Benthic invertebrate communities of the northeastern Chukchi Sea

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Introduction

In 2008, a multi-year, interdisciplinary survey was initiated in the vicinity of two proposed oil and gas exploration areas (Burger and Klondike) with an epifaunal survey component initiated in 2009. This effort was sponsored by ConocoPhillips, Shell Exploration and Production Company, and Statoil USA E&P to collect information on the ecosystem in these areas prior to exploration, and to provide baseline environmental data that can be used for permit applications and for post-exploration and development comparisons. Oceanography processes provide nutrients to the benthos, resulting in tight pelagic-benthic coupling in the northeast Chukchi Sea. This coupling contributes to the structuring of benthic communities. Benthic organisms are important food sources for upper trophic levels such as fish, walrus, and gray whales. Additionally, some benthic invertebrate taxa are known indicators of environmental change. The results of the benthic (infauna & epifauna) component conducted during the 2008-2010 Chukchi Sea Environmental Studies Program (CSESP) are presented here.

Background

Productivity of the northeastern Chukchi Sea is a result of a combination of seasonal ice cover and the influx of North Pacific Ocean water (Fig. 1) resulting in highly variable benthic communities.

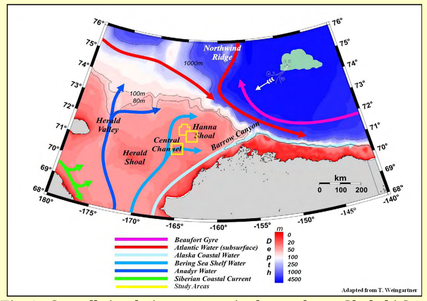

Fig. 1. Overall circulation patterns in the northeast Chukchi Sea.

Seasonally, melting sea ice stratifies the water column, creating conditions favorable for plankton blooms. Unconsumed plankton falls to the bottom as a food source for benthic invertebrates. Under-ice and ice-edge production also contribute to annual food budgets for benthic organisms.

Sampling of benthic infauna:


Double van Veen grab


Hilary rinsing a sample


Rinsed sample

Sampling of benthic epifauna:


Retrieving the beam trawl


Carrie covered in mud


Typical haul in Burger


Typical haul in Klondike

Methods

Sediment-dwelling macrofauna were collected for taxonomic analysis at 52 sites within Burger and Klondike with a double van Veen grab in August, 2008 and 2009 (Fig. 2). At each site (fixed and random), three replicates were collected and organisms identified to the lowest possible taxonomic category, counted, then weighed. Epifaunal invertebrates were collected using a 3 m plumb-staff beam trawl with a 4 mm codend liner aboard the M/V *Westward Wind* in August & September 2009 and September 2010. Sampling for epifauna took place at the fixed stations in the Burger, Klondike (both years), and Statoil (2010) survey areas. Sediments for grain-size determinations were sieved for determination of percent gravel, sand, and mud; and water depth was determined.

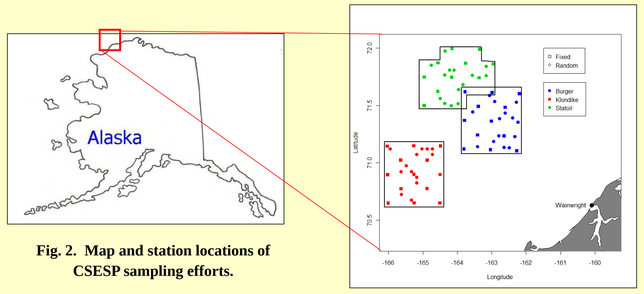

Fig. 2. Map and station locations of CSESP sampling efforts.

Results

Infaunal (2008-2009) and epifaunal (2009-2010) abundance and biomass were higher at Burger compared to Klondike (Fig. 3). Although most organisms were common at all sites, Burger was dominated by infaunal and epifaunal organisms more closely associated with depositional areas, while Klondike was dominated by organisms typical of dynamic environments (Fig. 4). For epifauna, Statoil contained organisms more similar to those found in Klondike. Multi-dimensional scaling demonstrates separation of invertebrate communities among survey areas reflecting the strong environmental gradients in the area (Fig. 5). Sampling over multiple years suggest little temporal difference in faunal composition.

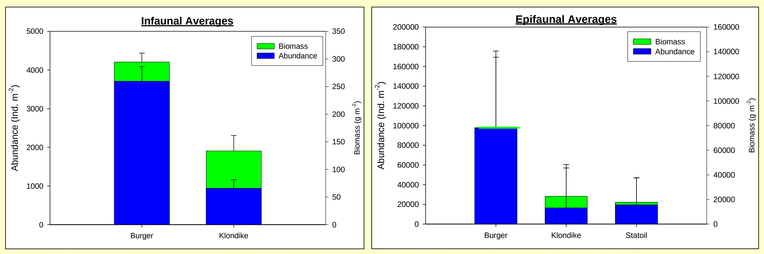

Fig. 3. Average abundance and biomass (± SD) of benthic invertebrates in the Chukchi Sea.

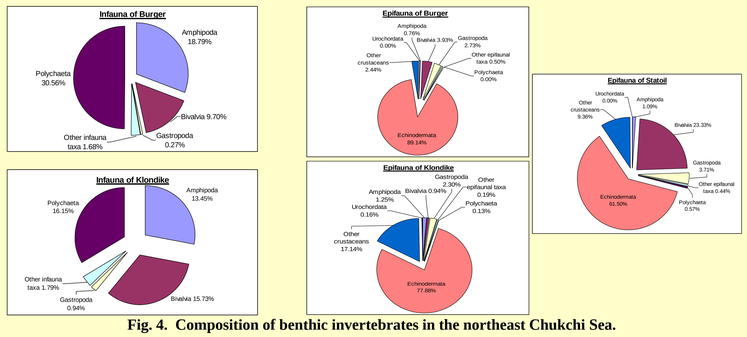

Fig. 4. Composition of benthic invertebrates in the northeast Chukchi Sea.

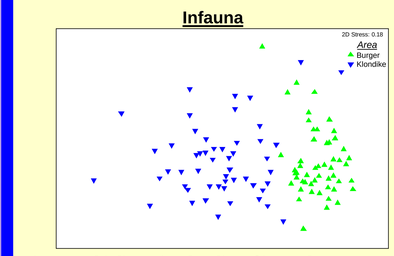

Fig. 5. Multi-dimensional scaling of invertebrate communities in the northeast Chukchi Sea. The closer two points are to one another, the more similar those points are than two points that are farther apart.

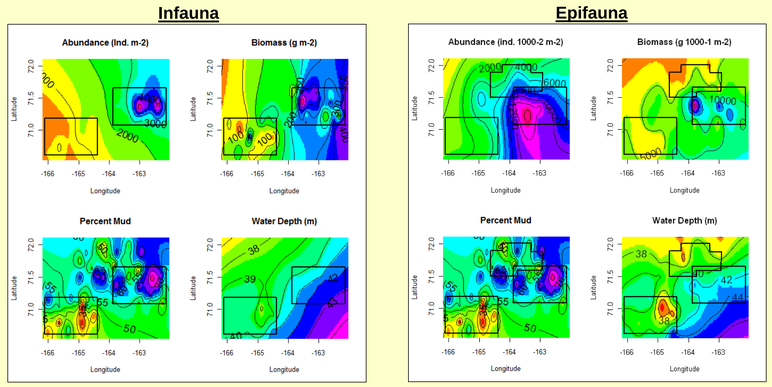

Fig. 6. Contour plots of predictions from geostatistical modeling (kriging plot) of average abundance, biomass, percent mud, and water depth for two years: 2008-2009 infauna and 2009-2010 epifauna. A kriging plot depicts dependent variable changes relative to location.

Geostatistical analyses (kriging plots) indicate that Burger was a "hot spot" for abundance of benthic invertebrates. The overall trend was increasing abundance and biomass from west to east. Overall trends in biomass were less clear with varying values throughout the study area. It appears that trends in abundance and biomass were associated with the water depth gradient, and to a lesser extent to percent mud, as indicated by the similar trends in depth, abundance, and biomass in the northeast Chukchi Sea.

Conclusions

Abundance and biomass of benthic invertebrates was high in the northeast Chukchi Sea. The advection of nutrient-rich water from the North Pacific Ocean and eastern Bering Sea contribute to the high abundance and biomass of faunal communities in the study area. The composition of invertebrate communities are associated with physical variables such as water depth and sediment grain-size which reflect a wide range of covariates such as hydrodynamics, geomorphology, nutrient distribution, and the advection of nutrient-rich North Pacific water into the northeast Chukchi Sea. There appears to be low interannual variability in the invertebrate communities between years. This research will contribute to understanding the distribution of benthic invertebrates in relation to the physical environment, as well as provide baseline data that could be used for environmental monitoring initiatives following exploration and developmental activities.

Acknowledgments

We thank ConocoPhillips, Shell Exploration and Production Company, and Statoil USA E&P for funding this study. We thank Olgoonik/Fairweather LLC, the crews of the M/V *Bluefin* (2008) and M/V *Westward Wind* (2009 and 2010), as well as Aldrich Offshore Services and Olgoonik Oilfield Services for logistics and support.