Influence of environmental gradients on macrofaunal community structure in the northeastern Chukchi Sea

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Introduction

In 2008, a multi-year, interdisciplinary study was initiated in the vicinity of two proposed oil and gas exploration areas in the northeastern Chukchi Sea. This study 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 provide environmental data useful for permit applications and for post-exploration and development comparisons. Study objectives were to gain an understanding of the ecological aspects of benthic communities within the Burger and Klondike areas.

Methods

Sediment-dwelling macrofauna were collected for taxonomic analysis at 52 sites with a double van Veen grab in August, 2008 and 2009 (Fig. 1). At each site, three replicates were collected then rinsed over a 1.0 mm mesh sieve and preserved. In the lab, samples were sorted and identified to the lowest possible taxonomic category; organisms were counted then weighed for biomass. Sediments were sieved for determination of percent gravel, sand, and mud. They were also processed to determine chlorophyll using a fluorometer.

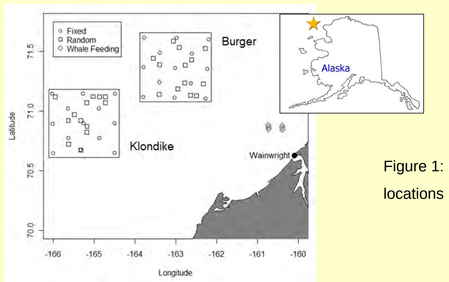


Figure 1: Infauna sampling locations in 2008 and 2009.

Results

The fauna found in 2008 and 2009 were abundant and animals large. Dominant fauna include the crustacean class Ostracoda, the amphipod *Paraphoxus* spp., the bivalves *Astarte* spp., *Ennucula tenuis*, *Nuculana pernula*, and *Macoma calcarea*, the peanut worm *Golfingia margaritacea*, and the polychaete worms *Lumbrineris* sp. and *Maldane glebifex* (Table 1). Abundance, biomass, and the number of taxa were significantly higher at Burger compared to Klondike. Whale feeding sites (2009 only) were dominated by the amphipods *Byblis* spp.

Environmental gradients were moderate in the study. Cold, salty water left over from brine formation through the winter persisted longer at Burger in 2008 and 2009 although 2009 was warmer than 2008 (Fig. 2). The Burger survey area was also deeper and had a higher percentage of mud (Fig. 3). Overall, the environmental characteristics of Burger (i.e., slower bottom-water replacement and greater depth and percent sand) suggest a depositional environment here.

The distribution and composition of benthic fauna were moderately associated with environmental gradients as demonstrated by the increasing abundance and biomass with greater depth and percent mud (Fig. 3). Klondike had a higher percentage of mollusks while Burger had more crustaceans (Fig. 4) corresponding to muddier sediments (Fig. 2 and 3). Distributions of animals were patchy at Klondike and more regular at Burger (Fig. 5).

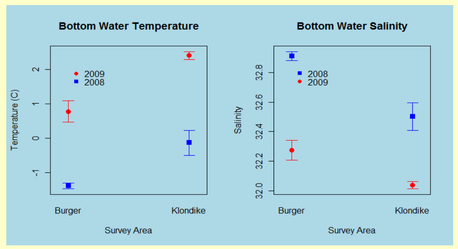


Figure 2: Bottom water and temperature of the northeast Chukchi Sea during the 2008 and 2009 CSESP. Data from Tom Weingartner and Seth Danielson, IMS, UAF.

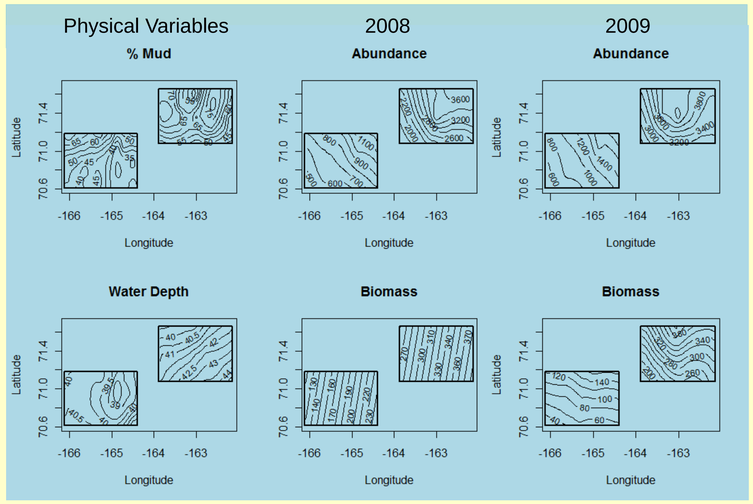
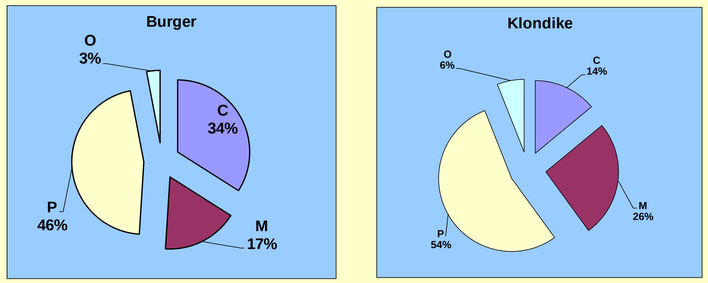


Figure 3: Geostatistical analysis (kriging plot) of abundance (ind. m^{-2}), biomass (g m^{-2}), percent mud, and water depth in Burger and Klondike in 2008 and 2009. A kriging plot depicts dependent variable changes relative to location.



C = crustacean, M = mollusk, P = polychaete, O = other

Figure 4: These two pie charts illustrate polychaetes being foremost in comparison to the other invertebrates for 2008.

	2008					2009				
Region	Taxon	Abundance	Taxon	Biomass	Region	Taxon	Abundance	Taxon	Biomass
Burger	*Maldane glebifex*	583	*Astarte borealis*	53.9	**Burger**	*Maldane glebifex*	2998	*Astarte borealis*	230
	Ostracoda	294	*Golfingia margaritacea*	35.9		Ostracoda	1156	*Macoma calcarea*	178.2
	Lumbrineris spp.	194	*Macoma calcarea*	29.5		*Photis* sp.	848	*Ennucula tenuis*	115.3
	Maldane spp.	189	*Ennucula tenuis*	27.8		*Ennucula tenuis*	758	*Maldane glebifex*	109.3
	Ennucula tenuis	182	*Maldane glebifex*	21.5		*Paraphoxus* sp.	659	*Golfingia margaritacea*	45.8
Klondike	*Ennucula tenuis*	68	*Golfingia margaritacea*	13.5	**Klondike**	*Ennucula tenuis*	446	*Maldane glebifex*	64.8
	Maldane glebifex	56	*Nuculana radiata*	9.3		Cirratulidae	236	*Nuculana pernula*	39.1
	Barantolla americana	44	*Astarte borealis*	8.5		*Maldane glebifex*	188	*Astarte borealis*	30.5
	Cirratulidae	42	*Macoma calcarea*	8.1		*Praxillella praetermissa*	127	*Chlamys behringiana*	27.7
	Praxillella praetermissa	22	*Axiothella catenata*	5.5		Capitellidae	114	*Axiothella catenata*	22.1

Table 1: The top 5 species by abundance and biomass in each study area during 2008 and 2009.

Temporal Comparisons

The faunal communities demonstrated little temporal change as faunal assemblages sampled offshore in 1986 were comparable to those of 2008 and 2009 (Fig. 5). Geostatistical modeling of the combined 1986 and 2008 data indicates a decline in abundance with greater distance offshore with the latter data clarify the extent of a benthic hot spot at Burger (denoted in blue in Fig. 6).

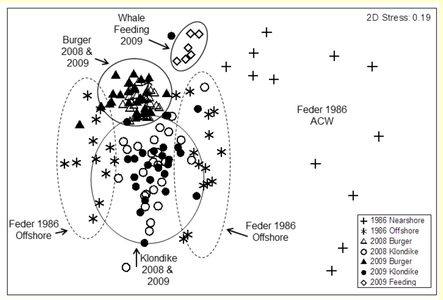


Figure 5: Multivariate ordination of Feder et al. 1986 and CSESP 2008 and 2009 data .

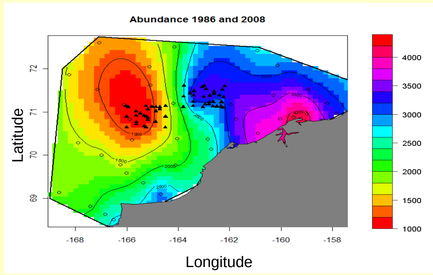


Figure 6: Kriging plots of historical data (Feder et al., 1986) with and without the 2008 benthic data.

Discussion

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 present study established that faunal community structure was associated with gradients in depth and sediment size reflecting a wide range of covariates such as hydrodynamics, geomorphology, and nutrient distribution as well as the nutrient-rich, North Pacific water. Burger had higher biomass and abundance than Klondike reflecting the depositional characteristics of that site.

Faunal characteristics of the gray whale feeding sites sampled in 2009 were very different from those of the Burger and Klondike survey areas as they were dominated by ampeliscid amphipods (*Byblis* spp.), a family known to be a preferred food source for gray whales.

There appears to be little temporal difference between faunal communities sampled in 1986 and those sampled in 2008 and 2009 in spite of large environmental changes in the northeastern Chukchi Sea.

Acknowledgments

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