Arctic Marine Biodiversity Observing Network (AMBON)

2015 cruise report

Chief Scientist: Katrin Iken (University of Alaska Fairbanks)

National Ocean Partnership Program (NOS Integrated Ocean Observations Systems (IOOS), award number: NA14NOS0120158) with funding from NOAA, Shell Oil Company, and BOEM (Bureau of Ocean Energy Management)

Project summary

The goal of the Arctic Marine Biodiversity Observing Network (AMBON) project is to build an operational marine biodiversity observation network (MBON) for the US Chukchi Sea continental shelf as a prototype network that could be applied to other marine systems within the nation. The importance of the Arctic Ocean to global climate and ecosystem processes, and the speed at which climate changes are already occurring in the Arctic, elevate the urgency for coordinated observations of Arctic marine biodiversity. In an end-to-end approach, from microbes to whales, AMBON science experts work with the Alaska Ocean Observing System (AOOS) to coordinate data streams from past and ongoing programs into one observation network for the US Arctic. In an interdisciplinary, multi-investigator approach, all ecosystem components will be sampled during this cruise: physical-chemical parameters of the water column and sediment, water and sediment microbes, phytoplankton, zooplankton, infauna and epifauna, demersal (and opportunistically pelagic) fishes, seabird, and marine mammal observations.

The AMBON project includes three field seasons (2015-2017), the first in summer 2015. The 2015 cruise took place 8 August – 5 September on the Norseman II, starting in Prudhoe Bay and ending in Wainwright. The survey lines were observed in the following order (see Figure 1):
DBO-3
CL
ML6
ML4 (incl. DBO4)
ML3
ML5
ML1

Science operations included 12-h observations of seabirds and marine mammals during daylight hours and 12-h stations work during night time hours. The typical sampling/gear order at a station was: CTD, vertical zooplankton net (150 µm), van Veen grabs (0.1 m^2), HAPS core (not at every station), Bongo net (505 µm), modified Plump-staff beam trawl (PSBT-A), Isaak Kit Midwater Trawl (IKMT; not at every station). Along some of the lines, we took additional CTD stations for better resolution of the hydrography (CL, ML3). The cruise objectives also included the recovery and deployment of several moorings.

The science party included (asterisks indicate discipline leads)

Physical oceanography and moorings
Seth Danielson (UAF) *
Peter Shipton (UAF)

Water column and sediment chemistry
Lee Cooper (U Maryland) *

Microbial sampling
R. Eric Collins (UAF) *

Zooplankton
Caitlin Smoot (UAF) *
Faith Stemmler

Infauna
Jacqueline Grebmeier (U Maryland) *
Christina Goethel (U Maryland)

Epifauna and Food webs
Katrin Iken (UAF, chief scientist) *
Ann-Christine Zinkann (UAF)
Tanja Schollmeier (UAF)

Fish
Lorena Edenfield (UAF) *

Seabird observations
Dan Cushing *
Athina Catherine Pham

Marine mammal observations
Suzanne Yin *
Sonia Groves

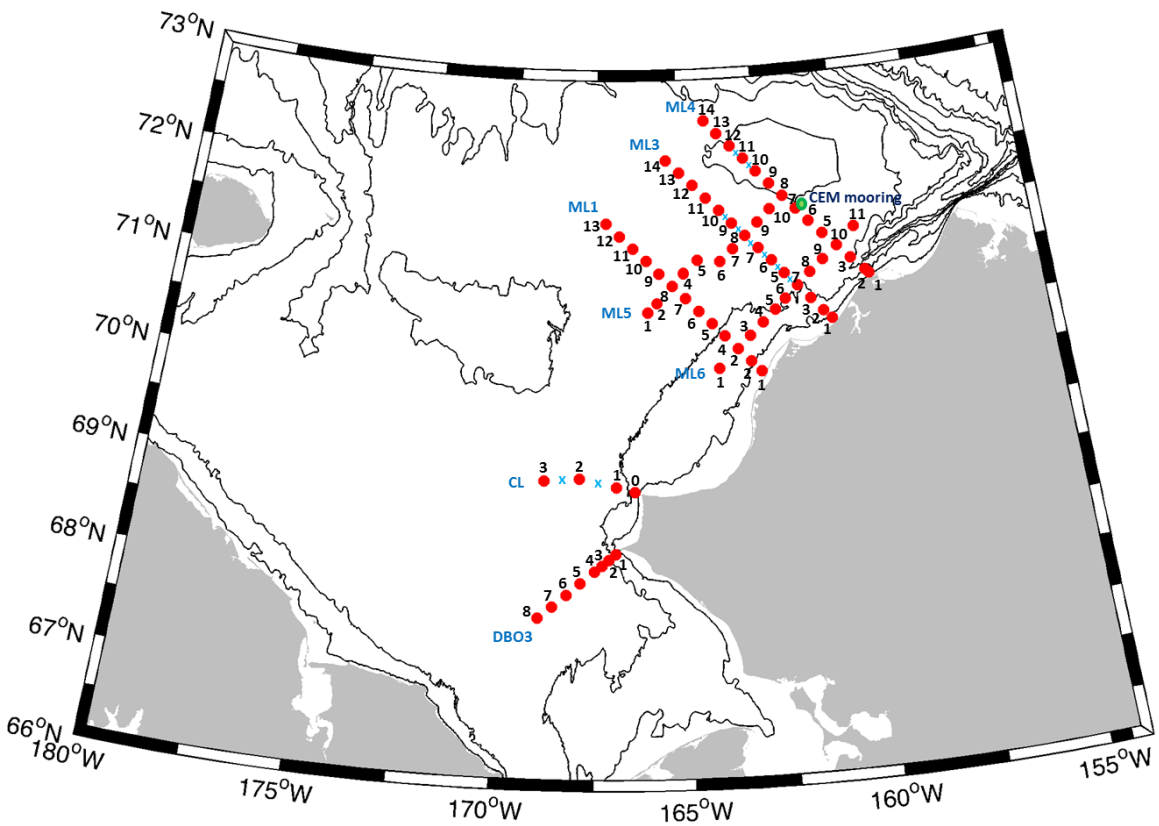

Figure 1: Station map of the AMBON 2015 cruise. Red dots indicate full stations, blue X indicates CTD stations only, green circle indicates CEM mooring.

Physical oceanography and moorings

Project discipline PI: Seth Danielson (UAF)

2015 on-board team: Seth Danielson, Peter Shipton

All dates and times of the physical oceanography and mooring report are given in GMT

Underway sampling:

Underway sampling includes the ship's Acoustic Doppler Current Profiler (ADCP), the weather data, NMEA navigational data streams, and the flow-through SBE-21 thermosalinograph (TSG).

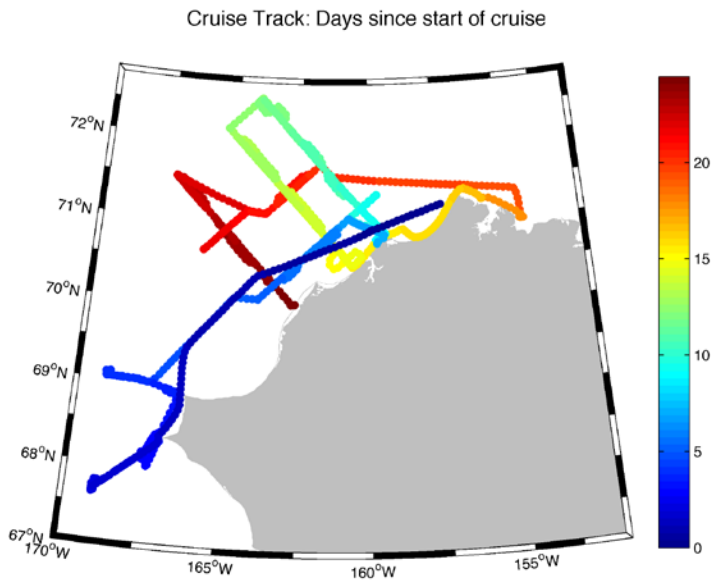

Figure 2: Cruise track of the AMBON 2015 cruise, progressive cruise dates shown by color scheme

The 2015 AMBON cruise embarked in Prudhoe Bay, transited to the southern Chukchi Sea to begin sampling on the DBO3 line, and then progressed northward and through the remainder of the sampling grid (Figure 2).

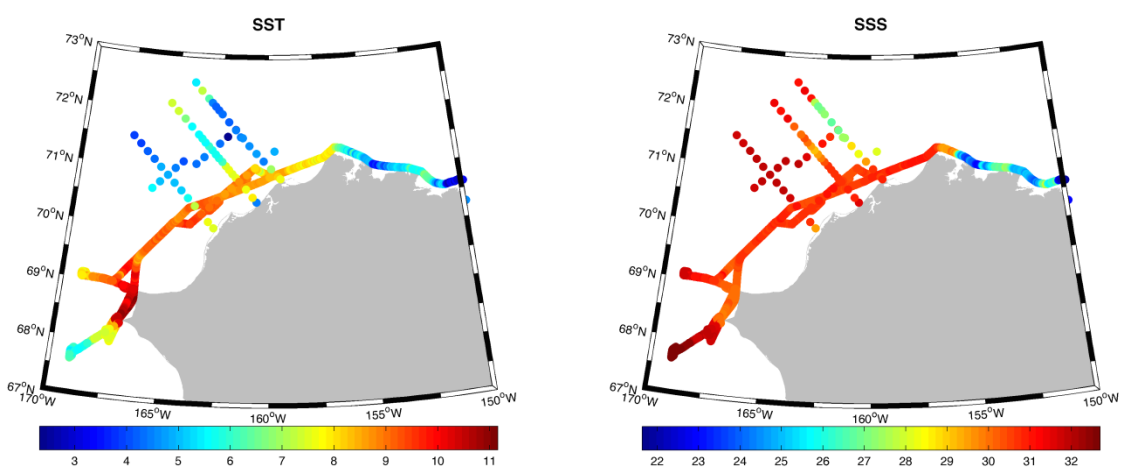

Figure 3: Sea surface temperature (SST, left graph) and sea surface salinity (SSS, right graph) during the AMBON 2015 cruise.

The thermosalinograph (TSG) operated for the first few days of the cruise, but abruptly stopped working on August 16 and failed to re-start. Troubleshooting indicated the problem to be in the electronics of the SBE21 system located in the engine room's seachest. Norseman II shore-side support determined that the system would be replaced for the following cruise leg (Winsor et al. ARCTREX cruise) but that the AMBON cruise would proceed without the SBE21, as it is not a mission-critical data stream.

Near-surface temperature and salinity were recorded by the TSG (continuous line) and the CTD (discrete points) (Figure 3). Near-surface waters in the Beaufort Sea between Prudhoe Bay and Point Barrow were often cool (T ~2-5 °C) and fresh (S < 28), reflecting a pervasive influence of sea ice melt in the Beaufort. Some temporal changes can be detected in CTD samples that are located close to other CTD and TSG locations but are showing different temperatures and salinities.

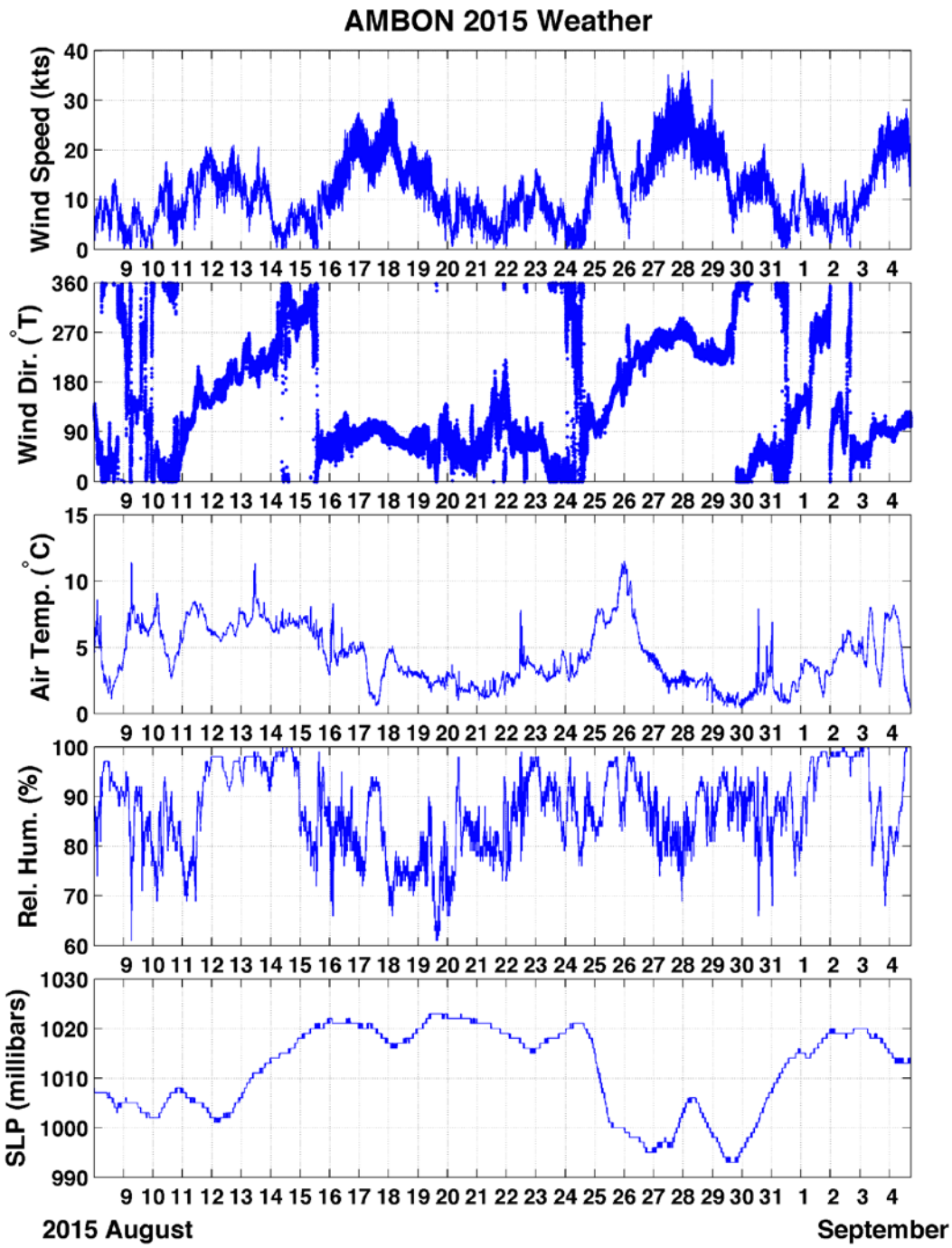

Figure 4: Weather patterns during the AMBON 2015 cruise, recorded by the ship's met station

Local weather conditions were recorded on the Norseman II during the AMBON cruise (Figure 4). Wind events peaking above 30 knots curtailed sampling on two separate occasions, the first time for about two days (Aug 16-18, when we hid from the easterlies close to shore near Wainwright) and the second time for about four days (Aug 25-29, when we hid from westerlies in the Beaufort Sea's Smith Bay). Rain showers (sometimes mixed with snow) occurred regularly throughout the cruise.

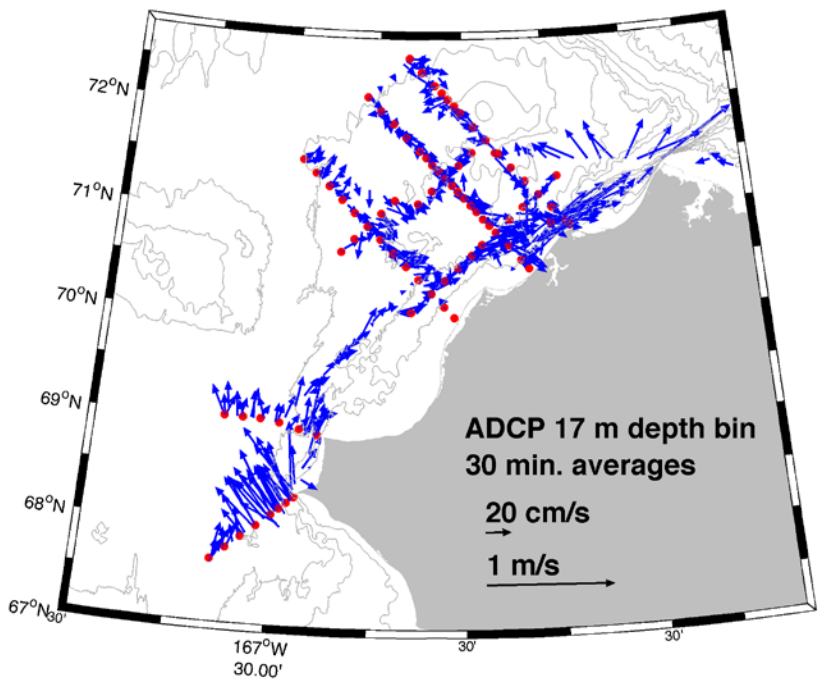

Figure 5: Water velocities at 17 m depth bin from continuous ADCP measurements

The ship's hull-mounted 307 KHz Teledyne RDI ADCP provided continuous measurements of the water column horizontal velocities stored in 1-min and 10-min averaged ensembles. Currents from the 17 m depth bin are shown in the Figure 5. Current vectors are scaled in the map so that the length of each vector represents approximately how far a water parcel or other Lagrangian drifter would be carried in 24 hours. Red dots denote the AMBON station locations.

Moorings:

We recovered three moorings and deployed two. The first recovery was a bottom-mounted tripod located in eastern Harrison Bay (HB_14 @70° 37.971' N, 150° 13.988' W, 10.3 m deep) that the ANIMIDA cruise (immediately preceding the AMBON cruise) failed to recover. We were able to snag the mooring via a dragging operation by briefly pausing during our transit from Prudhoe Bay to the AMBON study region (and without deviating from our transit route). The second operation was a planned taut-wire mooring recovery for Dr. T. Weingartner (UAF) at site BC2 (70° 55.485' N, 159° 56.816' W, 56 m), located at the head of Barrow Canyon near Wainwright. The third mooring recovery was the Chukchi Ecosystem Mooring (CEM, 70° 35.980' N, 161° 30.321' W), located on the SE flank of Hanna shoal near AMBON station ML4.7. The single 2014-15 CEM mooring was replaced by a pair of 2015-16 CEM moorings located about 900 m away from each other. The two newly deployed moorings are located at: CEM1-2015: 71° 35.997' N, 161° 30.042' W and CEM2-2015: 71° 35.9874' N, 161° 31.566' W.

CTD hydrography:

We occupied a total of 87 CTD stations, which included 75 casts at the "primary" AMBON survey station locations with full sampling, 10 "intermediate" stations that were occupied for CTD profiles only and two profiles near mooring sites BC2 and CEM (Figure 6-8, Table 1). The intermediate CTDs provided a higher horizontal resolution of the sampling lines. Because we occupied the ML5 and ML1 lines after a major wind event, we re-occupied stations with new CTD profiles where the ML5 line crossed the ML4 and ML3 lines (stations ML4.8 and ML3.8) and where the ML1 line crossed ML6 (ML1.3/ML6.2). Horizontal cross-sections of all primary CTD sensor streams from all AMBON transects are attached below.

Indications of ice melt water were seen on line ML4 (and to a lesser extent, ML3). These relatively cool (T ~ 4-5 C) and low-salinity (S < 29) waters overlaid much colder and saltier remnant winter waters (T < -1; S > 31.5). Close to the Alaskan coast, waters were generally warmer than found offshore (consistent with expectations of Alaskan Coastal Waters), but we did not find a corresponding (and generally expected) decrease in salinity at the nearshore stations of ML3 and ML4. We did observe both warming and freshening near the coast on the ML1, DBO3 and CL transects.

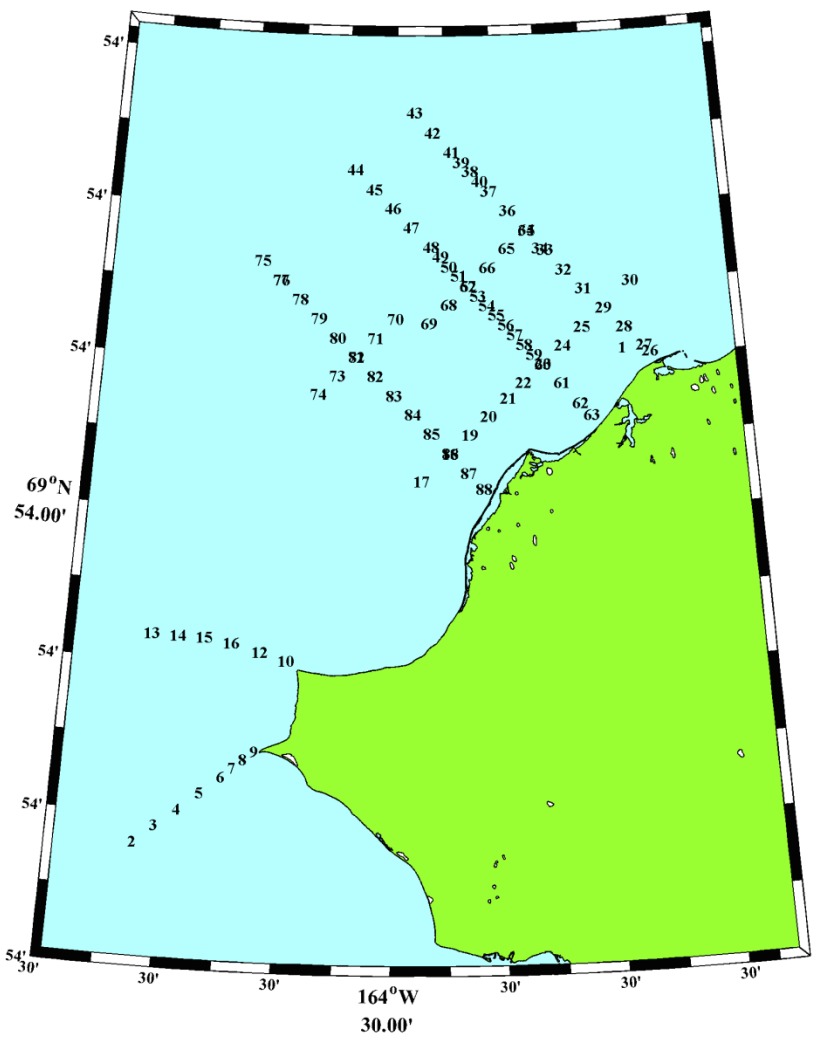

Figure 6: CTD consecutive station numbers from the 2015 AMBON cruise

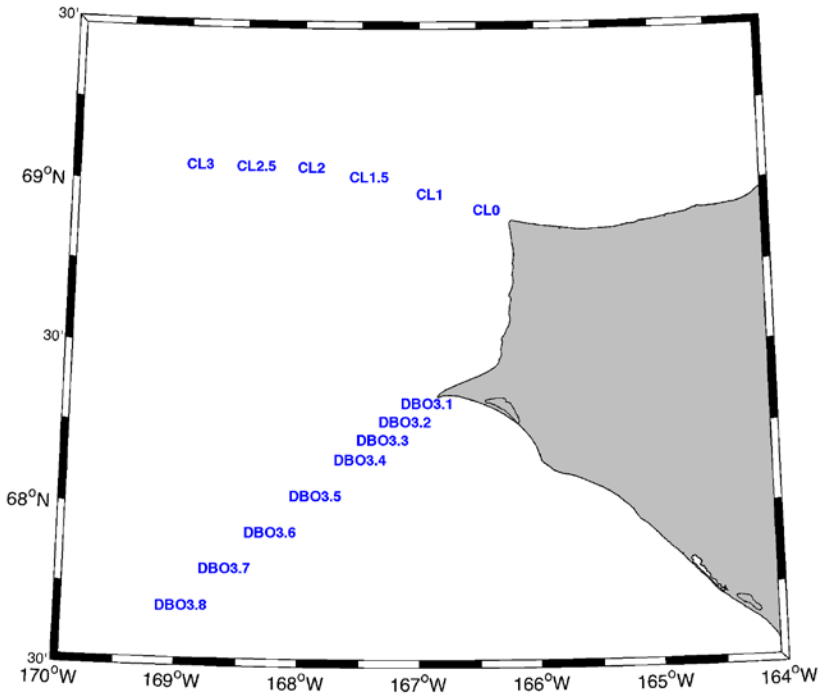

Figure 7: CTD station names on the southern Chukchi shelf during the 2015 AMBON cruise

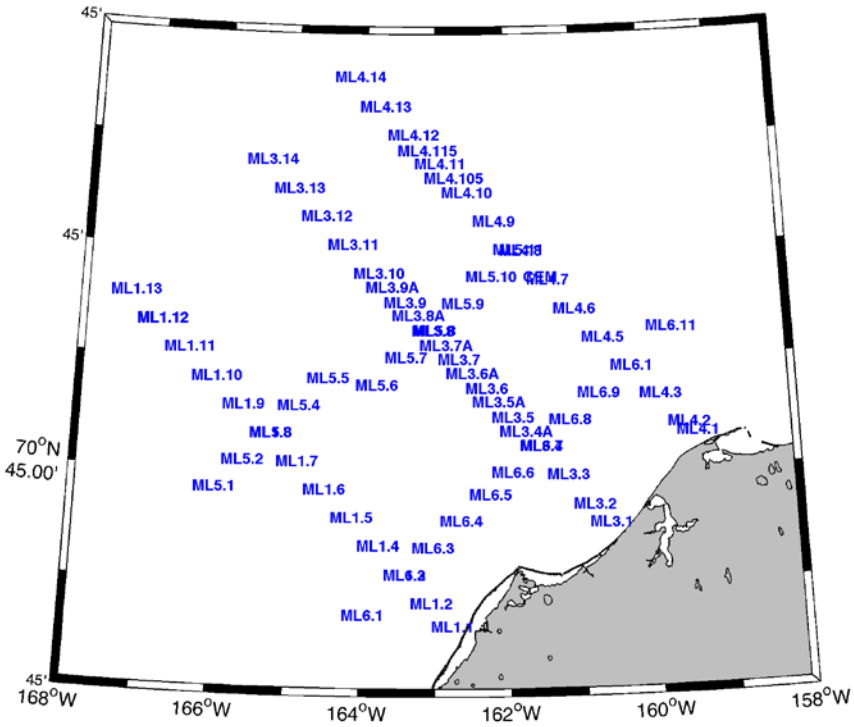

Figure 8: CTD station names on the northern Chukchi shelf during the 2015 AMBON cruise

Elevated chlorophyll-a concentrations were recorded by the CTD fluorometer at the farthest offshore stations of the DBO3 line (Figure 9), on the southern side of Hanna Shoal near to the CEM mooring site (station ML4.7 and those nearby, Figure 12), and at a few stations along the ML1 line (Figure 15). The bloom at DBO3 was found in the upper mixed layer, while the Hanna Shoal bloom was found at the base of the mixed layer and on ML1, the phytoplankton were distributed over most of the water column. PAR measurements showed some light down at 25-35 m below the surface during CTD casts that occurred when the sun was above the horizon (casts early in the evening and late in the morning). Stations with relatively large chlorophyll fluorescence values also coincided with considerable algal clogging of the zooplankton net tows. The elevated ML1 phytoplankton concentrations may have been in response to a new injection of nutrients into the euphotic zone caused by the major wind event of Aug 25-29.

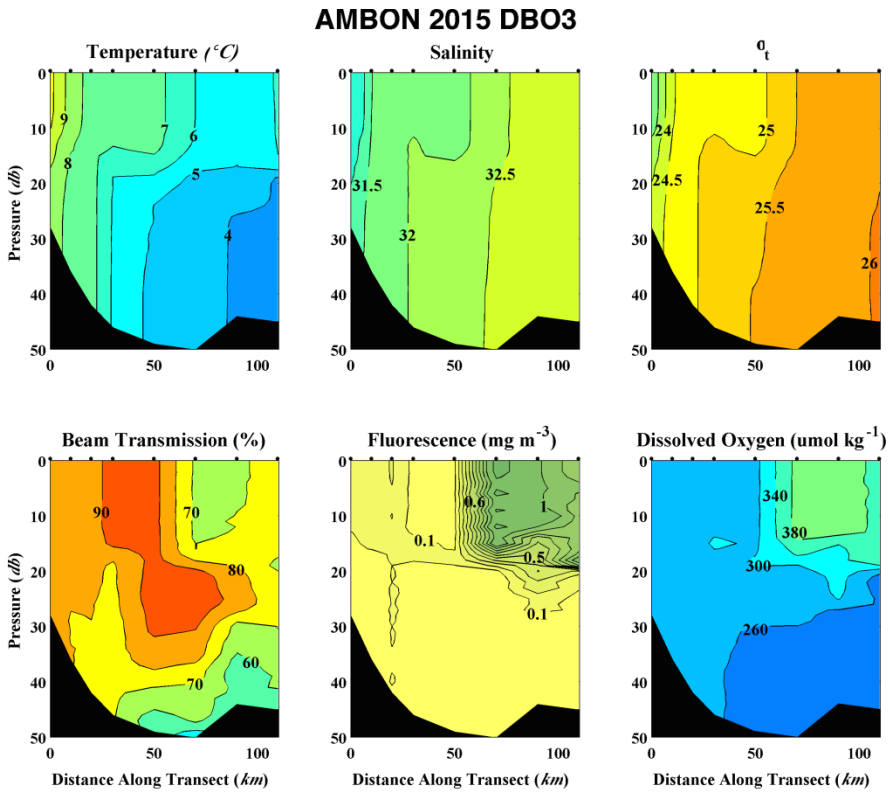

Figure 9: Transect DBO3, occupied on 12-13 August 2015.Distance along transect is from inshore to offshore

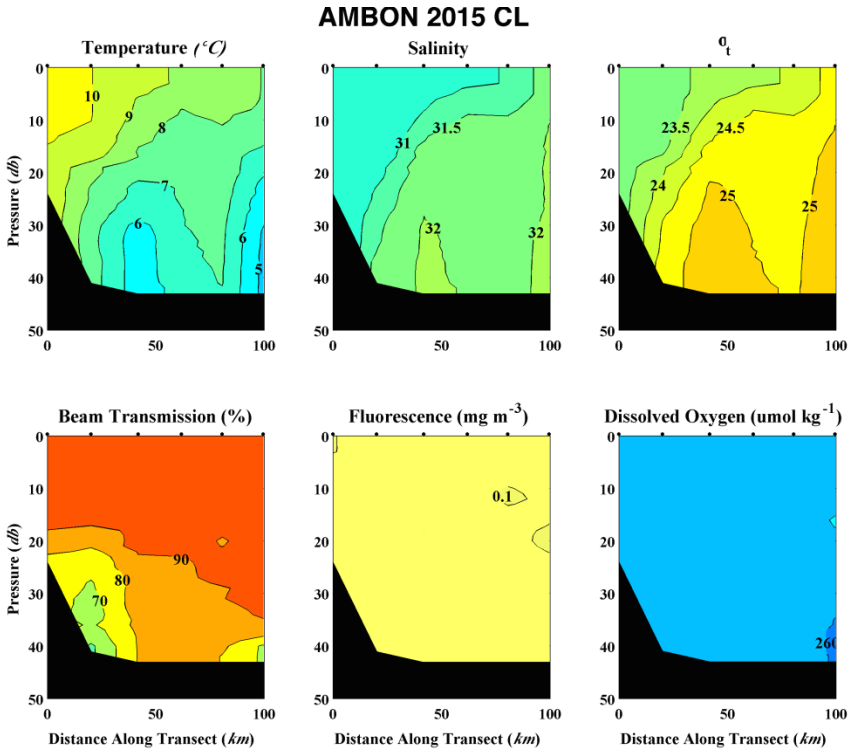

Figure 10: Transect CL, occupied on 13-15 August 2015.Distance along transect is from inshore to offshore

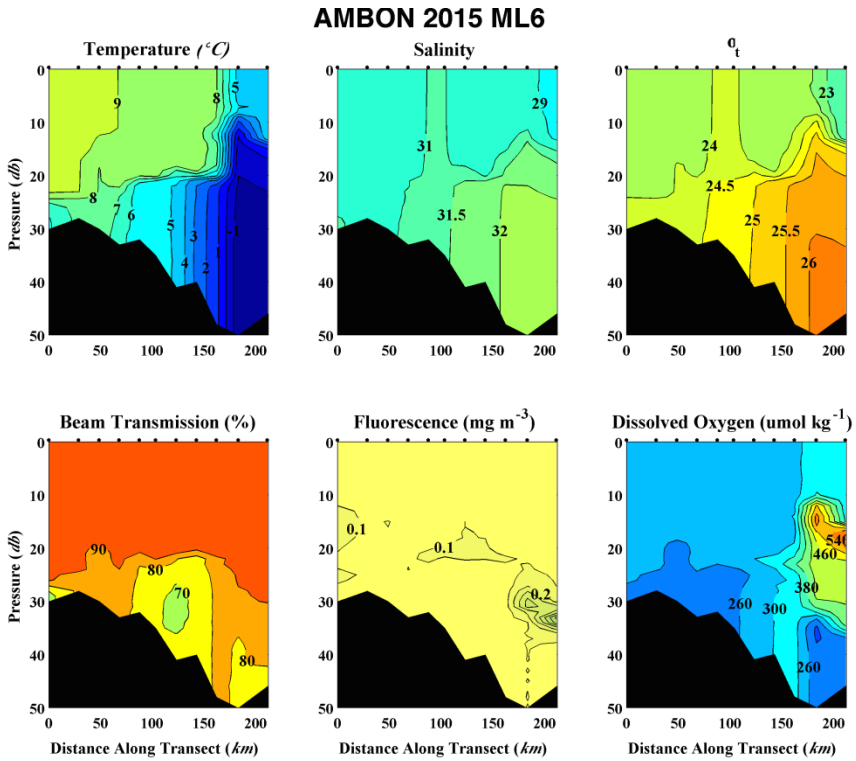

Figure 11: Transect ML6, occupied on 15-19 August 2015.Distance along transect is from south to north, greater depths in the north indicate the beginning of Barrow Canyon

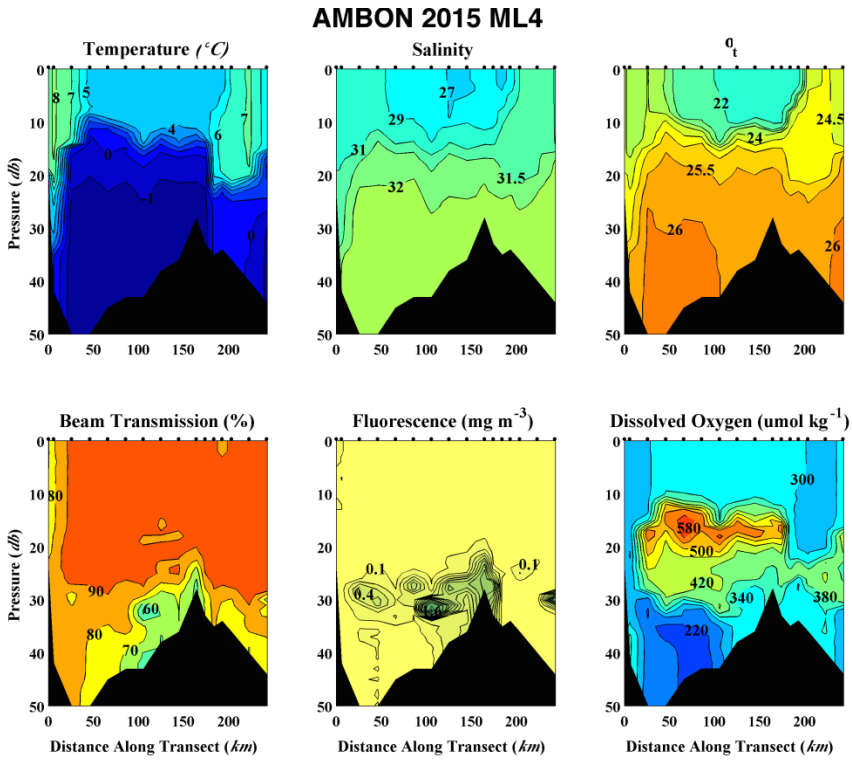

Figure 12: Transect ML4, occupied on 20-22 August 2015.Distance along transect is from inshore to offshore

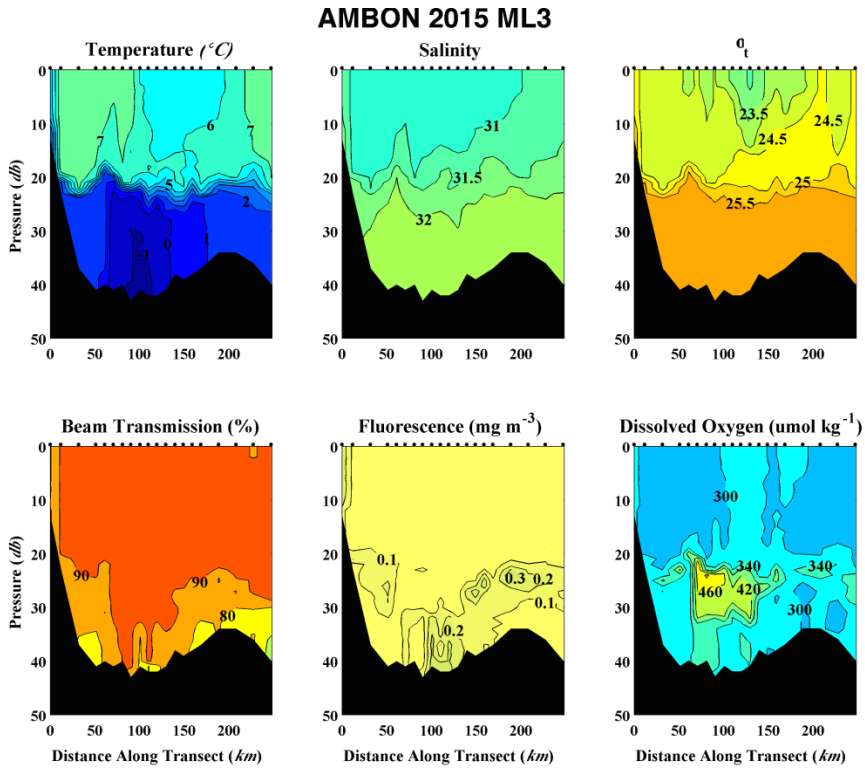

Figure 13: Transect ML3, occupied on 22-25 August 2015.Distance along transect is from inshore to offshore

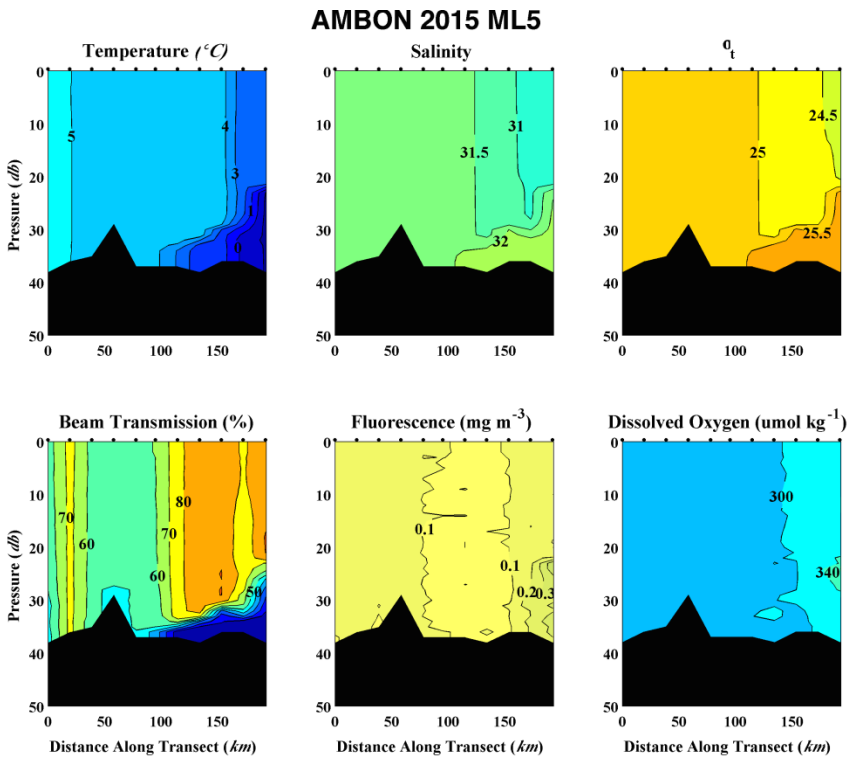

Figure 14: Transect ML5, occupied on 30-31 August 2015.Distance along transect is from south to north

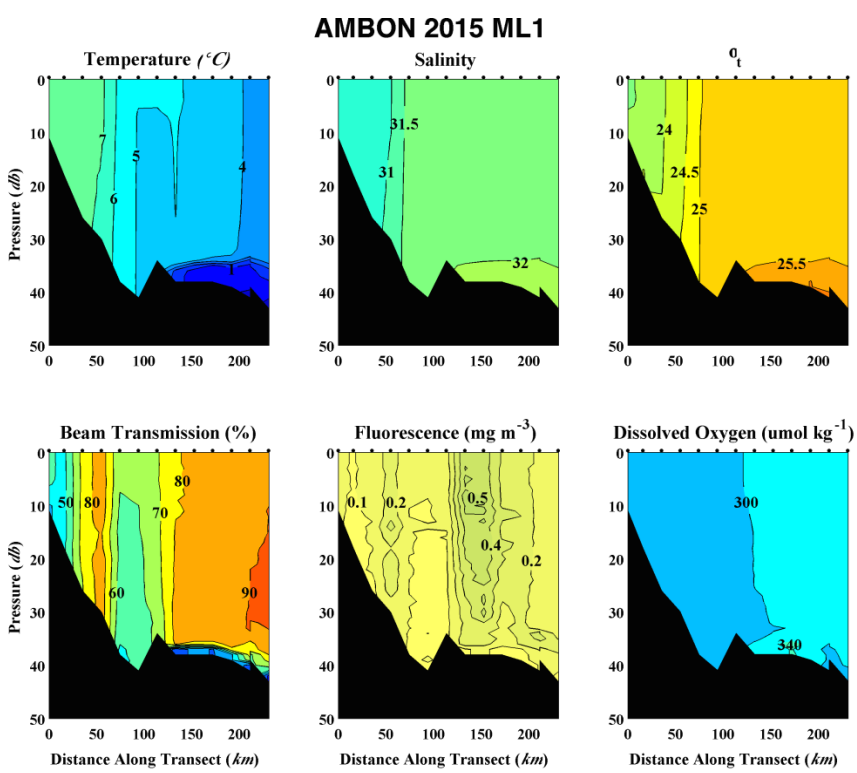

Figure 15: Transect ML1, occupied on 1-3 September 2015.Distance along transect is from inshore to offshore

Table 1. *Consecutive station number, station name, GMT Date/Time, Latitude (degrees N), Longitude (degrees W) and seafloor depth (m) for all CTDs.*

Station #	Station Name	GMT Date/Time	Latitude	Longitude	Depth
1	BC2	Aug 10 2015 08:54:48	70.9253	-159.943	51.6
2	DBO3.8	Aug 12 2015 04:17:41	67.6672	-168.955	51.2
3	DBO3.7	Aug 12 2015 07:16:08	67.7835	-168.6048	47.7
4	DBO3.6	Aug 12 2015 09:38:54	67.897	-168.2368	55.9
5	DBO3.5	Aug 12 2015 12:19:36	68.0115	-167.8657	50.8
6	DBO3.4	Aug 12 2015 14:42:53	68.1248	-167.4978	47.8
7	DBO3.3	Aug 13 2015 04:12:57	68.1862	-167.307	45.6
8	DBO3.2	Aug 13 2015 05:38:50	68.2427	-167.1243	41
9	DBO3.1	Aug 13 2015 07:42:57	68.2993	-166.9358	32.6
10	CL0	Aug 13 2015 12:34:33	68.899	-166.4228	28.8
12	CL1	Aug 13 2015 15:18:52	68.9482	-166.908	44.2
13	CL3	Aug 14 2015 04:04:17	69.0335	-168.8928	50.6
14	CL2.5	Aug 14 2015 10:36:51	69.0302	-168.4112	48.4
15	CL2	Aug 14 2015 11:58:11	69.0288	-167.9343	47.7
16	CL1.5	Aug 14 2015 14:46:54	69.0003	-167.4347	45.7
17	ML6.1	Aug 15 2015 04:12:43	70.087	-163.9603	29.5
18	ML6.2	Aug 15 2015 07:54:11	70.267	-163.4075	28.5
19	ML6.3	Aug 15 2015 10:21:38	70.3893	-163.022	30
20	ML6.4	Aug 15 2015 12:48:56	70.5093	-162.6438	33.1
21	ML6.5	Aug 16 2015 04:09:33	70.6265	-162.2487	37.4
22	ML6.6	Aug 16 2015 06:30:00	70.7257	-161.9403	39.4
23	ML6.7	Aug 16 2015 09:47:54	70.8435	-161.5382	42.8
24	ML6.8	Aug 16 2015 12:56:02	70.9595	-161.1378	41.8
25	ML6.9	Aug 16 2015 15:17:02	71.0753	-160.7348	52.2
26	ML4.1	Aug 19 2015 04:02:36	70.8923	-159.3928	25.9
27	ML4.2	Aug 19 2015 05:43:07	70.9322	-159.504	43.6
28	ML4.3	Aug 19 2015 08:17:36	71.0633	-159.8815	55.6
29	ML6.1	Aug 19 2015 11:23:24	71.1928	-160.2695	52.7
30	ML6.11	Aug 19 2015 14:35:25	71.3612	-159.6925	48.6
31	ML4.5	Aug 20 2015 04:50:18	71.3237	-160.6557	46.4
32	ML4.6	Aug 20 2015 07:40:47	71.4545	-161.0375	45.4
33	ML4.7	Aug 20 2015 11:06:37	71.588	-161.4005	45.1
34	CEM	Aug 20 2015 13:23:17	71.5987	-161.5062	44.4
35	ML4.8	Aug 21 2015 05:00:22	71.7193	-161.7733	42
36	ML4.9	Aug 21 2015 07:39:38	71.8508	-162.1582	39.8
37	ML4.10	Aug 21 2015 10:15:45	71.9795	-162.5413	30.2
38	ML4.11	Aug 21 2015 12:31:27	72.109	-162.9238	37.4
39	ML4.115	Aug 21 2015 14:44:56	72.1688	-163.1082	37.1
40	ML4.105	Aug 21 2015 16:01:18	72.045	-162.7292	35.8
41	ML4.12	Aug 22 2015 04:02:08	72.2387	-163.3172	37.9
42	ML4.13	Aug 22 2015 06:26:56	72.3645	-163.7218	42.2
43	ML4.14	Aug 22 2015 09:15:26	72.4965	-164.1027	47.4

44	ML3.14	Aug 22 2015 14:30:16	72.12	-165.3588	42.7
45	ML3.13	Aug 23 2015 04:11:48	71.9935	-164.9537	38.4
46	ML3.12	Aug 23 2015 06:53:42	71.8712	-164.556	37.7
47	ML3.11	Aug 23 2015 09:46:18	71.7453	-164.1662	36
48	ML3.10 AND DBO4.6	Aug 23 2015 12:27:57	71.617	-163.7655	38.8
49	ML3.9A AND DBO4.5A	Aug 23 2015 14:16:33	71.5553	-163.5708	40.2
50	ML3.9 AND DBO4.5	Aug 23 2015 14:57:41	71.4878	-163.3925	40.3
51	ML3.8A AND DBO4.4A	Aug 24 2015 03:57:22	71.429	-163.2003	40.4
52	ML3.8 AND DBO4.4	Aug 24 2015 04:39:51	71.3617	-163.0028	43.2
53	ML3.7A AND DBO4.3A	Aug 24 2015 06:52:07	71.2958	-162.8105	44
54	ML3.7 AND DBO4.3	Aug 24 2015 07:33:11	71.2328	-162.6355	43.5
55	ML3.6A AND DBO4.2A	Aug 24 2015 09:28:53	71.1713	-162.4518	43.4
56	ML3.6 AND DBO4.2	Aug 24 2015 10:31:12	71.1038	-162.2552	44.4
57	ML3.5A AND DBO4.1A	Aug 24 2015 12:26:44	71.0408	-162.0887	43.2
58	ML3.5 AND DBO4.1	Aug 24 2015 13:17:08	70.9725	-161.9008	43.4
59	ML3.4A AND DBO4.0A	Aug 24 2015 14:47:57	70.9073	-161.7178	42.7
60	ML3.4	Aug 24 2015 15:32:45	70.8412	-161.5417	43.6
61	ML3.3	Aug 25 2015 04:04:56	70.7145	-161.1793	40.3
62	ML3.2	Aug 25 2015 07:06:59	70.5778	-160.8357	25.2
63	ML3.1	Aug 25 2015 09:19:50	70.4958	-160.622	15.1
64	ML5.11 AND ML4.8	Aug 30 2015 04:38:41	71.721	-161.7812	41.6
65	ML5.10	Aug 30 2015 06:30:50	71.6028	-162.2022	41.2
66	ML5.9	Aug 30 2015 09:23:23	71.4828	-162.6043	41.3
67	ML5.8	Aug 30 2015 12:04:52	71.363	-163.0072	42.8
68	ML5.7	Aug 30 2015 13:40:28	71.2412	-163.4035	41.7
69	ML5.6	Aug 31 2015 04:04:23	71.1182	-163.8055	40.2
70	ML5.5	Aug 31 2015 06:57:03	71.1468	-164.4862	40.1
71	ML5.4	Aug 31 2015 09:38:06	71.0225	-164.8767	33
72	ML5.3	Aug 31 2015 11:53:01	70.8973	-165.2528	38.8
73	ML5.2	Aug 31 2015 13:08:15	70.7718	-165.6275	39.1
74	ML5.1	Aug 31 2015 15:19:41	70.648	-165.9955	40.3
75	ML1.13	Sep 01 2015 04:49:23	71.5073	-167.2205	46.4
76	ML1.12	Sep 01 2015 08:01:41	71.3862	-166.82	44.2
77	ML1.12	Sep 01 2015 08:32:57	71.3855	-166.8218	44.2
78	ML1.11	Sep 01 2015 10:59:09	71.2663	-166.42	42.3
79	ML1.10	Sep 01 2015 13:41:57	71.1432	-166.0282	40.9
80	ML1.9	Sep 02 2015 03:58:44	71.0203	-165.641	40.7
81	ML1.8	Sep 02 2015 06:30:02	70.8967	-165.2537	39.2
82	ML1.7	Sep 02 2015 08:54:53	70.772	-164.878	37.6
83	ML1.6 and ML6.2	Sep 02 2015 11:12:22	70.6468	-164.5018	44
84	ML1.5	Sep 02 2015 13:56:23	70.524	-164.1265	41.9
85	ML1.4	Sep 03 2015 04:18:01	70.398	-163.765	33.3
86	ML1.3	Sep 03 2015 06:51:02	70.2682	-163.4062	28.4
87	ML1.2	Sep 03 2015 08:28:43	70.1407	-163.051	19.6
88	ML1.1	Sep 03 2015 11:06:03	70.0358	-162.7657	12.4

Microbes

Project discipline PI: R. Eric Collins (UAF)

2015 on-board team: R. Eric Collins

Aims

The goal of the Microbes group was to collect a comprehensive set of samples representing the diversity of microbes in the Chukchi Sea. With a total of 458 samples collected from a wide variety of sources (Table 2), this collection make a significant contribution towards the categorization of Arctic microbial diversity, and the discovery of new taxa.

Table 2. Samples collected for each protocol.

Protocol		Samples collected	Collaborators (Equipment)
BACT	Seawater Bacteria	178	Danielson (CTD)
eDNA	Environmental DNA	15	Battell
VIRUS	Viruses	30	Danielson (CTD)
MEIO	Meiofauna	83	Grebmeier, Cooper (grab)
SED BACT	Sediment Bacteria	21	Grebmeier, Cooper (grab)
ZOOP	Zooplankton	20	Smoot, Hopcroft (nets)
MICRO	Microplankton	43	Smoot, Hopcroft (nets)
INV	Invertebrates	68	Iken (plumb-staff trawl)
	TOTAL	**458**	

Methods

Zooplankton and large microplankton were collected with a 150 µm net hauled vertically and frozen. Individuals from abundant zooplankton taxa were identified and picked by C. Smoot (see Zooplankton) and frozen in 96-well dishes. Sediments from the first van Veen grab taken at each station were sampled for meiofauna using two 5cc syringes and frozen (0-1 cm and 1-5 cm horizons). A subset of surface sediments was preserved with RNAlater and frozen for bacterial diversity analysis. Protists, bacteria and archaea were collected from surface seawater, mid-depth waters (e.g., subsurface chlorophyll maximum), and bottom water by filtration of 1–5 L of seawater through a 0.2 µm filter, which was preserved with RNAlater and frozen. Filtrate from the 0.2 µm filtration was amended with $Fe(III)Cl_3$ to precipitate viruses, which were then collected on another 0.2 µm filter. Surface seawater (2–6 L) was filtered for environmental DNA (eDNA) on 0.2 µm nylon filters for collaborators at Battell. Invertebrates collected with a plumb staff beam trawl were sorted by taxa and identified by K. Iken (see Epifauna). Individuals were frozen whole or dissected and sampled for gut contents or other tissues hosting microbes.

A summary of all samples collected is provided in Table 3. A list of sampled invertebrate taxa is provided in Table 4 (also see Figure 19). Maps are provided in Figures 16-18 (interactive version available at http://www.cryomics.org/work/ambon-map).

Table 3. Summary of microbe sampling by protocol.

station name	GMT Date	GMT Time	Depth	Latitude	Longitude	BACT	eDNA	VIRUS	MEIO	SED BACT	ZOOP	MICRO	INV
BC2	8/10/15	8:51	51.8	70.925	-159.943	3	0	0	0	0	0	0	0
DBO3.8	8/12/15	4:18	51.2	67.668	-168.955	3	0	0	1	1	4	0	6
DBO3.7	8/12/15	7:16	47.7	67.784	-168.605	3	0	0	2	0	1	0	4
DBO3.6	8/12/15	9:39	55.9	67.897	-168.237	3	0	0	1	1	1	0	3
DBO3.5	8/12/15	12:20	50.8	68.012	-167.866	3	0	0	2	0	0	1	9
DBO3.4	8/12/15	14:42	47.7	68.125	-167.498	3	2	3	1	1	2	1	3
DBO3.3	8/13/15	4:14	45.6	68.187	-167.307	3	0	0	2	0	0	0	8
DBO3.2	8/13/15	5:37	41.0	68.243	-167.124	3	0	0	1	1	0	0	1
DBO3.1	8/13/15	7:41	32.6	68.299	-166.936	3	0	0	1	0	0	0	4
CL0	8/13/15	12:30	29.0	68.899	-166.423	3	0	0	0	0	0	1	1
CL1	8/13/15	15:16	44.5	68.947	-166.910	0	0	2	1	1	0	1	0
CL3	8/14/15	4:04	50.6	69.034	-168.893	3	0	2	2	0	1	1	2
CL2.5	8/14/15	10:37	48.4	69.030	-168.412	3	0	0	0	0	0	0	0
CL2	8/14/15	11:58	47.7	69.029	-167.934	3	0	1	1	1	1	1	0
CL1.5	8/14/15	14:55	45.7	69.000	-167.451	0	1	0	0	0	0	0	0
ML6.1	8/15/15	4:10	29.6	70.086	-163.960	2	0	1	2	0	0	1	2
ML6.2	8/15/15	7:54	28.5	70.267	-163.408	2	0	0	1	1	0	0	0
ML6.3	8/15/15	10:20	30.0	70.389	-163.022	2	0	1	2	0	0	1	0
ML6.4	8/15/15	12:48	33.1	70.509	-162.644	0	1	0	2	0	0	0	1
ML6.5	8/16/15	4:04	37.3	70.626	-162.249	2	0	1	2	0	0	1	0
ML6.6	8/16/15	6:30	39.4	70.726	-161.940	3	0	0	1	0	0	0	2
ML6.7	8/16/15	9:45	43.0	70.843	-161.539	3	0	1	1	1	0	1	2
ML6.8	8/16/15	12:56	41.8	70.960	-161.138	3	0	0	1	0	0	0	2
ML6.9	8/16/15	7:17	50.5	71.075	-160.735	3	0	0	1	1	0	1	0
ML4.1	8/19/15	3:59	26.1	70.892	-159.391	2	1	1	1	0	0	1	1
ML4.2	8/19/15	5:43	43.7	70.932	-159.505	3	0	0	1	0	0	0	0
ML4.3	8/19/15	8:17	55.5	71.063	-159.881	3	0	2	2	0	1	1	2
ML6.10	8/19/15	11:21	52.6	71.193	-160.269	3	0	0	1	0	0	0	0
ML6.11	8/19/15	14:35	48.6	71.361	-159.692	5	0	1	2	0	0	1	2
ML4.5	8/20/15	4:50	46.5	71.324	-160.655	3	1	1	2	0	0	1	2
ML4.6	8/20/15	7:41	45.3	71.454	-161.037	3	0	0	1	0	0	0	0
ML4.7	8/20/15	11:08	45.0	71.588	-161.400	3	0	1	2	0	0	1	1
CEM	8/20/15	13:23	44.4	71.599	-161.507	0	0	0	0	0	0	0	0
ML4.8	8/21/15	5:00	42.0	71.718	-161.777	3	1	0	1	0	2	0	0
ML4.9	8/21/15	7:40	39.8	71.851	-162.158	3	1	1	1	1	0	1	0
ML4.10	8/21/15	10:14	30.2	71.980	-162.540	2	0	0	1	0	0	0	2
ML4.11	8/21/15	12:30	37.5	72.109	-162.924	3	0	1	2	0	0	1	0
ML4.11.5	8/21/15	14:44	37.1	72.169	-163.109	1	0	0	0	0	0	0	0
ML4.10.5	8/21/15			72.044	-162.732	0	0	0	0	0	0	0	0
ML4.12	8/22/15	4:03	38.1	72.239	-163.318	3	1	0	1	0	0	0	0
ML4.13	8/22/15	6:26	42.2	72.364	-163.722	2	1	0	1	1	0	1	0
ML4.14	8/22/15	9:14	47.3	72.496	-164.102	3	0	0	0	1	0	1	0
ML3.14	8/22/15	14:30	42.7	72.120	-165.359	0	0	0	1	1	0	1	0
ML3.13	8/23/15	4:11	38.2	71.993	-164.953	2	0	0	1	0	0	0	0
ML3.12	8/23/15	6:53	37.7	71.871	-164.555	3	0	1	2	0	0	1	0
ML3.11	8/23/15	9:45	36.0	71.745	-164.166	3	0	0	0	0	0	0	0
ML3.10	8/23/15	12:28	39.2	71.617	-163.765	2	0	0	1	1	0	2	0
ML3.9a	8/23/15	14:15	39.8	71.555	-163.571	0	0	0	0	0	0	0	0
ML3.9	8/23/15	14:57	40.3	71.488	-163.392	3	0	0	1	0	0	0	0
ML3.8a	8/24/15	3:57	40.6	71.429	-163.200	0	0	0	0	0	0	0	0
ML3.8	8/24/15	4:41	43.2	71.362	-163.003	2	1	0	2	0	0	1	3
ML3.7a	8/24/15	6:52	44.0	71.296	-162.811	0	0	0	0	0	0	0	0
ML3.7	8/24/15	7:31	43.5	71.233	-162.635	2	0	0	1	1	1	0	2
ML3.6a	8/24/15	9:27	43.3	71.173	-162.454	0	0	0	0	0	0	0	0
ML3.6	8/24/15	10:31	44.4	71.104	-162.255	2	0	0	2	0	0	1	0
ML3.5a	8/24/15	12:24	43.2	71.042	-162.089	0	0	0	0	0	0	0	0
ML3.5	8/24/15	13:09	43.3	70.973	-161.902	2	0	0	1	0	0	1	0
ML3.4	8/24/15	15:30	43.5	70.843	-161.539	0	0	0	0	0	0	0	0
ML3.4a	8/24/15	14:47	42.8	70.907	-161.718	0	0	0	0	0	0	0	0
ML3.3	8/25/15	4:05	40.2	70.714	-161.180	3	1	0	2	0	0	1	0
ML3.2	8/25/15	7:03	24.9	70.578	-160.835	3	0	0	1	0	0	0	0
ML3.1	8/25/15	9:19	15.1	70.496	-160.622	2	0	0	2	0	0	1	1
ML5.11	8/30/15	4:37	42.0	71.721	-161.781	2	0	0	0	0	0	0	0
ML5.10	8/30/15	6:28	41.0	71.603	-162.201	2	0	1	1	0	0	1	0
ML5.9	8/30/15	9:20	40.6	71.483	-162.604	2	0	0	0	0	0	0	0
ML5.8	8/30/15	12:06	42.6	71.363	-163.008	0	0	0	0	0	0	0	0
ML5.7	8/30/15	13:40	41.7	71.242	-163.403	2	0	0	0	0	0	0	0
ML5.6	8/31/15	4:04	40.2	71.118	-163.806	2	0	1	1	1	1	1	0
ML5.5	8/31/15	6:57	40.1	71.147	-164.487	2	0	0	1	0	0	0	0
ML5.4	8/31/15	9:38	33.0	71.023	-164.877	2	1	0	1	1	4	1	1
ML5.3	8/31/15	11:52	39.2	70.898	-165.253	0	0	0	1	0	0	0	0
ML5.2	8/31/15	13:08	39.0	70.772	-165.628	2	0	0	1	0	0	0	1
ML5.1	8/31/15	15:00	40.2	70.648	-165.996	2	0	1	1	0	0	1	0
ML1.13	9/1/15	4:58	46.4	71.507	-167.220	3	1	1	1	1	0	1	0
ML1.12	9/1/15	8:00	44.3	71.386	-166.820	3	0	0	1	0	0	0	0
ML1.11	9/1/15	10:58	42.2	71.266	-166.420	2	0	1	1	1	0	1	0
ML1.10	9/1/15	13:41	40.9	71.143	-166.029	0	0	0	1	0	0	0	0
ML1.9	9/2/15	4:00	40.7	71.020	-165.641	2	1	1	1	1	0	1	0
ML1.8	9/2/15	6:29	39.2	70.897	-165.254	2	0	0	1	0	0	1	0
ML1.7	9/2/15	8:55	37.6	70.772	-164.878	2	0	1	1	1	0	1	0
ML1.6	9/2/15	11:12	44.0	70.647	-164.502	2	0	0	1	0	0	1	0
ML1.5	9/2/15	13:53	41.8	70.524	-164.127	2	0	0	1	0	0	1	0
ML1.4	9/3/15	4:17	33.3	70.398	-163.765	3	0	0	1	0	0	1	0
ML1.3	9/3/15	6:43	28.4	70.268	-163.404	2	0	0	1	0	0	1	0
ML1.2	9/3/15	11:05	19.6	70.141	-163.051	2	0	1	0	0	0	1	0
ML1.1	9/3/15	11:05	12.3	70.036	-162.765	2	0	1	1	0	1	0	0

Table 4. Taxa sampled for host-associated microbiota

Station	Protocol	Group	Descriptor	Binomial	Tissue
ML6.8	invertebrates	amphipod	mix		whole
ML6.8	invertebrates	amphipod	mix		whole
DBO3.4	zooplankton	amphipod		*Themisto libellula*	whole
ML4.10	invertebrates	amphipod	infaunal		whole
DBO3.1	invertebrates	anemone	U36		gut
DBO3.1	invertebrates	ascidian		*Ascidia sp.*	outside, gut
ML6.1	invertebrates	ascidian	stalk	*Boltenia ovifera*	gut
DBO3.3	invertebrates	ascidian	flat	*Chelyosoma macleayanum*	outside, inside
DBO3.3	invertebrates	ascidian			outside
DBO3.3	invertebrates	ascidian		*Halocynthia aurantium*	gut
DBO3.3	invertebrates	ascidian	round	*Styela sp.*	whole
ML6.1	invertebrates	ascidian	tube	*Styela sp.*	gut
ML4.3	zooplankton	barnacle	nauplii		whole
DBO3.5	invertebrates	basket star		*Gorgonocephalus sp.*	legs, disk
DBO3.5	invertebrates	bivalve		*Ennucula tenuis*	whole
DBO3.6	invertebrates	brittle star		*Ophiura sarsii*	legs, disk
ML3.7	invertebrates	brittle star	small	*Ophiura sarsii*	whole
DBO3.8	invertebrates	brittle star		*Stegophiura nodosa*	whole
DBO3.8	invertebrates	bryozoan		*Alcyonidium gelatinosum*	whole
CL0	invertebrates	bryozoan			whole
ML3.7	invertebrates	bryozoan			whole
ML6.11	invertebrates	bryozoan	half moon		whole
DBO3.1	invertebrates	bryozoan	hard	*Heteropora sp.*	whole
DBO3.8	zooplankton	chaetognath		*Parasagitta elegans*	whole
ML4.8	zooplankton	chaetognath		*Parasagitta elegans*	whole
DBO3.3	invertebrates	chiton		*Amicula vesita*	outside
DBO3.7	invertebrates	clam	grey	*Macoma calcarea*	inside, shell
DBO3.7	invertebrates	clam	yellow	*Yoldia hyperborea*	inside, shell
DBO3.8	zooplankton	copepod		*Calanus glacialis*	whole
ML4.8	zooplankton	copepod		*Calanus sp.*	whole
DBO3.8	zooplankton	copepod		*Eucalanus sp.*	whole
CL2	zooplankton	copepod		*Oithona sp.*	whole
CL3	zooplankton	copepod		*Pseudocalanus sp.*	whole
DBO3.5	invertebrates	coral	soft	*Gersemia rubiformis*	whole
DBO3.1	invertebrates	coral	soft	*Gersemia rubiformis*	whole
DBO3.8	invertebrates	crab	big	*Chionoecetes opilio*	carapace
DBO3.8	invertebrates	crab	small	*Hyas coarctatus*	head
CL3	invertebrates	crab	hermit	*Pagurus trigonocheirus*	gut
DBO3.6	zooplankton	crab	zoea		whole
ML3.7	zooplankton	crab	zoea		whole
ML3.1	invertebrates	cumacean			whole
ML5.4	zooplankton	euphausiid		*Thysanoessa inermis*	whole
ML5.4	zooplankton	euphausiid		*Thysanoessa raschi*	whole
DBO3.7	zooplankton	euphausiid		*Thyssanoessa sp.*	whole
ML5.4	zooplankton	euphausiid		*Thyssanoessa sp.*	whole
ML4.5	invertebrates	flatworm			whole
ML4.3	invertebrates	holothurian		*Myriotrochus rinkii*	whole
ML5.4	invertebrates	holothurian	large	*Myriotrochus rinkii*	whole
ML6.11	invertebrates	holothurian	snotlings	*Myriotrochus rinkii*	whole
DBO3.3	invertebrates	hydroid			whole
ML3.8	invertebrates	isopod			whole
ML4.10	invertebrates	isopod			whole
ML4.3	invertebrates	isopod			whole
ML6.4	invertebrates	jelly		*Aglantha digitale*	whole
ML1.1	zooplankton	jelly	large		whole

DBO3.8	zooplankton	larvacean		*Oikiopleura vanhoeffeni*	whole
ML5.4	zooplankton	mysid		*Neomysis ragi*	whole
ML4.7	invertebrates	nemertean			whole
ML4.1	invertebrates	nudibranch		*Tritonia sp.*	outer, gut
DBO3.5	invertebrates	polychaete	large	*Maldanidae*	cast, body
DBO3.5	invertebrates	polychaete	small	*Maldanidae*	cast, body
DBO3.5	invertebrates	polychaete	large	*Nephtys sp.*	gut
DBO3.7	invertebrates	polychaete	cone tube	*Cistenides hyperborea*	whole
DBO3.4	invertebrates	polychaete		*Nereis sp.*	whole
DBO3.5	invertebrates	polychaete	naked	*Sternaspis fossor*	whole
DBO3.7	invertebrates	polychaete	tube	*Terebellidae*	whole
ML5.2	invertebrates	polychaete	cast		whole
DBO3.4	zooplankton	pteropod		*Clione limacina*	whole
ML5.6	zooplankton	pteropod		*Clione limacina*	whole
DBO3.5	invertebrates	sand dollar		*Echinarachnius parma*	whole
DBO3.2	invertebrates	scallop		*Chlamys sp.*	gut
ML4.5	invertebrates	sea cucumber		*Ocnus glacialis*	whole, gut
ML6.6	invertebrates	sea cucumber		*Psolus peronii*	outer, gut, polian vesicle
DBO3.8	invertebrates	sea star	purple	*Leptasterias groenlandica*	leg
DBO3.8	invertebrates	sea star	fat purple	*Leptasterias polaris*	leg
DBO3.3	invertebrates	sea urchin		*Strongylocentrotus pallidus*	shell
DBO3.4	invertebrates	sea urchin		*Strongylocentrotus pallidus*	gut
DBO3.3	invertebrates	shrimp		*Argis sp.*	whole
DBO3.6	invertebrates	shrimp			whole
DBO3.4	invertebrates	sipunculid		*Golfingia margaritacea*	gut
CL3	invertebrates	sipunculid		*Golfingia margaritacea*	gut
DBO3.5	invertebrates	snail		*Margarites costalis*	whole
DBO3.6	invertebrates	snail		*Neptunea heros*	shell
ML6.7	invertebrates	sponge		*Halichondria sp.*	whole
ML6.7	invertebrates	sponge		*Haliclona sp.*	whole
ML6.6	invertebrates	sponge	spongy sponge		inner
ML3.8	invertebrates	sponge	donut	*Choanites sp.*	whole
ML3.8	invertebrates	sponge	stalked	*Phakellia cribrosa*	whole

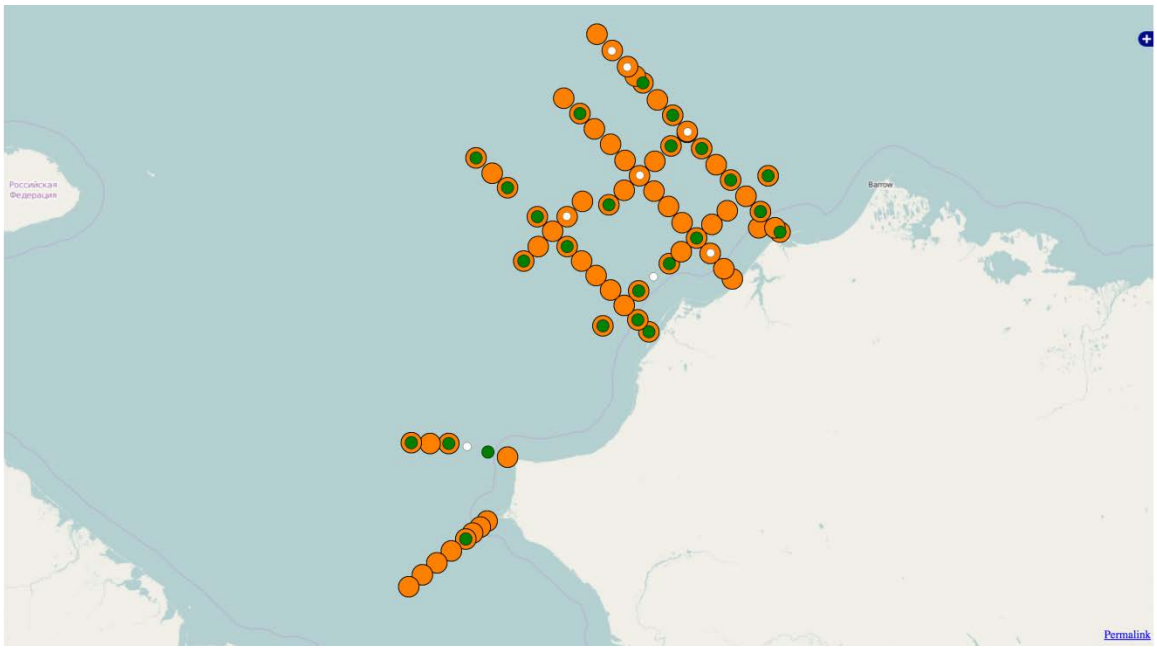

Figure 16: Stations sampled for bacteria (orange), viruses (green), and eDNA (yellow).

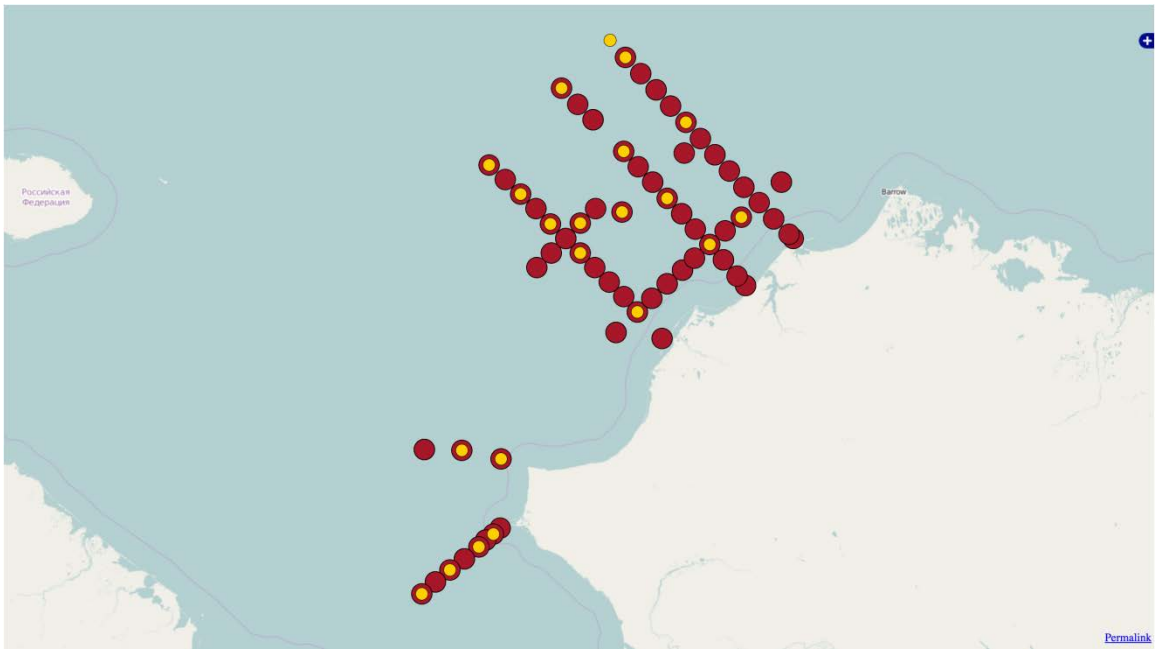

Figure 17: Stations sampled for sediment bacteria (yellow) and meiofauna (red).

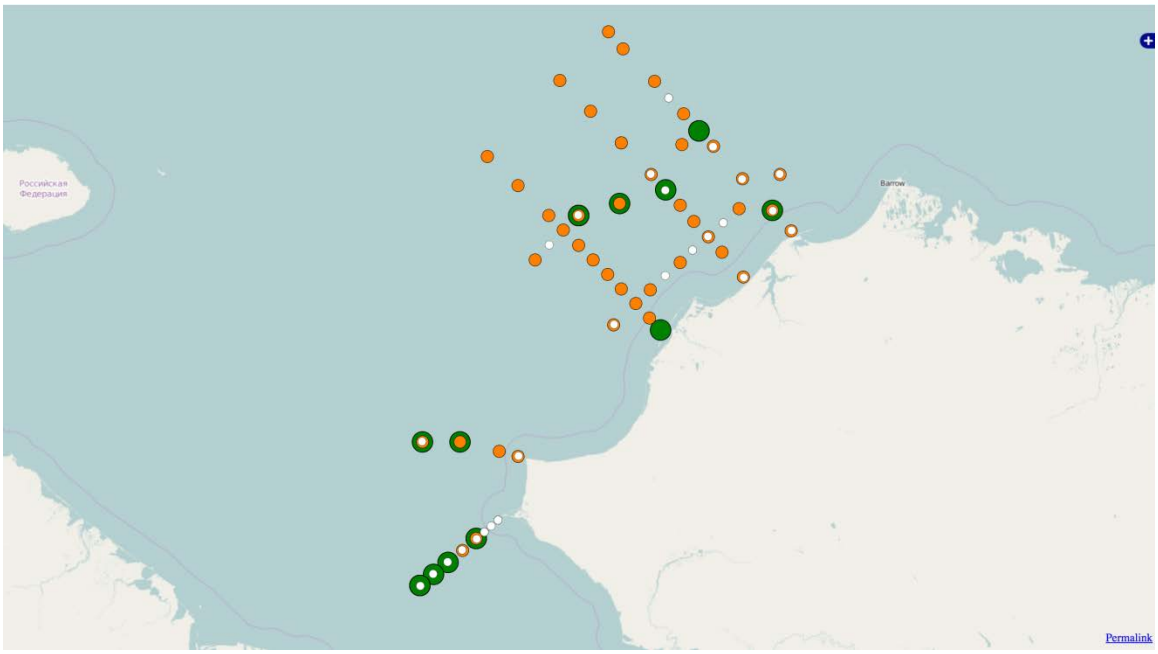

Figure 18: Stations sampled for microplankton (orange), zooplankton (green), and invertebrates (white).

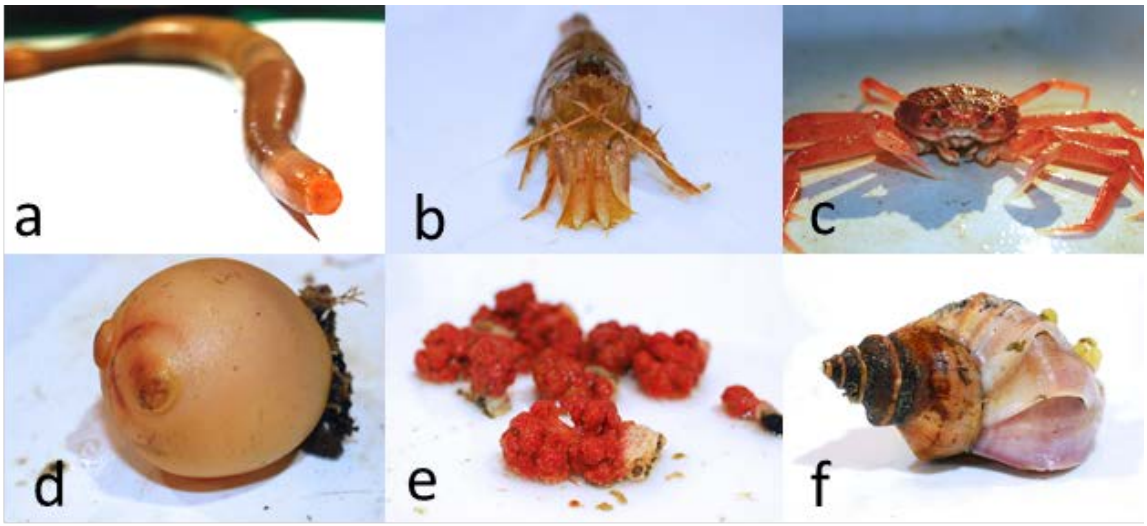

Figure 19: Invertebrates collected to investigate for associated microbes: a. Golfingia margaritacea (Sipuncula); b. Argis sp. (Decapoda); c. Chionoecetes opilio (Decapoda); d. Halocynthia aurantium (Ascidiacea); e. Gersemia rubiformis (Cnidaria); f. Neptunea heros (Gastropoda).

Zooplankton

Project discipline PI: Russ Hopcroft (UAF)

2015 on-board team: Catilin Smoot, Faith Stemmler

The zooplankton team performed sixty-seven 505 µm Bongo net casts, including one re-cast due to a large *Chrysaora melanaster* clogging both cod ends of the net. Side A of the Bongo net was examined using a light table to identify and measure delicate ctenophores and cnidarians prior to preservation. *Mertensia ovum* was the dominant ctenophore in the study area. *Beroe cucumis* and *Bolinopsis infundibulum* were also present, although in lower abundances. The cnidarian community was dominated by the hydrozoan *Aglantha digitale.* We also observed the hydrozoans *Melicertum octocostatum*, *Halotholis cirratus*, and *Catablema vesicarium*. *Calanus glacialis* was the dominant copepod captured in the Bongo net. The copepods *Eucalanus bungi* and *Neocalanus* spp. were observed in the southern portion of the study area; however, the relative contribution of these taxa declined toward the northern portion of the study area. Larval fish were also removed from side A of the Bongo net for on-board processing by the fisheries oceanography group. Side B of the Bongo net was immediately preserved in molecular grade ethanol. We performed seventy-three vertical 150 µm net casts, including one re-cast due to net entanglement. Samples were immediately preserved in formalin for processing in the laboratory. A subset consisting of samples from ~25 stations was preserved in molecular grade ethanol for future genetic analysis. Qualitatively, the zooplankton community composition observed during the AMBON 2015 field season is consistent with prior observations in the Chukchi Sea.

Water column and sediment chemistry, phytoplankton, infauna

Project discipline PIs: Lee Cooper and Jacqueline Grebmeier (University of Maryland)

2015 on-board team: Lee Cooper, Jacqueline Grebmeier, Christina Goethel

SUMMARY: The Chesapeake Biological Laboratory (CBL) research group of the University of Maryland Center for Environmental Sciences (UMCES) undertook both water column and sediment sample collections during the AMBON 2015 cruise, including a sub-set of stations on the Distributed Biological Observatory (DBO) transect lines (DBO3) in the southeast Chukchi Sea and DBO 4 in the NE Chukchi Sea as part of the ML3 line (see Figure 1, Table 1). Our component includes measurements in the water column of chlorophyll *a*, macronutrients, and $^{18}O/^{16}O$ ratios (a tracer of melted sea ice content in surface waters). In addition we are coordinating identification of phytoplankton communities. Sediment sample measurements include the total organic carbon and nitrogen content of surface sediments, grain size, and isotopic content of the organic fractions. Finally we are determining macroinfaunal community structure and biomass through use of multiple grabs from the sea floor at each station where that is practical (i.e., soft-bottom).

SAMPLING AND METHODOLOGY: Water samples collected from the CTD rosette were taken at all stations for water column chlorophyll, macronutrients (silica, phosphate, nitrate+nitrite, and ammonium), and $^{18}O/^{16}O$ ratio analyses. Samples for phytoplankton identifications were collected at 38 stations (Table 5). Sediment and macrofaunal samples were collect at about 80 stations (Table 5). In

some near-shore areas, the presence of rocky bottom substrates precluded quantititative collections of soft-bottomed infauna. The following description briefly outlines the measurements made by our team.

1. Water column

Water column collections included sampling for inorganic nutrients, chlorophyll a and stable oxygen isotopes from the CTD/rosette system. The water column and sediment chlorophyll concentrations were analyzed shipboard using a Turners Designs AU-20 fluorometer (non-acidification or Welschmeyer method) following a 24-h (water) or 12-h (sediment) in the dark extraction period in 90% acetone at 4°C. Calibration of the fluorometer was performed using Turner Designs liquid chlorophyll standards acquired immediately before the cruise and kept frozen shipboard. The liquid chlorophyll standards were measured at the start and end of the cruise to check for instrument drift. We also monitored performance of the instrument by use of Turner Designs dry standards throughout the cruise. Some modest adjustment of chlorophyll data (~10% increase) may be necessary based upon preliminary analysis of performance of the instrument over the month-long cruise.

Inorganic nutrients were also collected from the CTD rosette, filtered immediately, frozen, and subsequently will be analyzed at the Nutrient Analytical Service Laboratory (NASL) at CBL. Procedures and techniques used by NASL are available at http://nasl.cbl.umces.edu/. Water samples for $^{18}O/^{16}O$ ratios were also collected in small glass vials, sealed to prevent any evaporation, and stored at room temperature. These isotopic analyses will be performed at CBL using a Thermo Gasbench peripheral (carbon dioxide equilibration) attached to a Thermo DeltaPlus Stable Isotope mass spectrometer run in a continuous flow mode.

We collected 100 ml of seawater aliquots for phytoplankton identifications. These water samples were immediately preserved in Lugol's solution and formaldehyde for post-cruise species identification. Briefly, 100 ml of seawater from each standard depth were gently mixed in a small polyethylene container, with a 100 ml aliquot preserved by addition of 2.5 ml of Lugol's solution and subsequently stored in the refrigerator for 24 hrs. At the end of that period, 5 mL of 37% formaldehyde was added to the 100 ml seawater sample to a final concentration of ~2% (v/v), gently mixed, and stored for subsequent shipment to Poland for phytoplankton identifications. These methods have been recommended to us by colleagues at the Institute of Oceanology, Sopot, Poland, who will be performing the species identifications of phytoplankton collected.

2. Sediment

Surface sediments were collected throughout the cruise from the top of the 0.1 m^2 single van Veen grab on the first grab before it was opened to minimize disturbance of surface sediments. These collections included determination of inventories of chlorophyll *a* in surface sediments shipboard (as described above) as well as subsamples to determine total organic carbon (TOC) and nitrogen (TON) content, C/N ratios, $\delta^{13}C$ and $\delta^{15}N$, and grain size determination. Below is a description of the parameters measured or to be measured in post-cruise processing activities (also see Table 5).

Replicate 0-1 cm surface sediments for surface sediment chlorophyll a content were collected using cut-off 10 cc syringes, with sediment plugs extruded into tared and labelled Falcon centrifuge tubes for fluorometric analyses. 10 mL of 90% acetone were added to each tube, mixed, and then extracted in the refrigerator for 12 hrs. Subsequently measurements for chl a were made shipboard using the same Turner Designs Model AU-20 flourometer used for water column measurements.

The top 0-1 cm of surface sediments was collected with a spoon and placed in into a labelled 4 ounce whirlpak bag (filled 2/3 full) and frozen for post-cruise analyses of TOC/TON, $\delta^{13}C$ and $\delta^{15}N$, and grain size. TOC/TON, and $\delta^{13}C$ and $\delta^{15}N$ values of the organic fraction of these sediments will be measured at

CBL using the same stable isotope mass spectrometer used for the oxygen isotope analyses (described above), but using a combustion peripheral to oxidize carbon and oxidize and reduce nitrogen in the organic fraction of the sediments. Sediments will be de-carbonated using 0.1 N HCl prior to analysis. Grain size will be determined using standard methods in our laboratory. The remaining sediment in the first grab was sieved through a 1-mm metal sieve screen boxes with running seawater. Any retained macrofauna were used for collections for the food web component (see Iken, below).

Four additional grabs were collected and sieved through 1-mm metal sieve screen boxes with running seawater, with the retained animals placed in labelled plastic containers and preserved in 10% buffered seawater formalin for post-cruise analyses at CBL. Post-cruise analyses include identification to lowest taxon possible, at a minimum to family, but in some cases to species, and abundance and biomass determinations.

Preliminary Results

1. Water Column

Higher inventories of water column chlorophyll (Figure 20a) correspond to expected areas of higher productivity offshore along the DBO 3 transect (most southerly transect line) and to the southeast of Hanna Shoal (most northeasterly transect sampled). Surface sediment chlorophyll *a* inventories (Figure 20b) also reflect lower deposition rates and higher current flow inshore. As noted previously, data are preliminary and may be adjusted slightly following more detailed analysis of fluorometer performance during the cruise. All other water column parameters (nutrients, oxygen isotopes, and phytoplankton composition) will be determined post-cruise in the laboratory.

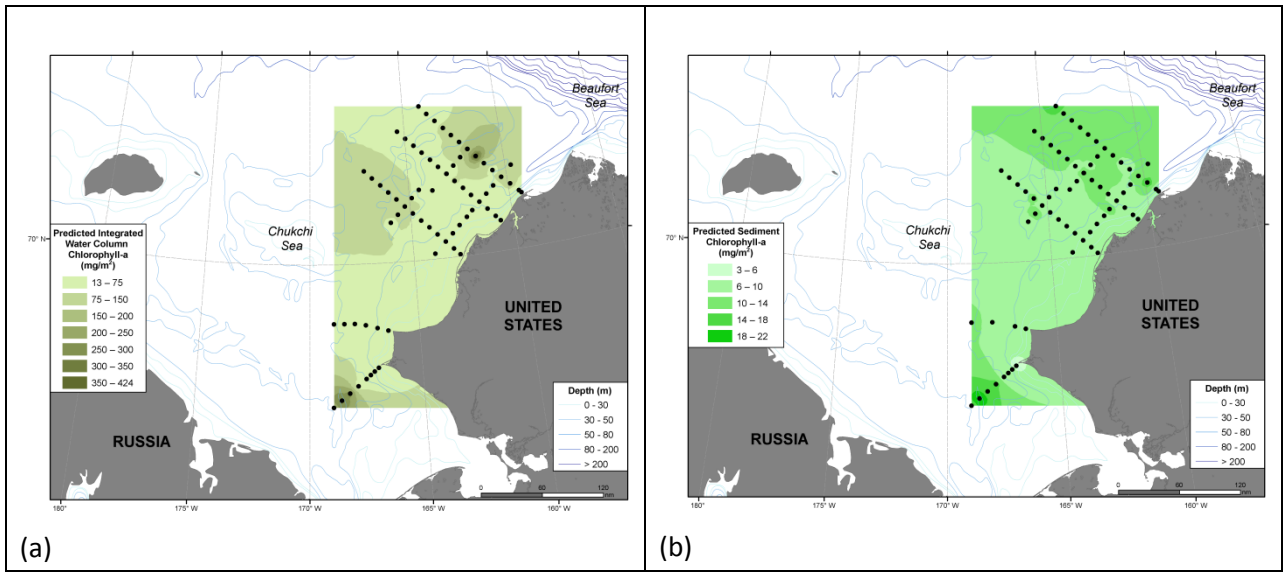

Figure 20. Integrated chlorophyll a (plot a) and surface sediment chlorophyll a (plot b) present in study area during the 2015 AMBON cruise

2. Sediments and Macrofauna

The sediments over the Chukchi Sea ranged from sand and rock near the Alaska coastline to muddy sediments in the offshore regions, with coarse sediments in portions of Hanna Shoal that were sampled. Gravel mixed with mud was encountered in the Central Channel flow paths across the central Chukchi Shelf, which is significant in terms of increasing effort required for macrofaunal identification and biomass determinations. The highest bivalve biomass was observed in fine sediment in the DBO 3.6-3.8

sites in the southern Chukchi Sea and just south and SE of Hanna Shoal along the ML4 line, particularly in the location of the biophysical CEM mooring just SE of Hanna Shoal. Notably, the apparent high bivalve biomass region was north of the current DBO4 line. Astartid bivalves were dominant in the NE Chukchi Sea, along with maldanid polychaetes, whereas tellinid bivalves dominated the offshore SE Chukchi Sea DBO3 hotspot. Sand dollars dominated a band of coarse sand on the nearest alongshore transect under faster current regimes in the Alaska Coastal Water.

Live samples of bivalves were collected during the cruise and returned to CBL for Marine Estuarine and Environmental Science program graduate student Christina Goethel, who is undertaking ocean acidification analyses at CBL as part of her graduate research program.

Table 5: Parameter collections for water, sediment and infauna during the 2015 AMBON cruise

Stn Cast	Stn Name	Date Time (UTC)	Lat °N	Long °W	Depth (m)	Chl a	Nuts	O-18	Phyto ID	Sed Chl	TOC/phi	Grab for Iken	Van Veen grabs (or 4-SWL15)
1	BC2	Aug 10 2015 08:54:48	70.9253	-159.9430	51.6								
2	DBO3.8=SEC1	Aug 12 2015 04:17:41	67.6672	-168.9550	51.2	x	x	x	x	x	x	x	4-SWL15
3	DBO3.7 =SEC2	Aug 12 2015 07:16:08	67.7835	-168.6048	47.7	x	x	x		x	x	x	4-SWL15
4	DBO3.6 =SEC3	Aug 12 2015 09:38:54	67.8970	-168.2368	55.9	x	x	x	x	x	x	x	4-SWL15
5	DBO3.5 =SEC4	Aug 12 2015 12:19:36	68.0115	-167.8657	50.8	x	x	x		x	x	x	4-SWL15
6	DBO3.4 =SEC5	Aug 12 2015 14:42:53	68.1248	-167.4978	47.8	x	x	x	x	x	x	x	4-SWL15
7	DBO3.3 =SEC6	Aug 13 2015 04:12:57	68.1862	-167.3070	45.6	x	x	x		x	x	x	1-SWL15
8	DBO3.2 =SEC7	Aug 13 2015 05:38:50	68.2427	-167.1243	41.0	x	x	x	x	x	x	x	1-SWL15
9	DBO3.1 =SEC8	Aug 13 2015 07:42:57	68.2993	-166.9358	32.6	x	x	x		x	x	x	1-SWL15
10	CL0	Aug 13 2015 12:34:33	68.8990	-166.4228	28.8	x	x	x		x	x	x	1-SWL15
12	CL1	Aug 13 2015 15:18:52	68.9482	-166.9080	44.2	x	x	x	x	x	x	x	4
13	CL3	Aug 14 2015 04:04:17	69.0335	-168.8928	50.6	x	x	x	x	x	x	x	4
14	CL2.5	Aug 14 2015 10:36:51	69.0302	-168.4112	48.4	x	x	x					
15	CL2	Aug 14 2015 11:58:11	69.0288	-167.9343	47.7	x	x	x	x	x	x	x	4
16	CL1.5	Aug 14 2015 14:46:54	69.0003	-167.4347	45.7	x	x	x					
x	ML6.1	Aug 15 2015 04:12:43	70.0870	-163.9603	29.5	x	x	x	x	x	x	x	4
18	ML6.2	Aug 15 2015 07:54:11	70.2670	-163.4075	28.5	x	x	x		x	x	x	4
19	ML6.3	Aug 15 2015 10:21:38	70.3893	-163.0220	30.0	x	x	x	x	x	x	x	4
20	ML6.4	Aug 15 2015 12:48:56	70.5093	-162.6438	33.1	x	x	x		x	x	x	4
21	ML6.5	Aug 16 2015 04:09:33	70.6265	-162.2487	37.4	x	x	x	x	x	x	x	4
22	ML6.6	Aug 16 2015 06:30:00	70.7257	-161.9403	39.4	x	x	x		x	x	x	4
23	ML6.7	Aug 16 2015 09:47:54	70.8435	-161.5382	42.8	x	x	x	x	x	x	x	4
24	ML6.8	Aug 16 2015 12:56:02	70.9595	-161.1378	41.8	x	x	x		x	x	x	4
25	ML6.9	Aug 16 2015 15:17:02	71.0753	-160.7348	52.2	x	x	x	x	x	x	x	4
26	ML4.1	Aug 19 2015 04:02:36	70.8923	-159.3928	25.9	x	x	x	x	x	x	x	4
27	ML4.2	Aug 19 2015 05:43:07	70.9322	-159.5040	43.6	x	x	x		x	x	x	4
28	ML4.3	Aug 19 2015 08:17:36	71.0633	-159.8815	55.6	x	x	x	x	x	x	x	4
29	ML6.10	Aug 19 2015 11:23:24	71.1928	-160.2695	52.7	x	x	x		x	x	x	4
30	ML6.11	Aug 19 2015 14:35:25	71.3612	-159.6925	48.6	x	x	x	x	x	x	x	4
31	ML4.5	Aug 20 2015 04:50:18	71.3237	-160.6557	46.4	x	x	x	x	x	x	x	4
32	ML4.6	Aug 20 2015 07:40:47	71.4545	-161.0375	45.4	x	x	x		x	x	x	4

33	ML4.7	Aug 20 2015	11:06:37	71.5880	-161.4005	45.1	x	x	x	x	x	x	x	4
34	mooring	Aug 20 2015	13:23:17	71.5987	-161.5062	44.4	x	x	x					
35	ML4.8	Aug 21 2015	05:00:22	71.7193	-161.7733	42.0	x	x	x		x	x	x	4
36	ML4.9	Aug 21 2015	07:39:38	71.8508	-162.1582	39.8	x	x	x	x	x	x	x	4
37	ML4.10	Aug 21 2015	10:15:45	71.9795	-162.5413	30.2	x	x	x		x	x	x	4
38	ML4.11	Aug 21 2015	12:31:27	72.1090	-162.9238	37.4	x	x	x	x	x	x	x	4
39	ML4.115	Aug 21 2015	14:44:56	72.1688	-163.1082	37.1	x	x	x		x	x	x	4
40	ML4.105	Aug 21 2015	16:01:18	72.0450	-162.7292	35.8								
41	ML4.12	Aug 22 2015	04:02:08	72.2387	-163.3172	37.9	x	x	x		x	x	x	4
42	ML4.13	Aug 22 2015	06:26:56	72.3645	-163.7218	42.2	x	x	x	x	x	x	x	4
43	ML4.14	Aug 22 2015	09:15:26	72.4965	-164.1027	47.4	x	x	x		x	x	x	4
44	ML3.14	Aug 22 2015	14:30:16	72.1200	-165.3588	42.7	x	x	x	x	x	x	x	4
45	ML3.13	Aug 23 2015	04:11:48	71.9935	-164.9537	38.4	x	x	x		x	x	x	4
46	ML3.12	Aug 23 2015	06:53:42	71.8712	-164.5560	37.7	x	x	x	x	x	x	x	4
47	ML3.11	Aug 23 2015	09:46:18	71.7453	-164.1662	36.0	x	x	x		x	x	x	4
48	ML3.10=DBO4.6	Aug 23 2015	12:27:57	71.6170	-163.7655	38.8	x	x	x	x	x	x	x	4-SWL15
49	ML3.9A=DBO4.5A	Aug 23 2015	14:16:33	71.5553	-163.5708	40.2	x	x	x		x	x	x	
50	ML3.9=DBO4.5	Aug 23 2015	14:57:41	71.4878	-163.3925	40.3	x	x	x		x	x	x	4-SWL15
51	ML3.8A=DBO4.4A	Aug 24 2015	03:57:22	71.4290	-163.2003	40.4	x	x	x		x	x	x	
52	ML3.8=DBO4.4	Aug 24 2015	04:39:51	71.3617	-163.0028	43.2	x	x	x	x	x	x	x	4-SWL15
53	ML3.7A=DBO4.3A	Aug 24 2015	06:52:07	71.2958	-162.8105	44.0	x	x	x		x	x	x	
54	ML3.7=DBO4.3	Aug 24 2015	07:33:11	71.2328	-162.6355	43.5	x	x	x		x	x	x	4-SWL15
55	ML3.6A=DBO4.2A	Aug 24 2015	09:28:53	71.1713	-162.4518	43.4	x	x	x		x	x	x	
56	ML3.6=DBO4.2	Aug 24 2015	10:31:12	71.1038	-162.2552	44.4	x	x	x	x	x	x	x	4-SWL15
57	ML3.5A=DBO4.1A	Aug 24 2015	12:26:44	71.0408	-162.0887	43.2	x	x	x		x	x	x	
58	ML3.5=DBO4.1	Aug 24 2015	13:17:08	70.9725	-161.9008	43.4	x	x	x		x	x	x	4-SWL15
59	L3.4A=DBO4.0A	Aug 24 2015	14:47:57	70.9073	-161.7178	42.7	x	x	x		x	x	x	
60	ML3.4	Aug 24 2015	15:32:45	70.8412	-161.5417	43.6	x	x	x		x	x	x	
61	ML3.3	Aug 25 2015	04:04:56	70.7145	-161.1793	40.3	x	x	x	x	x	x	x	4
62	ML3.2	Aug 25 2015	07:06:59	70.5778	-160.8357	25.2	x	x	x	x	x	x	x	1
63	ML3.1	Aug 25 2015	09:19:50	70.4958	-160.6220	15.1	x	x	x	x	x	x	x	1
64	ML5-11 = ML4-8	Aug 30 2015	04:38:41	71.7210	-161.7812	41.6	x	x	x	x				
65	ML5-10	Aug 30 2015	06:30:50	71.6028	-162.2022	41.2	x	x	x		x	x	x	4
66	ML5-9	Aug 30 2015	09:23:23	71.4828	-162.6043	41.3	x	x	x	x	x	x	x	4
67	ML5-8 = DBO4.4	Aug 30 2015	12:04:52	71.3630	-163.0072	42.8	x	x	x		x	x	x	4-SWL15
68	ML5-7	Aug 30 2015	13:40:28	71.2412	-163.4035	41.7	x	x	x	x	x	x	x	4

69	ML5-6	Aug 31 2015	04:04:23	71.1182	-163.8055	40.2	x	x	x		x	x	x	4
70	ML5-5	Aug 31 2015	06:57:03	71.1468	-164.4862	40.1	x	x	x	x	x	x	x	4
71	ML5-4	Aug 31 2015	09:38:06	71.0225	-164.8767	33.0	x	x	x		x	x	x	4
72	ML5-3	Aug 31 2015	11:53:01	70.8973	-165.2528	38.8	x	x	x	x				
73	ML5-2	Aug 31 2015	11:53:01	70.7718	-165.6275	38.8	x	x	x		x	x	x	4
74	ML5-1	Aug 31 2015	13:08:15	70.6480	-165.9955	39.1	x	x	x	x	x	x	x	4
75	ML1-13	Aug 31 2015	15:19:41	71.5073	-167.2205	40.3	x	x	x	x	x	x	x	4
76/77	ML1-12	Sep 01 2015	04:49:23	71.3862	-166.8200	46.4	x	x	x		x	x	x	4
78	ML1-11	Sep 01 2015	08:01:41	71.2663	-166.4200	44.2	x	x	x	x	x	x	x	4
79	ML1-10	Sep 01 2015	08:32:57	71.1432	-166.0282	44.2	x	x	x		x	x	x	4
80	ML1-9	Sep 01 2015	10:59:09	71.0203	-165.6410	42.3	x	x	x	x	x	x	x	4
81	ML1-8	Sep 01 2015	13:41:57	70.8967	-165.2537	40.9	x	x	x		x	x	x	4
82	ML1-7	Sep 02 2015	03:58:44	70.7720	-164.8780	40.7	x	x	x	x	x	x	x	4
83	ML1-6	Sep 02 2015	06:30:02	70.6468	-164.5018	39.2	x	x	x		x	x	x	4
84	ML1-5	Sep 02 2015	08:54:53	70.5240	-164.1265	37.6	x	x	x	x	x	x	x	4
85	ML1-4	Sep 02 2015	11:12:22	70.3980	-163.7650	44.0	x	x	x		x	x	x	4
86	ML1-3 = ML6-2	Sep 03 2015	06:51:02	70.2682	-163.4062	28.4	x	x	x	x				
87	ML1-2	Sep 02 2015	13:56:23	70.1407	-163.0510	41.9	x	x	x		x	x	x	4
88	ML1-1	Sep 03 2015	04:18:01	70.0358	-162.7657	33.3	x	x	x	x	x	x	x	4

Epibenthic communities and food web structure

Project discipline PI: Katrin Iken (UAF)

On-board team: Katrin Iken, Ann-Christine Zinkann, Tanja Schollmeier

Objectives

We pursued two primary goals during the AMBON cruise in 2015. The first was to map the benthic epifaunal community, i.e., the invertebrates living on top of the sediment and caught in the trawl nets used for fishing. On Pacific Arctic shelves, trawl hauls tend to be composed of >90% invertebrates by biomass versus <10% fish. Epibenthic invertebrates include prey items for higher trophic levels, such as crabs and shrimp, snails, and brittle stars. In addition, invertebrates contribute substantially to total benthic biomass, carbon recycling and biodiversity. As part of the epifauna work, we aimed to continue high-quality and taxonomically distinct photographs of common fauna to add to our developing benthic invertebrate identification guide as one of the outcomes of the AMBON project. Our second goal was to investigate the food web structure of the Chukchi Sea shelf using stable carbon and nitrogen isotopes of particulate organic matter, sediments, zooplankton, benthos and fishes. We also aimed at collection water, sediments, and benthic invertebrates for stable carbon isotope composition of essential amino acids as a specific tool to assess the contribution of microbial and of terrestrial production too food webs on the Chukchi Sea shelf. Food web studies give multiple insights into the complexity of trophic relationships in a given ecosystem including the number of trophic levels in the system, trophic redundancy, feeding types of individual taxa, food sources, the influence of freshwater and terrestrial carbon input onto the food web, etc. It also is one approach to assess functional diversity in a system.

Hence, our primary objectives were:

1. To investigate **epibenthic invertebrate** community structure and diversity across water masses and along a south-north gradient.
2. To determine the **food web structure** and its linkage to marine, terrestrial and bacterial production to assess functional diversity and its linkages to various carbon sources.

In addition to our primary objectives, we agreed to collect opportunistic samples for the following colleagues:

Meredith Everett and Ewann Berntson (NOAA): Samples of the soft coral *Gersemia rubiformis* from as many stations as possible, with ideally 5 individuals per station. Samples of about 3-4 cm length are to be preserved in molecular grade ethanol for later genetic analysis for population genetics of this species.

Emma Timmins-Schiffmann: Samples of the clam *Macoma calcarea* from as many stations as possible, with 8-20 individuals per station. Individuals are to be kept frozen for later genetic analysis of population genetics of this species.

Vanessa von Biela (USGS, UAF): Collection of large (> 40 mm) *Serripes groenlandica* for retrospective climate analysis based on growth rings.

Methods

<u>Epibenthic communities</u> were sampled from trawl samples, using the modified 3-m plumb-staff beam trawl (PSBT-A) with 7 mm mesh and 4 mm cod end liner deployed for fish surveys. Epibenthic invertebrates of the full catch or a well-mixed subsample of the catch were sorted to lowest taxonomic level practical on board. Counts and wet weight per taxon were determined on board using digital

hanging scales. Of the snow crab, *Chionoecetes opilio*, we took individual size measurements (as carapace width in mm) and determined the sex (male, female, immature female) to add to our growing database of Arctic snow crab population data that can be used for assessments of the sustainable fisheries potential of this species on the Chukchi shelf. Vouchers and selected samples were preserved in 4% formalin-seawater solution buffered with hexamethylenetetramine for later confirmation of species identifications with taxonomic specialists. Overview and detail pictures of many of the voucher organisms were taken to assist in the assembly of a photo catalogue of arctic benthic fauna.
About every other station was sampled for food web analysis. We collected water, sediment, pelagic, infaunal, epifaunal and fish samples for later carbon and nitrogen isotope measurements. Water samples for particulate organic matter (POM, n=3 per station) were collected from Niskin bottles in the chlorophyll maximum layer (if present). They were filtered onto pre-combusted GF/F filters and frozen for later analysis. A 50 ml water sample from the same depth was collected and preserved with 2% formaldehyde for later microbial biomass determination. Zooplankton organisms (mostly copepods and chaetognaths, n=3 per taxon where available) were collected from the Bongo tow or the IKMT. Benthic invertebrates were dissected to extract long-lived tissues such as muscle, body wall or whole organisms (depending on taxon and size; n=3 per taxon where available). Organism samples were dried on board at 60°C for 24 h. All samples will be treated to remove carbonate and lipids at the home lab and subsequently analyzed on a continuous flow isotope mass spectrometry using a Costech elemental analyzer interfaced with a ThermoFinnigan Delta Plus isotope mass spectrometer at the University of Alaska Fairbanks Stable Isotope Facility. Sediment samples were collected from a single HAPS core at each station that was also sampled for food web structure; sediments were sampled in 1-cm sections down to 10 cm depth. Sediment samples were frozen and will be analyzed for stable carbon isotope ratios of essential amino acids at the University of Alaska Fairbanks Stable Isotope Facility.

Preliminary results

We completed sampling of our various objectives along the entire station grid (Table 6). For epifauna community, we identified approximately 300 distinct taxa, although the taxon list will need to be verified based on voucher samples collected. As typical for many Arctic shelves, the community was dominated in taxon diversity by gastropods and crustaceans, although we also observed a large number of filter-feeding hydroids and bryozoans (Figure 21). The latter was probably driven by the relatively large number of coastal stations, where swift current leave a substantial amount of coarse substrate that is conducive to the settlement and feeding mode of these groups. Final abundance and biomass data will be calculated once CPUE conversions become available, but it is already obvious that taxa particularly high in abundance and/or biomass were within the echinoderms (the brittle star *Ophiura sarsii*, the sand dollar *Echinarachnius parma*, the sea cucumber *Psolus peronii*, and the basket star *Gorgonocephalus eucnemis*) and the decapods (the crab *Chionoecetes opilio*, the shrimp *Argis* sp.).
We collected close to 2000 individual samples for isotope analysis for the food web study and will make a decision on which samples will be analyzed based on dominant community members at each of the sampled stations. We also measured the size and determined the sex of approximately 4400 snow crab, ranging in size from 3.35 mm to 62.38 mm carapace width.

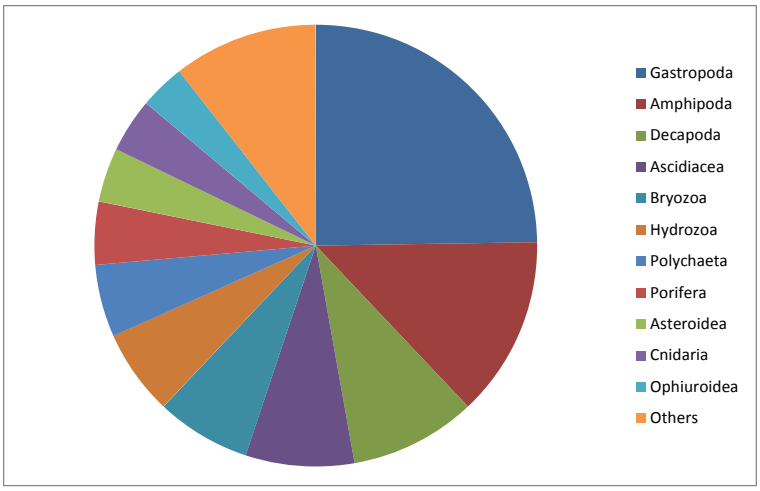

Figure 21: Number of taxa within larger taxon groups found for epibenthic communities from plumb-staff beam trawl hauls.

Table 6: List of samples collected at various stations during the AMBON cruise

Station	Epifauna	Snow crab	Food web	Sediments	Gersemia	Macoma	Serripes
DBO3-8	x	x	x	x	—	x	—
DBO3-7	x	x	—	—	—	x	x
DBO3-6	x	x	x	x	—	x	—
DBO3-5	x	x	—	—	x	—	x
DBO3-4	x	x	x	—	—	—	—
DBO3-3	x	x	—	—	x	—	—
DBO3-2	x	x	x	—	x	—	—
DBO3-1	x	x	—	—	x	—	—
CL0	x	x	x	—	—	—	—
CL1	x	x	x	x	—	—	—
CL3	x	x	x	x	—	—	—
CL2	x	x	x	—	—	—	—
ML6-1	x	x	x	x	—	—	—
ML6-2	x	x	—	—	x	—	—
ML6-3	x	x	x	x	x	—	—
ML6-4	x	x	—	—	—	—	—
ML6-5	x	x	x	—	—	—	—
ML6-6	x	x	—	—	x	—	—
ML6-7	x	x	x	—	—	—	—
ML6-8	x	x	—	—	—	—	—
ML6-9	x	x	x	—	x	—	—
ML4-1	x	—	x	—	x	—	—
ML4-2	x	—	—	—	—	—	—
ML4-3	—	—	x	—	—	—	—
ML6-10	x	—	—	—	—	—	—
ML6-11	x	x	x	x	—	—	—
ML4-5	x	x	x	x	—	x	—
ML4-6	x	x	—	—	—	—	—

ML4-7	x	x	x	—	—	x	x
ML4-8	x	x	—	—	x	x	—
ML4-9	x	x	x	x	—	x	—
ML4-10	x	x	—	—	—	—	x
ML4-11	x	x	x	x	—	—	—
ML4-12	x	x	—	—	—	—	—
ML4-13	x	x	—	—	—	—	—
ML4-14	x	x	x	x	—	—	—
ML3-14	x	x	x	x	—	—	—
ML3-13	x	x	—	—	—	—	—
ML3-12	x	x	x	x	—	—	—
ML3-11	x	x	—	—	x	—	—
ML3-10	x	x	x	x	—	—	—
ML3-9	x	x	—	—	x	—	—
ML3-8	x	x	x	x	—	—	—
ML3-7	x	x	—	—	x	—	—
ML3-6	x	x	x	x	—	—	—
ML3-5	x	x	—	—	—	—	—
ML3-3	x	x	x	—	—	—	—
ML3-2	x	x	—	—	—	—	—
ML3-1	x	—	x	—	—	—	—
ML5-10	x	x	x	—	—	—	—
ML5-9	x	x	—	—	x	—	—
ML5-7	x	x	—	—	—	—	—
ML5-6	x	x	x	—	—	—	—
ML5-5	x	x	—	—	—	—	—
ML5-4	x	x	x	—	x	—	—
ML5-2	x	x	—	—	x	—	—
ML5-1	x	x	x	—	—	—	—
ML1-13	x	x	x	x	—	—	—
ML1-12	x	x	—	—	—	—	x
ML1-11	x	x	x	x	—	—	—
ML1-10	—	—	—	—	—	—	—
ML1-9	x	x	x	x		—	—
ML1-8	x	x	—	—		—	—
ML1-7	x	x	x	x		—	—
ML1-6	x	x	—	—		—	—
ML1-5	x	x	x	x		—	—
ML1-4	x	x	—	—		—	—
ML1-2	x		—	—		—	—
ML1-1	x	x	x	—		—	—

Fish community structure

Project discipline PI: Franz Mueter (UAF)

On-board team: Lorena Edenfield

Methods

Benthic fishes were sampled from trawl samples, using an Abookire modified 3-m plumb-staff beam trawl (PSBT-A) with 7 mm mesh and 4 mm cod end liner and bottom roller gear to avoid penetration of the foot rope into the typically soft, muddy sediment on the shelf. The PSBT-A was deployed from the stern at 30 m/min with a ratio of 2-3 m of towing cable to 1 m of water depth. It was towed at approximately 1.5-2.0 kt speed for approximately four minutes.

Pelagic fishes were collected using an Isaacs-Kidd Midwater Trawl (IKMT), which targeted from the surface to approximately 10 m above the substrate. The IKMT had 3 mm mesh throughout body and codend with mouth dimensions of 1.5 m wide by 1.8 m high. A rigid diving vane kept the mouth of the net open during towing and exerted a depressing force to stabilize the net vertically. The IKMT was deployed from the stern and towed at approximately 3.5-4.0 kt in a double oblique tow. During the haul, the towing cable was continuously released or retrieved at the rate of approximately 30 m/min.

Start and end time stamps of trawling were taken to later be matched with specific latitude and longitudes from the ship records. The nets were also affixed with a time-depth recorder (TDR, Star Oddi) that provided a detailed profile of the trawl. The coordinates and TDR data together with ship speed during towing will allow us to calculate towed area and calculate catch per unit effort (CPUE) for each trawl.

Fishes were sampled from the entirety of each quantitative haul brought on board. Non-quantitative trawls were sorted for fish, if time allowed, and examined for rare or uncommon species to retain as vouchers. The remainder of the fish from non-quantitative hauls was returned to the ocean. All fish retained were euthanized according to IACUC approved protocol 753288-3. Fishes were identified to the lowest possible taxonomic level, usually species. Species in the genus *Lycodes* as well as juvenile and small fish from the Liparidae family are extremely difficult to identify visually and require specialized examination, such as genetic analysis of tissue. Therefore, those fish were identified to the lowest reasonable taxonomic level. Individual fish were then measured to the nearest mm. Wet weight per taxon were determined on board using spring scales. In general, up to 5 organisms per 10-mm size class were kept from stations where collections were done for food web analysis via stable isotope analysis (see Iken). Some exceptions to this included uncommon species and stations that were sampled prior to receiving revised instructions from the PI on 16 Aug 2015. Most fishes were frozen in seawater for transport to the UAF Fisheries Oceanography Laboratory in Fairbanks, AK. These specimens will be available for stable isotope and other potential analyses in the future. Juvenile fishes and very small specimens were combined from a from each station and preserved in molecular-grade 70% ethanol, resulting in one jar of specimens from stations where small fish were collected.

Results

Fish were sampled at 69 stations with the PSBT-A (68 quantitative hauls out of 75 hauls, Table 7) and 30 stations with the IKMT (30 quantitative hauls out of 30 hauls, Table 8). A total of 28 fish taxa representing ten families were identified from the trawls (Table 9). A total of 7335 fish were identified and measured from the PSBT-A and IKMT. An additional 109 fish were captured in either the Bongo or van Veen gears. Fish taxa were dominated by sculpins (Family Cottidae, N=2015), and within that family, *Gymnocanthus tricuspis* was most common. Pricklebacks (Stichaeidae, N=1821) and cods (Gadidae,

N=1280) were the next most common family groups. Absolute abundance and biomass patterns will require calculation of CPUE before they can be compared among stations and lines.

Table 7: Fishing effort with the PSBT-A during the 2015 AMBON cruise.

Date	Station Number	Haul	Quantitative?	Date	Station Number	Haul	Quantitative?
11-Aug-15	DBO3-8	1	Quantitative	22-Aug-15	ML4-14	39	Quantitative
12-Aug-15	DBO3-7	2	Quantitative	22-Aug-15	ML3-14	40	Quantitative
12-Aug-15	DBO3-6	3	Quantitative	22-Aug-15	ML3-13	41	Quantitative
12-Aug-15	DBO3-5	4	Quantitative	22-Aug-15	ML3-12	42	Quantitative
12-Aug-15	DBO3-4	5	Quantitative	23-Aug-15	ML3-11	43	Quantitative
12-Aug-15	DBO3-4	6	Quantitative	23-Aug-15	ML3-10	44	Quantitative
12-Aug-15	DBO3-3	7	Quantitative	23-Aug-15	ML3-9	45	Quantitative
12-Aug-15	DBO3-2	8	Quantitative	23-Aug-15	ML3-8 / ML5-8	46	Quantitative
13-Aug-15	DBO3-1	9	Non-Quantitative	24-Aug-15	ML3-7	47	Quantitative
13-Aug-15	DBO3-1	10	Quantitative	24-Aug-15	ML3-6	48	Quantitative
13-Aug-15	CL0	11	Quantitative	24-Aug-15	ML3-5	49	Quantitative
13-Aug-15	CL1	12	Quantitative	24-Aug-15	ML3-3	50	Quantitative
13-Aug-15	CL3	13	Quantitative	24-Aug-15	ML3-2	51	Non-Quantitative
14-Aug-15	CL2	14	Quantitative	25-Aug-15	ML3-2	52	Quantitative
14-Aug-15	ML6-1	15	Quantitative	25-Aug-15	ML3-1	53	Quantitative
15-Aug-15	ML1-3 /ML6-2	16	Quantitative	29-Aug-15	ML5-10	54	Quantitative
15-Aug-15	ML6-3	17	Quantitative	30-Aug-15	ML5-9	55	Quantitative
15-Aug-15	ML6-4	18	Quantitative	30-Aug-15	ML5-7	56	Quantitative
15-Aug-15	ML6-5	19	Quantitative	30-Aug-15	ML5-6	57	Quantitative
15-Aug-15	ML6-6	20	Quantitative	31-Aug-15	ML5-5	58	Quantitative
16-Aug-15	ML3-4 / ML6-7	21	Quantitative	31-Aug-15	ML5-4	59	Quantitative
16-Aug-15	ML6-8	22	Quantitative	31-Aug-15	ML5-2	60	Quantitative
16-Aug-15	ML6-9	23	Quantitative	31-Aug-15	ML5-1	61	Quantitative
18-Aug-15	ML4-1	24	Quantitative	31-Aug-15	ML1-13	62	Non-Quantitative
18-Aug-15	ML4-2	25	Quantitative	31-Aug-15	ML1-13	63	Quantitative
19-Aug-15	ML4-3	26	Non-Quantitative	1-Sep-15	ML1-12	64	Quantitative
19-Aug-15	ML4-3	27	Non-Quantitative	1-Sep-15	ML1-11	65	Quantitative
19-Aug-15	ML4-4 / ML6-10	28	Quantitative	1-Sep-15	ML1-10	66	Non-Quantitative
19-Aug-15	ML6-11	29	Quantitative	1-Sep-15	ML1-10	67	Non-Quantitative
19-Aug-15	ML4-5	30	Quantitative	1-Sep-15	ML1-9	68	Quantitative
20-Aug-15	ML4-6	31	Quantitative	1-Sep-15	ML1-8 / ML5-3	69	Quantitative
20-Aug-15	ML4-7	32	Quantitative	2-Sep-15	ML1-7	70	Quantitative
20-Aug-15	ML4-8 / ML5-11	33	Quantitative	2-Sep-15	ML1-6	71	Quantitative
21-Aug-15	ML4-9	34	Quantitative	2-Sep-15	ML1-5	72	Quantitative
21-Aug-15	ML4-10	35	Quantitative	2-Sep-15	ML1-4	73	Quantitative
21-Aug-15	ML4-11	36	Quantitative	3-Sep-15	ML1-2	74	Quantitative
21-Aug-15	ML4-12	37	Quantitative	3-Sep-15	ML1-1	75	Quantitative
21-Aug-15	ML4-13	38	Quantitative				

Table 8: Fishing effort with the IKMT during the 2015 AMBON cruise

Date	Station Number	Haul	Quantitative?
11-Aug-15	DBO3-8	1	Quantitative
12-Aug-15	DBO3-2	2	Quantitative
13-Aug-15	CL0	3	Quantitative
13-Aug-15	CL3	4	Quantitative
14-Aug-15	ML6-1	5	Quantitative
15-Aug-15	ML6-4	6	Quantitative
16-Aug-15	ML6-9	7	Quantitative
18-Aug-15	ML4-1	8	Quantitative
19-Aug-15	ML6-11	9	Quantitative
20-Aug-15	ML4-6	10	Quantitative
20-Aug-15	ML4-8 / ML5-11	11	Quantitative
21-Aug-15	ML4-11	12	Quantitative
22-Aug-15	ML4-14	13	Quantitative
22-Aug-15	ML3-14	14	Quantitative
23-Aug-15	ML3-11	15	Quantitative
23-Aug-15	ML3-8 / ML5-8	16	Quantitative
24-Aug-15	ML3-6	17	Quantitative
25-Aug-15	ML3-1	18	Quantitative
29-Aug-15	ML4-8 / ML5-11	19	Quantitative
30-Aug-15	ML5-10	20	Quantitative
30-Aug-15	ML5-9	21	Quantitative
31-Aug-15	ML5-5	22	Quantitative
31-Aug-15	ML5-4	23	Quantitative
31-Aug-15	ML5-1	24	Quantitative
31-Aug-15	ML1-13	25	Quantitative
1-Sep-15	ML1-10	26	Quantitative
1-Sep-15	ML1-8 / ML5-3	27	Quantitative
2-Sep-15	ML1-6	28	Quantitative
2-Sep-15	ML1-3 /ML6-2	29	Quantitative
3-Sep-15	ML1-1	30	Quantitative

Table 9: Fish taxa captured during the 2015 AMBON cruise.

Family	PSBTA	IKMT	Bongo	VanVeen	Total
Teleostii	**-**	**27**	**3**	**-**	**30**
unidentified	-	27	3	-	30
Agonidae	**76**	**16**	**3**	**-**	**95**
juvenile	1	1	-	-	2
Aspidophoroides monopterygius	1	1	-	-	2
Aspidophoroides olrikii	55	14	2	-	71
Podothecus accipenserinus	19	-	1	-	20
Ammodytidae	**115**	**628**	**43**	**-**	**786**
Ammodytes hexapterus	115	628	43	-	786
Cottidae	**1974**	**41**	**-**	**-**	**2015**
juvenile	3	8	-	-	11
Artediellus scaber	255	-	-	-	255
Gymnocanthus tricuspis	1285	32	-	-	1317
Icelus spatula	41	-	-	-	41
Myoxocephalus scorpius	366	1	-	-	367
Trichocottus brashnikovi	10	-	-	-	10
Triglops pingelii	14	-	-	-	14
Gadidae	**641**	**616**	**23**	**-**	**1280**
juvenile	144	29	10	-	183
Boreogadus saida	309	435	9	-	753
Eleginus gracilis	188	152	4	-	344
Hemitripteridae	**23**	**-**	**-**	**-**	**23**
Nautichthys pribilovius	23	-	-	-	23
Liparidae	**913**	**56**	**13**	**-**	**982**
juvenile	-	5	-	-	5
Liparis spp.	841	51	13	-	905
Liparis gibbus	18	-	-	-	18
Liparis tunicatus	54	-	-	-	54

Family	PSBTA	IKMT	Bongo	VanVeen	Total
Osmeridae	**-**	**1**	**-**	**-**	**1**
Mallotus villosus	-	1	-	-	1
Pleuronectidae	**190**	**46**	**9**	**-**	**245**
juvenile	35	44	9	-	88
Hippoglossoides robustus	59	-	-	-	59
Limanda aspera	4	-	-	-	4
Limanda proboscidea	1	2	-	-	3
Limanda sakhalensis	91	-	-	-	91
Stichaeidae	**1627**	**180**	**12**	**2**	**1821**
juvenile	-	13	1	-	14
juvenile, blenny	-	38	5	-	43
juvenile, shanny	3	46	2	-	51
Anisarchus medius	142	-	-	2	144
Lumpenus fabricii	1419	83	4	-	1506
Stichaeus punctatus	63	-	-	-	63
Zoarcidae	**165**	**-**	**-**	**1**	**166**
Gymnelus, juvenile	1	-	-	-	1
Gymnelus hemifasciatus	28	-	-	-	28
Gymnelus viridis	9	-	-	-	9
Lycodes spp.	53	-	-	1	54
Lycodes mucosus	4	-	-	-	4
Lycodes polaris	51	-	-	-	51
Lycodes raridens	19	-	-	-	19
Total	**5724**	**1611**	**106**	**3**	**7444**

Seabird observations

Project discipline PI: Kathy Kuletz (USFWS)

On-board team: Daniel A. Cushing, Athina Catherine Pham

The U.S. Fish and Wildlife Service (USFWS) conducted seabird surveys as a component of the Arctic Marine Biodiversity Observation Network (AMBON) Cruise, 8 August to 5 September, 2015, aboard the R/V *Norseman II*, a 35-m vessel. We embarked in Deadhorse, AK and disembarked in Wainwright, AK, and primarily surveyed in the Chukchi Sea, East of the International Date Line (Figure 22).

Two observers, working in alternate shifts on the bridge, conducted all observations from the port side of the wheelhouse. We surveyed seabirds using line transect methods, recording distance and radial angle from the bow for each group of birds detected, using bins for distance (0-50, 51-100, 101-150, 151-200, 200-300, > 300 m) and angle bins (5 degree increments). Line transect methods will allow us to estimate the probability that birds within the sampling window were detected by observers (which can vary by species), and determine the effects of variables such as sea state on detectability. We recorded flying birds using instantaneous scans, to minimize bias in counts due to movement of flying birds. Seabird observations were recorded directly into a laptop computer using software Dlogv3 (R.G. Ford Consulting, Portland, OR) which logged the geographic coordinates of each sighting, as well as the track line and environmental conditions (sea state, glare, weather, ice coverage) at 20 sec intervals.

We conducted 228 hours of seabird surveys during 23 days between 9 August and 3 September, 2015. A preliminary estimate of total distance surveyed is 3274 km. Our primary objective was to survey along the station lines sampled by the other AMBON project components. We also conducted additional opportunistic sampling as time allowed, in coordination with the marine mammal team and the Captain or Mate, aiming to maximize spatial and temporal survey coverage. We generally surveyed from 08:30 to 19:30 each day, and often surveyed before and after these times when possible. This increased our ability to keep up with the pace of the station sampling, conducted during the night, and maximize coverage of each line. However, on some days our sampling was curtailed due to high winds and seas.

Preliminary Results

On transect, we observed 10918 individuals of 32 species of marine birds (Table 10). The most frequently observed taxa were shearwaters (primarily Short-tailed Shearwater, *Puffinus tenuirostris*), Least Auklet (*Aethia pusilla*), Crested Auklet (*Aethia cristatella*), phalaropes (primarily Red Phalarope, *Phalaropus fulicarius*), Thick-billed Murre (*Uria lomvia*), Common Murre (*Uria aalge*), and Black-legged Kittiwake (*Rissa tridactyla*).

Notable were unusually high numbers of Kittlitz's Murrelets (*Brachyramphus brevirostrus*) observed in the vicinity of Icy Cape. Over 2000 shearwaters were observed on transect in the vicinity of Barrow Canyon. We also observed high densities of Least Auklets and murres in the vicinity of Pt. Hope and Cape Lisburne. Crested Auklets were particularly abundant south of Hanna Shoal. Other notable sightings include small numbers of Ancient Murrelets (*Synthliboramphus antiquus*), Dovekies (*Alle alle*) and Spectacled Eiders (*Somateria fischeri*).

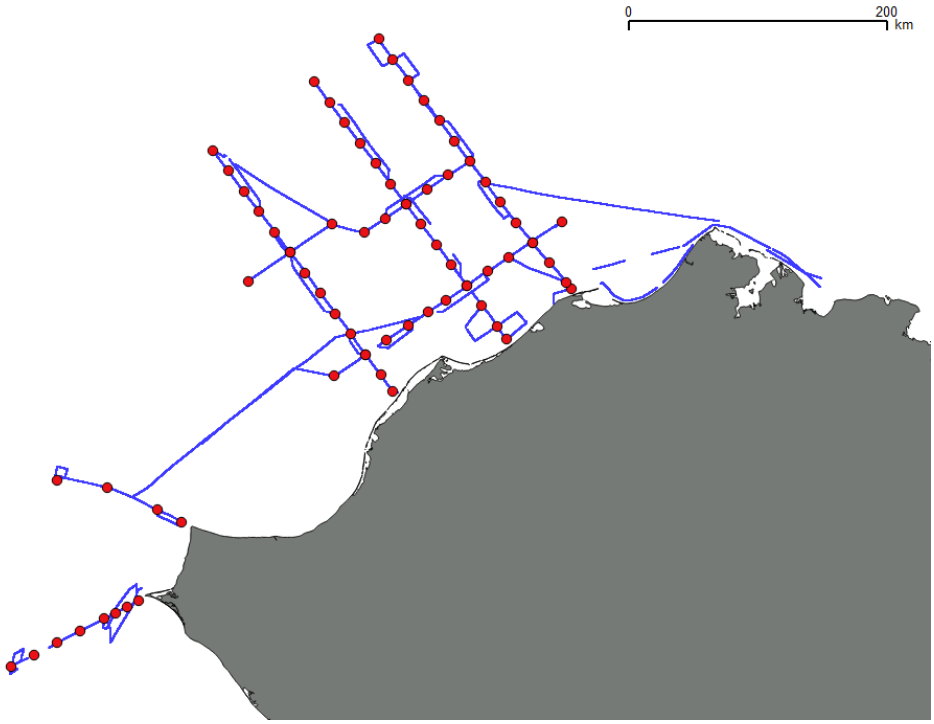

Figure 22. Locations of seabird surveys (blue lines) conducted as a component of the 2015 AMBON cruise in the Chukchi and Beaufort Seas. AMBON stations are depicted by red circles.

Table 10. Marine birds observed on transect during the 2015 AMBON cruise.

Common Name	Scientific Name	Number Observed	Percent of Total
Pacific Loon	*Gavia pacifica*	29	0.27
Yellow-billed Loon	*Gavia adamsii*	4	0.04
Loon spp.	*Gavia spp.*	10	0.09
Northern Fulmar	*Fulmarus glacialis*	76	0.70
Short-tailed Shearwater	*Puffinus tenuirostris*	681	6.24
Dark Shearwater spp.	*Puffinus spp.*	2623	24.02
Long-tailed Duck	*Clangula hyemalis*	59	0.54
Common Eider	*Somateria mollissima*	28	0.26
King Eider	*Somateria spectabilis*	7	0.06
Spectacled Eider	*Somateria fischeri*	5	0.05
Eider spp.	*Somateria spp.*	101	0.93
Red-breasted Merganser	*Mergus serrator*	1	0.01
Duck spp.	*Anatidae spp.*	1	0.01
Long-billed Dowitcher	*Limnodromus scolopaceus*	2	0.02
Red Phalarope	*Phalaropus fulicarius*	177	1.62

Red-necked Phalarope	*Phalaropus lobatus*	3	0.03
Phalarope spp.	*Phalaropus spp.*	365	3.34
Shorebird spp.	*Scolopacidae spp.*	6	0.05
Pomarine Jaeger	*Stercorarius pomarinus*	8	0.07
Parasitic Jaeger	*Stercorarius parasiticus*	12	0.11
Long-tailed Jaeger	*Stercorarius longicaudus*	1	0.01
Jaeger spp.	*Stercorarius spp.*	6	0.05
Glaucous Gull	*Larus hyperboreus*	63	0.58
Herring Gull	*Larus argentatus*	1	0.01
Thayer's Gull	*Larus thayeri*	1	0.01
Black-legged Kittiwake	*Rissa tridactyla*	293	2.68
Sabine's Gull	*Xema sabini*	14	0.13
Gull spp.	*Larus spp.*	7	0.06
Arctic Tern	*Sterna paradisaea*	68	0.62
Common Murre	*Uria aalge*	162	1.48
Thick-billed Murre	*Uria lomvia*	327	3.00
Murre spp.	*Uria spp.*	372	3.41
Dovekie	*Alle alle*	3	0.03
Black Guillemot	*Cepphus grylle*	2	0.02
Kittlitz's Murrelet	*Brachyramphus brevirostris*	59	0.54
Brachyramphus Murrelet spp.	*Brachyramphus spp.*	22	0.20
Ancient Murrelet	*Synthliboramphus antiquus*	2	0.02
Parakeet Auklet	*Aethia psittacula*	55	0.50
Crested Auklet	*Aethia cristatella*	2377	21.77
Least Auklet	*Aethia pusilla*	2745	25.14
Auklet spp.	*Aethia spp.*	2	0.02
Small Dark Alcid spp.	*Alcidae spp*	85	0.78
Horned Puffin	*Fratercula corniculata*	26	0.24
Tufted Puffin	*Fratercula cirrhata*	17	0.16
Alcid spp.	*Alcidae spp*	10	0.09
Total		**10918**	**100.00**

Marine mammal observations

Project discipline PI: Kate Stafford (U Washington), Sue Moore (NOAA)

On-board team: Suzanne Yin, Sonia Groves

Marine mammal observations took place, conditions permitting, daily from the bridge. Generally, visual observations started at about 8:30 am, after the daily morning safety meeting (attendance required). Start and end times varied for a variety of reasons, such as late ending of previous night's sampling, overcast conditions or darkness making visual observations impossible, fog or haze obscuring visibility to less than 1 nm, rough conditions of sea state or slow speeds (below 8 knots, which is the slowest survey

speed typically for line-transect marine mammal studies). Handheld 10x50 or 7x50 binoculars were used to scan from approximately 60 degrees left and right of the bow, sightings were entered into customized data collection program, WinCruz, with observers estimating distance. Early on in the cruise, observers asked the mate or captain to determine the distance of vessels or coastline using radar, as a means of calibrating distance. The marine mammal station was located just left of the centerline of the ship, just to the right of the bird observers (see above). Height of the bridge was determined to be 5 m, but reticle binoculars were not used for distance calculations. No course deviations were made for glare on the trackline.

Priority for visual observations was given to surveying the main transect lines, as close as possible temporally to the previous night or next night shift sampling. If extra time was available during the day, a sawtooth pattern from 1-5 nm from the main trackline was surveyed.

When an animal was spotted, the observer entered the sighting information into WinCruz, and attempted to get better looks at the animal(s) for species identification and group size. Animals were identified to the lowest taxonomic group possible. Photographs were taken –whenever possible - of animals that were close to the trackline. No attempts were made to alter course or speed to approach any animal.

Bridge observations were suspended at 19:30, as the captain had requested that the bridge be free of all science personnel for the period between 19:30-20:00. Occasionally, visual observations continued after the safety meeting at night until darkness or arrival at the next sampling station. This allowed observers to eliminate some backtracking on the next day's survey.

On several occasions, observations were made without suitable observational conditions during transit to and from lines or when running from rough weather. At these times, the observers were considered 'on effort' even though visibility may have been less than 1 nm, speeds were below 8 knots, and/or Beaufort was greater than 5. Due to poor weather, the ship anchored on 17, 26 and 28 August and 4 September, so no observation effort occurred on those days. Over 50% of survey effort occurred in sea states of Beaufort 4 or greater. Over 900 nm of trackline was covered 'on effort' (Figure 23).

Preliminary results

Overall, walrus (*Odobenus rosmarus*) were the most commonly identified marine mammal (Table 10). Unidentified phocids were the most common and these were likely a combination of spotted and ringed seals, which can be very difficult to identify in the field. There were 23 sightings of 24 total bearded seals (*Erignathus barbatus*). Unidentified large whales were the most common cetacean category, again, due to overall poor sighting conditions during this cruise (high winds, waves and fog). Gray whales (*Eschrichtius robustus*) were the most abundant identified cetacean, followed by bowhead whales (*Balaena mysticetus*). No other large whale species were identified during this cruise. Sightings were most abundant on lines ML4 and ML3 with fewest on DBO3 and CL. The sighting conditions on these two lines were quite poor.

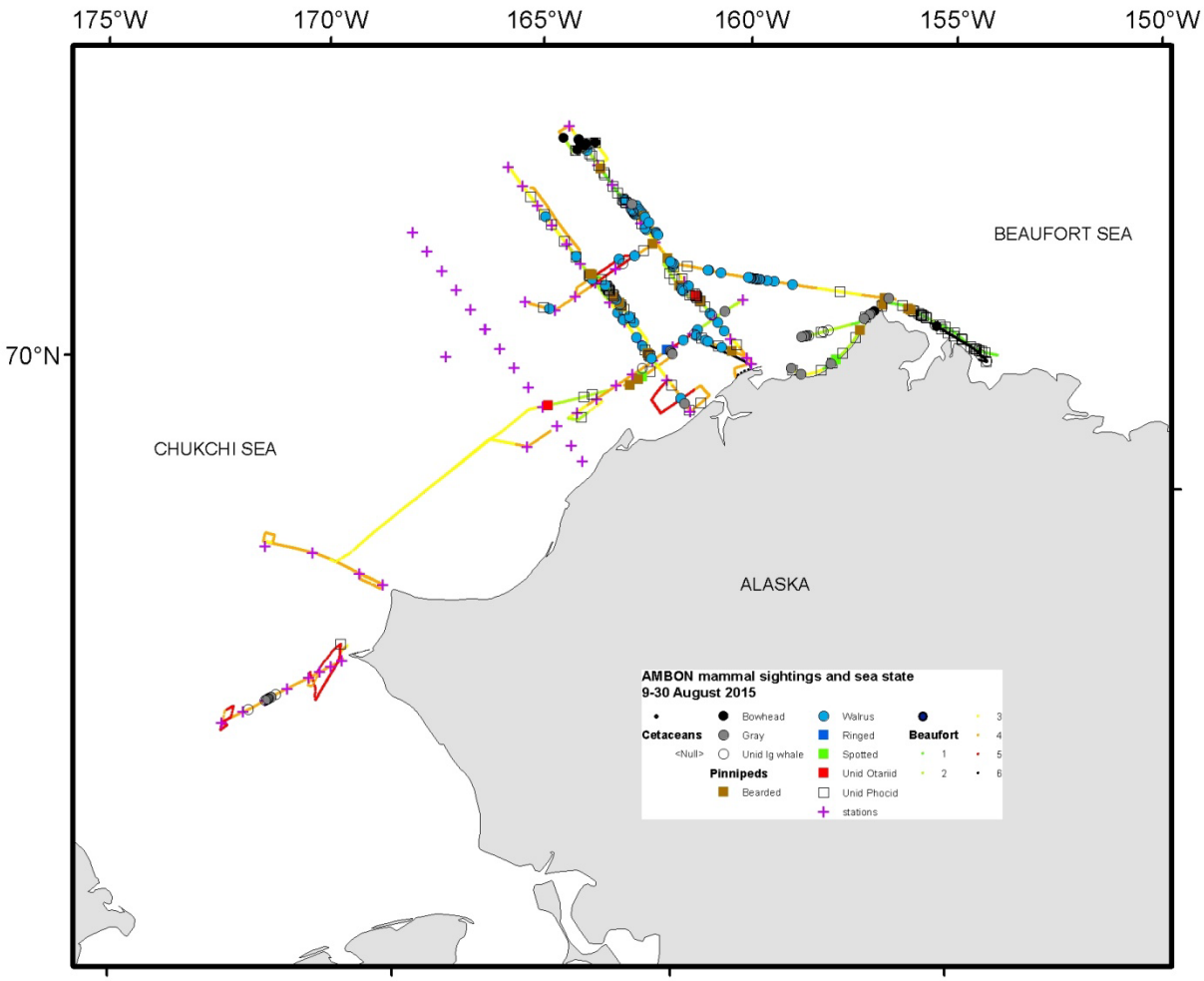

Figure 23. Map of effort by Beaufort sea state and all sightings 9-30 Aug 2015.

Table 10. Species, total number of sightings, and total best estimate for 9 August-4 September 2015

Species	**# sightings**	**Total # animals (best)**
Bowhead whale	9	18
Gray whale	17	53
Unid large whale	27	41
Walrus	81	206
Bearded seal	23	24
Ringed Seal	1	1
Spotted seal	2	3
Unid Phocid	129	130
Unid otariid	2	2

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