.9970 | -65.4841 | 110 | | X | | X |
| **100** | 247 | BBL_01 | 08/10/2015 | 43.2474 | -65.4796 | 55 | | X | | X |
| **101** | 249 | RL_01 | 09/10/2015 | 43.2439 | -65.0277 | 173 | | X | | X |
| **102** | 252 | RATBA_01 | 09/10/2015 | 42.8865 | -65.1815 | 151 | | X | | X |
| **103** | 255 | RATBA_02 | 09/10/2015 | 42.8681 | -65.1521 | 137 | | X | | X |
| **104** | 258 | LHB_08 | 09/10/2015 | 41.8314 | -63.1133 | 3195 | | X | | X |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **105** | 260 | LHB_07 | 09/10/2015 | 42.0197 | -63.1898 | 2715 | X | X |
| **106** | 262 | LHB_06.7 | 10/10/2015 | 42.1952 | -63.2395 | 2350 | X | X |
| **107** | 264 | LHB_06.3 | 10/10/2015 | 42.4889 | -63.3548 | 1730 | X | X |
| **108** | 266 | LHB_06 | 10/10/2015 | 42.6614 | -63.3991 | 1150 | X | X |
| **109** | 268 | LHB_05.5 | 10/10/2015 | 42.7658 | -63.4477 | 530 | X | X |
| **110** | 270 | LHB_05 | 10/10/2015 | 42.9125 | -63.4987 | 165 | X | X |
| **111** | 272 | LHB_04 | 10/10/2015 | 43.3784 | -63.6619 | 204 | X | X |
| **112** | 274 | LHB_03 | 10/10/2015 | 43.6978 | -63.7571 | 231 | X | X |
| **113** | 276 | LHB_02 | 11/10/2015 | 44.0832 | -63.8969 | 155 | X | X |
| **114** | 278 | LHB_01 | 11/10/2015 | 44.3900 | -64.0068 | 39 | X | X |
| **115** | 283 | HL_03 | 11/10/2015 | 43.8820 | -62.8856 | 264 | X | X |
| **116** | 287 | HL_02 | 11/10/2015 | 44.2809 | -63.3252 | 162 | 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 (Figure 3) revealed 2 bad first replicate values (sample ID – 429726 (Figure 3A – 220) and 429799 (Figure 3 - 287) and 1 bad second replicate value (Sample ID – 429555 (Figure 3 - 55)). The poor replicates 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 ($r^2$=0.9980 – Figure 3).

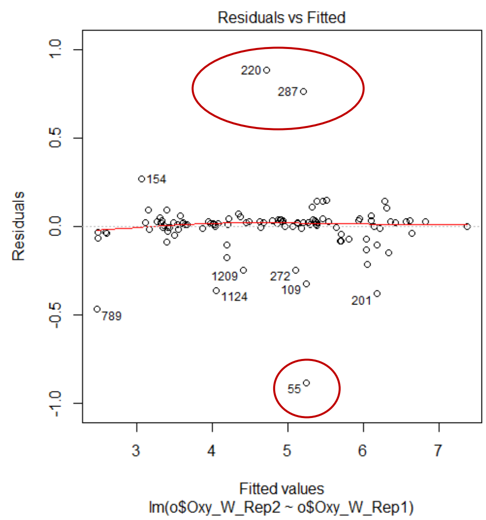



**Figure 3.** The residuals plotted against the fitted values of the linear regression. Note the 3 outliers removed from all further analysis, labelled by row ID.

As with other missions in 2014 and spring 2015, on average the 1st Winkler replicate value tends to be greater (0.033 ml/l) than the 2nd replicate. One possible reason for this "might" be attributable to gas exchange within the Niskin bottle following the introduction of a headspace when drawing the first oxygen sample. A net flux of oxygen from the seawater sample to the gas phase is inevitable where the sample is supersaturated in oxygen with respect to the atmosphere, due for example to high rates of photosynthesis or an increase in water temperature while the rosette is in the winch room. (Stephen Punshon, Pers. Comm., 2015). Nonetheless, without further testing this by extracting Oxygen samples at defined intervals from the rosette it is difficult to verify. Regardless of the reason, it has been noted repeatedly that this replicate discrepancy occurs and should be kept in mind when evaluating replicate differences in the future.

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:

$$(\text{SBE } O2 - \text{Winkler } O2) - \text{mean}(\text{SBE } O2 - \text{Winkler } O2)$$

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

$$\text{NewSoc} = \text{mean}(\text{previousSoc} * ([\text{Winkler } O2]/[\text{SBE } O2]))$$

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 4). Some outliers were observed from the secondary Oxygen sensor (#3030) during Event 104 and 106 (EH_01 and EH_02) and Event 194 at YL_10. These were replaced with NA value before proceeding to the next step, along with the primary sensor values during Event 19 (GULD_03).

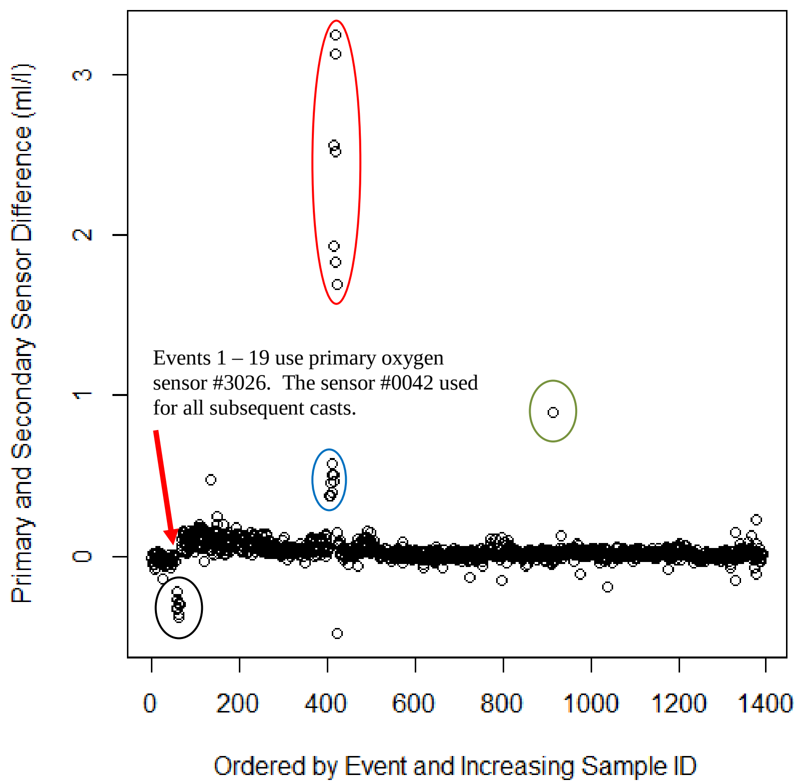



**Figure 4.** Note that secondary sensor values from EH_01 (red ellipse), EH_02 (blue ellipse) and YL_10 (green ellipse) were removed before proceeding. Note also that the primary sensors from GULD_03 (black ellipse) were removed.

As stated in the CTD narrative, the primary oxygen sensor used at the beginning of the mission (#3026) was replaced at the end of Event 19 at GULD_03 with sensor #0042. For this reason, the Soc calculation must be completed for both sets of sensors. Figure 5A represents the difference between the primary (#3026) and secondary (#3030) sensors, with a mean difference of -0.0253. Figure 5B is the difference between the primary (#0042) and secondary (#3030) oxygen sensors. The average difference between #0042 and #3030 is 0.0272.

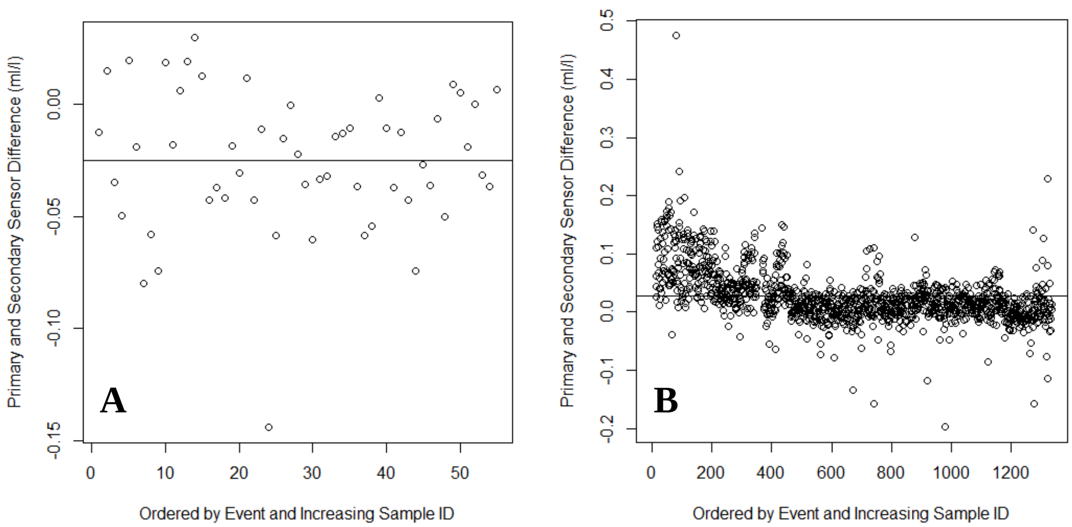



**Figure 5. A)** The difference between primary oxygen sensor #3026 and secondary oxygen sensor #3030 from Event 1 to Event 19 (excluding outliers mentioned in Figure 4). The average difference between sensors is -0.0253. **B)** The difference between primary oxygen sensor #0042 and secondary oxygen sensor #3030 from Event 28 to Event 287. The average difference between sensors is 0.0272.

Comparisons between the primary (#0042) and secondary (#3030) sensors showed a large discrepancy (~0.48) at sample ID 429640, thus this row was removed before proceeding further. The relationship between the primary (#3026) sensor and the average Winkler values prior to swapping primary oxygen sensors at the end of Event 19 was significant and strong as would be expected ($r^2$=0.9854) (Figure 7A). The relationship between average Winkler values and the new primary (#0042) sensor was not as strong ($r^2$=0.9527) because of outliers (430802, 430352, 429784, 429798, 429630, 430225, 430047, 430743, 430013, 429926, 430162, 430007, 430209, 430096, 429935, 430035, 430047, 430188, 429737, 430097, 429934, 430120, 430500, 430044, 430071, 430489, 430770, 430083). When these outliers are removed the relationship improves to $r^2$=0.9858 (Figure 7B).

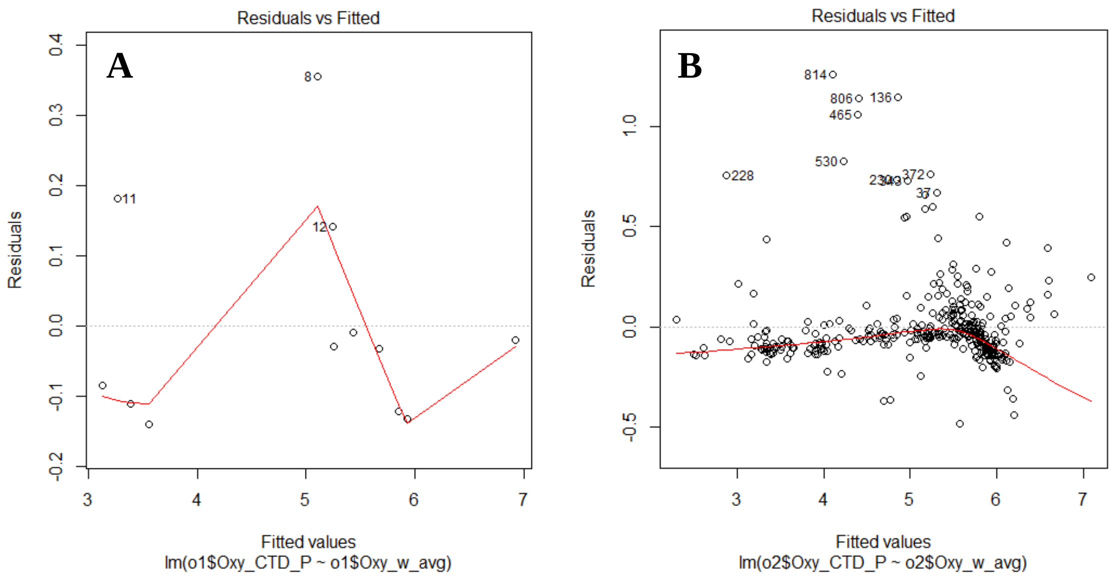



**Figure 7. A)** Plotted residuals between primary (#3026) oxygen sensor values and corresponding averaged Winkler values. **B)** Plotted residuals between primary (#0042) oxygen sensor values and corresponding average Winkler values. When outliers were removed, the fit had an $r^2$=0.9858. The red line follows the core of the residual distribution and demonstrates where changes in the relationship may occur.

The threshold value was calculated for both primary sensors (#3026 and #0042). These threshold values were used to remove outliers for both sensors 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 primary SBE oxygen sensors (#3026 and #0042). The ratio of the new and old Soc values was calculated for each sensor. The Soc ratios for both primary sensors were 1.0453 and 1.0383 (#3026 and #0042 respectively).

**Table 6**. Previous and New Soc values for both primary SBE Oxygen sensors.

| | **Old Soc** | **New Soc** | **Ratio (New:Old)** |
|---|---|---|---|
| **Primary Sensor #3026** | 4.3050e-1 | 4.500e-1 | 1.0453 |
| **Primary Sensor #0042** | 4.6557e-1 | 4.834e-1 | 1.0383 |

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

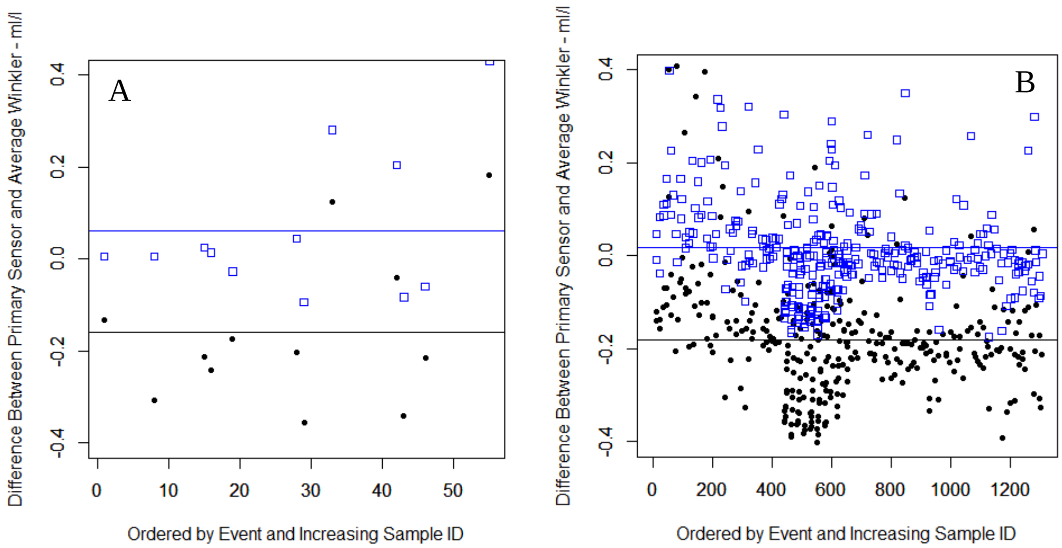



**Figure 8.** **A)** Black dots – uncorrected difference between primary sensor values (#3026) and corresponding Winkler values (mean = -0.1593). Blue squares – Soc corrected difference between primary sensor values and corresponding Winkler values (mean = 0.0624). **B)** Black dots – uncorrected difference between primary sensor values (#0042) and Winkler values (mean=-0.1594). Blue squares – Soc corrected difference between primary sensor values and Winkler values (mean=0.0367).

The secondary sensor (#3030) was the only secondary sensor used throughout the mission. After outliers were removed (similar to those mentioned above), the agreement with the averaged Winkler values was $r^2$=0.9851. Table 7 shows the previous and revised Soc values for the secondary SBE oxygen sensor (#3030). The ratio of the new and old Soc values was 1.0432. Figure 9 shows that the revised Soc value improved the secondary sensor's agreement with the average Winkler values.

**Table 7**. Previous and New Soc values for the secondary SBE Oxygen sensor (#3030).

| | **Old Soc** | **New Soc** | **Ratio (New:Old)** |
|---|---|---|---|
| **Secondary Sensor #3030** | 4.4970e-1 | 4.6915e-1 | 1.0432 |

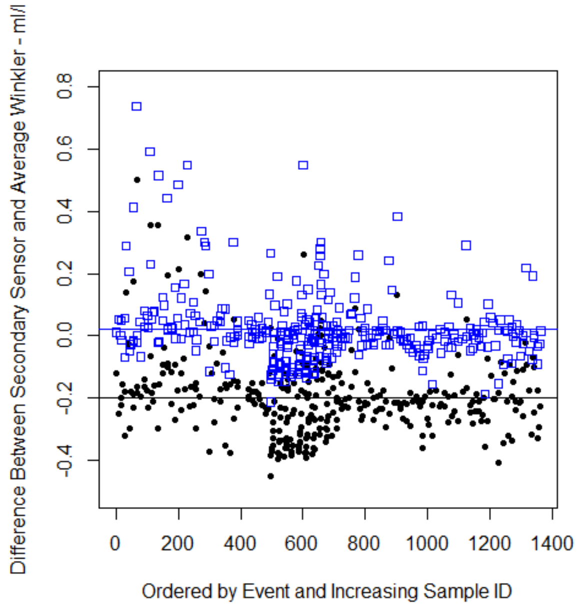



**Figure 9.** Corrected (0.0223) and uncorrected (-0.1960) mean difference between secondary sensor values (#3030) and corresponding average Winkler values.

Figure 10A shows the mean difference between Soc corrected (0.0147 ml/l) and uncorrected (0.0253 ml/l) primary (#3026) and secondary sensor (#3030) values. Figure 10B shows the mean difference between Soc corrected (-0.0015 ml/l) and uncorrected (-0.0273 ml/l) primary (#0042) and secondary sensor (#3030) values. The Soc correction improved the agreement of both primary sensors (#3026 and #0042) with the secondary sensor (#3030), and the agreement of all three sensors with their corresponding Winkler titration values.

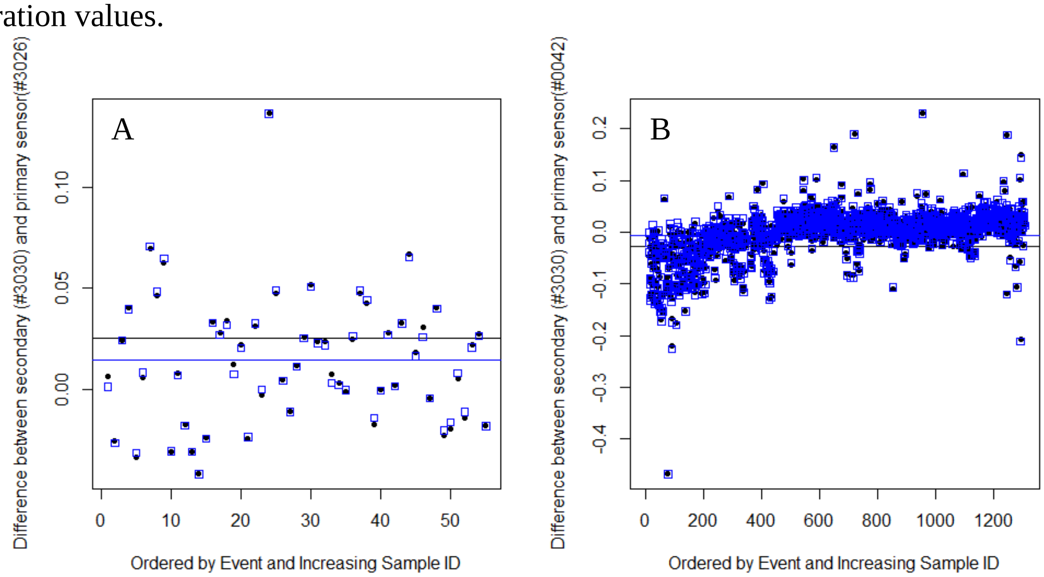



**Figure 10. A)** The Soc corrected difference between primary (#3026) and secondary (#3030) sensors (ml/l), and **B)** The Soc corrected difference between primary (#0042) and secondary (#3030) sensors (ml/l).

## Salinity

**(With portions extracted from HUD2014017 Cruise Report)**

With the exception of EH_01 (Event 106) and EH_02 (Event 104) (highlighted in red in Figure 11), the agreement between primary (#4361) and secondary (#3561) conductivity was generally good. When these erroneous values were removed, along with the primary and secondary values for 2 Sample_ID's (430829 and 430445 – LHB_06.3 and PL_02 respectively) and the primary sensor value for Sample_ID 430926 (the last event (287) at HL_02), the mean difference between primary and secondary sensor values was -0.0078.

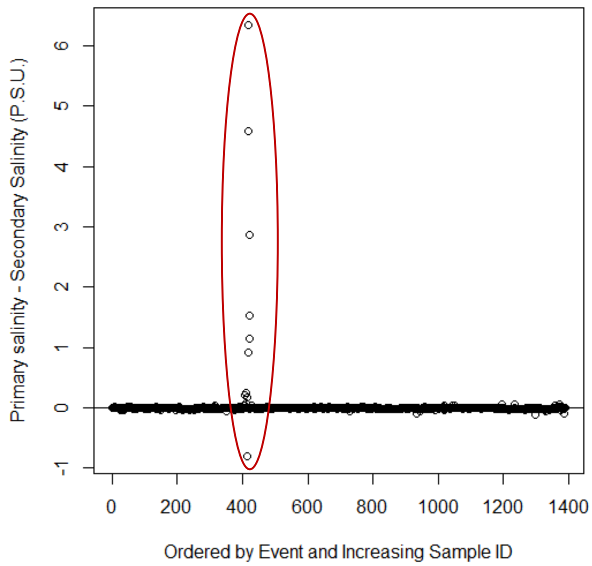



**Figure 11. A)** There was good agreement between the primary (#4361) and secondary (#3561) conductivity sensors throughout the mission. A malfunction of secondary pump during Events 106 (EH_01) and 104 (EH_02) caused a large difference (circled in red). These values should be removed before data is archived.

***Conductivity 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 1 atm/conductivity of KCl solution (32.4356g/kg) at 15°C and 1 atm.

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 defined. 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 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.

The swCSTp function, which uses the Gibbs-Sea Water (gsw_C_from_SP) formulation, from the R OCE package was used to convert the salinity of the bottle sample as measured by the salinometer (corrected to 15 degrees Celcius at 0 dbar) to conductivity ratio (Conductivity_bottle) which is then multiplied by 42.91754 to reach conductivity in mS/cm. Only data with a difference in primary and secondary sensor conductivities of 1 standard deviation (0.005131 mS/cm) around the mean difference (0.006597 mS/cm) were used to calculate the Intercept and slope values. These data were then used to fit a linear regression for both the primary and secondary CTD sensor conductivity values. The b1 (intercept) and b2 (slope) values for both the primary and secondary sensor regressions were extracted directly from the linear regression summary and used to "correct" the primary sensor values (Table 8). These terms should be used to calibrate the sensor salinity values for CTD output files prior to data archiving (CTD archiving or BioChem). When applied to both the primary and secondary sensors and then compared to auto-salinometer measures, in both cases calibration coefficients make the intercept very near 0 and the slope exactly 1.

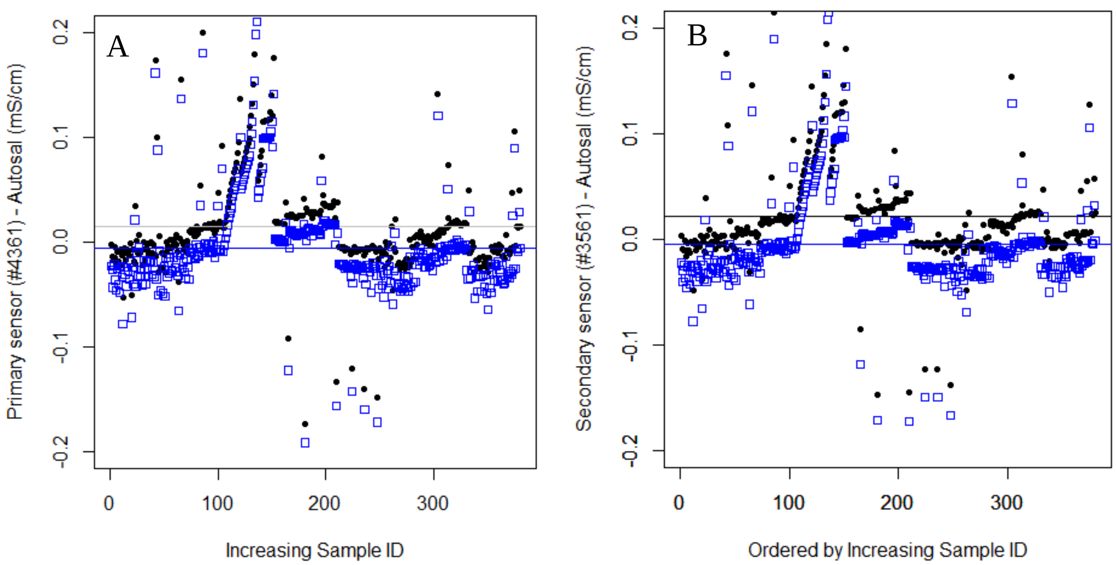
**Table 8.** The intercept (mS/cm) and slope calibration coefficients for primary and secondary conductivity sensors used during HUD2015030.

| | Intercept (b1) | Slope (b2) | $r^2$ |
|---|---|---|---|
| Primary (#4361) | -2.758052e-03 | 9.995162e-01 | 0.9999 |

| | | | |
|---|---|---|---|
| Secondary (#3561) | 4.671823-04 | 9.992833e-01 | 0.9999 |

After applying the corrections to the primary and secondary conductivity sensors, they both improve their fit with their corresponding Autosalinometer conductivity measures (Figure 12). The average difference between the primary and Autosalinometer measures (mS/cm) before correction was 1.46e-02 (mS/cm) and this improved to -5.87e-03 after (Figure 12 A). The average difference between the secondary sensor and the Autosalinometer before correction was 2.12e-02 (mS/cm) and this improved to 4.59e-3 after correction (Figure 12 B). As stated earlier when discussing the impact of the b1 and b2 factors on the relationship between the primary and secondary sensors, the average difference improved substantially after correction, from 6.60e-03 (mS/cm) to 1.28e-3 (Figure 12 C).

It is particularily apparent in firgures 12 A and B that something happens with the Autosalinometer from sample ID 430017 to 430088 (HL_12, 13 and 14). This correspondonds with a marked increase in tempearture (34 degrees Celcius) in the laboratory housing the Auosalinometer that causes it to overheat and produce poor quality data. Other "splits" are also observed periodically in these data and correspond with the recalibration of the Autosalinometer with a standard (Figure 13). A more in-depth analysis to derive b0 and b1 to correct sensor conductivity would involve removing these erroneous data so as not to underestimate the majority of the sensor data that is otherwise considerably closer to salinometer values.



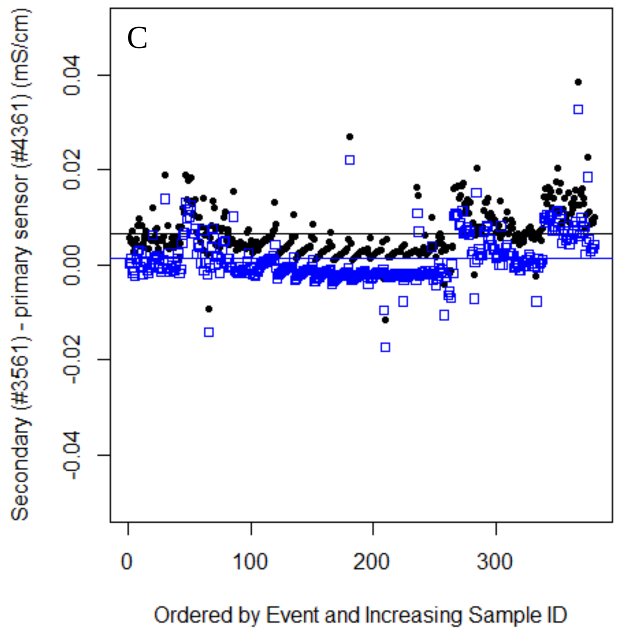



**Figure 12. A)** The difference between the primary conductivity sensor and the corresponding Autosalinometer conductivity. **B)** The difference between the secondary conductivity sensor and the corresponding Autosalinometer conductivity. **C**) The difference between the primary and secondary sensors both before (black dots) and after (blue squares) correction.

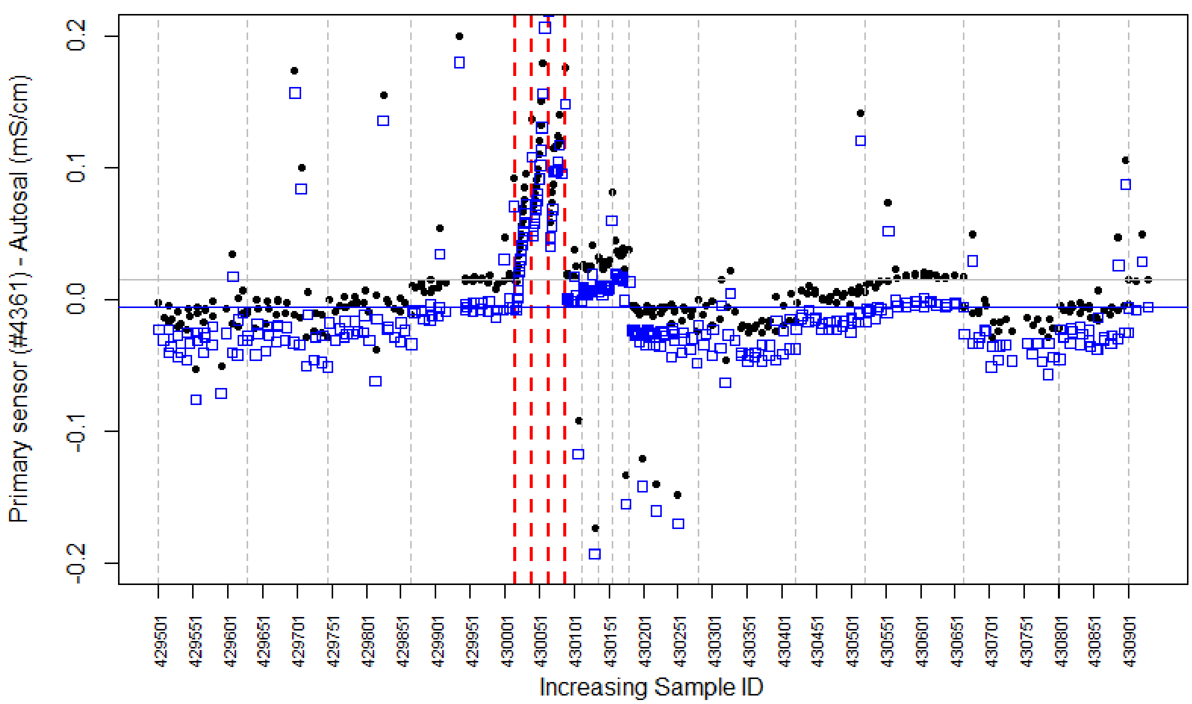



**Figure 13.** Vertical lines denoting the calibration standards run throughout the mission. Note that at vertical red lines, the temperature in the laboratory was 34 degrees Celcius and caused the Autosalinometer to overheat (HL_12, 13 and 14). Black dots represent uncorrected differences between the primary and Autosalinometer and blue squares represent calibrated differences.

## Chlorophyll a

Throughout the mission, Chl a was measured in-situ via a Chelsea and SeaPoint fluorometer attached to the CTD rosette ((Appendix 1A – 7 & 11 respectively). It was noted during the mission that the values of the 2 fluorometers differed wildly (10 fold) but appeared to have similar vertical structure, but the relationship between the 2 sensors was not investigated further while at sea. Figure 14 shows that there was no significant relationship between the in-situ Chelsea measurements and the replicate bottle samples as measured in the lab by the Turner fluorometer. In fact, the data generated by the Chelsea has proven very poor and should be discarded. Nonetheless, there was a significant linear relationship between the SeaPoint output and the mean bottle replicate Chl a from the Turner fluorometer (Figure 15). After removing extreme outliers, the relationship was highly significant with an $r^2$ value of .8081 (y=0.034167+0.094112x), which means that in-situ SeaPoint fluorometer measurements were approximately 1/10$^{th}$ those of the mean of the bottle replicates. No such relationship is evident between the Chelsea fluorometer and the mean bottle replicates.

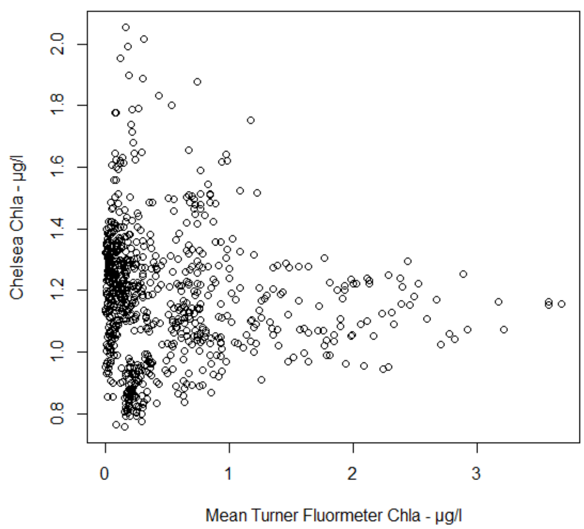



**Figure 14.** Note the lack of relationship between the in-situ Chelsea fluorometer measurement and the mean of the bottle replicates as measured by the Turner fluorometer in the lab.

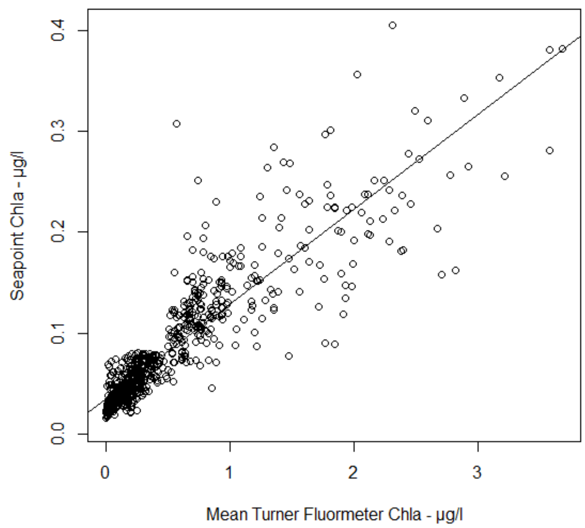



**Figure 15.** The relationship between the mean of the replicate bottle Chl a values (Turner) versus the in-situ Chl a as captured by the SeaPoint sensor on the CTD rosette.

Prior to the spring 2016 AZMP mission, some effort should be placed on trying to determine the source of the 10 fold discrepancy between in-situ and laboratory measures of Chl a. The Seapoint fluorometer uses a jumper cable to set the gain. There could be a problem with the cable used.

## 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 nearly all casts for reasons specified in the CTD Summary. It has been recommended to ODIS that the PAR data not be archived, and if it is to be associated with comments to denote its poor quality.

## 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 Summary, the data acquired was of poor quality because of cable malfunction. As with the previous mission, 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 HUD2015030, 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. This is followed by descriptions of "non-core" or ancillary biological sampling that included: vertical ring net tows in support of studies investigating the impact of ocean acidification on *C. finmarchicus* (Xiaohong Sun) and the non-breeding season diet of Dovekie (*Alle alle*), dissolved organic carbon measurements conducted by Greg Britten on behalf of 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 (Erin Wilson and Dr. Markus Kienast – Dalhousie University). The Biological Program section is concluded with a summary of pelagic seabird and marine mammal observations aboard HUD2015030, provided by Carina Gjerdrum of the Canadian Wildlife Service.

This field season marks the first since the inception of the program that integrated phytoplankton sampling did not take place, based on recommendations arising upon the conclusion of HUD2015004.

**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 and BioNess deployments were successful (Figure 16 and 17). The few problems encountered are described in detail below and in Table 9.

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 136 successful vertical ring net tows during the mission (Table 9). Of these, 7 were 76 µm mesh tows (30 cm diameter and 1:5 filtering ratio) along the shelf stations of the Halifax Line, and 39 were 202 µm mesh tows along the core AZMP sections (CSL, LL, HL and BBL). 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, 11 - 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 (Table 9 – objective 16). 12 successful - 202 µm net tow samples (Table 9 – objective 17) were also collected for a study investigated egg clutch size in *C. finmarchicus*. The remaining 74 successful ring net tows were conducted at non-core stations throughout the mission and supported 7 additional objectives (Table 9 – objectives 2, 4, 5, 6, 7, 8 and 9).

At Event 68 (LL_05) the net let go from the cross-bow and the tow had to be repeated, but the net was not lost (Table 9). At Event 91 (SPB_10), the net was lost and the tow was not repeated, so there is no sample at this Station. During Event 111 (BP_05) the net impacted with the bottom and the tow was repeated. There is also some concern with the tow at Event 126 that the net was hung up on the hull at the end of recovery for nearly ½ hour and likely compromised the sample integrity. During Event 269 (LHB_05) the net was replaced prior to deployment but no flow meter was placed at the mouth of the net.

Excluding the test in Bedford Basin, there were a total of 6 successful BioNess deployments during the mission (Figure 17 and Table 9). Unfortunately, poor sea state precluded BioNess tows in the Gully and the Cabot Strait Line during this mission.

During the first tests in Bedford Basin, the BioNess video camera blinked rapidly when being hauled in and when the nets were fired (Table 9). Upon conclusion of the tow, the camera was replaced and the connectors cleaned. With the exception of Event 279 (HL_03) when the tow had to be aborted because the motor was not tightened and the nets were not closing, the BioNess worked well throughout the mission.

This was the first sampling season with an updated operating system for controlling the very old BioNess software. This is a short term stop gap, but will at least allow AZMP to continue BioNess operations into the near future. Despite recent inquiries, there seems to be little money, motivation and/or people to allocate towards a rebuild or replacement of the current system. The current strategy is to continue to provide minimal funds to maintain BioNess until such time it fails catastrophically.

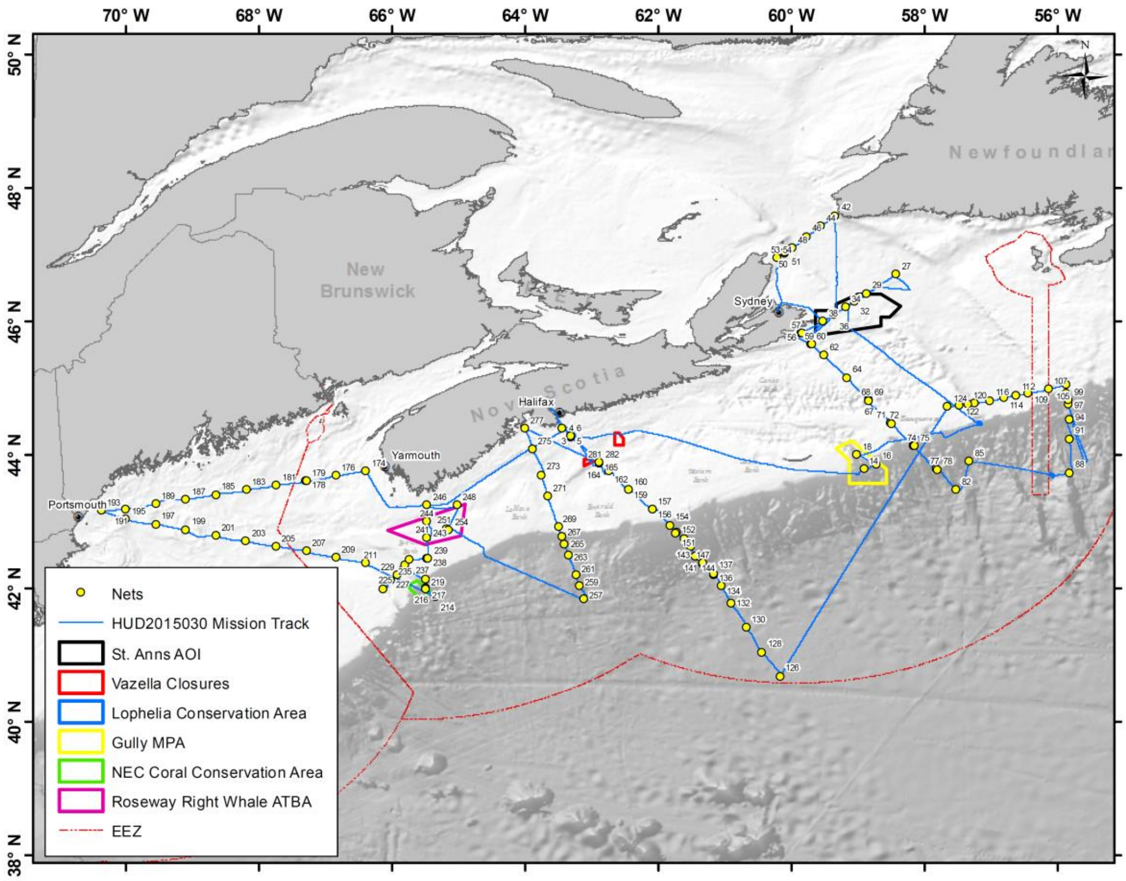



**Figure 16.** Locations for vertical ring net tows during HUD2015030 AZMP Fall survey. Each tow is labelled with the consecutive mission event.

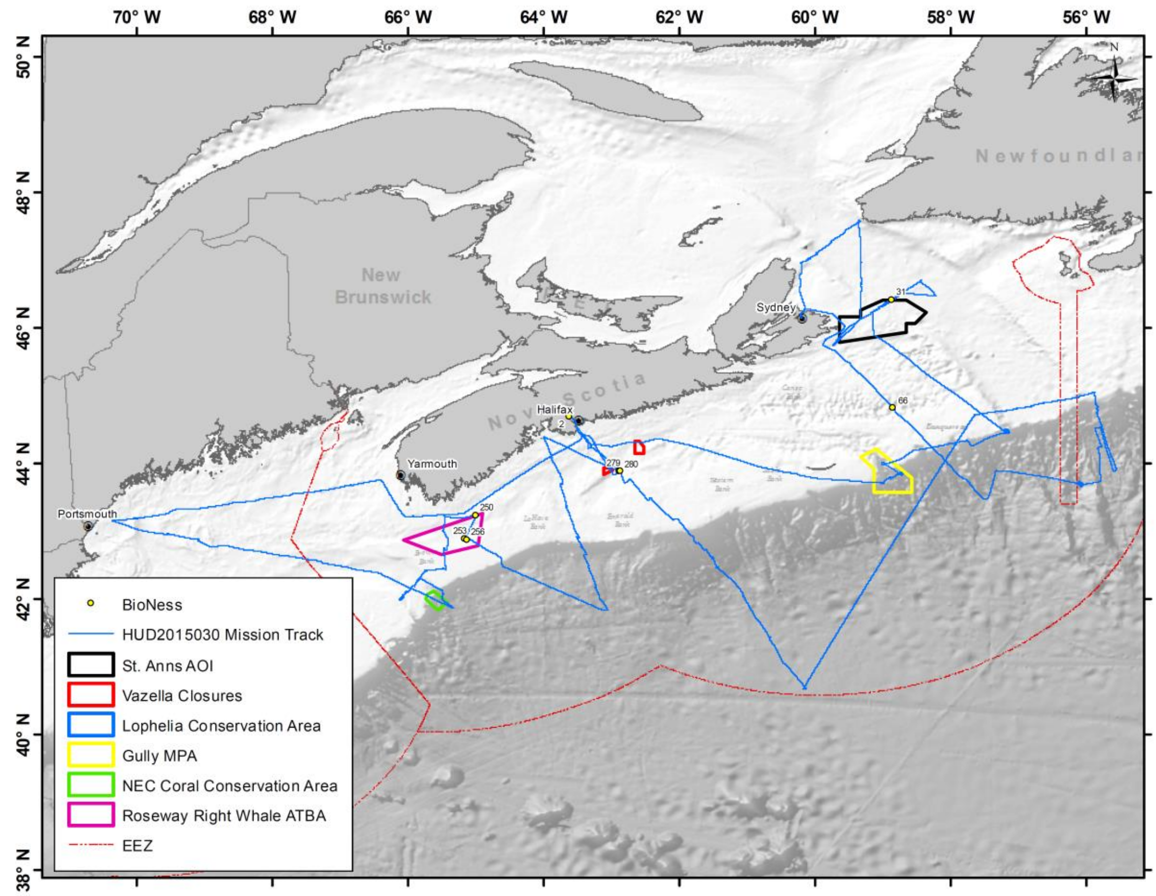



**Figure 17.** Start locations for BioNess tows during HUD2015030 AZMP Fall survey. Each tow is labelled with the consecutive mission event.

**Table 9.** Zooplankton collection activities during the HUD2015030 AZMP spring survey. The coordinates provided are in decimal degrees and reflect the ship's position at the time of deployment as recorded using the ELOG meta-data logger.

| # | Event | Date | Station | Operation | Mesh Size (µm) | Slat (DD) | SLong (DD) | Objective | Comment |
|---|---|---|---|---|---|---|---|---|---|
| **1** | 2 | 20/09/2015 | HL_00 | BioNess | | 44.6922 | -63.6396 | | Gear Testing – camera flickering when net motor fired. |
| **2** | 3 | 20/09/2015 | HL_02 | RingNet | 202 | 44.2672 | -63.3169 | 1 | |
| **3** | 4 | 20/09/2015 | HL_02 | RingNet | 76 | 44.2685 | -63.3186 | 1 | |
| **4** | 5 | 20/09/2015 | HL_02 | RingNet | 202 | 44.2706 | -63.3203 | 16 | |
| **5** | 6 | 20/09/2015 | HL_02 | RingNet | 202 | 44.2714 | -63.3213 | 17 | |
| **6** | 14 | 21/09/2015 | GULD_04 | RingNet | 202 | 43.7862 | -58.9048 | 4 | |
| **7** | 16 | 21/09/2015 | SG_23 | RingNet | 202 | 43.8597 | -58.7325 | 4 | |
| **8** | 18 | 22/09/2015 | GULD_03 | RingNet | 202 | 43.9982 | -59.0209 | 4 | |
| **9** | 27 | 23/09/2015 | STAB_06 | RingNet | 202 | 46.7102 | -58.4358 | 5 | Net hit bottom |
| **10** | 29 | 24/09/2015 | STAB_05 | RingNet | 202 | 46.4166 | -58.8814 | 5 | |
| **11** | 31 | 24/09/2015 | STAB_05 | BioNess | | 46.4124 | -58.8763 | 5 | |
| **12** | 32 | 24/09/2015 | STAB_04 | RingNet | 202 | 46.2996 | -59.0635 | 5 | |
| **13** | 34 | 24/09/2015 | STAB_03 | RingNet | 202 | 46.2162 | -59.1942 | 5 | |
| **14** | 36 | 24/09/2015 | STAB_02 | RingNet | 202 | 46.1077 | -59.3644 | 5 | |
| **15** | 38 | 24/09/2015 | STAB_01 | RingNet | 202 | 45.9990 | -59.5344 | 5 | |
| **16** | 42 | 25/09/2015 | CSL_06 | RingNet | 202 | 47.5840 | -59.3439 | 1 | |
| **17** | 44 | 25/09/2015 | CSL_05 | RingNet | 202 | 47.4319 | -59.5626 | 1 | |
| **18** | 46 | 25/09/2015 | CSL_04 | RingNet | 202 | 47.2702 | -59.7788 | 1 | |
| **19** | 48 | 25/09/2015 | CSL_03 | RingNet | 202 | 47.1001 | -59.9910 | 1 | |
| **20** | 50 | 25/09/2015 | CSL_02 | RingNet | 202 | 47.0282 | -60.1086 | 1 | |
| **21** | 51 | 25/09/2015 | CSL_02 | RingNet | 202 | 47.0294 | -60.0985 | 17 | |
| **22** | 53 | 25/09/2015 | CSL_01 | RingNet | 202 | 46.9557 | -60.2182 | 1 | |
| **23** | 54 | 25/09/2015 | CSL_01 | RingNet | 202 | 46.9535 | -60.2162 | 17 | |
| **24** | 56 | 25/09/2015 | LL_01 | RingNet | 202 | 45.8262 | -59.8538 | 1 | |
| **25** | 57 | 25/09/2015 | LL_01 | RingNet | 202 | 45.8252 | -59.8512 | 17 | |
| **26** | 59 | 26/09/2015 | LL_02 | RingNet | 202 | 45.6592 | -59.7051 | 1 | |
| **27** | 60 | 26/09/2015 | LL_02 | RingNet | 202 | 45.6586 | -59.7032 | 16 | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **28** | 62 | 26/09/2015 | LL_03 | RingNet | 202 | 45.4909 | -59.5160 | 1 | |
| **29** | 64 | 26/09/2015 | LL_04 | RingNet | 202 | 45.1576 | -59.1744 | 1 | |
| **30** | 66 | 26/09/2015 | LL_05 | BioNess | | 44.8187 | -58.8516 | 1 | |
| **31** | 67 | 26/09/2015 | LL_05 | RingNet | 202 | 44.8156 | -58.8495 | 1 | |
| **32** | 68 | 26/09/2015 | LL_05 | RingNet | 202 | 44.8117 | -58.8492 | 17 | Net let go from cross-bow, had to repeat the tow. |
| **33** | 69 | 26/09/2015 | LL_05 | RingNet | 202 | 44.8095 | -58.8489 | 17 | |
| **34** | 71 | 26/09/2015 | LL_06 | RingNet | 202 | 44.4726 | -58.5068 | 1 | |
| **35** | 72 | 26/09/2015 | LL_06 | RingNet | 202 | 44.4693 | -58.5014 | 17 | |
| **36** | 74 | 26/09/2015 | LL_07 | RingNet | 202 | 44.1332 | -58.1727 | 1 | |
| **37** | 75 | 26/09/2015 | LL_07 | RingNet | 202 | 44.1276 | -58.1583 | 16 | |
| **38** | 77 | 26/09/2015 | LL_08 | RingNet | 202 | 43.7816 | -57.8305 | 1 | |
| **39** | 78 | 26/09/2015 | LL_08 | RingNet | 202 | 43.7754 | -57.8119 | 16 | |
| **40** | 82 | 27/09/2015 | LL_09 | RingNet | 202 | 43.4744 | -57.5259 | 1 | |
| **41** | 85 | 27/09/2015 | SF_01 | RingNet | 202 | 43.8964 | -57.3310 | | |
| **42** | 88 | 27/09/2015 | SPB_11 | RingNet | 202 | 43.7298 | -55.8289 | 7 | |
| **43** | 91 | 28/09/2015 | SPB_10 | RingNet | 202 | 44.2374 | -55.8312 | 7 | Net lost, no sample collected. |
| **44** | 94 | 28/09/2015 | SPB_09 | RingNet | 202 | 44.5301 | -55.8284 | 7 | |
| **45** | 97 | 28/09/2015 | SPB_08 | RingNet | 202 | 44.7616 | -55.8463 | 7 | |
| **46** | 99 | 29/09/2015 | EH_04 | RingNet | 202 | 44.8185 | -55.8476 | 7 | |
| **47** | 101 | 29/09/2015 | EH_03 | RingNet | 202 | 44.8806 | -55.8698 | 7 | |
| **48** | 103 | 29/09/2015 | EH_02 | RingNet | 202 | 44.9202 | -55.8697 | 7 | |
| **49** | 105 | 29/09/2015 | EH_01 | RingNet | 202 | 45.0516 | -55.8805 | 7 | |
| **50** | 107 | 29/09/2015 | BP_01 | RingNet | 202 | 44.9795 | -56.1379 | 7 | |
| **51** | 109 | 29/09/2015 | BP_04 | RingNet | 202 | 44.9167 | -56.4413 | 7 | |
| **52** | 111 | 29/09/2015 | BP_05 | RingNet | 202 | 44.8903 | -56.6300 | 7 | Net touched bottom - repeated. |
| **53** | 112 | 29/09/2015 | BP_05 | RingNet | 202 | 44.8927 | -56.6303 | 7 | |
| **54** | 114 | 29/09/2015 | BANQ_B6 | RingNet | 202 | 44.8470 | -56.8078 | 7 | |
| **55** | 116 | 29/09/2015 | BANQ_B5 | RingNet | 202 | 44.8088 | -57.0270 | 7 | |
| **56** | 118 | 29/09/2015 | BANQ_B4 | RingNet | 202 | 44.7764 | -57.2535 | 7 | |
| **57** | 120 | 30/09/2015 | BANQ_B3 | RingNet | 202 | 44.7607 | -57.3494 | 7 | |
| **58** | 122 | 30/09/2015 | BANQ_B2 | RingNet | 202 | 44.7446 | -57.4751 | 7 | |
| **59** | 124 | 30/09/2015 | BANQ_B1 | RingNet | 202 | 44.7190 | -57.6537 | 7 | |
| **60** | 126 | 01/10/2015 | HL_14 | RingNet | 202 | 40.6760 | -60.1773 | 2 | Net hung up on hull at end of |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | recovery, compromised? |
| **61** | 128 | 01/10/2015 | HL_13 | RingNet | 202 | 41.0375 | -60.4466 | 2 | |
| **62** | 130 | 01/10/2015 | HL_12 | RingNet | 202 | 41.4103 | -60.6773 | 2 | |
| **63** | 132 | 02/10/2015 | HL_11 | RingNet | 202 | 41.7697 | -60.9092 | 2 | |
| **64** | 134 | 02/10/2015 | HL_10 | RingNet | 202 | 42.0318 | -61.0633 | 2 | |
| **65** | 136 | 02/10/2015 | HL_09 | RingNet | 202 | 42.1996 | -61.1709 | 2 | |
| **66** | 137 | 02/10/2015 | HL_09 | RingNet | 202 | 42.2173 | -61.1724 | 17 | |
| **67** | 140 | 02/10/2015 | HL_08 | RingNet | 202 | 42.3643 | -61.3416 | 2 | |
| **68** | 141 | 02/10/2015 | HL_08 | RingNet | 202 | 42.3702 | -61.3383 | 17 | |
| **69** | 143 | 02/10/2015 | HL_07 | RingNet | 202 | 42.4715 | -61.4418 | 1 | |
| **70** | 144 | 02/10/2015 | HL_07 | RingNet | 202 | 42.4768 | -61.4430 | 16 | |
| **71** | 147 | 03/10/2015 | HL_06.7 | RingNet | 202 | 42.6175 | -61.5175 | | Objective not specified - slope sampling for RAPID |
| **72** | 149 | 03/10/2015 | HL_06.3 | RingNet | 202 | 42.7328 | -61.6161 | | Objective not specified - slope sampling for RAPID |
| **73** | 151 | 03/10/2015 | HL_06 | RingNet | 202 | 42.8324 | -61.7355 | 1 | |
| **74** | 152 | 03/10/2015 | HL_06 | RingNet | 202 | 42.8229 | -61.7407 | 16 | |
| **75** | 154 | 03/10/2015 | HL_05.5 | RingNet | 202 | 42.9392 | -61.8330 | | Objective not specified - slope sampling for RAPID |
| **76** | 156 | 03/10/2015 | HL_05 | RingNet | 202 | 43.1800 | -62.0966 | 1 | |
| **77** | 157 | 03/10/2015 | HL_05 | RingNet | 76 | 43.1767 | -62.0930 | 1 | |
| **78** | 159 | 03/10/2015 | HL_04 | RingNet | 202 | 43.4786 | -62.4506 | 1 | |
| **79** | 160 | 03/10/2015 | HL_04 | RingNet | 76 | 43.4709 | -62.4531 | 1 | |
| **80** | 162 | 04/10/2015 | HL_03.3 | RingNet | 202 | 43.7626 | -62.7538 | | Objective not specified - site of interest for scattering layer (OTN) |
| **81** | 164 | 04/10/2015 | HL_03 | RingNet | 202 | 43.8780 | -62.8922 | 1 | |
| **82** | 165 | 04/10/2015 | HL_03 | RingNet | 76 | 43.8757 | -62.8927 | 1 | |
| **83** | 167 | 04/10/2015 | HL_02 | RingNet | 202 | 44.2673 | -63.3151 | 1 | |
| **84** | 168 | 04/10/2015 | HL_02 | RingNet | 76 | 44.2630 | -63.3164 | 1 | |
| **85** | 169 | 04/10/2015 | HL_02 | RingNet | 202 | 44.2571 | -63.3177 | 16 | |
| **86** | 171 | 04/10/2015 | HL_01 | RingNet | 202 | 44.4031 | -63.4468 | 1 | |
| **87** | 172 | 04/10/2015 | HL_01 | RingNet | 76 | 44.3992 | -63.4480 | 1 | |
| **88** | 174 | 05/10/2015 | YL_01 | RingNet | 202 | 43.7512 | -66.3998 | 9 | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **89** | 176 | 05/10/2015 | YL_02 | RingNet | 202 | 43.6828 | -66.8490 | 9 | |
| **90** | 178 | 05/10/2015 | YL_03 | RingNet | 202 | 43.6108 | -67.2994 | 9 | |
| **91** | 179 | 05/10/2015 | YL_03 | RingNet | 202 | 43.6059 | -67.2985 | 17 | |
| **92** | 181 | 05/10/2015 | YL_04 | RingNet | 202 | 43.5450 | -67.7453 | 9 | |
| **93** | 183 | 05/10/2015 | YL_05 | RingNet | 202 | 43.4717 | -68.2000 | 9 | |
| **94** | 185 | 05/10/2015 | YL_06 | RingNet | 202 | 43.3999 | -68.6573 | 9 | |
| **95** | 187 | 05/10/2015 | YL_07 | RingNet | 202 | 43.3281 | -69.1078 | 9 | |
| **96** | 189 | 05/10/2015 | YL_08 | RingNet | 202 | 43.2608 | -69.5585 | 9 | |
| **97** | 191 | 06/10/2015 | YL_09 | RingNet | 202 | 43.1881 | -70.0080 | 9 | |
| **98** | 193 | 06/10/2015 | YL_10 | RingNet | 202 | 43.1599 | -70.3767 | 9 | Small salps, 2 bottles required for sample. |
| **99** | 195 | 06/10/2015 | PL_01 | RingNet | 202 | 43.0337 | -70.0098 | 9 | |
| **100** | 197 | 06/10/2015 | PL_02 | RingNet | 202 | 42.9583 | -69.5547 | 9 | |
| **101** | 199 | 06/10/2015 | PL_03 | RingNet | 202 | 42.8742 | -69.1036 | 9 | |
| **102** | 201 | 06/10/2015 | PL_04 | RingNet | 202 | 42.7887 | -68.6560 | 9 | |
| **103** | 203 | 06/10/2015 | PL_05 | RingNet | 202 | 42.7018 | -68.2060 | 9 | |
| **104** | 205 | 06/10/2015 | PL_06 | RingNet | 202 | 42.6251 | -67.7565 | 9 | |
| **105** | 207 | 07/10/2015 | PL_07 | RingNet | 202 | 42.5547 | -67.2936 | 9 | |
| **106** | 209 | 07/10/2015 | PL_08 | RingNet | 202 | 42.4622 | -66.8496 | 9 | |
| **107** | 211 | 07/10/2015 | PL_09 | RingNet | 202 | 42.3755 | -66.4010 | 9 | |
| **108** | 213 | 07/10/2015 | BBL_07 | RingNet | 202 | 41.8693 | -65.3596 | 1 | |
| **109** | 214 | 07/10/2015 | BBL_07 | RingNet | 202 | 41.8675 | -65.3557 | 17 | |
| **110** | 216 | 07/10/2015 | BBL_06 | RingNet | 202 | 41.9975 | -65.5094 | 1 | |
| **111** | 217 | 07/10/2015 | BBL_06 | RingNet | 202 | 41.9846 | -65.4980 | 16 | |
| **112** | 219 | 07/10/2015 | BBL_05 | RingNet | 202 | 42.1317 | -65.5008 | 1 | |
| **113** | 225 | 08/10/2015 | PS_10 | RingNet | 202 | 41.9890 | -66.1346 | 6 | |
| **114** | 227 | 08/10/2015 | PS_08 | RingNet | 202 | 42.1160 | -66.0343 | 6 | |
| **115** | 229 | 08/10/2015 | PS_06 | RingNet | 202 | 42.1988 | -65.9356 | 6 | |
| **116** | 231 | 08/10/2015 | PS_04 | RingNet | 202 | 42.2705 | -65.8694 | 6 | |
| **117** | 233 | 08/10/2015 | PS_02 | RingNet | 202 | 42.3375 | -65.8144 | 6 | |
| **118** | 235 | 08/10/2015 | PS_01 | RingNet | 202 | 42.4196 | -65.7447 | 6 | |
| **119** | 237 | 08/10/2015 | BBL_04 | RingNet | 202 | 42.4491 | -65.4800 | 1 | |
| **120** | 238 | 08/10/2015 | BBL_04 | RingNet | 202 | 42.4457 | -65.4719 | 16 | |
| **121** | 239 | 08/10/2015 | BBL_04 | RingNet | 202 | 42.4426 | -65.4653 | 17 | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **122** | 241 | 08/10/2015 | BBL_03 | RingNet | 202 | 42.7555 | -65.4785 | 1 | |
| **123** | 243 | 08/10/2015 | BBL_02 | RingNet | 202 | 42.9999 | -65.4810 | 1 | |
| **124** | 244 | 08/10/2015 | BBL_02 | RingNet | 202 | 43.0002 | -65.4828 | 16 | |
| **125** | 246 | 08/10/2015 | BBL_01 | RingNet | 202 | 43.2492 | -65.4795 | 1 | |
| **126** | 248 | 08/10/2015 | RL_01 | RingNet | 202 | 43.2473 | -65.0328 | 8 | |
| **127** | 250 | 09/10/2015 | RL_01 | BioNess | | 43.2314 | -65.0167 | 8 | |
| **128** | 251 | 09/10/2015 | RATBA_01 | RingNet | 202 | 42.8912 | -65.1830 | 8 | |
| **129** | 253 | 09/10/2015 | RATBA_01 | BioNess | | 42.8935 | -65.1785 | 8 | |
| **130** | 254 | 09/10/2015 | RATBA_02 | RingNet | 202 | 42.8687 | -65.1524 | 8 | |
| **131** | 256 | 09/10/2015 | RATBA_02 | BioNess | | 42.8731 | -65.1466 | 8 | |
| **132** | 257 | 09/10/2015 | LHB_08 | RingNet | 202 | 41.8318 | -63.1214 | 7 | |
| **133** | 259 | 09/10/2015 | LHB_07 | RingNet | 202 | 42.0269 | -63.1958 | 7 | |
| **134** | 261 | 10/10/2015 | LHB_06.7 | RingNet | 202 | 42.1915 | -63.2423 | 7 | |
| **135** | 263 | 10/10/2015 | LHB_06.3 | RingNet | 202 | 42.4854 | -63.3537 | 7 | |
| **136** | 265 | 10/10/2015 | LHB_06 | RingNet | 202 | 42.6595 | -63.4118 | 7 | |
| **137** | 267 | 10/10/2015 | LHB_05.5 | RingNet | 202 | 42.7703 | -63.4550 | 7 | |
| **138** | 269 | 10/10/2015 | LHB_05 | RingNet | 202 | 42.9131 | -63.4993 | 7 | net replaced, no flow meter on replacement. |
| **139** | 271 | 10/10/2015 | LHB_04 | RingNet | 202 | 43.3783 | -63.6646 | 7 | |
| **140** | 273 | 10/10/2015 | LHB_03 | RingNet | 202 | 43.6978 | -63.7620 | 7 | |
| **141** | 275 | 11/10/2015 | LHB_02 | RingNet | 202 | 44.0845 | -63.9013 | 7 | |
| **142** | 277 | 11/10/2015 | LHB_01 | RingNet | 202 | 44.3888 | -64.0089 | 7 | |
| **143** | 279 | 11/10/2015 | HL_03 | BioNess | | 43.8893 | -62.8968 | 1 | Aborted, motor not tightened. |
| **144** | 280 | 11/10/2015 | HL_03 | BioNess | | 43.8829 | -62.8832 | 1 | |
| **145** | 281 | 11/10/2015 | HL_03 | RingNet | 202 | 43.8831 | -62.8872 | 1 | |
| **146** | 282 | 11/10/2015 | HL_03 | RingNet | 202 | 43.8826 | -62.8866 | 17 | |
| **147** | 284 | 11/10/2015 | HL_02 | RingNet | 202 | 44.2699 | -63.3188 | 1 | |
| **148** | 285 | 11/10/2015 | HL_02 | RingNet | 76 | 44.2740 | -63.3217 | 1 | |
| **149** | 286 | 11/10/2015 | HL_02 | RingNet | 202 | 44.2776 | -63.3238 | 16 | |

## Dissolved Carbon Sampling

**Contribution by:** Helmuth Thomas (Dalhousie University)

The Dalhousie $CO_2$ group's objective on the AZMP Fall 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 4 AZMP core transects: Halifax Line (HL), Louisburg Line (LL), Cabot Strait Line (CSL) and Browns Bank Line (BBL). Dissolved carbon sampling was carried out successfully on the fall AZMP cruise, 2015. Apart from three bottle misfirings incurred over the course of the cruise (Events #s 430153, 430177, 430202), all samples were successfully recovered. All integer-valued stations were sampled along Halifax, Brown's Bank, Louisbourg, and Cabot Strait Lines, plus Halifax Line 3.3. Two Dalhousie volunteers carried out the sampling, Gregory Britten and Qian Huang. Qian Huang experienced severe sea sickness, however, and left the ship permanently at Sydney Harbour five days into the cruise. With some help from DFO science staff, Gregory Britten carried out all remaining sampling. All samples were returned to Dalhousie following the cruise to be processed.

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

**Principle Investigator:** Dr. Markus Kienast (Dalhousie University)
**Sampling by:** Erin Wilson (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 live in, in particular sea surface temperatures. In order to establish seasonal variability and explore possible effects of non-thermal factors on the chemical composition of alkenones, this study aims to sample seasonal time series of suspended alkenones along the AZMP cruise track.

Sampling Methods

A total of 31 suspended particle filters from the ship's seawater intake were collected along the cruise track. Filtering was focused along the LaHave Basin Line (LHB), Halifax Line (HL), and Louisbourg Line (LL) transects. Approximately 230L of water, on average, was filtered through a pre-combusted 142 mm GFF filter placed on a Millipore PVC filter holder. Upon recovery, filters were packed in pre-combusted aluminum foil and frozen immediately at -20°C.

Filters will be analyzed for alkenone concentration, 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 192 water samples were taken from the CTD Rosette at all pre-determined bottle firing depths for seven Halifax Line stations (HL_02, 03, 04, 05, 06, 07 and 09 (6 replicate samples taken at this station)), two Cabot Strait Line stations (CSL_05 and 04), one Brian Petrie station (BP_04), and one Banquereau station (BANQ_B6). Water samples were filtered using 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 frozen at -20°C immediately.

## Pelagic Seabird and Marine Mammal Observations

**Seabird Survey Report**
**20 September – 11 October, 2015**
**Canadian Wildlife Service, Environment Canada**
**Prepared by: Carina Gjerdrum carina.gjerdrum@ec.gc.ca**
**Observer(s): Sue Abbott and Isabeau Pratte (leg 1, trainee)**

### *Background*

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

### *Methods*

Seabird and marine mammal surveys were conducted from the port side of the bridge of the Hudson during the fall Scotian Shelf AZMP from 20 September – 11 October, 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 300 m-wide transect were recorded, and we used the snapshot approach for flying birds (intermittent sampling based on the speed of the ship) to avoid overestimating abundance of birds flying in and out of transect. Distance sampling methods were incorporated to address the variation in bird detectability. Marine mammal observations were also recorded, although surveys were not specifically designed to detect marine mammals. Details of the methods used can be found in the CWS standardized protocol for pelagic seabird surveys from moving platforms[1].

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

### *Results*

#### Seabird Sightings

We surveyed 2432 km of ocean from 20 Sept – 11 Oct, 2015. A total of 1495 marine birds were observed in transect from 10 families (Table 10). Bird densities averaged 1.9 birds/km$^2$ (ranging from 0 - 330 birds/km$^2$). The highest densities of birds were observed in the Gulf of Maine (Figure 18).

Shearwaters accounted for 58% of the observations, most of which were Great Shearwaters (Table 10). Great Shearwaters breed in the southern hemisphere but occur in

Atlantic waters from April through November. Their densities were particularly high in the Gulf of Maine (Figure 19A). Cory's Shearwaters were observed primarily in slope waters off the Scotian Shelf and in higher densities on Brown's Bank (Figure 19A) where they were presumably migrating towards their wintering grounds along the eastern seaboard of the US. Manx, Audubon's, and Sooty Shearwaters were also observed in small numbers (Table 10). Northern Fulmar were observed primarily over shelf waters and in relatively low densities (Figure 19B).

Gulls, terns, skuas, and jaegers (Laridae) accounted for 13% of the observations (Table 10). Herring and Great Black-backed Gulls were the most common of this group and were observed close to shore, but Herring Gulls were also sighted in deep water well beyond the shelf break (Figure 19C). The jaegers were primarily observed along the Brown's Bank Line and in the Gulf of Maine, whereas the skua sightings were scattered throughout the survey area.

Storm-Petrels accounted for 7% of the observations (Table 10), the majority of which were Leach's Storm-Petrels. They were observed throughout the survey area (Figure 19D). Leach's Storm-Petrels breed in high densities on islands along the eastern shore as well in south western Nova Scotia and are still feeding their young into October. The related Wilson's Storm-Petrel, which breeds in the southern hemisphere, were also observed, although in fewer numbers than the Leach's Storm-Petrel and mainly at the shelf break and in slope waters (Figure 19D). Interestingly, a White-faced Storm-Petrel was observed in slope waters along the Halifax Line (Figure 19D). This species breeds on the Cape Verde and Salvages islands, is seen occasionally off the southeastern US, but is only rarely observed north of Maine.

Northern Gannet (7% of the observations; Table 1) were observed primarily off the coast of Cape Breton Island, near Halifax Harbour, the Roseway Basin, and in the Gulf of Maine (Figure 19E) on their way to wintering grounds off the coast of the southern US and in the Gulf of Mexico. Phalaropes accounted for 6% of the sightings (Table 10), the highest densities of which were observed in the Gulf of Maine (Figure 19F). Phalaropes breed in the Arctic, but stage in the Bay of Fundy/Gulf of Maine in large numbers during fall migration.

## Marine Mammal Sightings

A total of 174 marine mammals were recorded during the fall AZMP surveys (Table 11). Dolphins (Atlantic White-sided, Atlantic Spotted, and Common) were the most common species observed (Figure 20A). In addition, 5 Long-finned Pilot Whales, 3 Minke, and 1 Blue Whale were also recorded (Figure 20B).

## Gully MPA

Most of the operations within the Gully MPA occurred during the night, therefore, only 23 km of surveys were conducted within the MPA (Figure 21). Bird sightings within the Gully included just 2 species, the Great Shearwater and Leach's Storm-Petrel (Table 12). Two Long-finned Pilot Whales and 1 unidentified cetacean were the only marine mammals observed within the Gully MPA (Table 12).

**Table 10.** List of bird species observed during the seabird survey on the Fall Scotian Shelf AZMP from 20 Sep – 11 Oct, 2015.

| Family | Species | Latin | Number observed | Total number |
|---|---|---|---|---|
| Gaviidae | Common Loon | *Gavia immer* | 0 | 1 |
| | | | | |
| Procellariidae | Northern Fulmar | *Fulmarus glacialis* | 133 | 280 |
| | Cory's Shearwater | *Calonectris diomedea* | 88 | 127 |
| | Great Shearwater | *Puffinus gravis* | 721 | 1255 |
| | Manx Shearwater | *Puffinus puffinus* | 1 | 2 |
| | Audubon's Shearwater | *Puffinus lherminieri* | 4 | 4 |
| | Sooty Shearwater | *Puffinus griseus* | 2 | 6 |
| | Unidentified Shearwater | *Puffinus* or *Calonectris* | 53 | 57 |
| | | | | |
| Hydrobatidae | White-faced Storm-Petrel | *Pelagodroma marina* | 1 | 1 |
| | Leach's Storm-Petrel | *Oceanodroma leucorhoa* | 77 | 166 |
| | Wilson's Storm Petrel | *Oceanites oceanicus* | 12 | 17 |
| | Unidentified Storm-Petrel | Hydrobatidae | 13 | 44 |
| | | | | |
| Phaethontidae | White-tailed Tropicbird | *Phaethon lepturus* | 1 | 3 |
| | | | | |
| Sulidae | Northern Gannet | *Morus bassanus* | 104 | 346 |
| | | | | |
| Phalacrocoracidae | Double-crested Cormorant | *Phalacrocorax auritus* | 2 | 26 |
| | | | | |
| Anatidae | Canada Goose | Branta canadensis | 0 | 10 |
| | Common Eider | *Somateria mollissima* | 0 | 12 |
| | Surf Scoter | Melanitta perspicillata | 0 | 6 |
| | | | | |
| Scolopacidae | Red Phalarope | *Phalaropus fulicaria* | 58 | 60 |
| | Red-necked Phalarope | *Phalaropus lobatus* | 12 | 12 |
| | Unidentified Phalarope | *Phalaropus* | 18 | 25 |
| | | | | |
| Laridae | Parasitic Jaeger | *Stercorarius parasiticus* | 2 | 4 |
| | Pomarine Jaeger | *Stercorarius pomarinus* | 14 | 31 |
| | Great Skua | *Stercorarius skua* | 6 | 10 |
| | Unidentified Jaeger | *Stercorarius* Jaegers | 8 | 17 |
| | Unidentified Skua | *Stercorarius* Skuas | 1 | 2 |
| | Ring-billed Gull | *Larus delawarensis* | 4 | 5 |
| | Herring Gull | *Larus argentatus* | 72 | 115 |
| | Great Black-backed Gull | *Larus marinus* | 52 | 84 |
| | Black-legged Kittiwake | *Rissa tridactyla* | 5 | 7 |
| | Unidentified Tern | *Sterna* | 28 | 28 |
| | | | | |
| Alcidae | Black Guillemot | Cepphus grylle | 0 | 4 |
| | Atlantic Puffin | *Fratercula arctica* | 1 | 2 |
| | Common Murre | Uria aalga | 1 | 2 |
| | Unidetified Murres | *Uria* | 1 | |
| | Unidentified Auk | Alcidae | 0 | 2 |
| | | | | |
| **Total** | | | **1495** | **2773** |

**Table 11.** List of marine mammals observed during the survey on the Fall Scotian Shelf AZMP from 20 Sep – 11 Oct, 2015.

| English | Latin | Number observed |
|---|---|---|
| Atlantic White-sided Dolphin | *Lagenorhynchus acutus* | 26 |
| Atlantic Spotted Dolphin | *Stenella attenuata* | 15 |
| Common Dolphin | *Delphinus delphis* | 10 |
| Unidentified Dolphins | Delphinidae | 91 |
| Long-finned Pilot Whale | *Globicephala melas* | 5 |
| Minke Whale | *Balaenoptera acutorostrata* | 3 |
| Blue Whale | *Balaenoptera musculus* | 1 |
| Family: Rorquals and Humpback Whales | Balaenopteridae | 7 |
| Order: Whales and Dolphins | Cetacea | 16 |
| Totals | | 174 |

**Table 12.** List of species observed within the Gully MPA during the survey on the Fall Scotian Shelf AZMP from 20 Sep – 11 Oct, 2015.

| English | Latin | Number observed |
|---|---|---|
| Leach's Storm-Petrel | *Oceanodroma leucorhoa* | 6 |
| Great Shearwater | *Puffinus gravis* | 1 |
| Long-finned Pilot Whale | *Globicephala melas* | 2 |
| Order: Whales and Dolphins | Cetacea | 1 |
| Totals | | 10 |

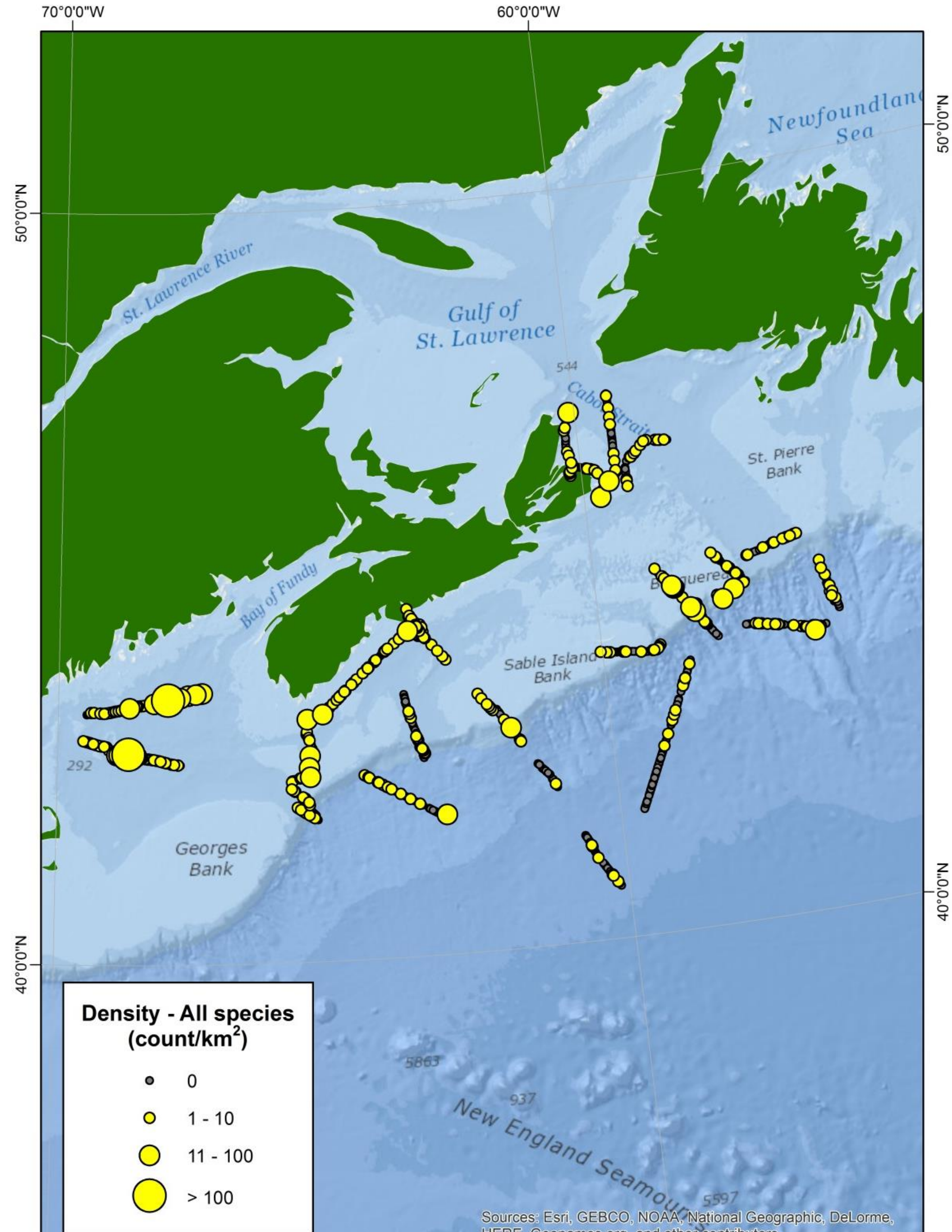
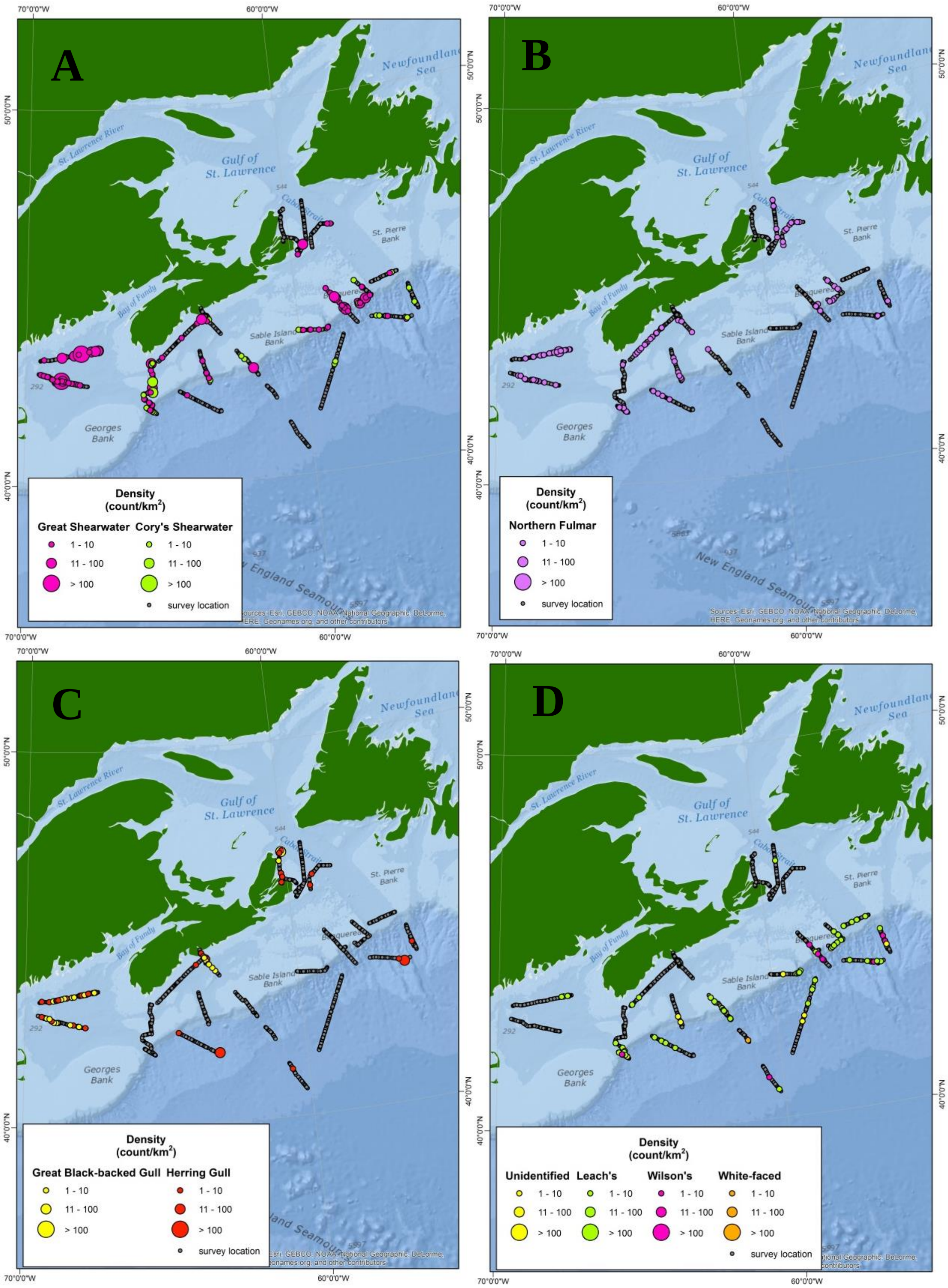



**Figure 18.** Density (count/km2) of birds observed during Fall AZMP on the Scotian Shelf from 20 September – 11 October, 2015.


A
B
C
D
70°0'0"W
60°0'0"W
50°0'0"N
40°0'0"N
Newfoundland Sea
Gulf of St. Lawrence
St. Lawrence River
Bay of Fundy
Cabot Strait
St. Pierre Bank
Sable Island Bank
Georges Bank
New England Seamounts
Sources: Esri, GEBCO, NOAA, National Geographic, DeLorme, HERE, Geonames.org, and other contributors
Density (count/km$^2$)
Great Shearwater
Cory's Shearwater
Northern Fulmar
Great Black-backed Gull
Herring Gull
Unidentified
Leach's
Wilson's
White-faced
1 - 10
11 - 100
> 100
survey location

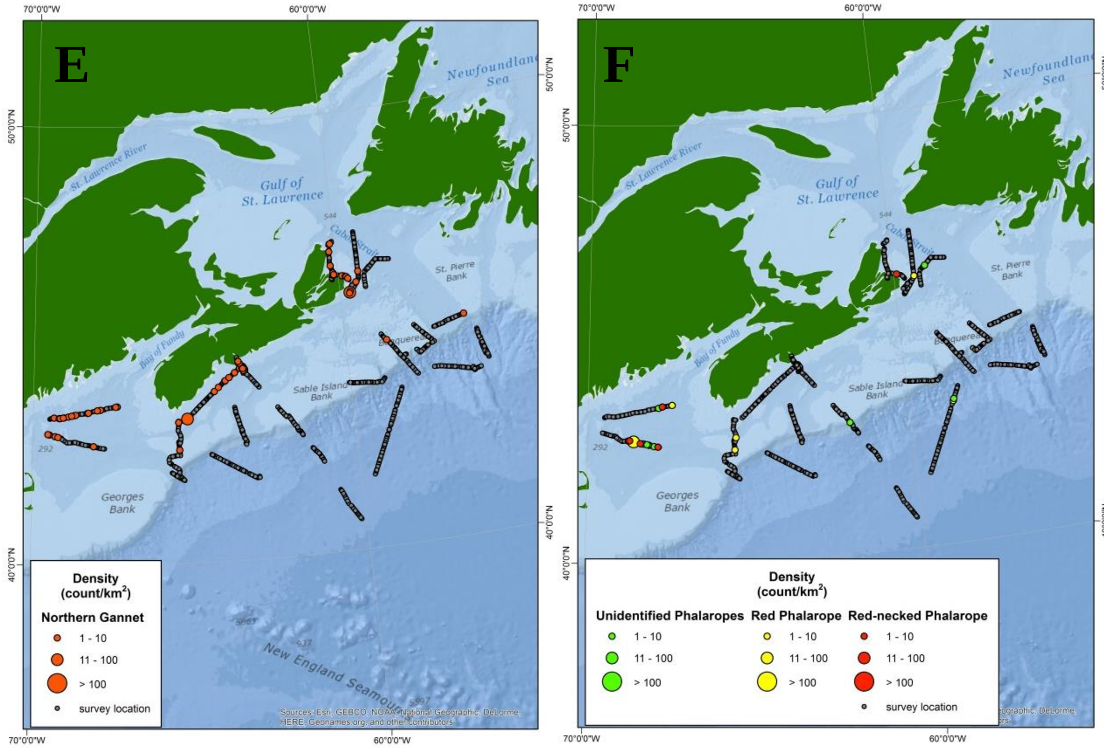



**Figure 19.** Density (count/km2) of (A) shearwaters, (B) Northern Fulmar, (C) gulls, (D) storm-petrels, (E) Northern Gannet, and (F) phalaropes observed during Fall AZMP on the Scotian Shelf from 20 September – 11 October, 2015.

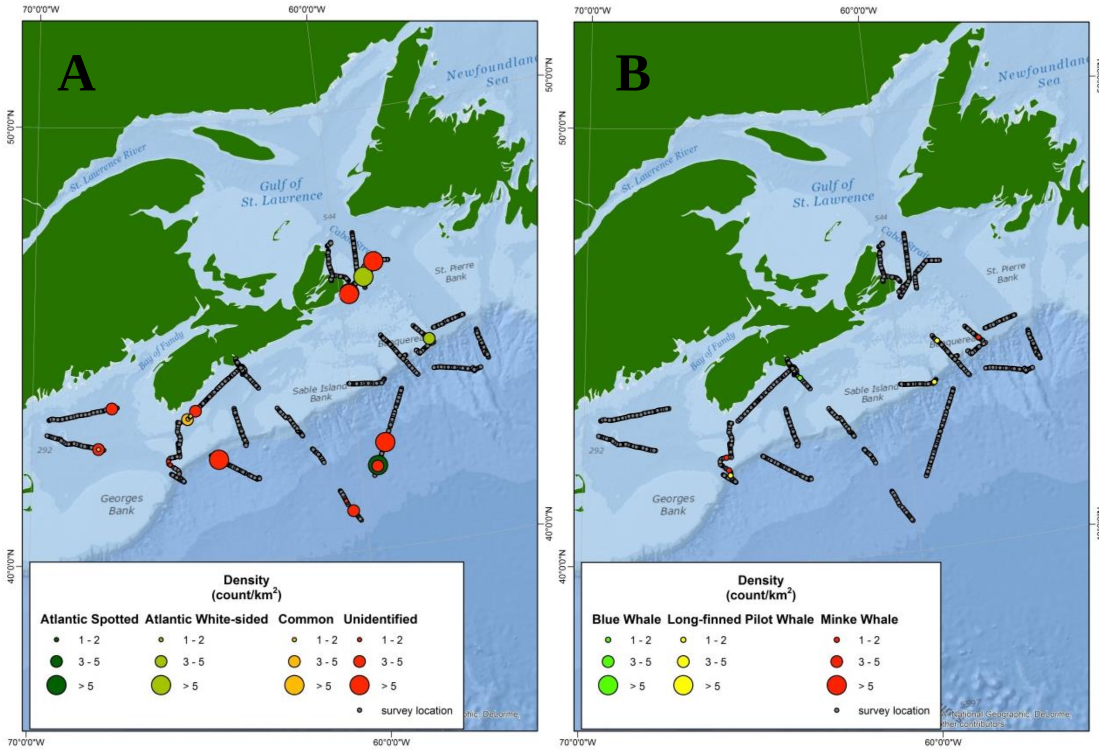



**Figure 20.** Counts of (A) dolphins and (B) whales observed during Fall AZMP on the Scotian Shelf from 20 September – 11 October, 2015.

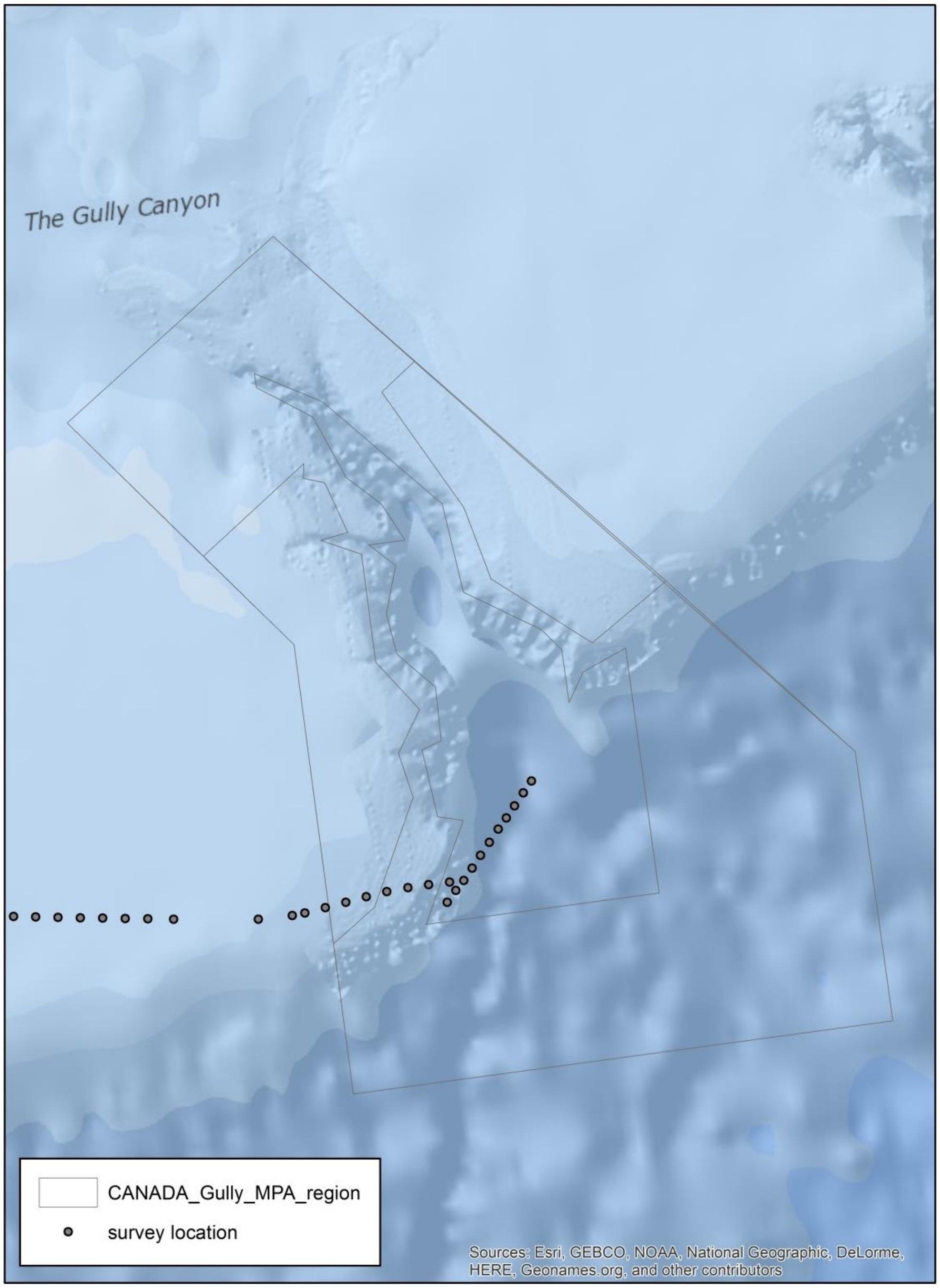



**Figure 21.** Survey locations within the Gully MPA during Fall AZMP on the Scotian Shelf from 20 September – 11 October, 2015.

## *Mooring Operations*

**Narrative**

During the 2015 Fall AZMP mission, vessel time was provided to conduct oceanographic mooring operations for ancillary programs. These activities included deployment and recovery operations (Figure 22 and Table 13). With support from the officers and crew of the CCGS Hudson, the mooring technicians conducting these activities were Jay Barthelotte and Adam Hartling from the Ocean Physics, Program Coordination and Support Division, Science Branch.

Over a 2 hour period, while the Hudson was located in the Gully at station SG_28 on September 21st, 2015, mooring releases to be used during subsequent deployments were successfully tested (Events 8-12). On September 22nd, AMAR mooring #M1908 was successfully deployed within the bounds of the Lophelia Conservation Area at Stone Fence (Event 20). In the morning of the following day (September 23rd), 1 mooring was deployed (M1902 – Event 21), 1 was recovered (M1896 – Event 22) and another was unsuccessfully dragged for (M1863 – Event 23). In the afternoon 3 more moorings were deployed (M1898 – Event 24, M1899 – Event 25 and M1903 – Event 26) before regular station occupations resumed for the evening. The final 2 mooring deployments were made in the late morning and early afternoon of the 24th of September (M1901 – Event 40 and M1902 – Event 41). Refer to the Mission Summary Overview for a more detailed account of mooring deployments.

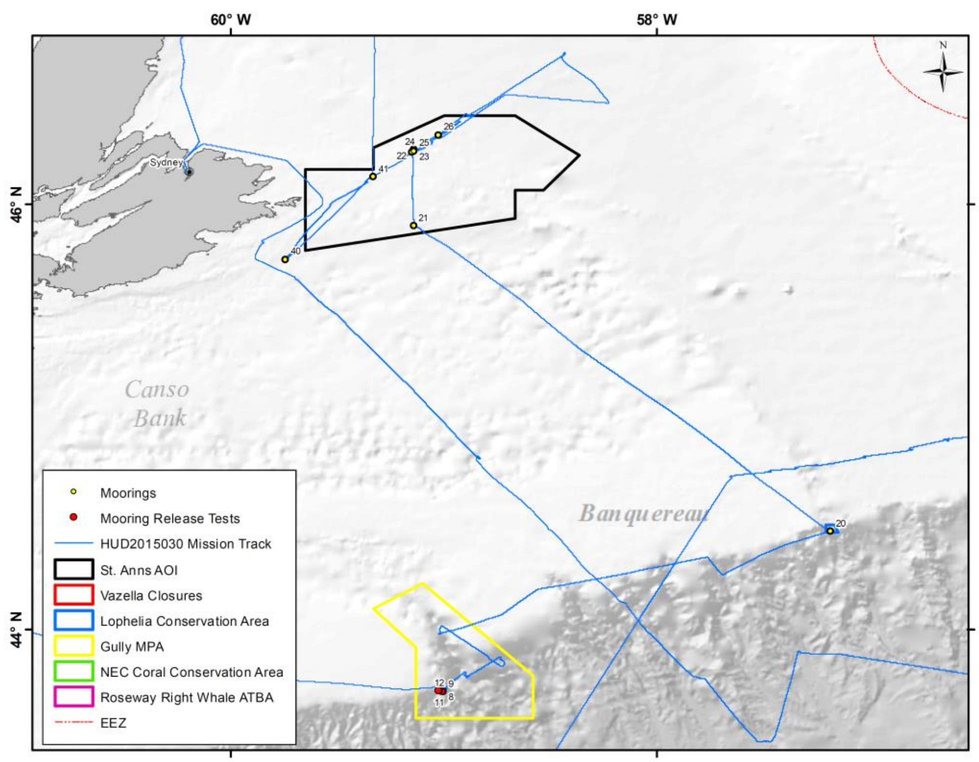



**Figure 22.** The location for each mooring operation during HUD2015030. Refer to Table 13 for more details.

**Table 13.** List of mooring operations conducted during HUD2015030. The coordinates provided below are in decimal degrees and represents the ship's position at the time of the operation.

| Date | Event | Operation | Station | Slat (DD) | SLong (DD) | Program |
|---|---|---|---|---|---|---|
| 21/09/2015 | 8 | test release | SG_28 | 43.7097 | -59.0036 | testing |
| 21/09/2015 | 9 | test release | SG_28 | 43.7093 | -59.0041 | |
| 21/09/2015 | 10 | test release | SG_28 | 43.7099 | -59.0084 | |
| 21/09/2015 | 11 | test release | SG_28 | 43.7112 | -59.0207 | |
| 21/09/2015 | 12 | test release | SG_28 | 43.7113 | -59.0250 | |
| 22/09/2015 | 20 | Deployed | M1908 | 44.4623 | -57.1842 | AMAR |
| 23/09/2015 | 21 | Deployed | M1902 | 45.8995 | -59.1421 | NCP |
| 23/09/2015 | 22 | Recovered | M1896 | 46.2451 | -59.1498 | |
| 23/09/2015 | 23 | Aborted | M1863* | 46.2575 | -59.1402 | |
| 23/09/2015 | 24 | Deployed | M1898 | 46.2552 | -59.1412 | |
| 23/09/2015 | 25 | Deployed | M1899 | 46.2505 | -59.1407 | |
| 23/09/2015 | 26 | Deployed | M1903 | 46.3259 | -59.0261 | |
| 24/09/2015 | 40 | Deployed | M1901 | 45.7417 | -59.7427 | |
| 24/09/2015 | 41 | Deployed | M1900 | 46.1299 | -59.3305 | |

*****Missing buoy not recovered.

## *ARGO Float Deployments*

**Contributions by**: Ingrid Peterson

**Narrative**

There were a total of 8 successful ARGO float deployments during HUD2015030 (Figure 23 and Table 14).

All floats deployed reported their housekeeping files on the day of their deployment. As of November 17th, 2015 the APEX floats (Table 14) continue to report profiles and they can be accessed here:

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

Through recent correspondence with Pelle Robbins and Birgit Klein, it can be confirmed that the SOLO float data is currently being archived but has not yet been reported to this database.

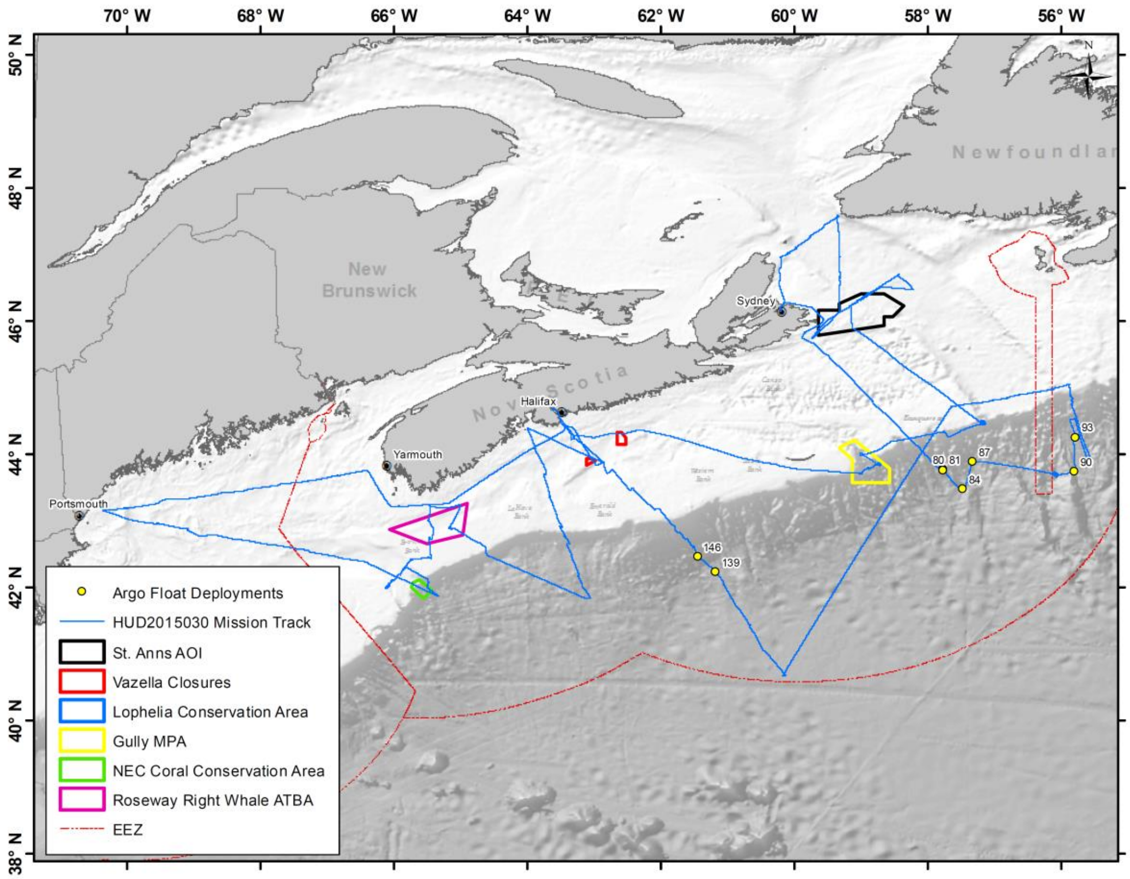



**Figure 23.** The locations for each Argo float deployment during HUD2015030. Refer to Table 14 for more details.

**Table 14.** Details for Argo float deployments during HUD2015030. The coordinates provided below are in decimal degrees and represent the ship's position at the time of deployment.

| Date | Event | Station | Float Type | Float Deployed (UTC) | IMEI# | WMO # | Slat (DD) | Slong (DD) |
|---|---|---|---|---|---|---|---|---|
| **26/09/2015** | 080 | LL_08 | APEX | 22:49 | 300234062957504 | 6902634 | 43.7661 | -57.7741 |
| **26/09/2015** | 081 | LL_08 | APEX | 22:52 | 300234062957502 | 6902632 | 43.7643 | -57.7725 |
| **27/09/2015** | 084 | LL_09 | APEX | 04:33 | 300234062957505 | 6902635 | 43.4734 | -57.4731 |
| **27/09/2015** | 087 | SF_01 | APEX | 10:56 | 300234062957503 | 6902633 | 43.8900 | -57.3276 |
| **27/09/2015** | 090 | SPB_11 | SOLO | 22:32 | 300234062957263 | | 43.7363 | -55.8088 |
| **28/09/2015** | 093 | SPB_10 | SOLO | 05:11 | 300234062957257 | | 44.2558 | -55.7927 |
| **02/10/2015** | 139 | HL_09 | SOLO | 15:27 | 300234062957299 | | 42.2382 | -61.1829 |
| **03/10/2015** | 146 | HL_07 | APEX | 02:09 | 300234062957506 | 6902636 | 42.4596 | -61.4543 |

## *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 not checked regularly for proper operation after September 21st.

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. VmDas stopped running on September 20th and was restarted at 20:11 UTC. The operating computer was shut down on the 21st and restarted on the same day at 16:10 UTC. On the 21st, the UPS failed and the unit was plugged into ship's power and restarted at 17:39 UTC. On October 11th at 10:18 UTC it was noticed the VmDas had stopped working while attempting to update Seaport Software. It is unclear how long the system was down.

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

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

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

## Navigation and Bathymetry

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

The Knudson 12 kHz sounder was utilized in transit and 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.

## Underway Seawater System – Thermosalinograph

An underway system, also referred to as thermosalinograph (TSG), was place in the forward and connected to the pumped uncontaminated seawater plumbing. Over the last year or so, additional sensors have been added and new tanks constructed. Due to other commitments, the $pCO_2$ sensor was not available. Thus, the second tank that normally contains the $pCO_2$ and $O_2$ was not onboard. A modification to the TSG tank, moving the outflow to the top of the tank was made since the last cruise, the AZOMP cruise. Thus, any air in the tank would escape and not affect the conductivity measurements. The configuration on HUD2015030 consisted off SBE21 sn: 2178132-3396 with conductivity and temperature, an external temperature located at the ship's intake (SBE 38 sn: 380766), WET Labs chlorophyll WETStar (sn: WSCHL-1468) with a scale factor of 15.5 ug/l/V, Seapoint CDOM fluorometer with a 30x gain jumper and SBE pH sensor (sn: 1159). The sampling rate was 0.2 Hz. Initial analysis suggests that the water takes approximately 90 s to travel from the ship's intake to the TSG.

The pump for the underway system was started in Bedford Basin on 20 September at 16:10UTC. The water pumped to the forward lab with exhaust routes (direct discharge over the side of the ship, through the TSG and from the debubbler. The initial flow rate through the TSG (44 l/min) was much for the since so the valve to the TSG was turned done so the flow was 25 l/min. At 18:38, air/overflow output to the debubbler resulting in a flow rate of 15 l/min through the TSG. At 21:36, the flow rate was 18 l/min. At 11:08 on Sept 21$^{st}$, the flow was 18 l/min. The flow was recorded when samples were taken (see Table). On Sept 25$^{th}$, the intake was closed at 09:16 and reopened at 0941. Normal operations resumed. On Oct 11$^{th}$ at 1650, the system was stopped. The flow rate was 18 l/min.

TSG underway data was managed the NOAA Scientific Computing Systems (SCS) software. These data are submitted to ODIS upon conclusion of the mission but Dr. Dave Hebert (Dave.Hebert@dfo-mpo.gc.ca) is the point of contact for these data.

## *Data Management*

**Prepared by:** Robert Benjamin
**Division:** Program Coordination and Support

Please refer to Appendix 3 for a table detailing the data collected during HUD2015030, 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 including position and sounding was again used during HUD2015030. ELOG was accessible via computers 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.

### 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. Salinities 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. Reports were generated from these data to compare with corresponding CTD sensor data and conduct preliminary analyses included in this report.

### Hardware

Regulus/Aldebaran computers (supplied by NRCAN) were placed in the Drawing room, the CTD computer room, the Forward lab and the general purpose lab (GP Lab) to provide positioning and Station Name information to operations in these locations.

The Knudsen sounder was used extensively to collect bottom depth. It is important to note that it became increasing difficult to "find" the bottom using both the 12 kHz and 3.5 kHz sounders as the mission progressed.

# APPENDICES

## *Appendix 1A. CTD configuration file – HUD2015030_1.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 1B. CTD configuration file – HUD2015030_2.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 : 0042
Calibrated on : 23-Dec-14
Equation : Sea-Bird
Soc : 4.65560e-001
Offset : -5.13700e-001
A : -3.28970e-003
B : 1.56950e-004
C : -2.21530e-006
E : 3.60000e-002
Tau20 : 1.36000e+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 : 0920
Calibrated on : 14-Jul-2014
pH slope : 4.6369
pH offset : 2.5500

13) A/D voltage 7, 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

Scan length : 37

*Appendix 3. Data and Meta-data Collections During HUD2015030*

| 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 | 464 files/1 folder/576 MB | \\dcnsbiona01b\BIODataSvcSrc\2010s\2015\HUD2015030\CTD | pH and PAR data were of poor quality and should be removed before long term archival process. |
| 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 | 1174 files/8 folders/170MB | \\dcnsbiona01b\BIODataSvcSrc\2010s\2015\HUD2015030\CTD | |
| Scientific Computing Software acquisition files for underway system | Robert Benjamin | .RAW files for meterological data, Gyro, coordinates, Sounder and TSG collected | .RAW | 168 files/597 MB | \\dcnsbiona01b\BIODataSvcSrc\2010s\2015\HUD2015030\SCS | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | over the duration of the mission | | | | |
| SBE TSG data collection as well as pdf scan of log book and sensor calibration informaiton | Robert Benjamin/Adam Hartling | SBE .hex format data collection from the TSG | .hdr, .hex, .XMLCON, pdf | 94 files/20.8 MB | \\dcnsbiona01b\BIODataSvcSrc\2010s\2015\HUD2015030\TSG | |
| VMADCP | Adam Hartling | Scanned log sheet describing VMADCP logging and digital logs | .PDF, .VMO, .txt, .STA, .NMS, .N2R, .N1R, .LTA, .LOG, .ENX, .ENR, .ENS, .ini | 724 files/1 folder/3.3 GB | \\dcnsbiona01b\BIODataSvcSrc\2010s\2015\HUD2015030\VMADCP | |
| 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 | 28 files/2 folders/499 KB | \\dcnsbiona01b\BIODataSvcSrc\2010s\2015\HUD2015030\Elog_Logbook | Includes operational details for: CTD, Moorings, BioNess, Vertical Net Tows, Multi-Net, and ARGO floats, as well as any |

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|---|---|---|---|---|---|---|
| | | | | | | other deployed gear. |
| 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, bridge log | .xls, .xlsx | 4 files/1 folder/1.75 MB | \\dcnsbiona01b\BIODataSvcSrc\2010s\2015\HUD2015030\BIOCHEM | These data have already been ported into AZMP operational database currently in possession of Robert Benjamin. |
| Rosette/Vertical Net Tows/Shore-side Laboratory Analysis | Jeff Spry/Marc Ringuette | CHN, HPLC, Nutrients and Zooplankton analysis. | | | \\dcnsbiona01b\BIODataSvcSrc\2010s\2015\HUD2015004\BIOCHEM | As of November 18th, 2015 no data has been added to this folder |
| Rosette – Shipboard Laboratory Analysis | Jeff Spry | Chlorophyll, Winkler | .xls, .xlsx, .B15, .T15, | 63 files/6 folders/7.61 MB | \\dcnsbiona01b\BIODataSvcSrc\2010s\2015\HUD2015030\ | |

| | | | | | | |
|---|---|---|---|---|---|---|
| and Bioness data files | | Oxygen, salinities and Bioness files | .dat | | ProcessedData_JeffSpry\2015030 | |
| GIS files – Derived from GPS and Operational Data and Meta-data | Robert Benjamin | GIS planning data products | .csv, .tif, .xlsx, .jpg, .mxd, .shp, .shx, .dbf, .prj, .sbn, .sbx, qgs, jpgw, .pdf, .lyr, .ini, .XML, | 168 files/6 folders/2.55 GB | \\dcnsbiona01b\BIODataSvcSrc\2010s\2015\HUD2015030 | |
| GPS - Navigation Files | Robert Benjamin | Daily Regulus files utilized to create cruise track. Mission Regulus waypoint library | .txt, .15N | 68 files/1 folder, 872 MB | \\dcnsbiona01b\BIODataSvcSrc\2010s\2015\HUD2015030\Navigation_Regulus_InProcessing | |
| Data Summary Reports | Robert Benjamin | Data summaries for cruise report | .csv | 4 files/1 folder, 245 KB | \\dcnsbiona01b\BIODataSvcSrc\2010s\2015\HUD2015030\Reports_InProcessing | |
| SBE35 | Robert Benjamin/Terry Cormier | bottle fire high resolution temperature data | .ASC | 109 files/1 folder, 436 KB | \\dcnsbiona01b\BIODataSvcSrc\2010s\2015\HUD2015030\SBE35 | |
| CTD Rosette - Ocean Acidification Data | Dr. Helmuth Thomas and Dr. Pierre Pepin/Kumiko Azetsu- | 2 independent projects both examining PCO2, total alkalinity, total | | | | Refined data will be received for archiving at a much later |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Scott | dissolved carbon and pH | | | | date. PI's should be contacted periodically for updates. |
| CTD Rosette sampling for study investigating Isotopic Composition of Nitrate | Dr. Markus Kienast | 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. |
| CWS shallow tow zooplankton samples | Carina Gjerdrum/Marc Ringuette/Erica Head | 50 m tows at selected locations for zooplankton analysis for Dovekie feeding study | | | | These data will be analyzed and published separately and there are no plans to acquire these data for long term archiving. |

| | | | | | | |
|---|---|---|---|---|---|---|
| Ocean acidification impacts on *C. finmarchicus* | Marc Ringuette/Kumiko Azetsu-Scott | Zooplankton sampled at various sites for analysis | | | | These data will be analyzed and published separately and there are no plans to acquire these data for long term archiving. |
| Net tows/Bioness tows | Jeff Spry/Sprytech | Zooplankton samples analyzed for taxonomic ID and enumeration for core and ancillary AZMP program | .xlsx | No files as of November 18, 2015 | \\dcnsbiona01b\BIODataSvcSrc\2010s\2015\HUD2015030\BIOCHEM\Plankton | These data will be produced and placed in this folder when they are finally completed and should be added to the AZMP database template before adding to BioChem. |