ARCTIC NEARSHORE IMPACT MONITORING IN DEVELOPMENT AREA – III (ANIMIDA III)

2014 Field Report

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ANIMIDA III 2014 Field Report

1.0 Introduction

As part of the four-year *Arctic Nearshore Impact Monitoring in Development Area* (ANIMIDA III) contract with the Bureau of Oceans and Energy Management (BOEM), Olgoonik Fairweather (OF), in conjunction with a team of sub-contractors, conducted a 7-day sampling cruise in the Beaufort Sea during August 2014. The cruise originally intended to use two vessels, an offshore vessel for water depths between ~ 12-60m and a nearshore vessel for water depths less than ~20m, in the immediate vicinity of the coastline. However, due to mechanical difficulties and foul weather, the nearshore vessel was not able to conduct any sampling this year. Forty-three stations were originally slated for sampling as per the ANIMIDA sampling plan. Forty-three stations were sampled, in addition to 13 (totaling 56 stations) other secondary and /or opportunistic stations where various samples were collected, depending on the particular discipline (see discipline-specific sections contained herein). Some of the intended stations were replaced by secondary or opportunistic stations as a result of challenges experienced with the nearshore vessel. Samples collected include sediment for physical, chemical, and biological analysis, water for physical and chemical analysis, biota for chemical and taxonomic analysis, and water column sensor data for physical oceanographic analysis (e.g., conductivity, temperature, current velocity; an Acoustic Doppler Current Profiler (ADCP) was used only on the offshore vessel).

The subcontractors brought a wide variety of discipline expertise to the project and include Battelle (hydrocarbon chemistry), Kinnetic Laboratories Inc. (KLI, nearshore vessel operations and sampling support), Florida Institute of Technology (FIT, metals chemistry and geochemistry), University of Alaska – Fairbanks (UAF, epibenthic and physical oceanography), University of Texas at Austin (UT-A, benthic taxonomy, data management, and website development). OF's role served primarily as project management, HSE, and offshore vessel operations and logistics.

The following tasks are included in this field report:

- Task 1 – Sediment chemistry monitoring for hydrocarbons and metals.
    - Task 1A – Field Logistics (additional detail can be found in the Logistics Plan, a separate deliverable)
    - Task 1B – Establishing baseline for benthic biomass, species composition, and oil industry anthropogenic chemicals to detect changes that may result from future oil and gas activities.
    - Task 1C – Supporting water column and physical oceanographic information.
    - Task 1D – Reconstruct historical trend for anthropogenic chemicals.
    - Task 1E – Identify and sample natural or other anthropogenic sources of contaminants to the study area.
- Task 2 – Initiate and develop a conceptual food web related to bioaccumulation and risk of trophic transfer of oil industry anthropogenic chemicals.
- Task 3 – Collaboration with entities.
    - Task 3A – Coordination.

- Task 4 – Project and data management.
    - Task 4A – Project management.
    - Task 4B – Data management.
    - Task 4C – Quality control and quality assurance.
- Task 5 – Local and scientific outreach.

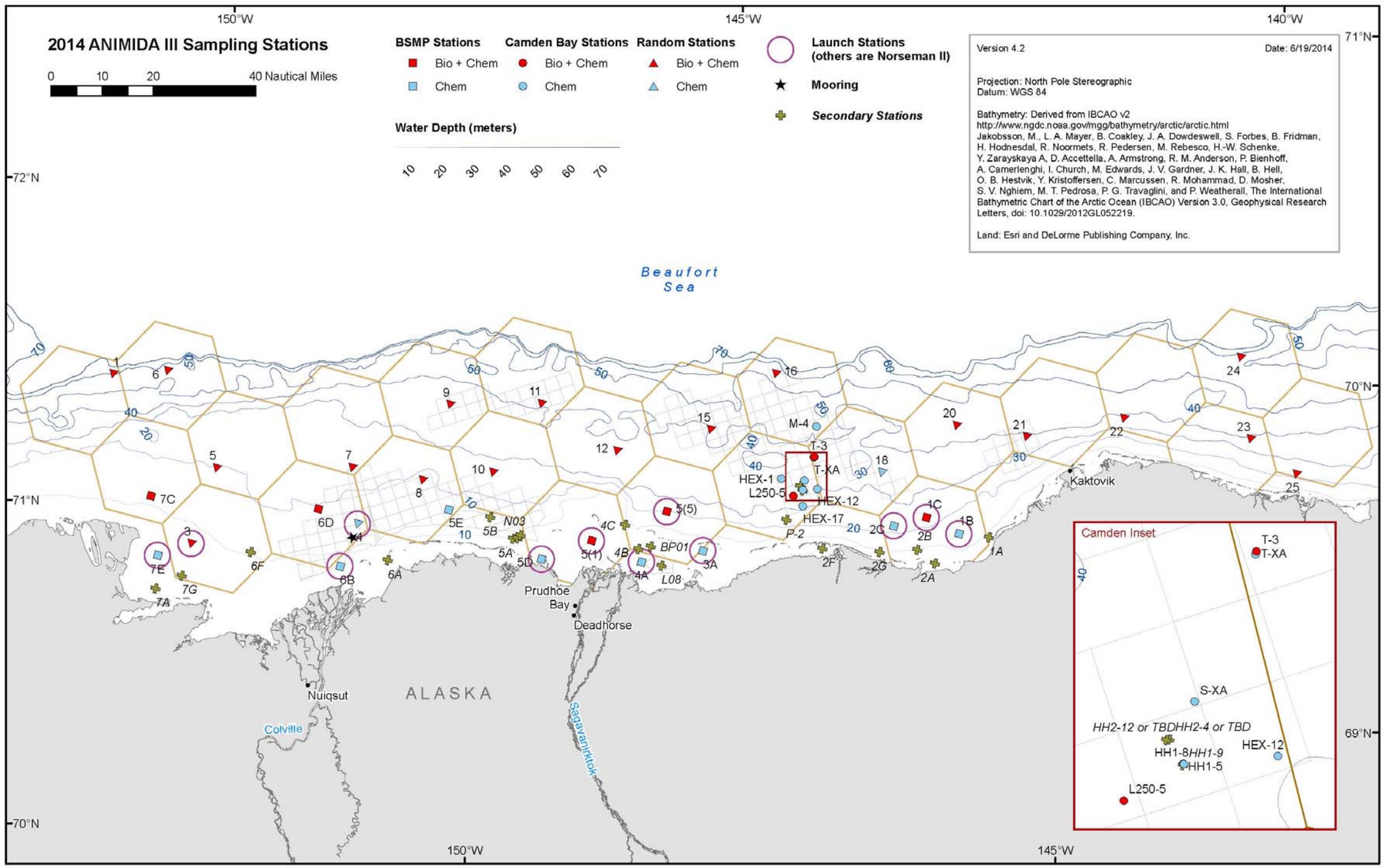
The ANIMIDA III project augments with new stations many of the stations included during ANIMIDA I and ANIMIDA II (previously called ANIMIDA (1999-2003) and cANIMIDA ("continuation" of ANIMIDA (2004-2007) respectively).

The objectives of the 2014 ANIMIDA III field sampling work in support of the specific tasks outlined above were:

(1) Collect sediment, tissue (for biological and chemical analysis), and water samples (a combination of sensor only data and discrete water samples) at 13 former Beaufort Sea Monitoring Program (BSMP) stations (see Figure 1).
(2) Collect sediment, tissue (for chemical analysis only), and water column sensor data at 10 Camden Bay stations.
(3) Collect sediment, tissue (for biological and chemical analysis), and water samples (a combination of sensor only data and discrete water samples) at 25 random, deep-water stations.
(4) Collect at least five sediment cores at targeted stations.
(5) Coordinate sampling between offshore and nearshore locations.
(6) Streamline sampling efforts, wherever possible, to reduce duplicative collections at the same stations.

The objectives were met, for the most part, during the 2014 sampling cruise. The nearshore stations were not sampled as originally intended in the Sampling Plan due to technical and weather challenges with the nearshore vessel. Specific sampling locations are outlined in the discipline-specific summaries.

Figure 1. Station Locations for the 2014 ANIMIDA III Field Sampling Program.



2.0 Logistics – Actual Cruise Schedule

The ANIMIDA III cruise began on July 30, 2014 with the deployment of a physical oceanography mooring and ended on August 7, 2014 with the completion of all sampling activities. This cruise timing is specific to the offshore vessel (the *Norseman II*) only, as the nearshore vessel (Launch 1273) was immobilized due to a bent propeller and was unable to collect any samples. July 29 served as the mobilization of the team to the offshore vessel (crew change) and August 10 served as the demobilization day for the team to return to shore. The original demobilization crew change was slated for August 8, however inclement weather blew in and the crew change was delayed for two days. All crew changes occurred in and out of Prudhoe Bay. Table 1 summarizes the actual cruise schedule.

Table 1. Summary of Actual Cruise Schedule.

Date	Activity / Proposed Stations for Sampling[1]
Saturday, July 26	Team traveled to and convened in Fairbanks, AK
Sunday, July 27	Completion of "Learn to Return Offshore Survival Techniques" Class at UAF
Monday, July 28	OF HSE training and remaining science planning conducted at UAF
Tuesday, July 29, 2014	Team traveled to Deadhorse and loaded on NII (Launch delayed in Barrow)
Wednesday, July 30, 2014	Norseman II leaves port and begins scientific operations (completed deployment of physical oceanography mooring 35-miles NW of West Dock). Launch is still delayed. Launch scientific personnel remain in Deadhorse.
Thursday, July 31, 2014	NII: Completed stations 6D, 4, 7 and 8. Launch: Delayed off Barrow due to ice/weather.
Friday, August 1, 2014	NII: Scientific operations continue. Completed stations 10, 5E, 5(5), HEX-1, L250-5, HEX-17. Launch: Arrived at West Dock. Team preparing to mobilize 8/2.
Saturday, August 2, 2014	NII: Scientific operations continue. Completed stations HE-12, H1-5, S-XA, T-3, T-XA, M-4, 18, 20, 21, 22. Launch: Delayed in West Dock due to lack of receipt of food delivery. Launch Scientific personnel remain in Deadhorse.
Sunday, August 3, 2014	NII: Completed stations 23, 24, 25, 1B.

Date	Activity / Proposed Stations for Sampling[1]
	Launch: Departed West Dock and transited to Flaxman Island.
Monday, August 4, 2014	NII: Completed stations 1C, 2C, 16, 15. Launch: Unable to sample due to rudder/propeller issues. Were able to transit back to West Dock. Unlikely able to sample from vessel for remainder of cruise.
Tuesday, August 5, 2014	NII: Completed stations 12, 11, 9, 9A, 6F. Launch: Vessel remained in West Dock, awaiting repairs.
Wednesday, August 6, 2014	NII: Completed stations 5, 7C, 6, 6.1, 1.2, 1.01, 1.02, 1.03, 1.04, 1.05, 1.06 (parallel to coast transect). Launch: Vessel remained in West Dock, awaiting repairs.
Thursday, August 7, 2014	NII: Completion of stations 1.07, 1.08, 1.09, 1.10, 1.11, 1.12, 1.13, physical oceanography mooring retrieved, 5B, N03. Sampling completed.
Sunday, August 10, 2014	Scientific team demobilized from NII and transported via charter flight back to Anchorage. Launch team had previously departed Deadhorse.

2.1 Offshore and Nearshore Vessels

Two vessels were attempted for use for field activities during the 2014 field season: the R/V *Norseman II* (Figure 2) and the R/V *Launch 1273* (Figure 3). The *Norseman II* is owned by Norseman Maritime (Seattle, WA) and the *Launch 1273* is owned by BOEM. The *Norseman II* conducted field activities to completion from July 30 through August 7. The *Launch 1273*, as previously mentioned had technical and weather difficulties and was unable to complete any sampling. Each vessel is described in more detail in the 2014 ANIMIDA III Sampling Plan, previously provided to BOEM.

Figure 2. The R/V Norseman II.

Figure 3. The R/V Launch 1273.

2.1 Scientific Field Teams

The 2014 field teams were comprised of scientists on the offshore vessel and the nearshore vessel. All personnel were on the Norseman II for the entire cruise. Scientific personnel staffing the Launch were on-board only for a short duration as the vessel transited from West Dock to Flaxman Island, experienced rudder/propeller issues, and then transited back to West Dock. Tables 2 and 3 summarize the field personnel and the approximate shift schedule for both the Norseman II and the Launch 1273, respectively.

Table 2. R/V Norseman II (Offshore vessel) scientific field personnel.

	Scientific Personnel	Affiliation/Discipline	Vessel	Shift
1	D. Holiday	BOEM, COR (Epibenthic/Fish)	Norseman II	Day
2	J. Kasper	UAF (Phys O)	Norseman II	Day
3	P. Shipton	UAF (Phys O)	Norseman II	Night
4	M. Fitzpatrick	BAT (Chem)	Norseman II	Day
5	M. Walsh	BAT (Chem)	Norseman II	Night
6	J. Trefry	FIT (Chem)	Norseman II	Day
7	B. Trocine	FIT (Chem)	Norseman II	Day
8	A. Fox	FIT (Chem)	Norseman II	Night
9	Y. Yan	FIT (Chem)	Norseman II	Night
10	K. Iken	UAF (Epibenthic)	Norseman II	Day
11	L. Edenfield	UAF (Fish)	Norseman II	Night
12	L. Bell	UAF (Epibenthic)	Norseman II	Day
13	S. Schonberg	UTA (Benthic)	Norseman II	Day
14	C. Bonsell	UTA (Benthic)	Norseman II	Night
15	C. Harris	UTA (Benthic)	Norseman II	Day
16	S. Wisdom	OF (PM)	Norseman II	Day

[1] *No medic/HSE. Ten scientists on day shift, 6 scientists on night shift. At least one from each affiliation/discipline divided between day and night.*

Table 3. R/V Launch 1273 (Nearshore vessel) scientific field personnel.

	Scientific Personnel	Affiliation/Discipline	Vessel	Shift
1	J. Hardin	BAT (Chem)	Launch 1273	Day
2	K. Walker	UAF (Fish)	Launch 1273	Day
3	K. Dunton	UTA (Benthic)	Launch 1273	Day

3.0 Field Report Discipline Summaries

The following sections present brief summaries of the sampling activities completed for each discipline during the 2014 ANIMIDA III field cruise.

3.1 Physical Oceanography

- Jeremy Kasper, PI, University of Alaska Fairbanks
- Jeremy Kasper and Peter Shipton, shipboard team

Fifty-six CTD stations (Table 4) were occupied between July 30 and Aug. 7, 2014 on the eastern and central sections of the Alaskan Beaufort Sea shelf (ABS) an area marked by a paucity of observations. The stations included a mix of full, partial and physical oceanography only stations. The latter generally consisted of a CTD cast with no water samples (Table 4, Figure 4). The physical oceanography only stations were carried out in rapid succession along a track line to create a "quasi-synoptic" section (stations 1.01-1.05 and 1.05-1.14, Figure 4). Full CTD stations included water samples collected at discrete depths (surface, bottom and chlorophyll maximum) that were sampled for nutrients, chlorophyll *a* and selected chemicals. A total of 101 samples were collected for analysis of major and trace nutrients (Whitledge et al., 1981). An additional 45 samples were collected and filtered and will later be analyzed for water column barium (Ba). Barium is an effective tracer for the presence of Mackenzie River water (e.g., Guay and Falkner, 1998). Collection of Ba samples was concentrated on the eastern portion of the ABS and near the shelf break (Figure 4) where we believed Mackenzie river water may be present. The chlorophyll *a* and other chemical analyses are described in more detail in separate reports. In addition to the CTD stations, data from the vessel-mounted acoustic Doppler current profiler were logged for the duration of the cruise. Data from a flow-through thermosalinograph that sampled at approximately 1 m below the surface at 1 Hz also were collected during the cruise.

The physical oceanography only-CTD transects provide a snapshot of shelf conditions. The analysis of salinity and potential temperature from these transects should provide a map of water masses on the shelf including areas whether nutrient rich Pacific Water Masses are typically present. These water masses are typically advected by the shelfbreak jet which forms the northern boundary of the ABS (e.g., Pickart 2004) and are transported onto the shelf by upwelling favorable winds.

In addition, a bottom mounted mooring was deployed on the first day of the cruise, July 30, 2014. The mooring consisted of a bottom mounted "Sea Spider" fiberglass mooring frame, an AOOS-funded acoustic Doppler current profiler (ADCP) as well as a Seabird 16+ CTD and transmissometer (Figure 5). The Sea Spider, CTD and transmissometer were loaned to the project from the UAF equipment pool. The ADCP will measure surface wave direction, height and period as well as current speed and direction throughout the water column, acoustic backscatter and when ice is present, ice draft and ice velocity. The mooring will be in place for one year and was placed strategically in the Colville River Delta to overlap with the spring through ice sampling scheduled for 2015.

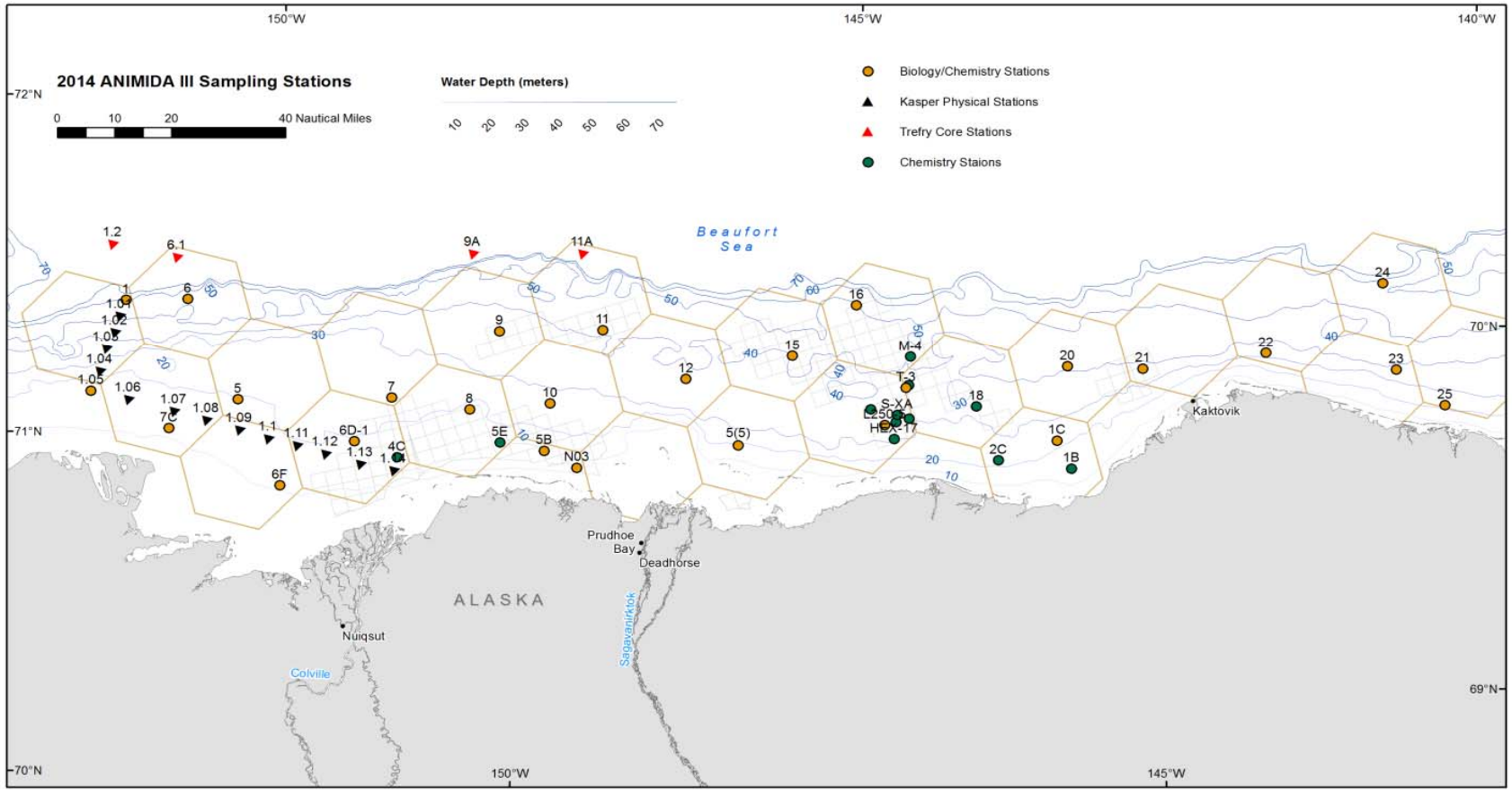


Figure 4. Map indicating ANIMIDA 2014 station locations and type.

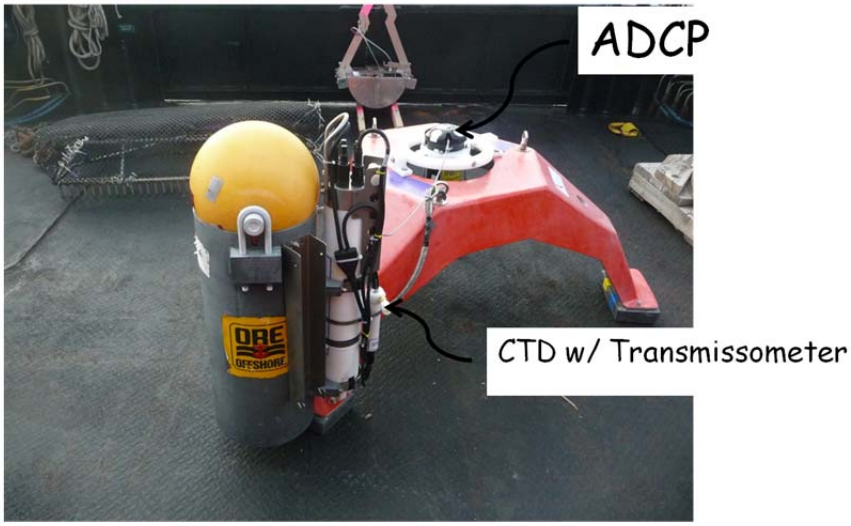


Figure 5. Physical oceanographic mooring deployed in Harrison Bay.

Table 4. Summary of samples collected in the Beaufort Sea for nutrient and water column Ba analysis.

Station ID	Station Type[1]	Latitude (°N)	Longitude (°W)	Nutrient Samples	Water Column Barium
6D	B/C	70.749	150.475	3	
4C	C	70.672	150.155		
7	B/C	70.850	150.061	3	
8	B/C	70.757	149.440	3	
10	B/C	70.713	148.765	3	
5E	C	70.638	149.272		
5(5)	B/C	70.437	147.344	3	
HEX-1	C	70.422	146.182		
L250-5	B/C	70.365	146.118	3	
HEX-17	C	70.316	146.081		
HEX-12	C	70.360	145.906		
HH1-5	C	70.363	146.018		
S-XA	C	70.382	145.985		
T-3	B/C	70.451	145.837	3	
T-XA	C	70.456	145.810		
M-4	C	70.537	145.710		
18	C	70.332	145.336		
20	B/C	70.358	144.495	3	3
21	B/C	70.275	143.910	3	3
22	B/C	70.192	142.905	3	3
23	B/C	70.004	141.963	3	3
24	B/C	70.260	141.763	3	3
25	B/C	69.851	141.718	3	3
1B	C	70.065	144.778		
1C	B/C	70.158	144.805	3	3
2C	C	70.159	145.322		
16	B/C	70.734	145.992	3	3
15	B/C	70.646	146.661	3	3
12	B/C	70.672	147.591	3	3

[1]BC = Biology and Chemistry, C = Chemistry. CTD = CTD sensor only (no bottles)

Station ID	Station Type	Latitude (°N)	Longitude (°W)	Nutrient Samples	Water Column Barium
11	B/C	70.884	148.135	3	3
11A	Core	71.117	148.107	5	
9A	Core	71.206	149.031	5	
9	B/C	70.963	148.995	3	3
6F	B/C	70.672	151.188	3	2
6.1	Core	71.408	151.567	6	
6	B/C	71.283	151.560	3	3
1.2	Core	71.488	152.099	6	
1	B/C	71.320	152.090	3	
1.01	CTD	71.273	152.187		
1.02	CTD	71.226	152.266		
1.03	CTD	71.183	152.370		
1.04	CTD	71.120	152.470		
1.05	B/C	71.072	152.582	3	
1.06	CTD	71.019	152.287		
1.07	CTD	70.955	151.924		
1.08	CTD	70.908	151.673		
1.09	CTD	70.858	151.415		
1.1	CTD	70.813	151.194		
1.11	CTD	70.773	150.965		
1.12	CTD	70.729	150.751		
1.13	CTD	70.674	150.484		
1.14	CTD	70.632	150.222		
5	B/C	70.953	151.354	3	2
7C	B/C	70.913	151.995	3	2
5B	B/C	70.580	148.933	2	
N03	B/C	70.506	148.711	2	
			Totals	101	45

[1]BC = Biology and Chemistry, C = Chemistry. CTD = CTD sensor only (no bottles)

Guay, C.K., Falkner, K.K., 1998. A survey of dissolved barium in the estuaries of major Arctic rivers and adjacent seas, Continental Shelf Research, 18, 859-882.

Pickart, R. S., 2004. Shelfbreak circulation in the Alaskan Beaufort Sea: Mean structure and variability. *Journal of Geophysical Research, **109**, (C4), C04024 10.1029/2003JC001912.*

Whitledge, T.E., Malloy, S.C., Patton, C.J., Wirick, C.D., 1981. Automated nutrient analyses in seawater. Brookhaven National Laboratory Technical Report BNL 51398.

3.2 Hydrocarbon Chemistry

- Greg Durrell, PI, Battelle
- Matt Fitzpatrick and Scott Libby, on-board team

Hydrocarbons are relevant indicator chemicals for establishing baseline data relative to the oil and gas industry. These organic chemicals have natural and anthropogenic sources in the Beaufort Sea, and it is important to know baseline concentrations and likely sources. Aliphatic hydrocarbons are routinely used for assessment of anthropogenic inputs to the Arctic and can provide a temporal record of changes (Macdonald *et al*. 2004). Other sources exist, however, and as such, an expanded set of alkanes are being studied. This expanded set will allow for a measure of terrestrial versus marine derived organic carbon in sediments. In work from the Chukchi and Beaufort Seas, sediments show pronounced odd carbon (e.g., C25, C27) predominance that is characteristic of terrestrial plants (Belicka et al., 2004).

Distributions of n-alkanes in the nearshore and offshore Beaufort Sea environments can be useful for comparing contaminant inputs delivered from the terrestrial system, and other sources. Polycyclic aromatic hydrocarbon (PAHs) and chemical biomarkers (steranes and triterpanes; S/T) will be used to determine the characteristics of the hydrocarbons, and to understand their sources and fate. Certain types of PAHs found in oil have known toxic effects on some marine organisms (NRC, 2003). Toxicity is dependent upon the concentration and duration of exposure to the specific bioavailable PAHs. In general terms, toxicity may be acute (*i.e.*, from an acute spill event) or sub-lethal (e.g., additional impacts following an acute spill or chronic long-term exposure). No evidence of toxic levels of organic substances have been found to date in the ANIMIDA study area (Neff *et. al*. 2009); therefore, we propose to postpone any sediment toxicity studies until such time that contaminated sediments are discovered (i.e., above relatively uniform background conditions). However, sediment contaminant concentrations will be compared to reference effects values to assess the potential for ecological impact.

A total of 45 surface sediment (0-1cm) samples were collected for analysis from a double van Veen grab at 43 stations (two sets of replicates; Table 5 and Figure 6). These samples will be analyzed for a suite of petroleum hydrocarbons including 54 PAHs, base saturated hydrocarbons (SHC), and chemical biomarker ratio S/T. Additional sediment samples were collected at 20 stations from the van Veen grabs for environmental DNA (eDNA) analysis (Table 5). These samples were taken in triplicate from a single van Veen at most stations with a total of 59 samples collected. The eDNA results will be compared against benthic infaunal analyses to evaluate the suitability of the method to accurately assess the biodiversity and community structure of the benthic ecosystem. Sediment gravity cores were obtained for analysis at 7 stations (Table 5). The lengths of the sediment cores ranged from 24-100 cm as noted in Table 5. The cores were sub-sectioned aboard ship in 2-cm thick layers down to 48 cm, then 3 cm intervals to the bottom, which resulted in a total 173 samples available for analysis of selected PAHs. A variety biota samples were collected throughout the study area via van Veen grab, beam trawl, plankton net, clam dredge, and amphipod traps. Of the various biota sampled, a subset of amphipods, clams, arctic cod, whelk, and crabs were collected for PAH and S/T analyses (Table 5 and Figures 6-9). The

amphipod, clam, and arctic cod samples were collected over a wide distribution of stations in the survey area (Figures 6- 9).

Table 5. Summary of samples collected in the Beaufort Sea for hydrocarbon analysis.

Date	Station	Sediment	Sed core	eDNA	Amphipod	Clam	Misc. Biota
7/31/2014	4	1					
7/31/2014	7	1		1	1	1	
7/31/2014	8	1		4[1]	2[1]		
7/31/2014	6D	1		1	1	1	Arctic Cod
8/1/2014	10	1		3	1		
8/1/2014	5(5)	1		3	1		Arctic Cod
8/1/2014	5E	1					
8/1/2014	HEX-1	1	11				
8/1/2014	HEX-12	1					
8/1/2014	HEX-17	1					
8/1/2014	HH1-5	1					
8/1/2014	L250-5	2[1]		3			Arctic Cod
8/1/2014	S-XA	1					
8/2/2014	18	1					
8/2/2014	20	1		3	1	1	Arctic Cod, Whelk
8/2/2014	21	1		3	1		
8/2/2014	22	1	12	3	1	2[1]	
8/2/2014	M-4	1					
8/2/2014	T-3	1		3	2[1]	2	
8/2/2014	T-XA	1					
8/3/2014	23	1		3	1	1	
8/3/2014	24	1		3	2[1]		
8/3/2014	25	1		3	1	1	Arctic Cod
8/3/2014	1B	1					
8/4/2014	12	1		3	1	1	Arctic Cod
8/4/2014	15	1		3	1		Arctic Cod
8/4/2014	16	1		3	1	1	
8/4/2014	1C	1	23	3			
8/4/2014	2C	1					
8/5/2014	9	2[1]		3			Arctic Cod

Date	Station	Sediment	Sed core	eDNA	Amphipod	Clam	Misc. Biota
8/5/2014	11	1		3			
8/5/2014	11A	1	29				
8/5/2014	6F	1					
8/5/2014	9A	1	24				
8/6/2014	1	1					Arctic Cod, Crab, Whelk
8/6/2014	1.05	1			1		Arctic Cod
8/6/2014	1.2	1	36				
8/6/2014	5	1			1		Arctic Cod, Whelk
8/6/2014	6	1		5[1]	1		Arctic Cod, Crab
8/6/2014	6.1	1	38				
8/6/2014	7C	1			1		Arctic Cod
8/7/2014	5B	1			1		
8/7/2014	N03	1			1	1	
Total	**43**	**45**	**173**	**59**	**24**	**12**	**18**

[1]Includes replicate samples.

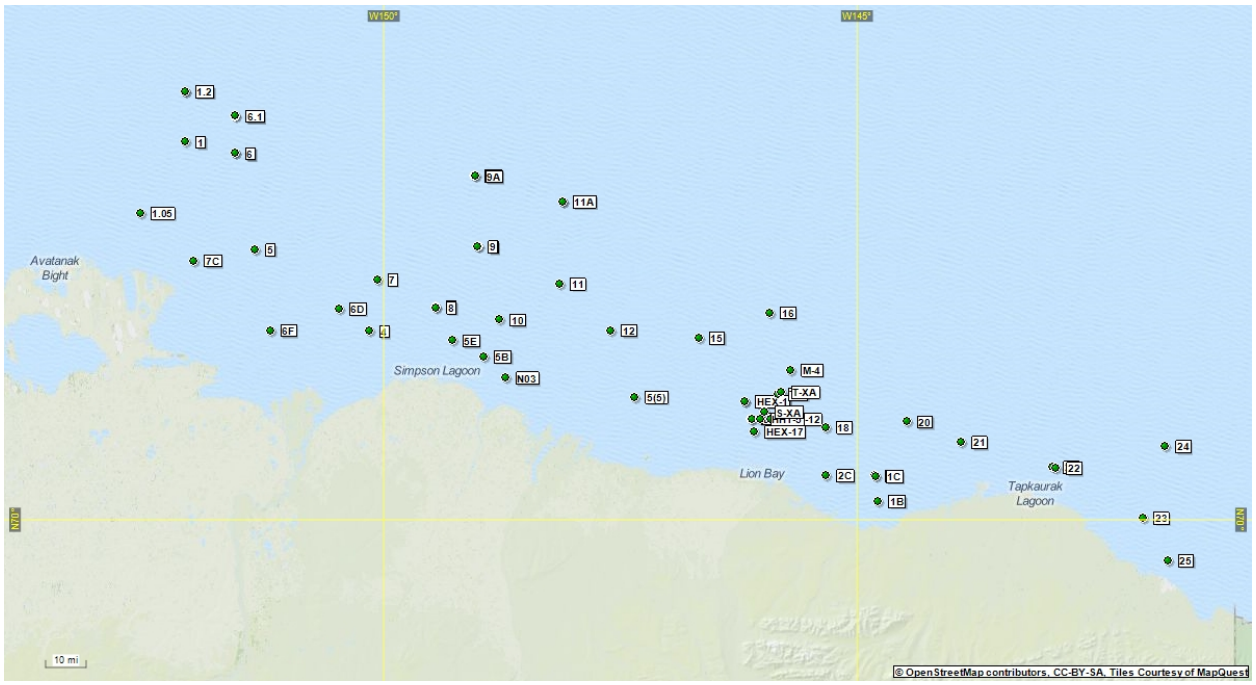


Figure 6. Surface sediment sample (0-1 cm) stations for hydrocarbon analyses – includes all 43 chem, bio/chem and sediment core stations.

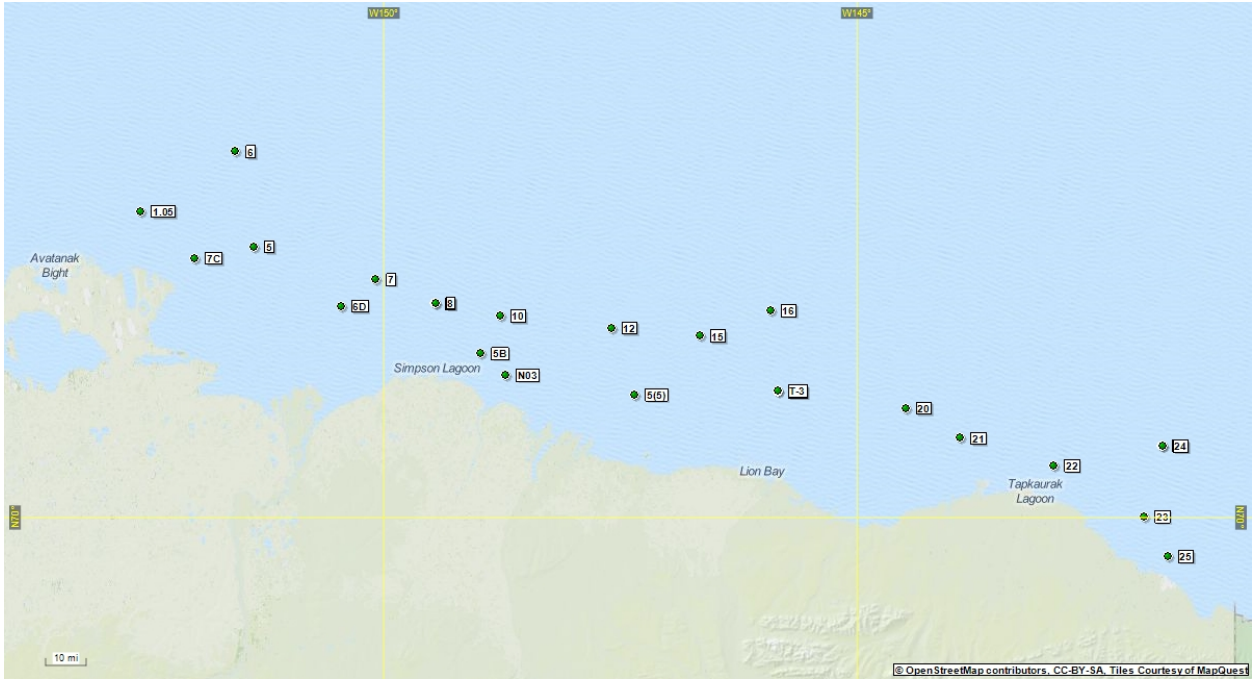


Figure 7. Amphipod samples collected from 21 of the 43 stations.

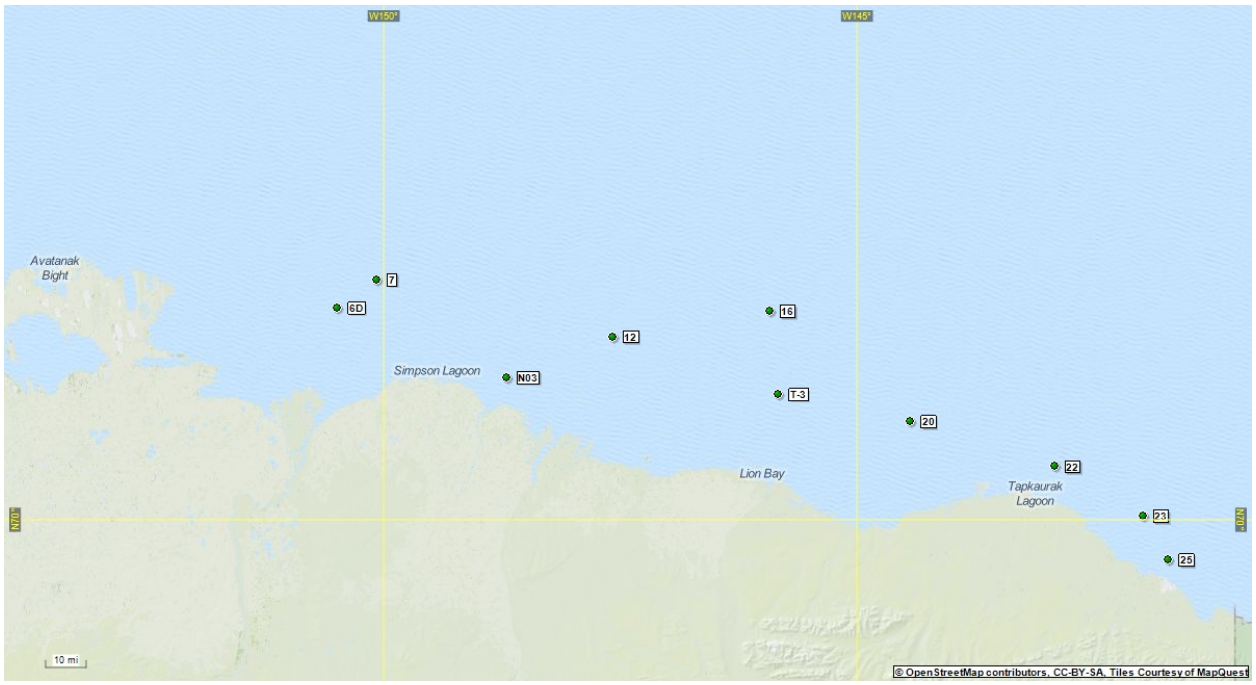


Figure 8. Clams collected from 10 of 43 stations.

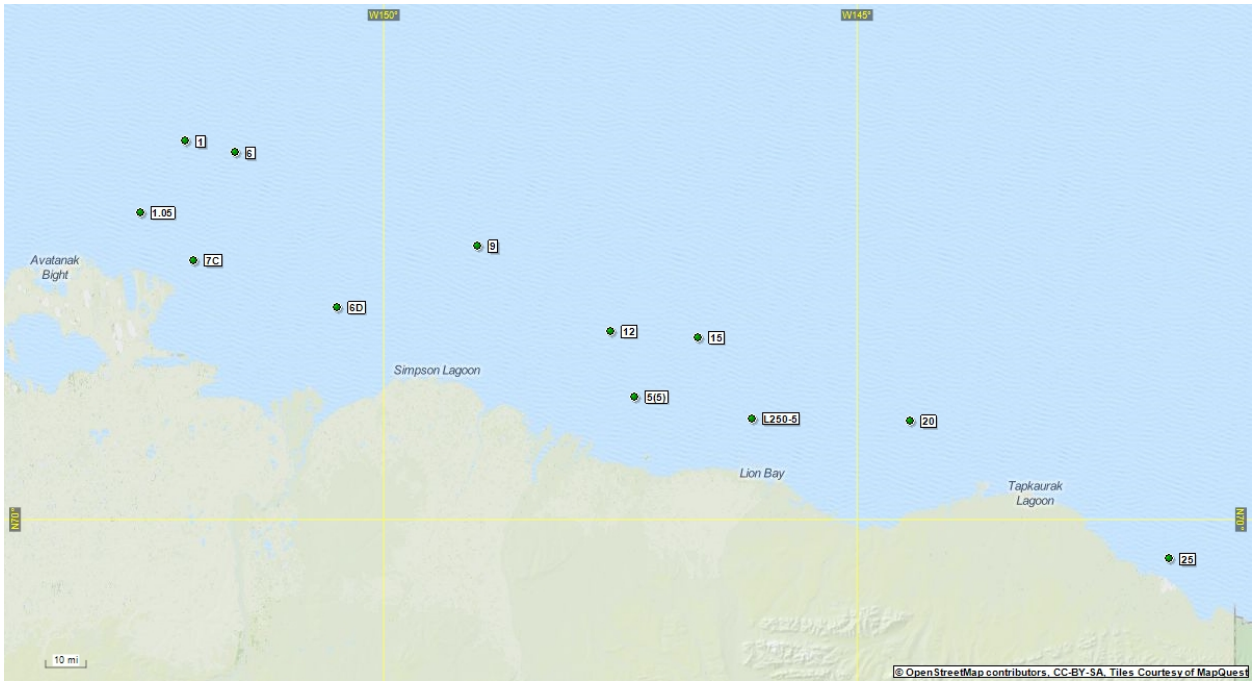


Figure 9. Arctic cod collected from 13 of the 43 stations.

Belicka LL, Macdonald RW, Yunker MB, Harvey HR(2004). The role of depositional regime on carbon transport and preservation in Arctic Ocean sediments. Mar Chem 86, 65-88.

Macdonald RW, Naidu AW, Yunker MB, Gobeil C (2004) The Beaufort Seas; distribution, sources fluxes and burial rates of organic carbon. In: Stein R, Macdonald RW, (eds) The Organic Carbon Cycle in the Arctic Ocean, Springer, Berlin, p 177–192.

Neff JM, Trefry JH, Durell GS (2009) cANIMIDA Task 5. Integrated biomonitoring and bioaccumulation of contaminants in biota of the cANIMIDA study area, OCS Study MMS 2009-037. U.S. Department of Interior, Anchorage.

NRC (2003) National Research Council. Oil in the Sea: Inputs, fates, and effects. National Academies Press, Washington, DC.

3.3 Trace Metal Chemistry

- John Trefry, PI, Florida Institute of Technology
- John Trefry, Bob Trocine, Austin Fox, Yuchao Yan, on-board team

Metals are valuable indicator chemicals for establishing baseline conditions prior to human activity, including oil and gas exploration and production. Metals have natural and anthropogenic sources in the Beaufort Sea, and it is important to know baseline concentrations and likely sources. Trace metals in sediments and biota serve as sensitive indicators of anthropogenic inputs to the Beaufort Sea from industrial activities (Trefry et al., 2003, 2013). Baseline concentrations of 16 metals (Ag, As, Ba, Be, Cd, Co, Cr, Cu, Hg, Mn, Ni, Pb, Sb, Tl, V and Zn) in sediments and biota from the coastal Beaufort Sea were previously determined during the ANIMIDA project (Trefry et al. 2003, Brown et al., 2010). Now that a baseline is established for sediment and biota metals in the coastal Beaufort Sea, future monitoring can proceed with defined limits for identifying contamination. No follow-up monitoring in the study area has occurred since 2006 and little or no study of sediment metals has taken place farther offshore, except in Camden Bay (Trefry et al. 2013). Samples of suspended matter, bottom sediments and biota were collected during August 2014 to determine concentrations of numerous trace metals in the coastal Beaufort Sea.

A total of 77 water samples were collected from surface, mid-water and near bottom water depths at 23 stations (Table 6). Water samples were filtered aboard ship in a plastic hood to obtain samples for particulate organic carbon (POC on glass fiber filters) and particulate metals (Al, Fe, Mn, Ba, Cr and other metals as appropriate on polycarbonate membrane filters). Concentrations of total suspended solids (TSS) also will be determined for each water sample using the polycarbonate filters.

Surface sediments (0-1 cm) were collected for metal analysis a double van Veen grab at 45 stations (Table 6). Sediment gravity cores were obtained for metal analysis at 7 stations (Table 6). The lengths of the sediment cores ranged from 24-100 cm as noted in Table 6. The cores were sub-sectioned aboard ship in 1-cm thick layers over the top 10 cm and in 2-cm thick layers at depths >10 cm. These sediments will be analyzed for selected trace metals. Some cores will be age-dated using ^{137}Cs and excess ^{210}Pb geochronology.

A large selection of biota samples were collected throughout the study area (Table 6). The biota sampled include phytoplankton, zooplankton, arctic cod, snow crabs, whelk, bivalves, amphipods, crabs and other specimens. These samples will be analyzed for total and methyl Hg and several other metals.

Table 6. Summary of samples collected in the Beaufort Sea for trace metal analysis during 2014.

Station ID	Station Type[1]	Latitude (°N)	Longitude (°W)	Water Samples	Surface Sediment	Sediment Core	Biota
6D	B/C	70.749	150.475	4[2]	1		
4C	C	70.672	150.155		1		
7	B/C	70.850	150.061	3	1		
8	B/C	70.757	149.440	4[2]	1		
10	B/C	70.713	148.765	3	1		
5E	C	70.638	149.272		1		
5(5)	B/C	70.437	147.344	4[2]	1		
HEX-1	C	70.422	146.182		1	25 cm	
L250-5	B/C	70.365	146.118	4[2]	1		
HEX-17	C	70.316	146.081		1		
HEX-12	C	70.360	145.906		1		
HH1-5	C	70.363	146.018		1		
S-XA	C	70.382	145.985		1		
T-3	B/C	70.451	145.837	3	1		
T-XA	C	70.456	145.810		1		
M-4	C	70.537	145.710		1		
18	C	70.332	145.336		1		
20	B/C	70.358	144.495	3	1		
21	B/C	70.275	143.910	3	1		
22	B/C	70.192	142.905	3	1	24 cm	
23	B/C	70.004	141.963	3	1		
24	B/C	70.260	141.763	3	1		
25	B/C	69.851	141.718	3	1		
1B	C	70.065	144.778		1		
1C	B/C	227.950	144.805	3	1	46 cm	
2C	C	70.159	145.322		1		
16	B/C	70.734	145.992	3	1		
15	B/C	70.646	146.661	3	1		
12	B/C	70.672	147.591	3	1		

[1]BC = Biology and Chemistry, C = Chemistry. [2]Includes duplicate sample.

Station ID	Station Type	Latitude (°N)	Longitude (°W)	Water Samples	Surface Sediment	Sediment Core	Biota
11	B/C	70.884	148.135	3	1		
11A	Core	71.117	148.107		1	60 cm	
9A	Core	71.206	149.031		1	70 cm	
9	B/C	70.963	148.995	3	1		
6F	B/C	70.672	151.188	3	1		
6.1	Core	71.408	151.567		1	90 cm	
6	B/C	71.283	151.560	3	1		
1.2	Core	71.488	152.099		1	87 cm	
1	B/C	71.320	152.090	3	1		
1.01	CTD	71.273	152.187				
1.02	CTD	71.226	152.266				
1.03	CTD	71.183	152.370				
1.04	CTD	71.120	152.470				
1.05	B/C	71.072	152.582	3	1		
1.06	CTD	71.019	152.287				
1.07	CTD	70.955	151.924				
1.08	CTD	70.908	151.673				
1.09	CTD	70.858	151.415				
1.1	CTD	70.813	151.194		1		
1.11	CTD	70.773	150.965		1		
1.12	CTD	70.729	150.751				
1.13	CTD	70.674	150.484				
1.14	CTD	70.632	150.222				
5	B/C	70.953	151.354	2	1		
7C	B/C	70.913	151.995	2	1		
5B	B/C	70.580	148.933		1		
N03	B/C	70.506	148.711		1		
			Totals	77	45	7 (402	

[1]BC = Biology and Chemistry, C = Chemistry. [2]Includes duplicate sample.

Brown J, Boehm P, Cook L, Trefry J, Smith W, Durell G (2010) Hydrocarbon and metal characterization of sediments in the cANIMIDA study area. OCS Study MMS 2010-004, US Dept. Interior, Anchorage.

Trefry JH, Rember RD, Trocine RP, Brown JS (2003) Trace metals in sediments near offshore oil exploration and production sites in the Alaska Arctic. Environ Geol 45149–160.

Trefry JH, Dunton KH, Trocine RP, Schonberg SV, McTigue ND, Hersh ES, McDonald TJ (2013) Chemical and biological assessment of two offshore drilling sites in the Alaskan Arctic. Mar Environ Res 86:35-45.

3.4 Epibenthic Invertebrates and Fish Community Structure

- Bodil Bluhm, PI, University of Alaska Fairbanks (UAF)
- Katrin Iken, Lorena Edenfield, Lauren Bell, on-board team

Our objectives for the ANIMIDA III 2014 cruise were to establish the epibenthic invertebrate and demersal fish community structure in the nearshore and middle central/eastern Beaufort Sea shelf. On Pacific Arctic shelves, trawl hauls tend to be composed of up to 90% invertebrates by biomass versus about 10% fish. Epibenthic invertebrates include prey items for fish (e.g., amphipods and other crustaceans, and epifaunal polychaetes). In addition, invertebrates contribute substantially to total benthic biomass, carbon recycling and biodiversity. Fishes are key organisms in the energy flow on Arctic shelves as predators of the invertebrate fauna and as food for higher trophic levels such as ice seals. Bottom-feeding fish can also be important in structuring the benthic invertebrate communities.

Epibenthos and fishes were sampled from trawl samples, using a 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. Start and end time stamps of the bottom trawling were taken to later be matched with specific latitude and longitudes from the ship records. The net was also affixed with a time-depth recorder (TDR, Star Oddi) that provides a detailed profile of bottom time 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 epibenthic invertebrates and fishes.

Epibenthic invertebrates from the full catch when feasible, or a well-mixed subsample of the catch, were sorted to lowest taxonomic level practical on board. Fishes always were collected from the entire haul. Counts and wet weight per taxon were determined on board using digital hanging scales. Invertebrate vouchers were preserved in a 4% formalin-seawater solution buffered with hexamethylenetetramine for later confirmation of species identifications with taxonomic specialists. Select organisms were preserved in molecular-grade ethanol for genetic analysis to assist in species identification (esp., anemones, pycnogonids, isopods, select decapods). Several individuals (targeted n = 4) of the more common epibenthic invertebrates were supplied to collaborators (UT) for stable isotope food web work. In some cases, we also supplied large clams and gastropods to Battelle and FIT collaborators for contaminant work. Most fish were identified and measured to the nearest mm, weighed as a species group, and then transferred to Battelle/FIT collaborators for contaminant analysis or to University of Texas at Austin collaborators for stable isotope analysis. Two *Boreogadus saida* captured around 151°W were preserved in *RNALater*™ for the BOEM Arctic Cod Genetics Study. Any fish that were superfluous to contaminant or stable isotope needs were frozen and will be transported to the University of Alaska Fairbanks Fisheries Oceanography Laboratory for detail measurements of length and weight.

Epifauna and fish were sampled at 26 stations from the PSBT-A, with a second trawl taken at three stations (Table 7). At those stations with repeat hauls, the first trawl was quantitative but the catch very small and considered not representative of the present fauna. A total of ~240 putative invertebrate taxa and 25 fish taxa were identified from the trawls.

Table 7. Trawl stations during ANIMIDA III 2014 cruise and number of putative invertebrate and fish taxa collected at each station.

Station	Date	Depth	Invert taxa (#)	Fish taxa (#)
AN14-6D	31-Jul-14	19	34	6
AN14-7	31-Jul-14	25	44	6
AN14-8	31-Jul-14	19	35	3
AN14-10	1-Aug-14	24	21	5
AN14-5(5)	1-Aug-14	19	37	10
AN14-L250-5	1-Aug-14	30	52	4
AN14-T3	2-Aug-14	38	33	9
AN14-20	2-Aug-14	39	34	5
AN14-21	2-Aug-14	39	40	10
AN14-22	2-Aug-14	35	49	6
AN14-24	3-Aug-14	52	39	4
AN14-23	3-Aug-14	35	43	6
AN14-25	3-Aug-14	23	49	8
AN14-1C	4-Aug-14	24	34	6
AN14-16	4-Aug-14	61	29	9
AN14-15	4-Aug-14	40	43	8
AN14-12	5-Aug-14	39	44	8
AN14-11	5-Aug-14	44	44	5
AN14-9	5-Aug-14	36	33	7
AN14-6F (haul 21)	5-Aug-14	13	17	1
AN14-6F (haul 22)	5-Aug-14	13	12	3
AN14-7C (haul 23)	6-Aug-14	10	10	3

Station	Date	Depth	Invert taxa (#)	Fish taxa (#)
AN14-7C (haul 24)	6-Aug-14	10	16	5
AN14-5	6-Aug-14	19	30	6
AN14-6	6-Aug-14	54	54	9
AN14-1	6-Aug-14	64	50	7
AN14-1.05	6-Aug-14	16	16	3
AN14-5B (haul 29)	7-Aug-14	17	13	1
AN14-5B (haul 30)	7-Aug-14	17	35	3

Epibenthic invertebrate taxa mostly belonged to Crustacea, Mollusca, Annelida, Bryozoa, Cnidaria and Echinodermata (Figure 10). Within the Crustacea, most taxa were Amphipoda and Decapoda and in the Mollusca, the most taxon-rich group was the Gastropoda. While Echinodermata were not represented by many taxa, they dominated some stations by relative abundance (mostly the brittle star *Ophiocten sericeum*) or relative biomass (the sea star *Urasterias lincki* and the sea cucumber *Psolus peronii*). Absolute abundance and biomass patterns will require proper calculation of CPUE before they can be compared among stations.

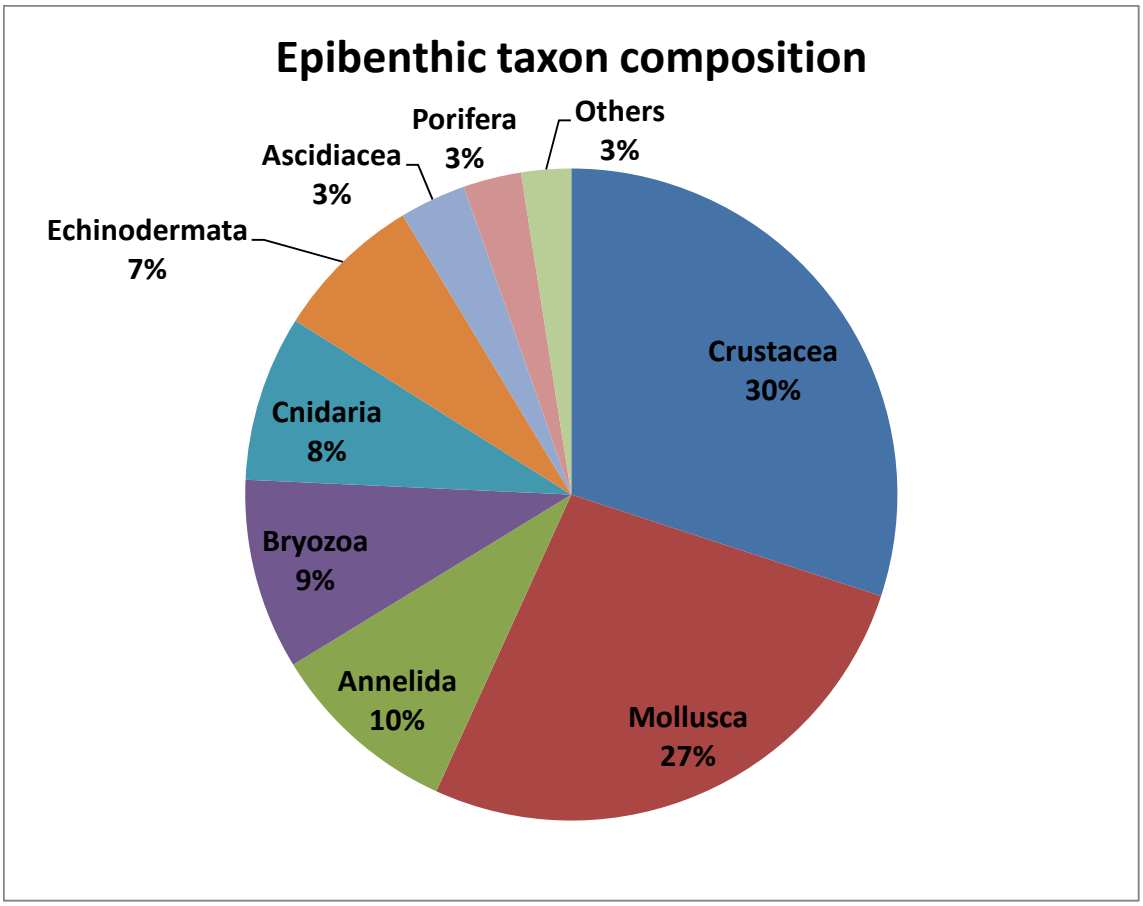


Figure 10. Epibenthic taxon composition by phyla during ANIMIDA III in 2014.

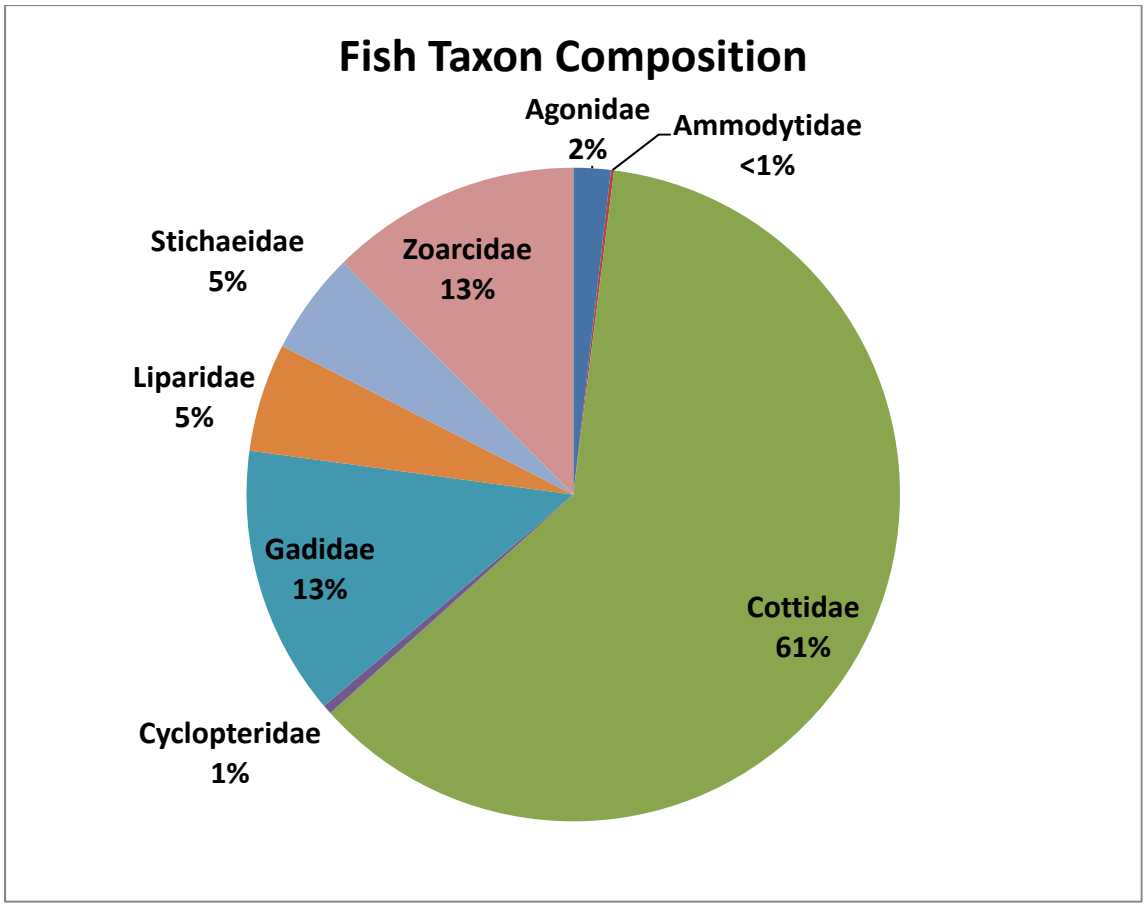


Figure 11. Fish taxon composition by family during ANIMIDA III in 2014.

A total of 652 fish were captured during 2014 ANIMIDA III. One *Ammodytes hexapterus* was captured in a vanVeen grab and one *Gymnocanthus tricuspis* was captured in the clam rake. The remaining 650 fish were captured in the benthic trawl. Fish taxa were dominated by sculpins (Family Cottidae) and within that family, *Gymnocanthus tricuspis* were most common. Eelpouts and Cods were the next most common family groups (Figure 11). All these families are fairly typical for the region and the depth range sampled.

Table 8. Fish taxon and count of individuals captured in the modified plumb staff beam trawl (PSBT-A) during ANIMIDA III in 2014.

Taxa captured in benthic trawl	Number of Fish
Agonidae	**12**
Aspidophoroides olrikii	12
Cottidae	**399**
Artediellus scaber	74
Cottidae	1
Cottidae (juvenile)	12
Gymnocanthus tricuspis	195
Icelus bicornis	14
Icelus spatula	72
Triglops pingelii	31
Cyclopteridae	**3**
Cyclopteridae	3
Gadidae	**87**
Boreogadus saida	87
Liparidae	**35**
Liparis fabricii	6
Liparis gibbus	2
Liparis sp.	21
Liparis tunicatus	6
Stichaeidae	**33**
Anisarchus medius	6
Eumesogrammus praecisus	5
Lumpenus fabricii	21
Stichaeidae (juvenile)	1
Zoarcidae	**81**
Gymnelus hemifasciatus	27
Gymnelus viridis	3
Liparis c.f. bathyarcticus	4
Lycodes c.f. palearis	4
Lycodes mucosus	5
Lycodes polaris	37
Lycodes rossi	1
Fish Total (from PSBT-A)	**650**

Both epibenthic invertebrate and fish taxon richness had a slightly positive correlation with depth over the depth gradient sampled during ANIMIDA III (Figure 12). Fewer taxa were found in the nearshore, shallow region (< 20 m) than in the depth range ~20-65 m. Depth-related abundance and biomass patterns will be evaluated once CPUE data are available.

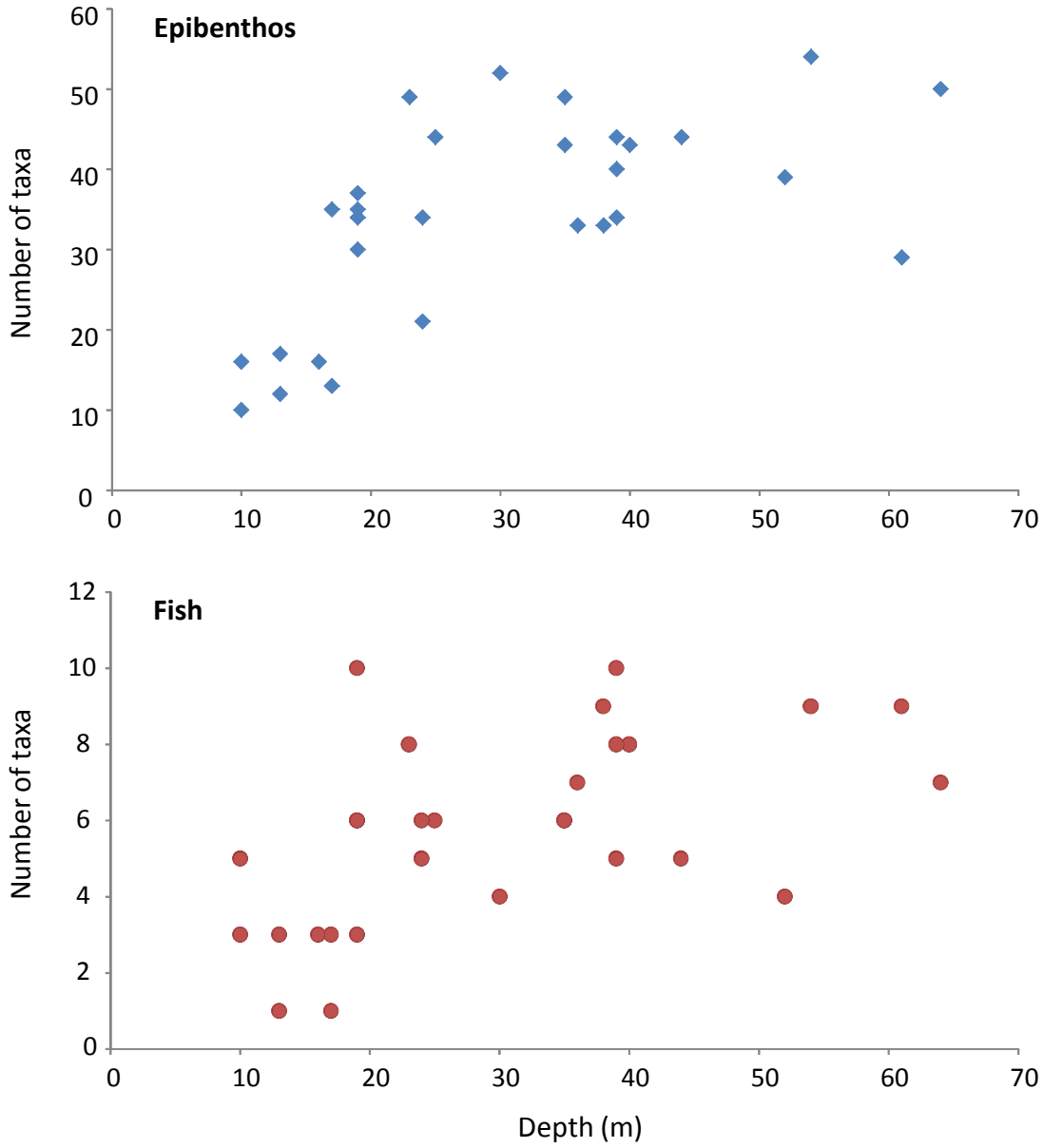


Figure 12. Epibenthic invertebrate and demersal fish taxon richness in relation to bottom depth.

3.5 Trophic structure, faunal inventory, and sediment biogeochemical processes

- Ken Dunton, PI, The University of Texas at Austin Marine Science Institute
- Susan Schonberg, Carolynn Harris, and Christina Bonsell, on-board team

During the ANIMIDA III 2014 cruise, The University of Texas component collected samples from water, hand nets, sediment grabs and bottom trawls to learn about the food web structure of the Beaufort Sea shelf. Results from these efforts will serve as a baseline to assess the current state of the Beaufort shelf system and future ecological changes resulting from natural and/or anthropogenic sources.

WATER FROM CTD – 26 stations (2 replicates/station)

Replicate water samples were collected from CTD bottles tripped in the chlorophyll maximum and near bottom waters. About 500 mls of seawater were filtered through duplicate non-combusted 25 mm GFF filters then frozen for future HPLC chlorophyll analyses. In addition, 2 liters off seawater were filtered onto a combusted GFF filter, dried and stored for POM stable isotope analyses.

HAND NETS – 26 stations

Phytoplankton and zooplankton nets were deployed to collect pelagic organisms for stable isotope analyses. These samples will be analyzed at the University of Texas.

A 20µ phytoplankton net was lowered vertically to near the sea floor then retrieved. The collected sample was poured through a series of 3 sieves the smallest being 63µm mesh. The resulting filtrate was filtered onto two 25 mm combusted GFF filters and dried.

A 335µ zooplankton net was lowered vertically to near the sea floor then retrieved. The sample was poured through a 1mm mesh sieve. The resulting filtrate was filtered onto two 25 mm combusted GFF filters and dried. Large calanoid copepods, *Calanus hyperboreus,* were occasionally collected in the 1 mm mesh sieve and hand-picked as an additional isotope sample.

SURFACE SEDIMENTS FROM GRABS

Surface sediment chemistry – 26 stations (1 grab/station)

Surface sediments were collected in duplicate from a double van Veen grab for four analyses: chlorophyll *a*, C:N, ammonium, and microalgae. Chlorophyll *a* samples were collected using a 20 cc syringe, stored in a pp Falcon tube and frozen. C:N samples were also taken with a 20 cc syringe and dried. Ammonium samples were collected with a 60 cc syringe and frozen. The microalgae sample was collected with a spatula, placed in a 10 ml vial and frozen.

Quantitative Biology – 26 stations (3 grabs/station)

At each station 2 double van Veen grabs were deployed for quantitative analysis and stable isotope collections. One side from the double grab was sampled for surface sediment chemistry and the other side was used for quantitative infauna to assure that the two data types were collected from the same area. The second and third quantitative grabs came from two subsequent deployments of the double van Veen. The grab samples were washed using a slide table with a 1 mm mesh capture box at the base of the slide. Infauna was collected from the table and the screen as the sediment grab was washed then taken inside for sorting under a microscope and bottled in 100% ethanol, which is required for potential DNA analyses.

EPIBENTHIC TRAWLS (26 stations/ > 1000 samples)

A selection of epifauna organisms, including fish, polychaetes, echinoderms, and mollucs, were collected by the Bluhm/Iken component on this cruise (Table 8). Representative species were shared with our group for stable isotope analyses (Table 9). Large organisms were dissected to retrieve muscle tissue and smaller organisms where kept whole. Samples were either dried or frozen. An EA-IRMS (Elemental Analyzer- Isotope Ratio Mass Spectrometer) at the University of Texas will be used for the stable isotope analyses.

Table 9. Stations where the UT team collected and processed samples in summer 2014 aboard the Norseman II. True water depth was corrected from ship's sensor reading by adding 3 meters.

Sta Name	Sta Type	Lat	Long	Depth(m)
6D-1	Biological/Chemical	70.7495	150.4754	18.9
7	Biological/Chemical	70.8499	150.0608	26.3
8	Biological/Chemical	70.7574	149.4400	18.6
10	Biological/Chemical	70.7126	148.7655	24.6
5(5)	Biological/Chemical	70.4366	147.3442	19.6
L250-5	Biological/Chemical	70.3648	146.1182	31.5
T-3	Biological/Chemical	70.4513	145.8372	38.5
20	Biological/Chemical	70.3579	144.4952	39.8
21	Biological/Chemical	70.2752	143.9104	36.0
22	Biological/Chemical	70.1915	142.9047	36.0
23	Biological/Chemical	70.0038	141.9630	35.8
24	Biological/Chemical	70.2600	141.7631	53.5
25	Biological/Chemical	69.8510	141.7181	22.5
1C	Biological/Chemical	70.1580	144.8053	24.7
16	Biological/Chemical	70.7342	145.9916	61.0
15	Biological/Chemical	70.6460	146.6607	36.0
12	Biological/Chemical	70.6717	147.5905	38.4
11	Biological/Chemical	70.8845	148.1355	43.7
9	Biological/Chemical	70.9633	148.9953	37.0

Sta Name	Sta Type	Lat	Long	Depth(m)
6F	Biological/Chemical	70.6722	151.1876	13.5
6	Biological/Chemical	71.2826	151.5597	55.0
1	Biological/Chemical	71.3199	152.0900	63.5
1.05	Biological/Chemical	71.0718	152.5822	16.4
5	Biological/Chemical	70.9529	151.3542	19.3
7C	Biological/Chemical	70.9129	151.9948	14.4
5B	Biological/Chemical	70.5803	148.9327	17.4

4.0 Field Documentation / Data Management

Sample collection in the field was documented using station logs, field forms and/or field notes, depending on the particular discipline. Station coordinates, water depth, and other pertinent information was logged at each location. All samples were held and transferred under custody at all times.

Data management on this multi-faceted program is extremely important and the standard of care exercised for the COMIDA-CAB and Hanna Shoal projects was followed here. The data management program provides persistent and sustainable information which will be (once processed and finalized) readily accessible to the target audience and features a GIS-enabled project database. Data management on this project will be handled in three phases: collection, analysis, and reporting (to NODC), ostensibly the collection and analyses phases are most relevant to this document. In the collection phase, datasets will be authored by individual co-PIs as Excel files. In the analysis phase, observations will be integrated geographically using ArcGIS in a similar manner to that used by Dunton et al. (2005) for historical surveys of the Chukchi Sea.

During the data analysis phase, the observational data and interpolations of their values over the domain of interest will be generated using ESRI's ArcMap and its geostatistical capabilities. A digital base map of the Alaskan Beaufort Sea with shelf bathymetry was created for this project at UTMSI. The basemap includes sample sites of previous station locations in the study area and a tessellated grid created for ANIMIDA III sample sites. We will use GIS software to manage, analyze, and display spatially referenced point samples, and interpolate surfaces for data types collected on this project.

Data archiving at NODC for the proposed project will follow a similar procedure as that of the COMIDA-CAB project. Data will be submitted to NODC (or any site selected by BOEM) for data repository on a yearly basis as part of the annual report. Each year's report to BOEM will contain a description of field and lab methods, results, discussion and comparisons to other findings in the literature or from concurrent projects. Co-PIs will be given a set of standards for reporting that follow Digital Geospatial Metadata (CSDGM), Vers. 2 format for date, latitude, longitude, datum, etc. Each Co-PI will be responsible for submitting a chapter of the annual report which will be compiled under the direction of the project coordinator.

A project website will be developed for PIs to share results with each other, with other scientists, with regulators, and with stakeholders. The website will be linked to a password-protected data management system for project members to securely share preliminary results, while final results will be made publicly available both on the website and via the NODC archives. The project website will be used for sharing geographic data and mapping support will be provided via a project geodatabase.

5.0 Quality Assurance/Quality Control

A rigorous QA/QC program was implemented. For example, SOPs were followed, field documentation was completed, instruments were properly calibrated, and QC samples were collected in the field (and will be included with relevant sample analysis in the laboratory) to demonstrate accuracy, precision, representativeness, and, where applicable (i.e., chemical analysis) to ensure there is no field or laboratory-based sample contamination.

6.0 Permit Information

The following permits (Table 10) were obtained by OF or other team members to conduct the ANIMIDA sampling program in 2014. Deliverables required by each permit will be addressed by OF.

Table 10. Summary of permits obtained for the 2014 ANIMIDA field sampling program.

Permit Name	Date Submitted and/or Signed	Reason for Permit
North Slope Borough Land Use Permit	Submitted: 5/21/14, Approved: 5/28/14	Authorization from North Slope Borough to conduct research/sampling in the nearshore area of the Beaufort Coastal Area (Permit No. 14-757).
National Marine Fisheries Services (NMFS) Letter of Acknowledgement (LOA)	Approved: 6/10/14	Acknowledgement that certain activities on a research vessel (the NII in this case) that are defined as fishing but are scientific in nature, are exempted from broader requirements under the Magnuson-Stevens Act. (LOA: 2014-07).
AK Fish & Game Fish Resources Permit	Submitted: 5/14/14, Approved: 6/3/14	Permit authorizing sample collection of fishes and other organisms in the Beaufort Sea for scientific purposes. Anticipated species list provided by Bluhm's group at UAF (Permit No. CF-14-099).
IACUC Permit	Submitted: 6/2/14, Approved: 6/10/14	Institutional Animal Care and Use Committee permit authorizing laboratory facility to conduct research using animals based on animal welfare/ethical treatment (601331-2).

APPENDIX A – DAILY FIELD REPORTS FROM THE NORSEMAN II