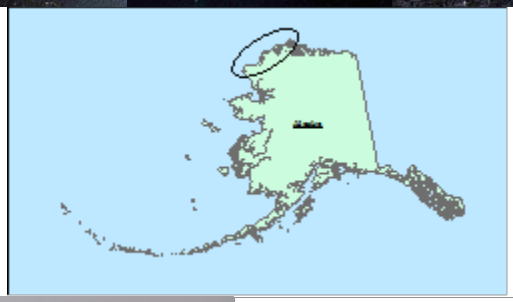
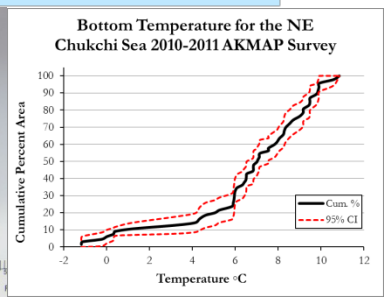
Alaska Monitoring and Assessment Program
2010 and 2011
Chukchi Sea Coastal Survey
Statistical Summary





Prepared by University of Alaska, School of Fisheries and Ocean Sciences, Institute of Marine Science and Alaska Department of Environmental Conservation, Division of Water, Water Quality Standards, Assessment, and Restoration

Alaska Monitoring and Assessment Program (July 2015)

Table 1 – Picture Credits and Caption

Lyre Crab (*Hyas coarctatus*)@Roger Clark	**(*Neptunea heros*)@Roger Clark**	**Sand dollar (*Echinarachnius parma*)@ Roger Clark**
Alaska Map showing 2010 – 2011 Stations		
Crested sculpin (*Blepsias bilobus*) @ Roger Clark		**Cumulative Distribution Function Bottom water Temperature**

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Preface

The Alaska Department of Environmental Conservation (DEC), Division of Water, Water Quality Standards, Assessment and Restoration, and University of Alaska Fairbanks (UAF), School of Fisheries and Ocean Sciences (SFOS) and Institute of Marine Science (IMS) conducted an Alaska Monitoring and Assessment Program (AKMAP) survey of the Chukchi Sea near shore corridor in 2010, 2011, and 2012. The National Oceanic and Atmospheric Administration joined this effort in 2011. The surveyed region lies within a 25 to 50 mile exclusion corridor between the near shore (~10-50 m depth) and the Bureau of Ocean Environmental Management (BOEM) oil/gas lease Sale #193. A spatial probabilistic survey design, developed under the U.S. Environmental Protection Agency Environmental Monitoring and Assessment Program, was used to assess the ecological status of this area. Over the summers of 2010 and 2011, 60 stations were surveyed as part of the probabilistic survey. Additional targeted stations were sampled: one in 2010; three in 2011; and 11 in 2012.

This report provides the statistical background for the 60 stations sampled in 2010 and 2011 comprising the probabilistic survey that will be used in preparing the *Alaska Monitoring and Assessment Program (AKMAP) 2010 – 2011 Chukchi Sea Coastal Survey Environmental Status Summary* on water and sediment quality, and biological status for this region.

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The document can be downloaded at the following URL:

http://dec.alaska.gov/water/wqsar/monitoring/chukchisea.html

Acknowledgments

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Disclaimer

The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the opinion or policies of the U.S. Government. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. government.

Note that the design supports probability-based estimates of the percent area of the target population surveyed for particular ecological status defined by measured values of assessment indicators. However, this design does not provide for specific assessments of the ecological status within a particular estuary or coastal area.

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Definitions

305(b): Refers to section 305 subsection (b) of the Clean Water Act. 305(b) generally describes a report of each states water quality and is the principle means by which EPA, Congress, and the public evaluates whether US waters meet water quality standards, the progress made in maintaining and restoring water quality, and the extent of the remaining problems.

assessment: Evaluation and interpretation of scientific results for the purpose of assisting policy development and establishing management plans for aquatic resources. Aquatic resource assessments often include the description of the fraction of the target population that meets or exceeds quality criteria, characterization of the aquatic resource conditions and description of the association between indicators of resource conditions, and environmental stressors.

base samples: The number of sites (sample size) that will fulfill the monitoring program requirements for precision and uncertainty (generally +\- 10% precision at 90% confidence).

ecological indicator: A characteristic of an ecosystem that is related to or derived from a measure of a biotic or abiotic attributes that can provide quantitative information on ecological condition, structure, and function. An indicator can contribute to a measure of integrity and sustainability.

EMAP: Environmental Monitoring and Assessment Program - an EPA Office of Research and Development long term research program. EMAP was developed to establish the scientific basis for monitoring programs that measure the current and changing conditions of the nation's ecological resources. This program has since been renamed to National Aquatic Resource Surveys.

known confidence: Refers to the estimate of uncertainty or confidence limits associated with a survey result. Usually the 90% confidence limits are estimated and presented along with the survey results.

NARS: National Aquatic Resource Survey – EPA program formerly called EMAP.

non-target population: Sample Frame may contain non-target elements, e.g., misidentified sample units.

probability sample: A probability sample is a sample where every element of the target population has a known, non-zero probability of being selected. That is, it is possible for every element of the target population to be in the sample. Two important features of a probability sample are that the probability selection mechanism (1) guards against site selection bias and (2) is the basis for scientific inference to characteristics of the entire target population.

over samples: When known or suspected circumstances are likely to prevent sampling at some base sample sites, e.g., frame errors, denied access, hazardous site conditions, etc. prior additional sample sites can be identified. These Over-Sample sites are sampled whenever a Base-Sample site cannot be sampled. Alternate terminology: Replacement Samples.

sample frame: Refers to the list or map that identifies every unit within the target population of interest, a physical representation of the target population. Such a list is needed so that every

individual member of the population can be identified unambiguously. The individual members of the target population whose characteristics are to be measured are the sampling units.

status: Often seen as a "snapshot" of resource conditions, e.g., the number of stream kilometers in Region III that meet their designated uses.

survey design: The process of selecting sites at which a response will be determined. Includes a probability model for inference based on the randomized selection process.

target population: Target population denotes the aquatic resource about which information is wanted. A clear, precise definition of the resource is required. Definition of the elements that make up, or are associated with, the target population (i.e., perennial streams and rivers, lakes or estuaries) are included. Usually the target population is generally described within a broad description of the area of interest or study area (i.e., State, conterminous States of EPA Regions 8, 9, and 10).

Acronyms and Abbreviations

°C	degrees Celsius
AKMAP	Alaska Monitoring and Assessment Program
BOEM	Bureau of Ocean Energy Management
CDF	cumulative distribution function
CI	confidence interval
CIAP	Coastal Impact Assistance Program
CTD	conductivity, temperature and depth measurements
DEC	Department of Environmental Conservation
DNR	Department of Natural Resources
DO	dissolved oxygen
dw	dry weight
EMAP	Environmental Monitoring and Assessment Program
EPA	Environmental Protection Agency
IMS	Institute of Marine Science
kg	kilogram
l	liter
NARS	National Aquatic Resource Survey
NOAA	National Oceanic and Atmospheric Administration
NST	National Status and Trends Program
PAH	polycyclic aromatic hydrocarbons
pH	measure of acidity or alkalinity
PHH	planar halogenated hydrocarbons
PO4	phosphate (dissolved inorganic phosphate)
ppt	parts per thousand
PSEP	Puget Sound Estuary Program
PSU	practical salinity units
QA	quality assurance
QA/QC	quality assurance/quality control
QAPP	quality assurance project plan
QC	quality control
SAV	submerged aquatic vegetation
SCCWRP	Southern California Water Resources Research Program
SD	standard deviation
SOP	standard operating procedure
THMW	total high molecular weight
TLMW	total low molecular weight
TPAH	total polycyclic aromatic hydrocarbons
TPH	total petroleum hydrocarbons
TSS	total suspended solids
UAF	University of Alaska Fairbanks

Chapter-1: Introduction

The Alaska Monitoring and Assessment Program (AKMAP) led by Alaska Department of Environmental Conservation (DEC) in partnership with the University of Alaska Fairbanks, School of Fisheries and Ocean Sciences, Institute of Marine Science (IMS) conducted a coastal aquatic resource survey of the northeastern near shore Chukchi Sea coastal environment in 2010 and 2011 (Figure 1). This region was investigated because of the need for baseline data in an area expected to see increasing oil/gas resource survey and development pressure. In 2011, the National Oceanic and Atmospheric Administration (NOAA) National Status and Trends Program (NS&T) joined this effort.

Principal funding for the AKMAP Chukchi Sea coastal survey was provided through the Alaska Department of Natural Resources Coastal Impact Assistance Program (CIAP) (DNR, 2015). The Federal government provided CIAP funding to Outer Continental Shelf (OCS) oil and gas producing states to mitigate the impacts of OCS oil and gas activities. CIAP was originally administered by the United States Department of Interior, Minerals Management Service (renamed Bureau of Ocean Energy Management (BOEM)) and was established by Section 384 of the Energy Policy Act of 2005 (https://www.congress.gov/bill/109th-congress/house-bill/6). The U.S. Fish and Wildlife Service assumed administrative responsibility of CIAP on July 1, 2011. Additional support was provided by Shell Exploration and Production Company for conducting sea bird and marine mammal surveys in 2010 and 2011.

The AKMAP Chukchi Sea coastal survey design is based on the EPA sampling survey approach developed under its Environmental Monitoring and Assessment Program (U.S. EPA, 2015). EPA has since renamed the program National Aquatic Resource Survey (NARS). This design utilized a spatial probabilistic selection of sample stations as part of a multi-tiered, integrated monitoring of selected environmental indicators.

This sampling design provides for the interpretation of the ecological status of large areas with a relatively small number of sampling sites (McDonald 2000). Data are integrated from multiple environmental media, including water quality, sediment, biological, physical and chemical parameters. This integrated data provides for a better evaluation and assessment of ecosystem status than more traditional monitoring which typically emphasize single media and a stand-alone approach.

This report provides the statistical background for the 60 stations sampled in 2010 and 2011 that comprised the AKMAP Chukchi Sea coastal probabilistic survey. Analyses presented here will be used in preparing the *Alaska Monitoring and Assessment Program (AKMAP) 2010 – 2011 Chukchi Sea Coastal Survey Environmental Status Summary* on water and sediment quality, and biological status for this region.

Survey results are incorporated into the State of Alaska's federal Clean Water Act Section 305(b) report on the status of Alaska's waters. The project helps establish the current environmental status relative to Alaska Water Quality Standards (DEC, 2015).

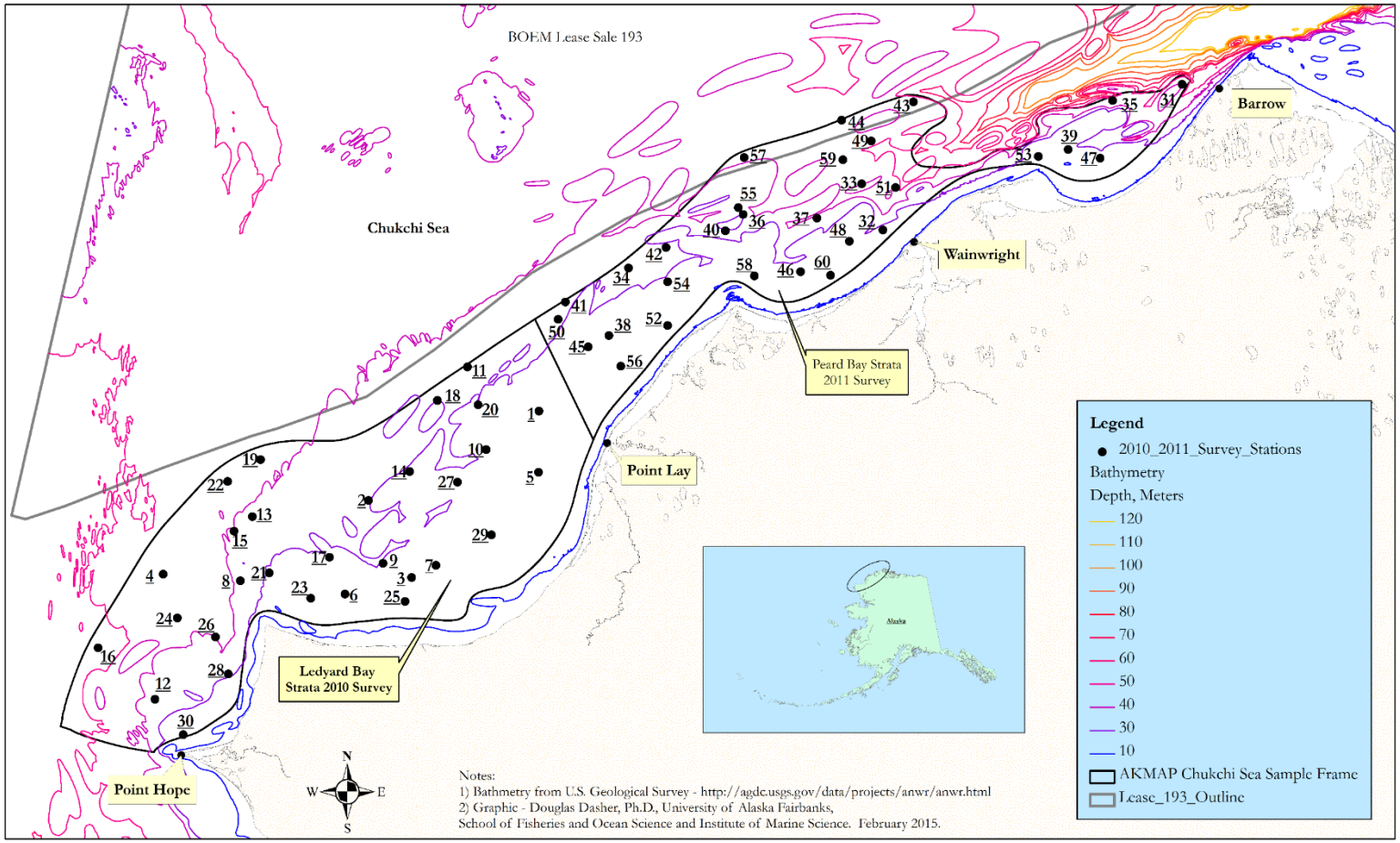

Figure 1 - Map of AKMAP 2010 and 2011 Probabilistic Sampling Survey Stations

Goals & Questions

Two overarching goals of the AKMAP Chukchi Sea 2010 – 2011 coastal survey were to 1) support statistical estimation of the spatial extent of ecological status based on measured indicators of marine environmental quality, and 2) establish baseline measurements to evaluate future changes in environmental status. Within these goals, specific questions can be further evaluated and potentially answered. For example:

> *What proportions of the northeastern Chukchi Sea coastal marine measured indicators have contaminant levels that indicate potential ecotoxicological impacts?*
>
> *What is the prevalence of chemical contaminant loads in biota tissues that indicate potential ecosystem exposure to contaminant sources?*
>
> *What proportions of the northeast Chukchi Sea coastal waters have levels of nutrients, dissolved oxygen, or other tested water quality parameters that indicate poor water quality for resident benthic fish and invertebrates?*

Environmental Indicators

The NARS National Coastal Condition Assessment was the basis for the Chukchi Sea survey using a standard set of environmental parameters as indicators of environmental status. NARS water quality condition assessment is based on three groups of indicators:

- Habitat condition indicators representing overall habitat condition;
- Abiotic and biota tissue condition indicators representing exposure to contaminants; and
- Biota condition indicators representing the condition of benthic invertebrate and demersal fish resources.

The habitat condition indicators describe physical and chemical conditions at a station, thereby providing information that can be used to interpret results of biological condition indicators. Habitat indicators include depth, salinity, temperature, dissolved oxygen concentration, chlorophyll-*a* concentration, dissolved nutrients concentrations, total suspended solids, and pH in the water as well as sediment grain size and total organic carbon. Abiotic and biota tissue condition indicators describe the concentration and types of contaminants present that may be harmful to the biota. These indicators include sediment and fish tissue contaminants. The biotic condition indicators help describe the condition of the biota at each site. These indicators include abundance and number of taxa for macroinvertebrates. Epifauna and demersal fish indicators include abundance and biomass.

Chukchi Sea Survey Design – Station Selection

Sixty base and 60 oversample stations were selected using a spatially-balanced equal probability survey design covering the target population. Each of the strata, Ledyard and Peard Bay, received 30 base and 30 oversample stations. No replacements of base stations by oversample stations were required during the field work. The target population with the strata and the 60 base stations examined during the 2010 and 2011 northeastern Chukchi Sea survey are shown in Figure 1. Total target population area was 27,593 km2, with 17,165 km2 and 10,428 km2 respectively in Ledyard an

Peard Bay strata. The R statistical program and the EPA spSurvey package were used to create the station selections.

Chukchi Sea Survey Design – Data Analysis

The water, sediment, and biological condition and indicator data are also analyzed using R and the spSurvey package. Results are presented as Cumulative Distribution Functions (CDF) graphics as shown in Figure 2 and in table format for population summary estimates of quantitative variables, e.g., mean, standard deviation, and median. CDFs are used to represent the proportion (cumulative percentage area) of the study area that is above or below some threshold or indicator value (e.g. water quality standards). A CDF graph is presented for the majority of indicators with the exception of those where too few samples were collected, such as pH and dissolved oxygen. CDFs have been used as a means to analyze aquatic resource survey datasets in numerous coastal and freshwater surveys (Olsen, Sedransk et al. 1999; Paul, Scott et al. 2001; Stein and Cadien 2009). Details on the statistical background and methods may be found at the EPA Aquatic Resource Monitoring web site - http://www.epa.gov/nheerl/arm/.

In Figure 2 the generic CDF for sediment arsenic (As) concentrations illustrates the probability that a given value will be found within a percentage of the sample area. Measured values of the indicator are shown on the horizontal axis and the cumulative probabilities (or estimates of percent area) provided on the vertical axis. Dashed lines indicate the 95% confidence band (confidence interval, or CI) for the CDF. For this example, an estimated 60% of the sample area has sediment As concentrations of 13.3 mg/kg dry weight with true area proportions falling between 50% and 70% of the sample area (60%±10%; the 95% confidence interval). The 50th percentile in this example would be described by stating that it is estimated that 50% of the study area has sediment As concentration of 12.05 mg/kg dry weight or less. Any percentile of interest may be estimated in this way. The CDF can also be used to compare survey results to an ecologically important value. In this example, an estimated 100% of the study area has sediment As concentration exceeding the Effects Range Low concentration of 8.2 mg/kg.

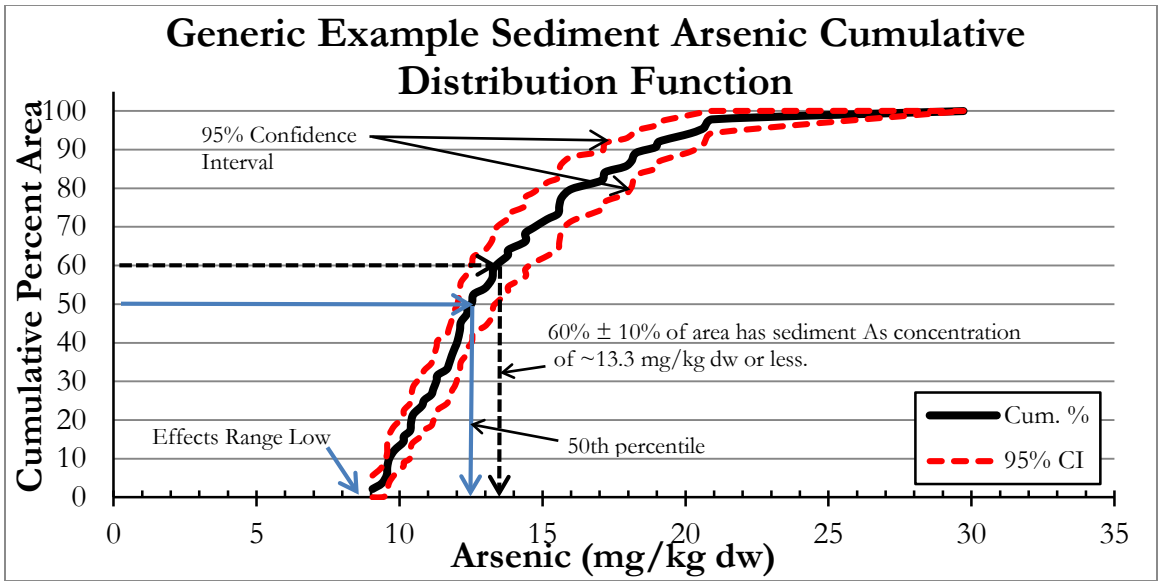

Figure 2 – Example: Percent area (and 95% C.I.) vs. sediment of arsenic (mg/kg dw).

Data Processing Procedures with Missing Data

Minimum Strata Data Set Number for Survey Analysis

AKMAP as a general design goal aims for at least for 30 stations in each stratum to yield a 90% confidence interval of about ± 10% around the estimates of areal extent (y-axis in CDF plot). Thirty stations within a stratum has been a design goal of the Southern California Coastal Water Research Program for supporting management decisions (SCCWRP, 2008). If the 30 station goal cannot be met due to initial design constraints, i.e., logistical and fiscal, or equipment failure during field work, then 20 stations are considered as the lower limit for conducting a probabilistic or survey data analysis. If a stratum has less than 20 stations, results will be presented in table form as sample summary statistics and graphically as box plots.

Water Data Sets

CTD, pH, and dissolved oxygen (DO) data was available for 28 Ledyard Bay stations, representing about 93% of the stratum. However, due to CTD instrument problems pH and DO data for Peard Bay was obtained for only 18 stations representing about 60% of the stratum. Ledyard Bay pH and DO results are presented as CDFs and population summary estimates of quantitative variables. For Peard Bay, pH and DO are presented as sample summary statistics.

If less than 30, but at least 20 stations had results for indicators such as nutrients or Chlorophyll a, sample weights were adjusted to allow for inferences to be made to the total sample frame. The rational for this strategy was that though results for some stations were missing this was not due to conditions in the sampled media, in this case water, making it possible to resample the station in the future. This differs from the case presented by sediments where grain size, e.g., cobbles or boulders, makes it impossible to physically resample these stations by AKMAP sediment grab techniques.

Sediment Data Sets

Successful sediment grab samples were collected at a total of 55 out of 60 stations. Sediment samples could not be collected at five stations (one in 2010 and four in 2011) due to physical habitat conditions that prevented successful sediment grabs, i.e., large gravel and cobbles. The CDF results in this case provide cumulative percent area for the 55 stations representing 93% or 25,630 km^2 of the total sample frame combined Ledyard Bay and Peard Bay strata of 27,593 km^2. The remaining 7% or 1,963 km^2 is considered to represent benthic habitat that cannot be sampled by surficial sediment grab methodology due to substrate characteristics. For this reason all AKMAP Chukchi Sea sediment data sets, i.e., chemistry, physical parameters and macroinvertebrate, represent only 93% of the total sample frame.

Field, Laboratory and Quality Assurance and Quality Control

The AKMAP Chukchi Sea survey followed field methods, quality assurance and quality control, and laboratory methodology described in National Coastal Condition Assessment web site - http://water.epa.gov/type/oceb/assessmonitor/ncca.cfm. Other operations, such as trawls and zooplankton, have methods detailed in Standard Operating Procedures (SOPs) that are stored with the data sets in DEC's Ambient Water Quality Monitoring System.

Data Management

Data sets will be entered into DEC's Ambient Water Quality Monitoring System, which is then uploaded to the EPA National STORET database for public access.

Other Data Collection Activities

During the 2010 and 2011 AKMAP field activities other water and biological samples were collected by or for other researchers that are not reported in this document. Zooplankton was sampled in 2010 and 2011 for Dr. Russ Hopcroft and his graduate student Jennifer Questel at UAF IMS. Ocean acidification (pCO2) samples were collected for Dr. Jeremy Mathis, with NOAA, in 2010 and 2011. Information on these studies should be obtained through the researchers –

Dr. Russ Hopcroft	Dr. Jeremy Mathis
Institute of Marine Science 120 O'Neill P.O. Box 757220 University of Alaska Fairbanks Fairbanks, AK 99775-7220 Phone: (907) 474-7842 Fax: (907) 474-7204 rrhopcroft@alaska.edu	NOAA Pacific Marine Environmental Laboratory 7600 Sand Point Way NE Seattle, WA 98115 Phone: (206) 526-4809 Fax: (206) 526-6744 jeremy.mathis@noaa.gov

Not reported in this AKMAP Chukchi Statistical Report are the results of the sea bird and marine mammal surveys, carbon and nitrogen stable isotope data for sediments and biota, % lipids on biological tissues analyzed for organics, and drop camera video benthic habitat video of some stations. Sediment samples for chlorophyll *a* were collected, but lost in a freezer malfunction. Other than the drop camera video the other data can be requested by contacting DEC, Terri Lomax, AKMAP Section Manager, dec.akmap@alaska.gov, 907-269-7635.

Chapter-2: Indicator Results

Habitat Condition Indicators

Water quality measurements were obtained continuously in the water column with a conductivity temperature and pressure (CTD) instrument as a function of depth or from discrete water samples taken at the surface, mid-depth, and several meters off the bottom. In the shallow Chukchi Sea, waters are typically well-mixed. The focus of this report is on the surface and bottom sample results. For the summaries presented herein, the values for CTD measurements are presented as 1 meter binned average values for the surface and bottom profiled waters. Discrete values are reported for the surface and bottom chlorophyll *a*, nutrients, and total suspended solids samples. Specific details on the individual indicators are noted in the text that follows. Table 2 provides statistical summaries for nutrients, chlorophyll *a*, salinity (PSU), stratification, temperature and total suspended solids

Depth (meters)

Across the 60 stations, depths ranged from 17 to 60 meters (m). The depths associated with each individual station are shown in Table 3 and a CDF of sample population depths is shown in Figure 3. This information is useful when comparing study area habitats among the various national regions and provinces included in the National Coastal Condition Assessment.

Water temperature (°C)

This temperature data represents a snapshot in time and is not meant to address differences between the years, or climatic variations. The data set is relevant in the context of assessing other water quality variables, such as percent dissolved oxygen saturation. Temperature measurements obtained from the CTD profile for surface and bottom samples are shown in Figures 4 – 5 and Table 2.

Practical salinity units (PSU)

Salinity influences water column density and, thus, the stability or stratification of the water column and many other water quality factors. Salinity can also influence the benthic community (Rosenberg and Möller 1979). Salinity was measured throughout the water column during the CTD cast, but it is presented herein as averaged (1 meter bin) for the surface and bottom only. Results are shown in Figures 6 – 7 and in Table 2.

Practical Salinity Units (PSU): A measure of the salt content of seawater (practical salinity), based upon electrical conductivity of a sample relative to a reference standard of sea water with a known salt content.

Water-Column Stratification

A simple water column stratification index was calculated for the 55 stations where temperature and salinity data were available at the surface and bottom of the water columns. This index is the difference between bottom and surface densities which were calculated from the respective salinities, temperatures, and depths. The stratification indices ranged from -0.01, very little stratification, to 2.69 in areas with stronger temperature and salinity gradients. A stratification index value greater than 2 represents a strong vertical stratification of the water column (Nelson et al., 2008). The water column stratification index is presented in Figure 8 and in Table 2.

Table 2 – Statistical Summaries of Habitat Indictor Results

Water Quality Parameters	n	Mean	Std. Dev.	Median	Min	Max
Population Summary Statistics – Combined 2010 & 2011 AKMAP Surveys						
Nutrients						
Surface NO_3-N (mg/l)	56	0.025	0.015	0.024	0.003	0.088
Surface PO_4-P (mg/l)	56	0.043	0.011	0.041	0.001	0.09
Bottom NO_3-N (mg/l)	51	0.063	0.069	0.411	0	0.337
Bottom PO_4-P (mg/l)	57	0.082	0.032	0.081	0.002	0.192
Chlorophyll a, µg/l						
Surface Chl a (µg/l)	60	0.88	0.35	0.81	0.31	1.88
Bottom Chl a (µg/l)	58	1.06	0.84	0.81	0.20	4.87
Salinity, Practical Salinity Units (PSU)						
Surface Salinity (PSU)	54	30.41	0.40	30.36	29.64	31.34
Bottom Salinity(PSU)	54	31.30	0.65	31.29	30.13	32.74
Temperature						
Surface Temperature (^{0}C)	54	8.90	1.57	8.66	4.85	11.33
Bottom Temperature (^{0}C)	54	6.42	3.05	6.86	-1.17	10.85
Total Suspended Solids, TSS						
Surface TSS (mg/l)	52	11.68	6.28	10.25	3.4	31.7
Bottom TSS (mg/l)	52	15.56	10.96	12.25	3.5	69.6
Water Column Stratification						
Stratification index(Δ σT_kg_m^3)	55	0.97	0.61	0.98	-0.01	2.69
Population Summary Statistics – 2010 Ledyard Bay AKMAP Survey						
Dissolved Oxygen, mg/l						
Surface DO (mg/l)	28	9.42	0.35	9.40	8.66	9.98
Bottom DO (mg/l)	28	7.8	1.12	8.16	4.86	9.90
pH						
Surface pH	28	7.91	0.51	8.14	6.23	8.41
Bottom pH	28	8.31	0.10	8.32	8.10	8.47
Sample Summary Statistics - 2011 Peard Bay Strata AKMAP Survey						
Dissolved Oxygen, mg/l						
Surface DO (mg/l)	16	9.53	0.45	9.59	8.75	10.28
Bottom DO (mg/l)	16	8.41	0.83	8.69	6.99	9.74
pH						
Surface pH	16	7.93	0.23	7.97	7.77	7.90
Bottom pH	16	7.94	0.08	7.95	7.84	7.90

Table 3 – AKMAP Chukchi Sea 2010 and 2011 Stations

Site ID	Strata	Latitude	Longitude	Depth (m)
AKCH10-001	Ledyard_Bay	69.83830	-163.80960	26
AKCH10-002	Ledyard_Bay	69.40689	-165.41801	35
AKCH10-003	Ledyard_Bay	69.15037	-164.84800	24
AKCH10-004	Ledyard_Bay	68.99445	-167.34239	49
AKCH10-005	Ledyard_Bay	69.61162	-163.72070	23
AKCH10-006	Ledyard_Bay	69.04755	-165.48787	23
AKCH10-007	Ledyard_Bay	69.20987	-164.62152	25
AKCH10-008	Ledyard_Bay	69.02613	-166.55929	36
AKCH10-009	Ledyard_Bay	69.18472	-165.15963	27
AKCH10-010	Ledyard_Bay	69.66650	-164.29664	29
AKCH10-011	Ledyard_Bay	69.96078	-164.62578	37
AKCH10-012	Ledyard_Bay	68.53192	-167.17325	34
AKCH10-013	Ledyard_Bay	69.26988	-166.56249	40
AKCH10-014	Ledyard_Bay	69.53943	-165.04764	35
AKCH10-015	Ledyard_Bay	69.20343	-166.71857	42
AKCH10-016	Ledyard_Bay	68.67649	-167.83340	49
AKCH10-017	Ledyard_Bay	69.17295	-165.70949	30
AKCH10-018	Ledyard_Bay	69.81897	-164.88196	38
AKCH10-019	Ledyard_Bay	69.48472	-166.58961	44
AKCH10-020	Ledyard_Bay	69.82734	-164.45197	31
AKCH10-021	Ledyard_Bay	69.07526	-166.28663	31
AKCH10-022	Ledyard_Bay	69.38126	-166.88164	44
AKCH10-023	Ledyard_Bay	69.01036	-165.82455	23
AKCH10-024	Ledyard_Bay	68.84504	-167.11440	45
AKCH10-025	Ledyard_Bay	69.05790	-164.87295	20
AKCH10-026	Ledyard_Bay	68.80258	-166.69931	44
AKCH10-027	Ledyard_Bay	69.52922	-164.53881	30
AKCH10-028	Ledyard_Bay	68.67679	-166.50366	36
AKCH10-029	Ledyard_Bay	69.35413	-164.10756	25
AKCH10-030	Ledyard_Bay	68.42319	-166.83059	25
AKCH11-031	Peard_Bay	71.29931	-157.20987	60
AKCH11-032	Peard_Bay	70.67016	-160.39212	26
AKCH11-033	Peard_Bay	70.83534	-160.67080	52
AKCH11-034	Peard_Bay	70.41732	-163.08115	34
AKCH11-035	Peard_Bay	71.22428	-157.97552	54
AKCH11-036	Peard_Bay	70.69511	-161.98430	43
AKCH11-037	Peard_Bay	70.68939	-161.11998	44
AKCH11-038	Peard_Bay	70.15602	-163.19103	28
AKCH11-039	Peard_Bay	71.02928	-158.43527	28
AKCH11-040	Peard_Bay	70.60291	-162.09400	39
AKCH11-041	Peard_Bay	70.25755	-163.70162	32
AKCH11-042	Peard_Bay	70.51216	-162.71025	37
AKCH11-043	Peard_Bay	71.16147	-160.18890	53
AKCH11-044	Peard_Bay	71.06630	-160.96398	57
AKCH11-045	Peard_Bay	70.10309	-163.39226	30
AKCH11-046	Peard_Bay	70.48242	-161.23374	27
AKCH11-047	Peard_Bay	71.00431	-158.07657	27

Site ID	Strata	Latitude	Longitude	Depth (m)
AKCH11-048	Peard_Bay	70.61544	-160.74314	32
AKCH11-049	Peard_Bay	70.99924	-160.61278	52
AKCH11-050	Peard_Bay	70.18907	-163.75200	33
AKCH11-051	Peard_Bay	70.83393	-160.29730	53
AKCH11-052	Peard_Bay	70.22289	-162.58482	17
AKCH11-053	Peard_Bay	70.99503	-158.75763	25
AKCH11-054	Peard_Bay	70.38533	-162.64552	25
AKCH11-055	Peard_Bay	70.67170	-161.92336	40
AKCH11-056	Peard_Bay	70.04863	-163.02167	20
AKCH11-057	Peard_Bay	70.88492	-161.98708	46
AKCH11-058	Peard_Bay	70.44723	-161.72449	24
AKCH11-059	Peard_Bay	70.91849	-160.90527	51
AKCH11-060	Peard_Bay	70.48124	-160.90766	22

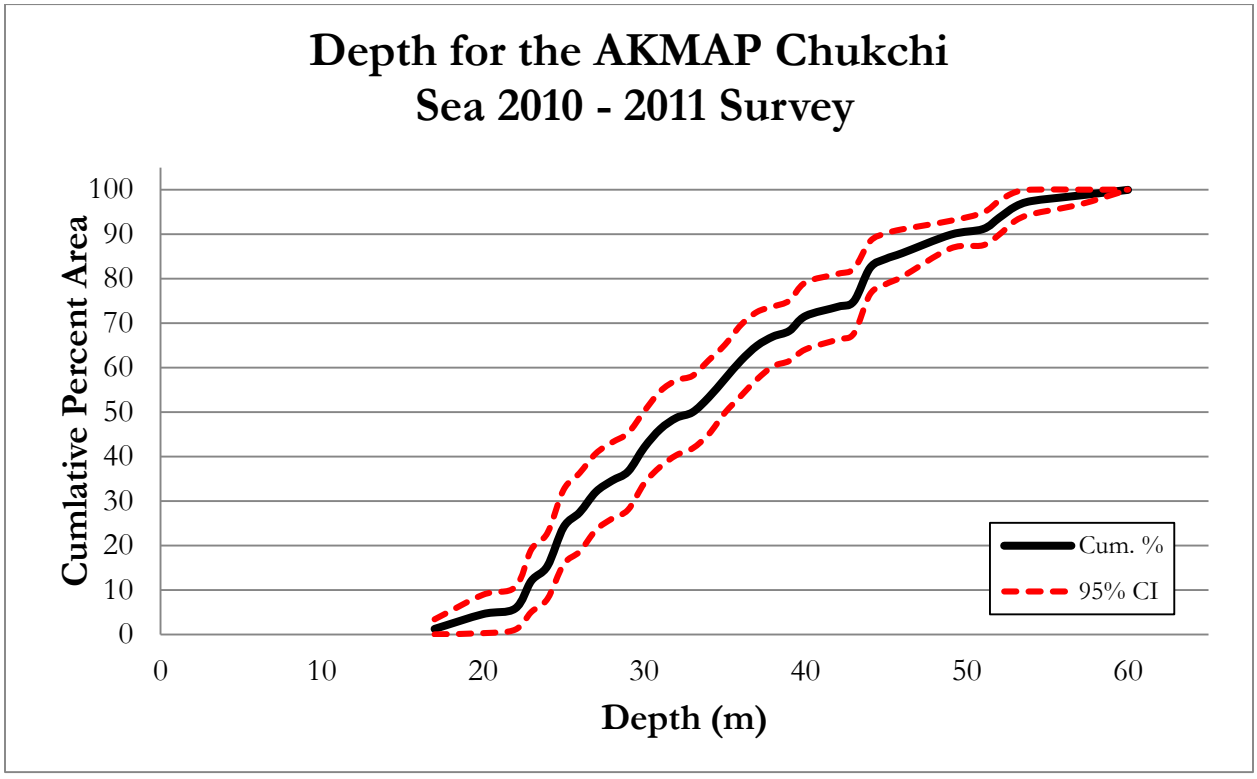

Figure 3 - Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. bottom depth (m).

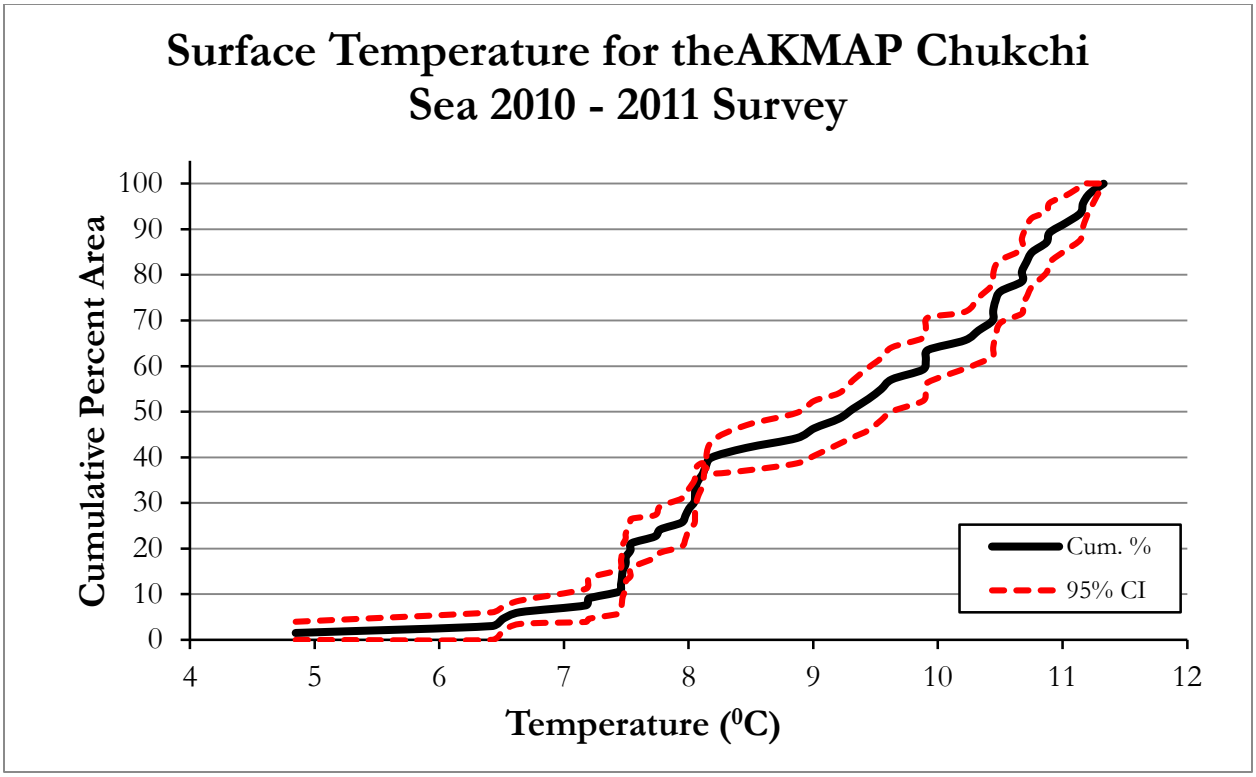

Figure 4 – Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. surface water temperature (^{0}C).

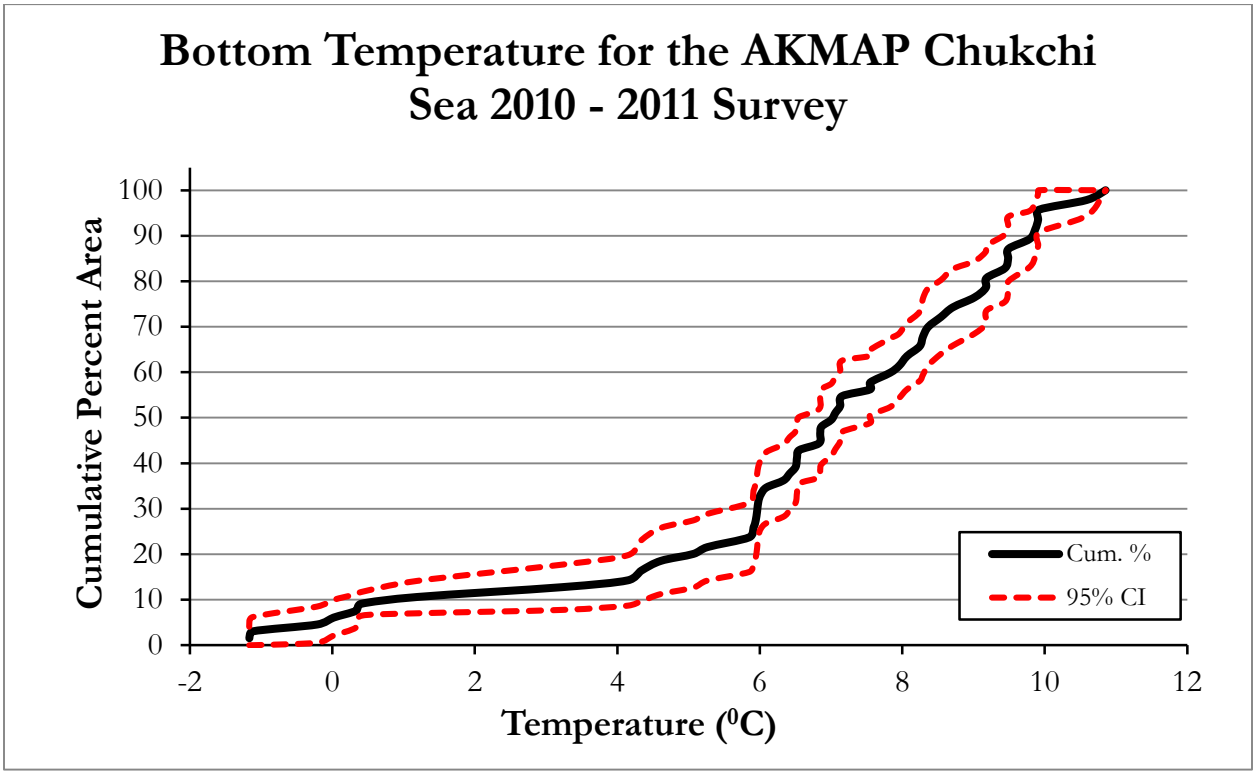

Figure 5 – Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. bottom water temperature (^{0}C).

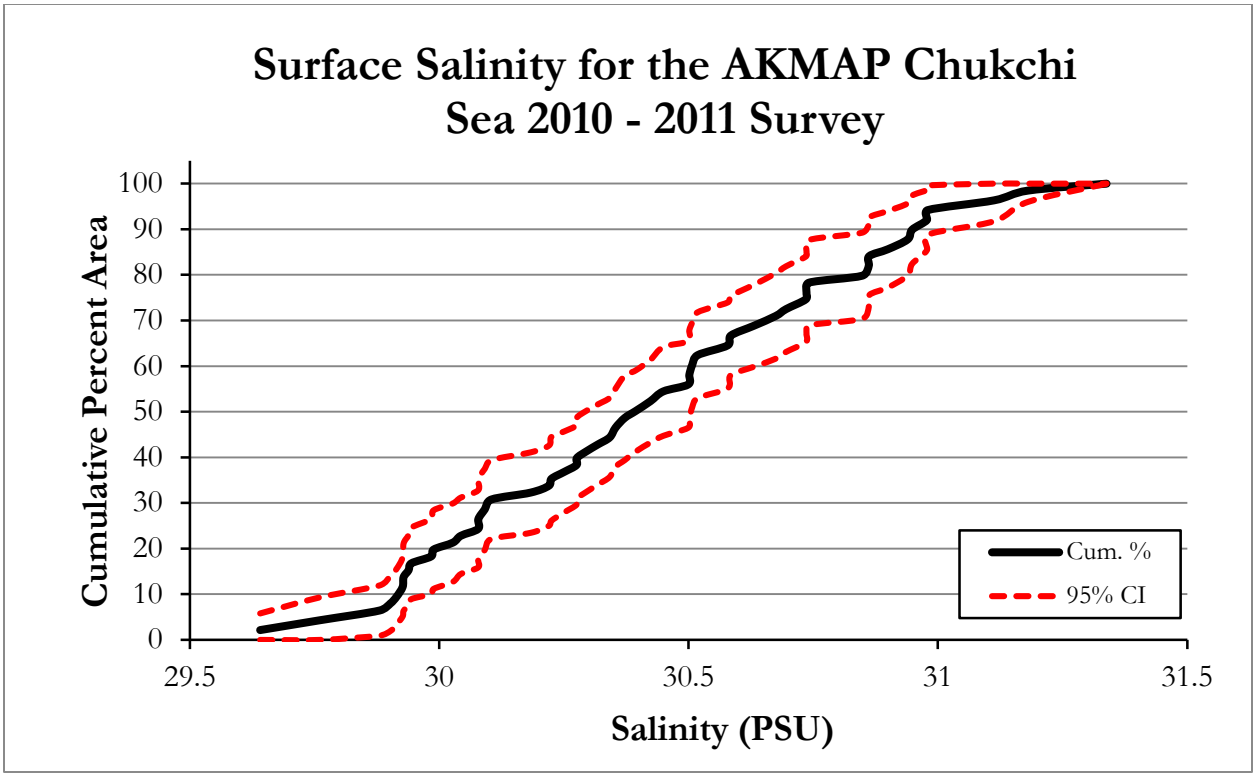

Figure 6 - Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. surface water salinity (PSU).

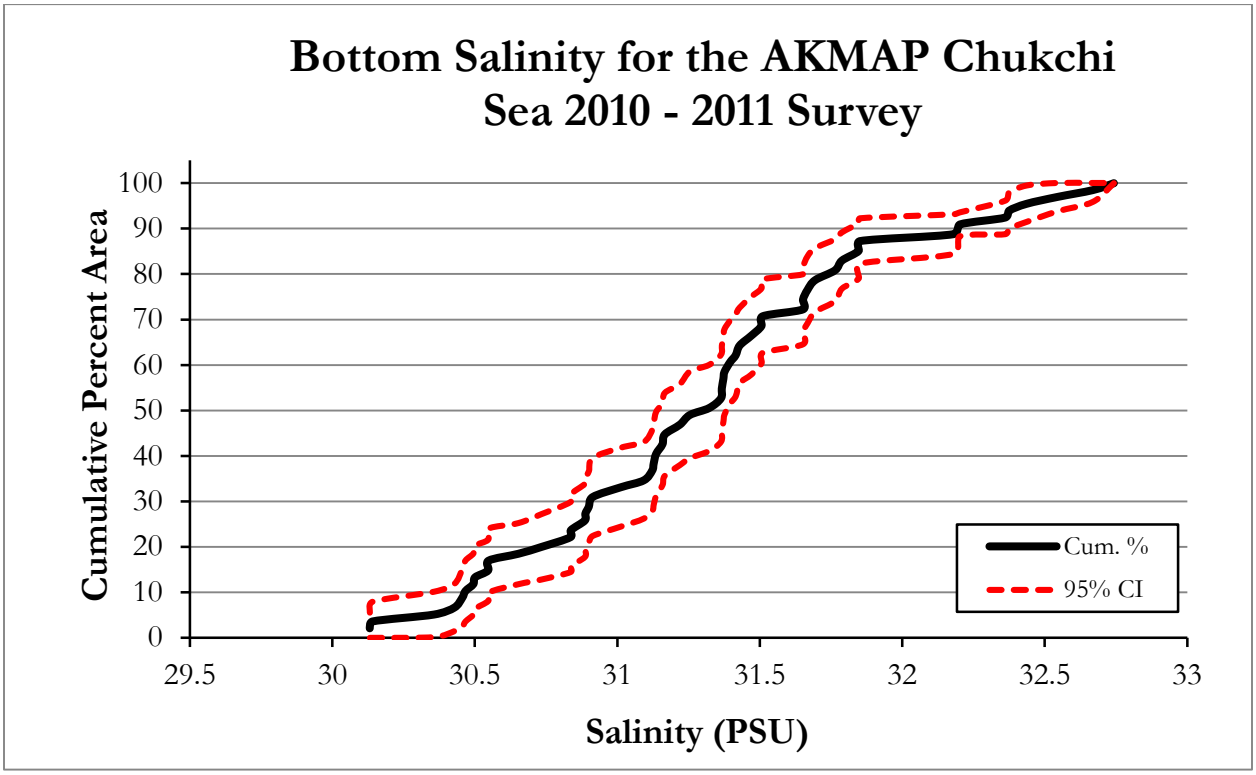

Figure 7 – Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. bottom water salinity (PSU).

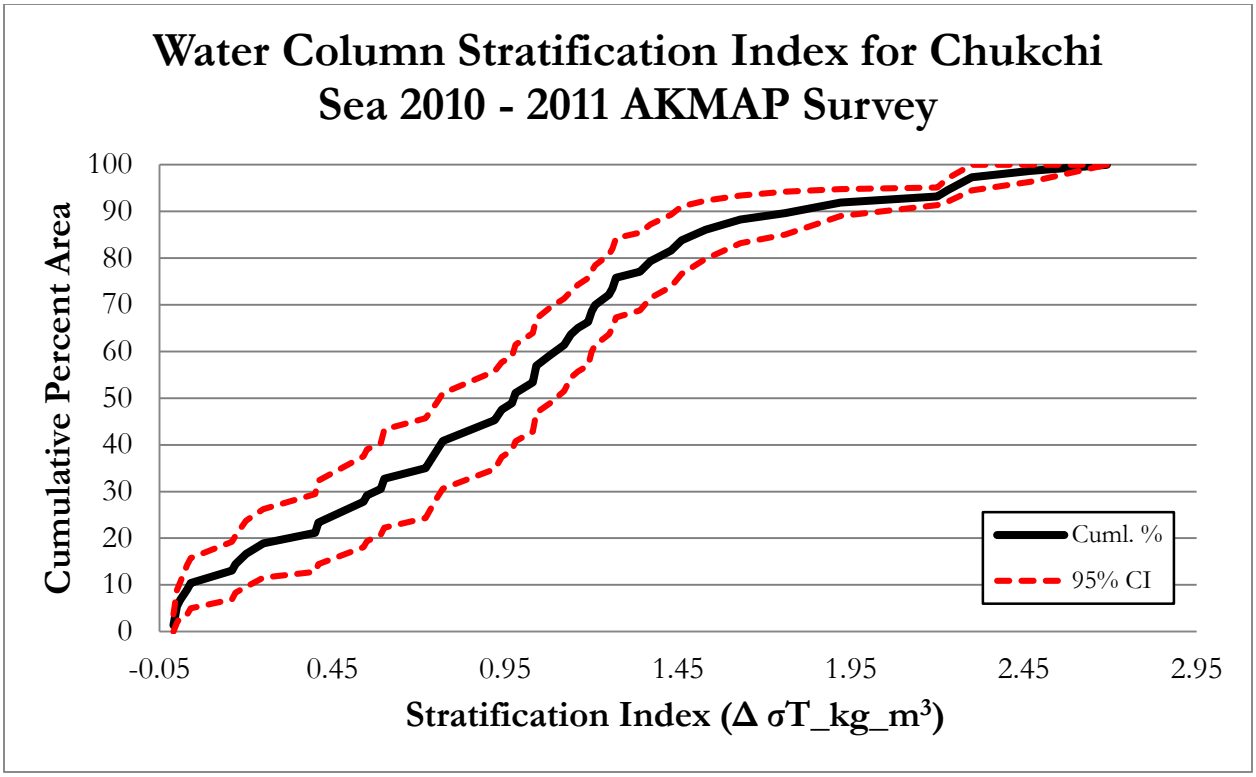

Figure 8 - Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. Stratification Index (Δ σT_kg_m^3).

pH and Dissolved Oxygen (DO)

The CTD, pH, and dissolved oxygen (DO) data was available for 28 Ledyard Bay stations. However, due to CTD instrument problems data for Peard Bay was obtained for only 18 stations. Ledyard Bay pH and DO strata results are presented as CDFs and population summary estimates of quantitative variables. For Peard Bay, pH and DO are presented as sample summary statistics and as boxplots.

pH

The acidity or alkalinity of sea water is measured by pH. Pelagic or open ocean marine waters are generally able to buffer and maintain pH in the range of 7.5 to 8.5, and many marine species have evolved to live within this range (The Royal Society, 2005). AKMAP measures pH of marine waters to compare with the Alaska Water Quality Standards. The methods AKMAP uses are not accurate or precise enough to allow the tracking of ocean acidification changes over time. NOAA's Pacific Marine Environmental Laboratory (PMEL) is conducting studies to assess ocean acidification in Alaska's marine waters, including the Chukchi Sea. AKMAP Chukchi Sea 2010 and 2011 survey did provide PMEL with water samples for their ocean acidification studies. Details on PMEL studies can be found at - http://www.pmel.noaa.gov/co2/story/Ocean+Acidification. The pH data is presented as CDF's for surface and bottom marine waters in Figures 9 - 10 and Table 2 for the Ledyard Bay strata. Peard Bay surface and bottom pH is presented as box plots in Figure 14 and as sample summary statistics in Table 2.

DO (mg/l)

Many biological organisms in marine waters need oxygen to survive. Oxygen is principally supplied to marine waters by plant respiration and to a lesser extent from transfer from the atmosphere. AKMAP measures the DO concentration in marine waters to evaluate if waters are hypoxic or depleted in dissolved oxygen due to anthropogenic or natural conditions. The DO data is presented as CDF's for surface and bottom marine waters in Figures 11 - 12 and Table 2 for the Ledyard Bay stratum. The Peard Bay stratum surface and bottom DO is presented in Figure 13 and as sample summary statistics in Table 2.

Dissolved Nutrients (mg/l)

Anthropogenic nutrient loading is contributing to degradation of coastal waters in much of the United States and is an important part of the national aquatic resource surveys (EPA, 2015c). Oceanic waters of the Chukchi Sea are not directly influenced by anthropogenic nutrient loadings because of the small human population and minimal industrial activity in this area. Sampling handling strategy for nutrients was based in part on sampling of waters with nutrient levels generally reflective of anthropogenic inputs. Ultra clean sample bottles and equipment cleaning were not part of the NARS standard operating procedures. Outliers were removed utilizing statistical methods in ProUCL 5.0 (EPA, 2015b).The results of NO_3-N and PO_4-P, provided in Figures 14 – 17 and Table 2 allow for a gross comparison with the nutrient guidelines derived by the EPA for the U.S. west coast and to be presented in the *Alaska Monitoring and Assessment Program (AKMAP) 2010 – 2011 Chukchi Sea Coastal Survey Environmental Status Summary* for NO_3-N and for PO_4-P.

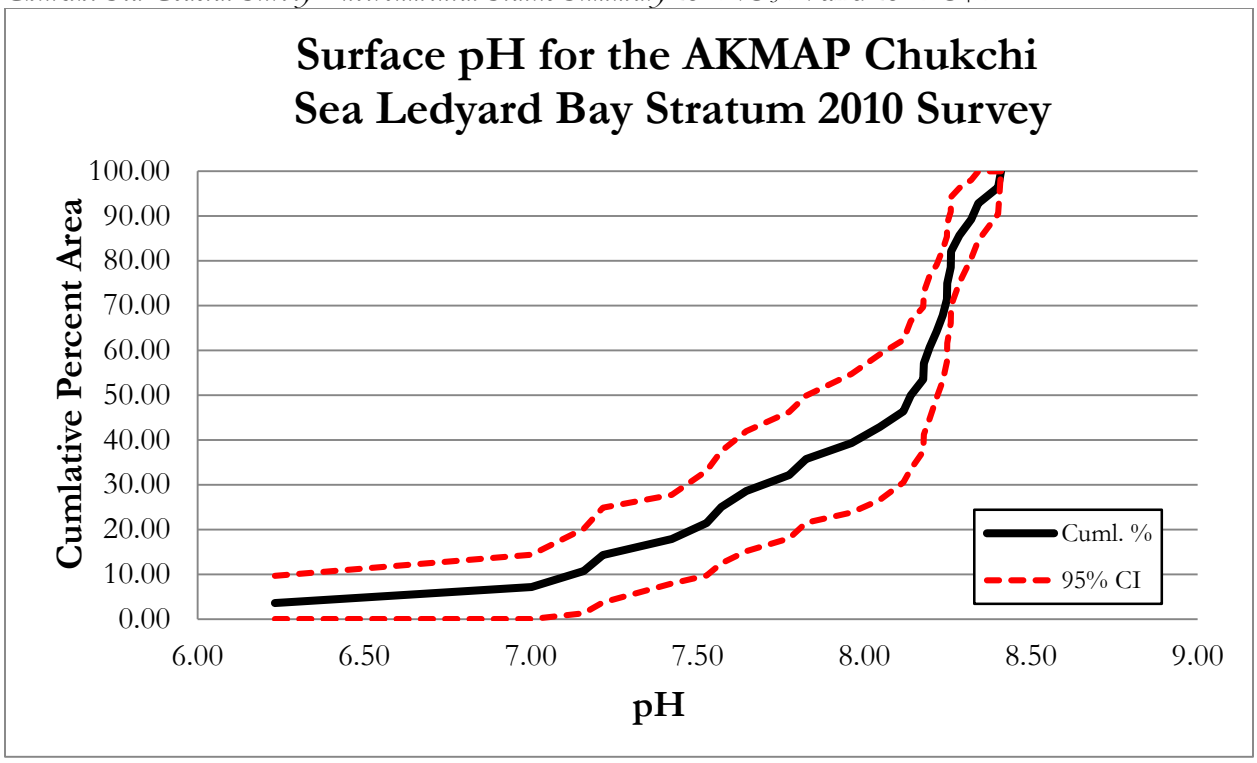

Figure 9 – Percent area (and 95% C.I.) AKMAP Chukchi Sea 2010 Ledyard Bay Stratum vs. surface water pH.

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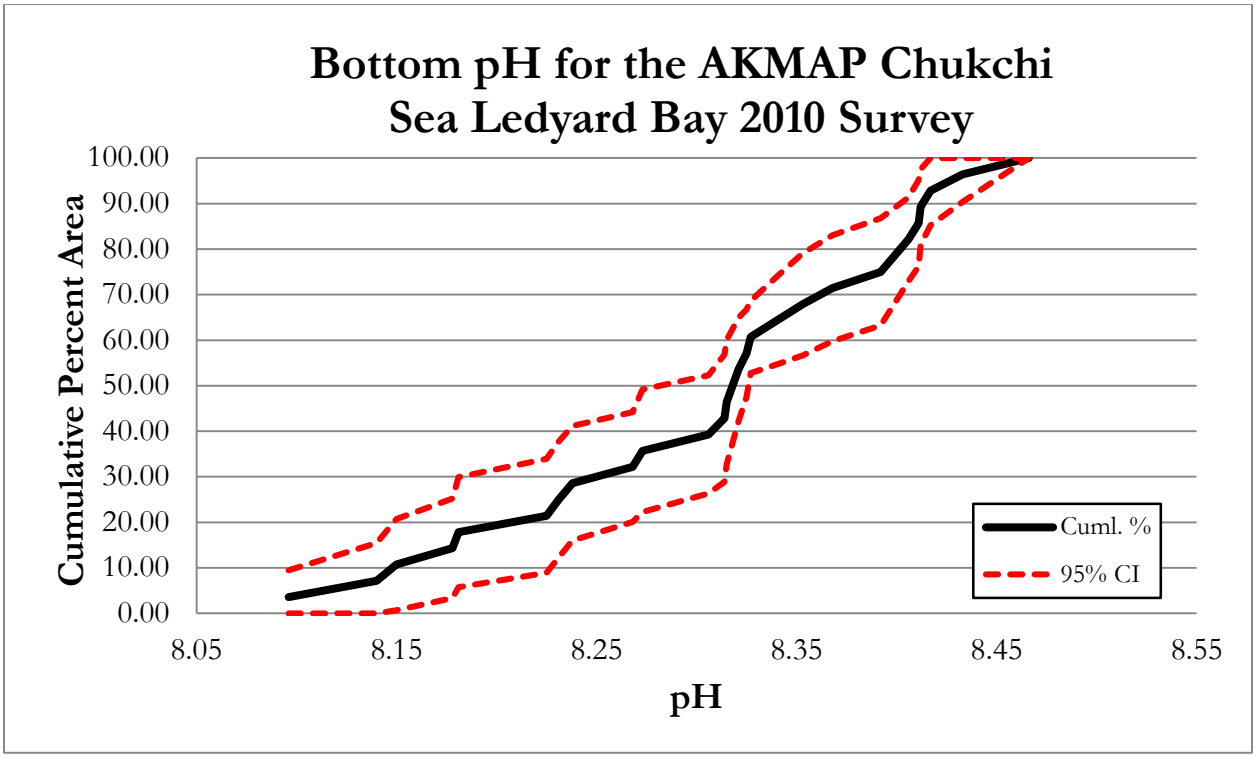


Figure 10 – Percent area (and 95% C.I.) AKMAP Chukchi Sea 2010 Ledyard Bay Stratum vs. bottom water pH.

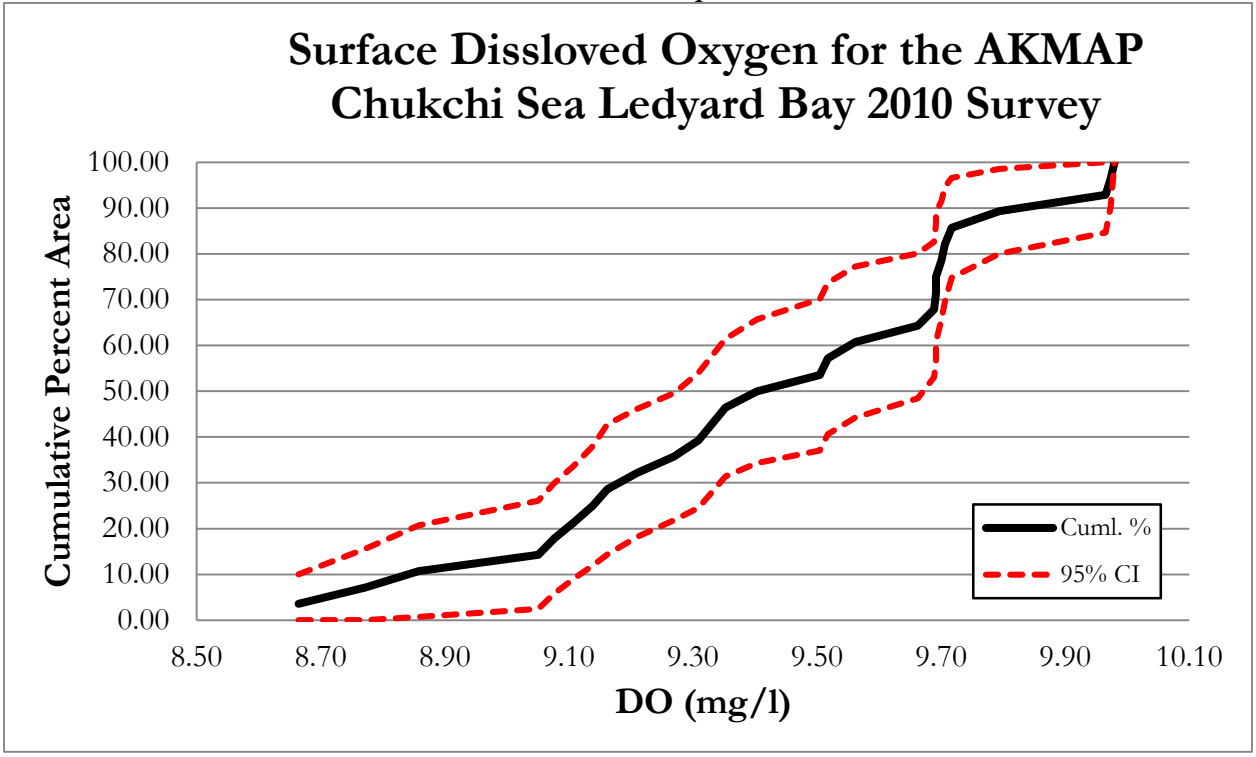


Figure 11 – Percent area (and 95% C.I.) AKMAP Chukchi Sea 2010 Ledyard Bay Stratum vs. surface water dissolved oxygen (mg/l).

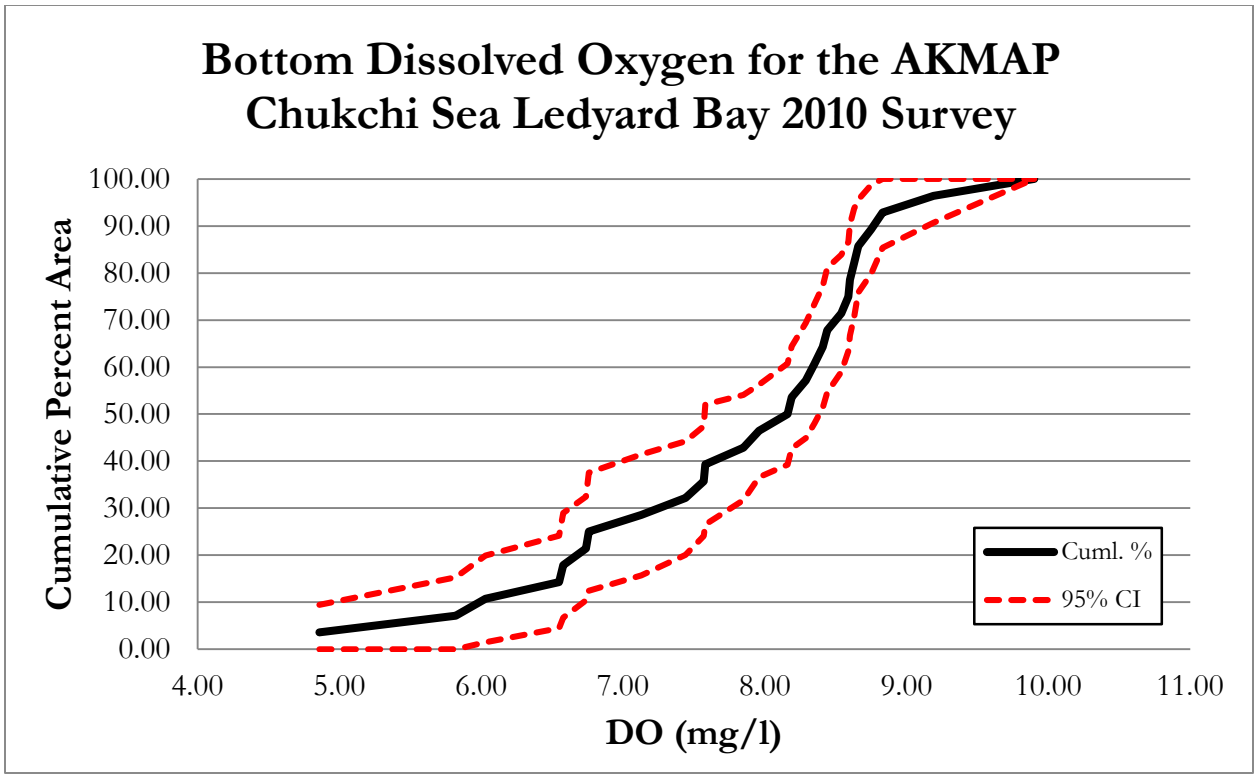


Figure 12– Percent area (and 95% C.I.) AKMAP Chukchi Sea 2010 Ledyard Bay Stratum vs. bottom water dissolved oxygen (mg/l).

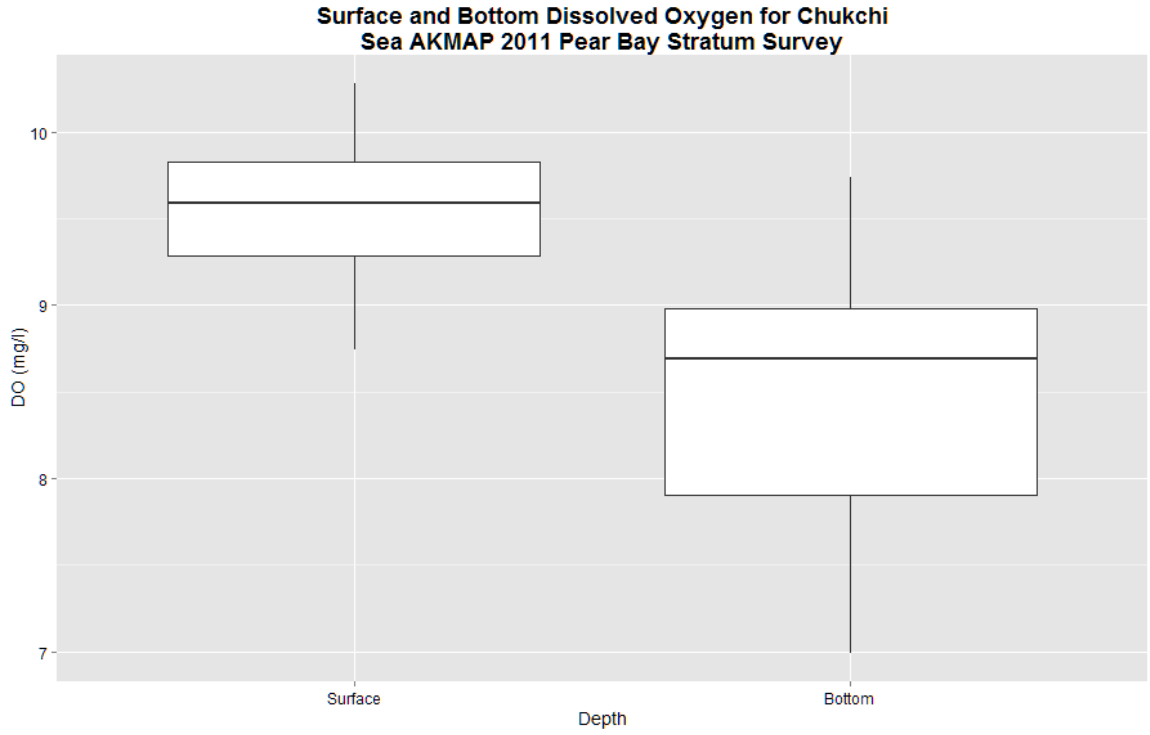


Figure 13 - Percent area (and 95% C.I.) AKMAP Chukchi Sea 2011 Peard Stratum vs. surface and bottom water dissolved oxygen (mg/l).

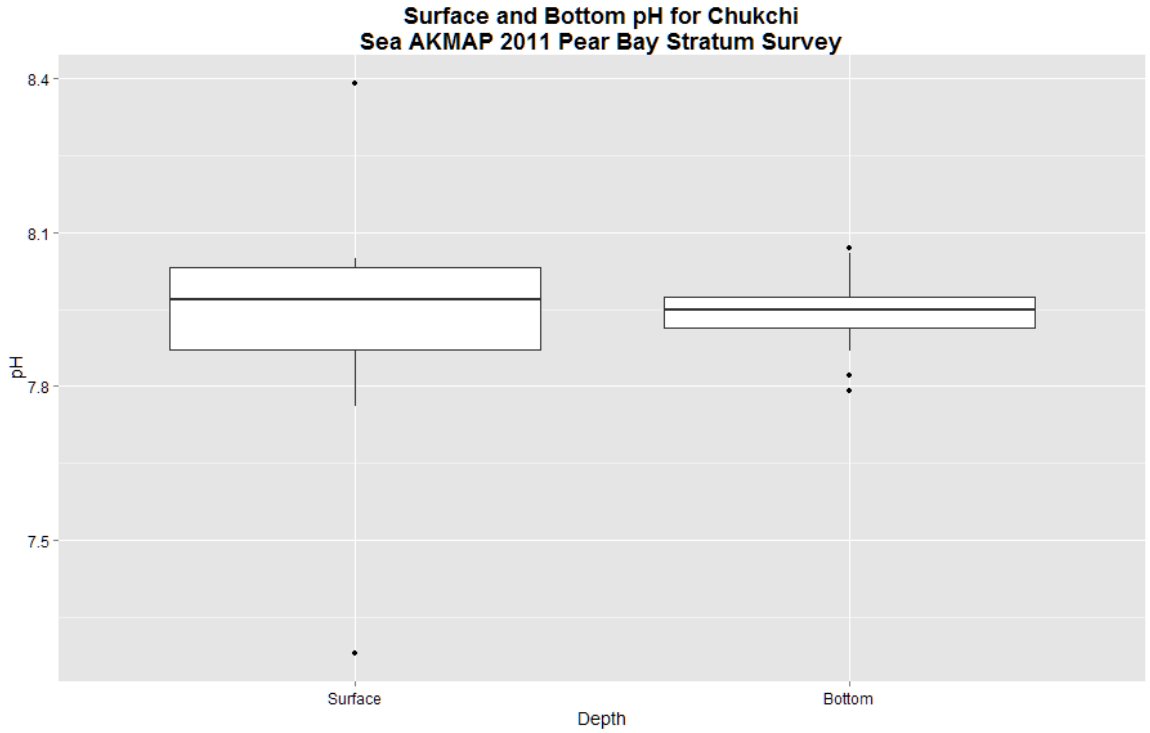


Figure 14 - Percent area (and 95% C.I.) AKMAP Chukchi Sea 2011 Peard Stratum vs. surface and bottom water pH.

Chlorophyll a (µg/l)

The concentration of the chlorophyll a pigments reflects the phytoplankton standing stocks in the water column and is used as one measure of assessing eutrophication in aquatic systems. The 2010 Ledyard Bay maximum acid ratio had to be estimated due to data loss and the resulting chlorophyll a values are considered approximate. Figures 19 -20 and Table 2 provide the results of the surface and bottom chlorophyll a water samples.

Total Suspend Solids (mg/l)

Total suspended solids at high concentrations can lower water quality by decreasing light with depth available to aquatic plants and phytoplankton decreasing photosynthesis and producing less dissolved oxygen. Total suspended solids (TSS) concentrations are presented in Figures 21 – 22 and Table 2.

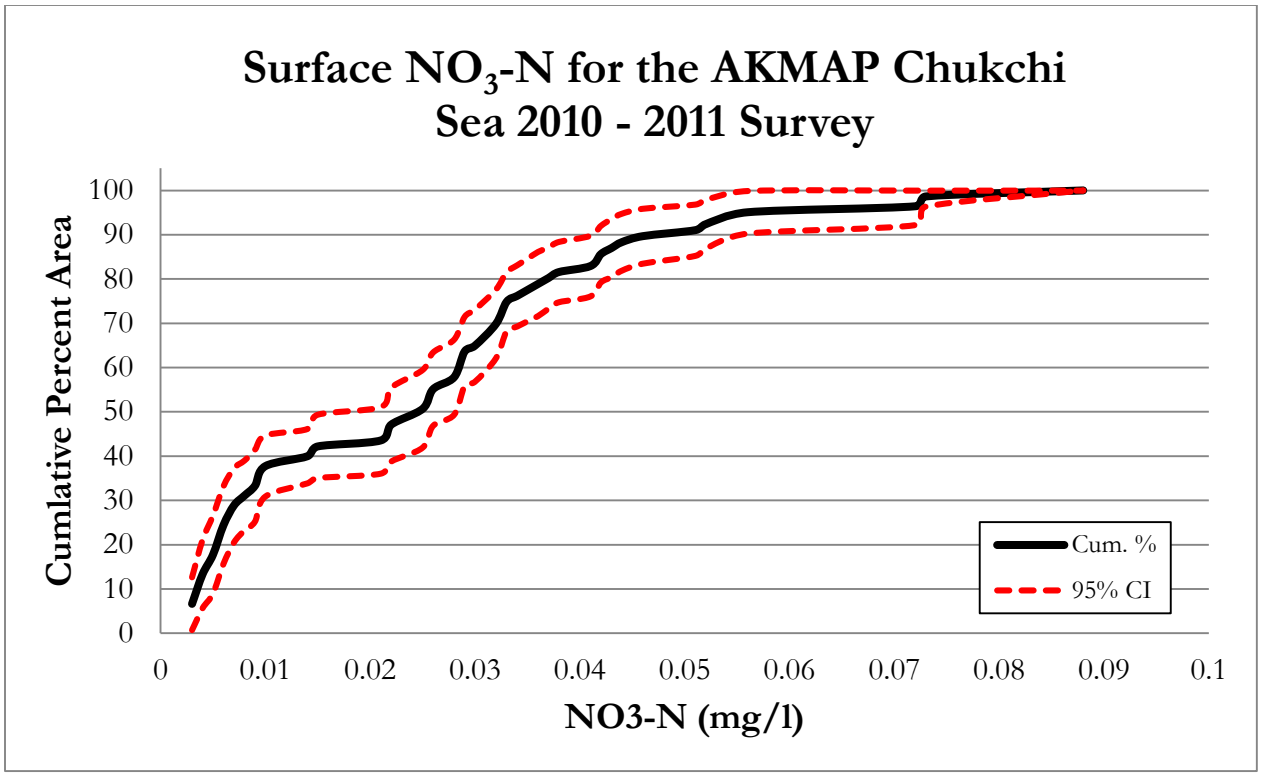


Figure 15 – Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. surface water NO_3-N (mg/l).

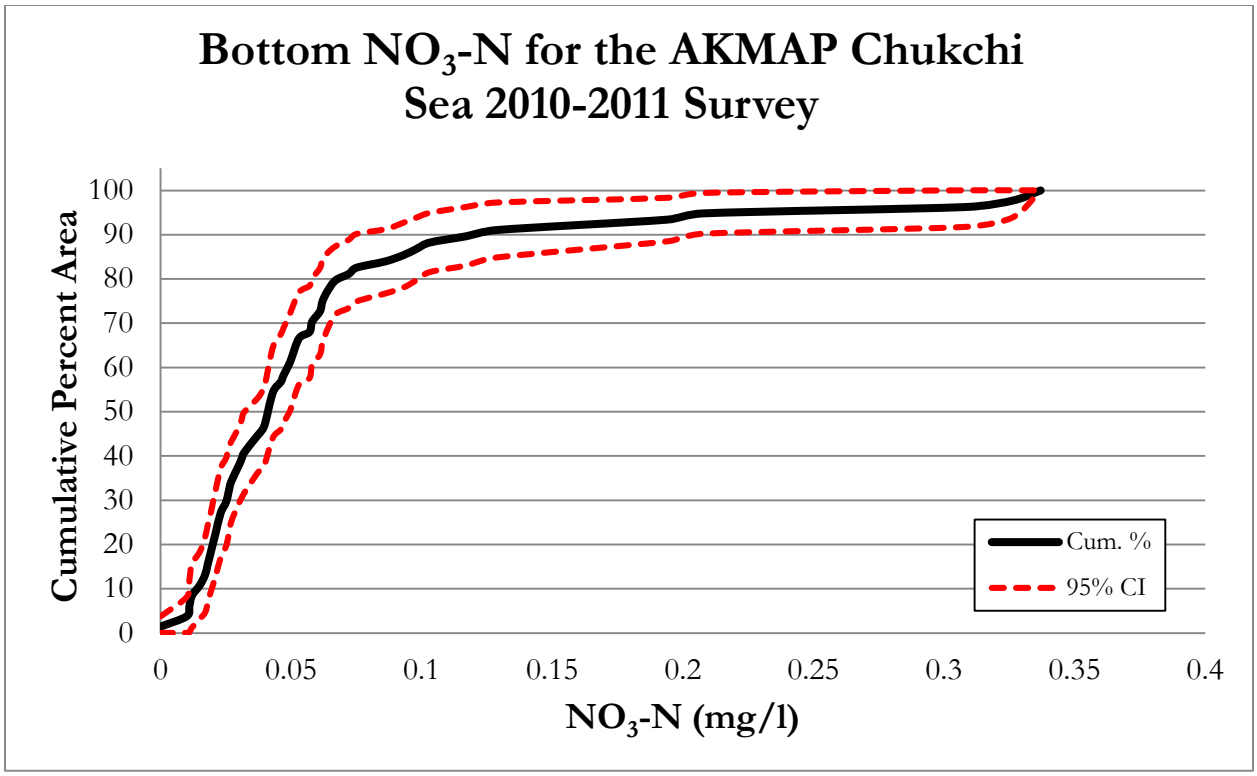


Figure 16 – Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. bottom water NO_3-N (mg/l).

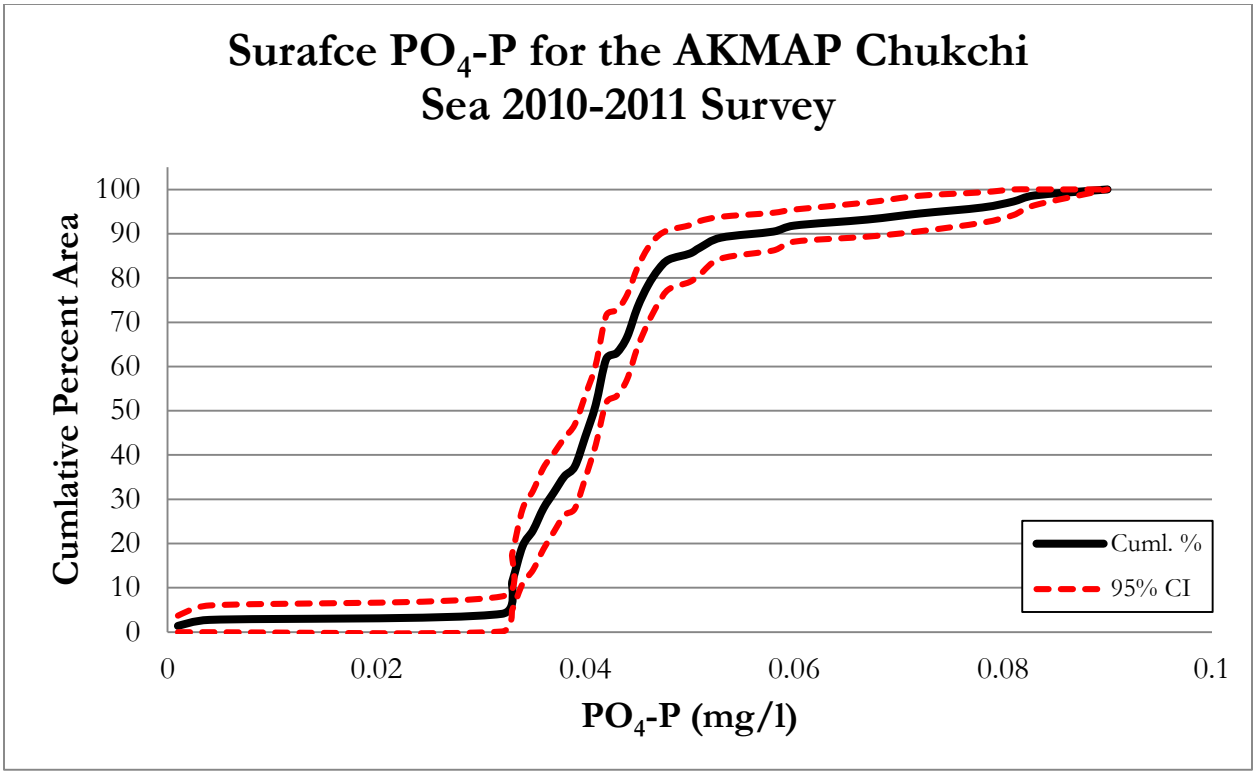


Figure 17 – Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. surface water PO_4-P (mg/l).

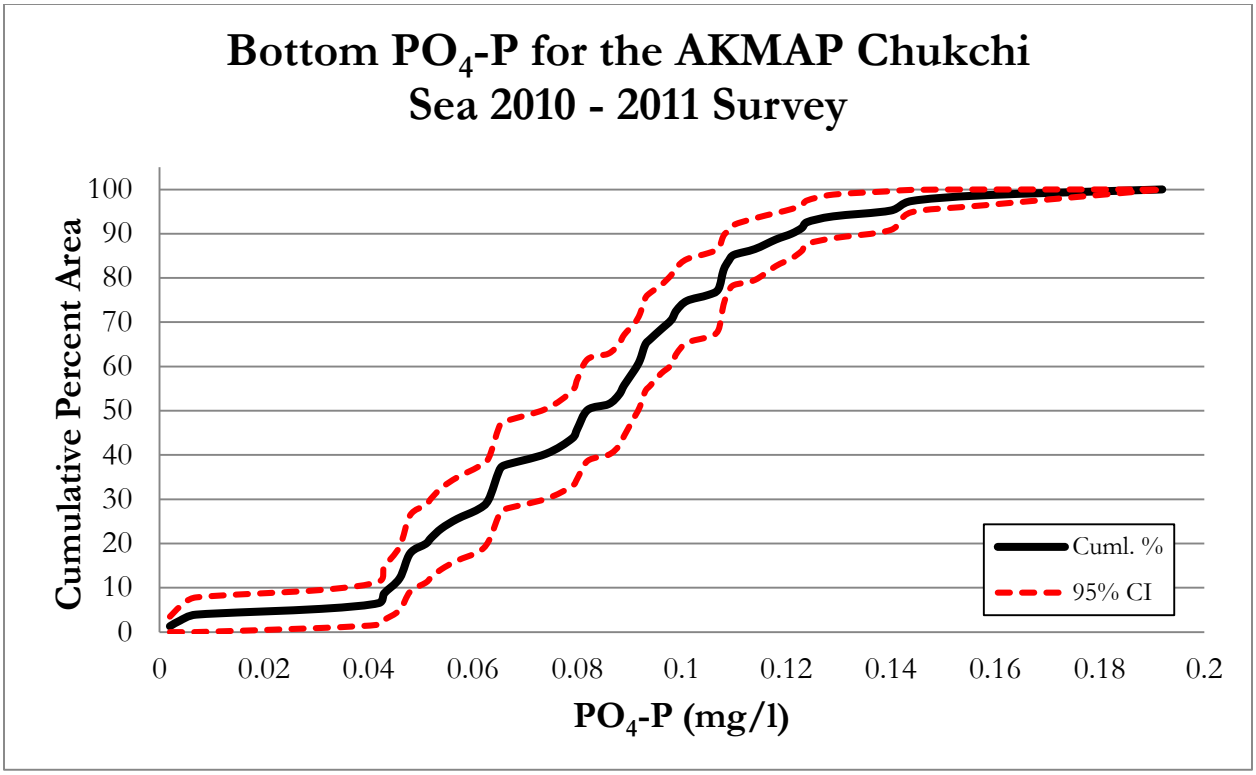


Figure 18 – Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. bottom water PO_4-P (mg/l).

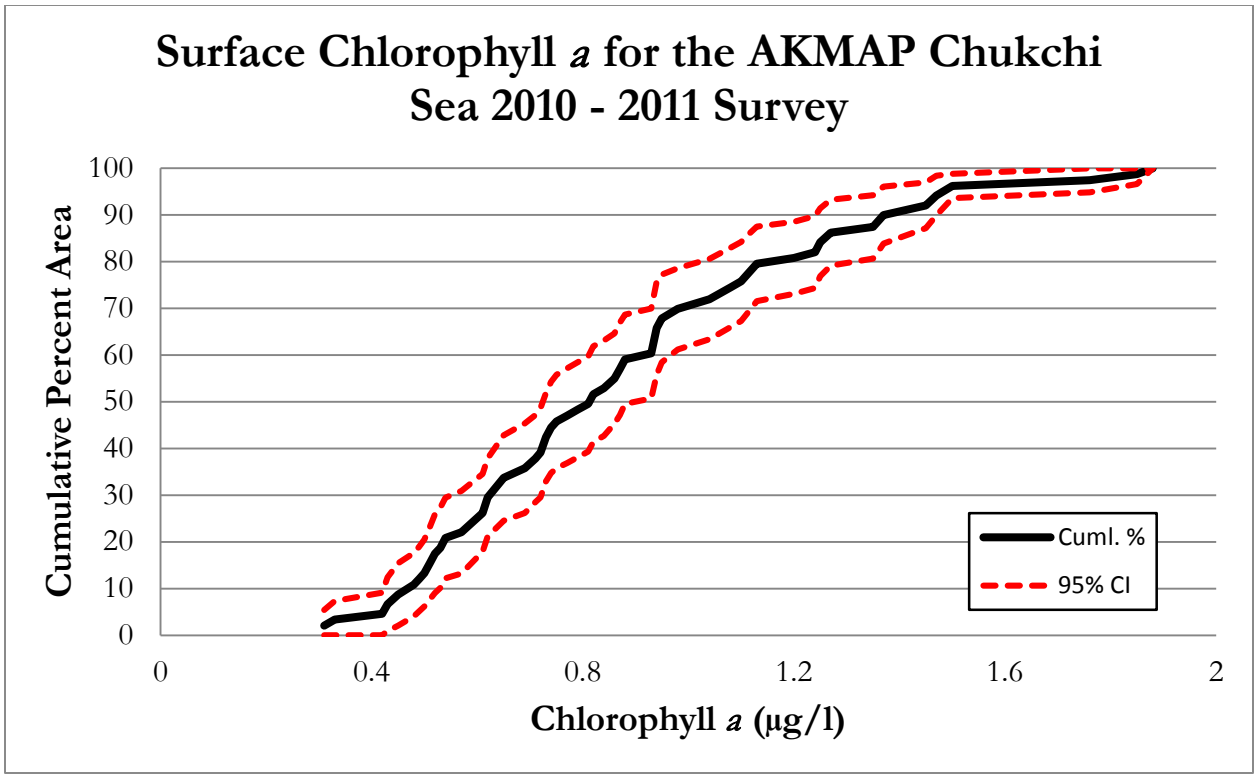


Figure 19 – Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. surface water Chlorophyll *a* (µg/l).

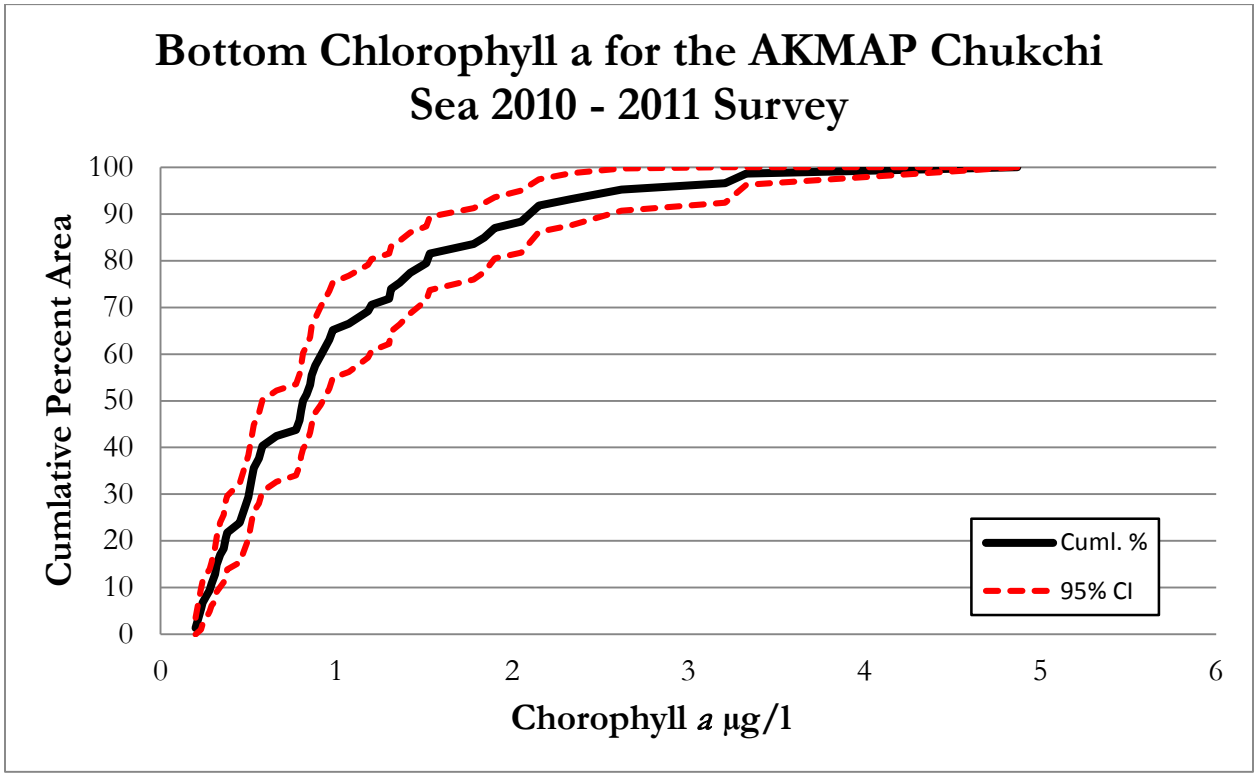


Figure 20 – Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. bottom water Chlorophyll *a* (µg/l).

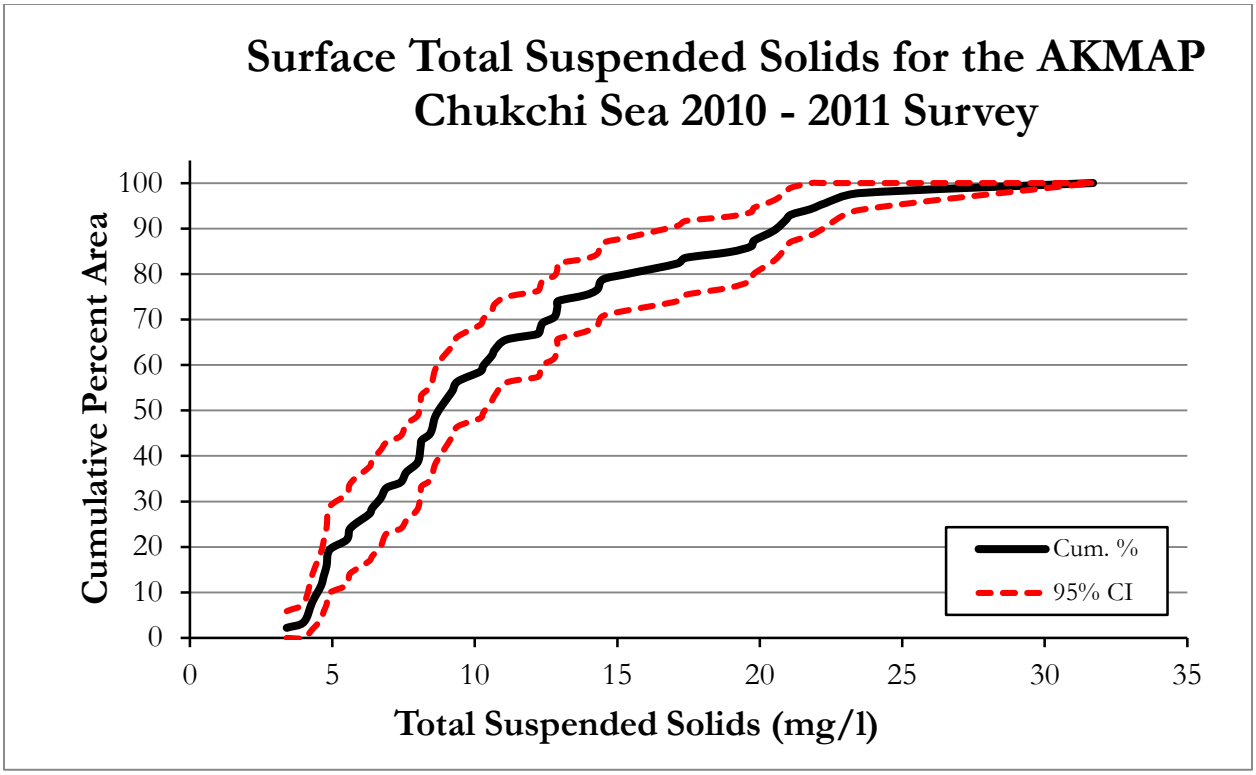


Figure 21 – Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. surface water total suspended solids (µg/l).

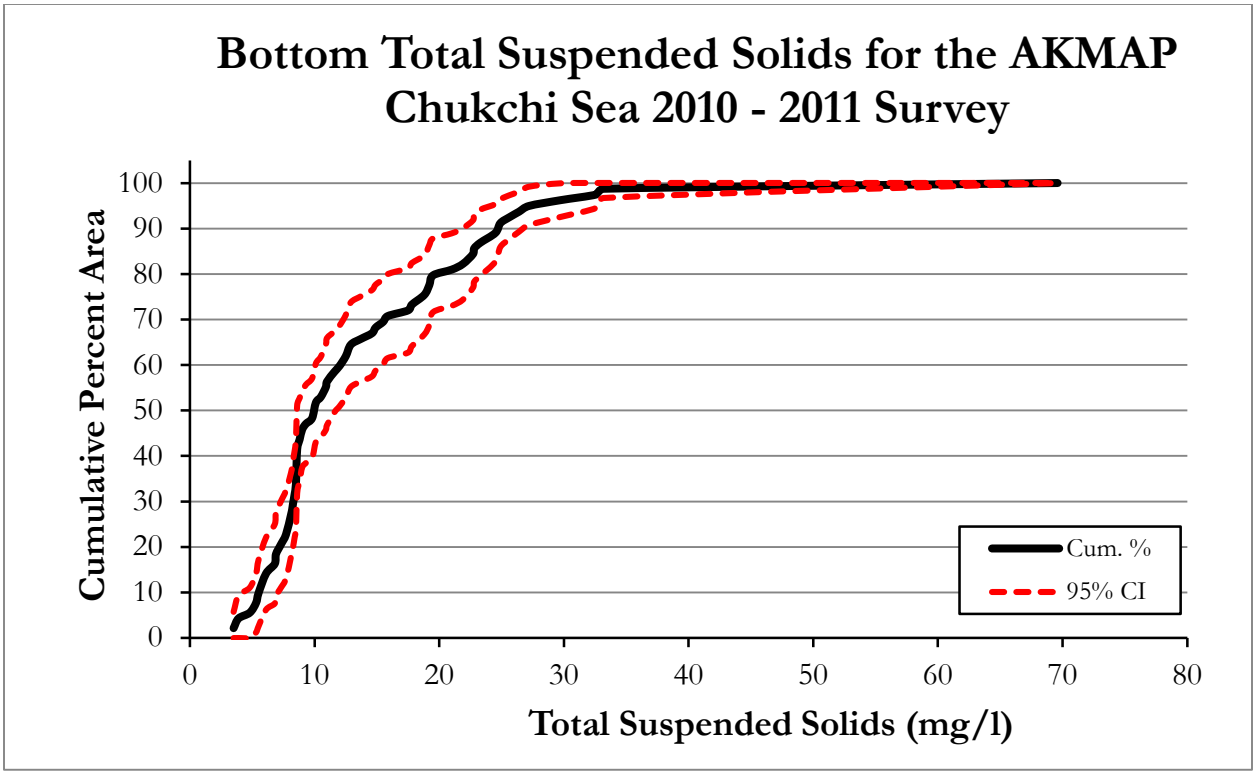


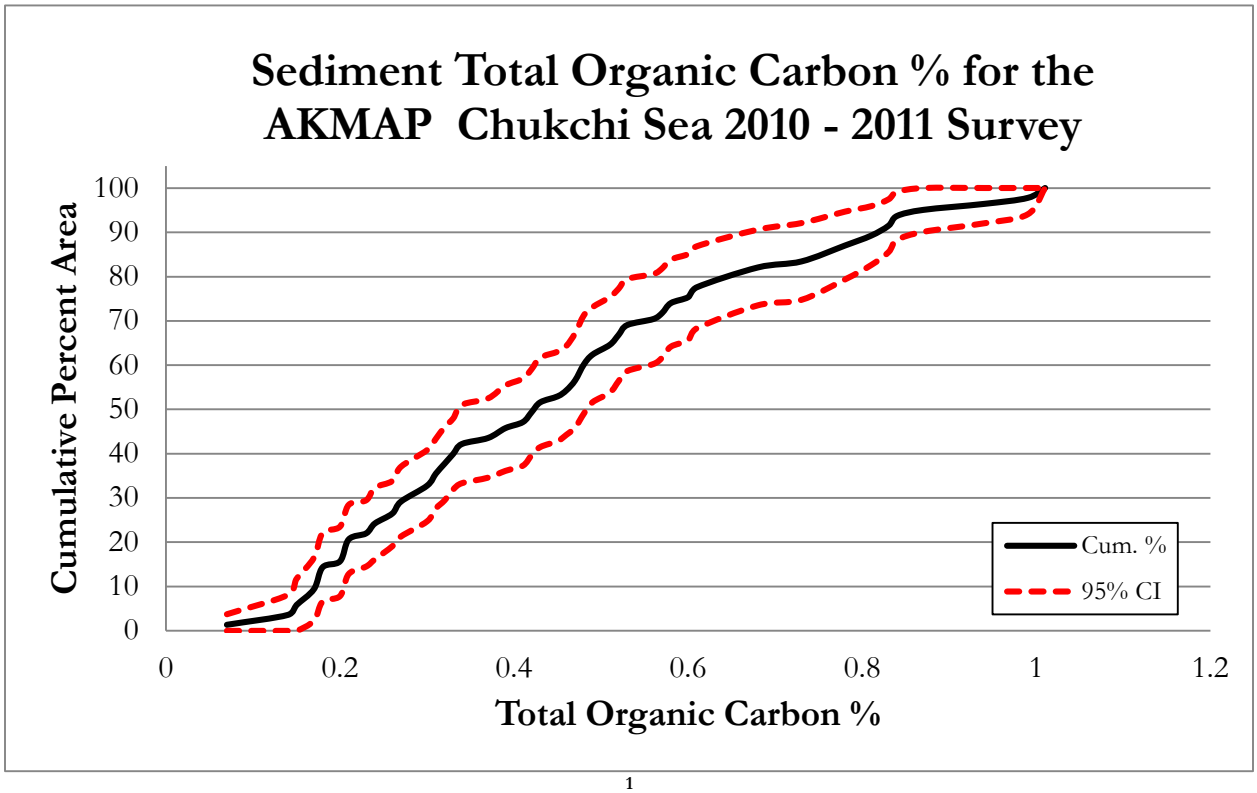
Figure 22 – Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. bottom water total suspended solids (mg/l).

Habitat Sediment Characteristics

At 55 stations sediment characteristics were described by grain size mud fraction (silt and clay) and total organic carbon with contaminant information provided by trace metals and petroleum hydrocarbons. Results are shown in Figure 23 – 24 and Table 4.

Table 4 – Sediment Grain Size and Organic Content

	Population Summary Statistics					
Grain Size	n	Mean	SD	Median	Min	Max
Gravel	55	5.43%	11.42%	0.50%	0	65.2%
Sand	55	76.14%	18.25%	84.43%	31.3%	99.5%
Mud	55	18.41%	17.37%	9.49%	0	60%
Total Organic Carbon %	55	0.46%	0.24%	0.42%	0.07%	1.01%



[1]

Figure 23 – Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. sediment total organic carbon %.

[1] The CDF results in this case provide cumulative percent area for the 55 stations representing 93% or 25,630 km² of the total sample frame (combined Ledyard Bay and Peard Bay strata) of 27,593 km².

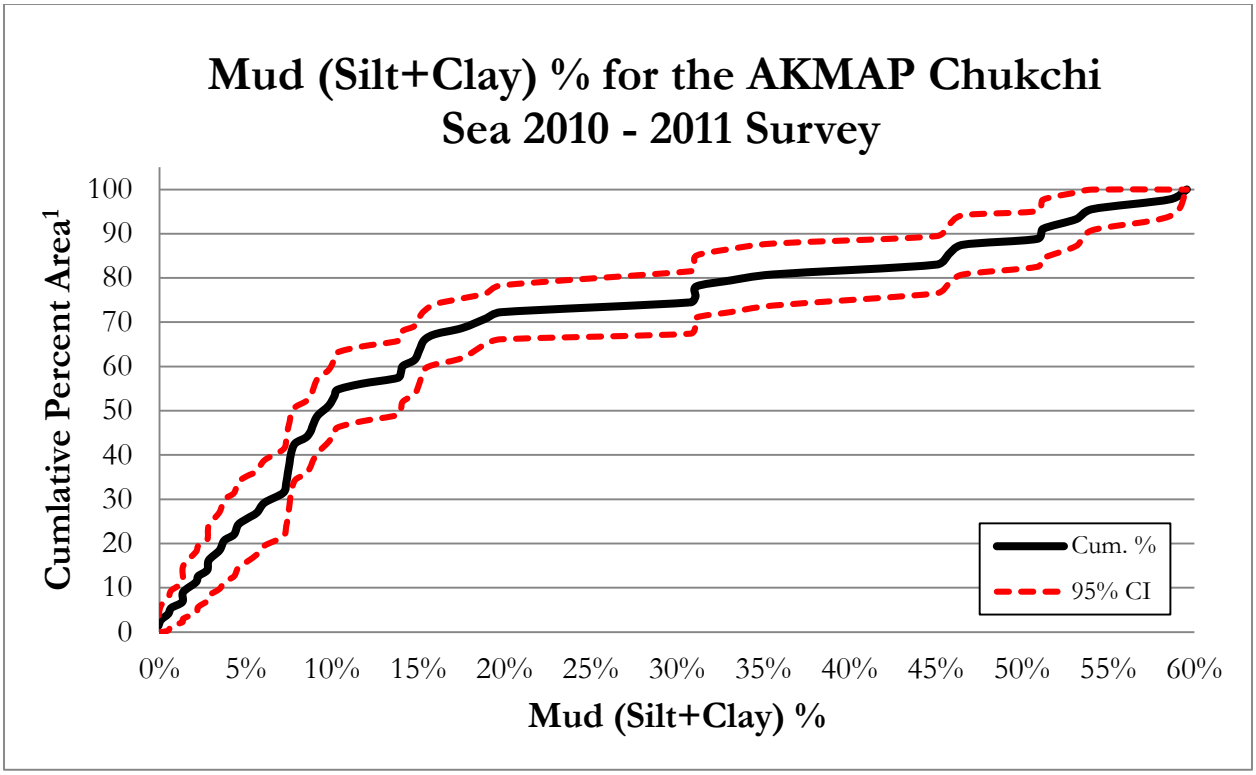


Figure 24 – Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. sediment Mud (Silt+clay) %.

Sediment and Fish Tissue Contaminant condition indicators

Sediment Contaminants - Trace Metals (mg metal/kg sediment)

Thirteen trace metals were analyzed for in sediments sampled in 2010 and 2011 as part of the AKMAP Chukchi Sea survey. The trace metal set was selected for comparison with an earlier 2008 Chukchi Sea environmental study (Neff et al., 2010). Arsenic (As), barium (Ba), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), mercury (Hg), manganese (Mn), lead (Pb), selenium (Se), silver (Ag), and zinc (Zn) were sampled because of potential concerns with toxicity and the association of these trace metals with oil and gas activities. Aluminum (Al), iron (Fe), and lithium (Li) were sampled to compare their usefulness for normalizing sediment metal concentrations to the mud (silt and clay) fraction in the sediments. Results are presented in Figures 25 – 27 and Table 5.

Table 5 – Sediment Trace Metals (mg/kg dw)

	Population Summary Statistics					
Trace metal	n	Mean	SD	Median	Min	Max
Aluminum	55	8892	2246	8460	5788	17190
Arsenic	54	13.73	3.87	12.56	9.054	29.72
Barium	55	379.9	83.40	375.7	217	723.8
Cadmium	34	0.12	0.20	0.13	0	1
Chromium	55	33.55	12.77	30.01	12.48	62.57
Copper	55	8.54	3.68	7.76	3.38	18.46
Iron	55	20380	13891	16190	8220	87970
Lead	54	7.53	1.61	7.16	4.62	11.44
Lithium	55	13.58	4.47	12.93	6.57	25.66
Manganese	55	156.3	60.66	139.9	85.65	358.8
Mercury	55	0.03	0.01	0.03	0.01	0.06
Selenium	52	0.8535	0.64	0.743	0.108	3.67
Silver	46	0.31	0.14	0.29	0.011	0.64
Zinc	55	59.35	21.13	54.03	28.11	122

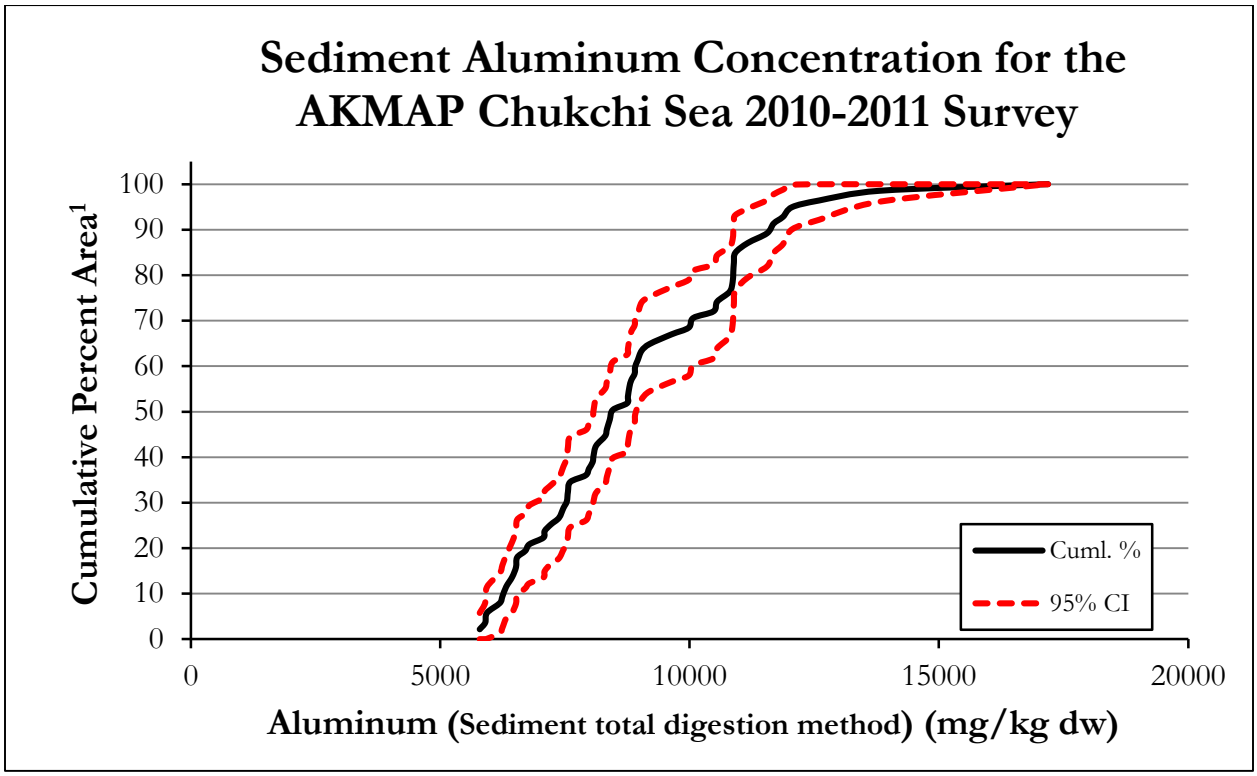


Figure 25 – Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. sediment aluminum concentration (mg/kg dw).

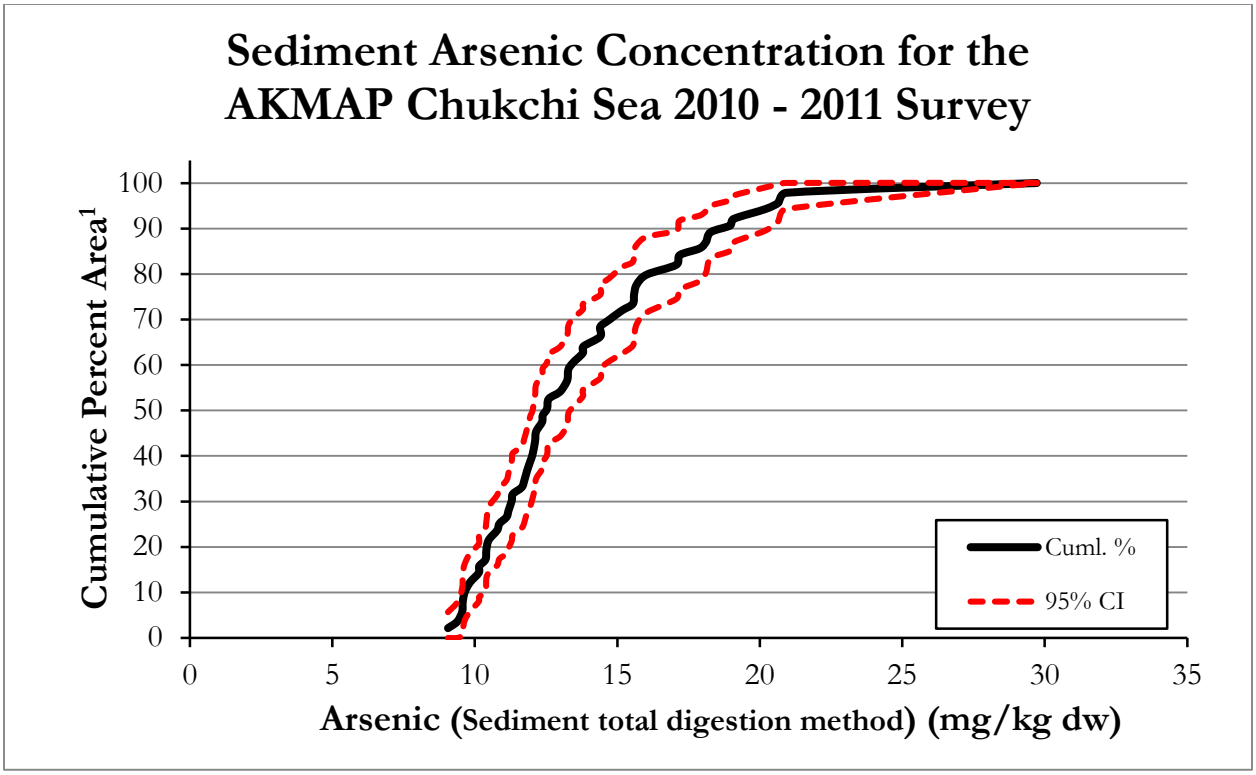


Figure 26 – Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. sediment arsenic concentration (mg/kg dw).

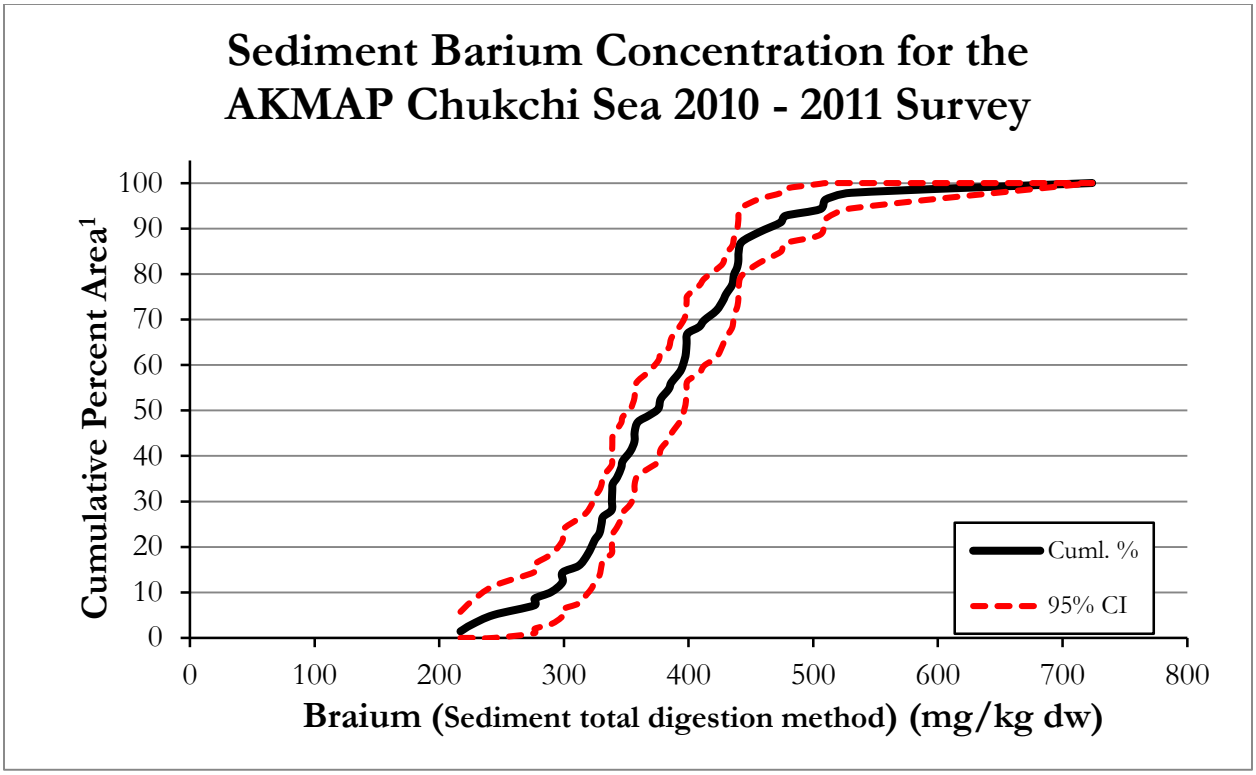


Figure 27 – Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. sediment barium concentration (mg/kg dw).

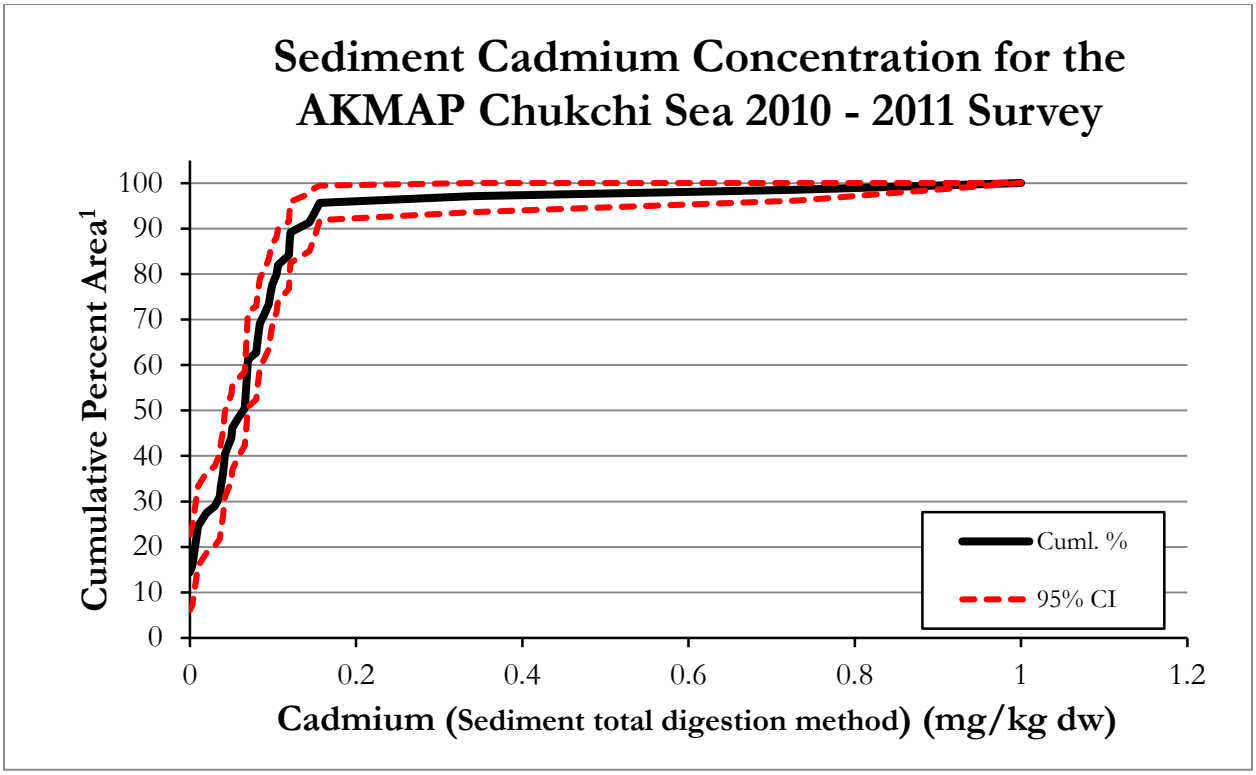


Figure 28 – Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. sediment cadmium concentration (mg/kg dw).

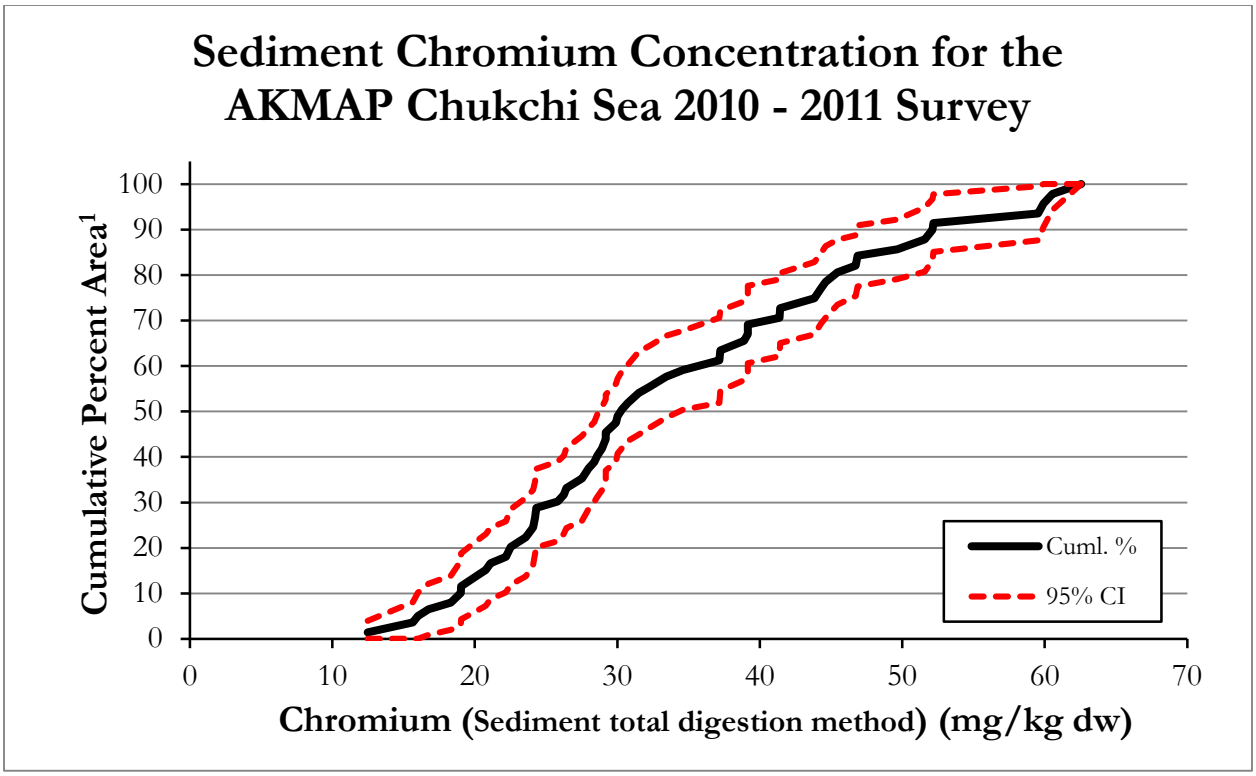


Figure 29 – Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. sediment chromium concentration (mg/kg dw).

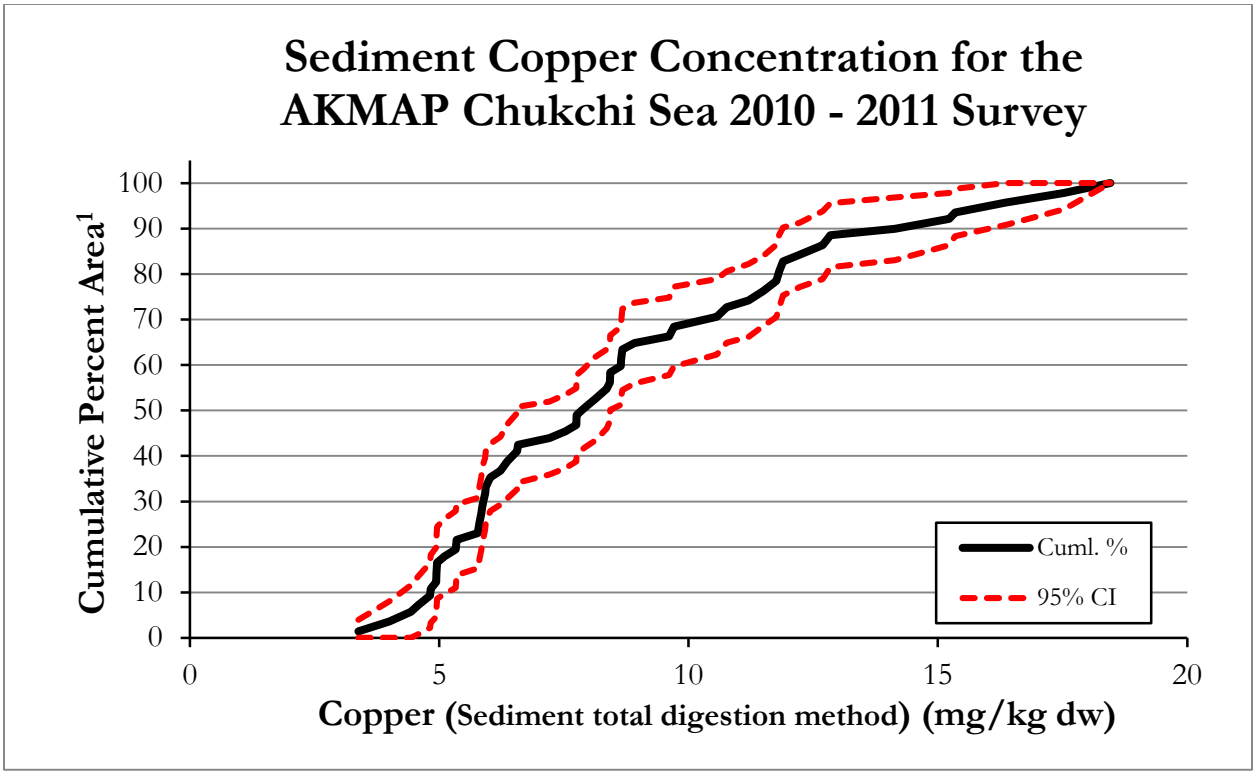


Figure 30 – Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. sediment copper concentration (mg/kg dw).

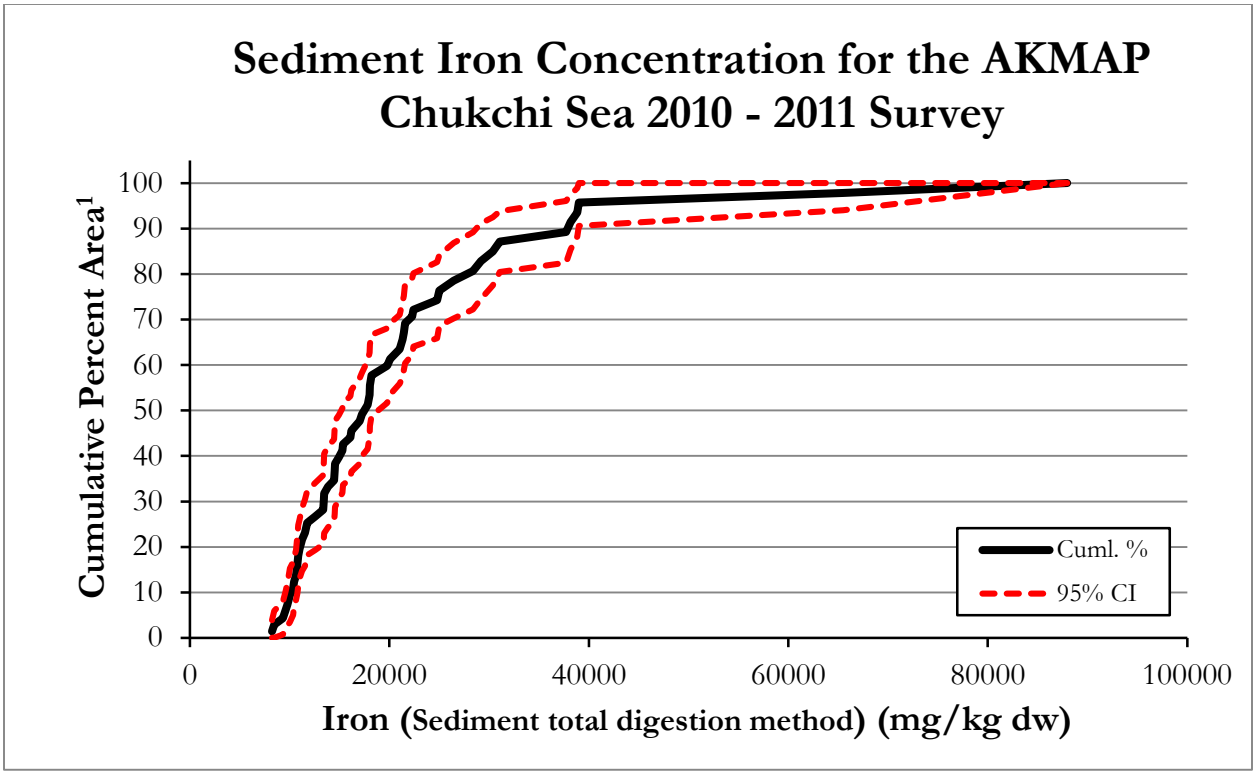


Figure 31 – Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. sediment iron concentration (mg/kg dw).

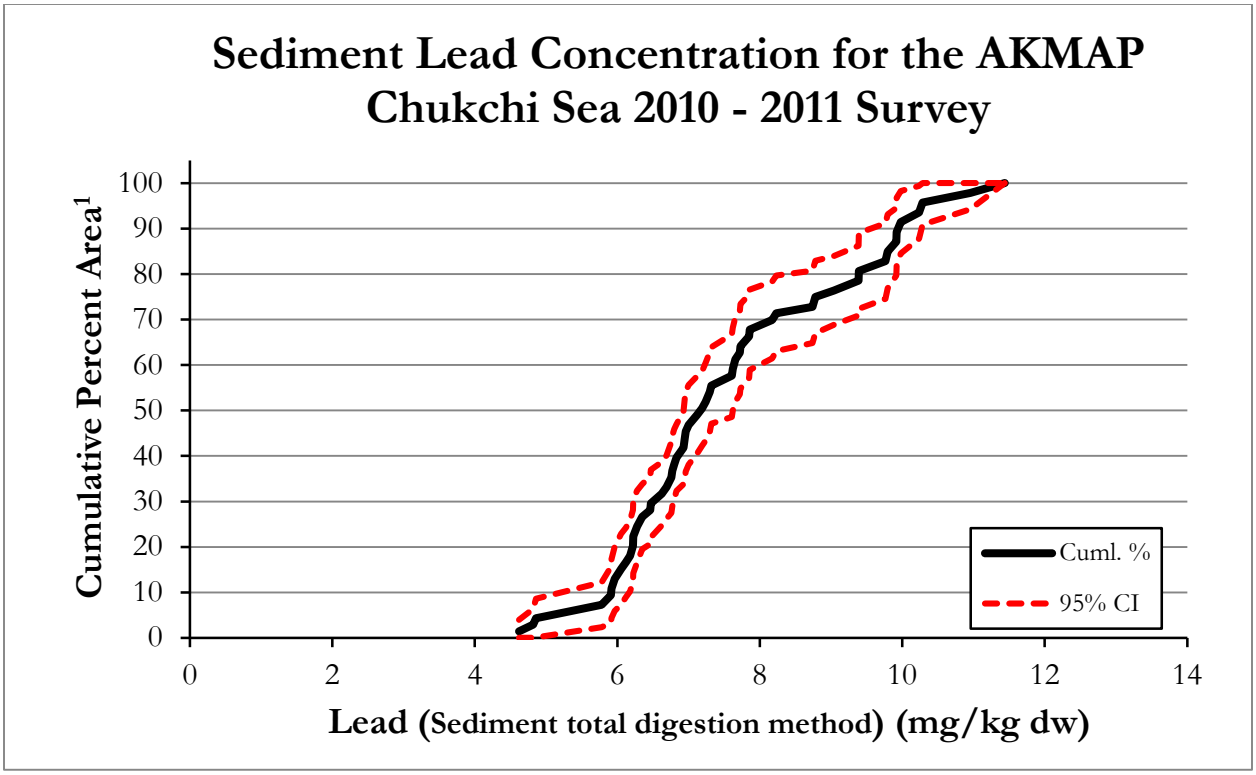


Figure 32 – Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. sediment lead concentration (mg/kg dw).

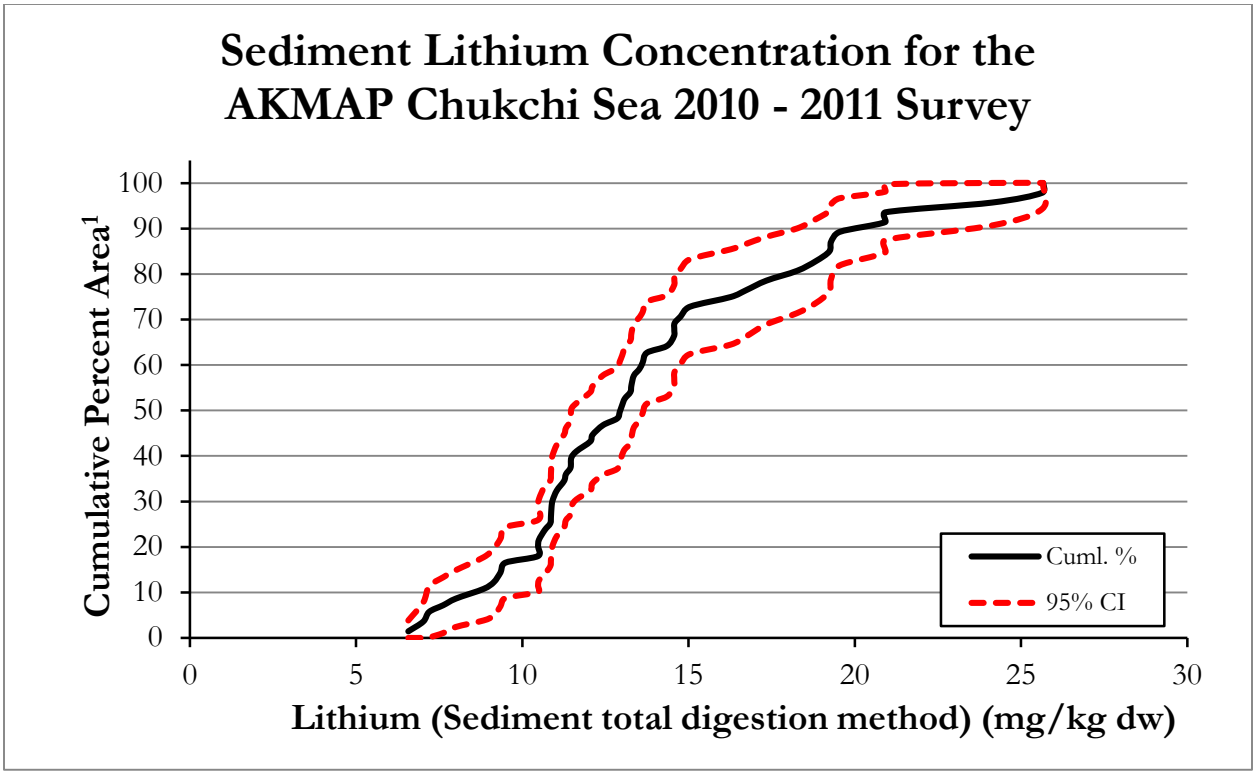


Figure 33 – Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. sediment lithium concentration (mg/kg dw).

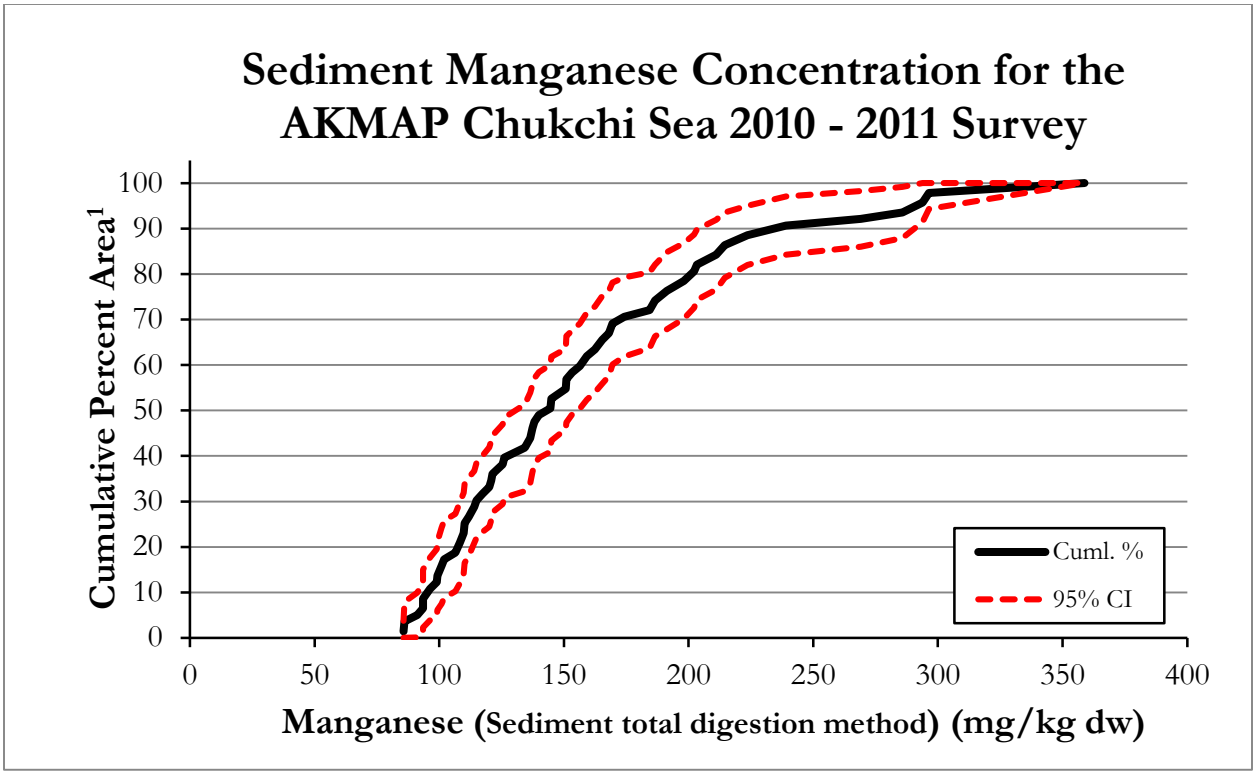


Figure 34 – Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. sediment manganese concentration (mg/kg dw).

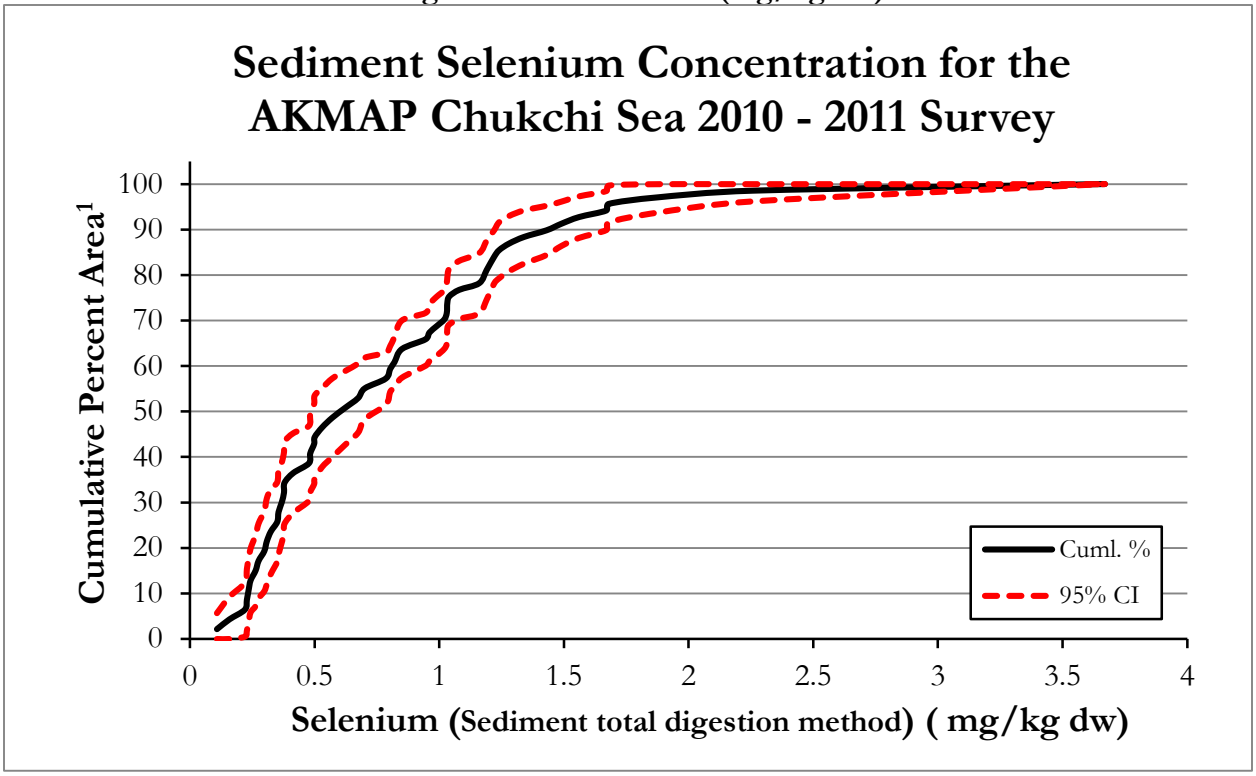


Figure 35 - Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. sediment selenium concentration (mg/kg dw).

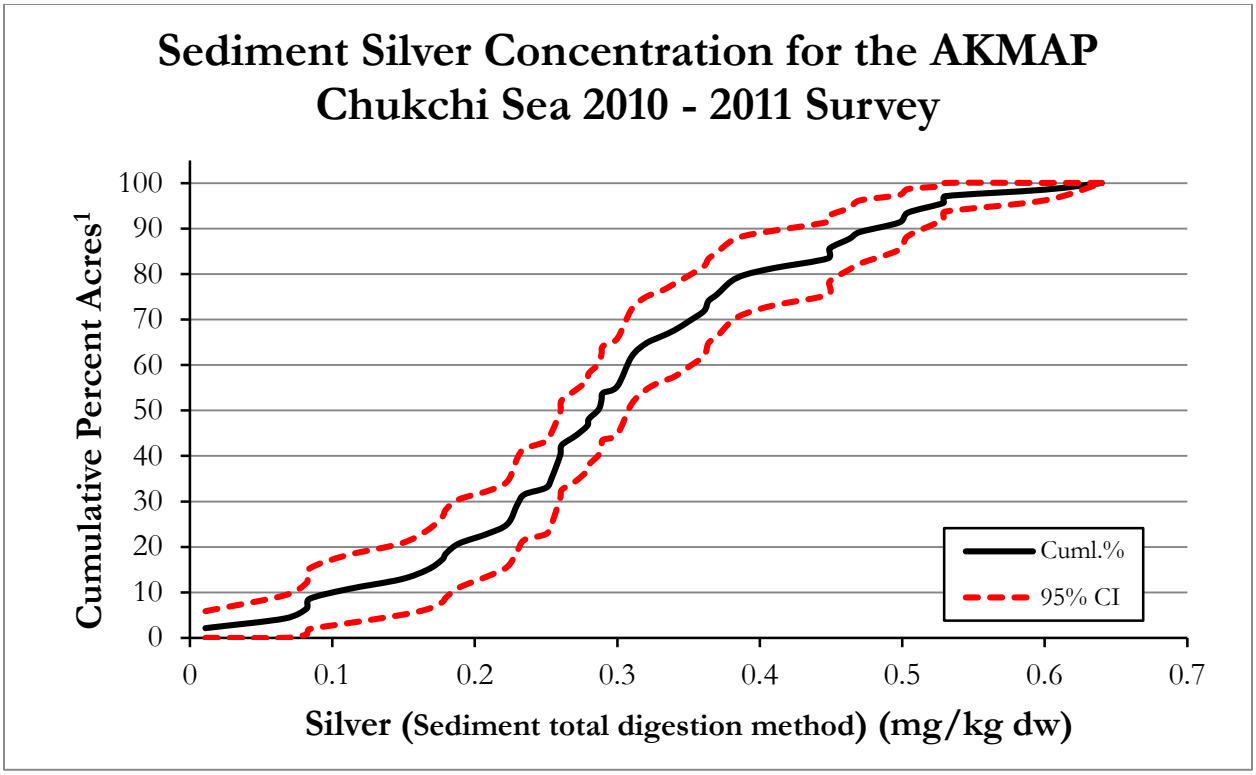


Figure 36 – Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. sediment silver concentration (mg/kg dw).

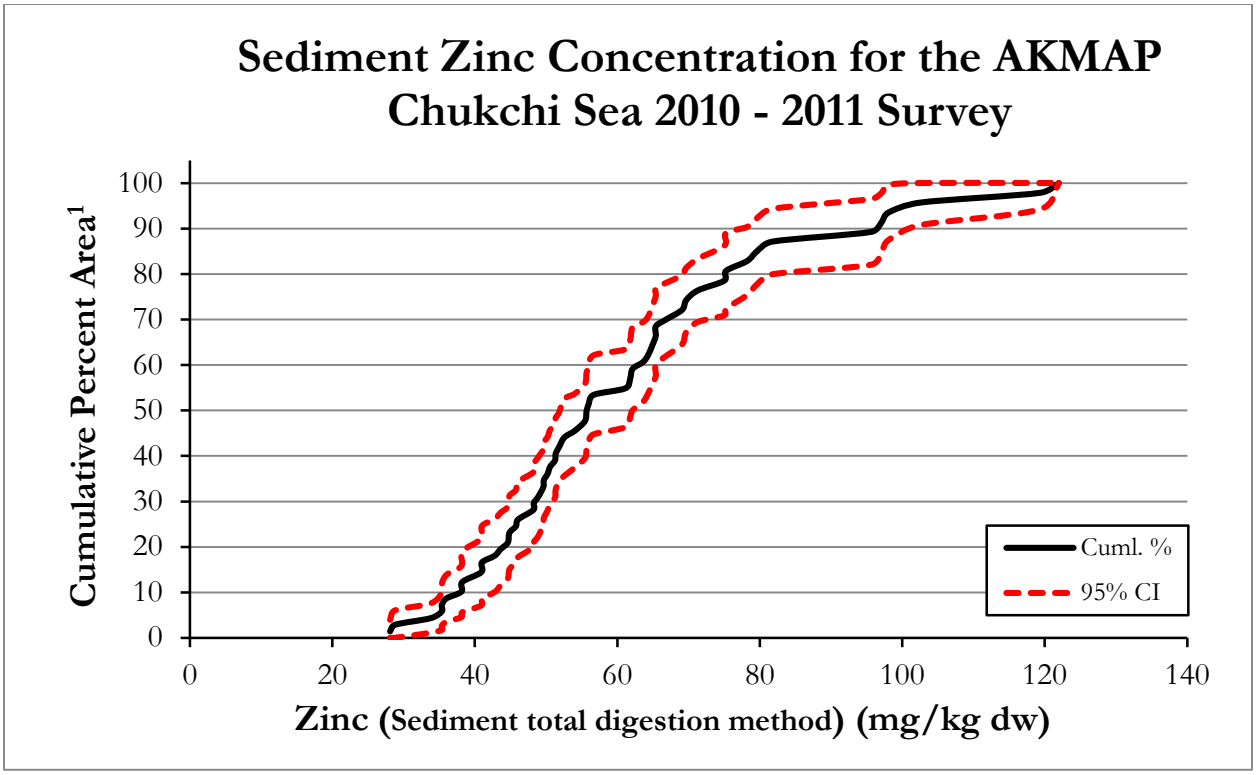


Figure 37 – Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. sediment zinc concentration (mg/kg dw).

Sediment Organic Contaminants - Polycyclic aromatic hydrocarbons

The *Alaska Monitoring and Assessment Program (AKMAP) 2010 – 2011 Chukchi Sea Coastal Survey Environmental Status Summary* utilizes the NOAA SQUIRT guidelines to assess potential toxicity of the sediment polycyclic aromatic hydrocarbon concentrations to aquatic organisms (Buchman, 2008). This information is used in establishing a sediment quality index condition.

Five hydrocarbon groupings will be used in assessing sediment PAH toxicity status in accordance with the NOAA SQUIRT guidelines. These are total and individual polycyclic aromatic hydrocarbons (TPAH and PAH), TPAH low molecular weight (e.g., 2 to 3 ring group of PAHs such as naphthalenes, fluorenes, phenanthrenes, and anthracenes), TPAH high molecular weight (e.g., 4 to 7 ring from chrysenes to coronenes). The TPAH has been separated into two sub-groups: first is for TPAH guideline using 13 PAHs (Long et al., 1995) to determine Effects Range Low and Effects Range Median and second is the NOAA NS&T TPAH based on 24 individual PAHs in its core program to assess sediment toxicity. The TPAH grouping results are summarized in Figure 38 – 41 and Table 6. Individual NOAA SQUIRT PAHs are not shown here, but are included in the sediment indices assessment in the A*laska Monitoring and Assessment Program (AKMAP) 2010 – 2011 Chukchi Sea Coastal Survey Environmental Status Summary.*

Table 6 – Sediment Hydrocarbons

	Population Summary Statistics					
TPAH group	n	Mean	SD	Median	Min.	Max.
TPAH (13 individual PAHs) (mg/kg dw)	55	116.05	89.01	79.51	6.70	425.80
NS & T – TPAH (24 individual PAHs) (mg/kg dw)	55	206.50	152.55	142.65	14.83	714.87
THMW PAHs (mg/kg dw)	55	126.58	113.61	91.36	11.89	717.42
TLMW PAHs (mg/kg dw)	55	671.78	573.38	414.35	7.68	2100

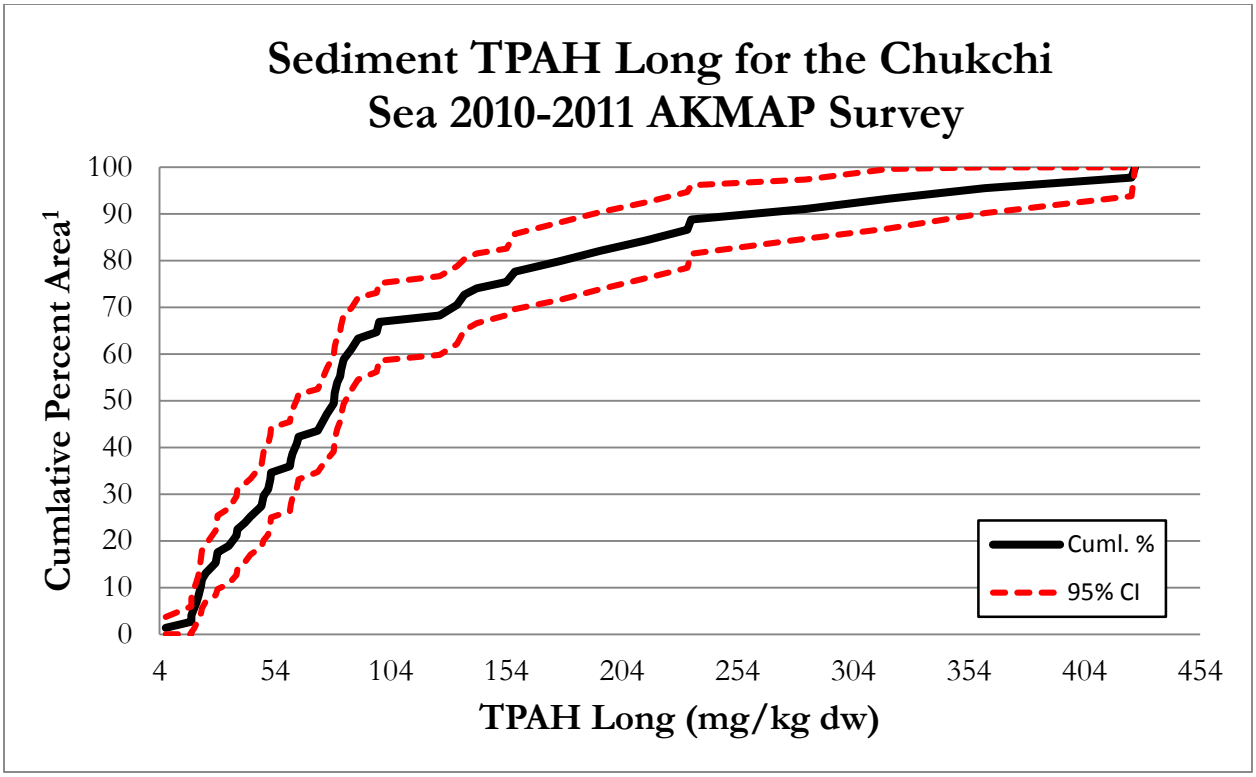


Figure 38 - Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. sediment total polycyclic hydrocarbon Long group (mg/kg dw).

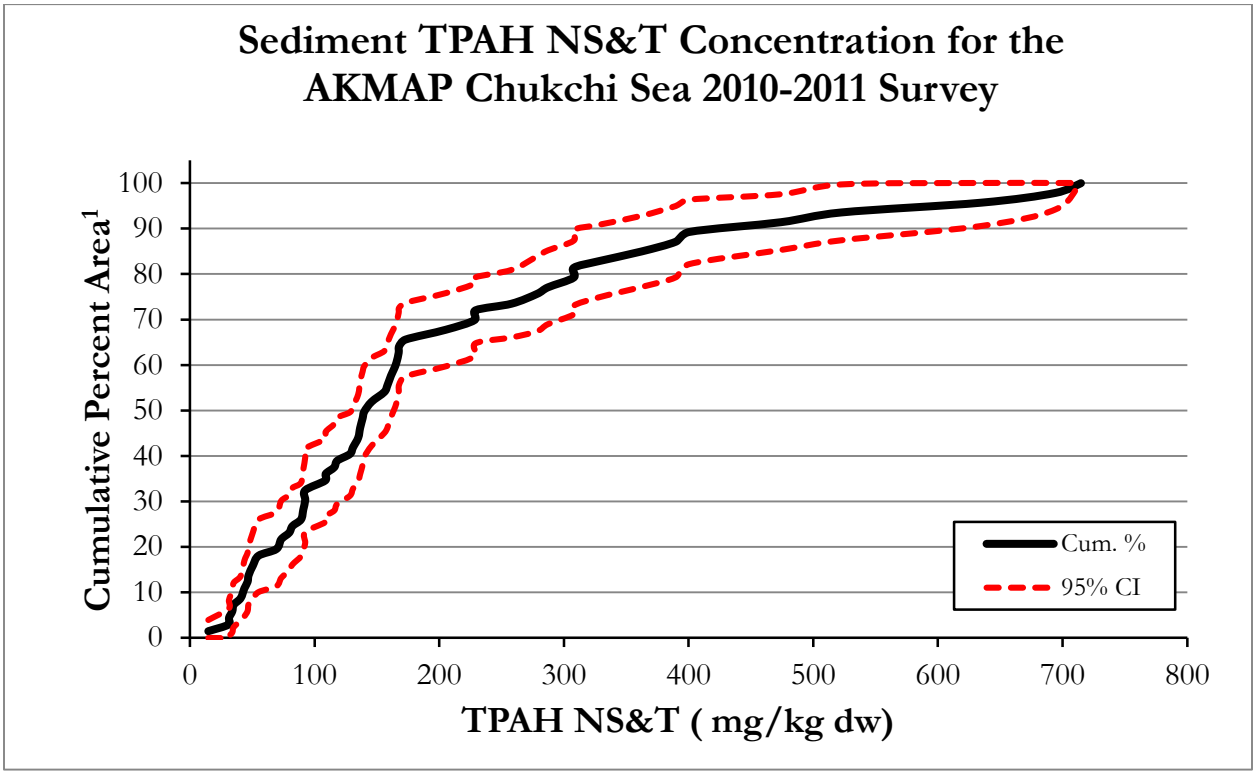


Figure 39 – Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. sediment total polycyclic hydrocarbon NOAA National Status & Trends set (mg/kg dw).

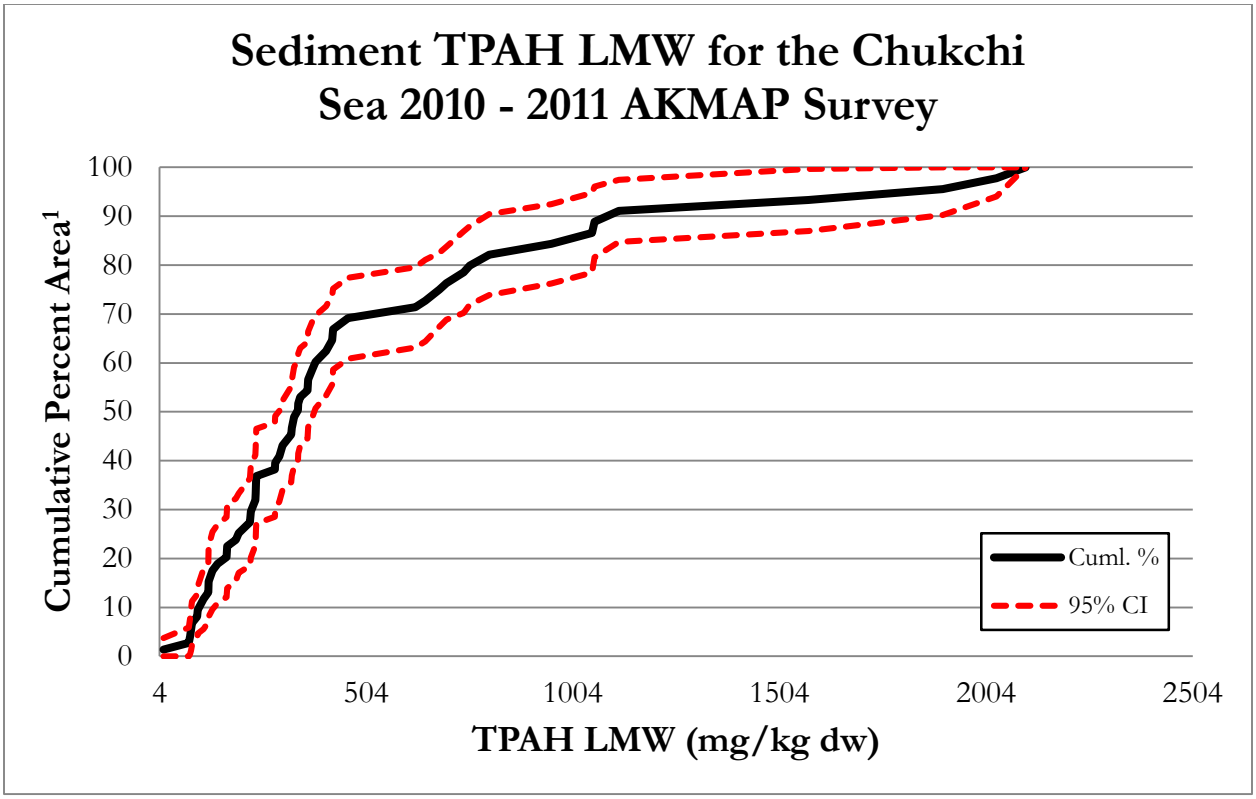


Figure 40 - Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. sediment total polycyclic hydrocarbon low molecular weight group (mg/kg dw).

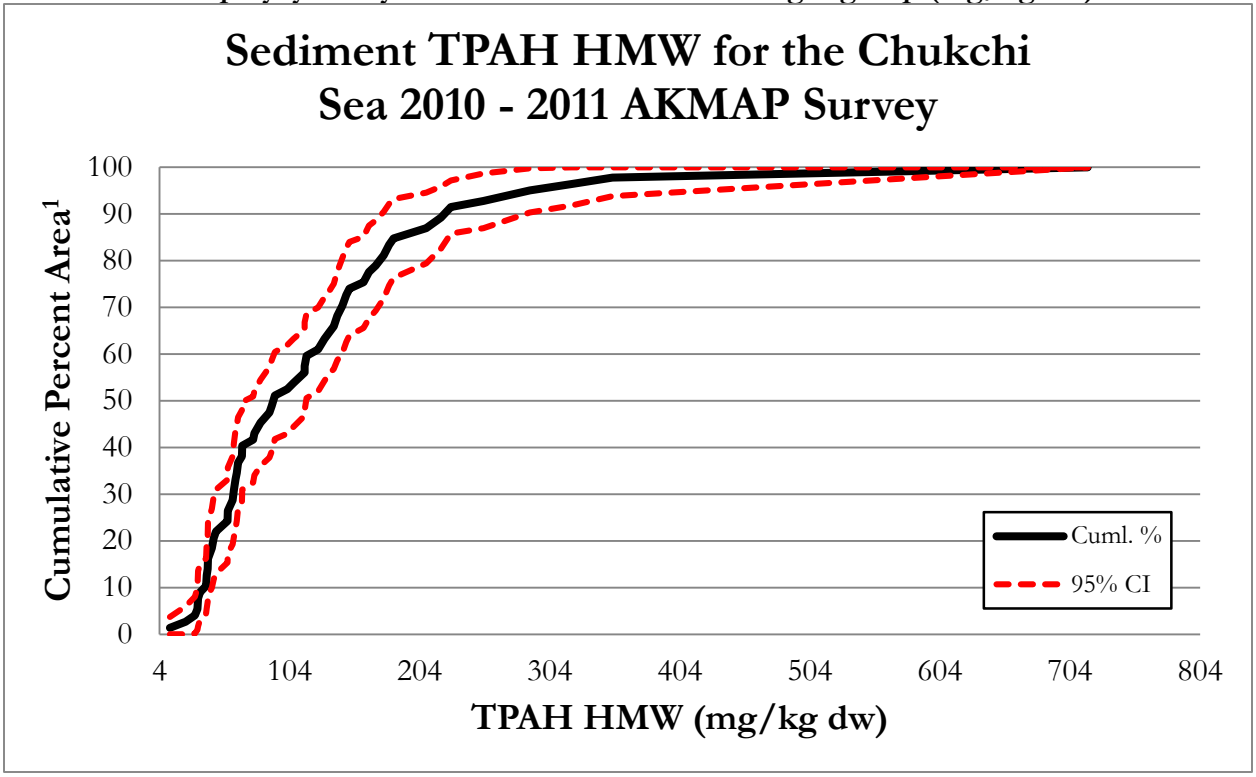


Figure 41 - Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. sediment total polycyclic hydrocarbon high molecular weight group (mg/kg dw).

Sediment OC & PCB

Organochlorine pollutants such as DTT and other pesticides and PCB were analyzed only in a subset of sediment samples as the survey was concerned with oil and gas contaminants. No formerly used defense sites (FUDS) were identified on the DEC list of contaminated sites (https://dec.alaska.gov/spar/csp/list.htm#Northern) associated with marine spills of organochlorine pollutants or PCB's. Resulting concentrations were very low, typically below detection limits.

Fish Tissue Contaminant

Originally the focus was on collection of large fish that could be sampled for assessment of human health in regards to tissue contaminants. Since the fish collected were small and not considered representative of fish kept for human consumption, a small subset of the trawl fish were kept for ecological risk assessment in the final report. Resulting concentrations for trace metals, organochlorine contaminants, and PCBs resulted in a number of non-detects. No detected concentrations exceeded wildlife toxic tissue screening concentrations (TSC) (U.S. EPA, 2006).

Biota condition indicators

Macroinvertebrates, epifauna, and demersal fish were sampled as indicators of biological condition. Both macroinvertebrates and epifauna are not generally highly mobile, and live within or close to sediments tend to accumulate chemical contaminants, and are subject to changes in environmental conditions, i.e. dissolved oxygen, salinity, temperature, etc.. Consequently, these organisms can be useful indicators of environmental quality. In addition, demersal fish which live near the bottom sediments, typically are part of the benthic food web and can reflect contaminant exposure from macroinvertebrates and epifauna.

In the contiguous United States, benthic indices have been developed for macroinvertebrates to assess environmental conditions (Weisberg et al., 1997; Engle and Summers, 1999). Alaska's coastal habitat diversity and lack of coastal data has constrained any attempts to develop benthic, epifauna or demersal water quality indices. For the Chukchi Sea survey, no benthic, epifauna, or demersal fish condition were assessed. However, their abundance and biomass or number taxon per station are presented for informational purposes.

Macroinvertebrates

Macroinvertebrates, such as worms, bivalves, crustaceans, and others living in the bottom sediments and epifauna, such as starfish, sculpin, sand dollars, and others living on or closely adjacent too bottom sediments are important to maintaining a healthy ecosystem (U.S. EPA, 2015a). Macroinvertebrate abundance and number of taxon at each station results are shown in Figures 42 – 43 and Table 7.

Table 7 – Macroinvertebrates

	Population Summary Statistics					
Variable	n	Mean	SD	Median	Min.	Max.
Abundance (count/m^2)	51	4006	4439	2700	170	5300
Number taxon station	39	49	25	45	9	69

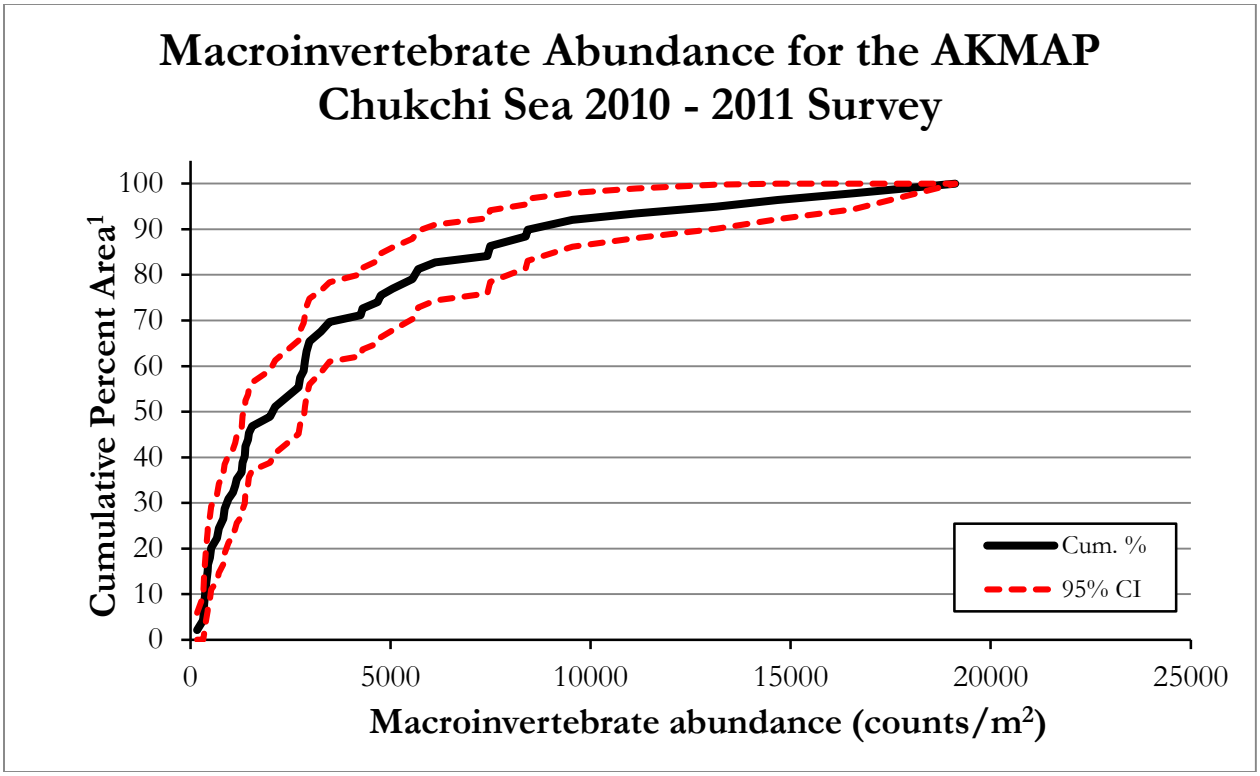


Figure 42 - - Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. macroinvertebrate abundance (counts/m^2).

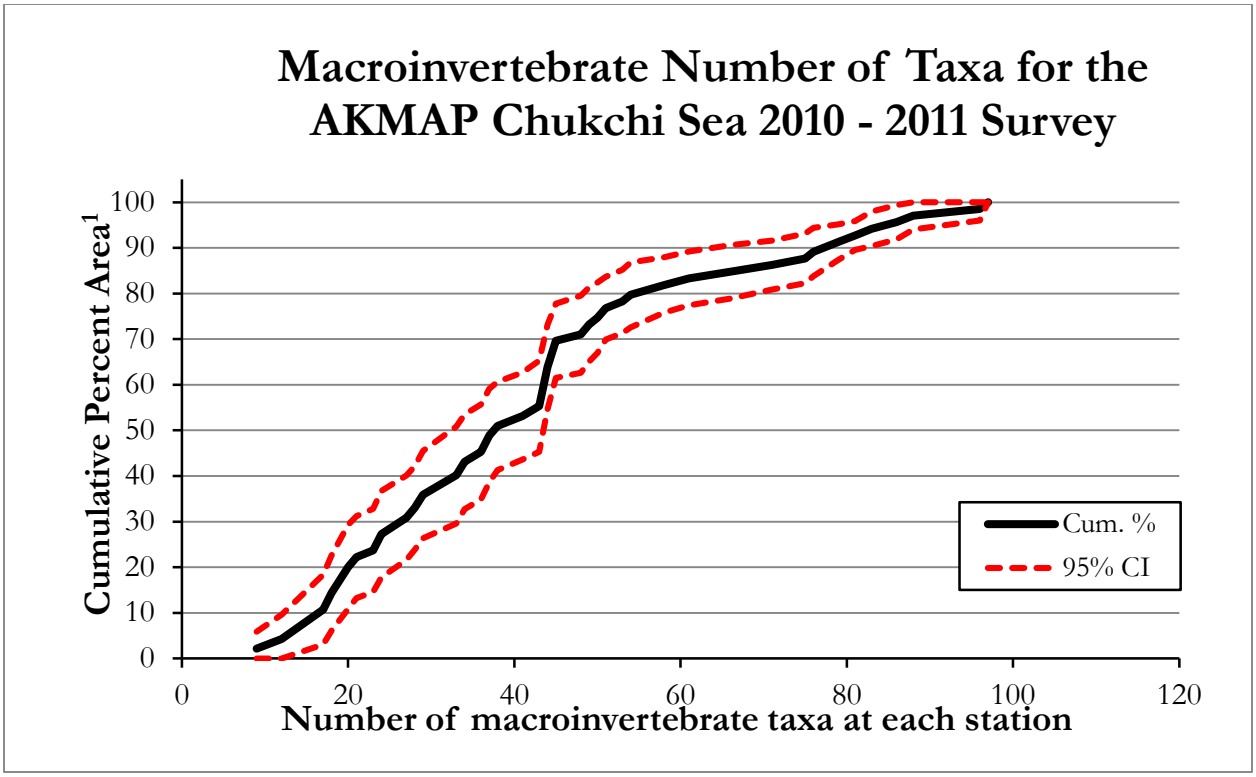


Figure 43 - Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. number of macroinvertebrate taxa

Epifauna

Epifauna represent an important link in the food web and support marine mammals, such as Grey Whales in the Chukchi Sea during the summer months. Epifauna abundance and biomass results are shown in Figures 44 – 45 and Table 8.

Table 8 - Epifauna

		Population Summary Statistics				
Variable	n	Mean	SD	Median	Min.	Max.
Abundance (count/km^2)	57	19,750,594	27,504,274	6,914,088	1,154,412	244,431,837
Biomass (kg/km^2)	57	107,480	98,411	59,968	7,812	652,455

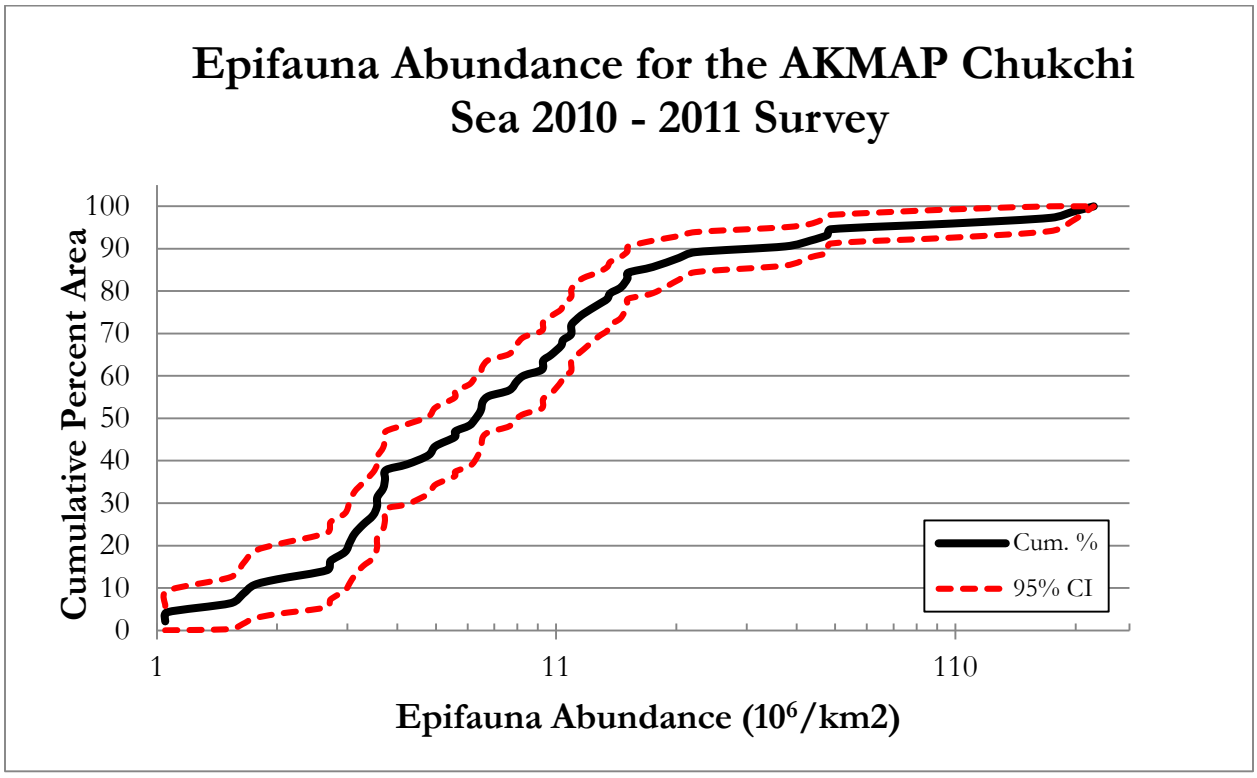


Figure 44 – Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. epifauna abundance (10^6/km^2).

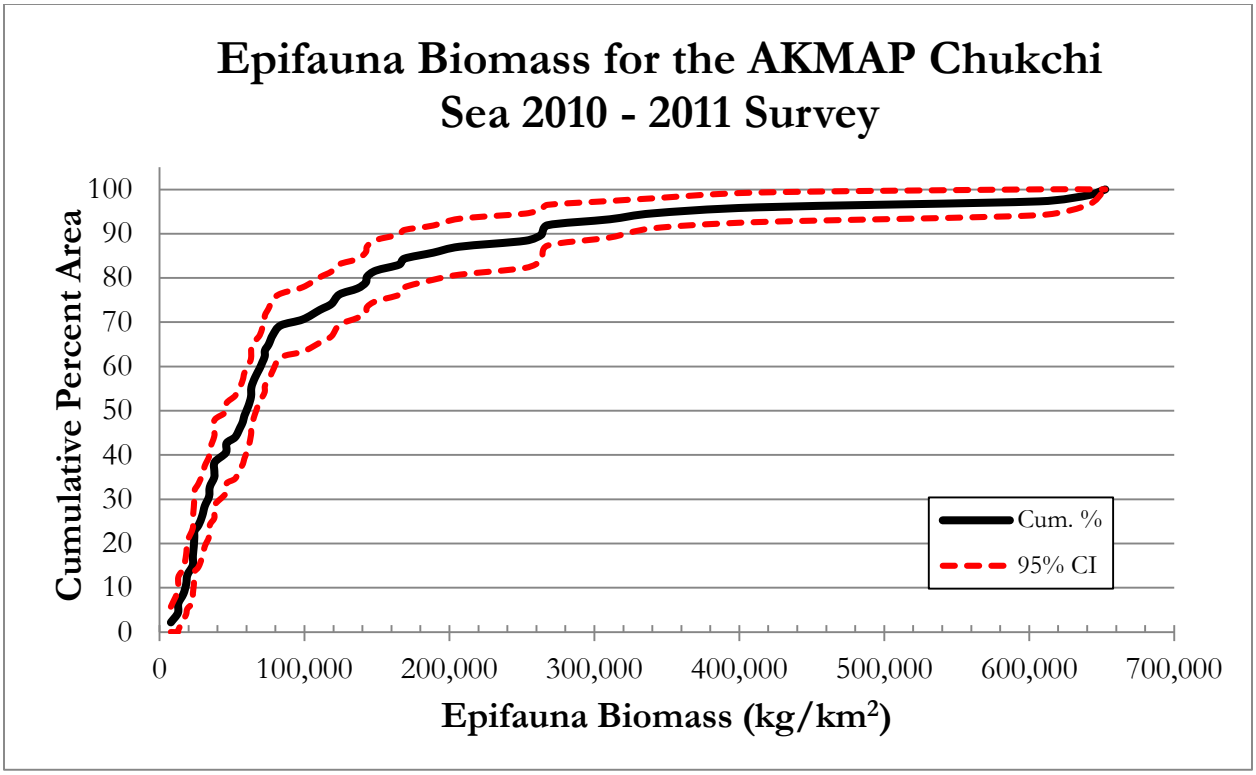


Figure 45 – Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. epifauna biomass (kg/km^2).

Demersal Fish

Demersal fish are an important food source for many marine mammals in the Chukchi Sea, such as ringed seals. Demersal fish abundance and biomass results are shown in Figures 46 – 47 and Table 9.

Table 9 – Demersal Fish

		Population Summary Statistics				
Variable	n	Mean	SD	Median	Min.	Max.
Abundance (count/km^2)	57	2024904	2102176	1129471	104507	13465303
Biomass (kg/km^2)	57	4101	3635	2688	178	20324

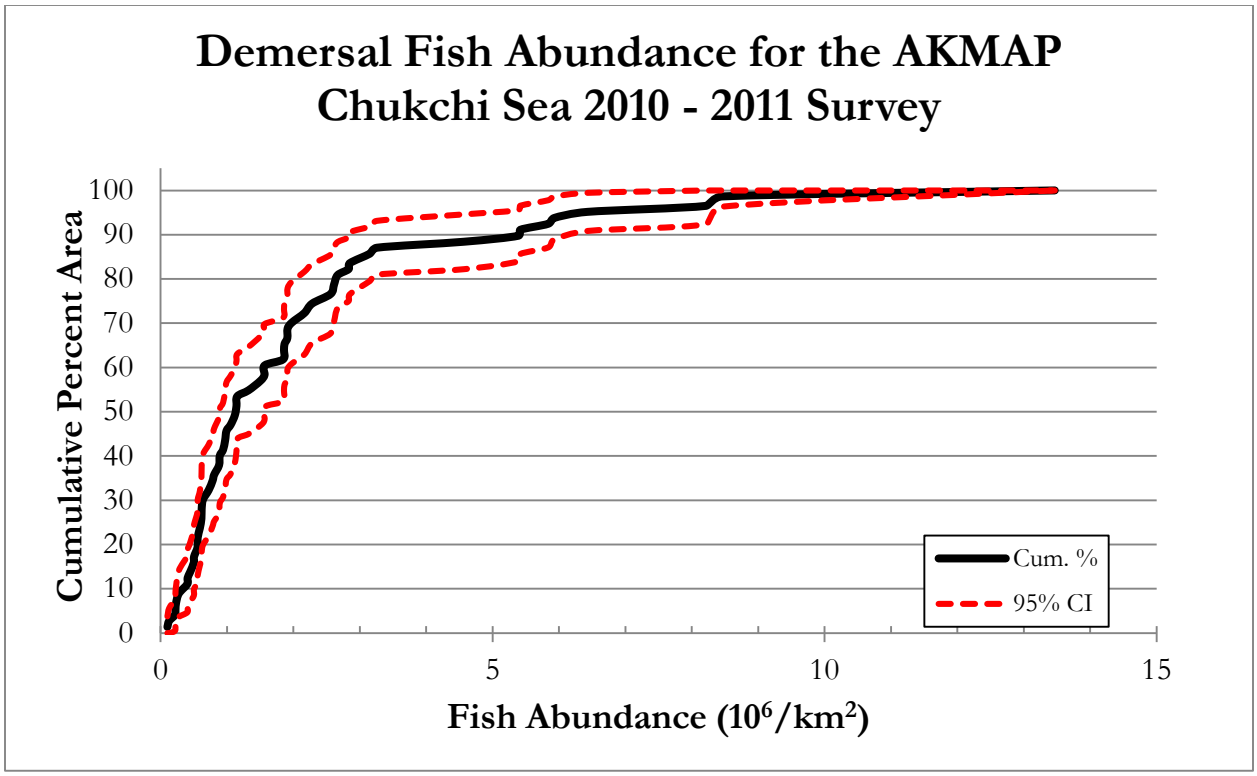


Figure 46 – Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. demersal fish abundance ($10^6/km^2$).

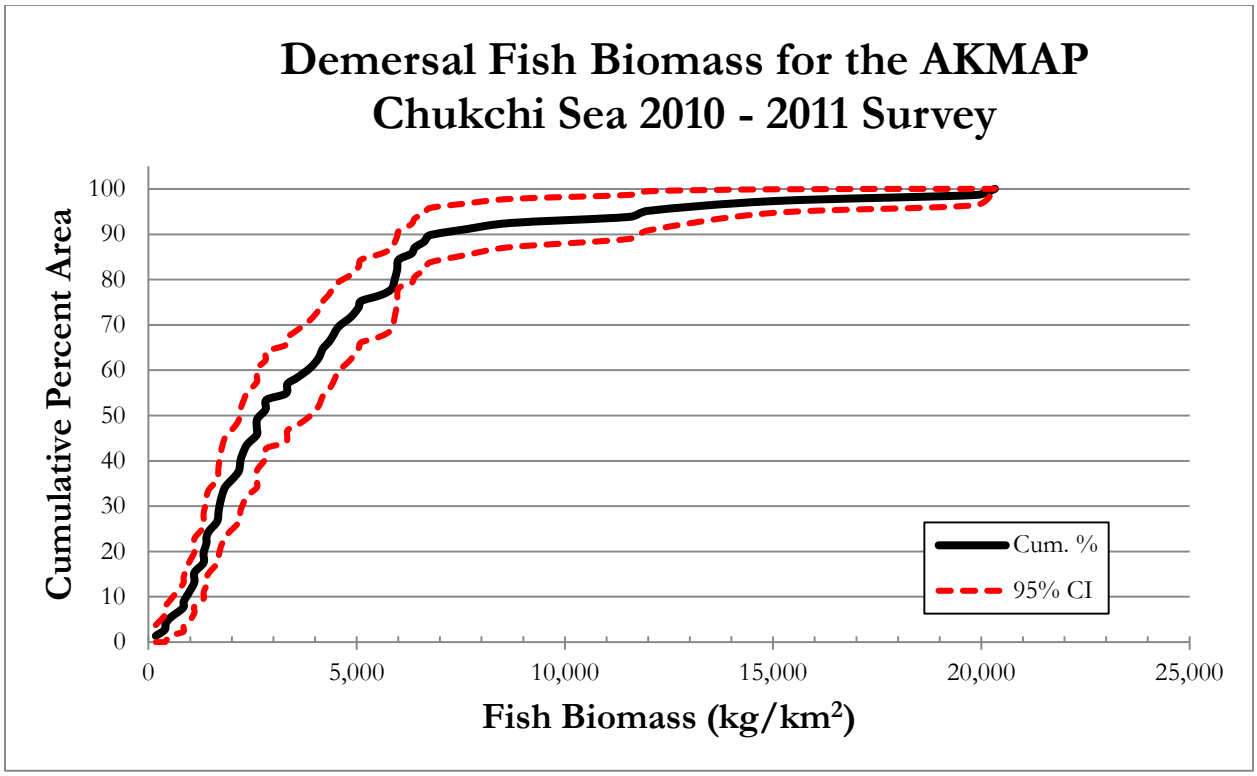


Figure 47 – Percent area (and 95% C.I.) AKMAP Chukchi Sea Survey vs. demersal fish biomass (kg/m^2).

9.0 References

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Appendix A - 2010 and 2011 Cruise Reports

Alaska Monitoring and Assessment Program

Freshwater Coastal

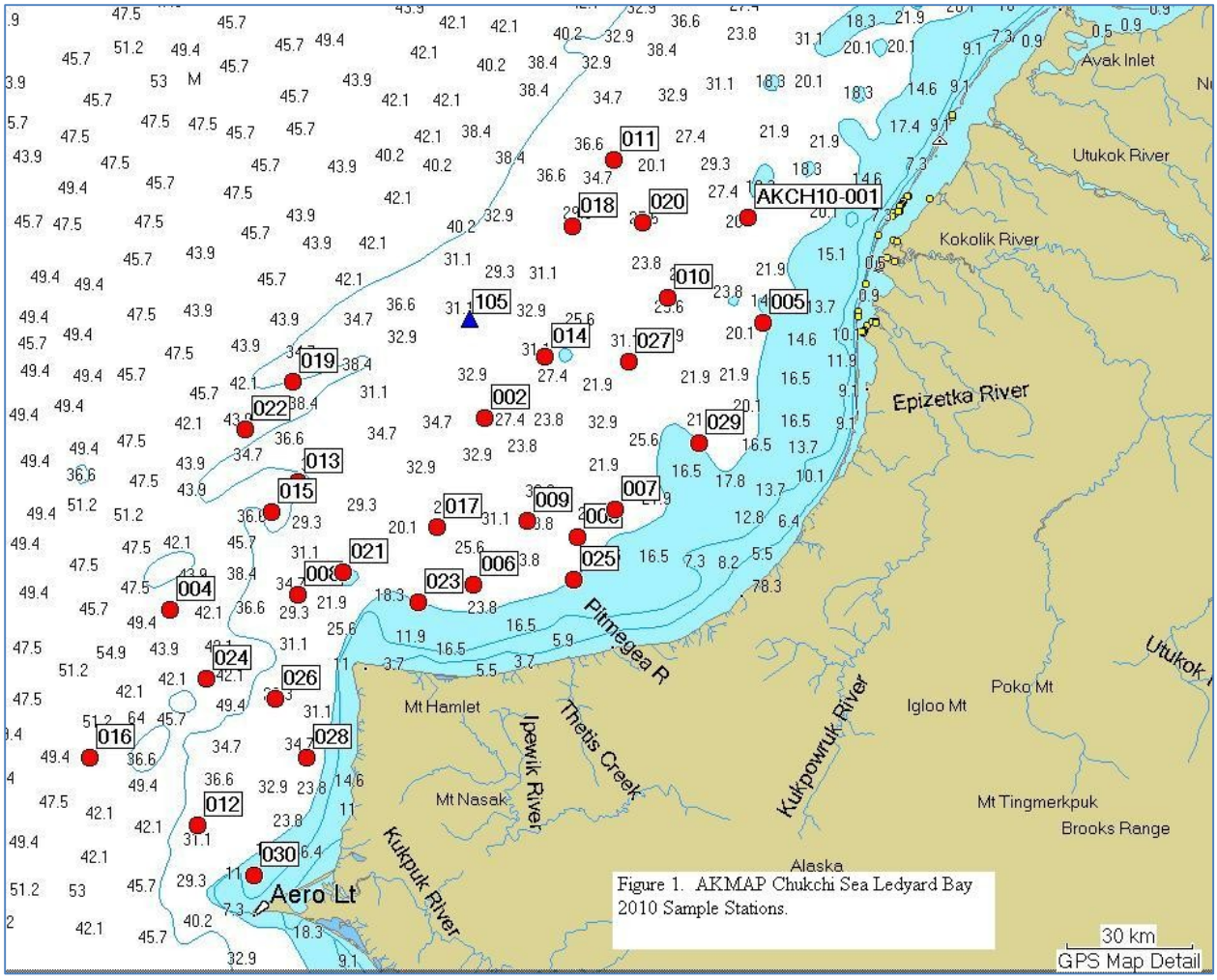
www.dec.alaska.gov/water/wqsar/monitoring/emap_Map.htm

2010 Cruise Report

Alaska Monitoring and Assessment Program (AKMAP)

Chukchi Sea 2010 Survey

Coastal Impact Assistance Program



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The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the opinions or policies of the U.S. Government. Mention of trade names or commercial products does not constitute their endorsement by the U.S. Government.

Cruise Report

AKMAP Chukchi Sea Ledyard Bay 2010 Coastal Impact Assistance Program Assessment

August 21 – September 4, 2010

R/V *Norseman II*

The Alaska Department of Environmental Conservation (DEC) established an Alaska Monitoring and Assessment Program (AKMAP) focused on conducting applied environmental research that uses a statistical survey design to provide estimates of the spatial extent of water quality status based on stressors, such as chemical contaminants, water quality parameters (pH, temperatures, salinity, dissolved oxygen) and indicators, such as benthic fish abundance. Environmental managers use this information to support the protection and restoration of coastal marine environments, mitigate damage to the marine ecosystem and implement discharge monitoring requirements in NPDES permits. The purpose of this cruise was for DEC and University of Alaska Fairbanks, School of Fisheries and Ocean Sciences, to sample the waters of the northeast Chukchi Sea, from Pt. Hope to Pt. Lay between 10 and 40 m water depths.

After an 11-day delay due mainly to inclement weather, the R/V *Norseman II* departed Nome, AK August 21 with a crew of 16, six from the ship and 10 scientists. We arrived at AKCH10-001 in the vicinity of Pt. Lay at 1330 hrs on August 23. We progressively sampled toward the south and concluded at AKCH10-030 in the vicinity of Pt. Hope at 1535 hrs on September 3. Throughout the 12-day sampling we occupied 31 stations, all 30 of the Base stations and one Alternate station (Figure 1). The Alternate station, AKCH10-105, was added to extend a quasi-nearshore-offshore transect through mid-Ledyard Bay. There were no delays due to bad weather. Three stations were sampled on most days.

Station sampling activity typically occurred in the following sequence, with number of stations sampled in parentheses: vertical plankton tow (31), drop camera (27), CTD (31), beam trawl (31), van Veen grab (30), Haps corer (8), otter trawl (29), rod and reel (11), and air sampling (17). A complete list of activities at each station is shown in Table 1. A list of organisms collected for contaminant analyses is shown in Table 2. Measurements of dominant invertebrate organisms at selected stations were made (Table 3). Voucher specimens were collected and various photographs of the cruise were taken to enhance subsequent reports. Several organisms from selected stations were collected for stable isotope analyses. All samples were preserved (froze, ETOH, formalin, nitric acid) and will be shipped to DEC or UAF.

A Sound Ocean Systems Eco-Winch was purchased with the intent of deploying the CTD. Several problems were encountered with the winch, the line slipped through metered wheel and the rate and line length display did not correspond with actual lengths. The ship engineer and crew attempted to correct these problems with line angle adjustments to no avail. The winch was marked with electrical tape at meter intervals and used in this manner for the majority of the cruise. CTD casts were intended to operate from Seabird 55 Carousel and Seabird 33 Deck Unit. During setup it was discovered the Seabird 33 would not communicate with the Seabird 55; this was assumed to be due to the serial to USB connections. Due to this inability to conduct live casts, we were unable to target the highest fluorescence level for water collection. The Seabird 55 was manually fired at surface, mid and bottom depths, and data were downloaded each night.

Demersal fishes and epibenthic invertebrates were sampled from beam trawl hauls at each site, and fishes were sampled from otter trawl hauls at most sites. The 3.05 m plumb-staff beam trawl was 7 mm mesh in the body, with a 4 mm codend liner, double tickler chain and 16 cm sections of chain attached to the footrope at 16 cm intervals; it was fished for 2-5 minutes at 1-1.5 kt. Beam trawl hauls were quantitative for area fished at all sites other than AKCH10-020, where approximately 2 tons of sand dollars were collected during a 2 minute haul that bent the beam beyond repair and tore the liner from the codend; no other hauls were attempted at that site. A boulder caused the

beam trawl to rip at AKCH10-029; another net was set for a successful haul. The 9.1 m otter trawl had 38 mm mesh in the body, 19 mm mesh in the codend, 27.5 m bridles and 61x122 cm (23 kg) doors; it was fished for 10 minutes at 2-2.5 kt. The otter trawl hauls were quantitative for area fished at 22 sites, and fishes also were collected from an additional 6 sites where the otter trawl was not consistently on bottom. Temperature Depth recorders (Star-Oddi Centi or Tilt) were attached to net headropes and downloaded each night; data from these units were used to determine whether nets had fished consistently on the sea floor.

A marine bird draft report was compiled by Tim Obritschkewitsch of ABR, Inc. His report, which focused on the Spectacled Eider in Ledyard Bay, essentially stated that few eiders were observed and the presence of eiders did not impact the cruise operations. Similarly, marine mammals, as reported by Amber Stephens of ABR, Inc., were seldom encountered and caused minimal interruption to the cruise. On one occasion the ship had to maneuver around a herd of feeding Pacific walrus.

Finally, the success of this cruise was attributed to the following outstanding personal:

Crew of the R/V *Norseman II*	Scientific Crew	
Captain Jack Molan	Terri Lomax, DEC	Brenda Holladay, UAF
Mate Scotty Hameister,	Heloise Chenelot, UAF	Nora Foster, UAF
Engineer Todd Campbell	Pat Rivera, UAF	Max Hoberg, UAF
Cook Joanne Molan	Roger Clark, Insignis	Amber Stephens, ARB, Inc.
Able Seaman Charlie Watson	Tim Obritschkewitsch, ABR, Inc.	
Able Seaman Jim Wells		

Stephen C. Jewett, Ph.D., UAF
Chief Scientist, Sept 4, 2010

Table 1. List of activities accomplished at stations on the AKMAP Chukchi Sea Ledyard Bay 2010 cruise

Date	8/23/2010	8/27/2010	8/28/2010	9/1/2010	8/25/2010	8/29/2010	8/28/2010	9/1/2010	8/29/2010	8/25/2010	8/24/2010	9/3/2010	8/31/2010	8/26/2010	8/30/2010	9/3/2010
Station	AKCH10-001	AKCH10-002	AKCH10-003	AKCH10-004	AKCH10-005	AKCH10-006	AKCH10-007	AKCH10-008	AKCH10-009	AKCH10-010	AKCH10-011	AKCH10-012	AKCH10-013	AKCH10-014	AKCH10-015	AKCH10-016
Consecutive Station #	1	11	13	25	6	16	12	24	15	5	2	30	21	9	20	31
Depth, m	26.3	35	24	49	23	23	25	36	27	28.7	36.8	34	40	34.5	41.8	49
ACTIVITY																
Vertical Plankton Tow	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Drop Camera*	1	1	1		1	1	1	1	1	1	1	1	1	1	1	
CTD	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Beam Trawl**	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Van Veen Grabs***	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Haps Corer				1		1			1					1		
Otter Trawl****	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1
Rod & Reel*****	1				1			1			1		1	1		
Air Sample	1			1	1	1	1			1	1				1	1
Contaminant samples		1		1		1	1	1	1		1		1	1	1	1
Isotope samples					1	1	1	1	1	1				1		
Date	8/30/2010	8/24/2010	8/31/2010	8/25/2010	8/30/2010	8/31/2010	8/29/2010	9/1/2010	8/28/2010	9/2/2010	8/26/2010	9/2/2010	8/26/2010	9/2/2010	8/27/2010	
Station	AKCH10-017	AKCH10-018	AKCH10-019	AKCH10-020	AKCH10-021	AKCH10-022	AKCH10-023	AKCH10-024	AKCH10-025	AKCH10-026	AKCH10-027	AKCH10-028	AKCH10-029	AKCH10-030	AKCH10-105	
Consecutive Station #	18	3	22	4	19	23	17	26	14	28	8	27	7	29	10	
Depth, m	30	37.5	44	31	31	44	22.5	45	19.5	44	30	36	24.5	25	38.5	
ACTIVITY																TOTALS
Vertical Plankton Tow	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	31
Drop Camera*	1	1	1	1	1	1	1		1		1	1	1	1	1	27
CTD	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	31
Beam Trawl**	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	31
Van Veen Grabs***	1	1	1	1	1	1	1	1		1	1	1	1	1	1	30
Haps Corer			1					1				1			1	8
Otter Trawl****	1		1		1	1	1	1	1	1	1	1	1	1	1	28
Rod & Reel*****		1		1					1		1				1	11
Air Sample	1	1		1		1			1	1	1		1			17
Contaminant samples	1	1	1		1	1	1	1	1	1		1		1	1	22

Isotope samples		1	1			1			1				1			12
* = 5 minutes																
** = 2-5 minutes																
*** = 1 for chemistry;																
3 for infauna																
**** = 10 minutes																
***** = 30 minutes																

Table 2. List of organisms collected for contaminants at stations on the AKMAP Chukchi Sea Ledyard Bay 2010 cruise

Date	8/23/2010	8/27/2010	8/28/2010	9/1/2010	8/25/2010	8/29/2010	8/28/2010	9/1/2010	8/29/2010	8/25/2010	8/24/2010	9/3/2010	8/31/2010	8/26/2010	8/30/2010	9/3/2010
Station	AKCH10-001	AKCH10-002	AKCH10-003	AKCH10-004	AKCH10-005	AKCH10-006	AKCH10-007	AKCH10-008	AKCH10-009	AKCH10-010	AKCH10-011	AKCH10-012	AKCH10-013	AKCH10-014	AKCH10-015	AKCH10-016
Consecutive Station #	1	11	13	25	6	16	12	24	15	5	2	30	21	9	20	31
Depth, m	26.3	35	24	49	23	23	25	36	27	28.7	36.8	34	40	34.5	41.8	49
Species for Contaminants																
Chlamys behringiana (scallop)								1							1	
Clinocardium ciliatum (cockle)				1												1
Serripes groenlandicus (cockle)																
Astarte borealis (clam)				1												1
Neptunea heros (gastropod)		1		1				1					1			1
Anonyx nugax (amphipod)							1	1	1							
Argis dentata (gray shrimp)		1		1		1	1	1	1		1		1		1	1
Hyas coarctatus (Lyre crab)		1					1	1	1		1		1		1	1
Chionoecetes opilio (Snow crab)		1		1				1	1		1		1		1	1
Telmessus cheirogonus (Helmet crab)						1	1		1							
Clupea pallasii (Pacific herring)														1		
Mallotus villosus (Capelin)																
Ammodytes hexapterus (Pacific sand lance)						1										
Boreogadus saida (Arctic cod)											1		1			
Date	8/30/2010	8/24/2010	8/31/2010	8/25/2010	8/30/2010	8/31/2010	8/29/2010	9/1/2010	8/28/2010	9/2/2010	8/26/2010	9/2/2010	8/26/2010	9/2/2010	8/27/2010	
Station	AKCH10-017	AKCH10-018	AKCH10-019	AKCH10-020	AKCH10-021	AKCH10-022	AKCH10-023	AKCH10-024	AKCH10-025	AKCH10-026	AKCH10-027	AKCH10-028	AKCH10-029	AKCH10-030	AKCH10-105	
Consecutive Station #	18	3	22	4	19	23	17	26	14	28	8	27	7	29	10	
Depth, m	30	37.5	44	31	31	44	22.5	45	19.5	44	30	36	24.5	25	38.5	

Species for Contaminants																**TOTALS**
Chlamys behringiana (scallop)																**2**
Clinocardium ciliatum (cockle)	1		1		1			1		1		1				**8**
Serripes groenlandicus (cockle)								1								**1**
Astarte borealis (clam)			1													**3**
Neptunea heros (gastropod)	1	1	1			1	1	1		1		1			1	**14**
Anonyx nugax (amphipod)												1		1		**5**
Argis dentata (gray shrimp)	1	1	1			1		1		1		1	1	1	1	**20**
Hyas coarctatus (Lyre crab)	1	1	1		1	1		1	1	1		1				**17**
Chionoecetes opilio (Snow crab)	1	1	1		1	1	1	1		1		1		1	1	**19**
Telmessus cheirogonus (Helmet crab)	1				1		1						1	1		**8**
Clupea pallasii (Pacific herring)			1							1						**3**
Mallotus villosus (Capelin)															1	**1**
Ammodytes hexapterus (Pacific sand lance)																**1**
Boreogadus saida (Arctic cod)																**2**

Table 3. Measurements of selected dominant invertebrate species at stations on the AKMAP Chukchi Sea Ledyard Bay 2010 cruise

Date	9/1/2010		8/25/2010		8/26/2010		8/30/2010		9/3/2010		8/31/2010		8/25/2010		8/30/2010	
Station	AKCH10-004		AKCH10-010		AKCH10-014		AKCH10-015		AKCH10-016		AKCH10-019		AKCH10-020		AKCH10-021	
Consecutive Station #	25		5		9		20		31		22		4		19	
Depth, m	49		28.7		34.5		41.8		49		44		31		31	
Species for Measurements	N	Mean±SD (mm)	N	Mean±SD (mm)	N	Mean±SD (mm)	N	Mean±SD (mm)	N	Mean±SD (mm)	N	Mean±SD (mm)	N	Mean±SD (mm)	N	Mean±SD (mm)
Hyas coarctatus (Lyre crab)*			17	38±9.61												
Chionoecetes opilio (Snow crab)**, ***	51	46.6±5.62			50	17±1.63	24	40.3±4.23	90	46.7±4.44	50	43.2±5.65			49	19.2±3.87
Telmessus cheirogonus (Helmet crab)**																
Echinarachnius parma (sand dollar)****			72	36.2±3.12									123	23.4±3.30		
Strongylocentrotus pallidus (sea urchin)****																
Date	8/31/2010		9/1/2010		8/28/2010		9/2/2010		9/2/2010		8/26/2010		9/2/2010		8/27/2010	
Station	AKCH10-022		AKCH10-024		AKCH10-025		AKCH10-026		AKCH10-028		AKCH10-029		AKCH10-030		AKCH10-105	
Consecutive Station #	23		26		14		28		27		7		29		10	

Depth, m	44		45		19.5		44		36		24.5		25		38.5	
Species for Measurements	N	Mean±SD (mm)	N	Mean±SD (mm)	N	Mean±SD (mm)	N	Mean±SD (mm)	N	Mean±SD (mm)	N	Mean±SD (mm)	N	Mean±SD (mm)	N	Mean±SD (mm)
Hyas coarctatus (Lyre crab)																
Chionoecetes opilio (Snow crab)**, ***	26	45±5.92	76	38.9±6.30			30	17.4±15.9	34	18.7±4.86			14	17.1±3.44	33	25.3±9.32
Telmessus cheirogonus (Helmet crab)**											50	36±5.15				
Echinarachnius parma (sand dollar)****																
Strongylocentrotus pallidus (sea urchin)****					50	49.3±4.33										

* = carapace length

** = carapace width
*** = % ovigerous females at stations: 016 = 30%;
004 = 10%; 022 = 4%; all others 0%.

**** = test width

ALASKA MONITORING AND ASSESSMENT PROGRAM

Freshwater Coastal

www.dec.state.ak.us/water/akmap

Cruise Report
Alaska Monitoring and Assessment Program (AKMAP) Chukchi Sea
2011 Coastal Impact Assistance Program Assessment
September 04 – September 17, 2011

Acknowledgements

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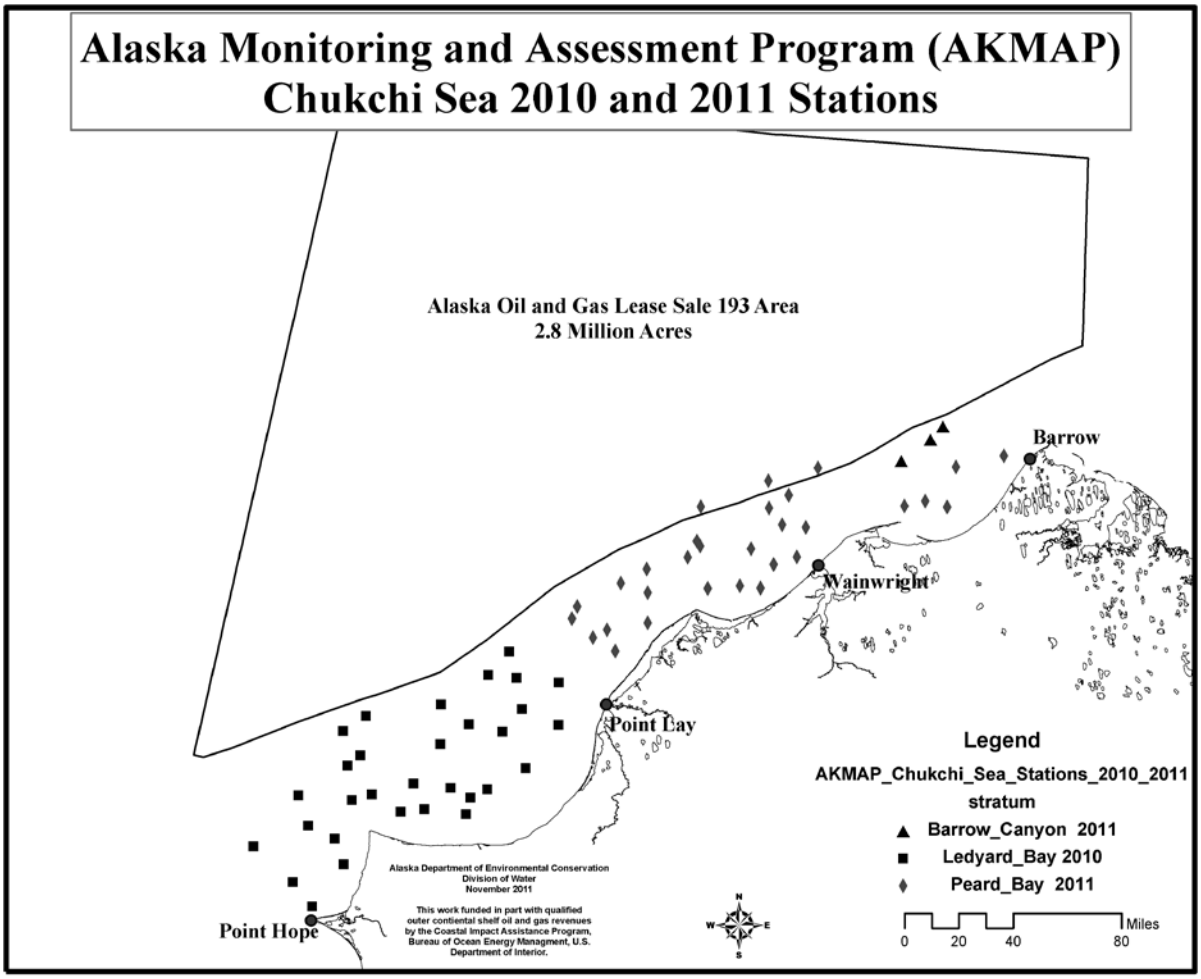


R/V *Norseman II*

The Alaska Department of Environmental Conservation (DEC) with its University of Alaska partner established an Alaska Monitoring and Assessment Program (AKMAP) focused on conducting aquatic resource surveys of Alaska's waters. DEC and the University of Alaska Fairbanks, School of Fisheries and Ocean Sciences (UAF, SFOS) conducted research cruises in 2010 and 2011 to survey the Chukchi Sea coastal environment. In 2011, the National Oceanic and Atmospheric Administration (NOAA) National Status and Trends Program joined this effort.

AKMAP used a statistical survey design for the Chukchi Sea assessment to provide for estimates of the spatial extent of water quality status based on stressors, such as chemical contaminants, water quality parameters (pH, temperatures, salinity, and dissolved oxygen) and indicators, such as benthic fish abundance. Environmental managers use this information to support the protection and restoration of coastal marine environments, mitigate damage to the marine ecosystem and implement discharge monitoring requirements in National Pollution Discharge Elimination System (NPDES) permits. The purpose of the 2011 cruise was to assess the water quality and ecological status of waters of the northeast Chukchi Sea, from Pt. Lay to Barrow, between the 10 and 50 meter water depths within the Beaufort-Chukchi Coastal – Shelf ecosystem.

The AKMAP sampling team departed Oliktok Point, at Prudhoe Bay, late on September 4th, on small lightering vessels to the R/V *Norseman II* and departed for AKCH11-031 just to the Northwest of Barrow, AK. We arrived on station at 19:30 on September 5th. The field team consisted of nine ship crew and 13 scientists. Stations sampled in 2011 are shown in Figure 1.

Station sampling proceeded progressively southward until September 11th, when we attempted to move south to AKCH11-050, near Pt. Lay, but were turned back by rough weather. At that point we returned to near Wainwright and sampled AKCH11-060, 048 and 058 on September 11th. That evening we moved south to AKCH11-050 and worked from the south northward to finish our final Base station, AKCH11-036 on September 15th. Over the 11-day sampling period, 30 Base stations were occupied, meeting our 100% completeness goal. No delays were experienced due to bad weather. Three stations were sampled on most days. Activities conducted at these three stations are shown in Table 1, with species associated with contaminant sampling listed in Table 2.

Upon completion of the 30 stations planned for 2011 we still had one field day remaining, losing no days to weather. Three stations, AKCH-062 (79 m), 064 (110 m) and 069 (98 m), (Figure 1) within the upper region of the Barrow Canyon target were selected for opportunistic sampling. Sediments encountered were fine sand with clay, with Station 064 containing a ubiquitous population of *Musculus discors*, which had formed thick byssal thread mats in the sediments.

Table 1. List of activities accomplished at stations on the AKMAP Chukchi Sea Peard Bay 2011 cruise

Date	Station Id	Consecutive #	Depth, m	Plankton Tow (Vertical and Oblique)	Drop Camera*	CTD/WQ Collections	Van Veen Sediment Grab [c]	Beam Trawl**	Otter Trawl***	Biological Contaminant samples	Biological Isotope samples
9/5/11	AKCH11-031	1	60	X		X		X	X	X	X
9/6/11	AKCH11-035	2	54	X		X	X	X	X	X	X
9/6/11	AKCH11-047	3	27	X	X	X	X	X	X	X	X
9/6/11	AKCH11-039	4	28	X	X	X	X				
9/7/11	AKCH11-053	5	25	X	X	X	X	X	X	X	X
9/7/11	AKCH11-043	6	53	X		X	X	X	X	X	X
9/8/11	AKCH11-044	7	57	X		X	X	X	X	X	X
9/8/11	AKCH11-049	8	52	X		X	X	X	X	X	X
9/8/11	AKCH11-059	9	51	X		X	X[d]	X	X	X	X
9/08/11[a]	AKCH11-033	10	52	X		X	X[d]	X	X	X	X
9/9/11	AKCH11-051	11	53	X		X	X[d]	X		X	X
9/9/11	AKCH11-032	12	26	X	X	X	X	X	X	X	X
9/09/11[a]	AKCH11-048	13	32	X	X	X	X	X	X	X	X
9/10/11	AKCH11-037	14	44	X		X	X	X	X	X	X
9/10/11	AKCH11-57	15	46	X		X	X	X		X	X
9/11/11	AKCH11-060	16	22	X	X	X	X	X	X	X	X
9/11/11	AKCH11-046	17	27	X	X	X	X	X	X	X	X
9/11/11	AKCH11-058	18	24	X	X	X	X	X	X	X	X
9/12/11	AKCH11-050	19	33	X	X	X	X	X	X	X	X
9/12/11	AKCH11-45	20	30	X	X	X	X	X	X	X	X
9/12/11	AKCH11-056	21	20	X	X	X	X	X	X	X	X
9/12/11[a]	AKCH11-038	22	28	X	X	X	X	X	X	X	X
9/13/11	AKCH11-041	23	32	X	X	X	X	X		X	X
9/13/11	AKCH11-052	24	17	X	X	X	X	X	X	X	X
9/13/11[a]	AKCH11-054	25	25	X	X	X	X	X	X	X	X
9/14/11	AKCH11-034	26	34	X	X	X	X	X	X	X	X
9/14/11	AKCH11-042	27	37	X	X	X	X	X	X	X	X
9/14/11[a]	AKCH11-040	28	39	X		X	X	X	X	X	X
9/15/11	AKCH11-055	29	40	X		X	X	X		X	X
9/15/11	AKCH11-036	30	43	X		X	X	X	X	X	X
9/16/11	AKCH-062	31	70	X		X[b]	X				
9/16/11	AKCH-069	32	98	X		X[b]	X				
9/16/11	AKCH-064	33	110	X		X[b]	X	X	X	X	X
			Totals	33	17	33	32	30	26	30	30

a - Drop cam., Zooplankton tows, CTD and Van Veen conducted night before and beam and otter trawl sequence done next morning.

b - CTD profile only. No water samples.

c - Generally sediment chemistry and macroinvertebrates.

d -Sediment chemistry only no invertebrates.

* = 5 minutes

** = 2-5 minutes

*** = 10 minutes

Table 2. List of species collected for contaminants at stations on the AKMAP Chukchi Sea Peard Bay 2011 cruise

				Invertebrates										Fish					
Date	**Station Id**	**Consecutive Station #**	**Depth, m**	***Chlamys behringiana* (scallop)**	***Astarte borealis* (clam)**	***Neptunea heros* (gastropod)**	***Anonyx nugax* (amphipod)**	***Hyas coarctatus* (Lyre crab)**	***Chionoecetes opilio* (Snow crab)**	***Telmessus cheirogonus* (Helmet crab)**	***Argis lar (Northern Argid shrimp)***	***Sclerocrangon boreas (Sculptured shrimp)***	***Tecticeps sp. (Isopods)***	***L. fubricii***	***M. scorpius***	***G. tricuspus***	***Mallotus villosus* (Capelin)**	***A. hexapterus***	***Boreogadus saida* (Arctic cod)**
9/5/11	AKCH11-031	1	60	X			X	X				X							
9/6/11	AKCH11-035	2	54			X	X	X			X	X							
9/6/11	AKCH11-047	3	27		X	X	X				X								
9/6/11	AKCH11-039	4	28																
9/7/11	AKCH11-053	5	25			X	X			X	X			X	X	X			X
9/7/11	AKCH11-043	6	53					X											
9/8/11	AKCH11-044	7	57		X	X	X	X			X								
9/8/11	AKCH11-049	8	52			X	X	X	X		X	X							
9/8/11	AKCH11-059	9	51			X	X	X			X	X							
9/8/11	AKCH11-033	10	52			X	X	X	X		X	X							
9/9/11	AKCH11-051	11	53				X	X			X	X							
9/9/11	AKCH11-032	12	26				X						X						
9/9/11	AKCH11-048	13	32				X	X			X								
9/10/11	AKCH11-037	14	44			X		X			X	X							
9/10/11	AKCH11-057	15	46			X		X			X	X							
9/11/11	AKCH11-060	16	22			X	X			X	X	X		X	X	X	X		X
9/11/11	AKCH11-046	17	27				X				X	X					X		
9/11/11	AKCH11-058	18	24				X	X			X				X	X	X		X
9/12/11	AKCH11-050	19	33			X		X	X		X	X							
9/12/11	AKCH11-045	20	30			X		X			X	X		X	X	X	X		X
9/12/11	AKCH11-056	21	20							X	X							X	
9/12/11	AKCH11-038	22	28					X			X	X				X		X	
9/13/11	AKCH11-041	23	32			X		X	X		X								
9/13/11	AKCH11-052	24	17								X						X	X	
9/13/11	AKCH11-054	25	25				X	X			X	X							
9/14/11	AKCH11-034	26	34					X	X		X	X							
9/14/11	AKCH11-042	27	37					X	X		X								
9/14/11	AKCH11-040	28	39			X		X			X	X							
9/15/11	AKCH11-055	29	40			X		X			X								
9/15/11	AKCH11-036	30	43			X	X	X			X								
9/16/11	AKCH-062	31	70																
9/16/11	AKCH-069	32	98																
9/16/11	AKCH-064	33	110						X			X							
			Total	1	2	16	16	22	7	3	26	17	1	3	4	5	5	3	4

Station sampling activity typically occurred, in the following sequence: drop camera; vertical and oblique zooplankton tow; conductivity, temperature and depth (CTD) profiles (with some auxiliary measurements); Niskin bottle water samples; Van Veen grab sediment collection; beam trawl and otter trawl. The drop camera was deployed to record/characterize the benthic substrate; only 17 sites were within the depth range (~45 m) of the system. A two to five minute video was recorded on DVD as a station reference.

Voucher specimens were collected and photographs were taken to enhance subsequent reports. Organisms from each station were also collected for stable isotope analyses, which will help us to understand the existing food web. All biological, sediment, and water samples were preserved (frozen, ETOH, formalin, nitric acid, or refrigerated) on board. At cruise completion, samples will be analyzed at either at UAF or Texas A&M Geological Environmental Research Group (GERG) laboratory. Analytes that are typically run on the collected environmental media (water, sediments, and tissues) are shown in Table 3.

Table 3 – Analytes

Analytes	Water (Individual Niskin bottles*)	Marine Sediments	Biological Tissue Samples
Dissolved Nutrients	X		
Chlorophyll a	X		
Sediment Chlorophyll a		X	
Total Suspended Solids	X		
pH, Salinity, Dissolved Oxygen (CTD check sampled)	X		
Dissolved Inorganic Carbon, Total Alkalinity, and pH (for pCO_2)	X		
Trace Metals		X	X
Hydrocarbons		X	X
PCB's & Organochlorine pesticides		X	X
Total Organic Carbon		X	
Total Inorganic Carbon		X	
Sediment Grain Size		X	
Stable Isotopes (^{13}C&^{15}N)		X	X
% Lipids			X

Holo- and meroplanktonic organisms and cnidarians were sampled at a total of 33 stations. Two gears, each having two collection nets, were deployed at each station. A 10 minute double oblique tow with 505 µm mesh nets was conducted with the ship was underway at an average of two knots to target larger more mobile zooplankton. A five minute vertical haul with 150 µm nets while the ship was stationary was done to capture smaller more fragile zooplankton. General Oceanic flow meters were mounted in all nets to calculate volume of water filtered and Star-Oddi temperature depth recorders (TDRs) were attached to the vertical frames for an accurate record of deployment depth. Samples from the "A" nets were preserved for species composition, abundance and biomass analysis. Samples from the "B" net were preserved in ethanol for genetic sequencing. If the A sample was compromised due to jellyfish the B sample was then preserved.

The CTD (SBE 25 attached to a SBE 55) was operated autonomously rather than in real-time as the Eco-Winch wire line cable had a break occur in the conductor wire at an unknown location during

the previous cruise. Water collections occurred with Niskin bottles from the two meter depth, mid-depth and two to three meters off the bottom, using either a SBE 55 timed mode or the SBE 55/SBE25 pressure sequence setting. At the 33 stations conductivity, pressure and temperature measurement profiles were taken. Due to problems, which were overcome, fluorescence, pH, dissolved oxygen and PAR were not taken at the first 15 stations. After the 15th station (057), casts were also taken with a SBE 19Plus that provided backup CTD measurements. The CTD data were downloaded daily and backed up nightly. Water samples were taken at the three depths for dissolved nutrients, chlorophyll a, and total suspended solids. No water samples were collected at the Barrow Canyon stations, 062, 069 and 064. Samples were also taken at the two meter depth for a dissolved inorganic carbon, total alkalinity and pH for Dr. Jeremy Mathis for ocean acidification assessment (pCO_2 measurements). No Niskin bottle water samples were collected at the Barrow Canyon stations, 062, 069 and 064. On board measurements for pH and refractometer salinity checks were made on water samples collected from the Niskin bottles. A limited number of modified Winkler method dissolved oxygen checks were also completed as part of the Quality Control and Assurance.

Benthic infaunal, sediment grain size, and chemistry samples were collected using a double Van Veen sediment sampler. Rocks and cobble at four sites prevented the collection of sediment samples. Three replicate benthic infaunal samples from 26 sites were washed on a 1mm mesh screen. One benthic infaunal sample will be processed for taxonomic identification, and the remaining two will be held for future processing, which depends on funding.

Demersal fishes and epibenthic invertebrates were sampled from beam trawl hauls, and fishes were sampled from otter trawl hauls. The 3.05 m plumb-staff beam trawl was 7 mm mesh in the body, with a 4 mm codend liner, double tickler chain and 16 cm sections of chain attached to the footrope at 16 cm intervals; it was fished for 2-5 minutes at 1-1.5 kt. Beam trawl hauls were quantitative for area fished at all stations, with the exception of AKCH11-062, 069 and 039 where no trawls were conducted. The 9.1 m otter trawl had 38 mm mesh in the body, 19 mm mesh in the codend, 27.5 m bridles and 61x122 cm (23 kg) doors; it was fished for 10 minutes at 2-2.5 kt. The otter trawl hauls were quantitative for area fished at 28 sites. Temperature depth recorders (Star-Oddi Centi or Tilt) were attached to net headropes and downloaded each night; data from these units were used to determine whether nets had fished consistently on the sea floor.

Marine bird and marine mammal transect observations were conducted by respectively by Tawna Morgan and Amber Stephens of ABR, Inc. Presence of sea birds or marine mammals did not impact the cruise operations. Once the transect data are analyzed a report will be provided to AKMAP.

On September 17th, the AKMAP scientific team departed the Norsemann II at Wainwright. The success of this cruise was attributed to the following outstanding personal:

Crew of the R/V *Norseman II*	Scientific Crew
Captain Jack Molan	Terri Lomax, DEC
Mate Perry Seyler	Brenda Holladay, UAF

Engineer Todd Campbell
Engineer David Christenson
Cook Evan Dunaway
Cook Joanne Molan
Boatswain Scott Hameister
Able Seaman Charlie Watson
Able Seaman Jim Wells

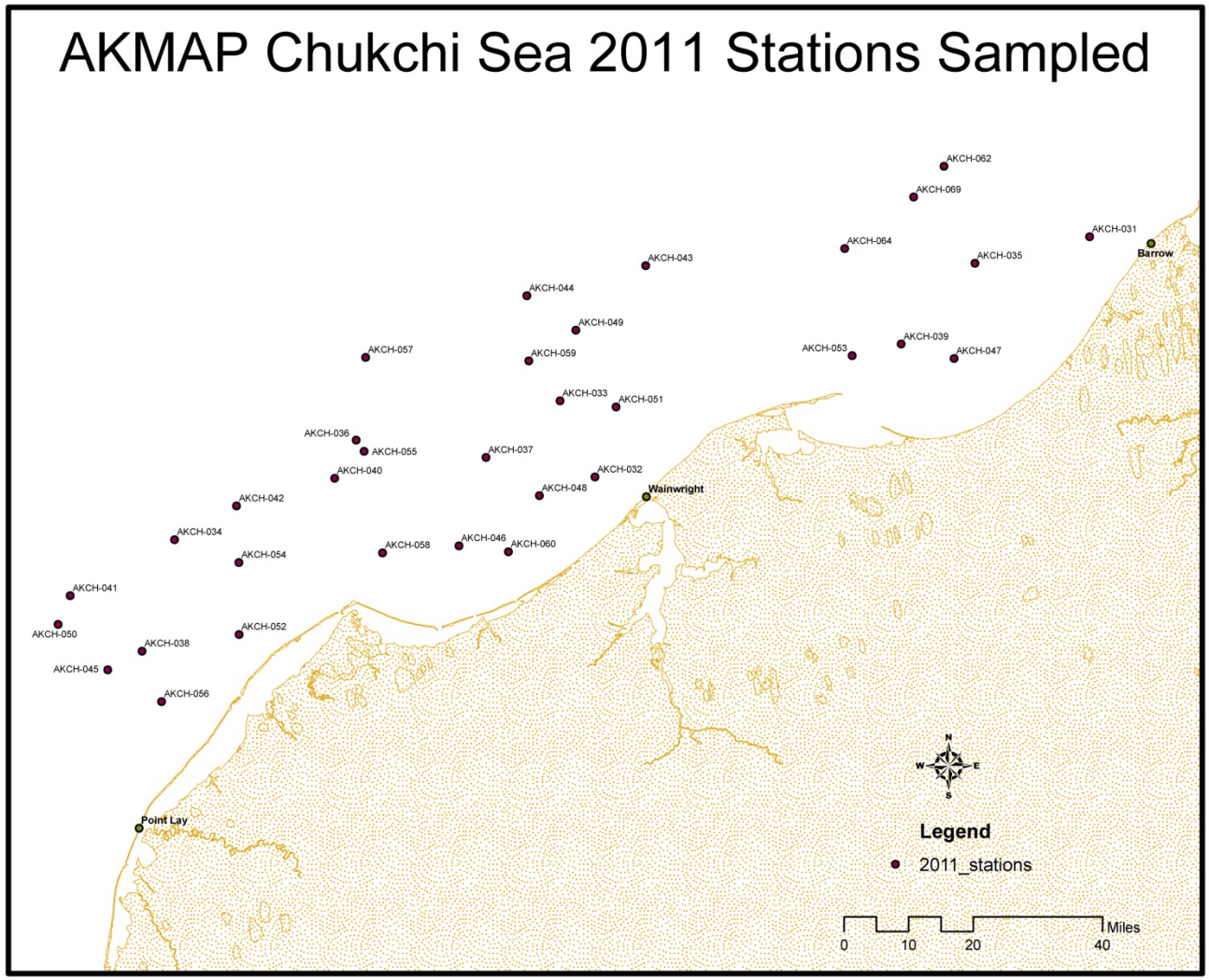
Patricia Rivera, UAF
Heloise Chenelot, UAF
Nora Foster, Contractor
Max Hoberg, UAF
Roger Clark, Contractor
Ian Hartwell, NOAA
Jennifer Questel, UAF
Benjamin Gray, UAF
Amber Stephens, ARB, Inc.
Tawna Morgan, ABR, Inc.

Douglas Dasher, Ph.D., DEC, Affiliate Professor UAF SFOS
Chief Scientist
September 28, 2011

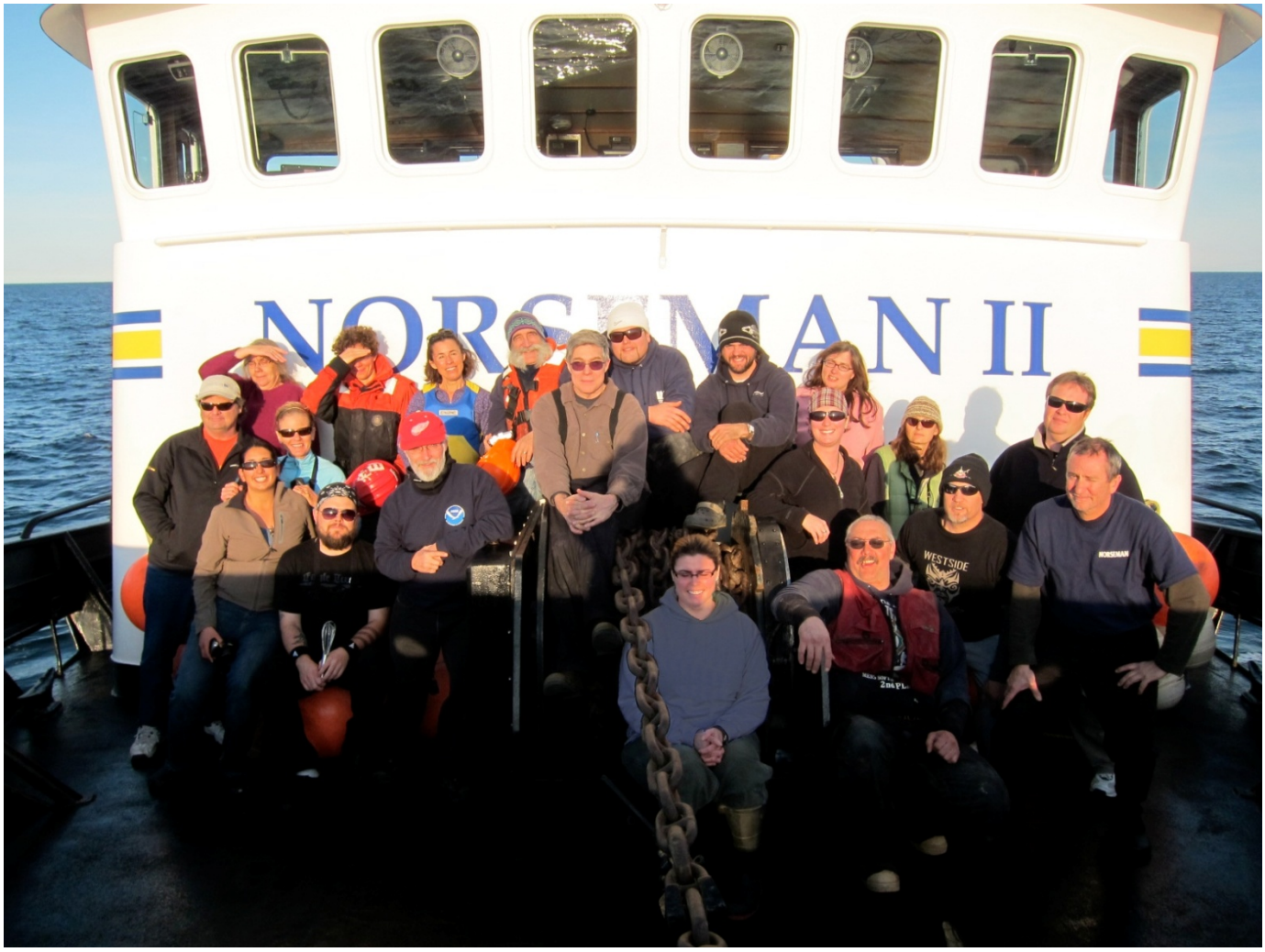
Note:

Station depths provided here are all final updated values that correct all recorded depths logged before September 13th. The Norseman II (NII) reported a discrepancy in reported depths on Sept 13, 2011. It was determined that depth has been over reported by ~8m from the onset of the cruise. In programming the NII fathometer to account for ship berth a 12 ft correction was added, later for our cruise the instrument was changed to report depth in meters. The 12 foot correction was not converted correctly to meters therefore depths were exaggerated by 12 meters. The correct conversion should have been ~ 4 meters. Station depths and corresponding calculations were adjusted by subtracting ~ 8 meters (12m – 4 m) from reported depths. Stations occupied on September 13th, (AKCH11-041) to the end of the cruise are assumed to be the correct depth.

Figure 48 - 2011 AKMAP Chukchi Sea Stations



AKMAP CIAP Chukchi Sea 2011 Vessel and Scientific Crew



Appendix B - Sediment and Tissue Analytical Parameters

Table 10 – Water Quality Measurements

Nutrients	CTD	Other
Filtered Water Sample		
Ammonia NH_3-N	Depth	Total Suspended Solids
Nitrate NO_3-N	Temperature	Secchi disk depth
Nitrite-Nitrate NO_3-NO_2	Conductivity/Salinity	Chlorophyll a
Phorphorus PO_4	Dissolved Oxygen	
Unfiltered Water Sample	PAR	
Total Nitrogen	Chlorophyll a	
Total Phorphorus		

Table 11 – Sediment and Tissue Trace Metals

		Reporting Limit			Reporting Limit
Sediment Trace Metals	Method	Conc.(ug/g)	Tissue Trace Metals	Method	Conc.(ug/g)
Aluminum (Al)	ICP-MS	50.00			
Arsenic (As)	ICP-MS	1.00	Arsenic (As)	ICP-MS	0.15
Barium (Ba)	ICP-MS	5.00	Barium (Ba)	ICP-MS	0.50
Cadmium (Cd)	ICP-MS	0.10	Cadmium (Cd)	ICP-MS	0.05
Chromium (Cr)	ICP-MS	5.00	Chromium (Cr)	ICP-MS	0.05
Copper (Cu)	ICP-MS	1.00	Copper (Cu)	ICP-MS	3.5
Iron (Fe)	ICP-MS	50.00	Iron (Fe)	ICP-MS	12.5
Lead (Pb)	ICP-MS	1.00	Lead (Pb)	ICP-MS	0.15
Lithium (Li)	ICP-MS	5.00	Lithium (Li)	ICP-MS	0.15
Mercury (Hg)	CVVA	~0.036	Manganese (Mg)	CVVA	5.50
Manganese (Mn)	ICP-MS	15.00	Mercury (Hg)	ICP-MS	~0.025
Nickle (Ni)	ICP-MS	0.05	Nickle (Ni)	ICP-MS	0.05
Selenium(Se)	ICP-MS	0.20	Selenium (Se)	ICP-MS	0.15
Silver (Ag)	ICP-MS	0.05	Silver (Ag)	ICP-MS	0.02
Zinc (Zn)	ICP-MS	1.00	Zinc (Zn)	ICP-MS	2.0

Table 12 – Hydrocarbons

Sediment Trace Metals	Method	Reporting Limit Conc.(ug/g)
Aluminum (Al)	ICP-MS	50.00
Arsenic (As)	ICP-MS	1.00
Barium (Ba)	ICP-MS	5.00
Cadmium (Cd)	ICP-MS	0.10
Chromium (Cr)	ICP-MS	5.00
Copper (Cu)	ICP-MS	1.00
Iron (Fe)	ICP-MS	50.00
Lead (Pb)	ICP-MS	1.00
Lithium (Li)	ICP-MS	5.00
Mercury (Hg)	CVAAS	
Manganese (Mn)	ICP-MS	15.00
Selenium (Se)	ICP-MS	0.20
Silver (Ag)	ICP-MS	0.05
Zinc (Zn)	ICP-MS	1.00

Tissue Trace Metals	Reporting Limit Conc.(ug/g)
Aluminum (Al)	0.150
Arsenic (As)	
Barium (Ba)	0.500
Cadmium (Cd)	0.050
Chromium (Cr)	0.050
Copper (Cu)	3.500
Iron (Fe)	12.500
Lead (Pb)	0.150
Lithium (Li)	0.150
Manganese (Mg)	5.500
Mercury (Hg)	
Selenium (Se)	0.150
Silver (Ag)	0.020
Zinc (Zn)	2.000

Sediment and Biota PAHs
Total PAHs
Total PAHs with Perylene
Total PAHs without Perylene
Total NS&T PAHs

Sediment PAH Compounds	
Naphthalene	Pyrene
C1-Naphthalenes	C1-Fluoranthenes/Pyrenes
C2-Naphthalenes	C2-Fluoranthenes/Pyrenes
C3-Naphthalenes	C3-Fluoranthenes/Pyrenes
C4-Naphthalenes	Benzo(a)anthracene
Biphenyl	Chrysene
Acenaphthylene	C1-Chrysenes
Acenaphthene	C2-Chrysenes
Fluorene	C3-Chrysenes
C1-Fluorenes	C4-Chrysenes
C2-Fluorenes	Benzo(b)fluoranthene
C3-Fluorenes	Benzo(k)fluoranthene
Phenanthrene	Benzo(e)pyrene
Anthracene	Benzo(a)pyrene
C1-Phenanthrenes/Anthracenes	Perylene
C2-Phenanthrenes/Anthracenes	Indeno(1,2,3-c,d)pyrene
C3-Phenanthrenes/Anthracenes	Dibenzo(a,h)anthracene
C4-Phenanthrenes/Anthracenes	Benzo(g,h,i)perylene
Dibenzothiophene	
C1-Dibenzothiophenes	2-Methylnaphthalene
C2-Dibenzothiophenes	1-Methylnaphthalene
C3-Dibenzothiophenes	2,6-Dimethylnaphthalene
Fluoranthene	1,6,7-Trimethylnaphthalene
	1-Methylphenanthrene

Sediment and Biota Alkanes
n-C10
n-C11
n-C12
n-C13
n-C14
n-C15
n-C16
n-C17
Pristane
n-C18
Phytane
n-C19
n-C20
n-C21
n-C22
n-C23
n-C24
n-C25
n-C26
n-C27
n-C28
n-C29
n-C30
n-C31
n-C32
n-C33
n-C34
n-C35
Total Alkanes

Sediment Bio-Markers					
Compound Name					
	No.	TERPANES		No.	STERANES
	H	Diterpane C19		A	Diapregnane
	A	Diterpane C20		1	5a(H),14b(H),17b(H)-pregnane
	B	Diterpane C21		B	Diahomopregnane
	C	Diterpane C22		2	5a(H),14b(H),17b(H),20-methyl pregnane
T4	D	Diterpane C23	S4	3	13b(H),17a(H)-diacholestane (20S)
T5	E	Diterpane C24	S5	4	13b(H),17a(H)-diacholestane (20R)
T6	1	Diterpane C25		8	13a(H),17b(H)-diacholestane (20S)
T6a	4	Tetracyclic terpane C24		9	13a(H)-17b(H)-diacholestane (20R)
T6b	5	Tricyclic triterpane C26 (22S)	S8	10	13b(H),17a(H),24-methyldiacholestane (20S) 24 S
T6c	6	Tricyclic triterpane C26 (22R)		11	13b(H),17a(H),24-methyldiacholestane (20S) 24 R
T7	9	Tricyclic triterpane C28 (22S)		14+15	13b(H),17a(H),24-methyldiacholestane (20R) 24 S/R isomers
T8	10	Tricyclic triterpane C28 (22R)		16	13a(H),17b(H),24-methyldiacholestane (20S)
T9	11	Tricyclic triterpane C29 (22S)	S12	17	5a(H),14a(H),17a(H)-cholestane (20S)
T10	12	Tricyclic triterpane C29 (22R)	S14	18	13b(H),17a(H),24-ethyldiacholestane (20S))
T11	13	18a(H)-22,29,30-trisnorhopane (TS)			+ 5a(H),14b(H),17b(H)-cholestane (20R)
T12	I	C30 Diahopane (Y)	S15	19	5a(H),14b(H),17b(H)-cholestane (20S)
	14	17a(H)-22,29,30-trisnorhopane [TM]		20	13a(H),17b(H), 24-methyldiacholestane (20R)
	15	17b(H)-22,29,30-trisnorhopane (22S)	S17	22	5a(H),14a(H),17a(H), cholestane (20R)
	16	17b(H)-22,29,30-trisnorhopane (22R)	S18	23	13b(H),17a(H),24-ethyldiacholestane (20R)
T14a	17	17a(H), 21b(H)-29,30-bisnorhopane		24	13a,17b,diasterane (20S)
T14b	J	17a(H),21b(H)-25-norhopane	S20	26	5a(H),14a(H),17a(H),24-methylcholestane (20S)
T15	19	17a(H),21b(H)-30-norhopane		27	13a,17b,diasterane (20R)
T16	20	18a(H) neonorhopane (29Ts)	S22	28	5a(H),14b(H),17b(H),24-methylcholestane (20R)
	F	C30 Diahopane	S23	29	5a(H),14b(H),17b(H),24-methylcholestane (20S)
T17	21	17b(H), 21a(H)-normoretane	S24	31	5a(H),14a(H),17a(H),24-methylcholestane (20R)
T18	22	18a(H)-oleanane	S25	33	5a(H),14a(H),17a(H),24-ethylcholestane (20S)
T19	23	17a(H),21b(H)-hopane	S26	34	5a(H),14b(H),17b(H),24-ethylcholestane (20R)
T20	24	17b(H),21a(H)-moretane	S27	35	5a(H),14b(H),17b(H),24-ethylcholestane (20S)
T21	27	17a(H),21b(H)-30-homohopane (22S)	S28	37	5a(H),14a(H),17a(H),24-ethylcholestane (20R)
T22	28	17a(H),21b(H)-30-homohopane (22R)		38	5a(H),14a(H),17a(H),isosterane (20S)
	G	Gammacerane		39	5a(H),14b(H),17b(H),isosterane (20R)
T26	30	17a(H),21b(H)-30,31-bishomohopane(22S)		40	5a(H),14b(H),17b(H),isosterane (20S)
T27	31	17a(H),21b(H)-30,31-bishomohopane (22R)		41	5a(H),14a(H),17a(H),isosterane (20R)
T30	34	17a(H),21b(H)-30,31,32-trishomohopane (22S)			
T31	35	17a(H),21b(H)-30,31,32-trishomohopane (22R)			
T32	36	17a(H),21b(H)-30,31,32,33-tetrakishomohopane (22S)			
T33	37	17a(H),21b(H)-30,31,32,33-tetrakishomohopane (22R)			
T34	38	17a(H),21b(H)-30,31,32,33,34-pentakishomohopane (22S)			
T35	39	17a(H),21b(H)-30,31,32,33,34-pentakishomohopane (22R)			

Table 13 – Other Analytical and Taxonomic Work

Sediment	*Biological*	Special Projects
Total Organic Carbon	**Sediment Macroinvetebrates 1 mm sieve - Taxonomic**	**Collect sediment and water samples for microbial**
Grain Size	**Fish Beam Trawl - Taxonomic & abundance**	**hydrocarbon degradation study by Bigelow**
Chlorophyll a (lost in freezer failure)	**Demersal Fish - Whole Fish Trace Metals & PAHs**	**Laboratory for Ocean Sciences.**
Carbon/Nitrogen Isotopes	**Carbon/Nitrogen Isotopes - Food Web**	
	% Lipids for tissues	