BOEM ENVIRONMENTAL STUDIES PROGRAM: Ongoing Studies

Region: Alaska

Planning Area(s): Chukchi Sea

Title: COMIDA: Factors Affecting the Distribution and Relative Abundance of Endangered Whales: Biophysical Moorings and Climate Modeling (AK-09-02b)

BOEM Information Need(s) to be Addressed: The BOEM is studying marine mammal distribution, benthic biota, and anthropogenic chemicals to monitor for environmental effects of oil and gas exploration in the Chukchi OCS. Interannual and seasonal variability in the Chukchi is very high and there is a need to distinguish oil and gas effects from those related to variability in the physical environment or from local effects of global warming. This task would provide that context to other monitoring tasks and also greatly improve our understanding of first order physics in the NE Chukchi Sea. In addition, this study will provide information useful for ground-truthing and tuning of numerical ocean models.

Total Cost: $2,068,928 plus Joint Funding

Period of Performance: FY 2010-2015

Conducting Organization: NOAA-Pacific Marine Environmental Laboratory

BOEM Contact: Dr. Heather Crowley

Description:

Background: During the last three decades there has been a northward shift of some fish species in the eastern Bering Sea. It is hypothesized that these changes are a result of global climate change and the loss of sea ice. The western Arctic physical climate is 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. 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. This reduction in sea ice area opens up vast new regions of the Arctic Ocean to increased absorption of sunlight and storage of heat. This heat is returned to the atmosphere in the following autumn resulting in increased Arctic temperatures of more than 5° C, extending the sea ice free season into November, and causing changes in wind patterns. Such Arctic changes appear to be irreversible. As the sea ice that has lasted for several years melts away and extra heat is stored in the ocean during autumn, potential future periods of colder than normal air temperatures may not be sufficient to rebuild the summer sea ice cover. Previous sea ice and climate analyses and projections for the Chukchi Sea are out of date.

One of the methods to be applied to the Chukchi Sea includes measuring the changing ecosystem in the eastern Bering Sea through long term biophysical moorings coupled

with shipboard observations. These will provide critical information on the ecosystem, including physical drivers of primary production and higher trophic levels, and support the development of hypotheses for mechanisms controlling ecosystem organization. The coupling of the passive listening device for whales with active acoustics for zooplankton size distribution and biovolume from the moorings has provided some interesting relationships between primary production, zooplankton biovolume and the presence/absence of fin whales. Moorings permit observations during ice covered periods and the critical spring and early summer when spring phytoplankton blooms occur. Such measurements are impossible to obtain from ships, because of the relatively short duration they spend in the area.

Euphausiids are important prey items for bowhead whales in the Chukchi Sea. Availability and prey concentrations are important factors in the habitat utilization of whales in the study area. Euphausiids are thought to be transported from the northern Bering Sea as reproduction of euphausiids within the Chukchi has not been observed. Modeled trajectories of passively floating particles to simulate euphausiid transport have been analyzed. The results suggest that the majority of euphausiid prey in the study area is derived from the northern Bering Sea. Furthermore, particles in close association with the bottom were more likely to be transported to the study area than particles in the surface waters.

Objectives:

- Obtain two full years of biophysical measurements on the shallow Chukchi shelf utilizing moorings at three sites, and collect hydrographic and lower trophic level data during deployment/recovery of the moorings.
- Collaborate with the protected-species study: "COMIDA: Factors Affecting the Distribution and Relative Abundance of Endangered Whales: Passive Acoustic Detection and Monitoring of Endangered Whales in the Arctic" 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.
- Rerun the National Center for Atmospheric Research (NCAR) climate model (Community Climate System Model: CCSM) for future projections using the sea ice extents from 2007/2008 as initial conditions.
- Analyze multiple ensemble members from the NCAR model and other International Panel on Climate Change (IPCC) models to assess the future variability of sea ice cover and extended sea ice free seasons during fall for the Chukchi Sea.
- Provide long-term estimates of habitat use for large whale species and compare this with predictions about annual ice coverage in order to establish predictive variables to describe large whale occurrence.

Methods: A pair of moorings will be deployed at three different sites of tight-acoustic arrays on the Chukchi Sea shelf (See protected-species study: "COMIDA: Factors Affecting the Distribution and Relative Abundance of Endangered Whales: Passive

Acoustic Detection and Monitoring of Endangered Whales in the Arctic.") Moorings will be deployed in August for one year, to be recovered the following August. Each mooring site has two moorings; one is a bottom mounted upward-looking ADCP with instruments that measure fluorescence, temperature, and oxygen deployed beneath the ADCP; the second mooring will contain the instrument to measure ice thickness with instruments that will measure nitrate, temperature and salinity beneath it. At one site there will also be an upward looking TAPS-8 (on the P mooring), which acoustically measures zooplankton biovolume as a function of size. During each deployment/recovery cruise, hydrographic data (temperature, conductivity, nutrients, chlorophyll, oxygen) and zooplankton will be collected at each mooring site, along the transect between moorings and at other selected sites in northern part of the Bering Sea and in the Chukchi.

Samples for mesozooplankton and micronekton will be collected using double-oblique tows of paired bongo frames (60-cm frame with 0.333 mm mesh and 20-cm frame with 0.150 mm mesh) or when appropriate, (e.g. for groundtruth of the acoustic data) using a Tucker Sled which allows us to collect samples right next to the bottom.

The climate modeling task will adapt the NCAR CCSM to examine the influence of natural variability on sea ice loss and compare results with a new set of IPCC model results. Within a year a new round of IPCC models will be available for analysis and we will evaluate them for application to Chukchi Sea climate projections. Recent satellite sea ice analyses, including high resolution AMSR-E microwave analyses from Europe, multiyear sea ice fraction from QuikSCAT, and ICESat thickness data are critical data to evaluate climate change as well as the numerical climate models. These data together with data from the moorings will be used for model verification.

Current Status: Awaiting final report.

Final Report Due: August 2015

Publications Completed:

Cheng, W., E. Curchitser, C. Ladd, P. Stabeno, and M. Wang. 2014. Ice-Ocean Interactions in the Eastern Bering Sea: NCAR CESM Simulations and Comparison with Observations. Deep Sea Research II, doi: 10.1016/j.dsr2.2014.03.002.

Overland, J. E., M. Wang, J. Walsh, and J.C. Stroeve. 2014. Future Arctic climate changes: Adaptation and mitigation timescales. Published online, Earth's Future. doi: 10.1002/2013EF000162.

Stabeno, P.J., N.B. Kachel, C. Ladd, and J.M. Napp. 2014. The CHAOZ project: Influence of climate variability on the northeastern Chukchi ecosystem. Oral presentation at the American Geophysical Union Ocean Sciences Meeting, February 26, 2014. Honolulu, HI.

Wang, M. and J. E. Overland. 2014. Projected future duration of the sea-ice-free season in the Alaskan Arctic. Poster presentation at the Alaska Marine Science Symposium, Anchorage, AK, January 2014.

Wang, M. and J. E. Overland. In press. Projected future duration of the sea-ice-free season in the Alaskan Arctic. Progress in Oceanography.

Wang, M., J. Overland, P. Stabeno and N. Bond. 2013. A sea ice free summer Arctic within 30 years: An update from CMIP5 models. Oral presentation, Alaska Marine Science Symposium, Anchorage, AK, January 2013.

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