Ecosystem Characteristics Based on Benthic Biomass, Density, and Stable Isotopic Signatures from Chukchi Sea Cruise COMIDA

Nathan McTigue, Susan Schonberg, Ken Dunton
University of Texas Marine Science Institute

Background:

•The Chukchi Sea Offshore Monitoring in Drilling Area (COMIDA) is a two-year program that began in the summer of 2009 to gather baseline data on benthic biological and chemical processes.

•The Chukchi Sea Shelf exhibits great heterogeneity in biological composition and density. The reasons for this are unclear, but likely are related local variations in hydrography, POM deposition, and biotic processes (e.g. competition, predation, and disturbance).

•A comprehensive knowledge of benthic community structure and trophic relationships are critical to our understanding of ecosystem function.

Objectives:

•To establish a baseline on benthic faunal composition, abundance, and biomass

•To describe the food web structure of the Chukchi Sea through application of stable isotopic signatures of carbon and nitrogen

Methods:

•During the COMIDA 2009 cruise on the *RV Alpha Helix*, biota were collected using a van Veen grab and benthic beam trawl.

•Organisms were keyed out in the field and preserved for shipping.

•Stable isotope analysis was conducted at UTMSI and UAF stable isotope labs.

δ ^{13}C Variation within Trophic Levels

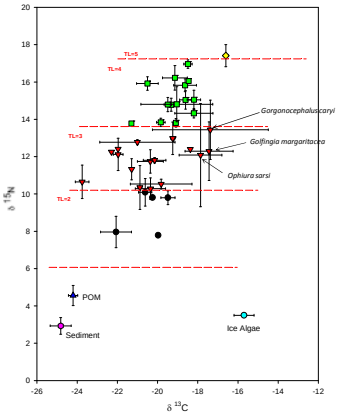

Figure 1. Dual stable isotope plots of mean δ ^{13}C and δ ^{15}N signatures (± SE). Trophic levels are indicated by dashed red lines. POM and sediment values from Iken et al., 2009. Ice algae values from McMahon et al., 2006.

Preliminary Conclusions:

•Organisms from the Chukchi basin range in δ ^{13}C values from -16.60‰ to -23.75 and in δ ^{15}N values from 7.79 to 17.41‰. The food web spans five trophic levels based on ^{15}N trophic level enrichments of 3.4‰ (Iken et al., 2009).

•Mollusks dominate the highest trophic levels, with a single species *Plicifusus kroyeri* in the 5th trophic level while other carnivorous gastropods, nudibranchs, and a single cephalopod occupy the 4th trophic level. Also present in this trophic level are crustacean scavengers, the sea star *Leptasterias polaris*, vertebrates (*Pisces*), and carnivorous polychaetes.

•Echinoderms are present at every trophic level. They experience the most variability in both δ ^{13}C and δ ^{15}N due to their indiscriminant feeding habits.

•Based on δ ^{13}C values, consumers derive a large fraction of their carbon from POM. However, consumer diets may reflect an ice algal signature in the spring, especially in some nonselective feeders (*Gorgonocephalus caryi, Golfingia margaritacea, and O. sarsi*) as reflected in their enriched δ ^{13}C values relative to other benthic consumers.

Benthic Invertebrate δ ^{15}N Values

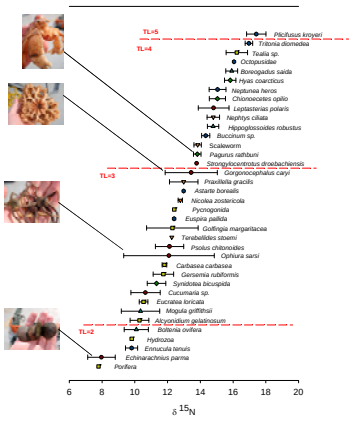

Figure 2. Stable nitrogen isotopic values for Chukchi Sea basin fauna. Values are mean ± SE. Trophic levels are indicated by dashed red lines.

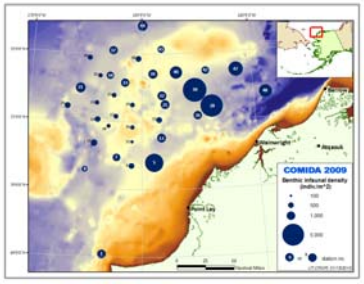

Figure 3. Benthic biota density values for the COMIDA stations are plotted in the above map.

- The stations with greatest abundance values (30, 28, 5, 48, 47) contained a very large number of one or two species. Station 30 was a rich sample in all categories but had extremely large numbers of the polychaetes *Owenia fusiformis* and *Lumbrineris fragilis*. Station 28 also contained a large range of species but had high numbers of the polychaete *Maldane sarsi* and amphipod *Pontoporeia femorata*. Station 5 was dominated by the polychaete family Capitellidae and station 48 by Lumbrineridae. None of these stations had large biomass values (see Biomass map). However, Station 47, dominated by the bivalve *Ennucula tenuis*, had both high density and biomass values.
- Stations 7, 8, and 28 contained hard substrate biota (bryozoa, hydrozoa, anthozoa, ascidians) in combination with the infauna. These stations were in areas where a current prevents fine deposits from settling so the sediments include gravel and pebbles. In contrast, all of the western and northwestern study stations had fine sediments dominated by bivalves, primarily *Ennucula tenuis* and *Nuculana pernula*. The bivalves *Macoma calcarea*, *Astarte borealis*, and *Yoldia hyperborea* were also collected at some of these sites.

Group	Percent Density	Group	Percent Biomass
Polychaete	**49**	**Bivalve**	**56***
Bivalve	**24**	**Sipunculid**	**17**
Crustacea	**21**	**Polychaete**	**15**
Ophiuroid	2	Ophiuroid	4
Gastropod	2	Gastropod	3
Sipunculid	1	Crustacea	2
Nemertea	1	Anthozoa	1
Priapulid	1	Priapulid	1
Anthozoa	<1	Nemertea	1
Ascidian	<1	Bryozoa	<1
Holothuroid	<1	Ascidian	<1
Nematode	<1	Hydrozoa	<1
Bryozoa	<1	Holothuroid	<1

*Bivalve biomass was measured with shell

Table 1.
The table above shows the percentage of benthic biota density and biomass by taxonomic group. Polychaetes, bivalves, and crustaceans (amphipods, cumaceans, cirripedia, etc.) dominate the samples in regards to density. Bivalves, sipunculids, and polychaetes are the groups contributing the most to benthic biomass.

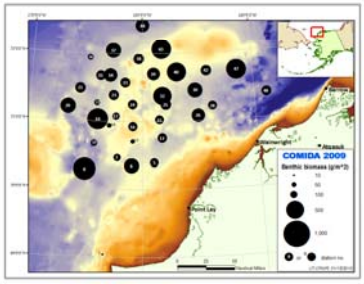

Figure 4. Benthic biota biomass values for the COMIDA stations are plotted in the above map.

- The stations with greatest biomass values (8, 19, 32, 40, 43, 47),) all contained combinations of bivalve species. The bivalve *Ennucula tenuis* was dominant at Stations 19, 32 and 47. At Station 19 *E. tenuis* was combined with *Nuculana pernula* and *Serripes groenlandica*. At Station 32 it was mixed with the sipunculid *Golfingia margaritacea*. Most study stations contained some individuals of *E. tenuis* and in the western section of the study area, *E. tenuis* was consistently found as a mix with *N. pernula*.
- Stations 8 and 43 had large specimens of the bivalve *Astarte borealis* and *Golfingia margaritacea*. Station 8 also had large maldanid polychaetes (*Nicomache lumbricalis*) and Station 43 had big individuals of the polychaete *Nephtys ciliata*.

Future Work:

In Summer 2010, we begin Phase II of COMIDA. We will continue our baseline studies by further investigation of the causes of ecosystem heterogeneity observed in the Chukchi basin. We will also examine the long term response of this ecosystem to climate change based on the analysis of retrospective datasets.

References:

Iken, K., Bluhm, B., and Dunton, K., Benthic food-web structure under differing water mass properties in the southern Chukchi Sea. Deep Sea Research II (2009), doi:10.1016/j.dsr2.2009.08.007

McMahon, K., Ambrose Jr., W., Johnson, B., et al., Benthic community response to ice algae and phytoplankton in Ny Alesund, Svalbard. Marine Ecology Progress Series (2006), 310:1-14.

Acknowledgements:

We would like to thank Captain John Seville and the crew of the *RV Alpha Helix* for all their invaluable hard work and assistance. We thank Kim Jackson, Patty Garlough (UTMSI), and Norma Haubenstock (UAF) for their efficient and timely work running isotope samples. Lastly, we are very grateful to Dr. Dick Prentki (MMS COR) for his enthusiastic support of all aspects of this research program.

Corresponding Author's Email: mctigue@mail.utexas.edu; Photographs provided by NM.