CRUISE REPORT

R/V ENDEAVOR 2017606

SCOTIAN SHELF

AZMP TRANSECTS +

Leg 1: Nov 24th – Dec 5th
Leg 2: Dec 5th – Dec 16th

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CRUISE NARRATIVE

Highlights

Area Designation:	NAFO Regions: 5Y, 5Ze, 4X, 4W, 4Vs, 4Vn, 3Pn, 3Ps Extent: 41^o 51'N - 47^o 35'N; 056^o 08'W - 066^o 08'W
Expedition Designation:	EN2017606 or 32EV17606 (ISDM format)
Chief Scientist:	Dave Hebert Ocean Ecosystem Science Division Marine Ecosystem Section Department of Fisheries and Oceans Bedford Institute of Oceanography PO Box 1006 Dartmouth, NS, Canada B2Y 4A2 David.Hebert@dfo-mpo.gc.ca
Ship:	R/V Endeavor (call sign - WCE5063) Oceanographic research vessel out of the University of Rhode Island.
Ports of Call:	Nov 24th, 2017 – Depart BIO, Dartmouth, NS Nov 26th, 2017 – Arrive BIO, Dartmouth, NS Nov 27th, 2017 – Depart BIO, Dartmouth, NS Dec 5th, 2017 – Arrive Sydney, NS Dec 5th, 2017 – Depart Sydney, NS Dec 9th, 2017 – Arrive BIO, Dartmouth, NS Dec 11th, 2017 – Depart BIO, Dartmouth, NS Dec 16th, 2017 – Arrive BIO, Dartmouth, NS
Cruise Dates:	Leg 1: Nov 24th – Dec 5th Leg 2: Dec 5th – Dec 16th

Mission Summary

Overview

The planned departure of the R/V Endeavor from BIO was planned to be at 1000 LT on November 24th. An issue with steerage delayed departure until 1045 LT. The start of the recovery of the Nova Scotia Current Mooring (M1996) started at 1500 LT and the new mooring (M2024) was deployed at 16:30 LT. Then, we headed to HL_01 to start the Halifax Line throughout the night, completing HL_03.3 at 0630. The AMAR mooring

(M1949) in Emerald Basin was recovered on the 24th on the 25th. We headed back to BIO to wait out an approaching storm, docking at 1830LT. We departed BIO at 1830 LT on the 26th and were running several hours late out to HL_04 due to sea state and weather. The weather was rough throughout the night so we waited until daylight before heading to HL_05. A release test was conducted just prior to the station occupation at HL_06. Stations occupations were then completed in order out to HL_06.3. At 0420 LT on the 28th, the conditions became too poor to continue in the southeast heading so it was decided to change headings to begin mooring work in Dawson Canyon. The weather deteriorated further and a decision was made to hold position near HL_06.7 and heave-to. At 0815LT, it decided to head to HL_06.7 and complete that station in addition to HL_07. Due to time constraints imposed by the planned port call in Sydney and impending weather in the area, the rest of the extended Halifax Line stations were dropped from the schedule.

On November 29th, a series of CTD casts were conducted in Dawson Canyon to await the deployment of the AMAR mooring at first light. The mooring deployment (M2027) was completed at 0930LT and we headed to Logan Canyon. The AMAR mooring at Logan Canyon (M2028) was deployed at 1600 LT and a CTD cast was conducted nearby before heading to the Gully.

While occupying SG_28 on November 30th, conditions deteriorated enough that we could not conduct a vertical net tow. After the CTD cast, we hoved-to until the weather improved. At the same location, a release test was conducted at 1630 LT. We deployed an AMAR mooring (M2026) at 1920 LT at the offshore Gully location and conducted a MCAL survey. The remainder of the Gully station occupations were followed by a recovery and deployment of an AMAR mooring (M1948 and M2025 consecutively) during the afternoon of December 1st.

Following the Gully work, the Louisbourg Line was occupied. After LL_09, the AMAR mooring at Stone Fence (M1950) was recovered at 0930 LT on the 2nd. The Louisbourg Line was completed and the St. Anns Bank Line was started. After completion of the line, the AMAR at the end of the line was deployed (M2029) and another recovered (M1947) on the morning of December 4th. We headed to M1999, a St Anns Bank mooring that could not be recovered on an earlier mission. There was no communication with the release so it is likely that it was released during a previous mission in November. Later in December, the ADCP and SUB were found in Newfoundland. On December 5th, we headed in to Sydney Harbour to disembark some of the science party (Jay Barthelotte, Adam Hartling, Jenni Tolman, Ian Luddington and Jennine Winkel) and the chief engineer. After the change, the Cabot Strait Line was completed on December 6th before heading to STAB_06. At 1600 LT, winds increased and our heading limited our ship speed to 6 kts and later, to 4 kts.

The line across the mouth of Laurentian Channel began in the afternoon of December 7th. The line was completed on the 8th and plans were made to head to BBL_01 to avoid an offshore storm. On December 8th at 1600 LT, the Captain decided the storm on Saturday/Sunday was too large to stay out given our close location to Halifax. We returned to BIO at 1400LT on the 9th. The ship departed BIO at 2130 LT on December 10th.

The Browns Bank Line began at around noon on December 11th. The section across the Northeast Channel was occupied, but BBL_07 was dropped due to impending weather. It was decided to head to the western end of the Yarmouth Line. On the way to YL_10, a CTD cast was undertaken at PL_08 on December 13th. The Yarmouth Line was started at 1430 LT on December 14th. At YL_06, communications to the CTD was lost as it started the upward portion of the cast. A decision was made to switch the CTD/net winches due to a shorted termination on Winch #1. Due to weather and timing, YL_03 was the last station occupied before heading back to BIO on December 15th. HL_02 was occupied before heading into Halifax. The RV Endeavor arrived at BIO at 1545 LT on December 16th.

Over the 23 day mission, the R/V Endeavor logged ~2861 nm and AZMP science staff conducted 175 operations at 87 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. Table 2 contains the break down in time allocated to each gear type.

*Note that approvals for work in the Gully and St. Anns Bank MPA are included in Appendix 1 of this report.

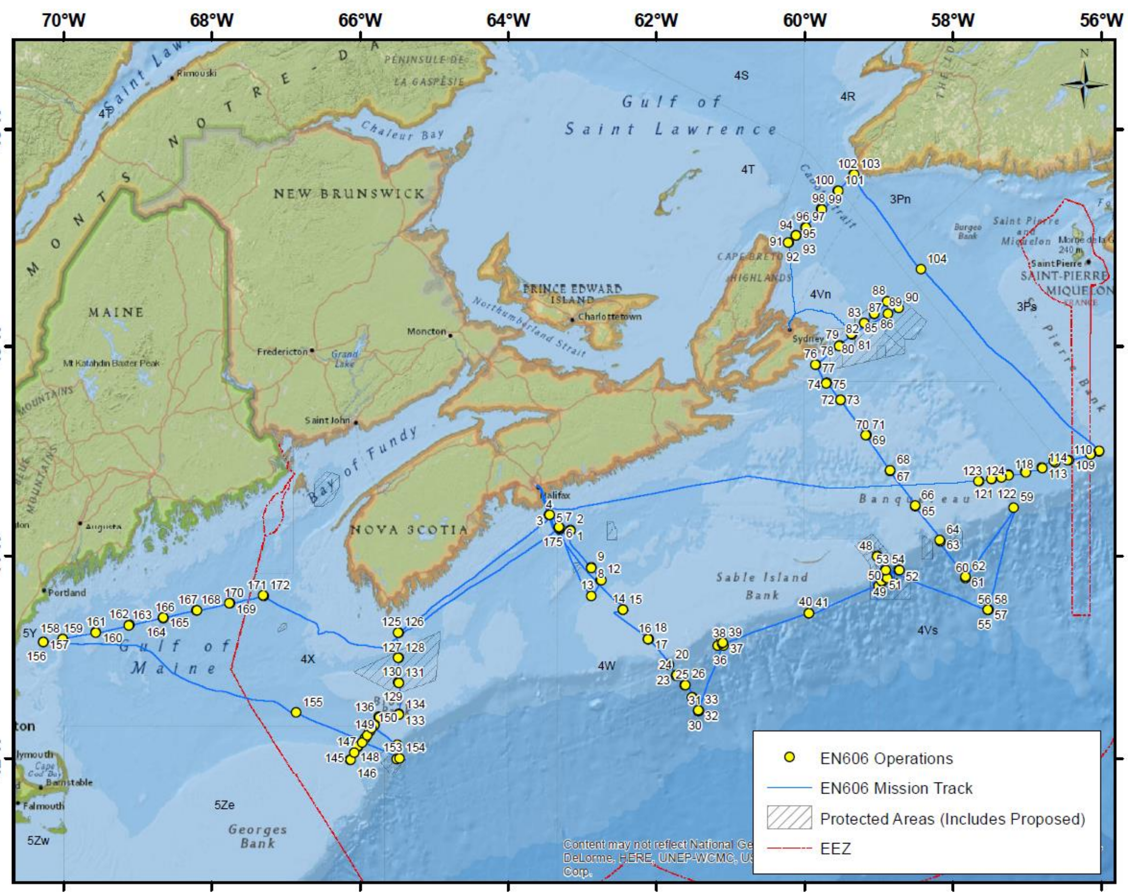


Figure 1. EN2017606 stations. Overlapping event labels may not visible.

Table 1. Station operation summary.

Operation	# of Operations	Figure
CTD	79	2
Vertical Ring Net Tows	76	16
ARGO Float Deployments	6	20
Mooring Recoveries	5	21
Mooring Deployments	6	21

Table 2. Operational time by gear type.

Gear	~Operation Duration (hrs)
CTD	~50
Vertical Net Tows	~24
Mooring Recoveries	~3
Mooring Deployments	~2
Argo Float Deployments	~1

* Surface water parameters were recorded throughout the mission. Refer to the Underway Seawater System Section of this report for more information.

Mission Participants

A complete ship's crew list for this mission can be found in Appendix 2.

Table 3. EN2017606 Science Staff.

	Name	Affiliation	Duty	Leg(s)	Shift
1	Barthelotte, Jay	DFO – OESD	Mooring Ops	1	Day
2	Belzile, Mélany	DFO – OESD	CTD Operator\Elog\Deck Ops	Both	Day
3	Benjamin, Robert	DFO – PCSD	Data Manager	Both	Day
4	Caverhill, Carla	DFO – OESD	Lab Tech\Deck Ops	Both	Day
5	Cogswell, Andrew	DFO – OESD	CTD Operator\Elog\Deck Ops	Both	Night
6	Hartling, Adam	DFO – OESD	Mooring Ops	1	Day
7	Hebert, Dave**	DFO – OESD	Chief Scientist\Deck Ops	Both	Day
8	Luddington, Ian	DAL – Erin Bertrand	Lab Tech	1	Day
9	MacIsaac, Kevin	DFO – OESD	Deck Ops\Biologist	Both	Night
10	Perry, Timothy	DFO – OESD	Lab Tech\Deck Ops	Both	Night
11	Spry, Jeffrey	DFO – OESD	Deck Ops\Lab Tech\Biologist	Both	Day
12	Tolman, Jenni	DAL – Julie LaRoche	Lab Tech	1	Day
13	Winkel, Jeannine	ECCC – CWS	Bird and Mammal Observer	1	Day

**Chief Scientist
DFO: Department of Fisheries and Oceans Canada

OESD: Maritimes - Ocean Ecosystem Science Division
PCSD: Maritimes - Program Coordination and Support Division
ECCC-CWS: Environment Canada and Climate Change - Canadian Wildlife Service
DAL: Dalhousie University

Objectives

There were 15 defined objectives for EN2017606. Table 4 describes whether each of these objectives was met along with any relevant supporting commentary.

Primary

1. Obtain 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. Occupy stations in support of the extended Halifax Line (XHL) (HL_08 and greater) **(Contact Dr. Igor Yashayaev)**
3. 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://inter-w02.dfo-mpo.gc.ca/Maritimes/Oceans/OCMD/Gully/Gully-MPA).
4. Nutrients and hydrography across the Northeast Channel and Gulf of Maine as part of NERACOOS Cooperative Agreement, (**Contact Dr. Dave Hebert** - http://www.neracoos.org/).
5. Deploy 6 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).
6. Collect underway and CTD water samples at specified locations and depths to fulfil 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. Kumiko Azetsu-Scott -** http://www.dfo-mpo.gc.ca/science/oceanography-oceanographie/accasp-psaccma/index-eng.html).
7. Collect water samples for the Bertrand lab at Dalhousie University to evaluate whether and how organic and organometallic micronutrients influence primary productivity and phytoplankton community structure on the Scotian Shelf (**Contact Erin Bertrand** – Erin.Bertrand@dal.ca).
8. Collect water samples from strategic locations and depths to support a microbial community analysis via DNA, RNA and flow cytometry, as well as the isolation of novel diazotrophs (**Contact Dr. Julie Laroche** - http://www.dal.ca/faculty/science/biology/faculty-staff/our-faculty/julie-laroche.html)
9. Bird and mammal observations as part of EC-CWS sea-bird observation program and in fulfilment of Gully MPA occupation requirements (**Contact Carina**

Gjerdrum – carina.gjerdrum@canada.ca).

10. Carry out hydrographic, chemical and biological sampling at stations in the St. Anns Bank MPA as a continued monitoring effort in support of Oceans and Coastal Management Division (**Contact Dr. Dave Hebert -** http://www.dfo-mpo.gc.ca/oceans/mpa-zpm/stanns-sainteanne-eng.html).
11. Attempt to recover a single mooring (M1999) deployed during the fall 2016 AZMP shelf survey (HUD2016027). An unsuccessful attempt to communicate with the acoustic release was made prior to EN2017606 during Dr. Ed Horne's mission aboard the CCGS Perley (Contact **Dr. Dave Hebert**).
12. Conduct hydrographic, chemical and biological sampling across the mouth of the Laurentian Channel (BP and BANQ stations). This transect has been proposed to enhance our understanding of hydrographic phenomenon in these areas in support of current modelling efforts (**Contact Dr. Dave Brickman**).
13. Collect 200 µm ring net zooplankton samples at 8 predefined stations across the Scotian Shelf to supplement the Canada C3 program sample collection (**Contact Dr. Claudio Dibacco -** https://canadac3.ca/en/expedition/the-research/)
14. Recover and deploy the Nova Scotia Current Mooring. This work, funded by AZMP, supports the operation of a mooring that continually monitors the Nova Scotia Current. These data are used to validate shelf circulation models. (**Contact Dr. Dave Hebert**).
15. Recover 4 Autonomous Multichannel Acoustic Recorders (AMAR) from Emerald Basin, the Gully MPA, the Stone Fence Lophelia Conservation Area and the St. Anns Bank MPA. In addition, deploy a total of 5 AMAR moorings; 4 across the eastern Scotian Shelf break at Dawson Canyon, Logan Canyon, and the Gully MPA and 1 deployed within the bounds of the St. Anns Bank MPA. (**Contact Dr. Hilary Moors-Murphy -** http://www.dfo-mpo.gc.ca/science/publications/article/2016/11-15-16-eng.html)

Table 4. EN2017606 objectives status.

Objective	Status	Comments
1	Mostly Complete	With the exception of station BBL_07 all stations were occupied.
2	Cancelled	Due to early delays all XHL stations were dropped.
3	Complete	
4	Complete	
5	Modified Complete	The original plan was to deploy 6 floats at HL_07, 10, 11 and 13; LL_08 and 09. Instead floats were deployed at HL_07(x3), LL_09 (x2) and LL_08.
6	Modified Complete	The sampling depths were modified for the Yarmouth Line. TIC/TA sampling strategy requires adjustment. We only occupied YL_01 to YL_08.
7	Modified Complete	Dal could only participate for the first leg and thus was unable to make collections from the western Scotian Shelf as originally planned.
8	Modified Complete	Dal could only participate for the 1st leg and thus was unable to make collections from the western Scotian Shelf as originally planned.
9	Modified Complete	Bird watcher could only participate for 1st leg. Met requirements of STAB and Gully MPA work.
10	Complete	
11	Failed	We were unable to establish communication with the release and dragging operations were abandoned.
12	Modified Complete	An additional station BP_00 was added to the NL shelf and all other stations were successfully occupied.
13	Partially Complete	Samples were collected from pre-defined stations that were occupied during the mission.

14	Complete
15	Complete

SUMMARY OF ACTIVITIES

CTD Summary

Narrative

As summarized in Table 1, there were a total of 79 CTD casts during the mission (Figure 2 and Table 5). The configuration file used for the mission is provided in Appendix 3.

At the beginning of the mission, DFO staff members were given a tutorial by the Ship's Tech on deploying and recovering the CTD off the starboard side of the vessel. Deployments and recoveries required 1 crane operator and 3 science staff. One science member was responsible for providing hand signals to the crane operator and controlling the swing of the CTD before it reached the rail. The other 2 science staff operated the tag lines on both deployment and recovery. On deployment, tag lines attached to the inboard rail of the ship, would loop the line around the vertical post of the CTD frame and then back to cleat mounted on the deck. On recovery, tag line operators used a long pole to secure a clip to metal extensions radiating from the CTD frame. Once clipped to the frame, they would put the free end of the line around a cleat and pull the line taught, which prevented the CTD from swinging as it was guided over the rail and into position. Once in position, the CTD was secured to the deck with ratchet straps and eyes screwed into the decks bolt pattern.

The ship was able to deploy and recover gear in winds and waves comparable to the CCGS Hudson. Nonetheless, because of the low freeboard and dynamics of the ship, science staff were regularly exposed to wash on the deck both during recovery and deployment and also during water collection.

Water sampling went smoothly but the ship was often required to hold position or steam slowly between stations. This impacted our program efficiency compared to our typical platform. The sampling area around the rosette was somewhat cramped and those sampling the starboard side of the CTD were often exposed to the wind and waves and were precariously close to a very low rail. Initially, water sampling was tricky, because sample bottle racks were brought out one at a time because of the risk of them being washed away or broken deck wash. Half way through the mission, a shelf was created on deck to accommodate racks while samples were being collected. The distance to the lab was minimal and made sampling more efficient. The proximity of lab space to CTD controls also made it simple for staff to stay in communication throughout the mission. Well positioned cameras around the decks of the ship allowed staff to gauge the state of operations.

The CTD performed very well. Only 1 CTD cast (event 165 at YL_06) was aborted when the deck unit through an error. After some quick diagnostic work by the Endeavor Technician, it was determined that the best course of action was to switch the other EM cable and move the net to the cable which required re-termination. This meant a delay of just less than 2 hours between the recovery of the aborted CTD and its redeployment. For the remainder of the mission the CTD and net were deployed from these new positions.

Overall, science staff were pleased with the experience, competence and helpfulness of the Ship's Tech, Crane Operators, Engineers and Bridge Staff that made these CTD operations a success.

Preliminary section plots of temperature (°C), salinity (p.s.u.) and sigma-t (kg/m^3) can be viewed in Appendix 4.

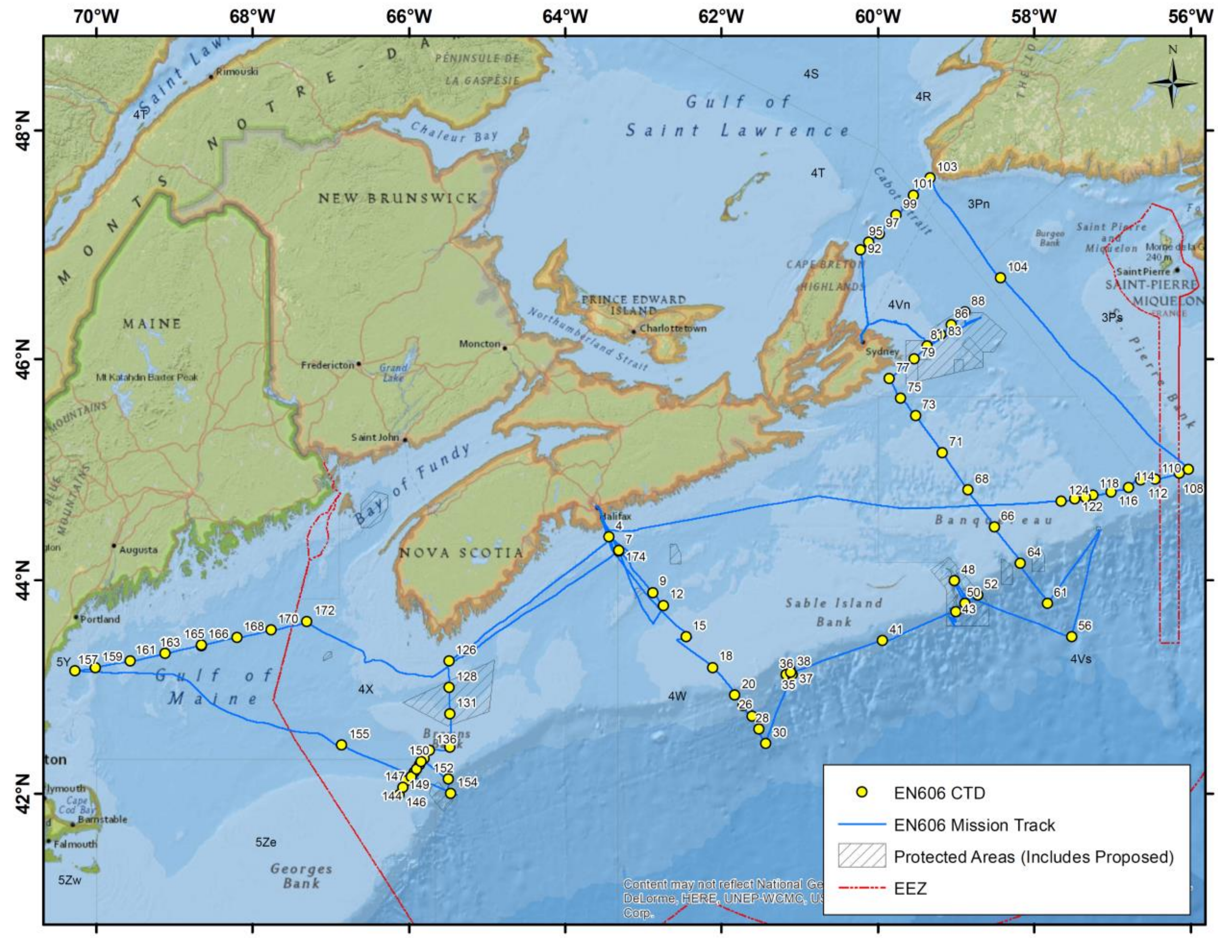


Figure 2. Locations for CTD casts during EN2017606. Each cast is labelled with the consecutive mission event.

Table 5. CTD casts during EN2017606. The coordinates provided are in decimal degrees and reflect the ship's position at the time of deployment as recorded using the ELOG meta-data logger.

#	Event	Station	Date	Slat (DD)	Slon (DD)	Sounding (m)	pH	Water Collected	Aborted
1	4	HL_01	24/11/2017	44.3951	-63.4422	83	X	X	
2	7	HL_02	25/11/2017	44.266	-63.3127	146	X	X	
3	9	HL_03	25/11/2017	43.8832	-62.8829	267	X	X	
4	12	HL_03.3	25/11/2017	43.7645	-62.7484	273	X	X	
5	15	HL_04	27/11/2017	43.4735	-62.4575	82	X	X	
6	18	HL_05	27/11/2017	43.1892	-62.1165	104	X	X	
7	20	HL_05.5	27/11/2017	42.9315	-61.8308	490	X	X	
8	24	HL_06	28/11/2017	42.8322	-61.7306	1136	X	X	
9	26	HL_06.3	28/11/2017	42.7357	-61.6108	1702		X	
10	28	HL_06.7	28/11/2017	42.613	-61.5192	2331		X	
11	30	HL_07	28/11/2017	42.4773	-61.4319	2722		X	
12	34	DC_01	29/11/2017	43.1411	-61.1217	1476			
13	35	DC_02	29/11/2017	43.1702	-61.1221	1489			
14	36	DC_03	29/11/2017	43.1242	-61.1699	1686			
15	37	DC_04	29/11/2017	43.1201	-61.0949	1423			
16	38	DC_01	29/11/2017	43.1436	-61.1213	1422			
17	41	LC_01	29/11/2017	43.4386	-59.9405	1366			
18	43	SG_28	30/11/2017	43.7057	-59.009	1014		X	
19	48	GULD_03	01/12/2017	43.9905	-59.0243	403		X	
20	50	GULD_04	01/12/2017	43.7838	-58.8924	2064		X	
21	52	SG_23	01/12/2017	43.861	-58.7284	1199		X	
22	56	LL_09	02/12/2017	43.4732	-57.5265	3702		X	
23	61	LL_08	02/12/2017	43.7831	-57.8339	2847		X	
24	64	LL_07	03/12/2017	44.1542	-58.1783	755	X	X	
25	66	LL_06	03/12/2017	44.4838	-58.5125	65	X	X	
26	68	LL_05	03/12/2017	44.8234	-58.8496	185	X	X	
27	71	LL_04	03/12/2017	45.1599	-59.1743	109	X	X	
28	73	LL_03	03/12/2017	45.4907	-59.5219	124	X	X	
29	75	LL_02	03/12/2017	45.6501	-59.7094	161	X	X	
30	77	LL_01	03/12/2017	45.823	-59.8547	93	X	X	
31	79	STAB_01	04/12/2017	46.0034	-59.5369	65	X	X	

32	81	STAB_02	04/12/2017	46.1114	-59.3683	65	X	X
33	83	STAB_03	04/12/2017	46.2142	-59.1969	94	X	X
34	86	STAB_04	04/12/2017	46.2997	-59.0658	156	X	X
35	88	STAB_05	04/12/2017	46.4143	-58.8916	386	X	X
36	92	CSL_01	05/12/2017	46.9617	-60.221	82	X	X
37	95	CSL_02	05/12/2017	47.0253	-60.1171	188	X	X
38	97	CSL_03	05/12/2017	47.0991	-59.9867	336	X	X
39	99	CSL_04	06/12/2017	47.2635	-59.7668	472	X	X
40	101	CSL_05	06/12/2017	47.4368	-59.5501	478	X	X
41	103	CSL_06	06/12/2017	47.5827	-59.3336	260	X	X
42	104	STAB_06	06/12/2017	46.7123	-58.4344	475	X	X
43	106	BP_00	07/12/2017	45.0056	-56.0275	103	X	X
44	108	BP_01	07/12/2017	44.9747	-56.1438	233	X	X
45	110	BP_04	07/12/2017	44.92	-56.46	398	X	X
46	112	BP_05	08/12/2017	44.9111	-56.6381	416	X	X
47	114	BANQ_B6	08/12/2017	44.8446	-56.7984	427	X	X
48	116	BANQ_B5	08/12/2017	44.8043	-57.0192	430	X	X
49	118	BANQ_B4	08/12/2017	44.7777	-57.2559	397	X	X
50	120	BANQ_B3	08/12/2017	44.7573	-57.3445	75	X	X
51	122	BANQ_B2	08/12/2017	44.7425	-57.4795	75	X	X
52	124	BANQ_B1	08/12/2017	44.7216	-57.6533	57	X	X
53	126	BBL_01	11/12/2017	43.2467	-65.485	64	X	X
54	128	BBL_02	11/12/2017	43.0008	-65.4813	119	X	X
55	131	BBL_03	11/12/2017	42.7524	-65.4741	101	X	X
56	134	BBL_04	12/12/2017	42.4369	-65.4719	100	X	X
57	136	PS_01	12/12/2017	42.4117	-65.742	100	X	X
58	138	PS_02	12/12/2017	42.3309	-65.8082	206	X	X
59	140	PS_04	12/12/2017	42.2747	-65.8648	227	X	X
60	142	PS_06	12/12/2017	42.2034	-65.9323	227	X	X
61	144	PS_08	12/12/2017	42.122	-66.0237	208	X	X
62	146	PS_10	12/12/2017	41.9869	-66.1267	96	X	X
63	147	PS_09	12/12/2017	42.0615	-66.0793	95	X	X
64	148	PS_07	12/12/2017	42.1633	-65.9656	224	X	X
65	149	PS_05	12/12/2017	42.2328	-65.904	237	X	X
66	150	PS_03	12/12/2017	42.3007	-65.8421	215	X	X
67	152	BBL_05	12/12/2017	42.1387	-65.4969	177	X	X
68	154	BBL_06	13/12/2017	42	-65.4713	1045	X	X

69	155	PL_08	13/12/2017	42.4613	-66.8581	327	X	X	
70	157	YL_10	14/12/2017	43.1548	-70.2741	129	X	X	
71	159	YL_09	14/12/2017	43.1834	-70.0134	89	X	X	
72	161	YL_08	14/12/2017	43.2523	-69.5615	149	X	X	
73	163	YL_07	15/12/2017	43.3182	-69.1170	144	X	X	
74	**165**	**YL_06**	**15/12/2017**	**43.3931**	**-68.6571**	**148**	**X**	**X**	**X**
75	166	YL_06	15/12/2017	43.3989	-68.6562	147	X	X	
76	168	YL_05	15/12/2017	43.4664	-68.2010	190	X	X	
77	170	YL_04	15/12/2017	43.5364	-67.7621	243	X	X	
78	172	YL_03	15/12/2017	43.6131	-67.3036	200	X	X	
79	174	HL_02	16/12/2017	44.2700	-63.3169	150	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.

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, comparisons between the primary (#1230, calibrated August 2, 2017) and secondary (#0345, calibrated August 2, 2017) sensors were completed to remove outliers (Figure 3). The 1.5 * inter quartile range (IQR) was used to determine "outlier" data that could bias the results. The first 15 events (444601-444660) showed an average sensor difference greater than the rest of the mission (Figure 3A). The difference during the mission also seemed to be changing slightly. There were some other minor removals, but another sequence of bad data was noticed during CSL_04 (Figure 3B). For oxygen sensors to be this close throughout the mission was actually quite good despite the removal of these outliers before proceeding to the next step.

Comparisons were also made between Winkler replicates (Figure 4). There were a total of 7 Winkler replicates removed from further Soc analysis (events 43, 81, 95, 122, 124, 163 and 174 which correspond to sample ID numbers 444795, 444999, 445062, 445241, 445243, 445492, and 445547). The average difference between the Winkler replicates before outlier removal was 0.002 ml/l. The "threshold field" was then calculated and remaining outliers were removed (Figures 5 and 6). Values beyond the IQR of the difference between the sensor and the Winkler minus the mean difference between the sensor and the Winkler, were removed before calculation of the revised Soc values. For the primary sensor, 17 outliers were removed before calculation of the revised Soc (Events 24, 26, 28, 30 , 43, 48, 52, 56, 61, 71, 116, 118, 149, and 172 which correspond to sample ID's numbers 444701, 444726, 444744, 444752, 444771, 444783, 444786, 444797, 444798, 444833, 444847, 444871, 444929, 445213, 445225, 445397, and 445529). Only one more threshold outlier for the secondary sensor was removed (Event 18, 444677) prior to calculating the new secondary sensor Soc value (Figure 6)

Table 6 shows the previous and revised Soc values and ratio for both the primary and secondary oxygen sensors (#1230 and #0345).

The sensor values were then multiplied by their new corresponding Soc ratios to produce corrected primary and secondary sensor values. This correction brought both sensors closer to at 1:1 relationship with their respective Winkler replicate values (Figure 7). With the corrections applied the mean difference between the average difference between the primary and secondary sensor went from -0.0180 ml/l before correction to -0.0016 ml/l after correction (Figure 8).

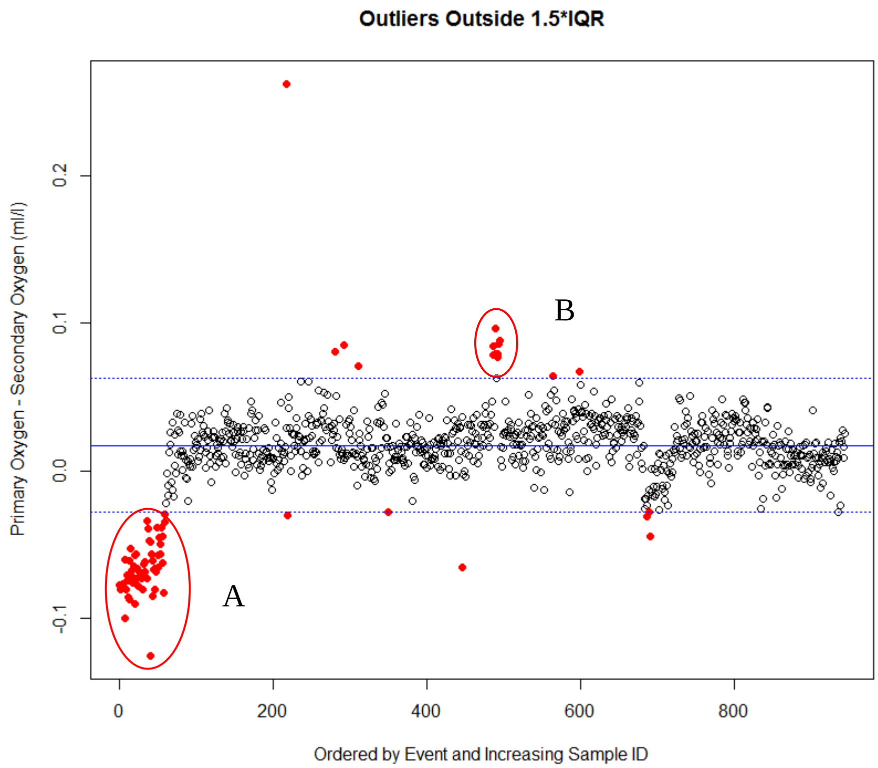


Figure 3. The difference between primary oxygen sensor #1230 and secondary oxygen sensor #0345. Outliers in red were removed prior to proceeding with Soc calculation: **A**) outliers from Events 1-15 (444601-444660), and **B**) Event 99 (CSL_04: 445093 - 445102). The mean difference between sensors before outlier removal (solid blue line) is 0.0168 ml/l. The upper and lower dotted blue lines are 0.0625 and -0.0277 ml/l respectively.

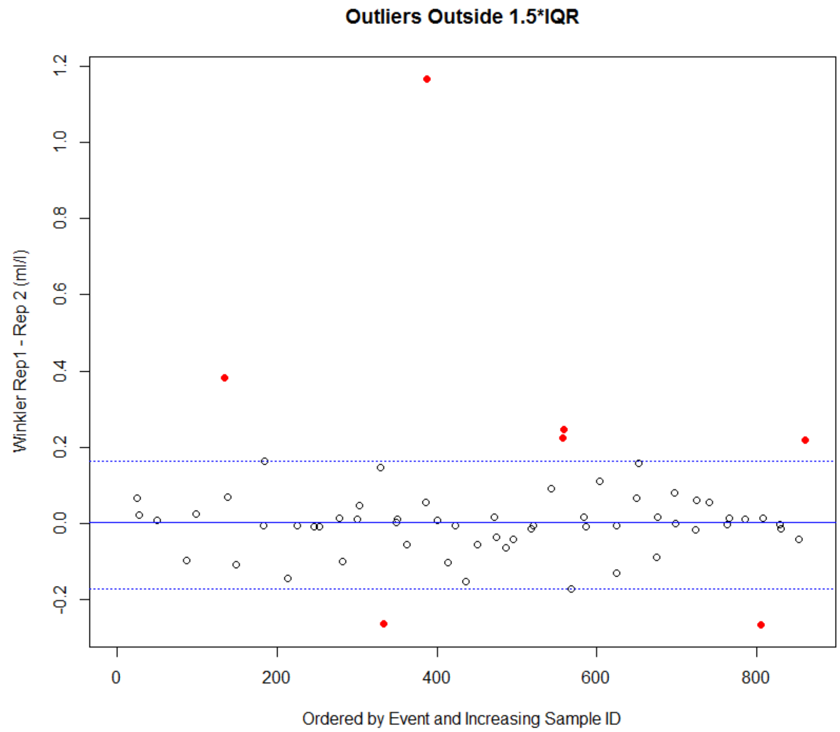


Figure 4. The mean difference (solid blue line) between 1st and 2nd Winkler replicates (-0.002 ml/l). The lower and upper dotted blue lines are -0.17 and 0.16 ml/l respectively. Note the 7 outliers in red that were removed prior to proceeding with Soc calculation (sample ID numbers 444795, 444999, 444062, 445241, 445243, 445492, and 445547).

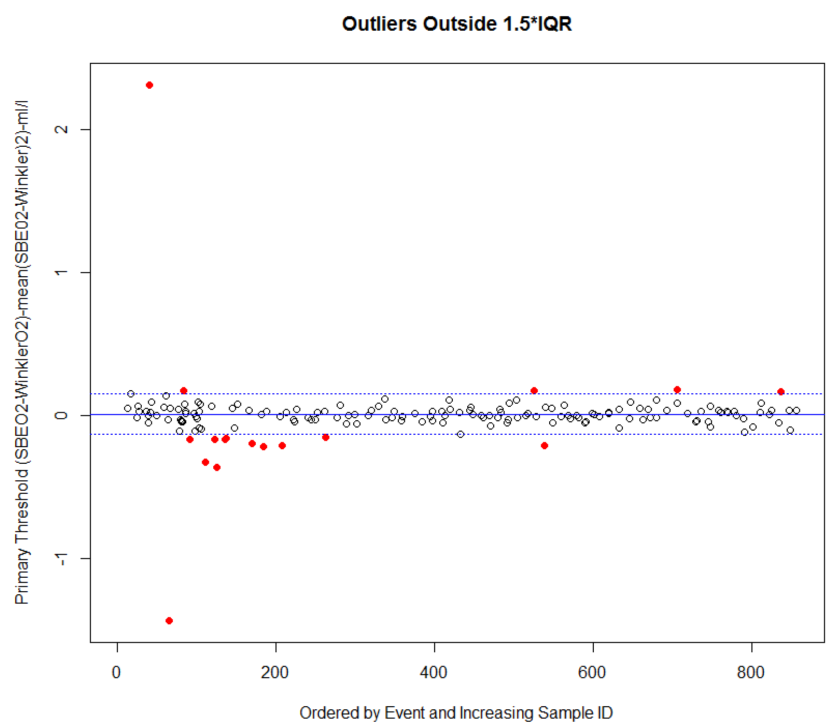


Figure 5. Outlier "threshold" values for the primary sensor were removed. The solid blue line is the mean value of the primary sensor threshold (~0.001 ml/l) and the lower

and upper dotted blue lines are -0.13 and 0.15 ml/l respectively. These outlier data points were removed and the remaining data were used to calculate the primary Soc values.

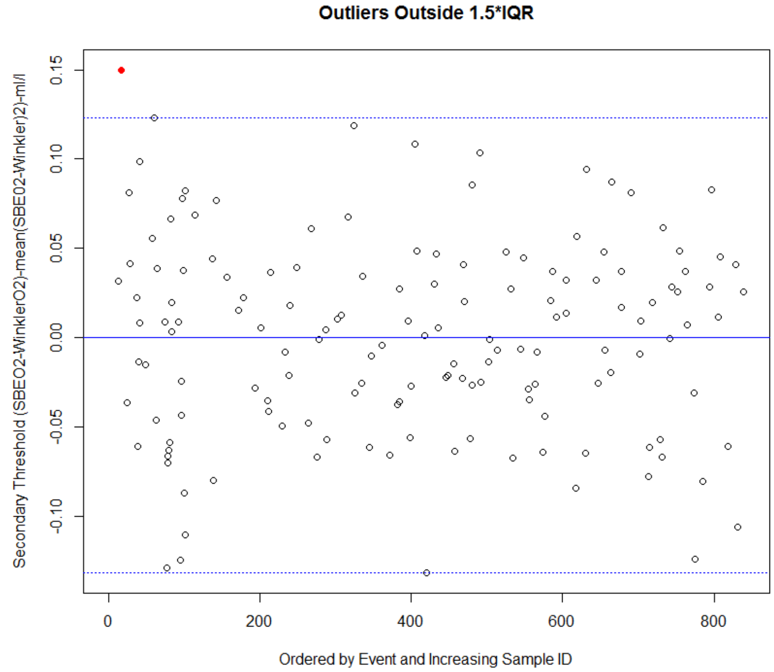
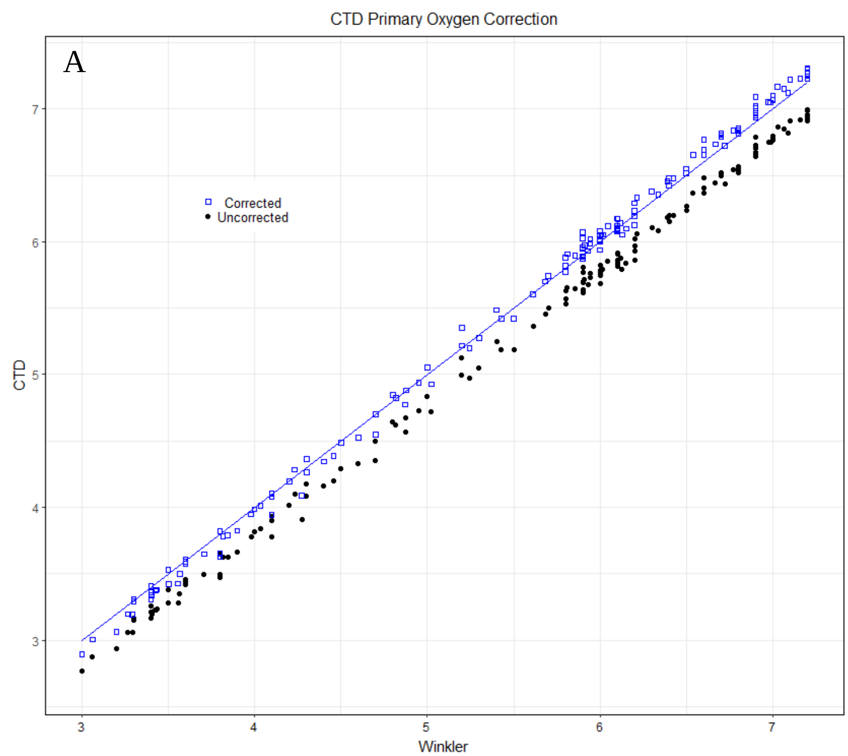


Figure 6. There was just a single "threshold" field value removed for the secondary sensor after the "bad" primary sensor threshold data had been removed.



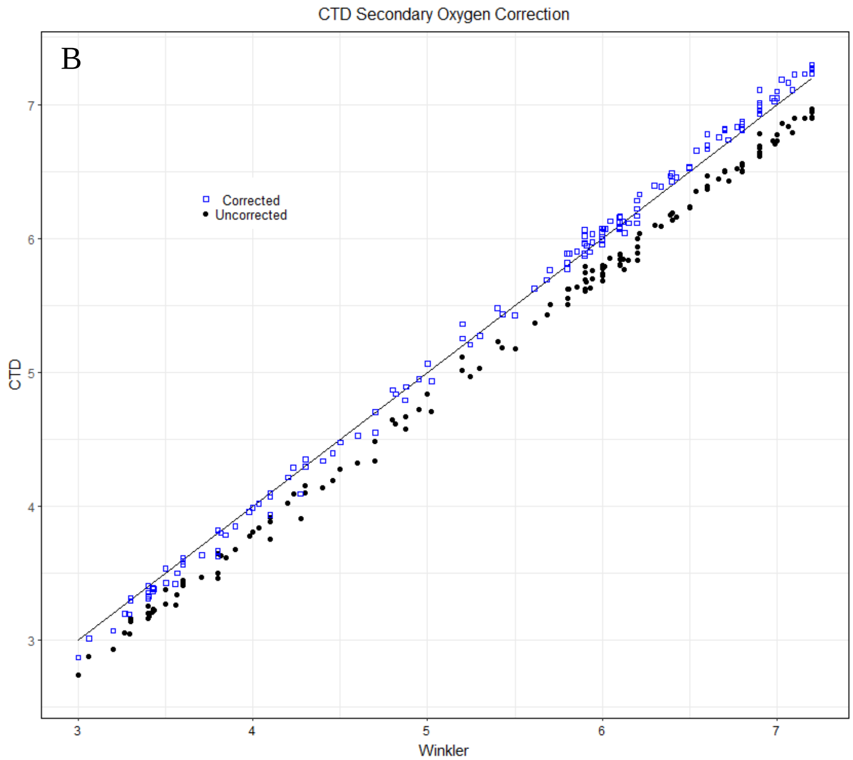


Figure 7. The comparison between the corrected (blue) and uncorrected (black) A) primary (#1230) and B) secondary (#0345) sensors to the mean Winkler value.

Table 6. Old and new Soc values for the primary and secondary SBE Oxygen sensors.

	Old Soc	**New Soc**	**Ratio (New:Old)**
Primary Sensor #1230	5.0347e-1	5.2597e-1	1.044693
Secondary Sensor #0345	3.8281e-1	4.0107e-1	1.047702

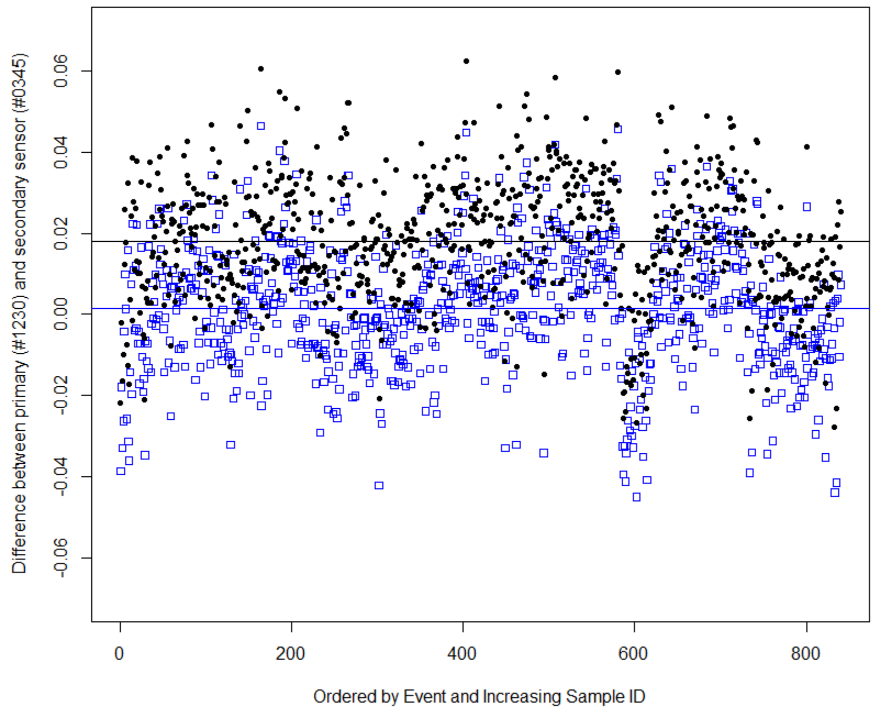


Figure 8. Black dots – non-outlier differences between primary (#1230) and secondary (#0133) sensor values before correction (black line is the mean = 0.0180 ml/l). Blue squares – Soc corrected difference between the primary and secondary sensor (blue line is the mean = 0.0016 ml/l).

Salinity

(With portions extracted from HUD2014017 Cruise Report)

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 (adopted for R using the Dan Kelley's oce 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.

Figure 9 shows the difference between the primary (#3220 calibrated Dec 16, 2016) and secondary (#0864 calibrated Dec 15, 2016) sensors throughout the mission, filtered by

IQR to identify outliers. In Figure 10, the difference between the primary and the salinometer is examined and outliers are identified and removed using the IQR method. The mean difference between the primary sensor and the salinometer is -0.007 P.S.U. before outliers are removed, with an upper IQR threshold of ~0.0098 and a lower threshold of -030306. All data points highlighted in red were removed before proceeding.

Figure 11 compares the difference between the secondary sensor and the salinometer and identifies 3 additional outliers that were removed before coefficients were calculated. The mean difference between the secondary and salinometer was -3.45e-03 and the IQR upper limit is 1.05e-02 and the lower limit is -2.13e-02 (dotted blue lines). .

The slope and intercept coefficients for both the primary and secondary sensors after are shown in Table 7. Figure 12 shows the difference between the 2 sensors both before and after correction. Before correction with new coefficients the average difference between filtered primary and secondary conductivity values was –3.36e-02 mS/cm. After correction, the average difference between sensors improved to 6.16e-05.

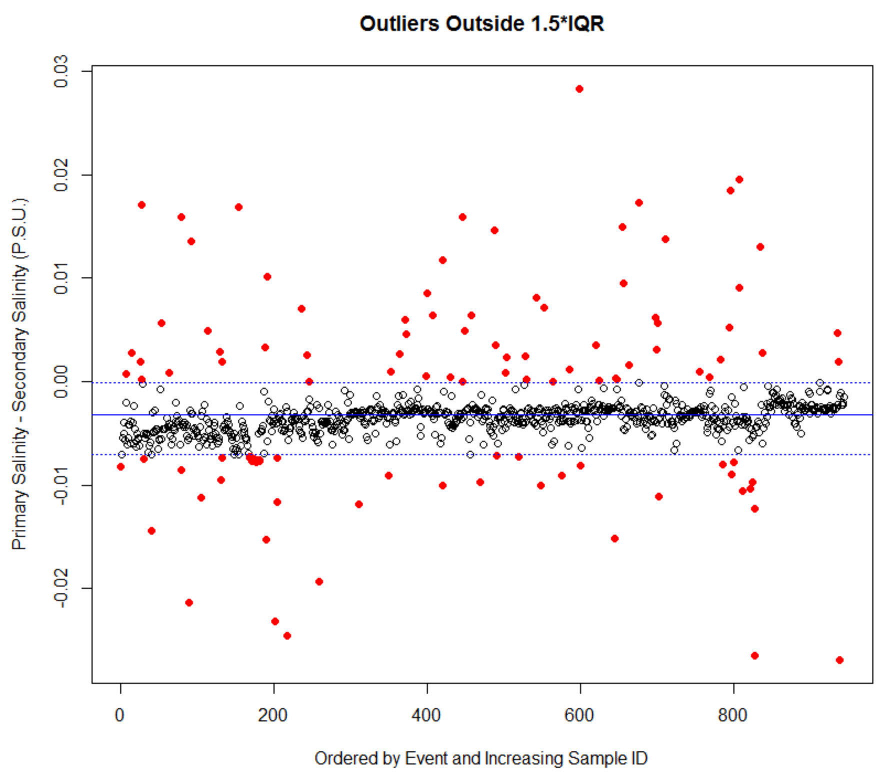


Figure 9. A) The mean sensor difference throughout the mission was was -0.0033 P.S.U (blue line). The lower and upper dotted blue lines are -0.007 and ~0 ml/l respectively. Erroneous data (red dots) were removed before proceeding to the next step.

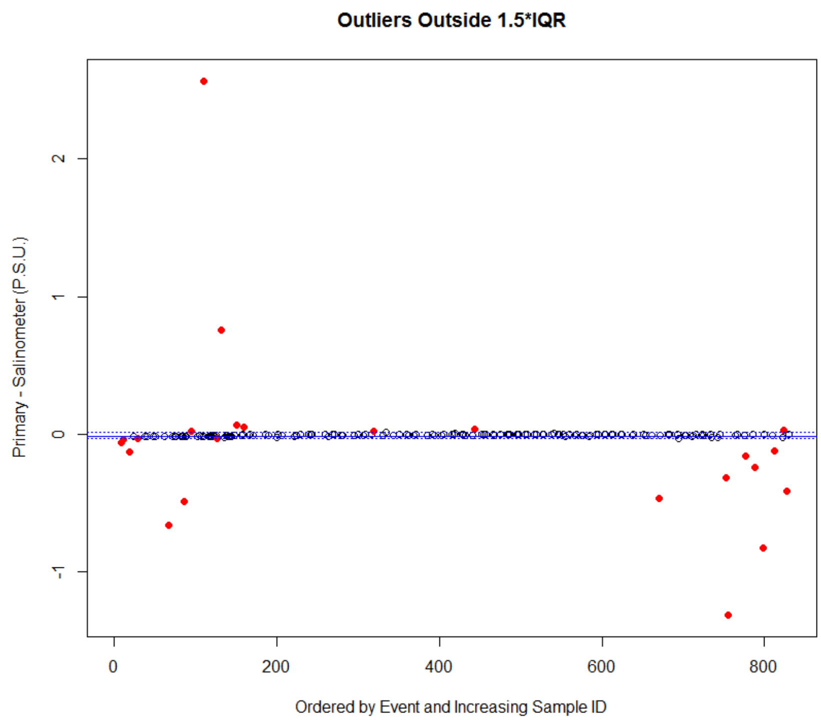


Figure 10. The difference between the primary sensor (#3220) and the salinometer after the removal of erroneous sensor data. Erroneous values (red dots) were removed before proceeding. The mean difference (solid blue line) between the primary and salinometer was 7.00e-03 and the IQR upper limit is 9.80e-03 and the lower limit is -3.06e-02 (dotted blue lines).

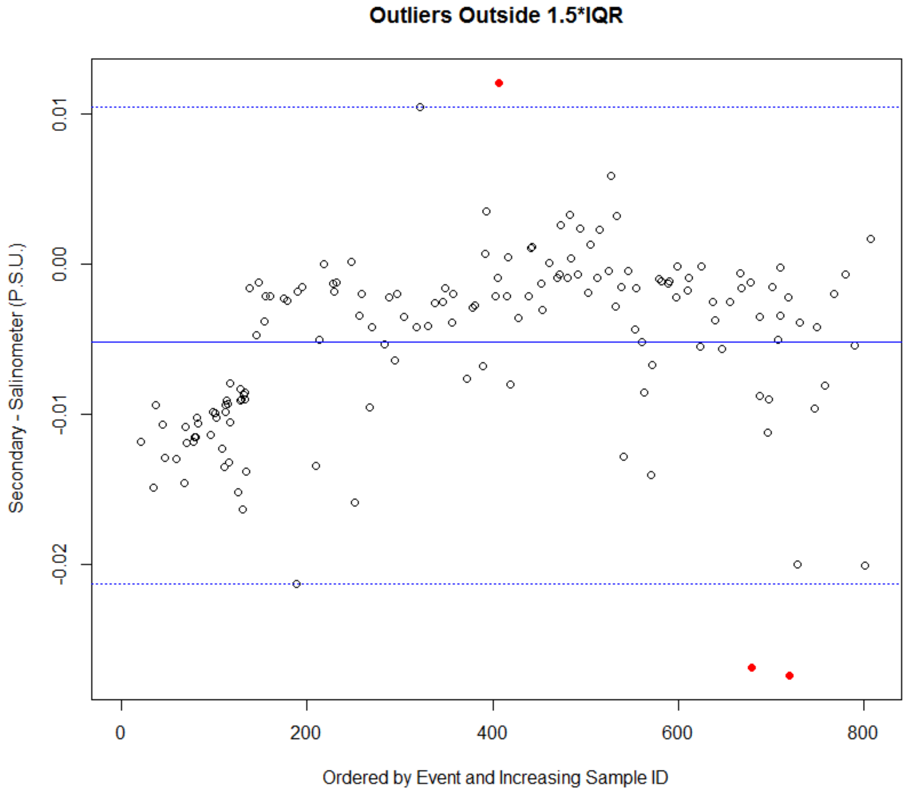


Figure 11. The difference between the secondary sensor (#0864) and the salinometer after removal of erroneous primary sensor and salinometer data. Only three additional erroneous values were removed prior to proceeding The mean difference (solid blue line) between the secondary and salinometer was -3.45e-03 and the IQR upper limit is 1.05e-02 and the lower limit is -2.13e-02 (dotted blue lines).

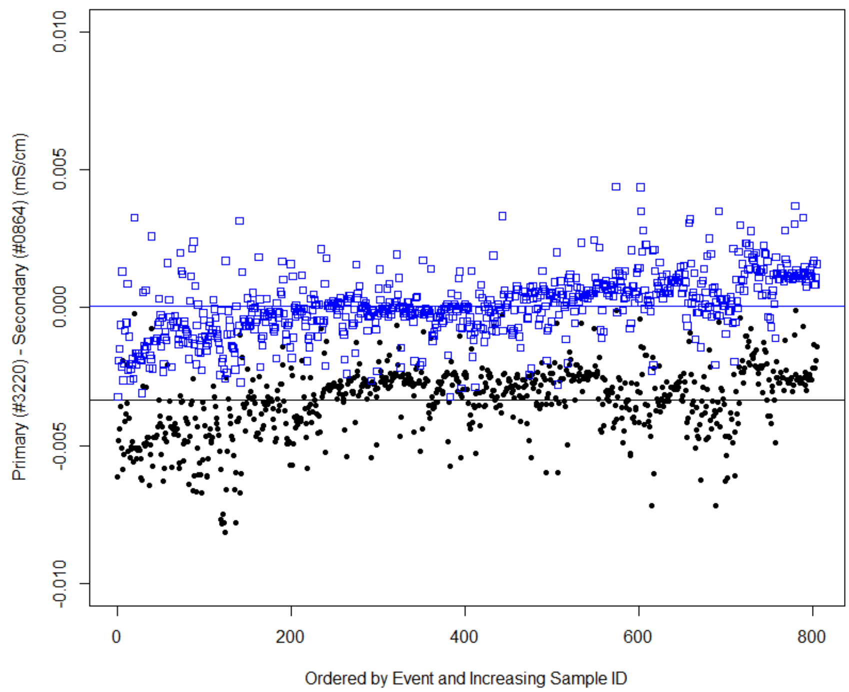


Figure 12. Before correction with new coefficients (black dots), the average difference between primary (#3220) and secondary (#0864) conductivity was –3.36e-03 mS/cm (solid black line). After correction (blue squares), the average difference between sensors was 6.16e-05 (solid blue line).

Table 7. The revised intercept (b1) and slope (b2) terms calculated for both the primary (#3220) and secondary (#0864) conductivity sensors from EN2017606.

Conductivity Sensor	b1	b2
Primary (#3220)	-1.0684e-02	1.000553
Secondary (#0864)	-7.7168e-03	1.000367

Chlorophyll a

Throughout the mission, ChlA was measured in-situ via a Wet Labs Eco-AFL/FL (SN: 492 – calibrated Dec 15, 2016) attached to the CTD rosette (Appendix 3). Duplicate samples were regularly taken for ChlA analysis with a Turner Fluorometer from Niskin bottles fired in the upper 100 m. A comparison of the replicates showed that while the mean difference between replicates was -0.0061 µg/L, there were a total of 98 out of 577 replicates that would be considered outliers (Figure 13). Outliers were selected via the 1.5 * interquartile range (1.5 IQR) method discussed in the previous oxygen and salinity sections of this report. These outliers were removed before making the comparison between the WetLabs sensor values and the mean Turner replicate values (Figure 14). The relationship is confused and appears to be broken into 2 parts. There seems that there could be two separate relationships throughout the mission but the reason for this is not entirely clear. The relationship is mostly above the 1:1 line from 0 to 0.4, above and below the line at 0.4 to 0.5 and mostly below the line after 0.5. Figure 15 shows the standardized percent difference between the sensor values and the Turner replicate mean throughout the mission. For roughly the first half of the mission (Halifax Line, Gully, Louisbourg Line, St. Anns Bank and Cabot Strait Line), the WetLabs fluorometer registered relative concentrations ~40% greater than the Turner fluorometer. Over the second half of the mission, relative concentrations for both the Turner and WetLabs Fluorometer were roughly equivalent with a mean value of ~ -0.02 %. This suggests that the WetLab fluorometer was more in line with Turner readings for the second half of the mission and because the ship was in warmer nutrient rich waters to the southwest, the ChlA concentrations observed were generally greater. These two factors likely account for the unusual relationship observed in figure 14.

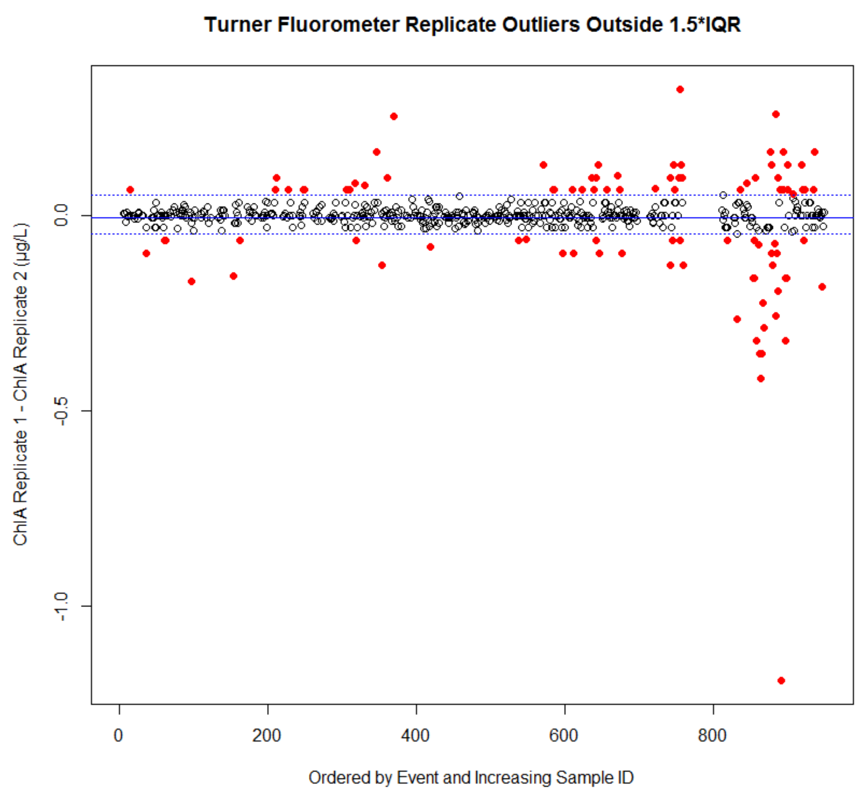


Figure 13. A total of 98/577 Turner fluorometer replicates were considered outliers using the IQR method.

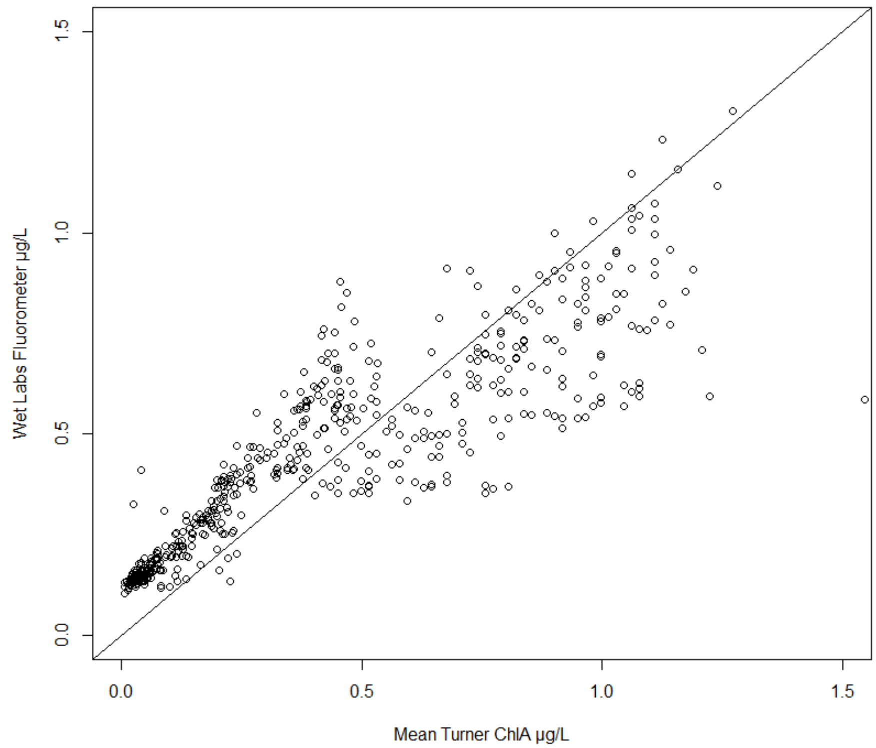


Figure 14. The relationship between the WetLabs Fluorometer and the mean of the corresponding turner replicates.

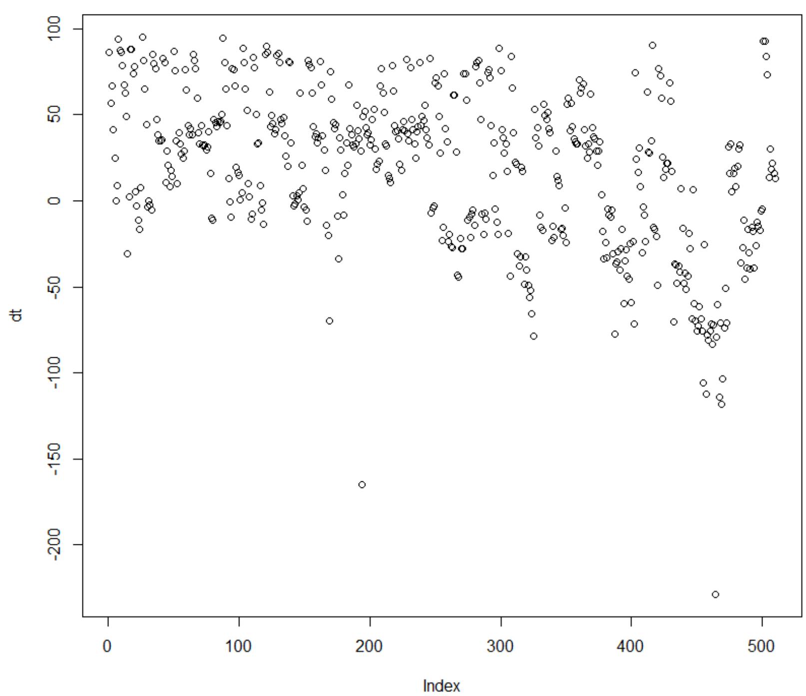


Figure 15. The standardized percent difference between the fluorometer and the mean Turner fluorometer throughout the mission.

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.

pH Sensor

The pH sensor (#1307, calibrated February 3, 2017) 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 to support an ACCASP initiative investigating the delineation of ocean acidification and calcium carbonate saturation state of the Atlantic zone.

Biological Program

Narrative

The "core" biological program conducted as part of cruise EN2017606, 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 2 elements:

1. mesozooplankton community structure, population growth and biomass, and
2. dissolved organic carbon measurements

Table 5 provides a review of the stations where water samples were taken from rosette bottles for element 2 above. The mesoplankton sampling program is described below in more detail. This is followed by descriptions of "non-core" or ancillary biological sampling that includes text describing water sampling efforts in support of projects investigating: organic and organometallic micronutrients and their influence on primary productivity and phytoplankton community structure on the Scotian Shelf (Erin Bertrand – Dalhousie University), and water samples from strategic locations and depths to support a microbial community analysis via DNA, RNA and flow cytometry. The Biological Program section is concluded with a summary of pelagic seabird and marine mammal observations during EN606, provided by Carina Gjerdrum of the Canadian Wildlife Service.

The ultimate aim of "core" studies is twofold:

1. to provide a description of the inventories of biogenic carbon, their turnover rates and variability in space and time as part of Ocean Ecosystem Science Division's (OESD)

continuing climate studies, and
2. to provide a description of plankton life-cycles and productivity on the Scotian Shelf and its influence or contribution to ecosystems in support of OESD’s ecosystem-related research.

<u>Mesozooplankton Sampling</u>

Remarks/Comments

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 most stations (or from a maximum depth of 1000 m – AZMP standard). In total, there were 76 vertical ring net tows during the mission (Table 8, Figure 16). Of these, 1 was a 76 µm mesh (30 cm diameter and 1:5 filtering ratio) at HL_02 (event 6). The 76 µm net tow at HL_02 serves 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. 35 of the 202 µm mesh tows were conducted at stations along core AZMP sections (HL, BBL, CSL and LL) (Table 8). The remaining 40 200 µm casts were conducted at ancillary stations throughout the mission (Table 8, Figure 16).

Six out of 76 casts were aborted for various reasons throughout the mission (HL_03.3, HL_06, HL_06.7, SG_28, STAB_05 and event 173 at HL_02). Of these, HL_06, HL_3.3 and HL_02 were successfully reattempted. It should also be noted that BBL_07 was not occupied because of forecasted inclement weather.

There were 6 - C3 genetics samples taken throughout the mission (of the 8 proposed locations) in support of Objective 13 (“Collect 200 µm ring net zooplankton samples at predefined stations across the Scotian Shelf to supplement the Canada C3 program sample collection”) (Table 8).

Overall, net operations were successful during the mission. As with the CTD, net deployments occurred on the starboard side of the vessel, exposed to the wind and waves. This occasionally made operations technically difficult during inclement weather. Despite the challenges, the rate of unsuccessful tows was no more or less than typically experienced on our primary oceanographic platform (CCGS Hudson).

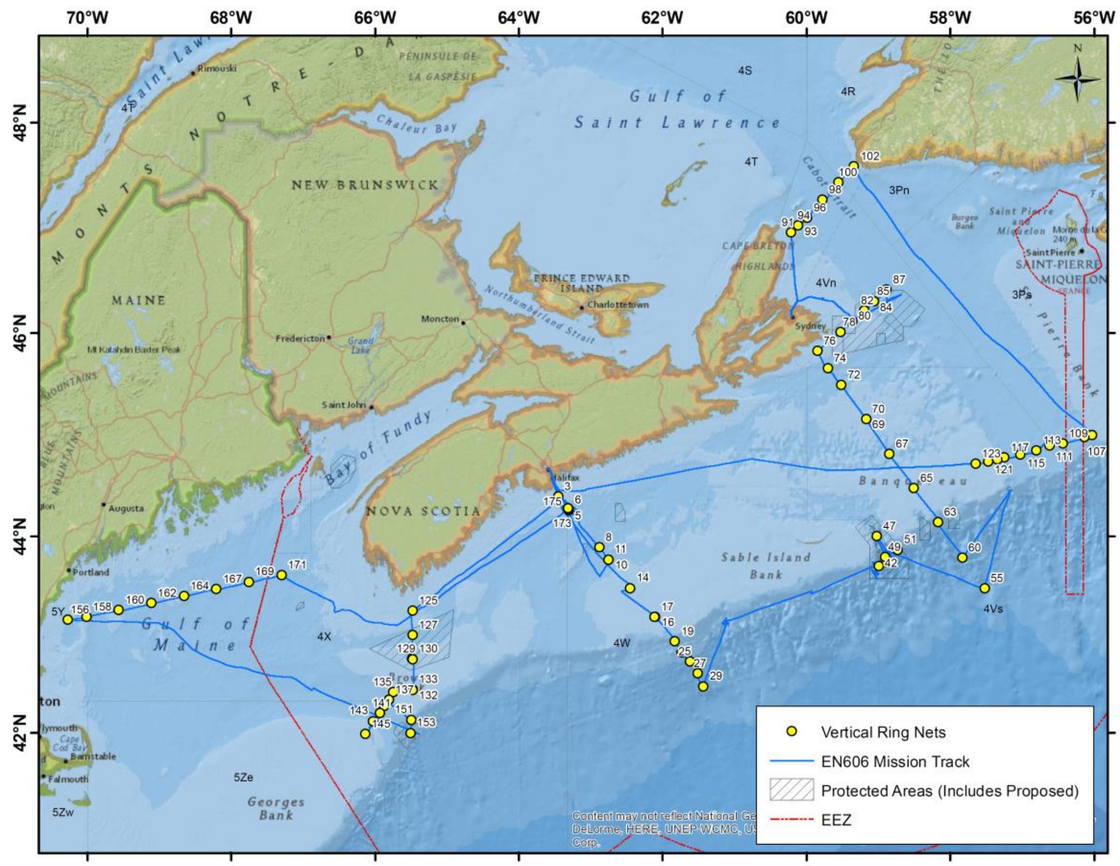


Figure 16. Locations for vertical ring net tows during EN2017606. Each tow is labelled with the consecutive mission event.

Table 8. Zooplankton collection activities during the EN2017606. The coordinates provided are in decimal degrees and reflect the ship's position at the time of deployment. Bold rows are tows that were aborted.

#	Event	Date	Station	Operation	Mesh Size (µm)	Slat (DD)	SLong (DD)	Objective	Comment
1	3	24/11/2017	HL_01	RingNet	202	44.3972	-63.4481	1	
2	5	25/11/2017	HL_02	RingNet	202	44.2625	-63.3086	1	
3	6	25/11/2017	HL_02	RingNet	76	44.2606	-63.3038	1	
4	8	25/11/2017	HL_03	RingNet	202	43.8854	-62.8836	1	
5	**10**	**25/11/2017**	**HL_03.3**	**RingNet**	**202**	**43.7644**	**-62.7546**		**Mud in sample aborted.**
6	11	25/11/2017	HL_03.3	RingNet	202	43.7645	-62.7519		No flow meter
7	14	27/11/2017	HL_04	RingNet	202	43.4780	-62.4524	1	
8	16	27/11/2017	HL_05	RingNet	202	43.1860	-62.1041	1	
9	17	27/11/2017	HL_05	RingNet	202	43.1877	-62.1099	13	C3 Gentics Sample
10	19	27/11/2017	HL_05.5	RingNet	202	42.9376	-61.8329		
11	**22**	**27/11/2017**	**HL_06**	**RingNet**	**202**	**42.8299**	**-61.7305**		**Lost sample.**
12	23	27/11/2017	HL_06	RingNet	202	42.8260	-61.7360	1	
13	25	28/11/2017	HL_06.3	RingNet	202	42.7313	-61.6202		Strong current.
14	**27**	**28/11/2017**	**HL_06.7**	**RingNet**	**202**	**42.6127**	**-61.5124**		**Lost sample, no reattempt.**
15	29	28/11/2017	HL_07	RingNet	202	42.4779	-61.4323	1	
16	**42**	**30/11/2017**	**SG_28**	**RingNet**	**202**	**43.7007**	**-58.9988**	**3**	**Wind gusts >40 kts on recovery and sample lost. No reattempt.**
17	47	01/12/2017	GULD_03	RingNet	202	43.9979	-59.0205	3	
18	49	01/12/2017	GULD_04	RingNet	202	43.7886	-58.9044	3	
19	51	01/12/2017	SG_23	RingNet	202	43.8629	-58.7335	3	
20	55	02/12/2017	LL_09	RingNet	202	43.4757	-57.5258	1	
21	60	02/12/2017	LL_08	RingNet	202	43.7835	-57.8365	1	
22	63	03/12/2017	LL_07	RingNet	202	44.1380	-58.1748	1	
23	65	03/12/2017	LL_06	RingNet	202	44.4769	-58.5101	1	

24	67	03/12/2017	LL_05	RingNet	202	44.8174	-58.8492	1	
25	69	03/12/2017	LL_04	RingNet	202	45.1611	-59.1737	1	
26	70	03/12/2017	LL_04	RingNet	202	45.1608	-59.1740	13	C3 Genetics Sample
27	72	03/12/2017	LL_03	RingNet	202	45.4910	-59.5173	1	
28	74	03/12/2017	LL_02	RingNet	202	45.6564	-59.7036	1	
29	76	03/12/2017	LL_01	RingNet	202	45.8246	-59.8521	1	
30	78	04/12/2017	STAB_01	RingNet	202	46.0039	-59.5323	10	
31	80	04/12/2017	STAB_02	RingNet	202	46.1109	-59.3656	10	
32	82	04/12/2017	STAB_03	RingNet	202	46.2163	-59.1955	10	
33	84	04/12/2017	STAB_04	RingNet	202	46.2997	-59.0652	10	
34	85	04/12/2017	STAB_04	RingNet	202	46.2994	-59.0655	13	C3 Genetics Sample
35	**87**	**04/12/2017**	**STAB_05**	**RingNet**	**202**	**46.4166**	**-58.8859**	**10**	**Mud in sample. No reattempt, continued with CTD then mooring.**
36	91	05/12/2017	CSL_01	RingNet	202	46.9602	-60.2187	1	
37	93	05/12/2017	CSL_02	RingNet	202	47.0240	-60.1161	1	
38	94	05/12/2017	CSL_02	RingNet	202	47.0246	-60.1165	13	C3 Genetics Sample
39	96	05/12/2017	CSL_03	RingNet	202	47.0995	-59.9906	1	
40	98	06/12/2017	CSL_04	RingNet	202	47.2715	-59.7780	1	Full stop at 188 m on descent. Full stop at 435 m on descent. ~2 kts of current, trying to reposition ship.
41	100	06/12/2017	CSL_05	RingNet	202	47.4351	-59.5585	1	
42	102	06/12/2017	CSL_06	RingNet	202	47.5829	-59.3393	1	
43	105	07/12/2017	BP_00	RingNet	202	45.0049	-56.0282	12	New station in 2017
44	107	07/12/2017	BP_01	RingNet	202	44.9784	-56.1396	12	
45	109	07/12/2017	BP_04	RingNet	202	44.9195	-56.4415	12	
46	111	08/12/2017	BP_05	RingNet	202	44.8968	-56.6252	12	
47	113	08/12/2017	BANQ_B6	RingNet	202	44.8485	-56.8035	12	
48	115	08/12/2017	BANQ_B5	RingNet	202	44.8078	-57.0256	12	

49	117	08/12/2017	BANQ_B4	RingNet	202	44.7811	-57.2509	12	
50	119	08/12/2017	BANQ_B3	RingNet	202	44.7609	-57.3473	12	
51	121	08/12/2017	BANQ_B2	RingNet	202	44.7439	-57.4776	12	
52	123	08/12/2017	BANQ_B1	RingNet	202	44.7205	-57.6525	12	
53	125	11/12/2017	BBL_01	RingNet	202	43.2492	-65.4810	1	
54	127	11/12/2017	BBL_02	RingNet	202	43.0019	-65.4796	1	
55	129	11/12/2017	BBL_03	RingNet	202	42.7590	-65.4821	1	
56	130	11/12/2017	BBL_03	RingNet	202	42.7562	-65.4780	13	C3 Genetics Sample
57	132	12/12/2017	BBL_04	RingNet	202	42.4467	-65.4805	1	
58	133	12/12/2017	BBL_04	RingNet	202	42.4423	-65.4768	13	C3 Genetics Sample
59	135	12/12/2017	PS_01	RingNet	202	42.4153	-65.7431	4	
60	137	12/12/2017	PS_02	RingNet	202	42.3373	-65.8070	4	
61	139	12/12/2017	PS_04	RingNet	202	42.2735	-65.8742	4	
62	141	12/12/2017	PS_06	RingNet	202	42.2006	-65.9350	4	2.5 kts of current during tow
63	143	12/12/2017	PS_08	RingNet	202	42.1192	-66.0328	4	
64	145	12/12/2017	PS_10	RingNet	202	41.9893	-66.1331	4	
65	151	12/12/2017	BBL_05	RingNet	202	42.1350	-65.4997	1	
66	153	13/12/2017	BBL_06	RingNet	202	41.9981	-65.5062	1	
67	156	14/12/2017	YL_10	RingNet	202	43.1563	-70.2715	4	
68	158	14/12/2017	YL_09	RingNet	202	43.1858	-70.0104	4	
69	160	14/12/2017	YL_08	RingNet	202	43.2561	-69.5605	4	All stop at 160 m on descent because the cable was under the ship.
70	162	15/12/2017	YL_07	RingNet	202	43.3246	-69.1090	4	
71	164	15/12/2017	YL_06	RingNet	202	43.3952	-68.6539	4	
72	167	15/12/2017	YL_05	RingNet	202	43.4683	-68.2044	4	
73	169	15/12/2017	YL_04	RingNet	202	43.5408	-67.7539	4	
74	171	15/12/2017	YL_03	RingNet	202	43.6059	-67.3007	4	
75	**173**	**16/12/2017**	**HL_02**	**RingNet**	**202**	**44.2693**	**-63.3164**	**1**	aborted
76	175	16/12/2017	HL_02	RingNet	202	44.2765	-63.3200	1	

Microbial Protein and Organic Micronutrient Sampling

Principle Investigator: Dr. Erin Bertrand (Dalhousie University, Department of Biology)
Sampling by: Jenni Tolman and Ian Luddington (Dalhousie University)

Objective

To collect underway and rosette samples for protein and vitamin analyses in order to determine whether and how organic and organometallic micronutrients influence primary productivity and phytoplankton community structure on the Scotian Shelf. Sampling locations were coordinated with the LaRoche lab since our data types are synergistically informative.

Microbial Protein Sampling

Purpose

Proteins are key to microbial activity: the type and amount of proteins present determines, in large part, the contributions microbes make to the ecosystems they occupy. Proteins can also be used as indices for nutritional status: elevated expression of specific proteins can be diagnostic for different nutritional states, such as nitrogen starvation, iron starvation, or vitamin starvation. Protein sequences also contain taxonomic information and can be used to assess contributions of different organisms to specific functions.

Samples were collected for targeted, mass spectrometry- based proteomic analyses of microbial communities in order to characterize the role of organic micronutrients in structuring phytoplankton communities on the Scotian Shelf. Primary objectives include measuring phytoplankton nutritional status indicator proteins (nitrogen, vitamin B_{12}, vitamin B_1 starvation) and vitamin- production biomarker proteins. Development and application of peptides for primary producer community composition analyses is a secondary focus.

Sampling Methods

A total of 31 size- fractionated microbial protein samples (10L of water each) were taken from the CTD rosette at depths ranging from the surface to 250 m depth (Table 9) along the Halifax and Louisburg Lines, and in the Gully. In each case, water was pre-filtered (330 µm) while dispensing from the Niskin bottle into 10L carboys. Water was then filtered through 3 and 0.2 µm polycarbonate filters via peristaltic pumping. Filters were then frozen immediately at -80°C.

Vitamin Sampling

Purpose

To determine the particulate and dissolved concentrations of organic and organometallic micronutrients on the Scotian Shelf. Organic and organometallic micronutrients are required by many phytoplankton groups and only produced by a select few microbes, setting up a series of interactive dependencies between microbial groups. The importance of these dependencies are not well known, as they have not yet been studied on the Scotian Shelf. Measuring the concentrations of these micronutrients in the particulate and dissolved phases is one step towards understanding the role of microbial interactions in driving primary productivity and phytoplankton community structure.

Sampling Methods

A total of 31 particulate and 23 dissolved vitamin samples (1L each) were taken from the CTD rosette at depths ranging from the surface to 250 m depth along the Halifax, Gully, and Louisburg lines (Table 9). Samples were protected from light and gently vacuum filtered through 0.2 μm nylon filters. Filters were frozen at -80°C and dissolved samples were frozen in amber HDPE bottles at -20°C.

Table 9. Protein and vitamin sampling, Bertrand Lab EN2017606.

Station	Event	Depth (m)	ID#	Protein	Particulate Vitamin	Dissolved Vitamin
HL_02	7	1	444635	-	-	-
		20	444629	-	-	-
		40	444624	-	-	-
		80	444618	-	-	-
HL_04	15	1	444675	1	1	1
		20	444670	1	1	1
		40	444666	1	1	1
		60	444662	1	1	1
HL_06	24	1	444721	1	1	1
		20	444716	1	1	1
		50	444712	1	1	1
		80	444707	1	1	1
HL_07	30	1	444781	1	1	1
		20	444777	1	1	1
		50	444772	1	1	1
GULD_04	50	1	444832	1	1	-
		20	444827	1	1	-
		40	444823	1	1	-
		60	444820	1	1	-
LL_09	56	1	444870	1	1	1
		20	444866	1	1	1
		80	444858	1	1	1
		250	444854	1	1	1
LL_07	64	1	444908	1	1	-
		20	444903	1	1	-
		80	444896	1	1	-
		250	444891	1	1	-
LL_04	71	1	444946	1	1	1
		20	444940	1	1	1

		40	444936	1	1	1
		80	444932	1	1	1
LL_01	77	1	444986	1	1	1
		20	444981	1	1	1
		40	444977	1	1	1
		60	444973	1	1	1

Microbial Community Analysis

Principle Investigator: Dr. Julie LaRoche (Dalhousie University)
Sampling by: Jenni Tolman and Ian Luddington (Dalhousie University)

Purpose

Microbial communities and their associated processes are the foundation of marine life. Of particular interest to our group is the marine nitrogen cycle, comprising complex microbially-driven reactions whereby atmospheric nitrogen is fixed into a biologically-available form and cycled through the ecosystem. Though nitrogen is an essential element for life, the availability of fixed nitrogen can be a limiting factor for primary production and thus diazotrophs – organisms capable of biological nitrogen fixation – can be key to the productivity of an ecosystem.

Samples were collected for genomic and fluorescence-based analyses of the microbial communities on the Scotian shelf. Community composition will be assessed via 16S tag sequencing (bacteria and chloroplasts), and the naturally-fluorescent population will be characterized via flow cytometry. The latter method can also be used to quantify the bacterial community via nucleic acid stain SYBR green. Community function will be assessed via metagenomic sequencing, and qPCR assays for selected functional genes. Further samples were taken for manipulation in the lab, including targeted metagenomics and single cell isolation via fluorescence-associated cell sorting (FACS), and enrichment culturing of putative diazotrophs.

Sampling Methods

Genomics:

At 12 select stations along core AZMP lines (Halifax, Louisbourg, St Ann’s Bank, and the Gully), duplicate 4L water samples were collected from the CTD rosette each of 4 depths ranging from the surface to 300 m (Table 10). During collection, water was pre-filtered through a 330 μm mesh to remove zooplankton. Each water sample was then sequentially filtered through 3 and 0.2 μm polycarbonate filters by peristaltic pump until the water was depleted or the filters clogged. Filters were immediately frozen at -80 °C. Samples have been collected at selected stations to provide time-series continuity with previous years (2014 and 2016).

Flow Cytometry:

At each station and depth where genomic samples were collected, duplicate 2mL water samples (330µm filtered) were fixed with 2% paraformaldehyde (PFA) for 10 minutes at room temperature, then frozen at -80°C for later enumeration of bacteria and characterization of the naturally fluorescent microbial community via the Accuri C6 flow cytometer.

At select stations (Table 10), 45 ml of 330 µm-filtered water were mixed with 5 ml of gly-TE buffer and frozen at -80 °C for later cell sorting on the BD Influx FACS instrument.

Enrichment Cultures:

At select stations (Table 10), large (1L) 330 µm-filtered water samples were collected. These samples were spiked with phosphate (200 nM) and iron (2 nM) and stored in conditions approximating natural light/dark cycles and ambient temperature until return to the lab.

Table 10. Microbial community samples, LaRoche lab EN2017606.

Station	Event	Depth (m)	ID#	DNA samples (size-fractionated)	Flow cytometry	Sorting Flow Cytometry	1L culture
HL_01	4	1	444613	2	2	-	-
		20	444609	2	2	-	-
		40	444605	2	2	-	-
		80	444603	2	2	-	-
HL_02	7	1	440574	2	2	-	-
		20	444630	2	2	-	-
		40	444625	2	2	-	-
		80	444619	2	2	-	-
HL_04	15	1	444676	2	2	-	-
		20	444671	2	2	-	-
		40	444667	2	2	-	-
		60	444663	2	2	-	-
HL_06	24	1	444720	2	2	-	-
		20	444717	2	2	-	-
		50	444711	2	2	-	-
		80	444708	2	2	-	-
HL_07	30	1	444782	2	2	-	-

		1	444779	-	-	1	1
		20	444776	2	2	-	-
		50	444773	2	2	-	-
		80	444769	2	2	-	-
GULD_04	50	1	444831	2	2	-	-
		20	444826	2	2	-	-
		60	444819	2	2	-	-
		250	444814	2	2	-	-
LL_09	56	1	444869	2	2	1	1
		20	444865	2	2	-	-
		80	444859	2	2	-	-
		250	444855	2	2	-	-
LL_07	64	1	444909	2	2	-	-
		20	444904	2	2	-	-
		80	444897	2	2	-	-
		250	444892	2	2	-	-
LL_04	71	1	444945	2	2	-	-
		20	444941	2	2	-	-
		40	444937	2	2	-	-
		80	444931	2	2	-	-
LL_01	77	1	444985	2	2	-	-
		20	444980	2	2	-	-
		40	444976	2	2	-	-
		60	444972	2	2	-	-
STAB_01	79	1	444998	2	2	-	-
		10	444995	2	2	-	-
		20	444993	2	2	-	-
		40	444990	2	2	-	-
STAB_05	88	1	445045	2	2	-	-
		20	445041	2	2	-	-
		80	445035	2	2	-	-
		300	445030	2	2	-	-

Pelagic Seabird and Marine Mammal Observations

Seabird Survey Report
Leg1: 24 Nov – 4 Dec, 2017
Canadian Wildlife Service, Environment Canada
Carina Gjerdrum carina.gjerdrum@ec.gc.ca
Observer: Jeannine Winkel

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 surveys were conducted from the port side of the bridge of the Endeavor during the Scotian Shelf AZMP from 24 Nov to 4 Dec, 2017 (Leg 1). Surveys were conducted while the ship was moving at speeds greater than 4 knots, looking forward and scanning a 90° arc to one side of the ship. All birds observed on the water within a 300m-wide transect were recorded, and we used the snapshot approach for flying birds (intermittent sampling based on the speed of the ship) to avoid overestimating abundance of birds flying in and out of transect. Distance sampling methods were incorporated to address the variation in bird detectability. Marine mammal observations were also recorded, although surveys were not specifically designed to detect marine mammals. Details of the methods used can be found in the CWS standardized protocol for pelagic seabird surveys from moving platforms[1].

Results

Seabird sightings

We surveyed 628 km of ocean from 24 Nov to 4 Dec, 2017. A total of 878 birds were observed in transect (1259 birds in total) from 7 families (Table 11). Bird densities averaged 4.5 birds/km^2 (ranging from 0 – 88.5 birds/km^2). The highest densities of birds (> 50 birds/km^2) were observed on the Canso Bank and Western Banks (Figure 17A).

Dovekie accounted for 32% of the sightings (Table 11) and were scattered throughout the survey area (Figure 17B). The Scotian Shelf (and Grand Banks of NL) is an important wintering ground for Dovekie breeding in Greenland. Other Alcids observed in lower numbers include the Atlantic Puffin and Thick-billed Murre (Table 11). Northern fulmar and Black-legged Kittiwake were also relatively common (Table 11), especially in the deeper water (Northern Fulmar) and on the Canso Bank (Black-legged Kittiwake; Figure 17C). A complete list of all species observed can be found in Table 11.

Marine Mammal sightings

A total of 36 marine mammals were recorded during the surveys (Table 12), 86% of which were long-finned pilot whales, observed in the eastern sections of the survey (Figure 17D). A single Grey Seal was also identified.

Gully MPA

Surveys were conducted within the Gully MPA in the afternoon of 30 Nov and the following morning on 1 Dec. A total of 46 birds were observed and 16 marine mammals in this area (Table 13; Figure 18).

St. Anns Bank MPA

Surveys were conducted within the St. Anns Bank MPA in the morning and early afternoon of 4 Dec before steaming to the mouth of Sydney Harbor to end Leg 1. A total of 74 birds and 11 marine mammals (all long-finned pilot whales) were sighted here (Table 14 and Figure 19).

Table 11. List of bird species observed during surveys on the Scotian Shelf AZMP, from 24 Nov to 4 Dec, 2017.

Family	English	Latin	Number observed in transect	Total number observed
Procellariidae	Northern Fulmar	*Fulmarus glacialis*	204	215
	Great Shearwater	*Ardenna gravis*	0	1
Phalacrocoracidae	Unidentified Cormorant	*Phalacrocorax*	16	16
Sulidae	Northern Gannet	*Morus bassanus*	1	2
Anatidae	White-winged Scoter	*Melanitta fusca*	0	2
	Black Scoter	*Melanitta nigra*	1	1
	Unidentified Duck	All duck genera	0	7
Laridae	Great Skua	*Stercorarius skua*	0	1
	Unidentified Skua	*Stercorarius*	3	3
	Black-legged Kittiwake	*Rissa tridactyla*	197	228
	Herring Gull	*Larus argentatus*	83	102
	Great Black-backed Gull	*Larus marinus*	31	36
	Glaucous Gull	*Larus hyperboreus*	2	3
	Unidentified Gull	*Larus*	25	26
Alcidae	Dovekie	*Alle alle*	278	552
	Atlantic Puffin	*Fratercula arctica*	12	13
	Thick-billed Murre	*Uria lomvia*	10	10
	Unidentified Murre	*Uria*	0	10
	Unidentified Alcid	Alcidae	15	30
Emberizidae	Dark-eyed Junco	*Junco hyemalis*	0	1
Total			**878**	**1259**

Table 12. List of marine mammals observed during surveys on the Scotian Shelf AZMP, from 24 Nov to 4 Dec, 2017.

English	Latin	Total number observed
Long-finned Pilot Whale	*Globicephala melas*	31
Unidentified Cetaceans	Cetacea	1
Gray Seal	*Halichoerus grypus*	1
Unidentified Seals	Phocidae	3
Total		**36**

Table 13. List of species observed in the Gully Marine Protected Area during surveys on the Scotian Shelf AZMP, from 24 Nov to 4 Dec, 2017.

Species	Latin	Number observed in transect
Dovekie	*Alle alle*	14
Herring Gull	*Larus argentatus*	13
Black-legged Kittiwake	*Rissa tridactyla*	6
Northern Fulmar	*Fulmarus glacialis*	6
Great Black-backed Gull	*Larus marinus*	5
Unidentified Skua	*Stercorarius*	2
Long-finned Pilot Whale	*Globicephala melas*	15
Unidentified Cetaceans	Cetacea	1
Total sightings		**62**

Table 14. List of species observed in the St. Anns Bank Marine Protected Area during surveys on the Scotian Shelf AZMP, from 24 Nov to 4 Dec, 2017.

Species	Latin	Number observed in transect
Northern Fulmar	*Fulmarus glacialis*	24
Dovekie	*Alle alle*	23
Thick-billed Murre	*Uria lomvia*	10
Black-legged Kittiwake	*Rissa tridactyla*	9
Herring Gull	*Larus argentatus*	3
Great Black-backed Gull	*Larus marinus*	3
Glaucous Gull	*Larus hyperboreus*	2
Long-finned Pilot Whale	*Globicephala melas*	11
Total sightings		**85**

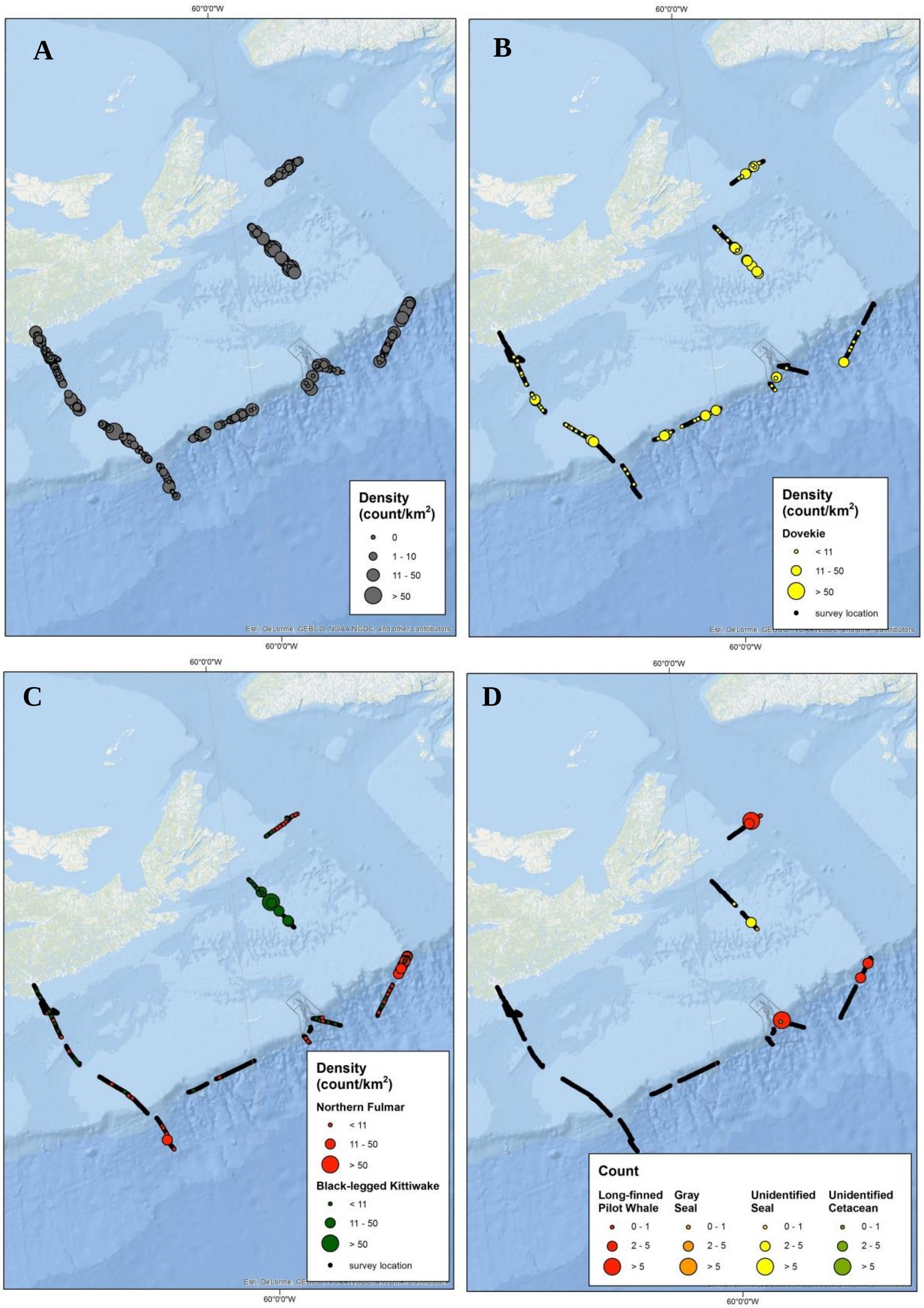


Figure 17. Density of A) all bird species combined, B) Dovekie, C) Northern Fulmar and Black-legged Kittiwake, and D) marine mammals observed during the seabird survey on the Scotian Shelf AZMP, from 24 Nov to 4 Dec, 2017.

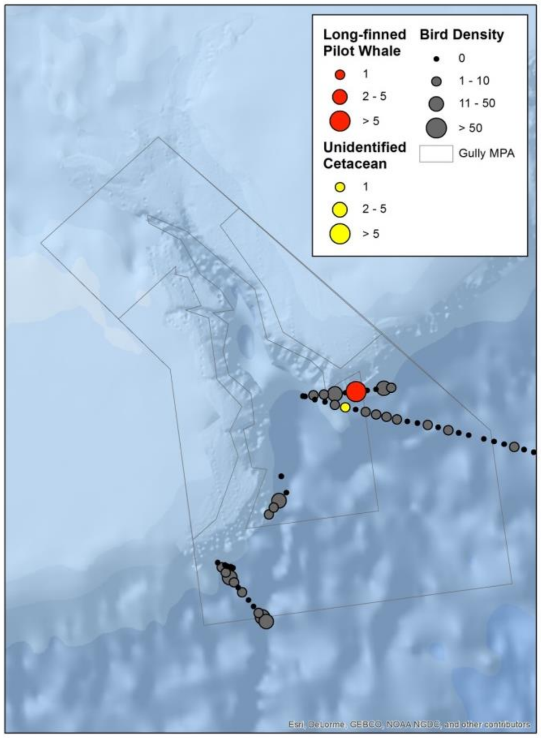


Figure 18. Density of birds and counts of marine mammals observed in the Gully Marine Protected Area on 30 Nov and 1 Dec, 2017.

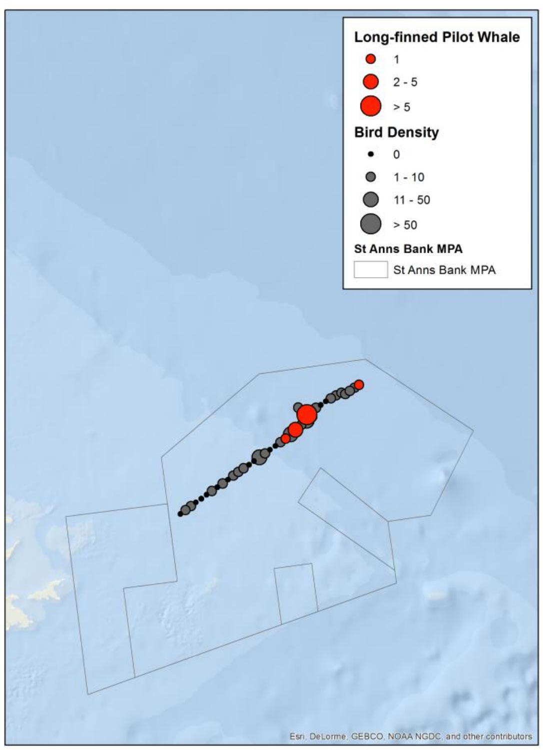


Figure 19. Density of birds and counts of marine mammals observed in the St. Anns Bank Marine Protected Area on 4 Dec, 2017.

ARGO Float Deployments

Contributions by: Ingrid Peterson

Narrative

There were a total of 6 APEX ARGO floats deployed during the mission (Figure 20 and Table 15). These floats continue to acquire data and their latest temperature profiles can be accessed on the following site by searching for their WMO numbers, 3901637-3901642 (Table 15). As of January 29th, 2018 the float profiles are not on the website but should be soon.

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

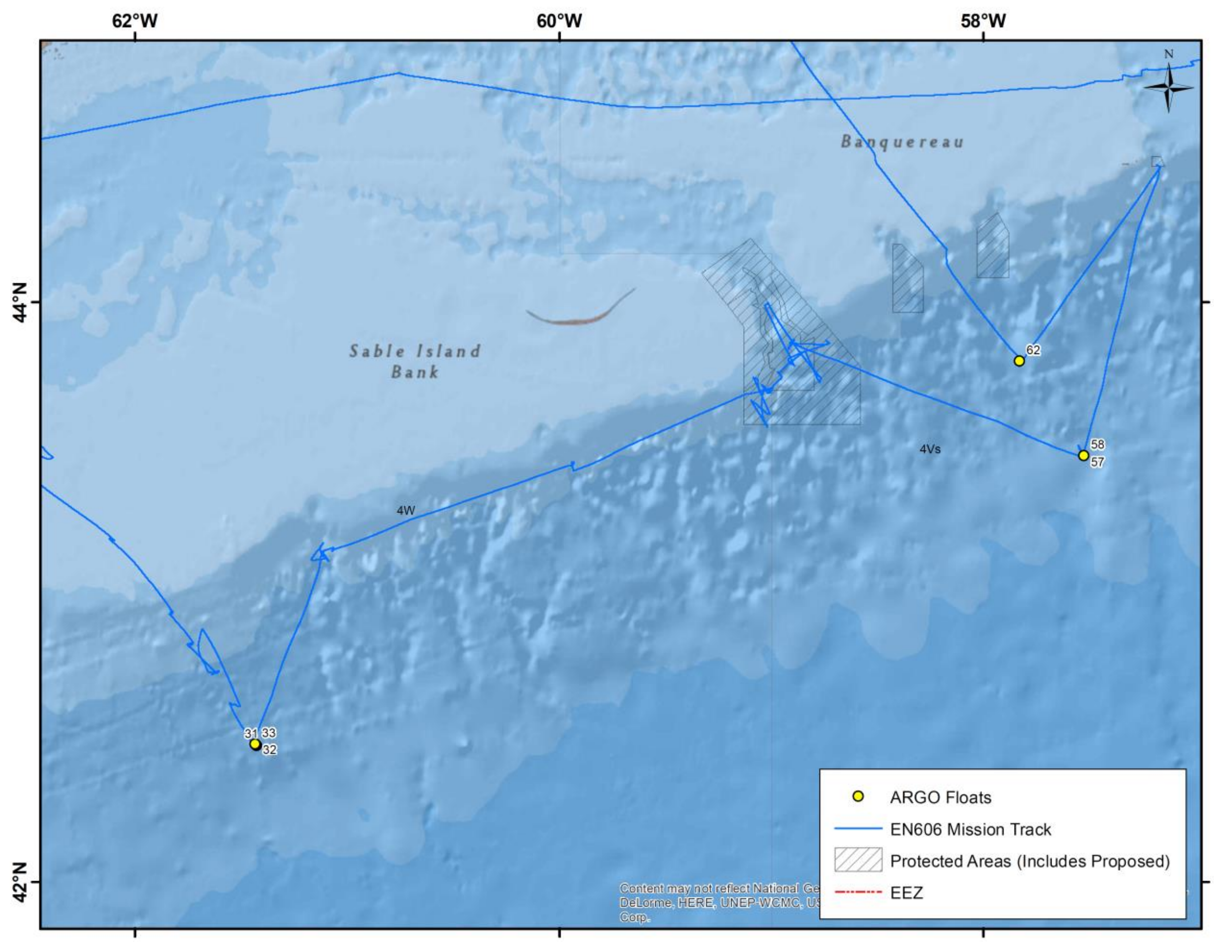


Figure 20. The locations for each Argo float deployment during EN2017606. Refer to Table 15 for more details.

Table 15. Details for Argo float deployments during EN2017606. 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)	WMO #	S/N	Lat (DD)	Long (DD)
28/11/2017	31	HL_07	NOVA	23:00:23	3901641	8235	42.4764	-61.4296
28/11/2017	32	HL_07	NOVA	23:05:20	3901640	8237	42.4790	-61.4321
28/11/2017	33	HL_07	NOVA	23:09:29	3901637	8245	42.4813	-61.4339
02/12/2017	57	LL_09	NOVA	06:14:37	3901642	8234	43.4757	-57.5274
02/12/2017	58	LL_09	NOVA	06:19:06	3901639	8238	43.4754	-57.5280
02/12/2017	62	LL_08	NOVA	22:24:55	3901638	8239	43.7976	-57.8297

Mooring Operations

Contributions by: Jay Barthelotte

Narrative

Over the duration of the mission there were 5 moorings recovered and 6 deployed (Figure 21; Table 16). Please refer to Appendix 5 for the mooring diagrams. The Nova Scotia Current Mooring (M1996) was recovered on November 24th, and M2024 was deployed in its place on the same date and with the same sensor configuration. The first acoustic mooring (M1949) was recovered on November 25th from Emerald Basin and was not replaced.

After completing the occupation of HL_07 late on November 28th, we began the steam towards Dawson Canyon to deploy acoustic mooring (M2027). We arrived on site just after midnight on the 29th and spent the next ~ 7 hrs doing 5 CTD casts (DC_01 – DC_04) in close proximity to the planned mooring deployment location. At day break, M2027 was deployed and we began the steam towards Logan Canyon to deploy M2028 later in the afternoon of the 29th. This was followed by a CTD in close proximity (LC_01) before proceeding to the Gully MPA. After station SG_28 was occupied early in the morning of the 30th, acoustic release tests were conducted until early evening when M2026 was deployed in the Gully MPA. For the remainder of the 30th and overnight on December 1st, the remaining stations in the Gully were occupied before M1948 was recovered in the morning and then later replaced by M2025 at ~ the same location.

After completing Gully operations, the ship sailed towards the deep end of the Lousibourg Line (LL_09). After occupying LL_09 in the early morning of the 2nd, the ship began the steam towards the Lophelia Conservation Area to recover M1950 by mid-morning of the 2nd. After this recovery, the rest of the Louisbourg Line and all of the St. Anns Bank Line was occupied before deploying the final acoustic mooring (M2029) on the morning of December 4th. Later on the same day, the final acoustic mooring (M1947) was recovered.

It should be noted that the ADCP mooring (M1999) planned for recovery via dragging could not be contacted on the afternoon of December 4th and plans for dragging for the mooring were cancelled. After the mission we received information that parts of the mooring were discovered in Newfoundland on January 2nd, 2018.

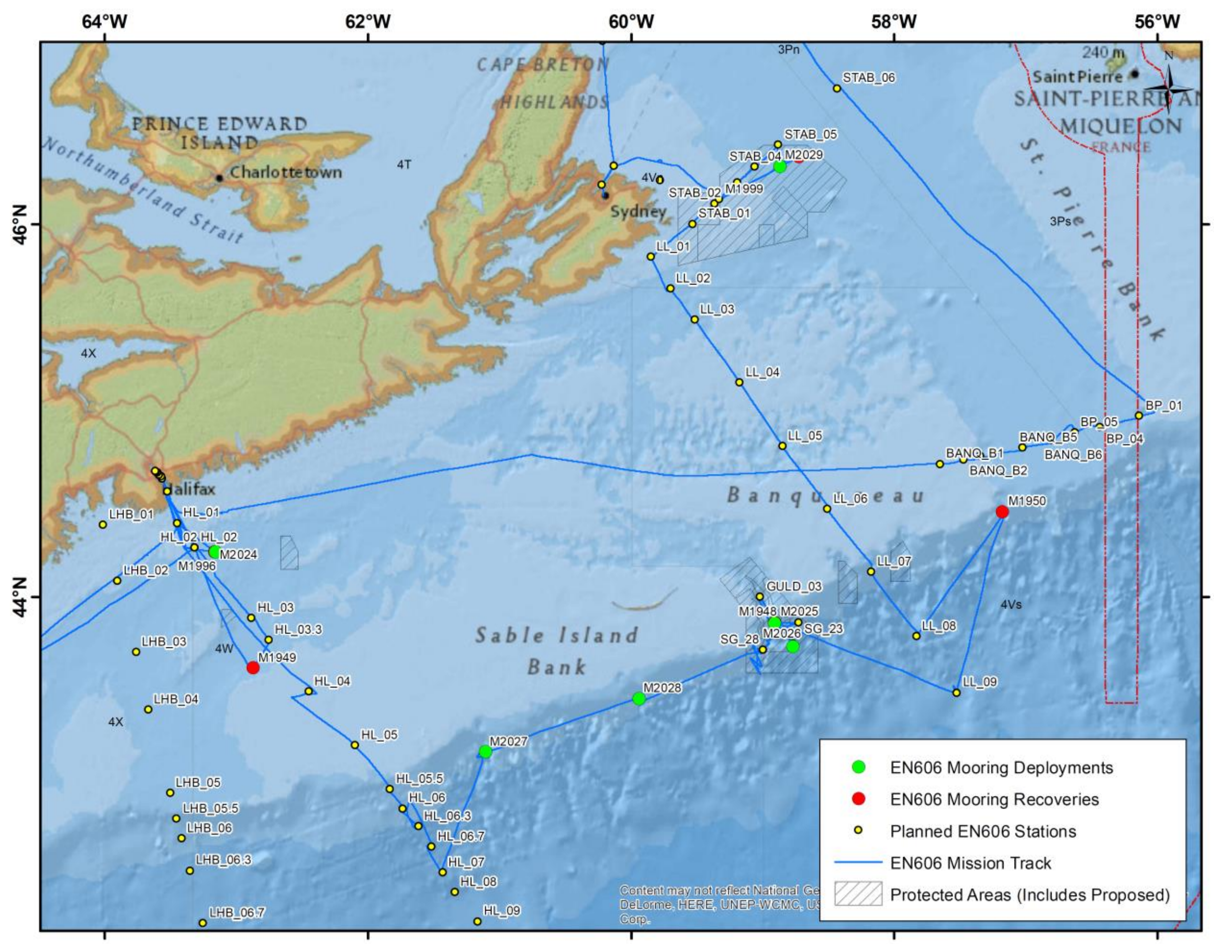


Figure 21. Mooring recovery and deployment locations during EN2017606.

Table 16. List of mooring operations during EN2017606. 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	Comments
24/11/2017	1	Recovery	M1996	44.2482	-63.1647	NSCM	Hebert
24/11/2017	2	Deployment	M2024	44.2455	-63.1631	NSCM	Hebert
25/11/2017	13	Recovery	M1949	43.6112	-62.8752	Acoustic	Moors-Murphy
27/11/2017	21	Release Test	HL_06	42.8302	-61.7287		
29/11/2017	39	Deployment	M2027	43.1500	-61.1104	Acoustic	Moors-Murphy
29/11/2017	40	Deployment	M2028	43.4424	-59.9428	Acoustic	Moors-Murphy
30/11/2017	44	Release Test	SG_28	43.7492	-58.9579		
30/11/2017	45	Release Test	SG_28	43.7567	-58.9669		
30/11/2017	46	Deployment	M2026	43.7306	-58.7739	Acoustic	Moors-Murphy
01/12/2017	53	Recovery	M1948	43.8620	-58.9135	Acoustic	Moors-Murphy

01/12/2017	54	Deployment	M2025	43.8583	-58.9107	Acoustic	Moors-Murphy
02/12/2017	59	Recovery	M1950	44.4647	-57.1838	Acoustic	Moors-Murphy
04/12/2017	89	Deployment	M2029	46.3044	-58.8742	Acoustic	Moors-Murphy
04/12/2017	90	Recovery	M1947	46.3562	-58.7306	Acoustic	Moors-Murphy

Underway Sampling

Contributions by: Robert Benjamin[1], Bill Fanning[2]
[1] Program Coordination and Support Division, DFO
[2] Marine Technician V, Endeavor, University of Rhode Island

Navigation

Positional data and Date/time ($GPGGA and $GPZDA) from the ship's GPS was logged throughout the mission along with sounding data from the ships EK60 scientific echo sounder ($SDDBT). Heading data ($HEHDT) was also logged. These data were logged at 1 Hz throughout the mission using NavNet, a data logging and distribution system designed by NRCAN. Prior to the ship's return to BIO, navigation data was converted into daily coordinate logs at 1 second intervals in both .csv and .shp formats.

The Endeavor's data logging systems where employed by the ships technician during the mission. This allowed logging of their TSG and ADCP systems internally and display of all systems where available during the mission including: ADCP, TSG, Wind direction and speed, Winch line-out and pressure, current position maps, and many on-board camera displays. A complete list of available sensors on the Endeavor can be found here:
R:\Science\BIODataSvc\SRC\2010s\2017\EN606\Ship Deliverables\EN606_Hebert\scs\docs\sensor.html

Underway Seawater System

The Endeavor's underway seawater system was used throughout the mission. The configuration file for the Thermosalinograph (TSG) on EN2017606 can be found in Appendix 6.

Twenty-five gallons per minute is available from an intake located in the starboard sea chest, 48 feet from the bow. Seawater passes through a steel shut-off valve to a non-metallic pump. 1" PVC pipe to 1" PVC valves located in the Wet lab, 01 lab and on the 01 deck supply a constant flow for devices such as incubators. The water in the Wet lab flows through a debubbler to a low-pressure manifold suitable for supplying flow through instruments. The flow through instrumentation included a SBE 21 SEACAT Thermosaliograph (TSG), and SBE3S remote thermistor located near the water intake, a WetLabs WetStart Fluorometer and WetLabs Eco-AFL/FL.

Prior to sailing the underway system was also plummed to include a water bath housing a ProOceanus CO_2-Pro Atmosphere system to measure the partial pressure of CO_2.

Every day, a single PCO2 and TIC sample, along with 2 ChlA samples were acquired and provided with a unique sample ID. The scanned paper log for these samples will eventually be located here: R:\Science\BIODataSvc\SRC\2010s\2017\EN2017606\SCANNED_LOGS and the digital e-logs can be found here: R:\Science\BIODataSvc\SRC\2010s\2017\EN2017606\ELOG\Flow-Through_Log. In total there were 21 PCO_2, 21 TIC and 42 Chla samples taken over this period.

All underway sea-water system data was submitted to ODIS upon conclusion of the mission. Dr. Dave Hebert Dave.Hebert@dfo-mpo.gc.ca) is the point of contact for these data.

Other Underway Data

The vessel also acquired a suite of underway measurements that are detailed on the Endeavor website. These data include vessel mounted ADCP, air temperature, humidity, wind speed and direction, barometric pressure, precipitation, short and long wave solar radiation and dual frequency (3.5 and 12 KHz) bathymetry. These data, as with all other data collected by ship provided equipment, were distributed to the DFO Data Manager and Chief Scientist upon the conclusion of the mission. They have been submitted to ODIS and can be found in the mission folder as specified in Appendix 7.

Data Management

Prepared by: Robert Benjamin
Division: Program Coordination and Support Division, DFO

Please refer to Appendix 7 for a table detailing the data collected during EN2017606.

Data Collection

In addition to standard AZMP manual data collection methods (i.e. various equipment specific deck sheets) ELOG, an electronic logbook system for collecting event metadata including position and sounding was used during EN2017606. This electronic logbook was accessible via computers connected to the RV Endeavor's network, including ship's data displays. Two locations in the main lab were used for data entry and one location in the Upper Lab for data Management. Metadata related to each piece of equipment was collected in the electronic log including position/time deployed, on bottom and recovered. Additional logbooks were employed to act as an itinerary, a daily operational log and a logbook to monitor the flow through. All digital logbooks were backed up daily and at the end of the mission were sent to ODIS for storage. After each event, the logbooks were entered into the Mission database.

CTD data was collected using the Endeavor’s CTD system, setup and managed by the Endeavor data technician and backed up on the science server**.** After each CTD cast, the data was processed using CTDDAP and entered into the Mission database.

Nav-Net, an on board ship’s data collection system was used to send data to Elog. In addition, Regulus was also used to record ship’s data sent to the science team during the entire mission. These data will be located in the archive here:

R:\Science\BIODataSvc\SRC\2010s\2017\EN606\Nav

At the end of the mission, the Endeavors’ data technician supplied a drive which contained all data collected by the vessel during the mission including TSG data. These data can be found here: R:\Science\BIODataSvc\SRC\2010s\2017\EN606\Ship Deliverables

NOTE: pC02 data was collected from the TSG system during the mission but NOT stored in SCS. These data will be stored here:

R:\Science\BIODataSvc\SRC\2010s\2017\EN606\pCo2

Salinity, Winkler Oxygen and Chlorophyll was analyzed while at sea. Data from the Analysis was routinely backed up and entered into the mission database.

<u>Data Input Template</u>

Reports were generated from shipboard input data in the AZMP Template Database to compare with corresponding CTD sensor data and conduct preliminary analyses included in this report.

<u>GIS</u>

Daily navigation and operations were maintained in a graphical information system (QGIS). Final line and point shapefile were generated from these data for the cruise report.

<u>Hardware</u>

One laptop was used to run the NavNet software. GPS data and Sounding data was sent to this computer via serial RS232 and logged. Data was transferred to our other computers via the ships network. The Endeavor’s TSG system was used during the mission and data was saved in the ships SCS repository. pCo2 was collected in the Wet Lab along with the TSG.

APPENDICES

Appendix 1. Gully and St. Anns Bank MPA Activity Approvals

Gully Approval
Signed Letter from R

StAnnsMPA_EN2017
606_approval.pdf

Appendix 2. Crew List for the R/V Endeavor 606.

CREW LIST
AMERICAN OCEANOGRAPHIC RESEARCH MOTOR VESSEL

R/V ENDEAVOR

IMO Number: 7604300
Registration: RI-59A

HOME PORT: NARRAGANSETT, RI, USA

No	Family Name	Fore Name(s)	Position	Seaman's Passport & Expire Date	Date of Birth/Gender	Citizen
1	CARTY	Paul F.	Master			USA
2	ARMANETTI	Christopher P.	Mate			USA
3	THORNTON	Brendan E.	Mate			USA
4	SISSON	Steven A.	Boatswain			USA
5	MAYNE	John P.	Able Seaman			USA
6	BUELL	Patrick J.	Able Seaman			USA
7	WALSH	Kevin D.	Able Seaman			USA
9	WADDELL	Jerome G.	Chief Engineer			USA
9	QUEISSER	Robert D.	Asst. Engineer			USA
10	DAVIS	Ryan E.	Asst. Engineer			USA
11	DUFFY	Michael J.	Steward			USA
12	GRUEBEL	Erich M.	Marine Tech			USA

Total Number of Crew: 12 including Master on Arrival
Dartmouth, Canada

Date: 16 December 2017

Cruise No. EN-606

16 DE 2017

Paul F. Carty
Master **R/V ENDEAVOR**

R/V ENDEAVOR
URI Graduate School Of Oceanography
PO Box 145
Saunderstown, RI 02874

Appendix 3. CTD Configuration File – EN606.xmlcon

Date: 01/17/2018

Instrument configuration file:
R:\Science\BIODataSvc\SRC\2010s\2017\EN606\CTD\CTD_PROCESSING\EN606\EN606.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 : Yes
Scan time added : No

1) Frequency 0, Temperature

Serial number : 2902
Calibrated on : 15-Dec-16
G : 4.34451712e-003
H : 6.44730310e-004
I : 2.28889365e-005
J : 2.12526223e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

2) Frequency 1, Conductivity

Serial number : 3220
Calibrated on : 16-Dec-16
G : -9.77555876e+000
H : 1.34416455e+000
I : -2.86467321e-005
J : 6.94809804e-005
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

Serial number : 0444
Calibrated on : 20-Dec-16
C1 : -5.378517e+004
C2 : -3.498580e-001
C3 : 1.648580e-002
D1 : 4.036100e-002
D2 : 0.000000e+000
T1 : 2.984744e+001
T2 : -3.538190e-004
T3 : 3.972770e-006
T4 : 2.922330e-009
T5 : 0.000000e+000
Slope : 0.99989692
Offset : -0.45761
AD590M : 1.125800e-002
AD590B : -8.763490e+000

4) Frequency 3, Temperature, 2

Serial number : 2034
Calibrated on : 13-Dec-16
G : 4.41249522e-003
H : 6.41293978e-004
I : 2.37750205e-005
J : 2.28693904e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

5) Frequency 4, Conductivity, 2

Serial number : 0864
Calibrated on : 15-Dec-16
G : -3.93005749e+000
H : 5.65787779e-001
I : -6.14331081e-004
J : 6.37838626e-005
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

6) A/D voltage 0, Transmissometer, WET Labs C-Star

Serial number : 969DR

Calibrated on : 06-Dec-16/15-Feb-17field
M : 19.5917
B : -1.1363
Path length : 0.250

7) A/D voltage 1, Fluorometer, WET Labs ECO-AFL/FL

Serial number : 492
Calibrated on : 15-Dec-16
Dark output : 0.0250
Scale factor : 2.40000000e+001

8) A/D voltage 2, Altimeter

Serial number : 49899
Calibrated on : 30-Mar-15
Scale factor : 15.000
Offset : 0.000

9) A/D voltage 3, PAR/Irradiance, Biospherical/Licor

Serial number : 70513
Calibrated on : 21-Nov-16
M : 1.00000000
B : 0.00000000
Calibration constant : 9900990099.00989910
Multiplier : 1.00000000
Offset : -0.10245222

10) A/D voltage 4, Oxygen, SBE 43

Serial number : 1230
Calibrated on : 02-Aug-17
Equation : Sea-Bird
Soc : 5.03470e-001
Offset : -5.15300e-001
A : -3.72370e-003
B : 2.04260e-004
C : -2.88240e-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

11) A/D voltage 5, Oxygen, SBE 43, 2

Serial number : 0345
Calibrated on : 02-Aug-17
Equation : Sea-Bird
Soc : 3.82810e-001
Offset : -7.22200e-001
A : -4.10370e-003
B : 1.65940e-004
C : -2.39230e-006
E : 3.60000e-002
Tau20 : 1.24000e+000
D1 : 1.92634e-004
D2 : -4.64803e-002
H1 : -3.30000e-002
H2 : 5.00000e+003
H3 : 1.45000e+003

12) A/D voltage 6, pH

Serial number : 1307
Calibrated on : 03-Feb-17
pH slope : 4.6258
pH offset : 2.5383

13) A/D voltage 7, Fluorometer, WET Labs ECO CDOM

Serial number : 3745
Calibrated on : 23-Nov-2017
Dark output : 0.000
Scale factor : 3.000

14) SPAR voltage, Unavailable

15) SPAR voltage, SPAR/Surface Irradiance

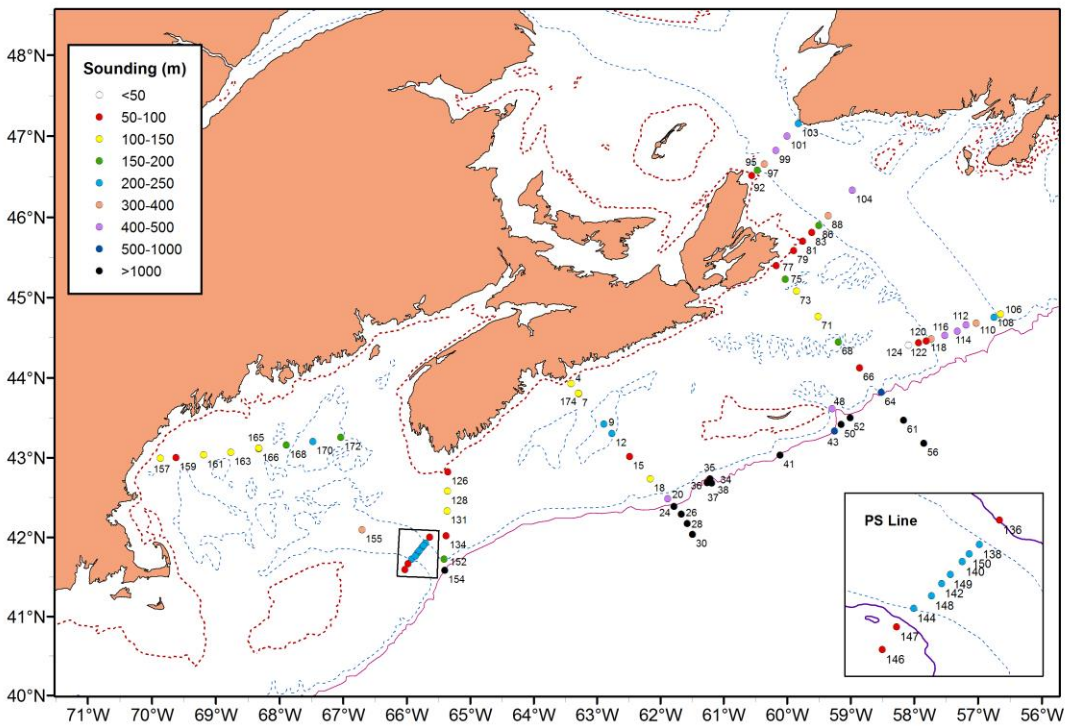
Serial number : 20190
Calibrated on : 21-Nov-16
Conversion factor : 1565.10000000
Ratio multiplier : 1.00000000

Scan length : 40

Appendix 4. Preliminary Section Plots and Anomalies (T/S/Sigma-T)

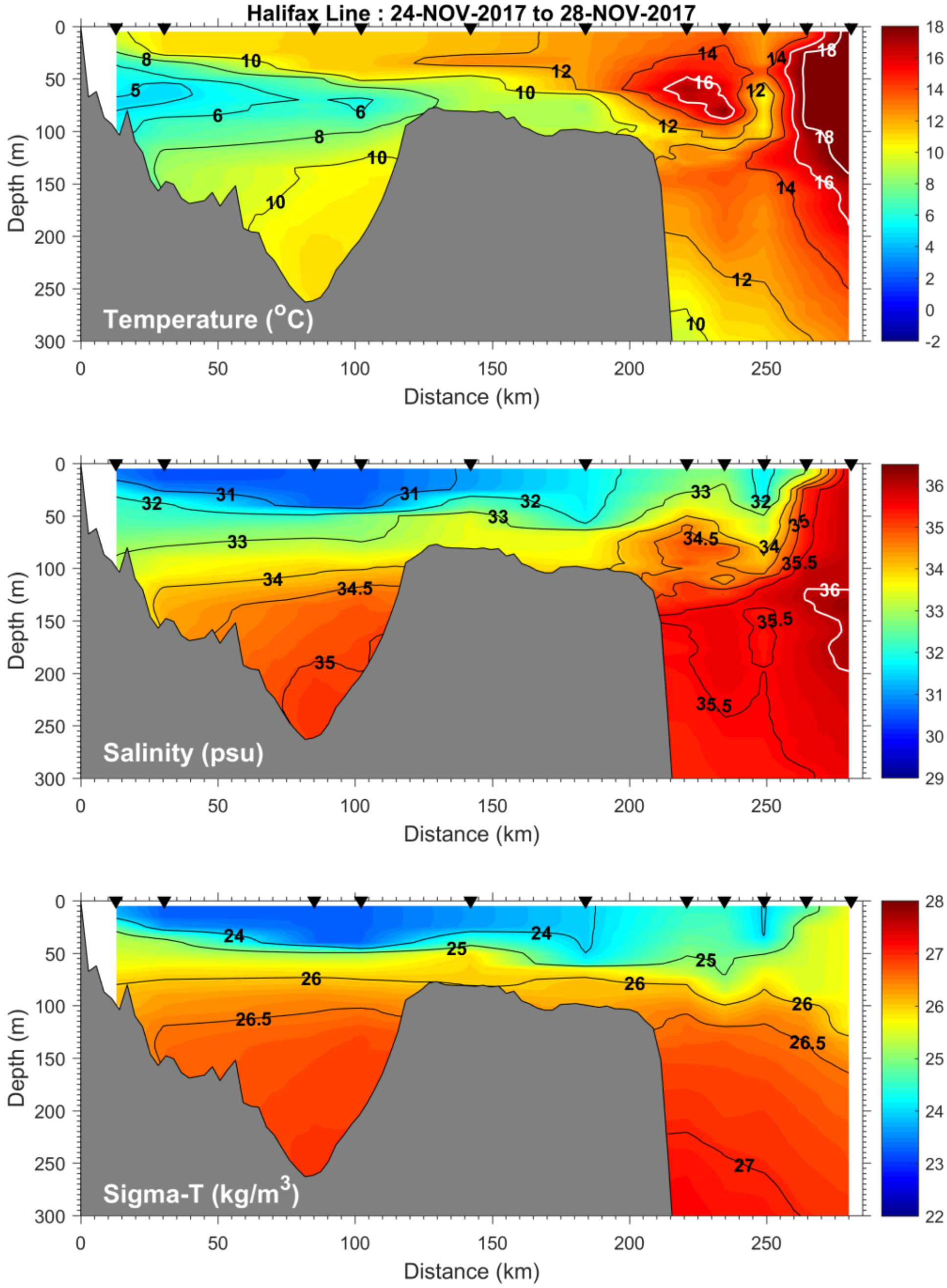
Section plots were produced for Temperature, Salinity and Sigma-T all sections from EN606 (See map below). It should be noted that no anomalies were produced because this mission was well outside of the typical sailing dates for most of the preceding fall AZMP missions. Finally, BBL_07 was not occupied during the mission as noted in the mission narrative.

Endeavor EN606, November 24 - December 16, 2017, 79 Stations



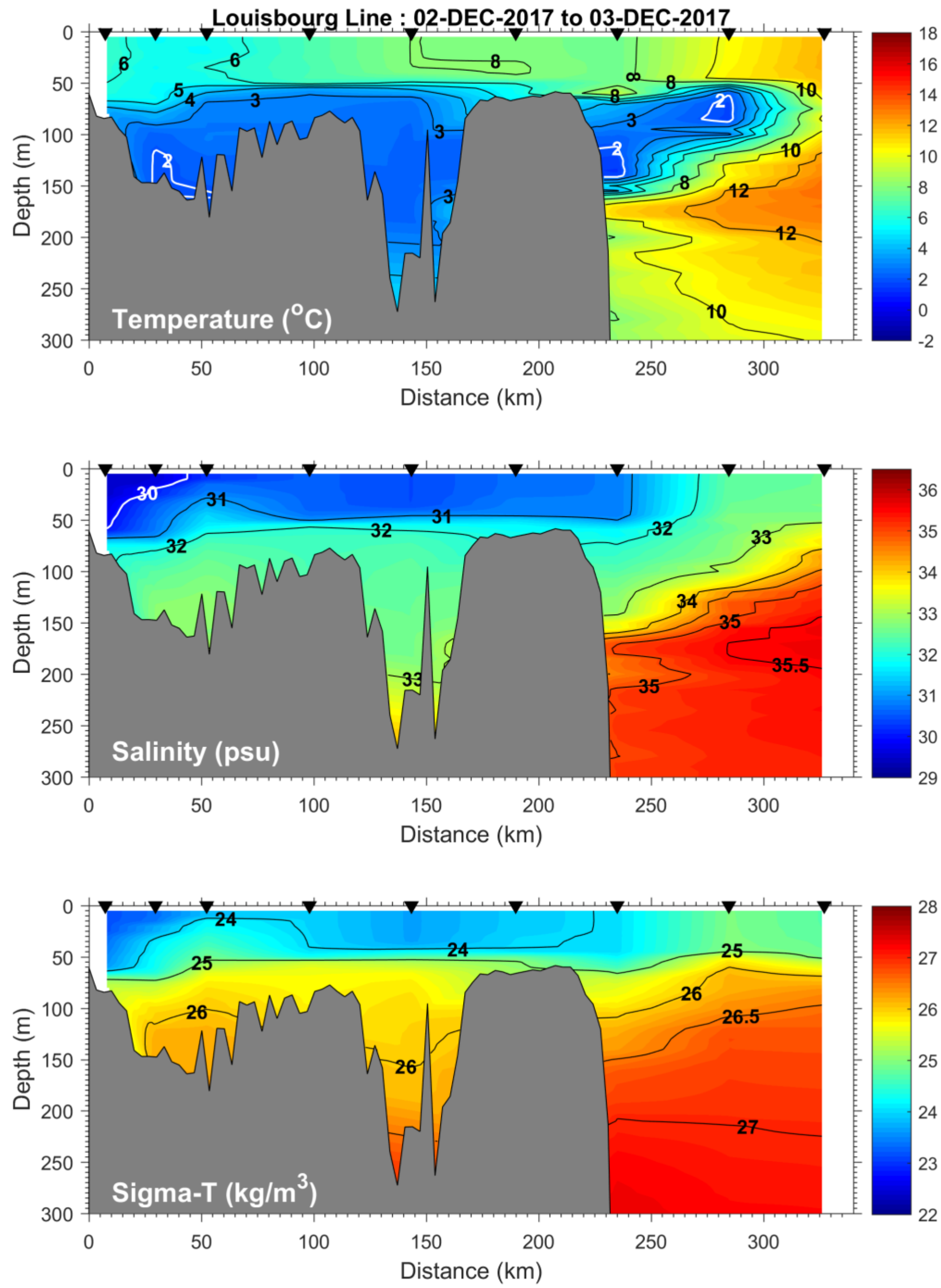
Halifax Line

Section



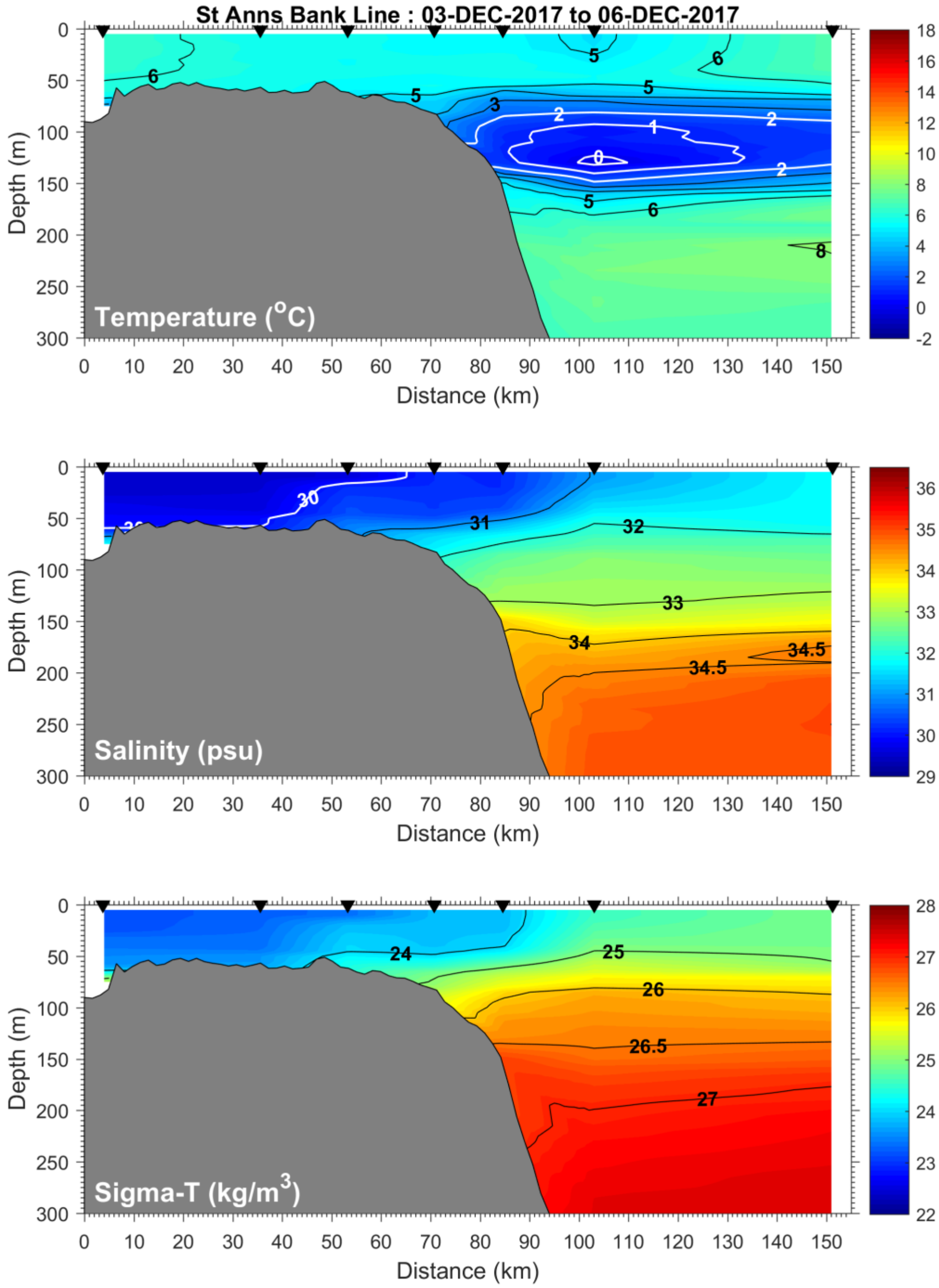
Louisbourg Line

Section



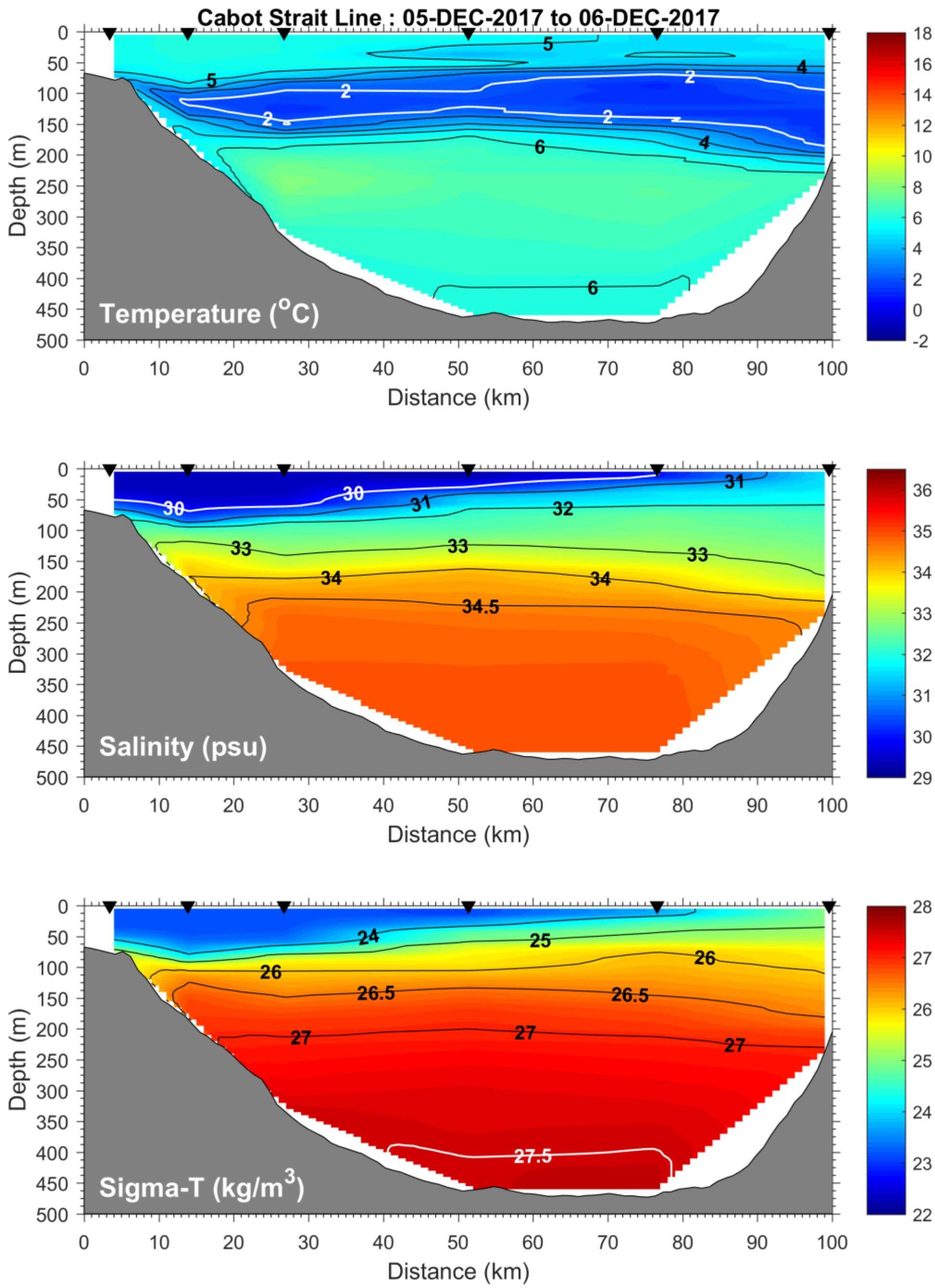
St. Anns Bank Line

Section



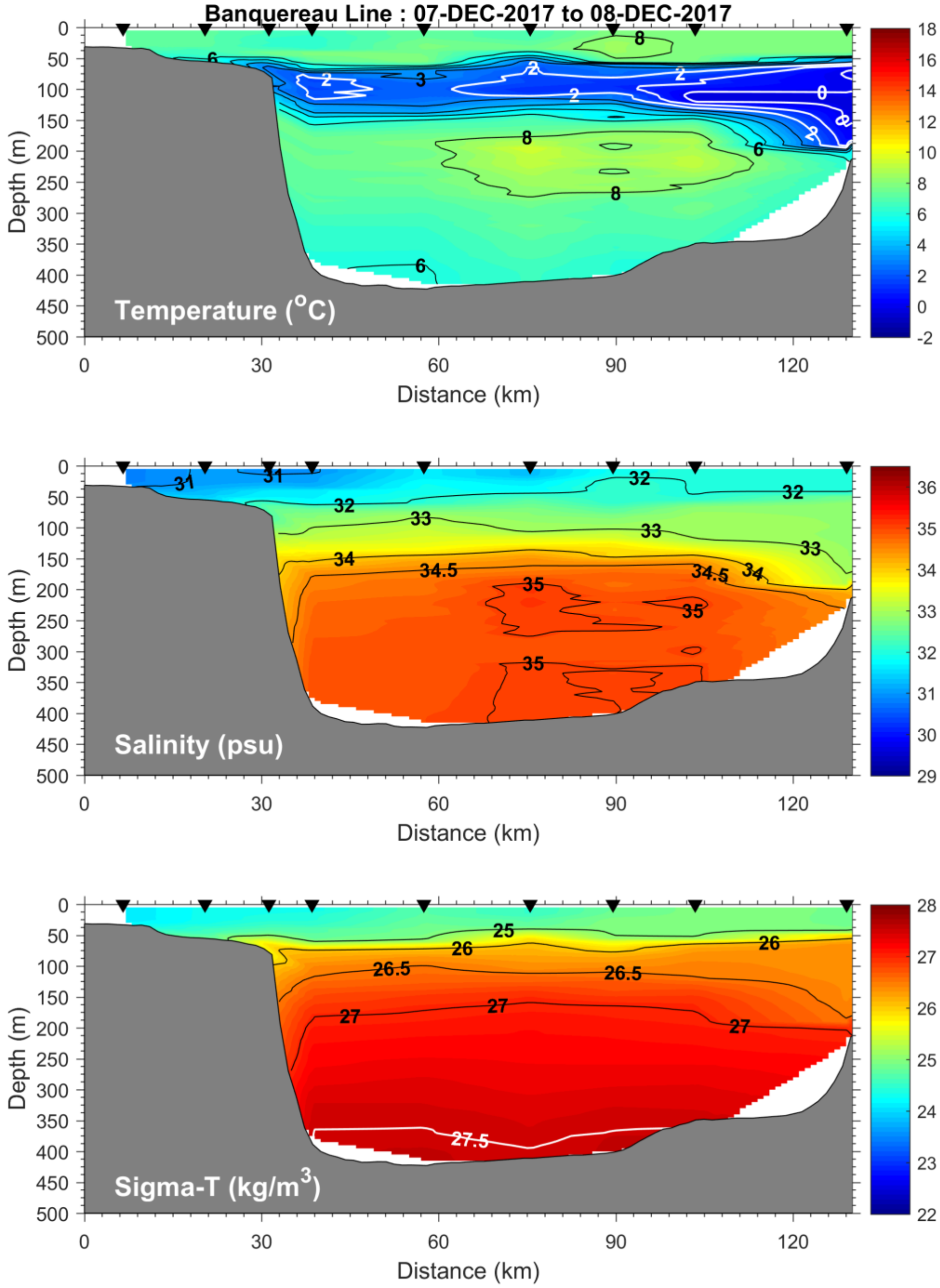
Cabot Strait Line

Section



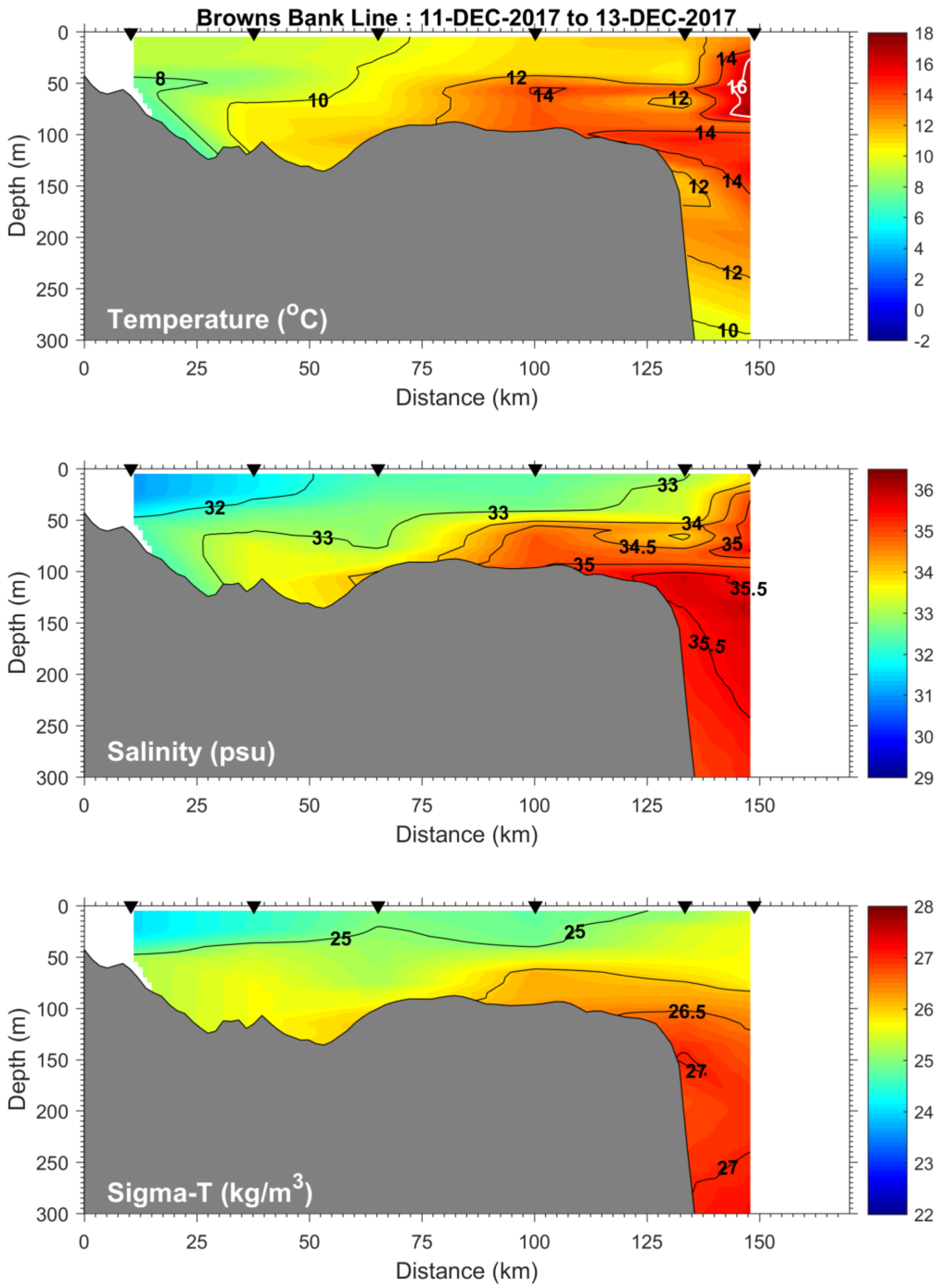
Brian Petrie/Banquereau Line

Section



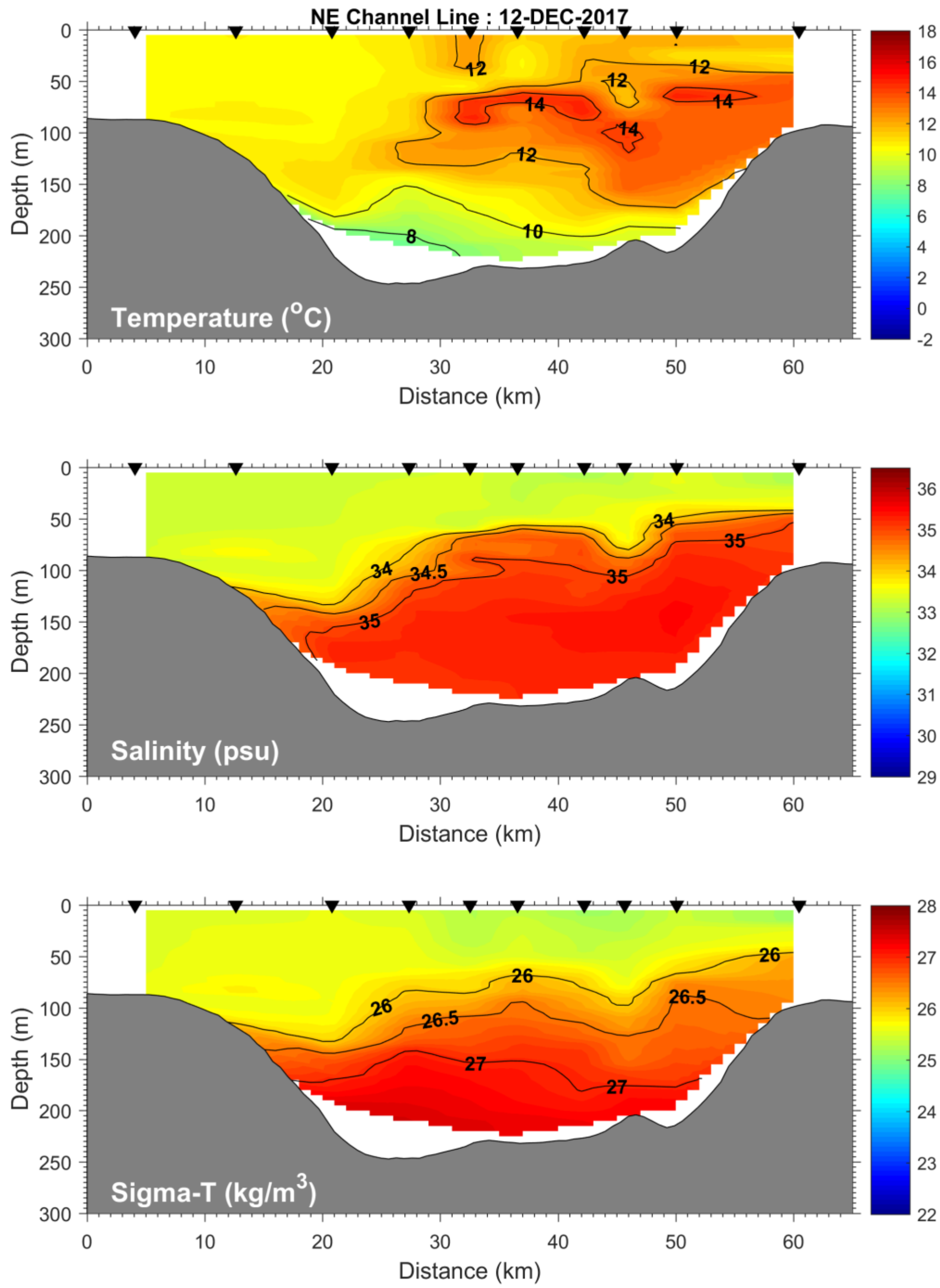
<u>Browns Bank Line</u>

Section



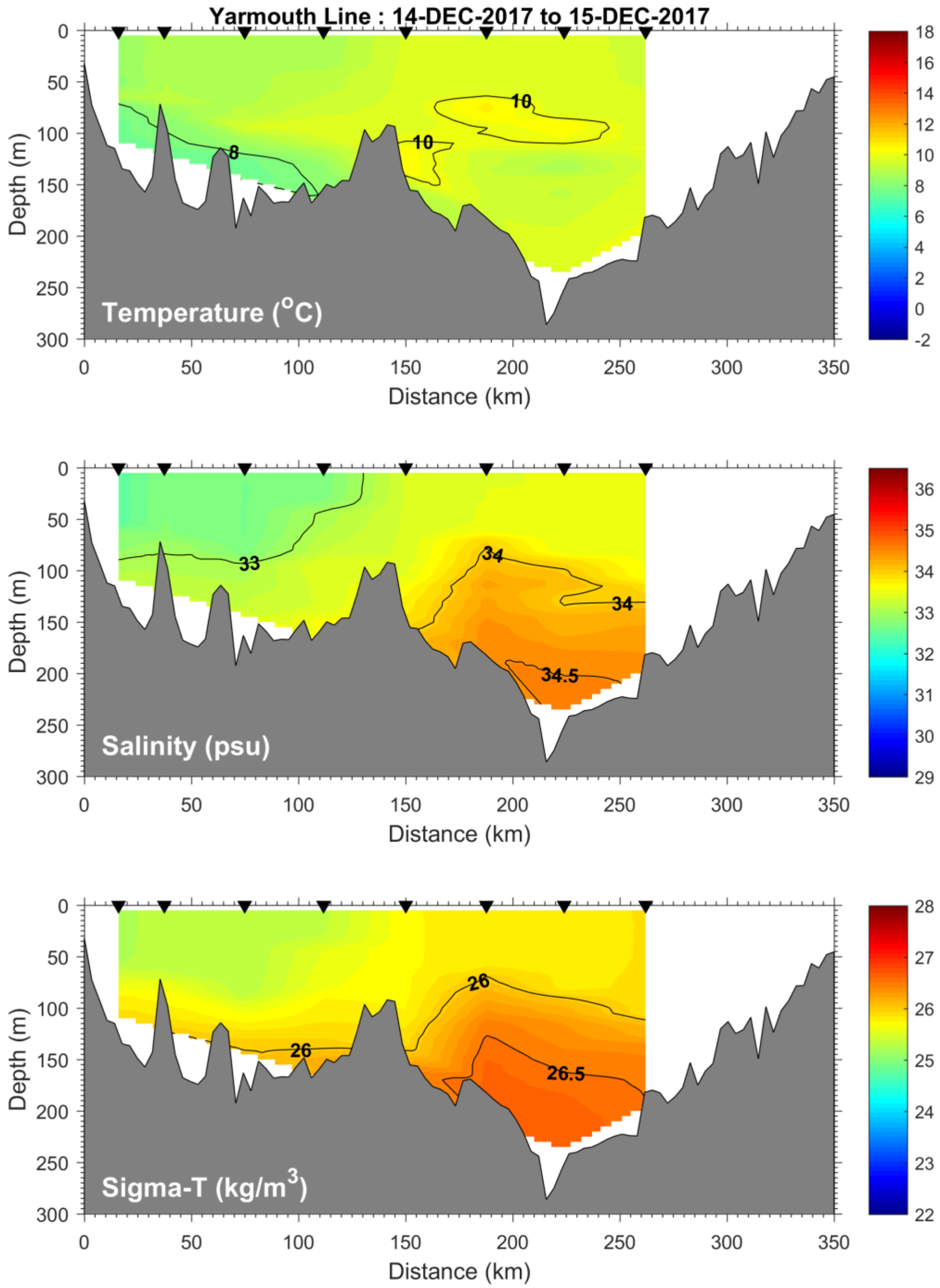
Peter Smith Line

Section



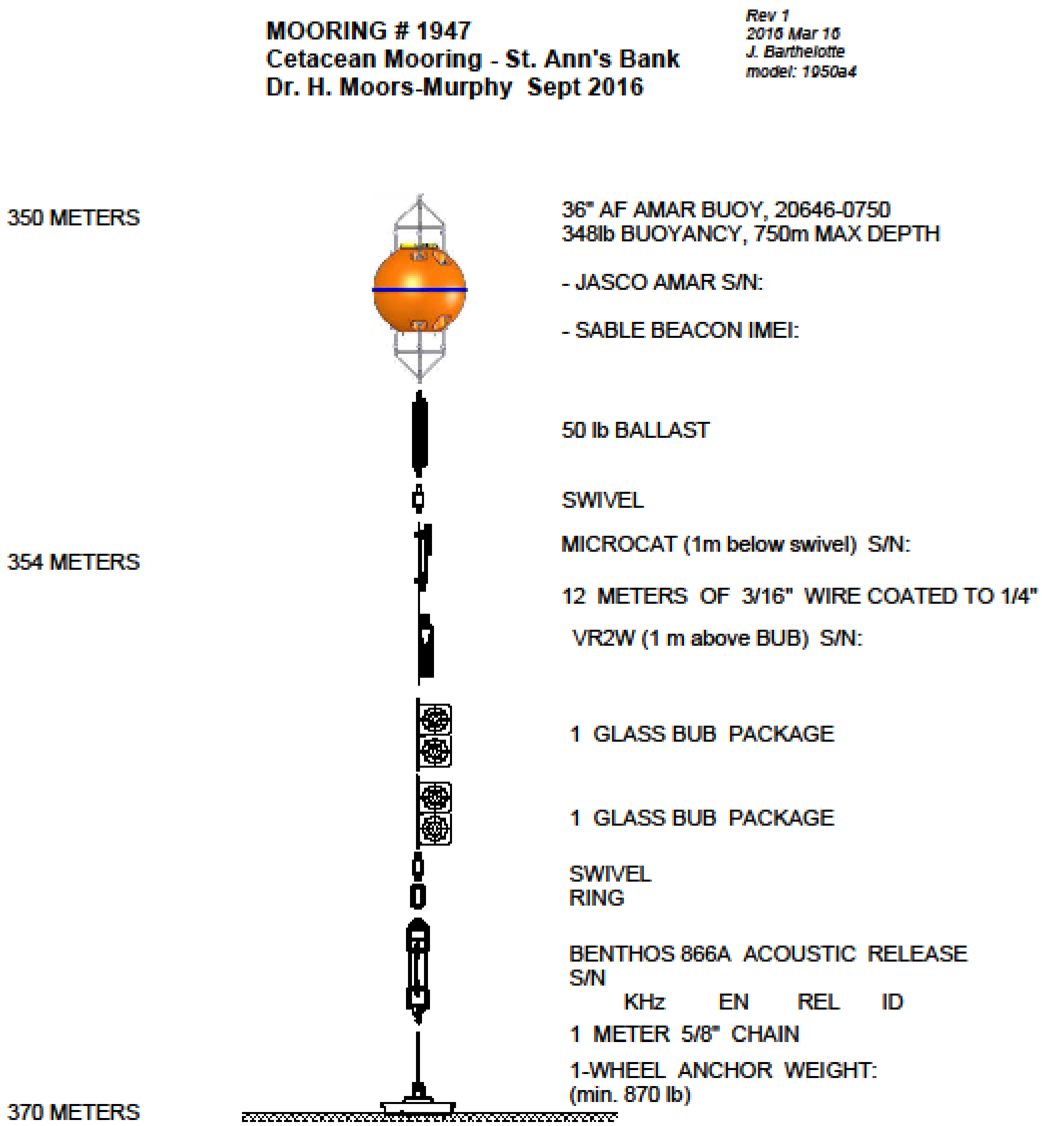
Yarmouth Line

Section



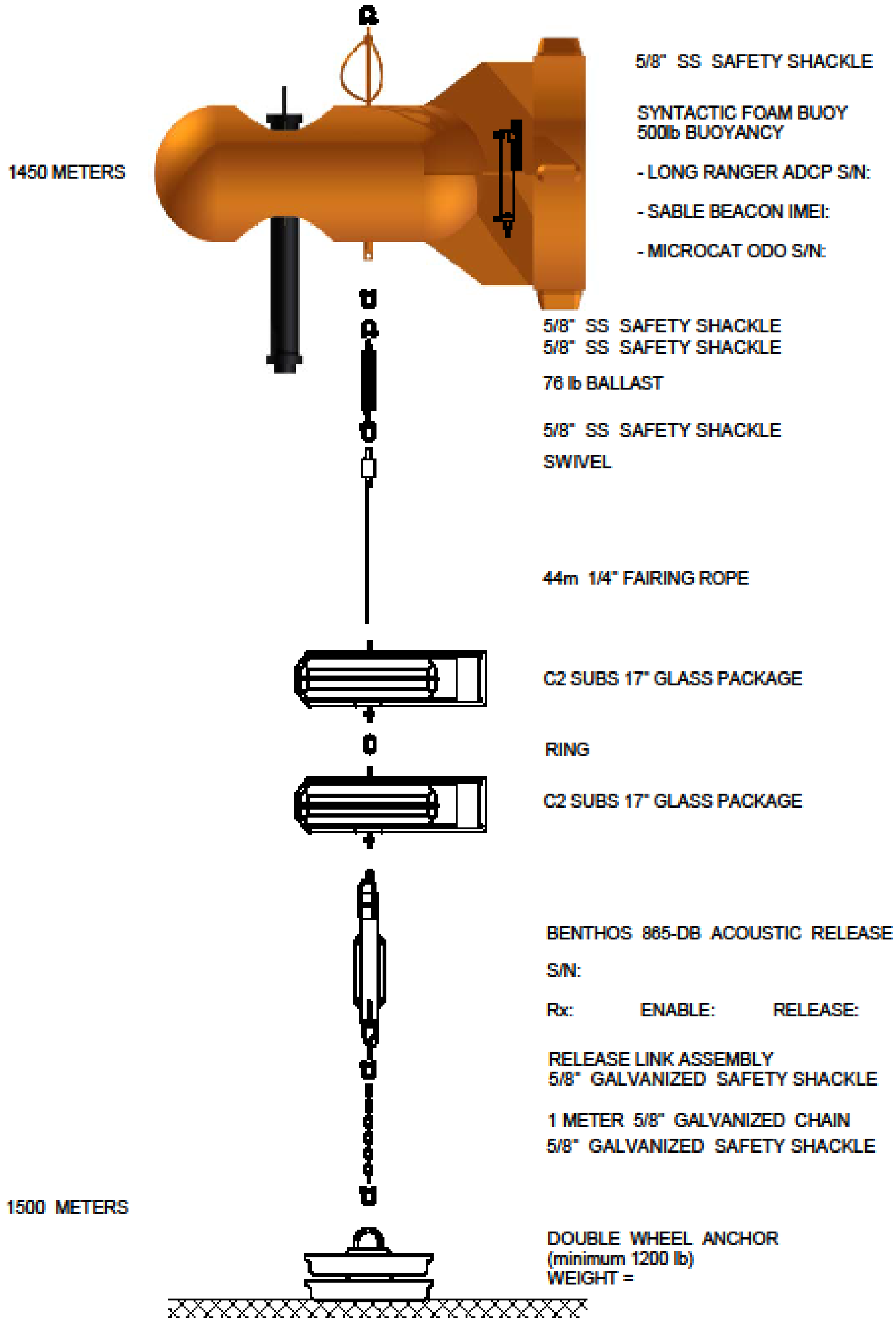
Appendix 5. Mooring Diagrams

Recoveries



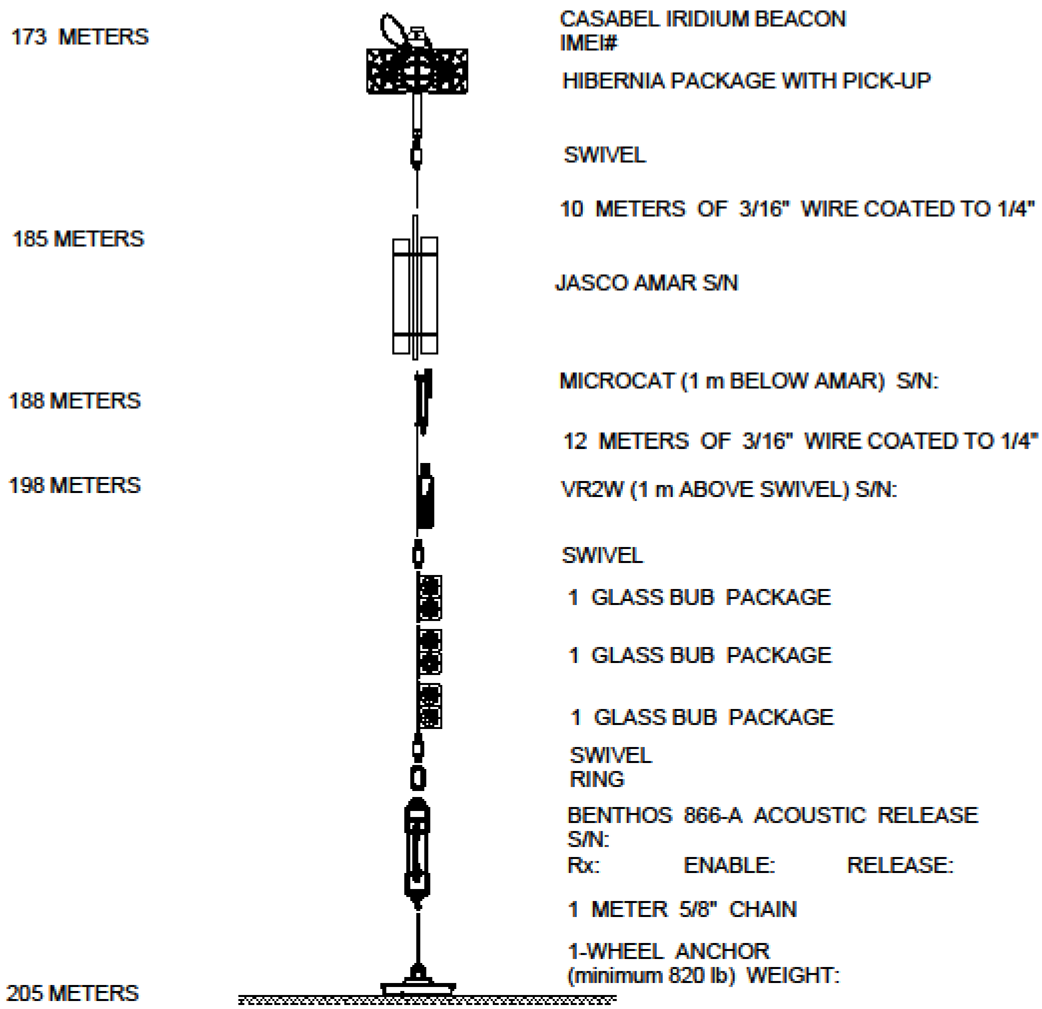
MOORING # 1948
Cetacean Mooring - The Gully
Dr. H. Moors-Murphy Sept 2016

Rev B:
Model 1948b1
2016 Mar 11
J. Barthelotte



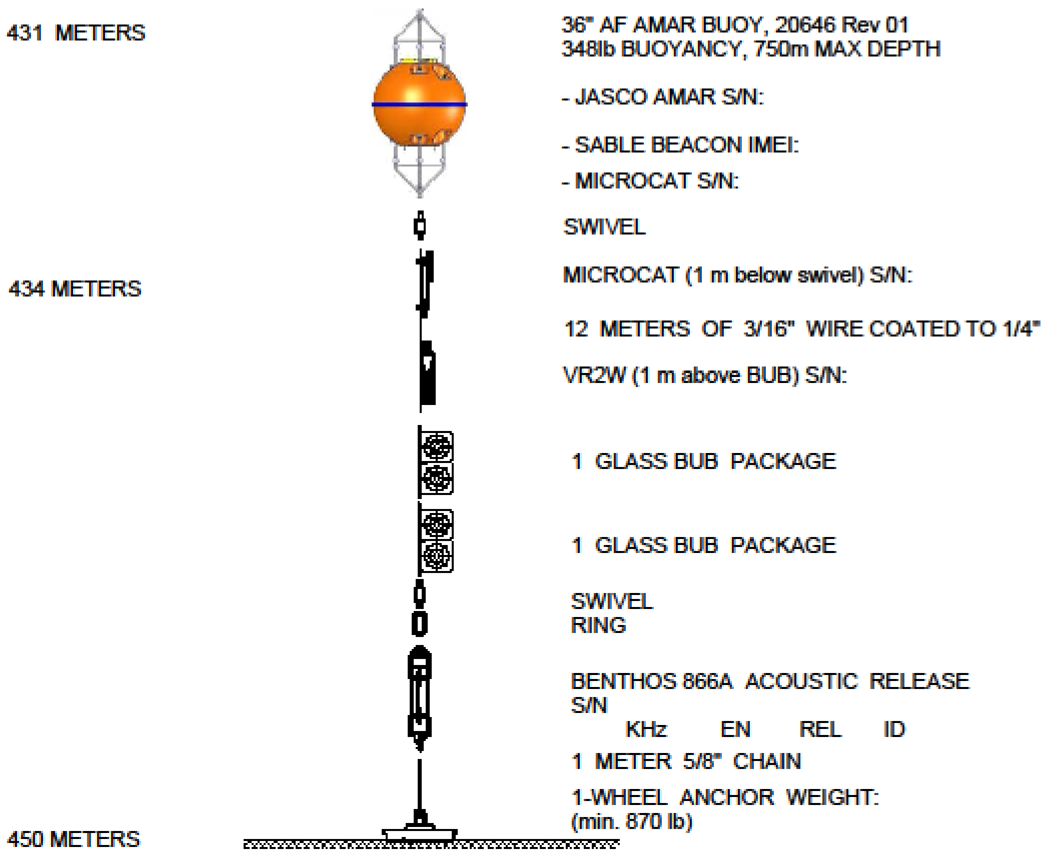
MOORING # 1949
Cetacean Mooring - Emerald Basin
Dr. H. Moors-Murphy Sept 2016

Rev 1
Model 1949a1
2016 Mar 16
J. Barthelotte



MOORING # 1950
Cetacean Mooring - Stone Fence
Dr. H. Moors-Murphy Nov 2016

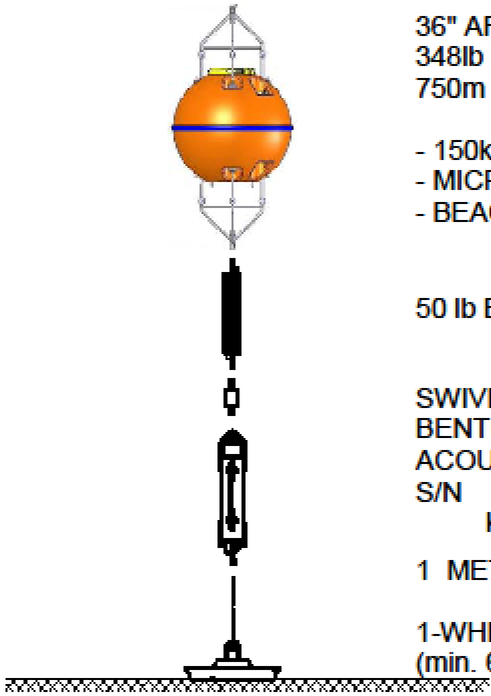
Rev 2
2016 Nov 2
J. Barthelotte
model: 1950a4



MOORING # 1996 NSCMP Sept 2016
Dr. Dave Hebert

Rev A1
2016 June 9
J. Barthelotte
model: 1950a4

165 METERS



36" AF BUOY
348lb BUOYANCY
750m MAX DEPTH

- 150kHz ADCP S/N:
- MICROCAT S/N:
- BEACON IMEI:

50 lb BALLAST

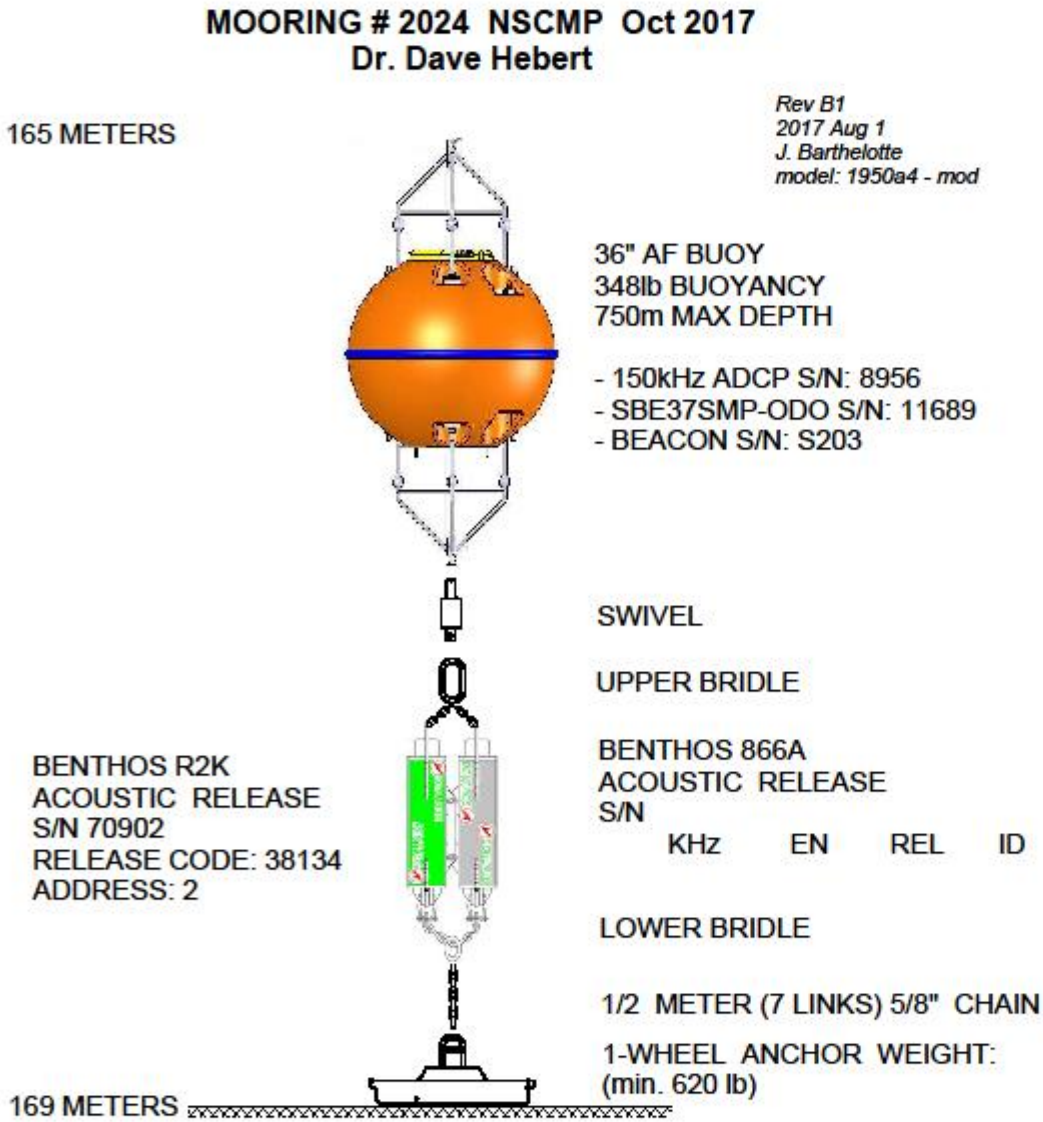
SWIVEL
BENTHOS 866A
ACOUSTIC RELEASE
S/N
KHz EN REL ID

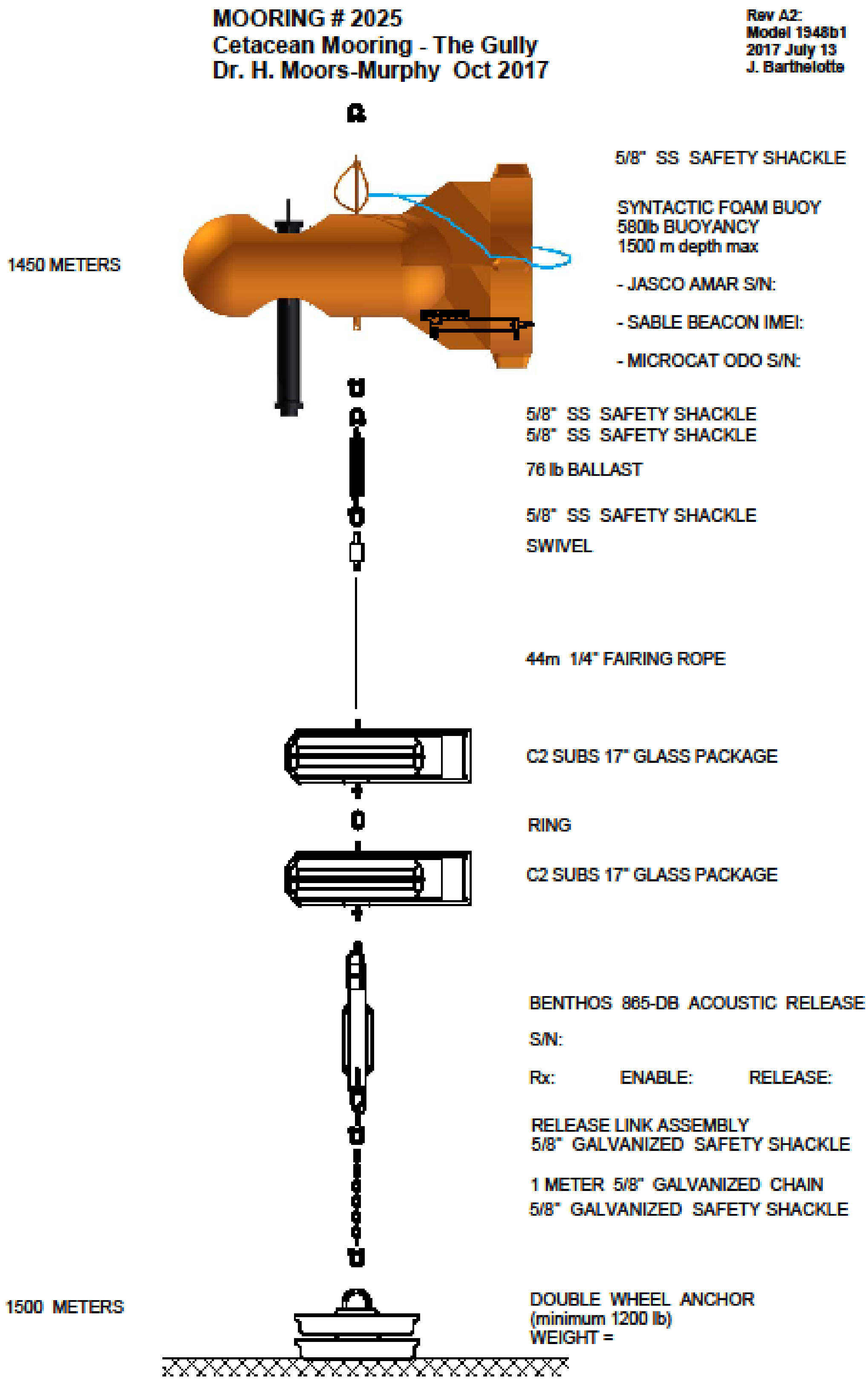
1 METER 5/8" CHAIN

1-WHEEL ANCHOR WEIGHT:
(min. 600 lb)

169 METERS

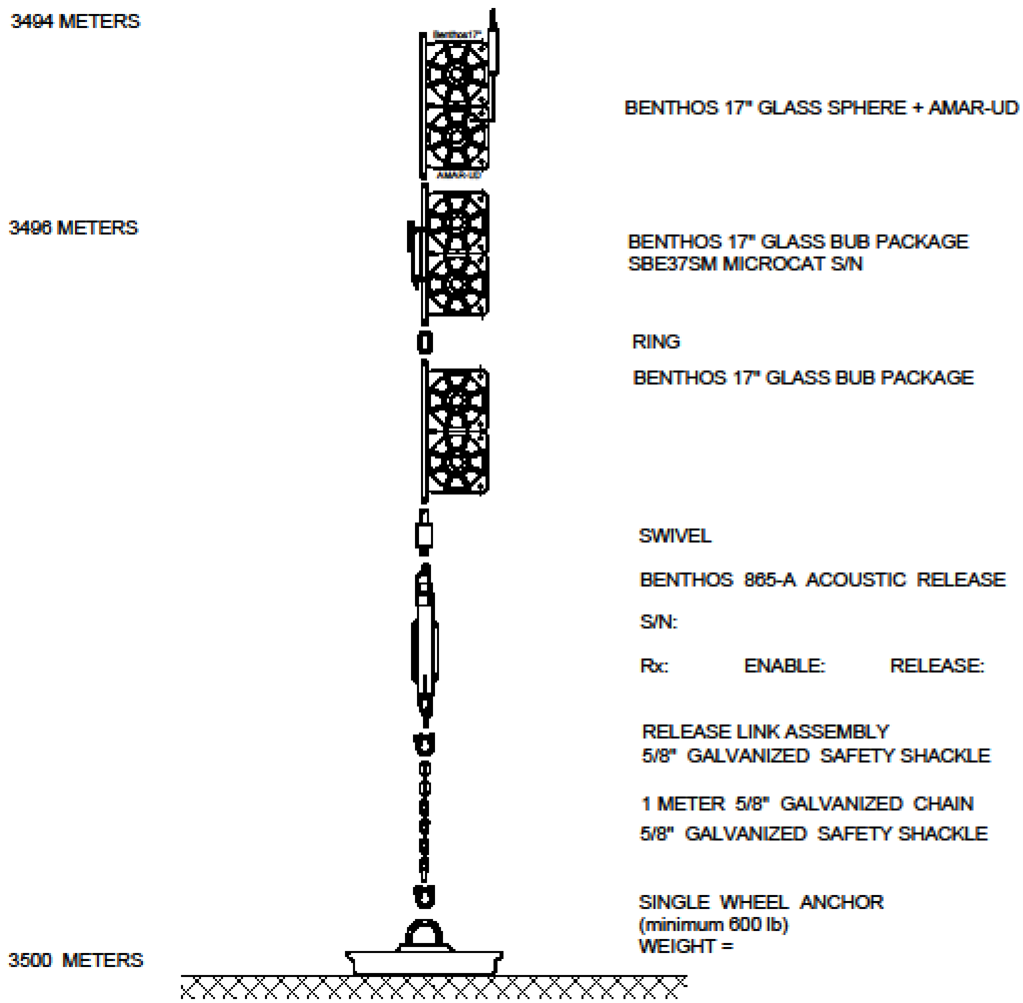
Deployments



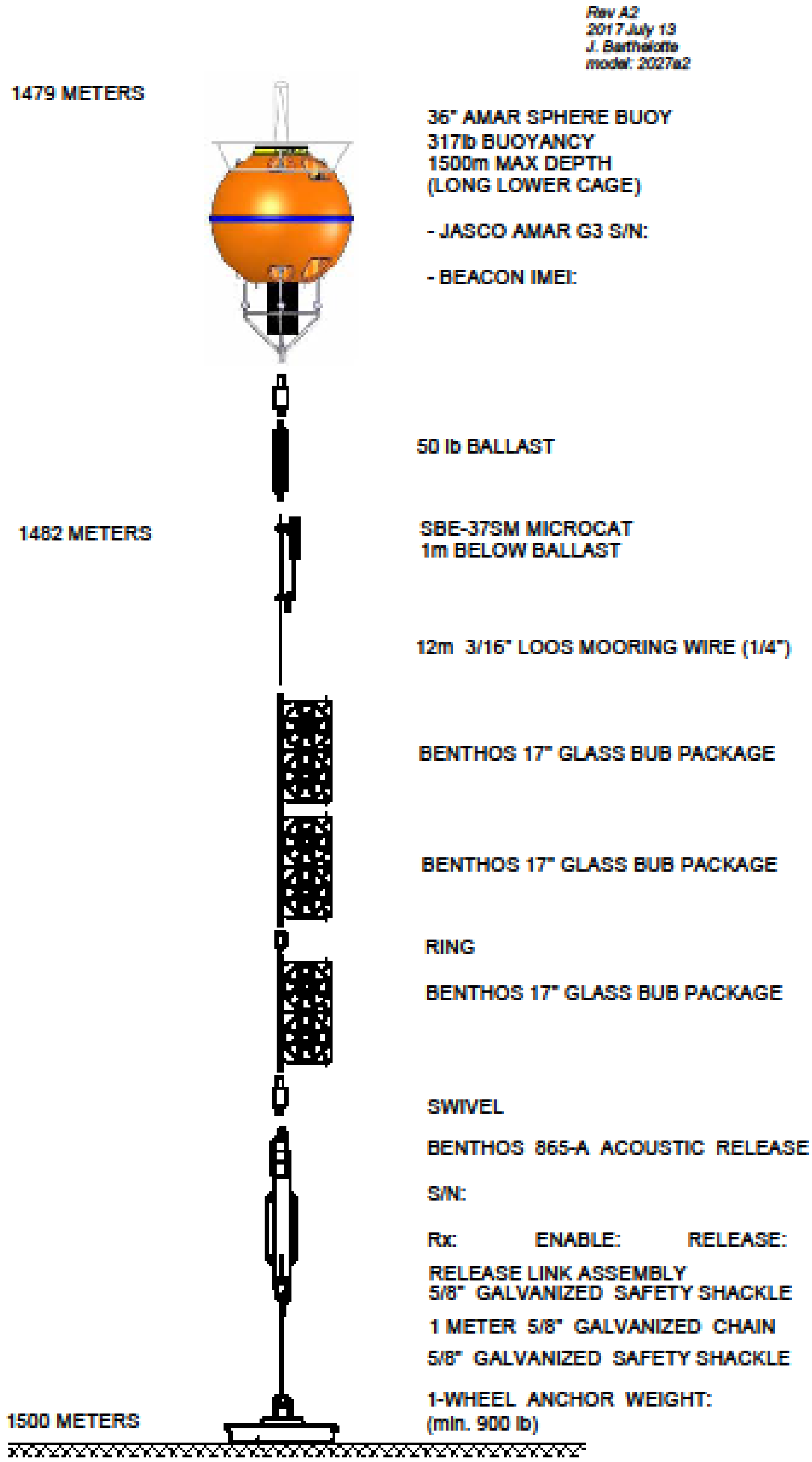

MOORING # 2025
Cetacean Mooring - The Gully
Dr. H. Moors-Murphy Oct 2017
Rev A2:
Model 1948b1
2017 July 13
J. Barthelotte
5/8" SS SAFETY SHACKLE
SYNTACTIC FOAM BUOY
580lb BUOYANCY
1500 m depth max
- JASCO AMAR S/N:
- SABLE BEACON IMEI:
- MICROCAT ODO S/N:
1450 METERS
5/8" SS SAFETY SHACKLE
5/8" SS SAFETY SHACKLE
76 lb BALLAST
5/8" SS SAFETY SHACKLE
SWIVEL
44m 1/4" FAIRING ROPE
C2 SUBS 17" GLASS PACKAGE
RING
C2 SUBS 17" GLASS PACKAGE
BENTHOS 865-DB ACOUSTIC RELEASE
S/N:
Rx: ENABLE: RELEASE:
RELEASE LINK ASSEMBLY
5/8" GALVANIZED SAFETY SHACKLE
1 METER 5/8" GALVANIZED CHAIN
5/8" GALVANIZED SAFETY SHACKLE
1500 METERS
DOUBLE WHEEL ANCHOR
(minimum 1200 lb)
WEIGHT =

MOORING # 2026
Cetacean Mooring - The Gully - Deep
Dr. H. Moors-Murphy Oct 2017

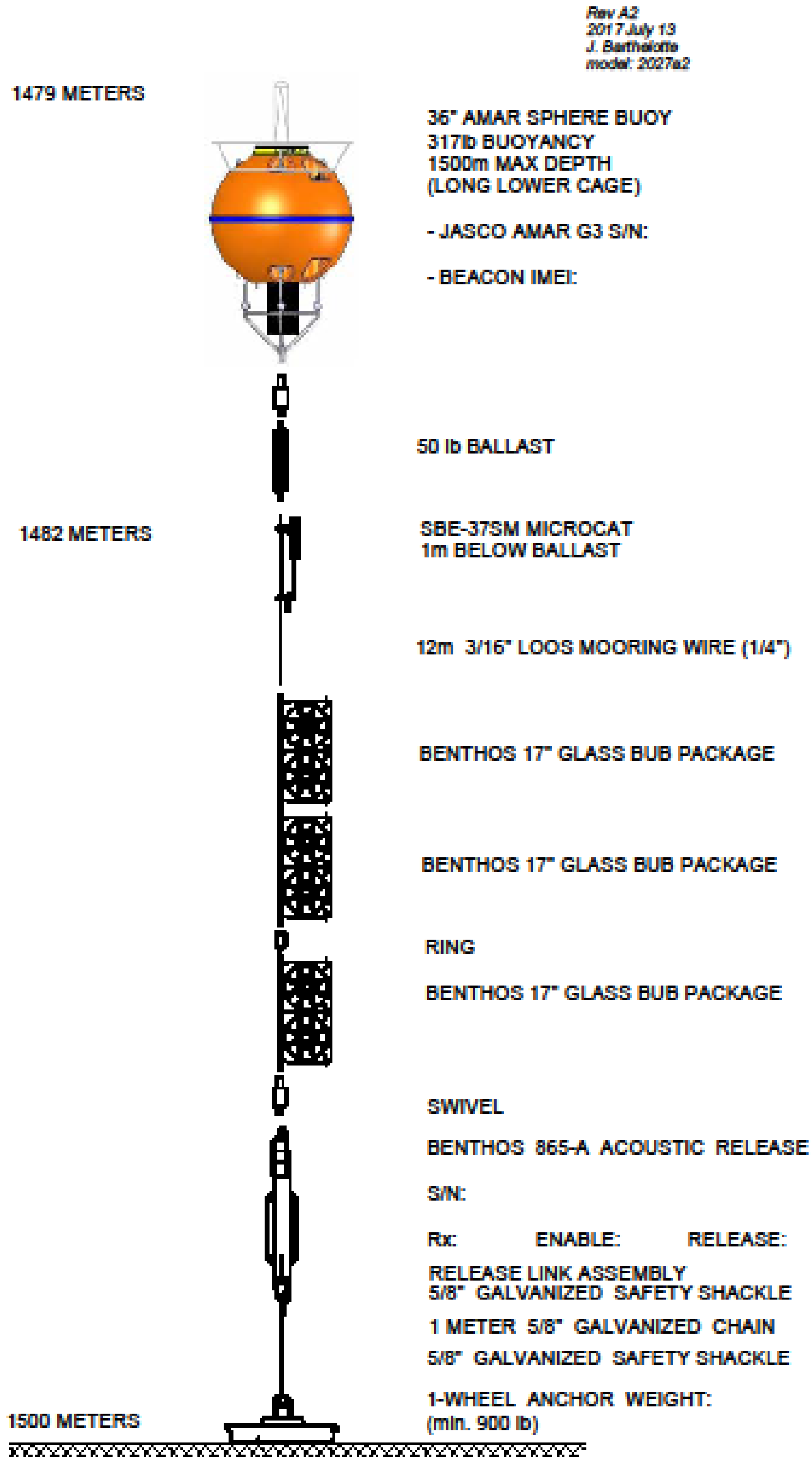
Rev A3:
Model 2026opta
2017 July 28
J. Barthelotte



MOORING # 2027 Cetacean - Dawson Canyon Oct 2017
Dr. Hilary Moors-Murphy

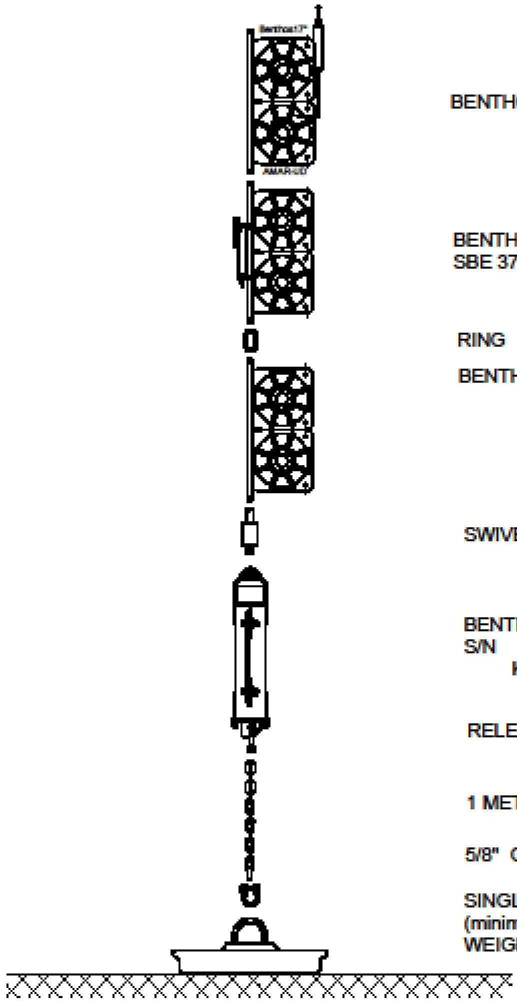


MOORING # 2028 Cetacean - Logan Canyon Oct 2017
Dr. Hilary Moors-Murphy



MOORING # 2029
Cetacean Mooring - St. Ann's Bank
Dr. H. Moors-Murphy Oct 2017

Rev A3:
Model 2026opta
2017 July 28
J. Barthelotte



Appendix 6. Endeavor TSG Configuration File – 27Nov2017a.xmlcon

Date: 01/29/2018

Instrument configuration file: R:\Science\BIODataSvc\SRC\2010s\2017\EN606\Ship Deliverables\EN606_Hebert\tsg\raw\27Nov2017a.XMLCON

Configuration report for SBE 21 Seacat Thermosalinograph

Remote temperature : SBE 3
External voltage channels : 2
Sample interval : 6 seconds
NMEA position data added : Yes
NMEA depth data added : No
NMEA time added : No
NMEA device connected to : deck unit
Scan time added : No

1) Frequency 0, Temperature

Serial number : 1578
Calibrated on : 14-Dec-16
G : 4.19581328e-003
H : 5.93731371e-004
I : 3.79065958e-006
J : -1.86524830e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

2) Frequency 1, Conductivity

Serial number : 1578
Calibrated on : 14-Dec-16
G : -4.01390242e+000
H : 4.78841495e-001
I : 1.20442267e-003
J : -2.89460350e-005
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

3) Frequency 2, Temperature, 2

Serial number : 0604
Calibrated on : 15-Dec-16

G : 4.80105098e-003
H : 7.12509078e-004
I : 4.85485321e-005
J : 6.14112724e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

4) A/D voltage 0, Fluorometer, WET Labs WETstar

Serial number : 1177
Calibrated on : 17-Mar-2017
Blank output : 0.063
Scale factor : 6.100

5) A/D voltage 1, Fluorometer, WET Labs ECO-AFL/FL

Serial number : 478
Calibrated on : 12142016
Dark output : 0.0170
Scale factor : 2.40000000e+001

Scan length : 34

Appendix 7. Data and Meta-data Collections

The mission data is uniquely organized because the charter vessel provided us with data files upon our departure for all shipboard instrumentation. The raw CTD data was processed using the Endeavor's protocols but was also processed using CTD-Dap to meet AZMP Maritimes standards.

The mission data and metadata is held here:

R:\Science\BIODataSvc\SRC\2010s\2017\EN606

This folder includes:

1. Raw and processed CTD data, configuration files and plots
2. Lists of stations and Navigation
3. Logs as they are scanned
4. Raw shipboard analysis (Winkler, Autosal, Turner Fluorometer)
5. Operation metadata (Elog)
6. The AZMP database template for the mission and summary reports
7. Ship deliverables
    a. ADCP
    b. CTD raw data and Endeavor processing
    c. Navigation
    d. SCS log
    e. TSG data and configuration files
    f. Winch logs
8. The BioChem folder will contain land based laboratory analysis as it becomes available, and includes:
    a. HPLC/Absorption
    b. POC/PON
    c. Nutrients
    d. Zooplankton
    e. Flow cytometry (samples collected but may be late to process)
    f. PCO2
    g. TIC/TA