BOEM ENVIRONMENTAL STUDIES PROGRAM: ONGOING STUDIES

Region: Alaska

Planning Area(s): Beaufort Sea, Chukchi Sea

Title: Social Indicators in Coastal Alaska: Arctic Communities (AK-11-09)

BOEM Information Need(s) to be Addressed: This study will update key socio-cultural and economic baseline data for analysis of potential local and regional impacts from offshore exploration and development activities that may occur in federal waters off the North Slope of Alaska. Information from this study will be used for Outer Continental Shelf Lands Act (OCSLA) and National Environmental Policy Act (NEPA) analyses, for documentation, and may serve as the basis for long-term monitoring for Chukchi and Beaufort oil and gas exploration and development in the region.

Total Cost: $670,000 **Period of Performance:** FY 2011-2014

Conducting Organization: Stephen R. Braund and Associates

Principal Investigator: Dr. Jack Kruse

BOEM Contact: Chris Campbell

Description:

Background: The goal of this study is to update baseline data measuring the pace, direction, and magnitude of regional socio-economic changes, as well as the sense of well-being as expressed by residents in select Arctic coastal communities. These data will assist in NEPA evaluation of the effects of exploration and possible development of offshore energy resources in the Chukchi and Beaufort Seas on local populations through the formulation of social indicators nested within sets of key social domains. This study will facilitate evaluation of current conditions and trends in: economic prosperity; the status of health and safety; cultural continuity and well-being; changes in the status of indigenous rights and local control; quality of the physical environment; and education. Likely communities for sampling will include: Pt. Lay, Wainwright, Barrow, Nuiqsut, and Kaktovik.

Objectives:

- Formulate a set of key social indicators nested within domains that will facilitate the monitoring of changes in human well-being in coastal communities of the Alaskan Arctic most proximate to proposed oil and gas exploration and development.
- Obtain an OMB control number for a longitudinal survey instrument that can be repeated to identify long term trends, periodic changes, and fluctuations in the rate of change throughout coastal Alaska.
- Provide useful information on regional socioeconomic conditions and regional aspirations from which government officials and stakeholders can monitor and evaluate potential changes in well-being resulting from oil and gas exploration and development.

BOEM ENVIRONMENTAL STUDIES PROGRAM: ONGOING STUDIES

Region: Alaska

Planning Area(s): Beaufort Sea

Title: Beaufort Sea Marine Fish Monitoring Survey in the Central Beaufort Sea (AK-10-06)

BOEM Information Need(s) to be Addressed: Fish resources are important to upper trophic levels in the Beaufort Sea ecosystem and to the coastal communities. NEPA analysts need additional species presence and abundance information for assessing potential impacts of offshore development activities. Study information will be used in NEPA analyses and documentation for Beaufort Sea Lease Sales, EPs, and DPPs in 2011 and beyond. This study addresses aspects of USGS study recommendations 3.05, 3.07 and 4.01.

Total Cost: $1,764,000 plus Joint Funding **Period of Performance:** FY 2010-2013

Conducting Organization: University of Alaska

Principal Investigator: Dr. Brenda Norcross

BOEM Contact: Kate Wedemeyer

Description:
Background: Enhanced marine fish information is needed for Beaufort Sea NEPA analyses. Data at the most basic level—e.g., fish species presence/absence and distribution data—are not only spotty, but also outdated. Fish assemblages and populations in other marine ecosystems off Alaska have undergone observable regime-shifts in diversity and abundance over the last 20-30 years. While the same is likely true of the Beaufort Sea, it is unconfirmed because the scant distribution and abundance data available are pre-regime-shift. Furthermore, important marine mating, spawning, rearing, feeding, and migration habitats (pre or post regime-shift) is yet to be delineated. A baseline of fish species, distribution, relative abundance, and the locations of critical or sensitive life history stage habitats in this central lease area remains a very high-priority information need for NEPA analyses. The original central Beaufort target area remains the region of most intense industry interest and thus the region of greatest BOEM information need.

An under-ice pilot survey is included because the Beaufort Sea lease area is under ice for half to three-fourths of the year. Thus, it is important that BOEM obtain a more complete data set that encompasses the under-ice season. The addition of the under-ice pilot survey study will provide a more complete methodology and a baseline data set that encompasses all seasons in the Beaufort Sea, including ice-covered seasons. Such a data set will allow BOEM to support environmentally sound offshore oil and gas exploration and development decisions.

The addition of bird and marine mammal observers and zooplankton sampling will provide transect data in offshore areas where data for those species is as sparse as for fish species. The contemporaneous collection will also enable first-time correlations between fish, zooplankton, birds and marine mammal species in this area.

Objectives:

- Identify the fish species that occupy the central OCS Beaufort Sea lease area.
- Develop and recommend a methodology adapted to arctic conditions and specific BOEM information needs in the Beaufort Sea for use in future surveys.
- Identify the fish species that occupy the central lease area during the ice-covered season.
- Correlate observation of seabirds and marine mammals to fish and zooplankton for increased understanding of this arctic ecological system.

Methods: The survey will sample fish and zooplankton in the central Beaufort between 147^{o} and 152^{o} west longitude, where BOEM information needs are greatest. Due to logistical conflicts encountered in 2008, it will incorporate new strategies for timing surveys to avoid interference from industry seismic exploration. It will include methods adapted to sampling small sized and rare fish thought to inhabit the Beaufort Sea and also assess additional options to effectively sample bottom habitats. Addition of bird and marine mammal observers will provide transect data to those specialties and allow correlations between fish, zooplankton, birds, and marine mammals.

A pilot under-ice marine survey will implement a design outlined in the 2007 MMS "Under-Ice Sampling Workshop." The survey will occur in three stages: 1) assemble local and traditional knowledge with Inupiat residents; 2) under-ice sampling by local residents and time lapse under-ice cameras, 3) test survey of three different and difficult-to-sample Arctic cod habitats at the ice-water interface with DIDSON sonar (dual frequency identification sonar), remotely operated vehicles (ROVs), and shallow-water scuba transects. The pilot study will provide statistical hypothesis testing between the open water, ROV and dive surveys, which will provide a baseline for subsequent surveys and provide sampling statistics, including variance estimators, for future time-series analyses.

The final products will include Geographic Information Systems (GIS) and report formats. Intermediate results will be provided for NEPA analyses.

Current Status: Ongoing

Final Report Due: March 2013

Publications Completed: None

Affiliated WWW Sites: http://www.boem.gov/Environmental-Stewardship/Environmental-Studies/Alaska-Region/Index.aspx

Revised Date: December 2011

BOEM ENVIRONMENTAL STUDIES PROGRAM: ONGOING STUDIES

Region: Alaska

Planning Area(s): Beaufort Sea, Chukchi Sea, Bering Sea

Title: Satellite Tracking of Bowhead Whales: Habitat Use, Passive Acoustic and Environmental Monitoring (AK-12-02)

BOEM Information Need(s) to be Addressed: This project will extend ongoing research to provide more information on the locations and use of bowhead whale feeding areas, the variability of those locations from year to year, and the environmental factors that can be used to predict where bowhead whales will concentrate. This information is used for developing mitigation options for Beaufort and Chukchi Lease sales and exploration and development activities. Information on the vocal behavior of bowhead whales under various environmental conditions is needed to interpret the habitat use and call behavior being collected on many passive acoustic recorders currently in use. Information from this study will be used for ESA Section 7 consultations and NEPA documentation. This study addresses aspects of USGS Recommendations 3.05, 3.06, 3.07, 4.01, 5.24, 6.07, 6.12 and 6.13.

Total Cost: TBD **Period of Performance:** FY 2012-2016

Conducting Organization: TBD

Principal Investigator: TBD

BOEM Contact: TBD

Description:

Background: A previous MMS study using satellite telemetry has greatly added to the knowledge of bowhead whale movements, concentration areas, and the timing of both. Multiple years of tracking during this study has begun to provide information regarding the inter-annual variability in movements and concentration areas. Continued tracking will provide a better understanding of this variability and will allow us to predict the timing and location of bowhead concentration areas making mitigation measures more directly applicable and useful.

Satellite-linked transmitters are a valuable tool for tracking bowhead whales and they have been effective at documenting movements of large and small whales of both sexes, and the timing and locations of concentration areas. Another tool, of increasing use, is the passive acoustic recorder deployed near areas of interest to record marine mammal vocalizations. Recorded bowhead vocalizations indicate that a bowhead was present at the time of vocalization, but an absence of calls could mean bowheads are present but not vocalizing. Bowhead whale vocalization rates related to various behaviors (e.g., feeding and travelling) or potential disturbances (e.g., boat traffic, seismic operations, and drilling) are needed to interpret the information being collected by passive acoustic recorders. Sensors for monitoring environmental conditions such as

temperature and salinity have been developed and are in use on large whales, including bowheads in Greenland.

Objectives: To better understand inter-annual variation in bowhead whale feeding concentrations and to interpret call counts and calling rates collected by passive acoustic recorders.

Methods: This study will track the movements and document the behavior of bowhead whales using satellite telemetry to compare among years emphasizing new tagging locations such as St. Lawrence, Island, Pt. Hope and Canada. Bowhead whale vocalization rates and ambient noise levels will be documented using an acoustic tag to develop analysis of call rates relative to behavior and disturbance. Tags equipped with environmental sensors will be deployed to monitor, summarize, and transmit ambient oceanographic conditions as bowheads migrate. Limited numbers of individuals of other species of large whales (Gray, Humpback, Fin) may be tagged and tracked as opportunities arise as a pilot study for future work.

This study also will continue collaborations between whaling captains, AEWC, NSB, ADF&G, NMFS, BOEM, DFO-Canada, and Natural Resources Greenland and develop additional collaborations with oil companies and consultants collecting acoustic data to accomplish this project. Satellite transmitters with environmental and passive acoustic monitoring capabilities will be deployed on bowhead whales near Native villages in the Beaufort, Chukchi, and Bering seas. Plots of whale tracks will be made available weekly and location data compared among years to determine inter-annual variability of movements and concentrations. Acoustic data will be analyzed to determine individual whale calling rates relative to whale behavior and disturbance factors. This study will be coordinated with AEWC and local whaling captains' associations go prevent any interference with subsistence whaling and hunting. All necessary research and access permits will be obtained by the PI.

Current Status: Planned new start

Final Report Due: TBD

Publications Completed: None

Affiliated WWW Sites: http://www.boem.gov/Environmental-Stewardship/Environmental-Studies/Alaska-Region/Index.aspx

Revised Date: December 2011

BOEM ENVIRONMENTAL STUDIES PROGRAM: ONGOING STUDIES

Region: Alaska

Planning Area(s): Chukchi Sea

Title: Chukchi Sea Offshore Monitoring in Drilling Area (COMIDA): Chemistry and Benthos (CAB) (AK-08-03)

BOEM Information Need(s) to be Addressed: This study will constitute a key component of Chukchi Sea environmental studies pertinent to Chukchi Sea Lease Sale 193 scheduled for 2008. Industry has expressed strong interest in leasing in this area, likely followed by exploration and possibly development. The BOEM analysts and decision makers will use the information in NEPA analysis and documentation for Lease Sales, EPs and DPPs and in post-sale and post-exploration decision making in the Chukchi Sea. This study addresses aspects of USGS Recommendations 3.02, 3.04, 4.01 and 5.24.

Total Cost: $2,560,000 **Period of Performance:** FY 2008-2012

Conducting Organization: University of Texas at Austin

Principal Investigator: Dr. Kenneth H. Dunton, Dr. Steven M. Lanoux

BOEM Contact: Dr. Richard Prentki

Description:
Background: The November 2006 COMIDA workshop described the importance of benthos and chemical monitoring to evaluate the health of the Chukchi ecosystem. The MMS/BOEM Scientific Committee (SC) recommended an adaptive initial two year sampling program that closely coordinated separate chemical and benthos monitoring efforts. This document combines those two efforts.

Benthic biological monitoring needs to be initiated in order to establish a current benthic community baseline prior to new oil and gas exploration activities. Our knowledge of the benthic fauna along the Chukchi shelf is largely based on MMS/Outer Continental Shelf Environmental Assessment Program (OCSEAP) surveys between the 1970s and early 1990s. A review of this information revealed “hot spots” of high and highly variable benthic biomass in several regions of the Chukchi Sea. The high abundance of bottom fauna was correlated with high pelagic primary production, possibly associated with the ice-edge and most of which reached the seabed ungrazed. With the retreat of the summer ice-edge to deeper, more northern waters in recent years, this pelagic/benthic coupling may be weakening. Recent changes in seabird and marine mammal distributions described in the COMIDA workshop may reflect undocumented changes in benthic hot spots in the Chukchi Sea as well as greater retreat of the ice pack.

Among the primary concerns about offshore oil and gas are anthropogenic inputs of metals and hydrocarbons. Earlier MMS/OCSEAP-sponsored monitoring design workshops for the Beaufort

Sea and Bering Sea recommended that MMS (now BOEM) develop multiyear contaminant baselines prior to offshore development. The Oceanography/Fate and Effects working group of the COMIDA Workshop considered multi-year monitoring of sediment metals, hydrocarbons, and other anthropogenic compounds to be a priority.

Objectives:

- Establish baseline for benthic biomass, species composition, and oil industry anthropogenic chemicals to detect changes as the result of future oil and gas activities.
- Initiate past and future time trend analyses for benthic populations and anthropogenic chemicals
- Distinguish among changes due to development, climate, and food web structure
- Identify natural or other anthropogenic sources of contaminants to the study area.
- Initiate and develop a conceptual food web related to bioaccumulation and risk of trophic transfer of oil industry anthropogenic chemicals.

Methods: The BOEM anticipates substantial collaboration and coordination of CAB with other Chukchi Sea Offshore Monitoring in Drilling Area (COMIDA) projects: Distribution and Relative Abundance of Marine Mammals: Aerial Surveys and Impact Monitoring of Offshore Subsistence Hunting. CAB will collaborate directly with the Alaska Monitoring and Assessment Program (AKMAP) and more site-specific oil industry studies. We are sharing logistical platforms and samples.

For anthropogenic chemicals, the 2-year sampling strategy collects surface sediments for the determination of standard sediment hydrocarbon parameters such as polycyclic aromatic hydrocarbon (PAH), relevant metals, including the Environmental Protection Agency (EPA) priority metals [total iron (Fe), manganese (Mn), aluminum (Al), barium (Ba), chromium (Cr), vanadium (V), lead (Pb), copper (Cu), cadmium (Cd), nickel (Ni), arsenic (As), silver (Ag), mercury (Hg), selenium (Se), beryllium (Be), thallium (Tl), tin (Sn), antimony (Sb), and zinc (Zn)]; supporting/normalizing parameters such as grain size, organic carbon or organic matter, etc.; and sourcing parameters such as diagnostic hydrocarbon ratios. The biological sampling is combined with the sediment sampling and Contractor-selected other sampling/assays/analyses to complete a sediment triad approach to evaluating effects of ambient anthropogenic chemical levels.

There is a full Quality Assurance/Quality Control (QA/QC) program with inter-laboratory comparisons and reference standards. Normalization techniques developed in MMS/BOEM Beaufort Sea monitoring will be adopted to minimize sample variability.

Pre-drilling activity baseline sampling was conducted in 2009, emphasizing the area leased by industry in the proposed Chukchi Sea oil and gas lease sale held in February, 2008. Additional adaptive sampling will occur in 2010, predicated on the findings and success in 2009 and locations of likely oil industry post-sale activities. Dated sediment cores are used to capture interannual variability of anthropogenic chemicals and normalization techniques to minimize effects of sample variability. Sampling design will be adaptive to incorporate locations of concentrated bird and marine mammal feeding and their prey within the COMIDA area. To identify sources of

anthropogenic chemicals to the study area, limited sampling will be conducted of sources such as water column, air, drilling mud, river input, seeps, or shoreline erosion.

A conceptual food web model related to bioaccumulation and trophic transfer of potential oil industry contaminants is part of initial study planning based on literature review and data-mining. Water and biota sampling are conducted to better understand pelagic/benthic coupling and other trophic transfer. The food-web model will be risk-based, conceptually considering mechanism, magnitude, and likelihood of contaminant transfer. The model will continue to be developed and updated throughout COMIDA, incorporating COMIDA results and other information, and will also be used as a tool to refine sampling strategy during COMIDA and recommend post-COMIDA monitoring strategy.

Current Status: Ongoing

Final Report Due: 2012

Publications Completed:

Dunton, K. H., L. W. Cooper, J. M. Grebmeier, R. Harvey, B. Konar, D. R. Maidment, S. V. Schonberg, and J. Trefry. 2010. An Integrated Chemical and Biological Study of the Benthos of the Chukchi Sea: Preliminary Results from the COMIDA Program [abstract]. In *Alaska Marine Science Symposium Book of Abstracts*, p. 20. Anchorage, AK: Alaska Marine Science Symposium.

Grebmeier, J. M., L. W. Cooper, R. Simpson, and L. Beaven. 2010. Chukchi Sea Infaunal Population Structure and Sediment Tracers as part of the MMS COMIDA and Shell Oil Exploration Environmental Studies [Poster]. In *Alaska Marine Science Symposium Book of Abstracts*, p. 105. Anchorage, AK: Alaska Marine Science Symposium.

Guarinello, M. L., L. W. Cooper, and J. M. Grebmeier. 2010. Epibenthic Habitats of the Bering and Chukchi Seas Observed and Categorized During COMIDA, BEST-BSIERP, and Shell Oil Exploration-Supported Seafloor Video Surveys [Poster]. In *Alaska Marine Science Symposium Book of Abstracts*, p. 103. Anchorage, AK: Alaska Marine Science Symposium.

Harvey, H. R., and K. A. Taylor. 2010. Organic Contaminant Distribution in Shelf Sediments and Biota of the Chukchi Sea: Initial Results from the COMIDA Program [Poster]. In *Alaska Marine Science Symposium Book of Abstracts*, p. 104. Anchorage, AK: Alaska Marine Science Symposium.

Hersh, E. S., and D. R. Maidment. 2010. Managing COMIDA Project Data for the Chukchi Sea Marine Ecosystem [Poster]. In *Alaska Marine Science Symposium Book of Abstracts*, p. 99. Anchorage, AK: Alaska Marine Science Symposium.

Konar, B., M. Schuster, J. M. Grebmeier, L. W. Cooper, R. Harvey, K. H. Dunton, S. V. Schonberg, and J. Trefry. 2010. COMIDA: Epibenthic Community Structure [Poster]. In *Alaska Marine Science Symposium Book of Abstracts*, p. 101. Anchorage, AK: Alaska Marine Science Symposium.

McTigue, N. D., S. V. Schonberg, and K. H. Dunton. 2010. Ecosystem characteristics based on benthic biomass, density, and stable isotopic signatures from Chukchi Sea cruise COMIDA [Poster]. In *Alaska Marine Science Symposium Book of Abstracts*, p. 101. Anchorage, AK: Alaska Marine Science Symposium.

Trefry, J., R. P. Trocine, and H. R. Harvey. 2010. Trace Metals in Seawater, Sediments and the

Northern Neptune Whelk (*Neptunea heros*) from the Chukchi Sea, COMIDA Project [Poster]. In *Alaska Marine Science Symposium Book of Abstracts*, p. 100. Anchorage, AK: Alaska Marine Science Symposium.

Cooper, L.; Guarinello, M.; Konar, B.; and Grebmeier, J. M. 2011. Characterization and Comparison of Benthic Biological Communities using Video and Trawling Approaches during COMIDA CAB [Abstract]. *Book of Abstracts Alaska Marine Science Symposium 2011*, Anchorage, AK, Anchorage, AK: Alaska Marine Science Symposium, p. 24.

Dunton, K.; Schonberg, S.; McTigue, N.; and Souza, A. 2011. COMIDA: Sources and Fates of Nitrogen and Carbon in the Benthic Ecosystem of the Eastern Chukchi Sea [abstract]. *Book of Abstracts Alaska Marine Science Symposium 2011*, Anchorage, AK, Anchorage, AK: Alaska Marine Science Symposium, p. 23.

Fink, H.; Mitchelmore, C. L.; Taylor, K.; and Harvey, H. R. 2011. Biomarker assessment in Arctic cod, *Boreogadus saida*, from the Chukchi Sea: results from the COMIDA program [Poster]. In: *Book of Abstracts Alaska Marine Science Symposium 2011*, Anchorage, AK, Anchorage, AK: Alaska Marine Science Symposium, p. 96.

Grebmeier, J. M.; Cooper, L. W.; Simpson, R.; Guarinello, M.; and Schonberg, S. 2011. COMIDA: Pelagic-Benthic Coupling and Benthic Community Structure in the Chukchi Sea [abstract]. In: *Book of Abstracts Alaska Marine Science Symposium 2011*, Anchorage, AK, Anchorage, AK: Alaska Marine Science Symposium, p. 24.

Harvey, H. R. and Taylor, K. A. 2011. Organic contaminant distributions and transfer in shelf sediments and biota of the Chukchi Sea: Results from the COMIDA Program [poster]. In: *Book of Abstracts Alaska Marine Science Symposium 2011*, Anchorage, AK, Anchorage, AK: Alaska Marine Science Symposium, p. 132.

Hersh, E. S.; Sangireddy, H.; and Maidment, D. R. 2011. COMIDA: Managing Marine Observations Data [poster]. In: *Book of Abstracts Alaska Marine Science Symposium 2011*, Anchorage, AK, Anchorage, AK: Alaska Marine Science Symposium, p. 125.

Konar, B.; Grebmeier, J. M.; Dunton, K.; Schuster, M.; and Ravelo, A. 2011. COMIDA: What determines spatial distribution of epibenthic communities in the Chukchi Sea? [poster]. In: *Book of Abstracts Alaska Marine Science Symposium 2011*, Anchorage, AK, Anchorage, AK: Alaska Marine Science Symposium, p. 171.

McTigue, N.; Schonberg, S.; Cooper, L.; and Dunton, K. 2011. Evidence for the Assimilation of Benthic Microalgae in the Chukchi Sea Food Web [poster]. In: *Book of Abstracts Alaska Marine Science Symposium 2011*, Anchorage, AK, Anchorage, AK: Alaska Marine Science Symposium, p. 127.

Ravelo, A.; Konar, B.; and Schuster, M. 2011. Temporal variability of epibenthic trawl surveys in the Chukchi Sea [poster]. In: *Book of Abstracts Alaska Marine Science Symposium 2011*, Anchorage, AK, Anchorage, AK: Alaska Marine Science Symposium, p. 135.

Souza, A. C. Dunton K. H. and Gardner W. S. 2011. Nitrogen fluxes and rates of microbial processes in the water column and sediment water interface of the Chukchi and Beaufort Seas [poster]. In: *Book of Abstracts Alaska Marine Science Symposium 2011*, Anchorage, AK, Anchorage, AK: Alaska Marine Science Symposium, p. 119.

Affiliated WWW Sites: http://www.boem.gov/Environmental-Stewardship/Environmental-Studies/Alaska-Region/Index.aspx
http://comidacab.org/

Revised Date: December 2011

BOEM ENVIRONMENTAL STUDIES PROGRAM: ONGOING STUDIES

Region: Alaska

Planning Area(s): Chukchi Sea, Bering Sea

Title: Biogeochemical Assessment of the OCS Arctic Waters: Current Status and Vulnerability to Climate Change (AK-08-12-03)

BOEM Information Need(s) to be Addressed: The oil and gas industry has expressed interest in leasing part of the North Aleutian Basin (NAB) to search for and possibly develop oil and gas deposits. This study would provide an assessment of the current status of the ecosystem and its vulnerability to acidification or other aspects of climate change to use in evaluation of potential local and regional impacts from offshore exploration and development activities that may occur in federal waters. The study initiated for NEPA analysis and documentation for the North Aleutian Basin but has shifted emphasis north into the Chukchi Sea. This study addresses aspects of USGS Recommendations 4.01, 7.03 and 7.04.

Total Cost: $757,000 plus Joint Funding **Period of Performance:** FY 2008-2013

Conducting Organization: CMI, UAF

Principal Investigator: Dr. Jeremy Mathis

BOEM Contact: Dr. Richard Prentki

Description:

Background: This study initially emphasized the North Aleutian Basin in the southeastern Bering Sea, one of the most productive marine ecosystems in the world. The scope of the study has expanded to include measurements first in the northern Bering Sea and now in the Chukchi Sea. Over the last decade, the character of the ecosystem productivity in the southeastern Bering Sea has undergone dramatic changes due to variability in hydrographic and climate forcing. In recent years, the system has changed from one dominated by cold-water, Arctic species to organisms more indicative of temperate zones with the historically rich fishing areas shifting northward. Available data suggest decreased coupling of benthic and pelagic production. The National Science Foundation's multi-component Bering Sea Ecosystem Study (BEST) is examining these changes and this study is an Alaska Coastal Marine Institute Task Order being conducted in conjunction with BEST and also the Bering Sea Integrated Ecosystem Research Program (BSIERP).

Objectives:

- Quantify upper ocean net ecosystem production (NEP) and its fate in North Aleutian Basin.
- Assess the effect of ocean acidification on the marine environment of the Bering Sea and Chukchi Sea.

Methods: The Task participates in multiple cruises in Bering and Chukchi Sea, including samples from the COMIDA CAB study. Dissolved organic and inorganic nutrients and carbon, total alkalinity, particulate organic matter, and pCO2 measurements are used to calculate net ecosystem production and acidification. The seasonal changes in stocks of inorganic C and N are a measure of NEP. The fraction of NEP accumulating in the dissolved organic matter, suspended particulate matter, and sinking particulate matter pools will be estimated.

Current Status: Ongoing

Final Report Due: December 2012

Publications Completed:

Fabry, V. J., J. B. McClintock, J. T. Mathis, and J. M. Grebmeier. 2009. Ocean Acidification at High Latitudes: The Bellwether. Oceaonography 22(4) 160-171.

Mathis, J. T., Cross, J. N., Bates, N. R., Moran, S. B., Lomas, M. W., and P. J. Stabeno. 2010. Seasonal Distribution of Dissolved Inorganic Carbon and Net Community Production on the Bering Sea Shelf. Biogeosciences 7: 1769-1787.

Affiliated WWW Sites: http://www.boem.gov/Environmental-Stewardship/Environmental-Studies/Alaska-Region/Index.aspx
http://www.sfos.uaf.edu/cmi/
http://www.sfos.uaf.edu/oarc/projects.php

Revised Date: December 2011

BOEM ENVIRONMENTAL STUDIES PROGRAM: ONGOING STUDIES

Region: Alaska

Planning Area(s): Beaufort Sea

Title: Beaufort/Chukchi Seas Mesoscale Meteorology Modeling Study Phase II (AK-06-05)

BOEM Information Need(s) to be Addressed: The final modeled data could be used to inform the BOEM oil-spill trajectory model. Information will be used in NEPA analysis and documentation for Beaufort and Chukchi Sea Lease Sales, Exploration Plans (EPs), and Development and Production Plan (DPPs). This study addresses aspects of USGS recommendations 3.01, 4.01, and 7.04.

Total Cost: $1,750,000 **Period of Performance:** FY 2006-2012

Conducting Organization: UAF Geophysical Institute

Principal Investigator: Dr. Xiangdong Zhang, Dr. Jing Zhang, Jeremy Krieger, Dr. Martha Shulski

BOEM Contact: Warren Horowitz

Description:
Background: An initial phase of the Beaufort Sea mesoscale meteorology was conducted during 2006–2008 by the University of Alaska Fairbanks. The Phase I study conducted a literature review with the aim of summarizing past and present research efforts concerning the mesoscale meteorological models that would best support BOEM objectives for the study of the Beaufort Sea mesoscale meteorology. Based on the review, the Weather Research and Forecasting (WRF) model was selected as the preferred model to be used in this study. Initial sensitivity tests with WRF were conducted in the Phase I study, which included an analysis of sensitivity to forcing data and to the modeling configuration, including the horizontal resolution, model physics, and the nudging technique. The model's performance in simulating the wind field was analyzed, with emphasis placed on evaluating the capabilities of WRF to accurately simulate the sea breeze and topographic effects. A Phase II study plan has been developed with the aim of achieving accurate simulation of the Beaufort and Chukchi seas surface wind and associated mesoscale meteorology. The final products from the Phase II study will be a 30-year (1979-2009) observational database; a 5 and 30-year hindcast simulation of the Beaufort/Chukchi seas; as well as a final report documenting the observational database quality control methods, final model sensitivity analysis, and climatological analysis of both the collected observations and long-term model simulation.

Objectives:

- Produce a geospatial surface meteorological database for the Beaufort and Chukchi seas and the adjacent coastal areas by collecting available conventional and unconventional surface and atmospheric data and conducting field work;
- Establish a well-tuned Beaufort/Chukchi seas mesoscale meteorology model through further modeling studies for the optimization and improvement of the model physics and configuration;
- Conduct a long-term hindcast simulation with the optimized data-modeling system and produce a high resolution meteorological dataset for the Beaufort and Chukchi regions;
- Document the high-resolution climatological features of the Beaufort/Chukchi seas surface winds, including an analysis of the interannual variability and long-term change, as well as the physical processes and mechanisms for shaping the Beaufort/Chukchi seas wind field climatology.

Methods: The contractor shall research the availability of observational data from all sources, including both conventional in situ and satellite, which are present across the project study area for the period 1979–2009. The contractor will collect and store the QuikSCAT SeaWinds and COSMIC soundings for the Beaufort and Chukchi regions. The contractor shall deploy meteorological buoy(s) out to 80 km off the coastline, to be monitored for a period of two (2) to three (3) months during the open water season in the first year (2009) of the project. The contractor shall import the existing MMS/BOEM database, plus all newly collected and quality-controlled data, including the observations collected in the field work, into an Oracle version 10g database, named as the Beaufort/Chukchi Seas Mesoscale Meteorology Surface Observational Database. The contractor shall conduct a climatological analysis of the collected in situ data over the entire thirty-year period (1979-2009). The contractor shall continue the sensitivity analysis for the evaluation of WRF model simulations based on the initial results achieved in the Phase I study. The contractor shall implement a thermodynamic sea ice model into WRF. The contractor shall produce a five-year experimental wind field simulation (2005-2009) and a thirty year hindcast simulation. The contractor shall use the new high spatial- (10 km) and temporal- (hourly) resolution surface wind data from the 30-year production simulation to examine its climatological features, interannual variability, and long-term change. The contractor shall analyze the output of the 30-year production simulation and perform a climatological analysis of the model output. The contractor shall investigate the physical processes and mechanisms along with the diagnostic and statistical analyses of various aspects of the wind field climatology, variability, and long-term change.

Current Status: Ongoing

Final Report Due: October 2012

Publications Completed: See website below for publications.

Affiliated WWW Sites: http://www.boem.gov/Environmental-Stewardship/Environmental-Studies/Alaska-Region/Index.aspx
http://mms-meso.gi.alaska.edu/
http://knik.iarc.uaf.edu/buoy

Revised Date: December 2011

BOEM ENVIRONMENTAL STUDIES PROGRAM: ONGOING STUDIES

Region: Alaska

Planning Area(s): Beaufort Sea, Chukchi Sea

Title: Adaptation of Arctic Circulation Model (NT-08-02)

BOEM Information Need(s) to be Addressed: Oil spill trajectory analysis for impact assessment is needed for the Beaufort and Chukchi Planning Areas. Oil Spill Risk Analysis (OSRA) is a cornerstone foundation for evaluating alternatives in OCS oil and gas leasing EIS preparation and for evaluating mitigation, such as oil spill contingency plans. Development and application of state-of the-art circulation models are essential to future OSRA-based EIS analyses. This study addresses aspects of USGS Recommendations 3.01, 3.02, 4.01 and 7.04.

Total Cost: $350,000 **Period of Performance:** FY 2011-2012

Conducting Organization: Rutgers University

Principal Investigator: Dr. Enrique Curchitser, Dr. Katherine Hedstrom, Dr. Thomas Weingartner, Seth Danielson

BOEM Contact: Dr. Walter Johnson

Description:

Background: The BOEM proposes to lease within the Beaufort and Chukchi Sea Planning Areas. To maintain its state-of-the-art in oil-spill-risk analysis, BOEM seeks to take advantage through time of the increasing skill of circulation models supported by more and better data. A coupled ice/ocean model can be modified and expanded to capture provide multi-year circulation, ice, and forcing fields for use in BOEM NEPA oil-spill-risk analysis and post-sale oil spill response planning.

Objectives: Adapt and maximize the utility of an existing, coupled ice-ocean circulation model to represent the physical processes, especially circulation, within the Chukchi and Beaufort Sea Planning Areas. Provide BOEM with ten-to-twenty years of relevant modeled fields, such as gridded wind, surface water, and ice velocity, ice cover; and limited other modeled fields as agreed on between contractor and BOEM.

Methods: A coupled ice/ocean model will be modified to maximize utility in the Chukchi and Beaufort seas and to capture the agreed upon model fields. Three-hour gridded velocity fields (wind, surface water, ice) and ice cover will be provided to BOEM in agreed format for a ten-to-twenty year hindcast simulation. Sensitivity testing and validation of the model and results will be conducted. The BOEM anticipates providing HF-radar results for Beaufort and Chukchi coasts to aid in validation. Documentation would be through the model manual, final report, and submittal of a peer-reviewed journal article.

Current Status: Ongoing

Final Report Due: June 2013

Publications Completed: None

Affiliated WWW Sites: http://www.boem.gov/Environmental-Stewardship/Environmental-Studies/Alaska-Region/Index.aspx

Revised Date: December 2011

BOEM ENVIRONMENTAL STUDIES PROGRAM: ONGOING STUDIES

Region: Alaska

Planning Area(s): Beaufort Sea

Title: Beaufort/Chukchi Seas Mesoscale Meteorology Modeling Study Phase II (AK-06-05)

BOEM Information Need(s) to be Addressed: The final modeled data could be used to inform the BOEM oil-spill trajectory model. Information will be used in NEPA analysis and documentation for Beaufort and Chukchi Sea Lease Sales, Exploration Plans (EPs), and Development and Production Plan (DPPs). This study addresses aspects of USGS recommendations 3.01, 4.01, and 7.04.

Total Cost: $1,750,000 **Period of Performance:** FY 2006-2012

Conducting Organization: UAF Geophysical Institute

Principal Investigator: Dr. Xiangdong Zhang, Dr. Jing Zhang, Jeremy Krieger, Dr. Martha Shulski

BOEM Contact: Warren Horowitz

Description:
Background: An initial phase of the Beaufort Sea mesoscale meteorology was conducted during 2006–2008 by the University of Alaska Fairbanks. The Phase I study conducted a literature review with the aim of summarizing past and present research efforts concerning the mesoscale meteorological models that would best support BOEM objectives for the study of the Beaufort Sea mesoscale meteorology. Based on the review, the Weather Research and Forecasting (WRF) model was selected as the preferred model to be used in this study. Initial sensitivity tests with WRF were conducted in the Phase I study, which included an analysis of sensitivity to forcing data and to the modeling configuration, including the horizontal resolution, model physics, and the nudging technique. The model's performance in simulating the wind field was analyzed, with emphasis placed on evaluating the capabilities of WRF to accurately simulate the sea breeze and topographic effects. A Phase II study plan has been developed with the aim of achieving accurate simulation of the Beaufort and Chukchi seas surface wind and associated mesoscale meteorology. The final products from the Phase II study will be a 30-year (1979-2009) observational database; a 5 and 30-year hindcast simulation of the Beaufort/Chukchi seas; as well as a final report documenting the observational database quality control methods, final model sensitivity analysis, and climatological analysis of both the collected observations and long-term model simulation.

Objectives:

- Produce a geospatial surface meteorological database for the Beaufort and Chukchi seas and the adjacent coastal areas by collecting available conventional and unconventional surface and atmospheric data and conducting field work;
- Establish a well-tuned Beaufort/Chukchi seas mesoscale meteorology model through further modeling studies for the optimization and improvement of the model physics and configuration;
- Conduct a long-term hindcast simulation with the optimized data-modeling system and produce a high resolution meteorological dataset for the Beaufort and Chukchi regions;
- Document the high-resolution climatological features of the Beaufort/Chukchi seas surface winds, including an analysis of the interannual variability and long-term change, as well as the physical processes and mechanisms for shaping the Beaufort/Chukchi seas wind field climatology.

Methods: The contractor shall research the availability of observational data from all sources, including both conventional in situ and satellite, which are present across the project study area for the period 1979–2009. The contractor will collect and store the QuikSCAT SeaWinds and COSMIC soundings for the Beaufort and Chukchi regions. The contractor shall deploy meteorological buoy(s) out to 80 km off the coastline, to be monitored for a period of two (2) to three (3) months during the open water season in the first year (2009) of the project. The contractor shall import the existing MMS/BOEM database, plus all newly collected and quality-controlled data, including the observations collected in the field work, into an Oracle version 10g database, named as the Beaufort/Chukchi Seas Mesoscale Meteorology Surface Observational Database. The contractor shall conduct a climatological analysis of the collected in situ data over the entire thirty-year period (1979-2009). The contractor shall continue the sensitivity analysis for the evaluation of WRF model simulations based on the initial results achieved in the Phase I study. The contractor shall implement a thermodynamic sea ice model into WRF. The contractor shall produce a five-year experimental wind field simulation (2005-2009) and a thirty year hindcast simulation. The contractor shall use the new high spatial- (10 km) and temporal- (hourly) resolution surface wind data from the 30-year production simulation to examine its climatological features, interannual variability, and long-term change. The contractor shall analyze the output of the 30-year production simulation and perform a climatological analysis of the model output. The contractor shall investigate the physical processes and mechanisms along with the diagnostic and statistical analyses of various aspects of the wind field climatology, variability, and long-term change.

Current Status: Ongoing

Final Report Due: October 2012

Publications Completed: See website below for publications.

Affiliated WWW Sites: http://www.boem.gov/Environmental-Stewardship/Environmental-Studies/Alaska-Region/Index.aspx
http://mms-meso.gi.alaska.edu/
http://knik.iarc.uaf.edu/buoy

Revised Date: December 2011

BOEM ENVIRONMENTAL STUDIES PROGRAM: ONGOING STUDIES

Region: Alaska

Planning Area(s): Beaufort Sea, Chukchi Sea

Title: Distribution and Relative Abundance of Marine Mammals in the Chukchi Sea and the Fall Migration of Bowhead Whales in the Beaufort Sea – Personnel Needs (AK-10-05)

BOEM Information Need(s) to be Addressed: This study will generate information pertaining to possible impacts to marine mammals from exploratory offshore seismic surveying for oil and gas and subsequent leasing in the Chukchi and Beaufort Seas. The information will assist BOEM in NEPA analyses, ESA Section 7 consultations, MMPA documentation for Lease Sales, EPs and DPPs, and post-sale and post-exploration decision-making in the Beaufort and Chukchi Seas. This study addresses aspects of USGS Recommendations 3.07, 6.08 and 6.09.

Total Cost: $4,787,000 **Period of Performance:** FY 2011-2016

Conducting Organization: NOAA-NMML

Principal Investigator: Dr. Megan Ferguson, Janet Clarke

BOEM Contact: Jeff Denton

Description:
Background: Bowhead whales (*Balaena mysticetus*), gray whales (*Eschrichtius robustus*), beluga whales (*Delphinapterus leucas*), Pacific walrus (*Odobenus rosmarus divergens*), polar bears (*Ursus maritimus*), bearded seals (*Phoca fasciata*), and several other species of ice seals are known to occupy the Chukchi Sea, at least during some seasons. All of these species are subject to changes in environmental variables such as oceanographic currents, sea temperature, sea ice cover, prey availability, and anthropogenic impacts. Moreover all of these species are used for subsistence both in Russia and the US and form an important part of the diet and cultural base for most people in villages along the Chukchi coast. Having a good understanding of the seasonal distribution, relative abundance, and habitat use of marine mammals in the Chukchi Sea is fundamentally important to evaluating the potential environmental impacts associated with oil and gas exploration and development and other anthropogenic activities. Reliable, up-to-date information of this type is needed for marine mammal populations in the Chukchi Sea. Aerial surveys of marine mammals are an efficient tool because they offer quick coverage of large marine areas. Past surveys are available for comparison with new data to assess whether changes in distribution or abundance have occurred since the earlier surveys were completed.

A recent, BOEM-funded investigation of the seasonal migration of the bowhead whales using satellite-tracked animal tags revealed that they are resident in the Bering Sea during the winter and return to the Beaufort Sea in the summer when opening spring leads allow for passage along

the Alaskan and Canadian coasts. The bowheads leave the Beaufort in the fall and cross the Chukchi Sea before moving back into the Bering Sea for the winter.

Since 1979, aerial surveying of the fall migration of the bowheads has been conducted, initially by the Bureau of Land Management and subsequently by MMS, now BOEM. This is one of the longest-maintained monitoring of a biological phenomenon and has produced an invaluable baseline of the distribution and habitat use of the bowheads. The baseline can be used to observe changes in distribution and habitat use that may occur due to changing atmospheric and oceanic climates and to offshore oil and gas development activities. This investigation will continue the aerial observations of the fall migration for evidence of these changes

Since the beluga whales and other marine mammals seasonally or otherwise resident in the Beaufort and Chukchi are often sighted during the bowhead whale aerial surveys, their occurrence will also be part of the acquired data. This will be coincidental sightings, but of scientific value nonetheless.

Objectives:

- Document the distributions and relative densities of marine mammals in the Chukchi Sea Planning Area.
- To the extent possible, delineate the areas that are most important to marine mammals during critical seasons of their annual life history cycles such as molting, calving/pupping, and feeding.
- Define the annual fall migration of bowhead whales, significant inter-year differences, and long-term trends in the distances from shore and water depths at which whales migrate.
- Monitor temporal and spatial trends in the distribution, relative abundance, habitat, and behaviors (especially feeding) of endangered whales in arctic waters.
- Provide real-time data to BOEM and NMFS on the general progress of the fall migration of bowhead whales across the Alaskan Beaufort Sea for use in protection of this Endangered Species, if needed.
- Provide an objective wide-area context for management understanding of the overall fall migration of bowhead whales and site-specific study results.
- Record and map beluga whale distribution and incidental sightings of other marine mammals.
- Determine seasonal distribution of endangered whales in other planning areas of interest to BOEM.

Methods: Aerial line-transect surveys will be flown in the Chukchi Sea Program Area during two time periods: late-July to early-August and October to early-November. Aerial line-transect surveys will be flown in the Beaufort Sea to observe the fall migration of the bowhead whales, continuing the decades-long set of observations. For surveys in both seas, the observational and data recording methodology shall follow protocols used by the BOEM in the past surveys of the bowhead fall migration.

The observations, data recording, and subsequent data analysis will be performed by scientists and support personnel at the National Marine Mammal Laboratory. Additionally, the scientists

will be responsible for the management of this project, all necessary training of support personnel, providing all needed field equipment, conducting all logistical tasks, and insuring the safety of all people involved.

Aircraft support is funded under the companion study titled "Distribution and Relative Abundance of Marine Mammals in the Chukchi Sea and the Fall Migration of Bowhead Whales in the Beaufort Sea – Aircraft Needs."

Current Status: Ongoing

Final Report Due: 2016

Publications Completed:

Final Reports include annual summaries for Fall 1987-2010. Recent reports include OCS Studies MMS 95-0033, 96-0006, 97-0016, 98-0059, 2000-066, 2002-014, 2002-061, 2005-037, 2010-029, 2010-040.

Clarke, J.T., M. C. Ferguson. 2010. Aerial Surveys for Bowhead Whales in the Alaskan Beaufort Sea: BWASP Update 2000-2009 with comparisons to Historical Data. SC/62/BRG14. International Whaling Commission. Cambridge, UK. 11p.

Clarke, J. T., M. C. Ferguson, C. L. Christman, S.L. Grassia, A.A. Bower, L.J. Morse. 2011. Chukchi Offshore Monitoring in Drilling Area (COMIDA) Distribution and Relative Abundance of Marine mammals: Aerial Surveys. Final Report, OCS Study BOEMRE 2011-06. NOAA-NMML, Alaska Fisheries Science Center. 7600 Sandpoint Way, NE, F/AKC#, Seattle WA. 286pp

Monnett, C. Bowhead Whale Aerial Survey Project. Spoken Presentation at 2005 Alaska Forum for the Environment.

Monnett, C., J. S. Gleason, and L. M. Rotterman. 2005. Potential effects of diminished sea ice on open-water swimming, mortality, and distribution of polar bears during fall in the Alaskan Beaufort Sea. Abstract and Poster: Ed., Society for Marine Mammalogy, 16th Biennial Conference on the Biology of Marine Mammals.

Monnett, C. and J. S. Gleason. 2006. Observations of mortality associated with extended open-water swimming by polar be in the Alaskan Beaufort Sea. Polar Biology 29: 681-687.

Treacy, S. D., J. S. Gleason, and C. J. Cowles. 2006. Offshore distances of bowhead whales (Balaena mysticetus) observed during fall in the Beaufort Sea, 1982-2000: an alternative interpretation, Arctic, 59(1): 83-90.

Gleason, J. S. C. Monnett, and C. J. Cowles. 2006. Long-term changes in habitats associated with polar bear sightings in the Alaskan Beaufort Sea; 1979-2004. Abstract and Poster, The Wildlife Society 13th Annual Conference, September 23-27, Anchorage, Alaska.

Schliebe, S., Rode, K.D., Gleason, J.S., Wilder, J., Proffitt, K., Evans, T.J., and Miller, S. 2008. Effects of sea ice extent and food availability on spatial and temporal distribution of polar bears during the fall open-water period in the southern Beaufort Sea. Polar Biology 31:999–1010.

Gleason, J.S. and Karyn D. Rode. 2009. Polar bear distribution and habitat association reflect long-term changes in fall sea ice conditions in the Alaskan Beaufort Sea. Arctic 62(4):405-417.

Affiliated WWW Sites:

http://www.boem.gov/Environmental-Stewardship/Environmental-Studies/Alaska-Region/Index.aspx
http://www.afsc.noaa.gov/nmml/species/species_bowhead.php#research
ftp://ftp.afsc.noaa.gov/posters/pClarke02_bwasp.pdf
ftp://ftp.afsc.noaa.gov/posters/pFerguson01_uas-bowhead-arctic.pdf
ftp://ftp.afsc.noaa.gov/posters/pClarke03_aerial-survey-mar-mammals.pdf
ftp://ftp.afsc.noaa.gov/posters/pChristman01_walrus-comida.pdf
ftp://ftp.afsc.noaa.gov/posters/pMorse01_marine-mammal.pdf
ftp://ftp.afsc.noaa.gov/posters/pClarke01_marine-mammal.pdf

Revised Date: December 2011

BOEM ENVIRONMENTAL STUDIES PROGRAM: ONGOING STUDIES

Region: Alaska

Planning Area(s): Beaufort Sea, Chukchi Sea

Title: Synthesis of Arctic Research (SOAR) Physics to Marine Mammals in the Pacific Arctic (AK-11-05)

BOEM Information Need(s) to be Addressed: The changing physical environment of the U.S. Arctic OCS is hypothesized to drive a rapid tempo of change in the distribution and behavior of a number of protected marine mammals that inhabit those waters. The same species may be affected by oil and gas activities within BOEM Planning Areas, with strong potential for deleterious interactions between natural and human induced phenomena. Under NEPA and the ESA, BOEM is required to evaluate whether and how federal actions associated with oil and gas development may affect these protected populations. Information on ocean circulation and hydrography is useful for those evaluations as well as for input into various models used to predict the outcome of oil spills and other physical phenomena. Given recent high investment in interdisciplinary biological and oceanographic research by the Governments in the region, a synthesis of results of completed and ongoing studies would be useful to inform management decision-makers and may be useful in determining needs of future research activities. This study addresses aspects of USGS Recommendations 5.23, 5.24, 5.26, 6.01, 6.06, 6.08, 6.09, 7.01 and 7.03.

Total Cost: $1,798,000 **Period of Performance:** FY 2011-2016

Conducting Organization: NOAA- Pacific Marine Environmental Laboratory

Principal Investigator: Dr. Sue Moore, Dr. Phyllis Stabeno

BOEM Contact: Dr. Heather Crowley

Description:

Background: The physical climate of the western Arctic appears to be rapidly changing. The summer minimum sea ice extent in 2007 and 2008 covered an area which was 37% less than the areal coverage of two decades ago and 20% less than the previous minimum coverage in 2005. High water temperatures and dense concentrations of zooplankton have been observed near Barrow. The rapidity of these changes was unexpected, as the consensus of the climate research community just a few years ago was that such changes would not be seen for another 30 years, as expected from the CO_2 anthropogenic contribution alone.

During the same period, several marine mammals have exhibited unusual movements or behaviors that may be related to these environmental changes. The range of humpback whales has moved northward to include the northern Chukchi and western Beaufort Seas. Fin whales have expanded their range northward to include waters north of Icy Cape in the Chukchi. In 2009, bowhead whales fed extensively in the northern Chukchi Sea, a phenomenon not observed since the end of commercial whaling one hundred years ago. In recent years, gray whales have fed in increasing

numbers along the coastline between Wainwright and Barrow. In 2007 and 2009, walrus formed large aggregations on shore between Norton Sound and Barrow. This behavior appears to be related to the summer retreat of sea ice well northward of traditional walrus feeding areas on the shelf break.

Given the continuing retreat of sea ice and the known high-latitude range of these species in other oceans, it is likely that the recent sightings represent a climate-related range expansion that will continue in future years. Other changes in behavior and/or expansion of feeding areas also may accelerate as ice continues to degrade and water temperatures rise.

Between the years 2005 and 2015 MMS/BOEM will invest approximately $50,000,000 in marine mammal and related oceanographic studies in the western Arctic. These data will increase our body of knowledge about the region considerably, but interpretation will be complicated by concurrent environmental changes. This study proposes a synthesis of research from the ongoing studies in the Region. These studies include, but are not limited to:

- Bowhead Whale Feeding Variability in the Western Alaskan Beaufort Sea: Satellite Tracking of Bowhead Whales & Oceanography and Feeding
- Passive Acoustic Detection and Monitoring of Endangered Whales in the Arctic
- Ecosystem Observations in the Chukchi Sea: Biophysical Mooring and Climate Modeling
- Distribution and Relative Abundance of Marine Mammals in the Chukchi Sea and the Fall Migration of Bowhead Whales in the Beaufort Sea
- Walrus Habitat Use in the Potential Drilling Area
- Pinniped Movements and Foraging: Bearded Seals
- Arctic marine research studies supported through NOPP
- Studies conducted by the State of AK and the North Slope Borough under the USDOI Coastal Impact Assistance Program (CIAP)

Objectives:

- Increase scientific understanding of the inter- and intra-relationships of oceanographic conditions, lower trophic prey species, such as small fish and krill, and marine mammal distribution and behavior in the Chukchi Sea lease area, and adjacent waters.
- Enhance capability to predict future changes in oceanographic features such as currents, upwellings, and ice leads and associated changes in the behavior of marine mammals and their prey.

Methods: Using a synthetic approach, PIs will analyze data available from BOEM supported, and related, studies in the Chukchi Lease Sale Area and adjacent waters, using available statistical and other models to identify and test hypotheses that cross scientific disciplines. This study will be guided by an oversight committee formed of senior scientists and accomplished through annual, or more frequent, meetings (with significant data preparation and analysis beforehand). In the first meeting participants will inventory available data and deem its sufficiency for use to address specific hypotheses and questions identified by the participants in facilitated sessions. Recommendations for further analyses and publication development will be provided in a report to BOEM summarizing that meeting. After BOEM review and approval, subgroups of interdisciplinary scientists will work together to prepare data for integration and conduct appropriate statistical analyses or modeling to identify interdisciplinary relationships and/or test

hypotheses previously identified. If useful, PIs may integrate data with on-going oceanographic programs (e.g. RUSALCA and the Distributed Biological Observatory) to inform ecosystem models and enhance their predictive capability. After analyses are completed, sub-groups will prepare multi-authored manuscripts for publication in appropriate peer-review literature. Topics for synthesis include, but are not limited to, inter- and intra-relationships of oceanographic circulation, sea ice, hydrography, lower-trophic abundance and distribution, and marine mammal distributions and behavior. Deliverables from this study will include multiple workshop proceedings and summary recommendation reports, as well as multiple peer-review journal publications.

Current Status: Ongoing

Final Report Due: March 2016

Publications Completed: None

Affiliated WWW Sites: http://www.boem.gov/Environmental-Stewardship/Environmental-Studies/Alaska-Region/Index.aspx
http://www.arctic.noaa.gov/soar/

Revised Date: December 2011

BOEM ENVIRONMENTAL STUDIES PROGRAM: ONGOING STUDIES

Region: Alaska

Planning Area(s): Chukchi Sea

Title: Hanna Shoal Ecosystem Study (AK-11-03)

BOEM Information Need(s) to be Addressed: This study will constitute a key component of Chukchi Sea environmental studies pertinent to Chukchi Sea Lease Sale 193 held in 2008. The highest oil industry interest is in the Burger prospect bordering Hanna Shoal to the south. The BOEM analysts and decision makers will use the information in NEPA analysis and documentation for Lease Sales, EPs and DPPs and in post-sale and post-exploration decision making in the Chukchi Sea. This study addresses aspects of USGS Recommendations 3.01, 3.02, 3.04, 3.05, 3.07, 4.01, 5.06 and 5.24.

Total Cost: $5,645,000 **Period of Performance:** FY 2011-2016

Conducting Organization: University of Texas at Austin

Principal Investigator: Dr. Kenneth H. Dunton, Dr. Steven M. Lanoux, Dr. David R. Maidment

BOEM Contact: Dr. Heather Crowley

Description:

Background: The ongoing COMIDA CAB study is highlighting the importance of Hanna Shoal in the NE Chukchi Sea as a biological oasis bordering the boundary between Chukchi and Arctic Ocean waters. The reason for this, however, is poorly understood. The shallower waters of the shoal have long been known as traps for grounding of bergy bits and deep-keeled sea ice, and a reoccurring polynya is created down current of the grounded ice.

Bering Sea water entering the Chukchi Sea and flowing north is thought to flow both to the east and west of the shoal. Historically, the transport of this warmer Bering Sea water past Hanna Shoal has resulted in melt out of open water "bays" in the ice cover on either side of Hanna Shoal. In most recent years with global warming, floating pack ice in summer persists in this area longer than elsewhere in the Chukchi, often surrounded by open water even to the north. This persistence strengthens the vertical stratification over Hanna Shoal as this residual summer ice melts and freshens the surface layer. Taylor columns may be responsible for maintaining ice in the regions of Herald and Hanna shoals. Circulation processes around Hanna Shoal are poorly understood, but the circulation here is part of a broader circulation field that connects the Chukchi and Beaufort. Waters draining through Herald Valley to the western Chukchi shelf and slope regions are carried to the eastern Beaufort, where outer shelf and slope waters are very likely brought back onto the shelf.

Biological "hot spots" in the Chukchi Sea are thought to be related to coupled pelagic and benthic productivity. A high abundance of bottom fauna is correlated with high pelagic primary

production, possibly associated with the ice edge that reached the seabed mostly ungrazed. However, the mechanisms that must explain the productivity at Hanna Shoal are relatively poorly understood. With the retreat of the summer ice-edge to deeper, more northern waters in recent years, this pelagic/benthic coupling may be weakening at Hanna Shoal. The ongoing productivity of this region depends on the timing and position of the ice edge. Other BOEM projects in the Chukchi are showing sustained benthic productivity in the area of Hanna Shoal accompanied by high concentrations of water birds, walrus, and whales.

Ongoing BOEM studies looking at ocean heat transport across the central U.S. Chukchi Sea, to the south and at circulation to the east, toward Barrow Canyon will provide context to this study.

Objectives:

- Refocus the ecological monitoring started under COMIDA CAB to the region of Hanna Shoal, including nearby biological "hot spots."
- Verify and enhance the food web/contaminant bioaccumulation structure developed in the COMIDA CAB study.
- Measure water column and benthic primary and secondary productivity and biomass, and determine the relation to oceanographic processes.
- Document annual circulation and density fields, as well as ice conditions, at Hanna Shoal throughout the year and examine important chemical, physical and biological interactions with the unique ecological regime in this highly productive area.
- Better understand the physical processes controlling circulation patterns in the region through analyses of numerical ocean process model results.
- Integrate effort and findings with recent and ongoing BOEM and other NE Chukchi Sea studies of higher trophic levels.
- Participate in the Distributed Biological Observatory for the Northeast Chukchi Sea

Methods: This project will continue COMIDA CAB benthic sampling, food web analysis, and contaminant measurements, focusing on the Hanna Shoal region. Water column primary and secondary production and biomass also will be measured. Cruise zooplankton data will be supplemented by data from moored zooplankton-sensing acoustic Doppler current profilers (ADCP) units capable of distinguishing copepod and euphausid biomass signatures. Appropriate moored and shipboard measurements of currents, sea ice drift, and hydrography (including geochemistry) will examine circulation and density fields. Moorings will be used for long term profiling of temperature and salinity, including under ice measurements in winter. Additional oceanographic data may be obtained from other projects such as the proposed extension of the Chukchi oceanographic study, these data include: HF radar, moored ADCPs, meteorological buoys, and gliders. Formal integration with other BOEM projects will be made through the planned "Marine Mammal/Physical Oceanography Synthesis" to provide upper trophic components to the study. Coordination will occur with other international, NSF, NOAA, ADEC, and industry research in the Chukchi Sea.

This study will use numerical ocean process model simulations for the Chukchi Sea, with focus on Hanna Shoal, to better understand the physical processes controlling circulation patterns in the region. Analyses will be performed on the model results to examine interactions of the flow

field and density structure with the topography and their relation to productivity and biomass distribution. An ecosystem model also may be incorporated into the simulations.

Current Status: Ongoing

Final Report Due: August 2015

Publications Completed: None

Affiliated WWW Sites: http://www.boem.gov/Environmental-Stewardship/Environmental-Studies/Alaska-Region/Index.aspx
http://comidacab.org/

Revised Date: December 2011

BOEM ENVIRONMENTAL STUDIES PROGRAM: ONGOING STUDIES

Region: Alaska

Planning Area(s): Beaufort Sea, Chukchi Sea

Title: COMIDA: Factors Affecting the Distribution and Relative Abundance of Endangered Whales: Passive Acoustic Detection and Monitoring of Endangered Whales in the Arctic (AK-09-02a)

BOEM Information Need(s) to be Addressed: Information from this study will document the general presence of bowhead, right, fin, gray, and other baleen whales in areas of potential seismic, drilling, construction, and production activities. Study results may be useful for estimating temporal limits and formulating designs of mitigation for such activities. Findings may be used for evaluating potential deferral areas and other potential limitations on offshore leasing and development. This study will provide useful information needed to support NEPA analysis and documentation for Beaufort and Chukchi Sea Lease Sales, DPPs, and monitoring. Results will support ESA consultations, MMPA permitting, and preparation of Biological Evaluations and Biological Opinions. This study addresses aspects of USGS Recommendations 3.07, 6.06, 6.07, 6.08, 6.09, 6.11, 6.16 and 6.18.

Total Cost: $4,304,000 plus Joint Funding **Period of Performance:** FY 2010-2015

Conducting Organization: NOAA, NMML

Principal Investigator: Dr. Catherine Berchok

BOEM Contact: Dr. Heather Crowley

Description:

Background: The observed northward retreat of the minimum extent of summer sea ice has the potential to expand oil and gas-related exploration and development into previously closed seasons and localities in the Alaskan Arctic. This change, coupled with steadily increasing abundance and related seasonal range expansion by the bowhead, gray, humpbacked, fin, and possibly other whales, indicates that more complete information on the year-round presence of large whales is needed in the western Beaufort Sea and Chukchi Sea planning areas. Aerial surveys can provide some of the needed coverage, but are not cost-effective for extended use on a year-around basis. Nor will planned aerial surveys provide the geographic extent of coverage potentially available from passive acoustic monitoring.

Passive acoustic detection and tracking is a proven tool for assessment of large whales in Alaskan seas. Specifically, acoustic detection has proven a key addition to the census of bowhead whales (*Balaena mysticetus*) during their spring migration past Barrow, and in relation to oil and gas development activities offshore Prudhoe Bay. More recently, gray whale calls have been detected year-round near Barrow on long-term recorders deployed in collaboration with the NSF/Shelf-Basin Interaction Study. Other data have been obtained on North Pacific right, humpback, and fin whales in the southern Bering Sea.

The proposed study will fund the fabrication and deployment of arrays of long-term acoustic recorders in the Beaufort and Chukchi seas that are capable of continuous recording, year-round. Acoustically recording the Beaufort and Chukchi seas year-round for several years will provide previously unattainable assessment of the seasonal occurrence of large whales in these regions and their response to environmental changes (including climate and anthropogenic use of the area).

Objectives:

- Assess the year-round seasonal occurrence of bowhead, gray, and other baleen whale calls in the Beaufort and Chukchi Seas.
- Track individuals through a hydrophone array to estimate relative abundance.
- Evaluate whether changes in seasonal sea ice extent is enabling a northward shift of Bering Sea cetacean species such as fin, humpback and North Pacific right whales.
- Provide long-term estimates of habitat use for large whale species and compare this with annual ice coverage in order to establish predictive variables to describe large whale occurrence.
- Collaborate with the study entitled: "COMIDA: Factors Affecting the Distribution and Relative Abundance of Endangered Whales: Biophysical Moorings and Climate Modeling" in order to evaluate the extent to which variability in environmental conditions such as sea ice, oceanic currents, water temperature and salinity, and prey abundance influence whale distribution and relative abundance.

Methods: Build autonomous hydrophones based on a proven design, modified for cold, shallow water deployment for 365 days per deployment. Deploy instruments in tight arrays having a minimum of 3 instruments to facilitate evaluating the movements of individual animals. Refurbish and redeploy instruments annually. Analyze annual data for whale calls to estimate: seasonal occurrence by species, inter-annual differences in occurrence by species, variation in occurrence due to changes in ice extent, types and strengths of anthropogenic noise in the study area.

Current Status: Ongoing

Final Report Due: August 2015

Publications Completed: ftp://ftp.afsc.noaa.gov/posters/pBerchok01_chaoz-arctic.pdf
ftp://ftp.afsc.noaa.gov/posters/pCrance02_2010-chaoz.pdf
ftp://ftp.afsc.noaa.gov/posters/pJNapp09_chaoz.pdf

Affiliated WWW Sites: http://www.boem.gov/Environmental-Stewardship/Environmental-Studies/Alaska-Region/Index.aspx

Revised Date: December 2011

BOEM ENVIRONMENTAL STUDIES PROGRAM: ONGOING STUDIES

Region: Alaska

Planning Area(s): Beaufort Sea, Chukchi Sea

Title: Characterization of the Circulation on the Continental Shelf Areas of the Northeast Chukchi and Western Beaufort Seas (AK-12-03a)

BOEM Information Need(s) to be Addressed: The BOEM needs information on several aspects of the temporal and spatial structure of ocean currents in the northeastern Chukchi and western Beaufort seas. This characterization encompasses a description of the mean circulation under different wind and sea ice coverage conditions. This knowledge will be valuable for (a) improving the quality of information used in the Oil Spill Risk Analysis conducted by BOEM, (b) inferring the transport of zooplankton, contaminants and other quantities in key areas, (c) providing insight into the flow-related feeding aggregations of bowhead whales near Barrow, (d) providing important information for the preparation of NEPA documents, (e) providing information for ocean modeling efforts (including validation and skill assessment), and (f) complementing ongoing social research on offshore subsistence hunting. This study addresses aspects of USGS Recommendations 3.01 and 5.06.

Total Cost: TBD **Period of Performance:** FY 2012-2017

Conducting Organization: TBD

Principal Investigator: TBD

BOEM Contact: TBD

Description:

Background: The circulation in the region of the junction between the Chukchi and Beaufort continental shelves is likely complex given the abrupt change in the orientation of the isobaths, change in shelf width, and the convergence of the mean westward wind-driven flow over the Alaskan Beaufort Sea with the mean northeastward flow along the eastern flank of Barrow Canyon. The nature of this junction varies with the winds and ice environment. The regional circulation is such that contaminants introduced on either the Chukchi or Beaufort shelf will likely have a variety of fates. These include being advected from one shelf to the other, being flushed offshore into the Arctic basin, or perhaps accumulating within the vicinity of the western Beaufort Sea due to flow convergence from currents on both shelves. The conditions under which these various scenarios occur are not well known.

This proposed study is a continuation and expansion of the existing surface circulation study within the northeast Chukchi Sea. Prior to 2009, surface current observations on the Chukchi shelf were extremely limited. Through a joint Industry/BOEM supported study, the University of Alaska Fairbanks (UAF), Coastal Marine Institute began measuring surface currents during the open water period on the Chukchi shelf beginning in September 2009 with the deployment of long range (180 km), High Frequency (HF) radar systems located at the villages of Barrow and Wainwright. In

2010, coverage was expanded to the southwest to include additional offshore lease areas. The surface current data was supplemented by water column profile data collected by Slocum Gliders. Acoustic Doppler current profilers (ADCPs) were also deployed across the Alaska Coastal Current at the head of Barrow Canyon to assess the annual flow regime, the connectivity between surface and subsurface currents during the open water season, and the changes in subsurface currents beneath the mobile pack ice and lead system during the winter months. This new study will expand our present efforts to improve understanding of the flow regime and shelf dynamics between the inner and outer Chukchi shelf, the exchange of waters between the Chukchi Sea and western Beaufort shelf through Barrow Canyon, and the upwelling of Atlantic Waters.

Objectives:

- Extend the present Chukchi Sea HF radar, mooring and glider study to include the western Beaufort shelf slope and Barrow Canyon to investigate the spatial and temporal structure of ocean currents within the western Beaufort and northeast Chukchi shelves and the exchange of waters between these areas.
- Characterize the flow regimes and surface water exchange among areas of the inner and outer Chukchi shelf and the western Beaufort shelf under varying conditions of wind forcing and sea ice coverage.
- Describe the oceanic response, at different levels in the vertical, using all available wind observations, as well as those generated by atmospheric and/or coupled models.

Methods: The above objectives will be pursued using a suite of instrumentation including: ADCPs, CTDs, Ice Profiling Sonar (IPS5), gliders, surface drifters and HF radars. Long Range HF radar systems presently deployed along the Chukchi coast at Point Lay, Wainwright and Pt. Barrow will be modified to increase the maximum observable range to approximately 250 km to capture the summer surface current flow over a larger area of the Chukchi shelf and around Hanna Shoal. A planned HF radar deployment at Cape Simpson (CIAP funds) will capture surface current flow along the western Beaufort shelf and slope and within Barrow Canyon. Gliders, surface drifters and moored ADCPs and CTDs will collect data on depth and time dependent current, temperature and salinity structure. Ice Profiling Sonar and moored ADCPs will be used to calculate ice drift and velocity. Sea ice extent will be obtained from satellite information, while drifting buoys will be crucial for computing flow trajectories and diffusivities. Data from the ADCPs, CTDs, glider deployments, HF radars, planned drifter measurements and available industry data will be synthesized to acquire a comprehensive characterization of the circulation in the study area. This project will coordinate and collaborate with other research projects in the area (BOEM, WHOI, industry, etc.) to synthesize and integrate all available data.

Current Status: In procurement

Final Report Due: TBD

Publications Completed: None

Affiliated WWW Sites: http://www.boem.gov/Environmental-Stewardship/Environmental-Studies/Alaska-Region/Index.aspx

Revised Date: December 2011

Methods: Establish formal contact with potential host communities and develop a written protocol to facilitate community participation and meaningful collaboration in the performance of this research. Conduct a literature search on previous northern social indicator studies. Utilize existing identified arctic social indicators or develop alternative relevant social indicators in conjunction with BOEM. Prepare a strategic survey instrument, pre-test it, and obtain the necessary approvals for use from relevant BOEM review offices and the Office of Management and Budget, and administer it. Organize data into a workable database and analyze with appropriate multivariate statistical techniques. Conduct a comprehensive analysis of the results of all prior tasks and prepare a draft report of the study findings. Circulate the draft report to the BOEM and host community leaders to facilitate parallel reviews by peer scientists and interested stakeholders; respond to review comments and prepare a final report, incorporating reviewer edits and comments where appropriate; report the study results to participating communities through public meetings or workshops.

Current Status: Ongoing

Final Report Due: August 2014

Publications Completed: None

Affiliated WWW Sites: http://www.boem.gov/Environmental-Stewardship/Environmental-Studies/Alaska-Region/Index.aspx

Revised Date: December 2011