CRUISE REPORT

HUDSON 2012042

SCOTIAN SHELF

AZMP TRANSECTS +

Sept 24 − Oct 15, 2012

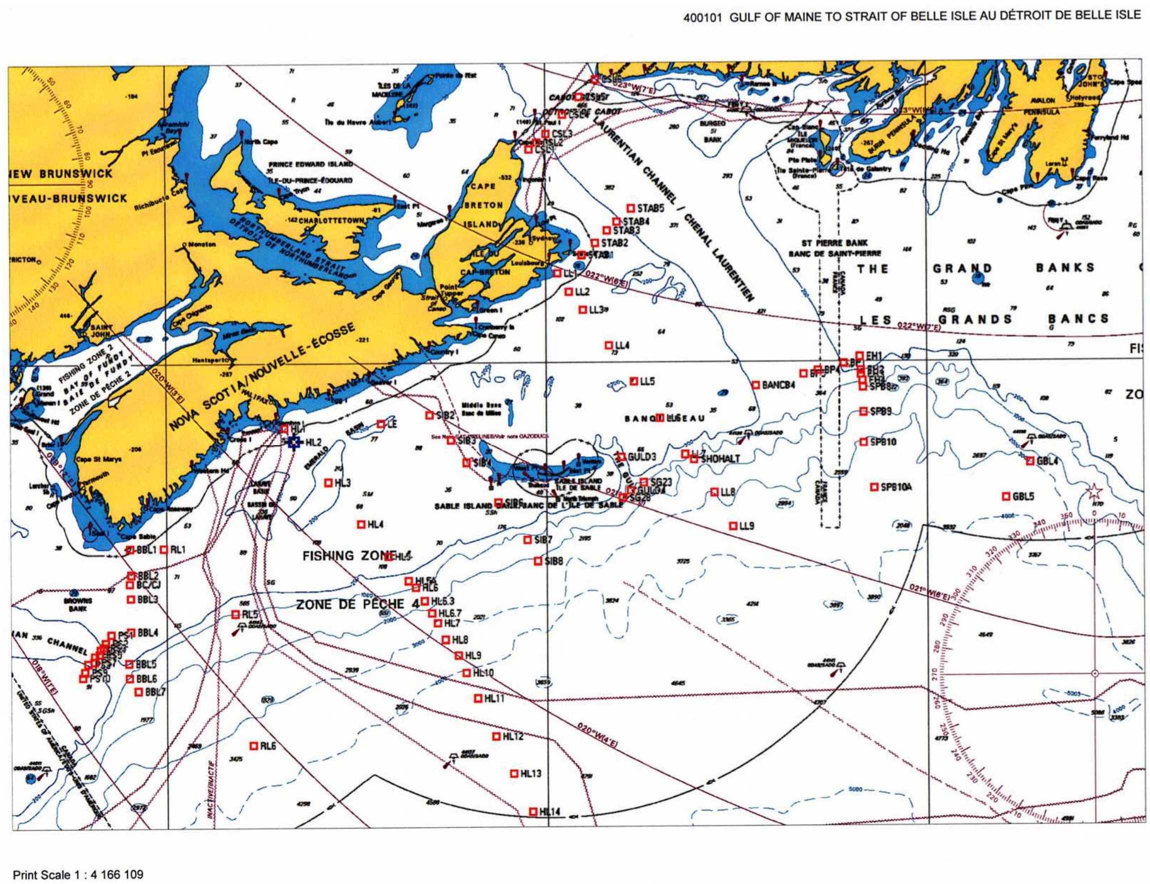
A. CRUISE NARRATIVE

1. Highlights

a. Area Designation:	AZMP Transects on Scotian Shelf
b. Expedition Designation:	HUD2012042 or 18HU12042 (ISDM format)
c. Chief Scientist:	Dr. Edward Horne Ecosystem Research Division Department of Fisheries and Oceans Bedford Institute of Oceanography PO Box 1006 Dartmouth, NS, Canada B2Y 2A4 Edward.Horne@dfo-mpo.gc.ca
d. Ship:	CCGS Hudson (call sign - CGDG) Oceanographic research vessel
e. Ports of Call:	September 24, 2012 Depart BIO Dartmouth, NS, October 03, 2012 – Touch @ BIO to exchange crew & resupply 08:00-15:00 October 15, 2012 Return BIO, Dartmouth, NS, Can.
f. Cruise Dates:	September 24 to October 15, 2012

2. Cruise Summary Information

a. Cruise Stations



b. Total number of stations occupied

84 stations occupied during this mission (AZMP core program + additional)

c. Floats and Drifters deployed

3 Nova Brand ‘Argo’ type floats deployed

d. Moorings deployed or recovered

Recover 1 ADCP mooring & guard buoys @ STAB3
Recover and replace 3 OTN moorings around HL2 station
Deploy 3 Bio-Acoustic moorings (whales) for Hiliary Moors
The UK RAPID-WAVE (West Atlantic Variability Experiment) mooring program was postponed to Spring of 2013.

3. List of Principal Investigators

Name	Affiliation	Responsibility
Edward Horne	BIO Edward.Horne@dfo-mpo.gc.ca	Senior Scientist, Science program coordination/ Overall logistics
Yuri Geshelin	BIO Yuri.Geshelin@dfo-mpo.gc.ca	Oxygen Technician, Water chemistry program
Richard Nelson	BIO Richard.Nelson@dfo-mpo.gc.ca	Senior Technician, Water chemistry program coordination
William Burt	Dalhousie University willburt@phys.ocean.dal.ca	Carbon dioxide (DOC) & alkalinity monitoring Seawater/atmospheric sampling
Jay Barthelotte	BIO Jay.Barthelotte@dfo-mpo.gc.ca	Mooring Specialist Technical Operations Manager
Jeff Spry	BIO Jeff.Spry@dfo-mpo.gc.ca	Biological/zooplankton sampling program Sample collection/Data flow

Table A.3.1. List of Principal Investigators (see Section 7 for addresses).

4. Scientific Programme and Methods

4.1 Physical /Chemical/Biological Program

a. Narrative

Objectives

The main objectives of the mission were:

- to obtain synoptic fall observations of the water column hydrography and the distributions of nutrients, phytoplankton, zooplankton and bacteria along three sections on the Scotian Shelf and one in Cabot Strait. To carry out the core sampling for fall of the Atlantic Zone Monitoring Program (AZMP). If time permits; further sampling is carried out to describe hydrographic inputs to our coastal system and help with our understanding of circulation patterns within that system.

- to service (retrieve and redeploy) OTN moorings around Halifax Line station 2. To deploy bio-acoustic 'listening' moorings along the slope edge near the Gully formation. To recover an ADCP mooring.

Additional objectives were:

- to carry out hydrographic, chemical and biological sampling at stations in the Gully and Roseway Basin and at stations along a transect (PSLine) across the NE Channel
- to measure the underwater light field relative to surface irradiance, optical backscatter, and measure levels of CDOM (colored dissolved organic material) when conditions were appropriate. Coordinated daily with satellite over-pass.
- to monitor solar irradiance, temperature, salinity and *in vivo* phytoplankton fluorescence continuously in the near surface (using a continuous flow-through system from a hull-mounted source)
- to investigate the vertical distribution of macrozooplankton (e.g. krill) in the deep shelf basins, the Gully and Cabot Strait by towing the Bioness sampler.
- to record acoustic backscattering (ADCP) along the ship's track to estimate 'biomass' present.
- to collect (sometimes preserve) water samples for analysis of oxygen, carbon dioxide and alkalinity levels at AZMP stations. In conjunction with the foregoing to sample for SF6/CFC-12 and O18 presence in the seawater.
- to make special collections of zooplankton for photomicrographs & measurements
- to make special collections of DOC water for US associate Barney Balch.

Hudson 2012042 program elements included:

1. Full-depth CTD profile measurements of pressure, temperature, salinity, dissolved oxygen, profiled current, fluorescence, and light intensity at a fixed set of stations (Scotian Shelf transects lines) spanning the Scotian shelf from the Northeast channel in the Gulf of Maine entrance as a western boundary to Cabot Strait at the entrance to the Gulf of St. Lawrence and the Grand Banks slope in the east.
2. Measurements of salinity, dissolved oxygen & carbon dioxide, nutrients (nitrate/nitrite, phosphate, silicate, ammonia), particulate organic carbon, chlorophyll, bacteria from discrete water samples from a rosette sampler on the CTD package;
3. Current measurements from a ship-mounted acoustic current profiler;

The physical-chemical program and the biological program described in Section 4.2 below were tightly coupled and shared water samples from the Rosette sampler.

4.2 Biological Program further

a. Narrative

The biological program conducted as part of cruise 2012042, 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 has consisted of essentially four elements:
1) phytoplankton biomass/primary productivity measurements ,
2) microbial sampling program (conducted for Dr.Bill Li),
3) mesozooplankton sampling program , and
4) dissolved organic carbon measurements

The ultimate aim of these 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.

b. Zooplankton Sampling M.Ringuette/J. Spry

<u>Sampling</u>

The Fall AZMP cruise goal for the zooplankton group was to describe the state of the mesozooplankton community of the Scotian shelf before the beginning of the winter season. Plankton collections using fine mesh nets are used to estimate the abundance and biomass of the zooplankton community.

Overall we visited and sampled 80 different stations resulting in 118 successful fishing activities (See table 01 for details). We used an array of sampling gear allowing us to efficiently sample different size spectra. A conical ring net of 202µm mesh size with an aperture of 75 cm in diameter (filtering ratio 1:5) equipped with a KC Denmark flowmeter was towed vertically from the bottom to the surface at each station where the water column did not exceed 1000m. This allows us to estimate the mesozooplankton community abundance and biomass. Contents of the cod end were preserved in 5% buffered formaldehyde. An extra cast was performed on certain stations in order to provide fresh/live material (see section "Other activities").

A 74µm net, 30 cm in mouth diameter also with a 1:5 filtering ratio was towed vertically at on-shelf Halifax Line stations only. This serves the same purpose of quantifying the community but targeting a smaller fraction of the mesozooplankton community i.e. smaller developmental stages, eggs and naupli. Contents of the cod end were preserved in 5% buffered formaldehyde.

The 'Bioness' towed vehicle targets larger and faster swimming organisms like krill (Euphausiids) and mesopelagic fish. Typically we use this equipment to sample the deep basins on the Scotian Shelf, the Gully, and the Laurentian channel. The Bioness frame carries multiple nets (up to 10 nets of 240µm mesh size, 0.5m square mouth), and is towed at ~3 knots speed through the water. The gear is sent to the bottom and brought back to surface as an oblique tow, closing nets on its way back up; thus taking samples at discrete strata. Contents of the cod end were preserved in 5% buffered formaldehyde.

The Multinet is a $0.25m^2$ mouth opening with 5 nets of 202 µm mesh size towed vertically from 1000m (or bottom) to the surface. Nets are closed during the ascent at 800m, 600m, 400m and 200m and then at the surface. In the fall the primary aim is to describe the vertical and spatial distribution the over-wintering copepod population. Content of the cod end was preserved in 5% buffered formaldehyde.

Others activities

We did extra net tows to catch live organisms to build a photo library that will provide useful material for graphical media, presentations at conferences, and websites. A total of 640 pictures were taken showcasing 30 different taxa. While starting to work on that project, Mark Ringuette decided to try to post one interesting, good quality picture a day for the interest of the ship's crew and scientific staff accompanied by interesting facts or curiosities about the small world of the mesozooplankton. This work was well received andresulted in 18 images with description.

Remarks/comments:

- Bioness winch cable-spooler/level-winder was not functioning optimally. Towing operations had to be interrupted and cable re-spooled "manually" several times in order to preserve the integrity of the cable. This caused an unduly long sampling time (and filtered volume) of some strata thus rendering the comparison within strata more complicated.

- We experienced what seemed to be a 'reluctance-to-release' brake problem on the Multinet winch which made the manipulation of the load difficult for the winchman (at slow speeds during payout especially). This was disconcerting for hands, particularly those on deck, since it make the load jerk uncontrollably. It is not really reassuring when you are standing below the load, in conditions of rough seas and blowing wind; to have the package trembling as the winch attempts to haul in.

Tables 001. Mesozooplancton sampling during AZMP fall cruise (HUD2012-042)

Date	Station	Lat	Lon	Z	Ring nets			Bioness	Multinet
		(deg, min)	(deg, min)	(m)	202μm	74μm	Live Bugs		
24 Sept	HL1	44.24	-63.27	88	X	X			
25 Sept	HL2	44.16	-63.19	149	X	X			
	HL3	43.53	-62.52	278	X	X		X	
	HL4	43.29	-62.27	85	X	X			
	HL5	43.10	-62.06	101	X	X	X		
26 Sept	HL5A	42.56	-61.49	556	X	X			
	HL6	42.51	-61.44	1036	X	X			
	HL6.3	42.44	-61.37	1020	X				
	HL6.7	42.37	-61.31	2300	X				
	HL7	42.32	-61.26	2750			X		X
27 Sept	HL8	42.22	-61.19	2600					X
	HL9	42.13	-61.11	3950					X
	HL10	42.04	-61.02	4125					X
	HL11	41.47	-60.55	4500			X		X
28 Sept	HL12	41.41	-60.68	4500					X
	HL13	40.39	-60.12	5040					X
29 Sept	HL14	40.37	-60.12	5200			X		X
	RL6	42.19	-63.52	2000	X				X
	RL5	42.37	-64.06	933	X		X		X
30 Sept	BBL 7	41.52	-65.21	1042	X				
	BBL 6	41.59	-65.30	1069	X		X		X
	BBL 5	42.08	-65.30	193	X				
1 Oct	BBL 4	42.27	-65.28	100	X				
	PS1	42.25	-65.44	97	X				
	PS4	42.16	-65.52	226	X				
	PS6	42.12	-65.57	227	X				
	PS8	42.08	-66.02	208	X				
	PS10	41.59	-66.08	95	X				
2 Oct	BBL 3	42.46	-65.29	105	X		X		
	BC/CJ	42.55	-66.00	169	X				
	BBL 2	43.00	-65.29	116	X				
	BBL 1	43.15	-65.29	65	X				
	RL1	43.15	-65.03	165	X			X	
3 Oct	HL2	44.16	-63.19	140	X	X			
4 Oct	STAB1	46.00	-59.32	65	X				
	STAB2	46.7	-59.22	65	X				
	STAB3	46.13	-59.12	88	X				
	STAB4	46.18	-59.04	150	X				
	STAB5	46.25	-58.53	365	X			X	
5 Oct	CSL 6	47.35	-59.21	268	X				
	CSL 5	47.26	-59.34	420	X				
	CSL 4	47.16	-59.47	435	X			X	
	CSL 3	47.06	-59.59	335	X				
	CSL 2	47.01	-60.07	180	X		X		

Tables 001. Mesozooplancton sampling during AZMP fall cruise (HUD2012-042) (Continued)

Date	Station	Lat	Lon	Z	Ring nets			Bioness	Multinet
		(deg, min)	(deg, min)	(m)	202µm	74µm	Live Bugs		
5 Oct	CSL 1	46.58	-60.13	82	X				
6 Oct	LL 1	45.50	-59.51	93	X		X		
	LL 2	45.40	-59.42	140	X				
	LL 3	45.29	-59.31	140	X				
	LL 4	45.10	-59.11	105	X		X		
	LL 5	44.49	-58.51	207	X				
7 Oct	LL 6	44.29	-58.31	69	X				
	Banq B4	44.47	-57.15	400	X				
	BP5	44.53	-56.37	400	X				
	BP4	44.55	-56.26	400	X				
	BP1	44.59	-56.09	224	X				
	EH1	45.03	-55.53	85	X				
	EH2	44.55	-55.52	183	X				
	EH3	44.52	-55.51	432	X		X		
8 Oct	EH4	44.49	-55.51	818	X				
	SPB8	44.46	-55.50	1098	X				X
	SPB9	44.31	-55.50	2200	X				X
	SPB10	44.14	-55.50	2920	X				X
9 Sept	SPB10A	43.48	-55.42	3500	X		X		
	GBL5	43.43	-53.58	3600	X				X
	GBL4	44.03	-53.39	3000	X		X		X
10 Oct	LL 9	43.28	-57.32	3600	X		X		X
11 Oct	LL 8	43.47	-57.50	2850	X				
12 Oct	GULDD3	44.01	-59.02	538	X			X	
13 Oct	SG23	43.52	-58.44	1087	X				
	GULDD4	43.48	-58.54	2100	X				
	SG28	43.43	-59.01	750	X				
	SIB8	43.07	-60.08	1896	X				
14 Oct	SIB7	43.19	-60.20	1500	X				
	SIB6	43.40	-60.39	60	X				
	SIB4	44.04	-61.04	60	X				
	SIB3	44.17	-61.16	105	X				
	SIB2	44.31	-61.32	150	X				
	SIB1	44.52	-61.53	65	X				
	LE	44.26	-62.11	221	X			X	
15 Oct	HL2	44.16	63.19	155	X	X			

c. CO2 & Atmospheric sampling W. Burt

Summary of work conducted during the 2012 Fall AZMP cruise aboard the CCGS Henry Hudson:

Dalhousie CO_2 Group:

Our primary focus for this cruise was the continuation of the carbon system time-series measurements in the Scotian Shelf region. This cruise represented the standard data collection methods for our lab when aboard AZMP cruises, which includes both continuous measurements and the collection of bottle samples in complete vertical profiles at stations along specific transects. Continuous measurements of atmospheric and surface water CO_2 provide information about air-sea CO_2 transfer, while bottle samples provide dissolved CO_2 and alkalinity data throughout the water-column. This data is used in studies related to carbon cycling and ocean acidification.

Similar to previous cruises, the sampling methodology used 3 separate systems. First, atmospheric CO_2 is recorded in 60 second intervals throughout the duration of the cruise using a CO_2 probe secured to the top deck of the ship. In the general purpose lab, measurements surface water CO_2 concentrations were made at the same time intervals using a continuous seawater intake system. Full vertical profiles of discrete water samples were completed at most stations along the Halifax Line (HL), Browns Bank Line (BBL), Cabot Strait Line (CSL), Louisbourg Line (LL) and Gully (GULD, SG, GWA) transects. During leg 1, approximately 265 water samples collected from the rosette were analyzed onboard using the VINDTA system. For legs 2 and 3, approximately 227 samples were collected, immediately poisoned to halt biological activity, and stored onboard for future analysis in the lab at Dalhousie. Overall, the sampling provided full profiles of dissolved inorganic carbon (DIC) and alkalinity at 44 stations.

d. Multi-frequency Acoustic Sampling: **N. Cochrane**

Multi-frequency acoustics measurement was not carried out during the mission Hud2012-042.

e. Primary Productivity experiment/measurement:

Not carried out this mission.

f. Pelagic Seabird & Marine Mammal Observation: **Carina Gjerdrum**

Observers were onboard during the entire mission - provided through Canadian Wildlife Service.

Leg 1:

Fall AZMP Cruise report: September 24, 2012 – October 2, 2012
Dartmouth, N.S. to Dartmouth, N.S.
Observer: Sarah Wong
Observer-in-training : Brad Toms
snpwong@dal.ca

General overview

Seabird and marine mammal observations were made from the bridge of the CCGS Hudson during the first part of the fall AZMP cruise from September 24 to October 2, 2012 beginning and ending at the Bedford Institute of Oceanography in Dartmouth, N.S. Seabird surveys followed the standardized protocol for pelagic seabird surveys from moving platforms and stationary platforms for the Eastern Canada Seabirds at Sea program (ECSAS). Another seabird observer (Sue Abbott) conducted surveys for the second part of the fall AZMP cruise. For the first leg of the fall AZMP cruise, the Hudson steamed southeast along the Halifax Line, off the Scotia Shelf to deep water (~5000m, Station 14), and also sampled along the following lines: Roseway, Browns Bank and Peter Smith (which extends into the northeast part of Georges Bank). The primary purpose of the cruise was to conduct oceanographic sampling (CTDs, net tows). Surveys were conducted between stations, although several opportunistic sightings were entered while we were stopped at station (marine mammals). During the cruise, Sarah Wong was training Brad Toms. Weather was excellent for the entire cruise. A total of 438 five-minute transects were completed, resulting in over 36 hours of observations and a total of 759 km surveyed.

Seabird sightings

During the first leg of the fall AZMP, 153 birds from 5 different families were counted in transect (this does not include birds outside of the 300m wide transect, birds following the ship or birds in flight that were not captured during the instantaneous snapshots)(Table 1). Fewer birds were sighted than expected. The number sighted in

2012 is nearly half the number of seabirds sighted during the same leg in 2011 (294 seabirds, 4 families). Greater shearwaters were the most common seabird sighted, followed by red phalaropes. In 2011, the most common seabirds sighted were northern fulmars, greater shearwaters and Cory shearwaters. Very few birds were sighted along the Halifax Line (it was dark when we passed the shelf edge), especially in deep water and while transiting to the Roseway Line. The number of seabird sightings increased near the shelf edge and around Browns Bank (shearwaters and storm-petrels).

Marine mammal sightings

More than 215 marine mammals were sighted during the first leg of the fall AZMP (Table 2). Please note: this total does not include the number of long-finned pilot whales sighted (I forgot to extract that data before I left the ship). Two northern bottlenose whales were sighted on September 30, 2012 at 41.9688^{0}N and 65.4924^{0}W. The most common marine mammals sighted were common dolphins and long-finned pilot whales. Spinner dolphins, usually found in warm waters, were also seen in the deep water.

Large fish sightings

Large predatory fish were also sighted during the cruise (Table 2). A blue shark was sighted at 42.1259^{0}N and 66.0503^{0}W. Two other sharks were sighted (41.9673^{0}N, 65.202^{0}W and 42.1159^{0}N, 66.0142^{0}W) but could not be identified to species (they were not thresher, basking or blue). Four ocean sunfish were sighted and lots of flying fish.

Table 1: List of seabird species observed during the seabird survey from Dartmouth, N.S. to Dartmouth, N.S., September 24-Oct2, 2012, during the first leg of the fall AZMP cruise. Total numbers include only those birds considered "in" transect. They do not include birds following the ship, birds outside 300m and flying birds not captured during the "snapshot". Additional species sighted that were not considered "in transect" include: Herring gull (*Larus argentatus*), an unknown tern and an unknown alcid (murre or razorbill).

Family	Species	Latin Name	Number Observed
Hydrobatidae	Unknown Storm-Petrel	*Oceanodroma* or *Oceanites*	18
	Leach's Storm-Petrel	*Oceanodroma leucorha*	13
	Wilson Storm-Petrel	*Oceanites oceanicus*	11
Laridae	Great Black-backed Gull	*Larus marinus*	4
	Pomarine Jaeger	*Stercorarius pomarinus*	3
	Unknown Jaeger	*Stercorariidae* spp.	1
	South Polar Skua	*Stercorarius maccormicki*	1
	Sabine's Gull	*Xema sabini*	1
Procellariidae	Greater Shearwater	*Puffinus gravis*	43
	Northern Fulmar	*Fulmarus glacialis*	4
	Cory's Shearwater	*Calonectris diomedea*	2
	Manx shearwater	*Puffinus puffinus*	2
	Unknown shearwater	*Puffinus* or *Calonectris*	2
Scolopacidae	Red Phalarope	*Phalaropus fulicaria*	23
	Unknown Phalarope	*Phalaropus* spp.	21
	Red-necked Phalarope	*Phalaropus lobatus*	1
Sulidaie	Northern Gannet	*Morus bassanus*	3

Table 2: List of marine mammals and large fish recorded during surveys from Dartmouth, N.S. to Dartmouth, N.S. during the first leg of the fall AZMP cruise, September 24-Oct 2, 2012.

Species	Latin Name	Number observed
Short-beaked Common dolphin	*Delphinus delphis*	103
Long-fined Pilot whale	*Globicephala melas*	Get numbers from database
Striped dolphin	*Stenella coeruleoalba*	50
Spinner dolphin	*Stenella longirostris*	27
Unknown dolphin		23
Baleen whale	Fin or sei	3
Northern Bottlenose whale	*Hyperoodon ampullatus*	2
Ocean sunfish	*Mola mola*	4
Unknown shark	Not thresher, basking or blue	2
Blue shark	*Prionace glauca*	1

Leg 2:

Fall AZMP Cruise report: September 24, 2012 – October 15, 2012
Leg 2 – Susan Abbott

General overview

Seabird and marine mammal observations were made from the bridge of the CCGS Hudson during the fall AZMP cruise from September 24 to October 15, 2012 beginning and ending at the Bedford Institute of Oceanography in Dartmouth, N.S. Seabird surveys followed the standardized protocol for pelagic seabird surveys from moving platforms and stationary platforms for the Eastern Canada Seabirds at Sea program (ECSAS). Surveys were conducted between stations, although several opportunistic sightings were entered while we were stopped at station (marine mammals). During Leg 1 of the cruise, Sarah Wong was training Brad Toms. Weather was excellent for the entire cruise. A total of 1068 five-minute transects were completed, resulting in 88 hours of observations and a total of 1899 km surveyed.

Protocol

The main objective of our protocol is to ensure that observers conducting surveys at sea from a moving platform are recording data in a consistent, unbiased fashion that permit subsequent conversion into seabird densities. This protocol is consistent with methods used elsewhere in the world, making these data comparable to other geographic areas.

Surveys are conducted while looking forward from the bridge, scanning ahead to a 90^{o} angle from either the port or starboard side, limiting observations to a transect band 300m wide from the side of the platform. A survey consists of a series of ten-minute observation periods, which are exclusively dedicated to detecting birds at sea. We conduct as many consecutive ten-minute observation periods as possible, regardless if birds are present or not, and try to ensure consistent coverage throughout the day. Observations can only be conducted when the platform is travelling at a minimum speed of 4 knots (7.4 km/h) and a maximum of 19 knots (35.2 km/h). We do not conduct observations when visibility is poor (i.e., when the entire width of the 300m transect is not visible due to rain or fog).

We scan the transect continuously by eye, to count and identify birds present in air or on water. Binoculars are used to confirm the species identification, and other details, such as age, moult, carrying fish, etc. We continuously record all birds observed on the sea surface throughout the ten-minute period, and estimate their distance from the platform. Flying birds are not recorded continuously throughout the 10-minute period, as this would overestimate bird density. Instead, we record flying birds using instantaneous counts, or “snapshots”, at regular intervals throughout the observation period. The number of snapshots conducted depends on the speed of the platform.

Seabird sightings

During the fall AZMP cruise, 1150 birds from 7 different families were counted in transect (this does not include birds outside of the 300m wide transect, birds following the ship or birds in flight that were not captured during the instantaneous snapshots) (Table 1). Great Shearwater were the most common seabird sighted (49% of observations), followed by Northern Gannet (19%). In general, birds were more numerous on the Scotian Shelf compared to deeper waters, and especially numerous over water near Cape Breton Island, Scatterie Island, and on the east side of the Laurentian Channel (Figure 1).

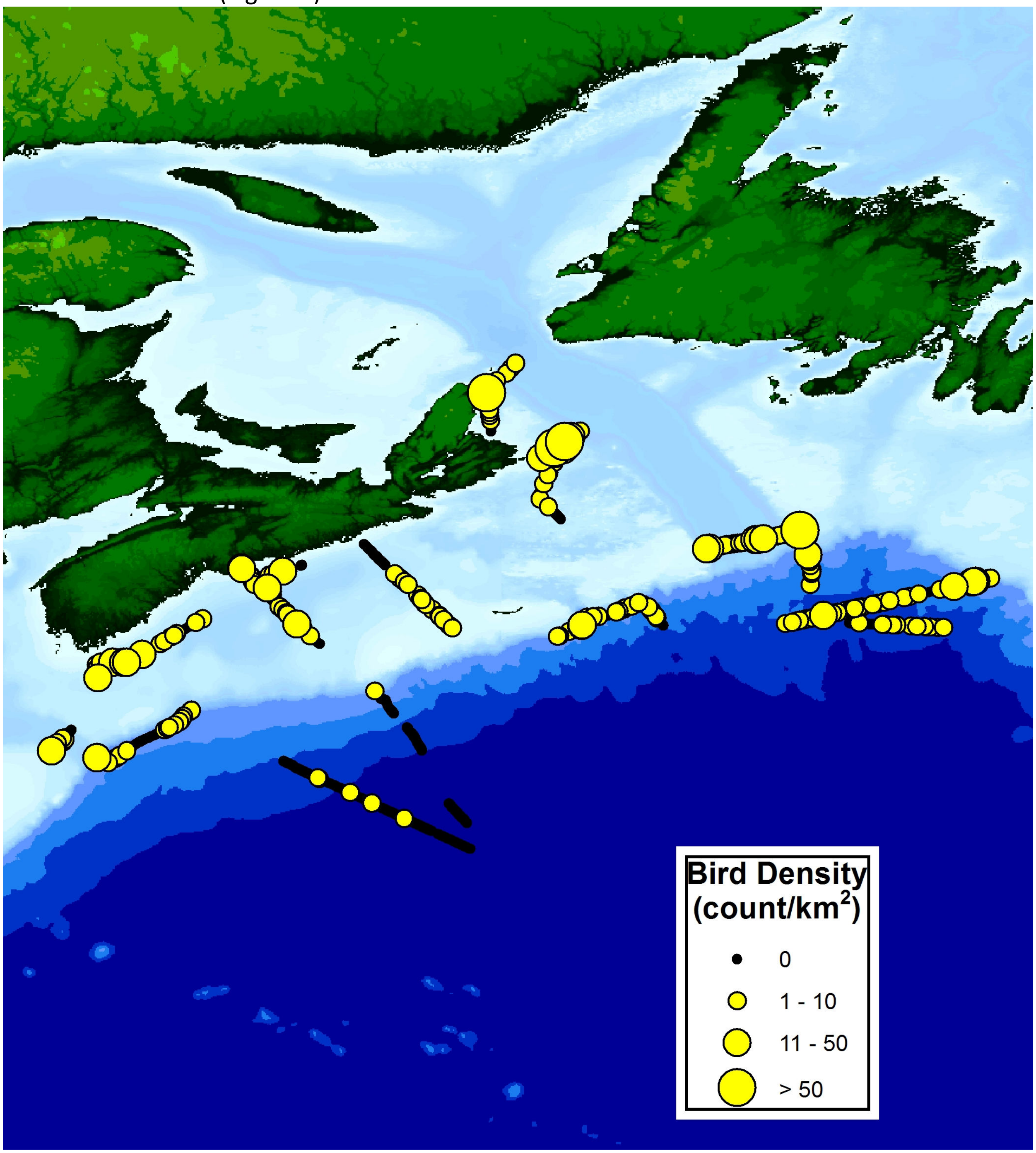


Table 1: List of seabird species observed during the seabird survey from Dartmouth, N.S. to Dartmouth, N.S., September 24-Oct 15, 2012, during the fall AZMP cruise. Total numbers include only those birds considered "in" transect.

Family	Species	Latin Name	Number Observed
Hydrobatidae	Unknown Storm-Petrel	*Oceanodroma* or *Oceanites*	**26**
	Leach's Storm-Petrel	*Oceanodroma leucorha*	**51**
	Wilson Storm-Petrel	*Oceanites oceanicus*	**18**
Laridae	Herring Gull	*Larus argentatus*	**37**
	Great Black-backed Gull	*Larus marinus*	**11**
	Ring-billed Gull	*Larus delawarensis*	**6**
	Pomarine Jaeger	*Stercorarius pomarinus*	**5**
	Parasitic Jaeger	*Stercorarius parasiticus*	**3**
	Unknown Jaeger	*Stercorariidae* spp.	**1**
	South Polar Skua	*Stercorarius maccormicki*	**1**
	Sabine's Gull	*Xema sabini*	**1**
	Great Skua	*Stercorarius skua*	**1**
Alcidae	Atlantic Puffin	*Fratercula arctica*	**6**
	Common Murre	*Uria aalge*	**1**
	Thick-billed Murre	*Uria lomvia*	**1**
	Unknown Murre	*Uria*	**1**
Procellariidae	Great Shearwater	*Puffinus gravis*	**568**
	Northern Fulmar	*Fulmarus glacialis*	**51**
	Cory's Shearwater	*Calonectris diomedea*	**76**
	Manx shearwater	*Puffinus puffinus*	**3**
	Unknown shearwater	*Puffinus* or *Calonectris*	**2**
Scolopacidae	Red Phalarope	*Phalaropus fulicaria*	**31**
	Unknown Phalarope	*Phalaropus* spp.	**26**
	Red-necked Phalarope	*Phalaropus lobatus*	**2**
Sulidaie	Northern Gannet	*Morus bassanus*	**220**
Phalacrocoracidae	Double-crested Cormorant	*Phalacrocorax auritus*	**1**
		Total	**1150**

Marine mammal and large fish sightings

During surveys dedicated to seabird sightings, 355 marine mammals were were also observed (Table 2). Short-beaked Common Dolphins (*Delphinus delphis*) were the most common. Also observed were a number of large predatory fish, including Ocean Sunfish, Tuna and several sharks (Table 2).

Table 2: List of marine mammals and large fish recorded during surveys from Dartmouth, N.S. to Dartmouth, N.S. during the fall AZMP cruise, September 24-Oct 15, 2012.

Species	Latin Name	Number observed
Short-beaked Common Dolphin	*Delphinus delphis*	**112**
Unknown Dolphin	Delphinidae	**109**
Long-fined Pilot Whale	*Globicephala melas*	**93**
Long-snouted Spinner Dolphin	*Stenella longirostris*	**15**
Atlantic White-sided Dolphin	*Lagenorhynchus acutus*	**15**
Unknown Whale	Balaenopteridae	**7**
Northern Bottlenose whale	*Hyperoodon ampullatus*	**2**
Blue Whale	*Balaenoptera musculus*	**1**
Humpback Whale	*Megaptera novaeangliae*	**1**
Ocean Sunfish	*Mola mola*	**7**
Tuna Fish	*Thunnus*	**5**
Unknown shark	(not thresher, basking or blue)	**4**
Blue shark	*Prionace glauca*	**1**
	Total	**372**

g. Special Chemistry Sampling:

Darlene Childs and Richard Nelson

Transient Tracers SF_6 and CFC-12.

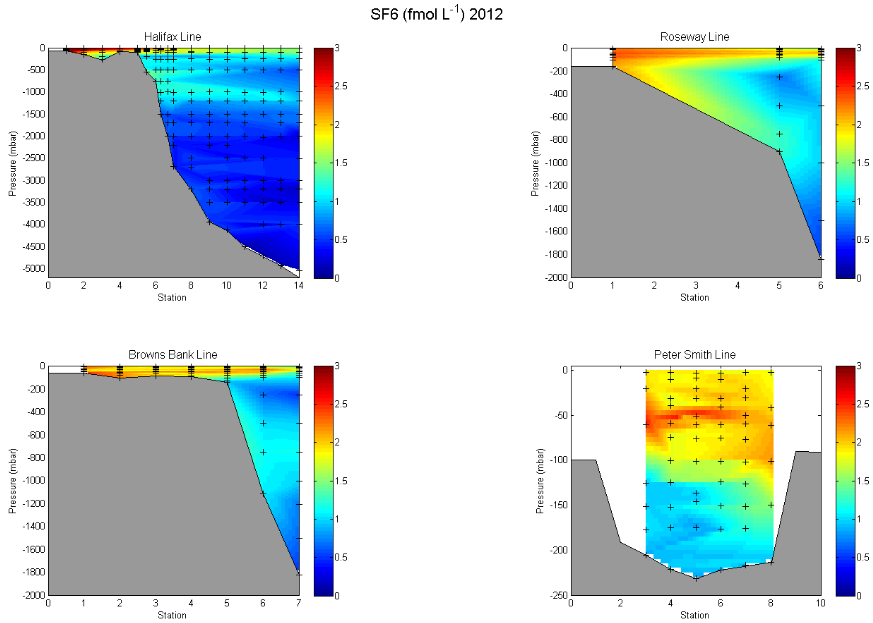
Concentrations of sulphur hexafluoride (SF_6) and chlorofluorocarbon-12 (CFC-12) were measured along the Halifax line during the first leg of the Fall AZMP cruise. These measurements are usually made in the spring in conjunction with the Labrador Sea mission; however, due to complications with ship time, this line was not visited in the spring. It was therefore necessary to collect measurements aboard the Fall AZMP mission.

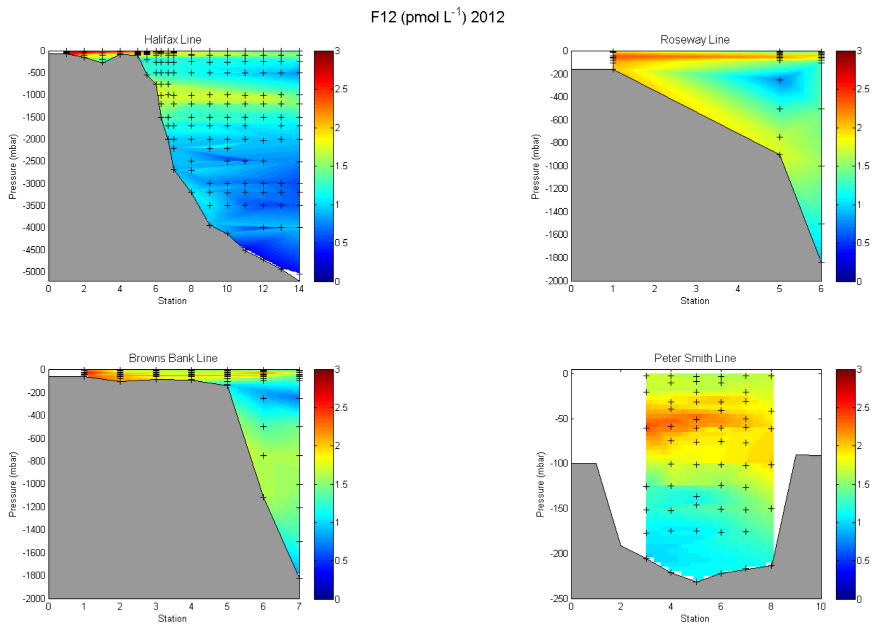
Method

Seawater samples were drawn directly from Niskin bottles into 250 mL glass syringes which were then stored at 2 °C in a low-temperature incubator for up to 12 hours. Immediately before analysis, the samples were warmed to around 20 °C in a water bath then injected into the purge vessel of a custom made purge-and trap system where dissolved gases were stripped from the sample in a stream of ultra high purity nitrogen with a flow rate of 120 mL per minute. SF_6 and CFC-12 were quantitatively retained in a trap comprising 30 cm of 1/16" stainless steel tubing packed with 100-120 mesh Carboxen 1000 held at -70 °C over liquid nitrogen. After each 7 minute purge cycle, the trap was heated to ~180 °C with a low voltage electric current and the desorbed gases were directed to a Varian gas chromatograph equipped with an electron-capture detector. SF_6 and CFC-12 were separated on a 1 m pre-column packed with Porasil B and a 3 m main column packed with Molecular Sieve 5A held isothermally at 92 °C. Total run-time was 11 minutes and 50 seconds for a water sample. The chromatographic sample peaks were quantified with Varian Galaxie software and the analytical system calibrated at least once each day using an air standard supplied by CMDL/NOAA, Boulder, Colorado. Analytical precision as determined by repeated injections of the gas standard was around ± 2 % for SF6 and ± 0.7 % for CFC-12.

Results

In addition to the Halifax Line, measurements were made along the Roseway Line, Brown's Bank Line and the Peter Smith line. Overall 348 samples were collected from 33 stations. Preliminary section plots from these lines for dissolved SF_6 and CFC-12 are shown below.





Total Inorganic Carbon and Total Alkalinity

Total inorganic carbon (TIC) and total alkalinity (TA) samples were collected during the Fall AZMP cruise as it was not possible to obtain these samples in the spring as stated above. Seawater samples for combined TIC and TA analysis were collected in 500 mL borosilicate glass reagent bottles and preserved by the addition of 100 µL of saturated mercuric chloride solution. A 5 mL headspace was created in each sample before sealing the bottles with greased glass stoppers held in place with rubber bands. The samples were transported back to BIO for analysis.

Delta Oxygen[18]

Delta oxygen[18] samples were collected in sodalime glass amber bottles and sealed with electrical tape and stored for later analysis at Dalhousie University.

Sample Inventory

		SAMPLES COLLECTED (OSD LAB)		
ID	PRES	SF6/CFC-12	CO2	O18
385251	83.518	x	x	x
385252	60.752	x	x	
385253	49.904	x	x	x
385254	40.522	x	x	x
385255	30.03	x	x	x
385256	21.183	x	x	x
385257	10.253	x	x	x
385258	1.831			
385259	1.95	x	x	x
385260	142.957	x	x	x
385261	100.83	x	x	x
385262	79.812		x	x
385263	61.354		x	
385264	51.118	x	x	x
385265	40.906		x	x
385266	30.931		x	x
385267	20.289	x	x	x
385268	10.269	x	x	x
385269	1.79			
385270	2.11	x	x	x
385271	258.915	x	x	x
385272	201.086	x	x	x
385273	102.114	x	x	x
385274	80.848		x	x
385275	60.765		x	
385276	51.198	x	x	x
385277	41.111		x	x
385278	31.17		x	x
385279	20.969		x	x
385280	10.709	x	x	x
385281	2.825		x	x
385282	2.449	x	x	x
385283	75.141	x	x	x
385284	60.339		x	
385285	60.454	x	x	x
385286	24.956	x	x	x
385287	20.762		x	x
385288	20.681	x	x	x
385289	10.832	x	x	x

385290	2.541				
385291	2.482	x	x	x	
385292	93.347	x	x	x	
385293	80.322	x	x	x	
385294	59.873	x	x		
385295	50.564	x	x	x	
385296	40.42	x	x	x	
385297	30.26	x	x	x	
385298	20.399	x	x	x	
385299	10.44	x	x	x	
385300	2.691				
385301	2.733	x	x	x	
385302	540.252	x	x	x	
385303	200.739	x	x	x	
385304	99.957	x	x	x	
385305	80.339		x	x	
385306	60.128		x		
385307	50.886	x	x	x	
385308	41.105		x	x	
385309	30.448		x	x	
385310	19.968		x	x	
385311	10.673	x	x	x	
385312	3.003				
385313	2.63	x	x	x	
385314	944.561	x	x	x	DNF
385315	751.005	x	x	x	
385316	500.241	x	x	x	
385317	250.734	x	x	x	
385318	101.234	x	x	x	
385319	80.91		x	x	
385320	59.98		x		
385321	50.278	x	x	x	
385322	38.834		x	x	
385323	30.167		x	x	
385324	19.908	x	x	x	
385325	10.083	x	x	x	
385326	2.392				
385327	1.699	x	x	x	
385328	1675.52	x	x	x	
385329	1501.51	x	x	x	
385330	1199.4	x	x	x	
385331	1001.3	x	x	x	
385332	750.155	x	x	x	
385333	500.85	x	x	x	
385334	250.775	x	x	x	
385335	100.451	x	x	x	
385336	80.92		x	x	
385337	60.561		x		
385338	50.931	x	x	x	
385339	40.261		x	x	
385340	30.702		x	x	
385341	21.319	x	x	x	
385342	10.567	x	x	x	
385343	2.901				
385344	2.373	x	x	x	
385345	2342.14				

385346	2342.75				
385347	2342.7				
385348	2342.76				
385349	2343.2				
385350	2343.32	x	x	x	DNF
385351	1999.91	x	x	x	
385352	1701.31	x	x	x	
385353	1500.75	x	x	x	
385354	1199.92	x	x	x	DNF
385355	999.864	x	x	x	
385356	749.923	x	x	x	
385357	501.131	x	x	x	
385358	251.24	x	x		
385359	100.16	x	x	x	
385360	79.564		x	x	
385361	61.217		x		
385362	50.348	x	x	x	
385363	40.154		x	x	
385364	30.455		x	x	
385365	20.347		x	x	
385366	10.615	x	x	x	
385367	2.001				
385368	2.062	x	x	x	
385369	2674.09				
385370	2675.16				
385371	2674.89				
385372	2674.65				
385373	2677.79	x	x	x	
385374	2500.28	x	x	x	DNF
385375	2200.96	x	x	x	
385376	2001.93	x	x	x	
385377	1702.4	x	x	x	
385378	1502.44	x	x	x	DNF
385379	1200.46	x	x	x	
385380	1001.06	x	x	x	
385381	500.755	x	x	x	
385382	252.009	x	x	x	
385383	101.461	x	x	x	
385384	80.101		x	x	
385385	59.956		x		
385386	49.331	x	x	x	
385387	40.124	x	x	x	
385388	30.259	x	x	x	
385389	21.042	x	x	x	
385390	11.081	x	x	x	
385391	2.327				
385392	2.188	x	x	x	
385393	3460.98	x	x	x	
385394	3201.34	x	x	x	
385395	3001.42	x	x	x	
385396	2702.12	x	x	x	
385397	2501.48	x	x	x	
385398	2201.07	x	x	x	DNF
385399	2000.94	x	x	x	
385400	1699.85	x	x	x	
385401	1500.45	x	x	x	

385402	1201.3	x	x	x	
385403	1000.91	x	x	x	
385404	500.31	x	x	x	
385405	249.85	x	x	x	
385406	100.319	x	x	x	
385407	79.64		x	x	
385408	60.4		x		
385409	49.778		x	x	
385410	39.972		x	x	
385411	29.902		x	x	
385412	20.985		x	x	
385413	10.538		x	x	
385414	2.196				
385415	1.801	x	x	x	
385417	3942.33				
385418	3941.65	x	x	x	
385419	3502.38	x	x	x	
385420	3199.35	x	x	x	
385421	3001.6	x	x	x	
385422	2499.84	x	x	x	DNF
385423	2199.51	x	x	x	
385424	2000.55	x	x	x	
385425	1701.72	x	x	x	
385426	1501.37	x	x	x	
385427	1200.37	x	x	x	
385428	999.966	x	x	x	
385429	501.495	x	x	x	
385430	250.973	x	x	x	
385431	101.16	x	x	x	
385432	80.21		x	x	
385433	60.723		x		
385434	50.431		x	x	
385435	40.521		x	x	
385436	29.928		x	x	
385437	20.315		x	x	
385438	10.973		x	x	
385439	3.333				
385440	3.295	x	x	x	
385441	4128.17				
385442	4129.83	x	x	x	
385443	3502.47	x	x	x	
385444	3205.13	x	x	x	
385445	3002.35	x	x	x	
385446	2500.62	x	x	x	
385447	2201.35	x	x	x	
385448	2000.67	x	x	x	
385449	1701.67	x	x	x	
385450	1500.62	x	x	x	
385451	1199.06	x	x	x	
385452	999.916	x	x	x	
385453	499.099	x	x	x	
385454	250.803	x	x	x	
385455	100.527	x	x	x	
385456	79.526		x	x	
385457	60.743		x		
385458	51.242		x	x	

385459	39.487		x	x
385460	29.55		x	x
385461	21.062		x	x
385462	10.656		x	x
385463	1.35			
385464	2.225	x	x	x
385465	4506.3			
385466	4506.59	x	x	x
385467	3500.59	x	x	x
385468	3199.65	x	x	x
385469	3001.73	x	x	x
385470	2499.53	x	x	x
385471	2201.61	x	x	x
385472	2000.74	x	x	x
385473	1700.28	x	x	x
385474	1501.57	x	x	x
385475	1201.01	x	x	x
385476	1001.04	x	x	x
385477	500.412	x	x	x
385478	250.415	x	x	x
385479	100.122	x	x	x
385480	81.147		x	x
385481	60.398		x	x
385482	50.39		x	x
385483	40.772		x	x
385484	30.907		x	x
385485	20.965		x	x
385486	11.038		x	x
385487	2.011			
385488	2.441	x	x	x
385489	4719.84			
385490	4719.31	x	x	x
385491	4000.42	x	x	x
385492	3501.86	x	x	x
385493	3199.3	x	x	x
385494	3009.93	x	x	x
385495	2499.37	x	x	x
385496	2024.59	x	x	x
385497	1697.72	x	x	x
385498	1502.31	x	x	x
385499	1201.05	x	x	x
385500	1001.56	x	x	x
385501	502.129	x	x	x
385502	249.802	x	x	x
385503	100.68	x	x	x
385504	79.993		x	x
385505	61.048		x	
385506	50.473		x	x
385507	40.519		x	x
385508	30.892		x	x
385509	19.859		x	x
385510	9.994		x	x
385511	2.307			
385512	1.422	x	x	x
385513	4930.96			
385514	4930.29	x	x	x

385515	4001.75	x	x	x	
385516	3499.43	x	x	x	
385517	3200.71	x	x	x	
385518	2999.8	x	x	x	
385519	2500.82	x	x	x	leaking badly... Dumped later
385520	1999.22	x	x	x	
385521	1700.02	x	x	x	
385522	1500.74	x	x	x	
385523	1200.84	x	x	x	
385524	1000.48	x	x	x	
385525	500.291	x	x	x	
385526	249.004	x	x	x	
385527	100.274	x	x	x	
385528	79.793		x	x	
385529	59.917		x		
385530	50.121		x	x	
385531	39.608		x	x	
385532	30.626		x	x	
385533	20.529		x	x	
385534	10.591		x	x	
385535	2.65		x	x	
385536	2.615	x	x	x	
385537	5041.64				
385538	5041.41	x	x		
385539	4001.19	x	x	x	
385540	3499.88	x	x		
385541	3201.31	x	x	x	
385542	3000.84	x	x		
385543	2501.83	x	x	x	
385544	2000.05	x	x		
385545	1698.55	x	x	x	
385546	1502.47	x	x		
385547	1201.71	x	x	x	
385548	1000.3	x	x		
385549	501.667	x	x	x	
385550	250.324	x	x		
385551	100.327	x	x	x	
385552	80.387		x		
385553	60.667		x	x	
385554	50.72		x		
385555	41.162		x	x	
385556	30.231		x		
385557	20.456		x	x	
385558	10.315		x		
385559	3.045	x	x	x	
385561	1846.7				
385562	1845.62	x			
385563	1502.05	x			
385564	1000.16	x			
385565	503.31	x			
385566	250.041	x			
385567	99.81	x			
385568	79.27	x			

385569	60.24	x
385570	50.654	x
385571	40.376	x
385572	31.785	x
385573	20.955	x
385574	11.003	x
385575	2.768	
385576	3.686	x
385577	902.554	x
385578	750.38	x
385579	502.37	x
385580	250.701	x
385581	101.153	x
385582	80.149	x
385583	60.384	x
385584	50.701	x
385585	40.29	x
385586	29.991	x
385587	20.975	x
385588	9.479	x
385589	1.989	
385590	2.192	x
385591	1820.82	
385592	1822.12	x
385593	1501.76	x
385594	1204.46	x
385595	1000.93	x
385596	750.827	x
385597	496.3	x
385598	250.346	x
385599	99.35	x
385600	79.842	x
385601	61.133	x
385602	49.78	x
385603	40.716	x
385604	30.672	x
385605	20.525	x
385606	10.863	x
385607	2.677	
385608	2.901	x
385609	1115.9	
385610	1116.38	x
385611	749.869	x
385612	500.167	x
385613	249.684	x
385614	99.506	x
385615	80.597	x
385616	61.187	x
385617	49.996	x
385618	39.841	x
385619	30.211	x
385620	19.506	x
385621	10.403	x
385622	2.381	
385623	2	x
385624	137.438	x

385625	128.536	x
385626	101.077	x
385627	79.497	x
385628	61.184	x
385629	49.699	x
385630	39.877	x
385631	29.396	x
385632	21.372	x
385633	10.783	x
385634	2.166	
385635	1.867	x
385636	92.125	x
385637	87.194	x
385638	61.622	x
385639	49.005	x
385640	40.245	x
385641	30.449	x
385642	20.688	x
385643	11.099	x
385644	2.487	
385645	2.749	x
385656	191.872	
385657	175.61	
385658	149.482	
385659	125.249	
385660	101.496	
385661	75.43	
385662	59.883	
385663	49.22	
385664	40.322	
385665	31.028	
385666	19.97	
385667	10.889	
385668	3.128	
385669	3.294	
385670	221.653	x
385671	175.043	x
385672	152.333	x
385673	124.991	x
385674	100.469	x
385675	74.887	x
385676	58.59	x
385677	50.931	x
385678	39.038	x
385679	31.528	x
385680	10.62	x
385681	2.873	
385682	2.404	x
385683	221.888	x
385684	176.942	x
385685	151.067	x
385686	124.238	x
385687	101.581	x
385688	75.722	x
385689	60.815	x
385690	50.287	x

385691	40.719	x
385692	31.098	x
385693	20.549	x
385694	10.453	x
385695	2.452	
385696	3.448	x
385697	213.725	x
385698	175.86	
385699	149.972	x
385700	127.504	
385701	101.404	x
385702	76.611	
385703	61.058	x
385704	51.047	
385705	41.669	x
385706	30.123	
385707	21.059	
385708	11.024	
385709	2.66	
385710	2.329	
385711	91.223	
385712	76.181	
385713	61.568	
385714	51.009	
385715	40.559	
385716	30.304	
385717	21.791	
385718	10.624	
385719	2.575	
385720	2.362	
385721	89.969	
385722	76.075	
385723	61.048	
385724	50.6	
385725	41.275	
385726	30.667	
385727	20.523	
385728	11.07	
385729	2.388	
385730	3.387	
385731	216.609	x
385732	176.074	x
385733	151.421	x
385734	126.445	x
385735	101.986	x
385736	76.71	x
385737	59.879	x
385738	50.056	x
385739	39.277	
385740	30.623	x
385741	20.885	x
385742	10.275	
385743	2.719	
385744	2.4	x
385745	231.418	x
385746	174.942	x

385747	145.778	x
385748	136.863	x
385749	101.262	x
385750	76.175	x
385751	60.59	x
385752	51.443	x
385753	40.475	x
385754	31.613	x
385755	20.361	x
385756	8.61	x
385757	2.947	
385758	3.425	x
385759	205.554	x
385760	177.219	x
385761	151.882	x
385762	125.819	x
385763	101.151	
385764	59.721	
385765	60.347	x
385766	50.586	
385767	38.522	
385768	28.902	
385769	20.39	x
385770	9.363	
385771	2.516	
385772	2.178	x
385773	105.269	x
385774	82.101	x
385775	61.607	x
385776	50.361	x
385777	41.593	x
385778	31.784	x
385779	20.746	x
385780	10.329	x
385781	2.266	
385782	3.512	x
385783	141.759	
385784	101.394	
385785	81.609	
385786	62.017	
385787	50.989	
385788	39.829	
385789	30.574	
385790	20.536	
385791	10.346	
385792	2.961	
385793	2.772	
385794	103.567	x
385795	80.874	x
385796	60.186	x
385797	50.905	x
385798	40.667	x
385799	29.942	x
385800	19.908	x
385801	8.899	x
385802	2.764	

385803	2.113	x
385804	58.269	x
385805	49.428	x
385806	39.038	x
385807	30.636	x
385808	21.669	x
385809	11.383	
385810	1.969	
385811	2.886	x
385812	159.138	x
385813	100.464	x
385814	80.989	x
385815	61.218	x
385816	50.521	x
385817	40.5	x
385818	31.311	
385819	20.384	
385820	11.535	x
385821	3.149	
385822	3.092	x

Accomplishments & Problems/Goals Not Achieved

All of the stations of the main AZMP lines were sampled, so that the first major objective, the core AZMP sampling, was successfully completed. 3 of the 3 OTN moorings were successfully recovered and replaced. The lone ADCP mooring @ STAB3 stn was recovered. All marine mammal acoustic moorings were deployed. Additional stations were sampled as required by the additional objectives stated above and all objectives were achieved

The first 'leg' of the mission was to the Western Scotian Shelf. The Halifax Line (including AZOMP stations 8 – 14) was first occupied; then the Browns Bank Line with a divergence for the PS (Peter Smith) Line which was run across Northeast Channel in order to examine the flux of nutrients into and out of the Gulf of Maine via this route. Roseway Basin was sampled on the run back to BIO for a scientific personnel exchange.

The second 'leg' of the mission was to the Eastern Scotian Shelf, the Gully and Cabot Strait. In addition to the AZMP sampling along the Cabot Strait, Sable Island Bank, and Louisbourg Lines, 4 stations were sampled in the central Gully and Gully mouth. Since we had excellent weather we also had time to sample the BP, EH, SPB (St. Pierre Bank), and GBL stations to the east to characterize the flow around the tail of the Grand Bank, into the Laurentian channel or diverging along the scotian slope.

6. Other Incidents of Note

7. List of Cruise Participants

Name	Responsibility	Affiliation
Adam Hartling	CTD operations, Tech Ops	OSD, BIO
Bob Ryan	CTD operations, Tech Ops	OSD, BIO
Bradley Toms	Seabird Trainee	CWS
Carla Caverhill	Sample processing	OESD, BIO
Carol Anstey	Sample process, Nutrient/Oxygen analysis	OESD, BIO
Darlene Childs	Chemistry SF6/CFC-12/O18	OESD, BIO
David Hebert	OIC trainee, CTD operations	OESD, BIO
Edward Horne	Chief Scientist, CTD operation, CDOM	OESD, BIO
Hiliary Moors	Acoustic mooring investigator	Oceans, BIO
Jay Barthelotte	Mooring Technician, Tech Ops	OSD, BIO
Jeff Spry	Zooplankton, Sample processing, data flow	OESD, BIO
Leah Pengalle	CO2 sampling	Dalhousie U.
Marc Ringuette	Zooplankton Biologist, Zoopl. Sampling	OESD, BIO
Marie-Claude Fortin	Observer, Ottawa HQ	DFO
Mellisa Nache	CO2 sampling	Dalhousie U.
Richard Nelson	Chemistry SF6/CFC-12/O18	OESD, BIIO
Robert Ryan	CTD maintenance, Computer/Winch Room,	OSD, BIO
Sarah Wong	Seabird Observer	CWS
Susan Abbott	Seabird Observer	CWS
Tim Perry	Sample processing	OESD, BIO
William Burt	CO2 sampling	Dalhousie U.

BIO	Bedford Institute of Oceanography\ 1 Challenger Drive, PO Box 1006, Dartmouth, NS, Canada, B2Y 2A4
Dalhousie	Dalhousie University. Oceanography Dept., Halifax, NS, Canada

B. UNDERWAY MEASUREMENTS

1. 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 echo sounder system used for collecting bathymetric data at station locations consisted of a 12 KHz Raytheon PTR echo sounder that created an analog trace on a Raytheon Line Scan Recorder located in the forward laboratory. 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.

2. Vessel Mounted Acoustic Doppler Current Profiler Technical Ops

Hudson is equipped with a Teledyne RDI Ocean Surveyor II vessel mounted acoustic Doppler current profiler (ADCP) 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 transducer assembly is mounted on a ram penetrating the ships hull that can be lowered if necessary. Transducer remained in the retracted position for the duration of the cruise. It was determined during sea acceptance testing that lowering the transducer did not effect the operation of the system. The transducer is located approximately 6m below the waterline.

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

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

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

Data will have to be reprocessed using gyro heading during periods with low quality or no attitude solution. Raw data can be reprocessed using VmDas.

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.

3. Continuous Flow Multisensor Package (CFMP) Jeff Anning

Water from approximately 4 m depth was continuously pumped to the forward lab. The temperature, conductivity and fluorescence were measured and logged every 60 sec. The temperature and conductivity were measured with Sea-Bird sensors and the fluorescence by a WET Labs flow through fluorometer. Incident Photosynthetically Active Radiation was not measured this mission with a Li-Cor Spherical Quantum Sensor - structural changes affected cable run. Exact time and positions were provided by the ship's GPS and logged with the other data.

4. XBT measurements

NA

5. Ashtech ADU5 Attitude determination unit

Adam Hartling

The Ashtech ADU5 is an attitude determination and real-time DGPS positioning system that provides motion corrections for the Ocean Surveyor II (OS-II) vessel-mounted ADCP.

The ADU5 uses differential carrier phase measurements from an array of four GPS receivers (Antennas) to compute heading, roll, and pitch in real-time at a 5 Hz update rate.

Position and velocities are computed only for Antenna 1. The remaining antennas provide carrier phase data for attitude determination. Antenna 1 is a Beacon antenna providing differential position when in range of a base station. Beacon corrections were available for all but the most northeast portion of the cruise.

Antenna separations in a normal multipath environment determine the level of solution accuracy. The fore-aft antenna separation of 3 m provides potential heading accuracy of 0.2 degrees. The port-starboard antenna separation of 1 m provides potential pitch/roll accuracy of 0.6 degrees.

User configurable data is output on two serial ports. Output Port A is not used. Output Port B, 115200, 1 Hz update rate, provides position and attitude data for the Ocean Surveyor II. NMEA strings used include GGA, VTG, and PASHR, AT2 (heading, pitch, roll)

When the receiver is searching for the ambiguities or when a valid solution has not been found, a code phase estimate of heading appears in the PASHR, AT2 string and pitch and roll are displayed as exactly 0.00. Heading may also be displayed as 0.00 if no estimate is available. The PASHR, AT2 string contains a quality flag which indicated the quality of the solution. When either of these situations exist, the attitude reset flag is set to 1 in the attitude output message (a 0 for the attitude reset flag indicates a good attitude solution).

If noisy or bad satellite measurement data was received by the ADU5 the Kalman filters sometimes get lost. This results in no valid solution. This often is the result of high multipath interference. BRMS and MRMS fields in the PASHR, AT2 string will exceed maximum noise levels, and the PDOP will become large. For a good solution PDOP should be less than 6.

Solution quality was monitored on a daily basis with the aid of the Teledyne RDI VMDAS and WinADCP software packages used to log and monitor the OSII ADCP current profile data.

6. 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 (Section B5) 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.

7. Atmospheric Chemistry

The atmospheric chemistry program carried out by investigators from Dalhousie University is described in Section 4.2.c in Part A above.

F. APPENDICES

Appendix 1. Operation Notes Report ?

Appendix 2. CTD Initial Setup Information **Bob Ryan**

Original Request _X__ Update _____
Information Supplied By: ____Bob Ryan______
Date: Sept 24, 2012

Mission: **HUD2012-002** DepartureDate:**24September, 2012**

Chief Scientist: **Edward Horne**

INSTRUMENT CONFIGURATION

Frequency channels suppressed = **0**
Voltage words Suppressed = **0**
Computer interface = **RS-232**
Scans to average = **1**
Surface PAR voltage added = **No X** Yes __
Scan time added= **No X** Yes __
NMEA position data added = **Yes**

DEEP Cast Set-up:

Channel Designation	Parameter	Model Number	Serial Number	Calibration Date	System Number
Frequency 0	Temperature - Primary	SBE3	**035081**	**16 April 2012**	**TS13**
Frequency 1	Conductivity - Primary	SBE4	**043561**	**16 April 2012**	**CS13**
Frequency 2	Pressure – SBE9*plus* s/n 9P7356-0289	410K-105	**69009**	**19 April 2012**	**PP06**
		Modulo 12P	**0362**	**31 January 1997**	
Frequency 3	Temperature - Secondary	SBE3	**035083**	**16 March 2012**	**TS14**
Frequency 4	Conductivity - Secondary	SBE4	**043562**	**16 March 2012**	**CS14**
Voltage 0	Altimeter	PSA-916	**49559**	**18 February 2010**	**AL05**
Voltage 1	Fluorometer Chelsea	AquaTracka Mk 3	**088172**	**19 January 2010**	**FC01**
Voltage 2	Oxygen	SBE43	**430133**	**13 December 2011**	**OX02**
Voltage 3	Oxygen	SBE43	**431588**	**23 November 2011**	**OX03**
Voltage 6	O2 concentration	Optode 4330F	**372**		
Voltage 7	O2 Temp	Optode 4330F	**372**		

SHALLOW Cast Set-up:

Channel Designation	Parameter	Model Number	Serial Number	Calibration Date	System Number
Frequency 0	Temperature - Primary	SBE3	**035081**	**16 April 2012**	**TS13**
Frequency 1	Conductivity - Primary	SBE4	**043561**	**16 April 2012**	**CS13**
Frequency 2	Pressure – SBE9*plus* s/n 9P7356-0289	410K-105	**69009**	**19 April 2012**	**PP06**
		Modulo 12P	**0362**	**31 January 1997**	
Frequency 3	Temperature - Secondary	SBE3	**035083**	**16 March 2012**	**TS14**
Frequency 4	Conductivity - Secondary	SBE4	**043562**	**16 March 2012**	**CS14**
Voltage 0	Altimeter	PSA-916	**49559**	**18 February 2010**	**AL05**
Voltage 1	Fluorometer Chelsea	AquaTracka Mk 3	**088172**	**19 January 2010**	**FC01**
Voltage 2	Oxygen	SBE43	**430133**	**13 December 2011**	**OX02**
Voltage 3	Oxygen	SBE43	**431588**	**23 November 2011**	**OX03**
Voltage 4	Irradiance (PAR)	LI-193SA	**SPQA2711**	**17 June 1999**	**IR03**
		PN 90310	**0002-CH1**	**17 April 98**	**LA01**
Voltage 5	Fluorometer, WetLabs	CDOM WETStar	**WSCD-987P**	**18 August 2003**	**FL07**
Voltage 6	pH Sensor	SBE18	**180743**	**06 March 2012**	**PH01**
Voltage 7					

Additional Configure Information

ASCII Output: **Shared File – C:\CTDdata\shared.dat (refer to attached)**
Deck Unit Modem COMM Port = **COM ___** (selected in 'Realtime Data : Start Acquisition')
Water Sampler
Number of Water Bottles = **24**
Water Sampler Type = **SBE Carousel**
Firing Sequence = **Sequential**
Bottle Positions For Table Driven = < See CTD System Administrator if REQUIRED >

SPARES

Parameter	Model Number	Serial Number	Calibration Date	System Number
Temperature	SBE3	031256	23 February 2009	**TS06**
Temperature	SBE3	032303	4 March 2010	**TS10**
Temperature	SBE3	031376	9 February 2009	**TS03**
Temperature	SBE3	032298	4 March 2010	**TS09**
Conductivity	SBE4	040997	23 February 2009	**CS06**
Conductivity	SBE4	041874	4 March 2010	**CS10**
Conductivity	SBE4	041076	9 February 2009	**CS03**
Conductivity	SBE4	041873	4 March 2010	**CS09**
Pressure – SBE9*plus* s/n 9P5676-0228	410K-105	51403	18 March 2010	**PP03**
	Modulo 12P	0105	31 December 1992	
Pressure – SBE9*plus* s/n 9P9984-0370	410K-105	50601	18 March 2009	**PP05**
	Modulo 12P	0838	30 April 2007	
Altimeter	PSA-916	49058	16 December 2009	**AL04**
Oxygen	SBE43	430133	21 January 2009	**OX02**

<u>ASCII Output Setup (for shared file)</u>

__**X**__ Generate Shared File

Shared File… **C:\Metering Sheave\shared.dat**

Number of seconds (data time) between ASCII updates: **0.5**

ASCII Output Variables

	Variable	Dec. Digits
Column #0	**scan number**	**0**
Column #1	**pressure**	**2**
Column #2	**altimeter**	**2**
Column #3	**none**	**3**
Column #4	**none**	**3**
Column #5	**none**	**3**
Column #6	**none**	**3**
Column #7	**none**	**3**

	Variable	Dec. Digits
Column #8	**none**	**3**
Column #9	**none**	**3**
Column #10	**none**	**3**
Column #11	**none**	**3**
Column #12	**none**	**3**
Column #13	**none**	**3**
Column #14	**none**	**3**