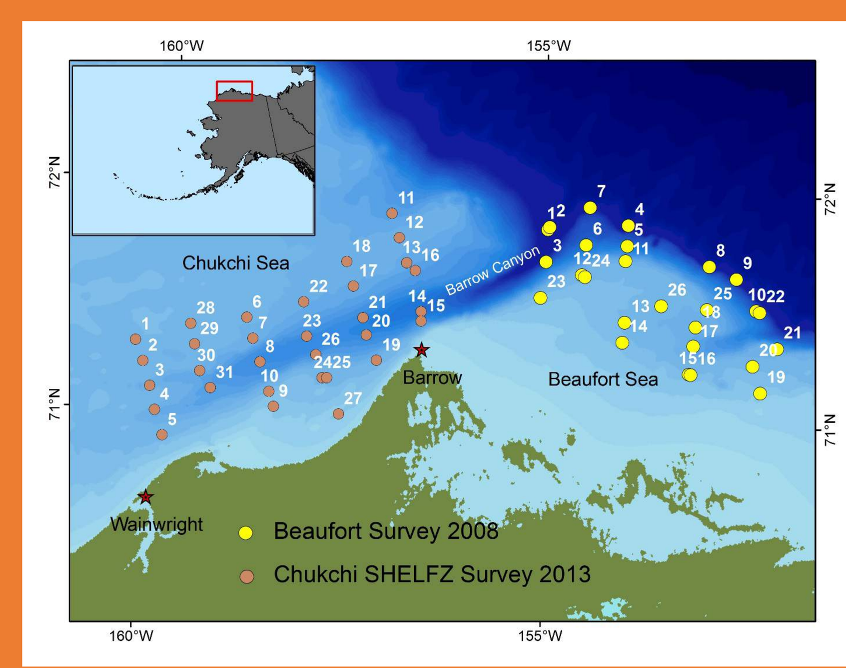
Examining two epifaunal invertebrate communities using functional traits and environmental variables in and around Barrow Canyon in the Chukchi and Beaufort seas

Kimberly Rand[1], Elizabeth Logerwell[1], Bodil Bluhm[2], Héloïse Chenelot, Seth Danielson[3], Katrin Iken[3], and Leandra de Sousa[4]

[1] Alaska Fisheries Science Center, NOAA NMFS, Seattle, WA, USA
[2] Department of Arctic and Marine Biology, University of Tromsø, Norway
[3] Institute of Marine Science, University of Alaska Fairbanks, Fairbanks, AK, USA
[4] Department of Wildlife Management, North Slope Borough, Barrow, AK, USA



Abstract

The Arctic supports a rich and diverse benthic ecosystem and within the benthos, epibenthic invertebrates comprise a large portion of the biomass. Two surveys in the northeast Chukchi (2013) and western Beaufort Seas (2008) collected data on 150+ species of epibenthic invertebrates using a small standardized otter trawl. The Beaufort Sea survey used the same net, however, a portion of the hauls had a liner (wherein Beaufort lined and Beaufort unlined). A canonical correspondence analysis (CCA) of taxa abundance constrained by a small suite of environmental variables explained 19-34% of observed variance for each of the three areas (Beaufort lined, Beaufort unlined, Chukchi). In the Beaufort Sea lined net hauls, depth was a significant variable (no significant variable in the Beaufort unlined) and bottom hardness was significant in the Chukchi.

Of the 150+ collected taxa from each survey, ~20 make up 90% of the total biomass in each system (Beaufort and Chukchi) and only have nine species in common. In this framework and to further characterize these two communities, we used biological traits analysis (BTA). The BTA concept uses biological traits as a way to define the underlying functionality of an ecological community. Although these two study areas (e.g., Chukchi and Beaufort) differed taxonomically, in abundance and distribution, they were functionally similar based on the biological traits we examined. Within each study area, several biological traits, such as body design and feeding mechanism, showed variability in their distribution. A traits analysis can advance knowledge of a community of organisms, however, it is most informative if used as a complement to a taxonomic composition analysis of abundance and distribution.

Results

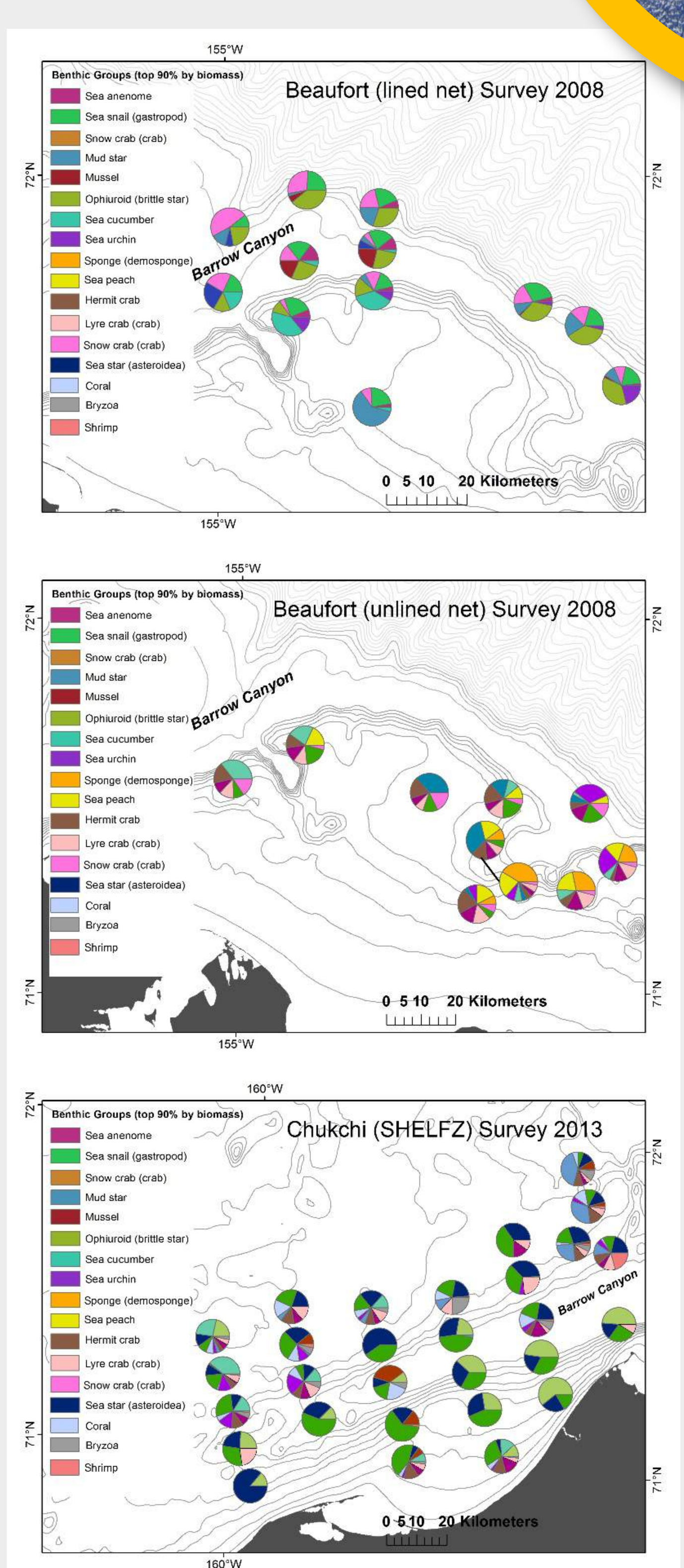


Figure 1. Benthic invertebrate species composition for the top 90% by biomass (CPUE kg/km²) for the Beaufort lined net, the Beaufort unlined net, and Chukchi hauls. Each pie chart represents one haul.

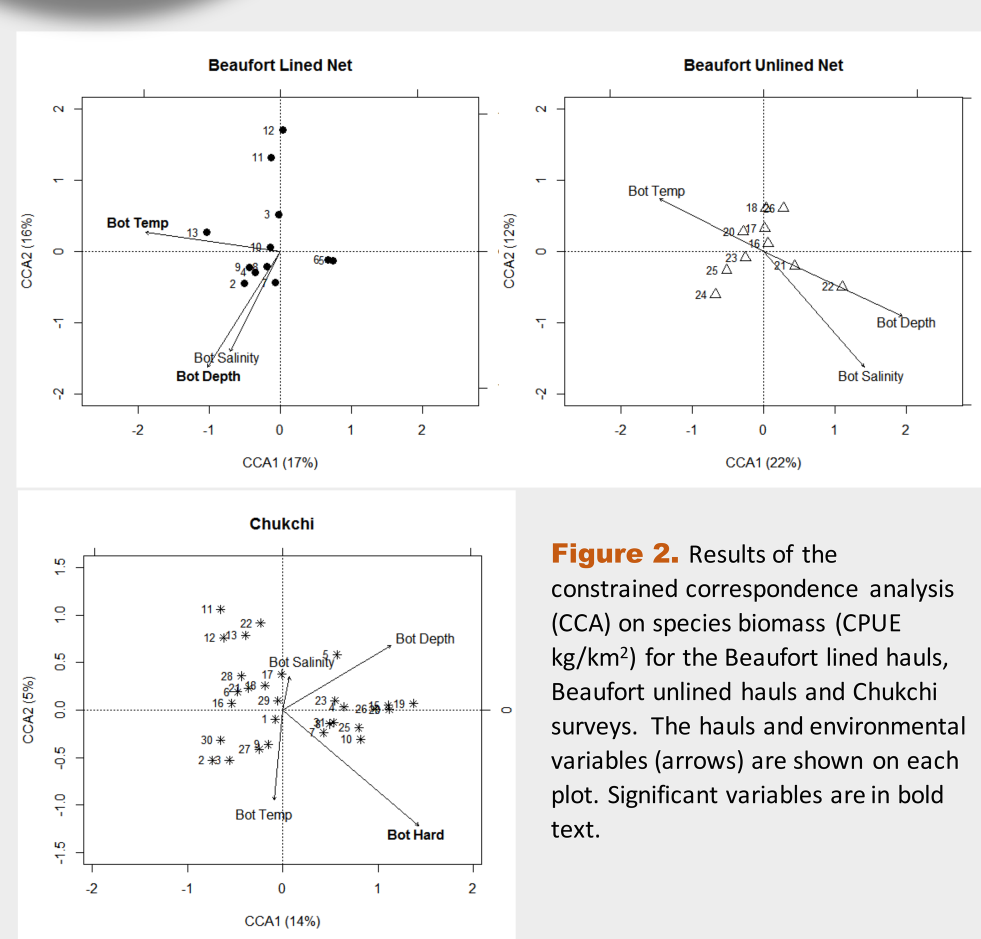


Figure 2. Results of the constrained correspondence analysis (CCA) on species biomass (CPUE kg/km²) for the Beaufort lined hauls, Beaufort unlined hauls and Chukchi surveys. The hauls and environmental variables (arrows) are shown on each plot. Significant variables are in bold text.

Table 2. The biological traits used in the FCA analysis. Within each "biological trait" are several "trait categories".

Biological Trait	Trait Categories	Trait Code
Size	small (<10 g)	S1
	medium (10-50 g)	S2
	large (>50 g)	S3
Body Design	soft	BD1
	soft/protected	BD2
	endoskeleton	BD3
	hard exoskeleton	BD4
	hard shell	BD5
Body Form	erect	BF1
	round	BF2
	flat	BF3
General Prey Type	herbivore	PT1
	omnivore	PT2
	carnivore	PT3
Feeding Mechanism	deposit feeder	FM1
	filter/suspension	FM2
	opportunist/scavenger	FM3
	predator	FM4
Degree of attachment	none	DA1
	semi-permanent	DA2
	permanent	DA3
Mobility	sessile	M1
	mobile	M2
Propagule Dispersal	pelagic	PD1
	substrate	PD2
Reproductive Mode	sexual/shed eggs	RM1
	sexual/shed larvae	RM2
	sexual/brood/shed egg	RM3
Larval Dispersal	direct	LD1
	planktotrophic	LD2
	lecithotrophic	LD3

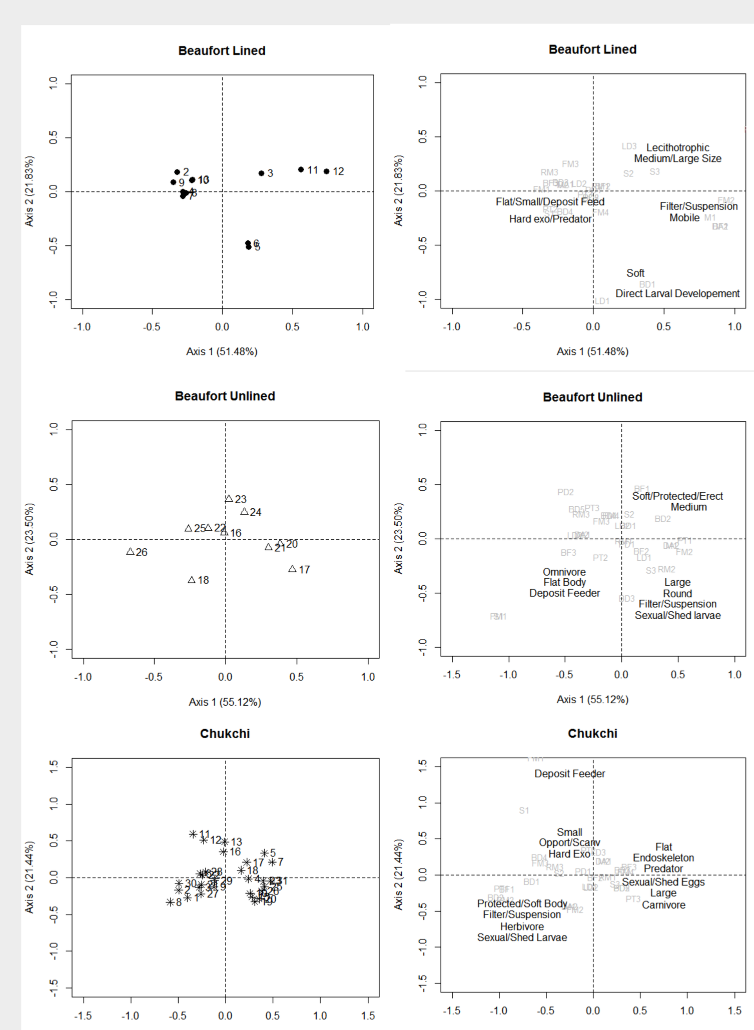


Figure 3. Results of the fuzzy correspondence analysis (FCA) on the biological traits for the Beaufort lined hauls (black dots), Beaufort unlined hauls (triangles) and the Chukchi (asterisk) surveys. The first column of graphs shows the ordination results by haul and the second column of graphs shows the ordination results by traits (in light gray text) and aids in the interpretation of the results in the first column. Hauls that are grouped can be considered similar in the biological traits they exhibit. Trait codes are written out in full black text.

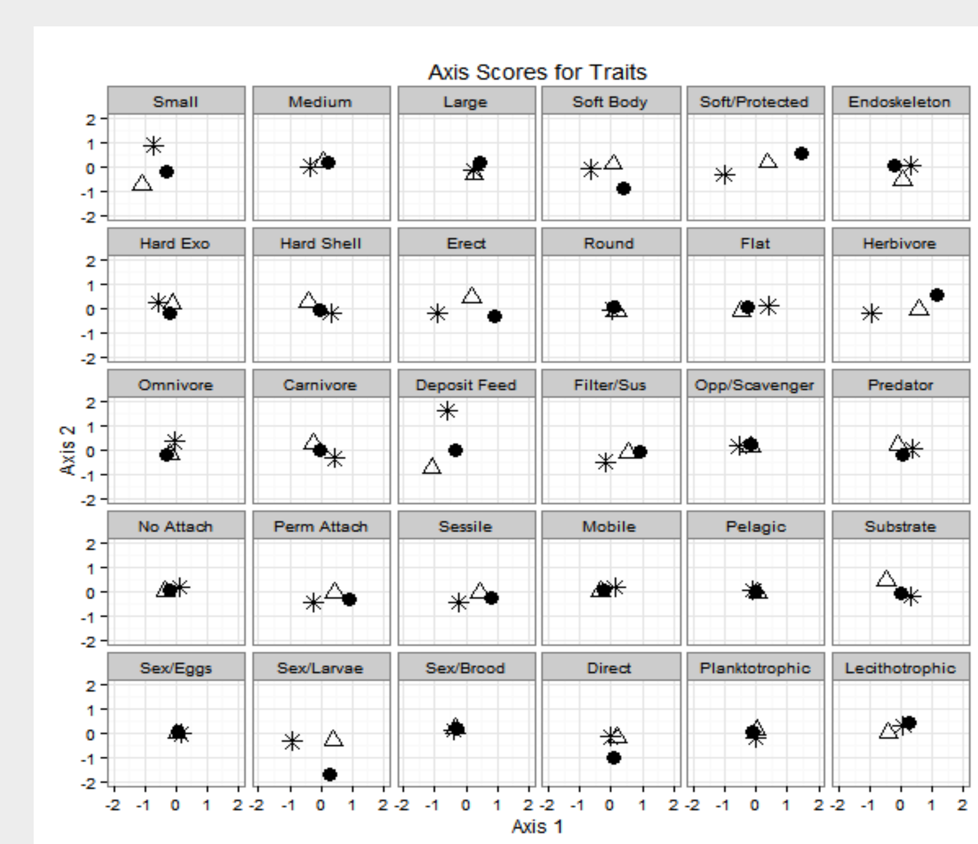


Figure 4. Traits score results from the fuzzy correspondence analysis (FCA) for the biological traits for the Beaufort lined hauls (black dots), Beaufort unlined hauls (triangles) and the Chukchi (asterisk) surveys. This figure is equal to the second column scores in Figure 3 and is a visual comparison of each trait, for each survey.

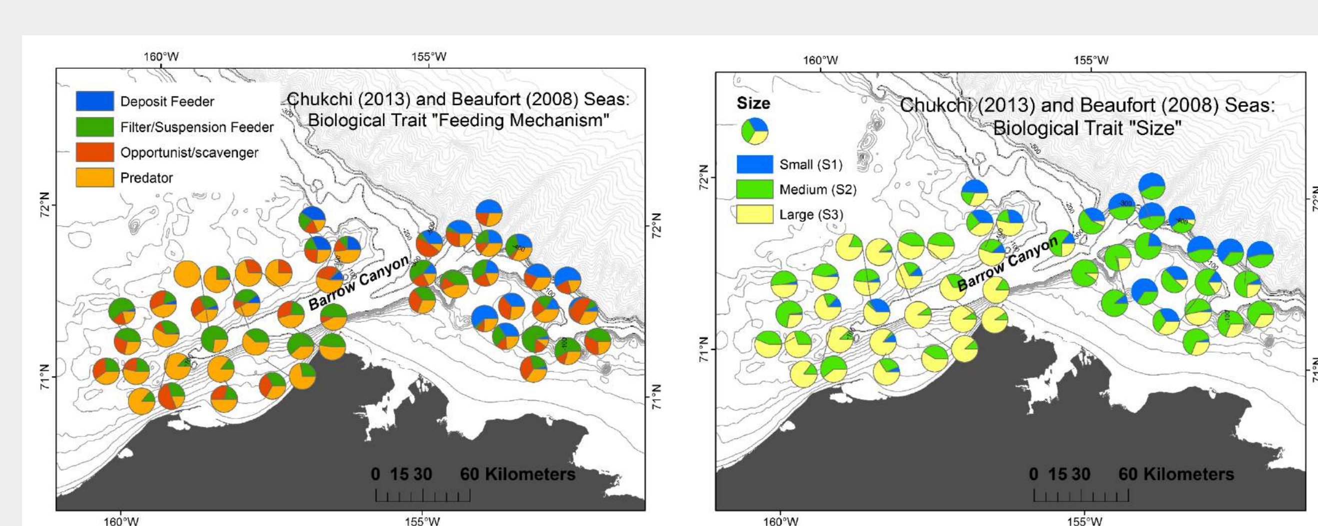


Figure 5. The biological trait "feeding mechanism" and "size" from the haul by trait matrix (weighted CPUE kg/km² trait scores) for the Beaufort lined net, Beaufort unlined net and Chukchi hauls. Each pie chart represents one haul.

Conclusions

- In the Beaufort lined net hauls, temperature and depth were significant factors in accounting for some of the variance in taxa distribution. In the Chukchi, bottom hardness was the only significant factor that accounted for some of the variance in taxa distribution.
- The W Beaufort and NE Chukchi Seas are dominated by invertebrate taxa that are similar in the biological traits we examined. There was not a biological trait exclusive to either system (i.e., all traits we examined were present in each system)
- There are differences in biological trait distributions within each system (Chukchi and Beaufort), such as "size" and "feeding mechanism".
- Using a biological traits analysis (BTA) as a complement to traditional taxonomic diversity measures could potentially be a useful tool in future monitoring of changes in the high Arctic benthic community.

Acknowledgments

For the Chukchi SHELFZ Survey: Funding was provided by *CIAP-USFWS*, *R/V Ukpik* Captain Mike Fleming and *F/V Alaska Knight* Captain Vidar Ljung and crew, Brian Person, Todd Sformo, Hugh Olemaun, Andy Whitehouse, Troy Buckley, Darcie Neff, Roger Clark, Bill Koplin, Arnold Arey, NSB-DWM, AFSC RACE Groundfish Assessment Program . For the Beaufort Sea Survey in 2008: Funding for this study was provided by the U.S. Department of the Interior's Mineral Management Service (MMS), Alaska Region, (Interagency Agreement M07PG13152 and AKC-058). We would like to thank National Marine Fisheries Service (NMFS), Alaska Fisheries Science Center's (AFSC) Resource Assessment and Conservation Engineering Division (RACE) for providing survey gear, support and expertise.