Regional benthic food-web structure on the Alaskan Beaufort Sea shelf

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Abstract

The purpose of this ongoing study is to investigate trophic structure of benthic food-webs on the Alaskan Beaufort Sea shelf using stable carbon and nitrogen ratios. Five regions were distinguished along the shelf to evaluate whether food-web structure and food source characteristics varied among regions. Total food-web length ranged from 4.1-5.2TL for the regions sampled. Trophic structures were similar among West Shallow and Deep sites and among Central Shallow and East Shallow regions. The Central Deep region was distinct as several taxa occupied TL5. High variability of food source isotope signatures and environmental conditions within and among regions, however, suggests that food sources and environment do not directly predict food-web structure on the Beaufort Sea shelf.

Introduction

Food-web structure and trophic dynamics are critical to our understanding of ecosystem functioning and stability and can be used as indicators of natural or anthropogenic changes. As climatic changes become more dramatic in Arctic marine ecosystems, it is imperative to acquire baseline knowledge of these systems. In contrast to the better studied Chukchi Sea[1], food-web dynamics the Beaufort Sea have only been studied in the coastal environments[2,3]. This warrants an in-depth study of benthic trophic dynamics on the Beaufort Sea shelf. The purpose of this study is to evaluate benthic food-webs on the Alaskan Beaufort Sea shelf as a baseline for future comparison.

Objectives

1. Determine if shelf regions vary in food source characteristics in particulate organic matter (POM) and sediment $\delta^{13}C$, $\delta^{15}N$, and C:N ratios

2. Determine if trophic structure, including taxa occupying different TL, varies across shelf regions

3. Compare hydrographic properties among shelf regions

Figure 2. Stable isotope preparation at UAF.

Methods

- Sample collection: 22 Aug- 3 Sep 2011 (*BeauFish 2011*)
- Regions defined *a priori* by depth and longitudinal boundaries (Fig. 1)
- POM samples from CTD rosette , ~10 m (n=3 per station)
- Sediments from top 1 cm of van Veen grabs (n=1 per station)
- Invertebrates collected from plump-staff beam trawl (n=3 per taxon, n= ~106 taxa across all regions)
- Temperature and salinity taken at POM sampling and bottom depths
- Samples analyzed for $\delta^{13}C$, $\delta^{15}N$ and C:N ratios at Alaska Stable Isotope Facility at UAF (Fig.2)
- Calculated (TL) using POM as a baseline:

$$TL_{(POM)} = (\delta^{15}N_{consumer} - \delta^{15}N_{POM}) / 3.4 + 1$$

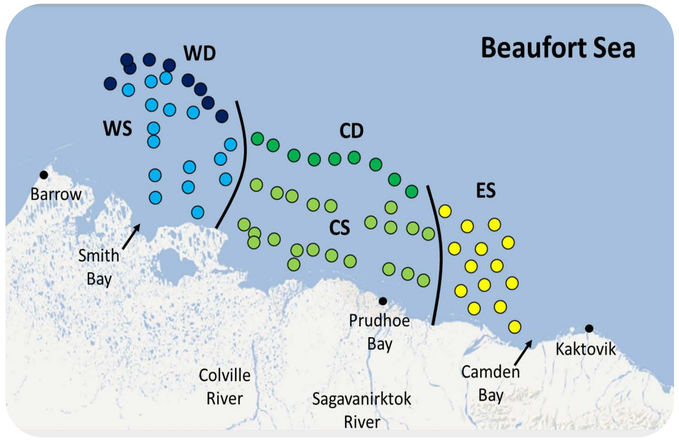

Figure 1. Station locations on the Alaskan Beaufort Sea shelf. Colors denote each of five regions: WD, 127-173 m= navy, WS, 17-74 m= blue, CD, 158-188 m= dark green, CS, 10-42 m= light green, ES, 27-61 m= yellow.

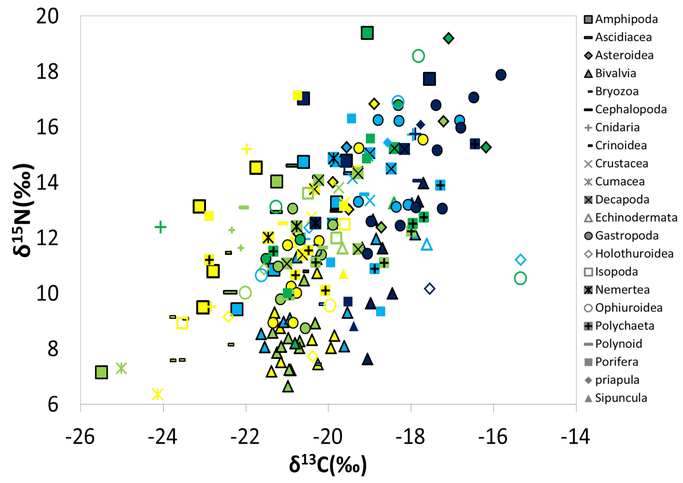

Figure 4. Carbon and nitrogen isotopic spreads of representative taxa across regions. Each data point represents one taxon.

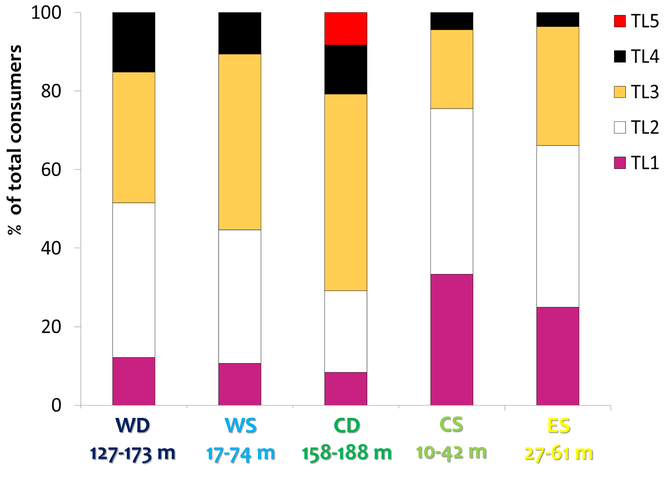

Figure 5. Relative contribution of taxa to trophic levels (1-5) across regions.

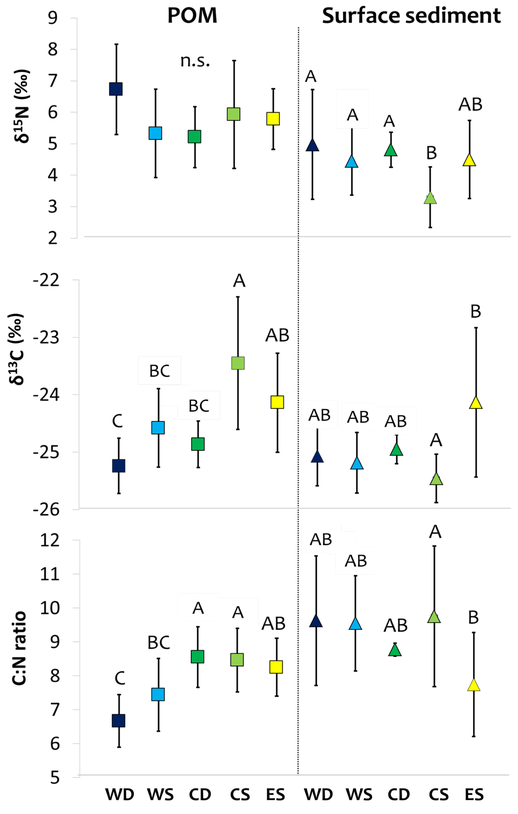

Figure 3. Mean $\delta^{15}N$, $\delta^{13}C$, and C:N ratios of POM and surface sediments in each region. Letters indicate significant differences ($p<0.05$).

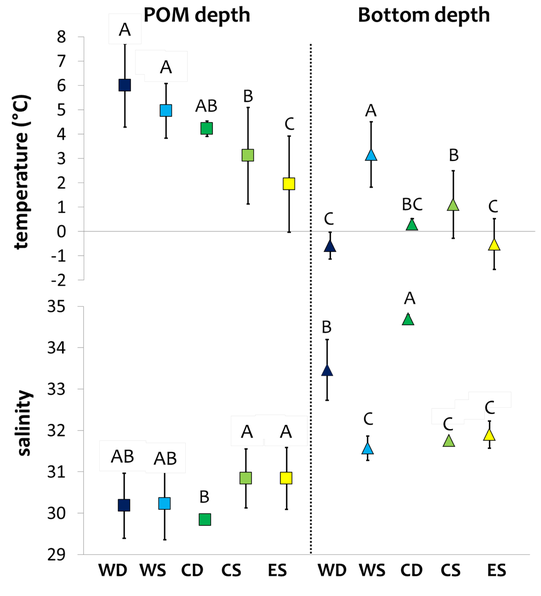

Figure 6. Temperature and salinity at POM and bottom depths for the study area. Letters indicate significant differences ($p<0.05$).

Results

- POM and surface sediment $\delta^{13}C$ and $\delta^{15}N$ ratios did not differ among most regions, except that POM $\delta^{13}C$ ratios were more enriched in CS and ES and remained high in sediments in ES (Fig. 3)
- Total isotopic spread was 11‰ for $\delta^{13}C$ and 14‰ for $\delta^{15}N$ (Fig. 4)
- Food web length ranged from 4.1 (CS) to 5.2 (CD) (Fig. 5)
- Proportions of trophic levels were similar between WD and WS and between CS and ES, while CD had a higher proportion of TL≥3 (Fig. 5)
- Surface T decreased from west to east , and were overall lower at bottom depths and salinity was lower in surface than bottom waters (Fig. 6)

Conclusions

- Overall, the western regions were similar in trophic structure, food source characteristics and environmental conditions that are reflective of the influence of Chukchi shelf waters[4].
- The CS and ES regions were very similar in trophic structure but differed in characteristics of the food sources and in temperature. This may indicate that food source characteristics or environmental conditions alone are not a reliable predictor of trophic structure.
- The CD region was distinct in terms of TL structure, and mostly intermediate between western and eastern environmental and food source characteristics.
- The stable isotope and hydrographic data reflect the complexity of water masses on the Beaufort shelf.
- A more detailed environmental analysis and of taxa within the regional food webs will possibly better define the drivers of food web structure on the complex Beaufort Sea shelf

Literature Cited

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