

Structure of meio- and macrobenthic communities on the Beaufort Sea shelf and slope

Sarah M. Hardy¹, Holly M. Bik², Jyotsna Sharma³, Alexis M. Walker¹

¹University of Alaska, Fairbanks; ²University of Birmingham; ³University of Texas, San Antonio

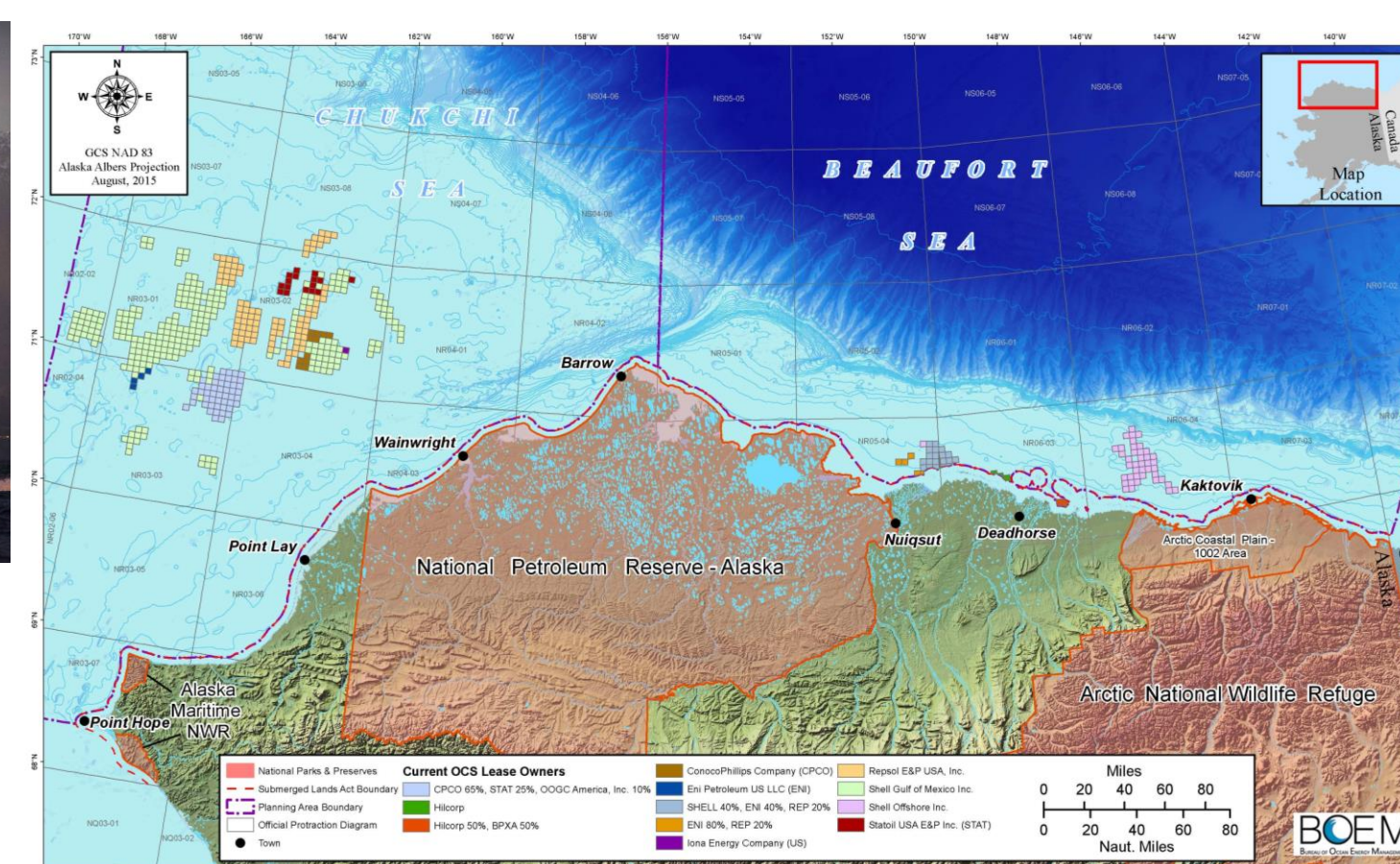
Contact: smhardy@alaska.edu



Rapid change is occurring in the Arctic concurrently with increased human activity, yet our knowledge of the structure and function of high-Arctic sediment communities is still rudimentary. The Beaufort Sea is particularly poorly sampled, and virtually unexplored at slope depths, providing little information with which to assess the impacts of petroleum exploration and extraction activities that are beginning in this area. We are investigating diversity and community structure of benthic infauna on the continental shelf and slope of the Beaufort Sea across a range of depths (50 to 1000 m) using traditional taxonomic and environmental DNA sequencing approaches. We are also comparing results to additional sites in the adjacent NE Chukchi Sea lease sale area. The Beaufort slope is topographically complex and characterized by an east-west gradient in benthic habitat characteristics, with heavy input of terrestrial organic matter particularly in the region of the Mackenzie River delta. Warmer, saltier subsurface Atlantic water masses impact benthic communities at mid-slope depths, likely resulting in influx of species of Atlantic origin. Food resources are variable across the region, with very high sediment chlorophyll concentrations at 350 m depth in some areas. Differences in nematode assemblages were detected across the Beaufort Sea shelf/slope, across depths within the Beaufort Sea, and between the Beaufort and adjacent NE Chukchi Sea. These differences were apparent in both morphological and environmental sequencing data. Preliminary analysis of macrofaunal communities showed variable community structure among transects, with high abundance and high dominance coincident with the Chl-max.

Beaufort Sea Study Area

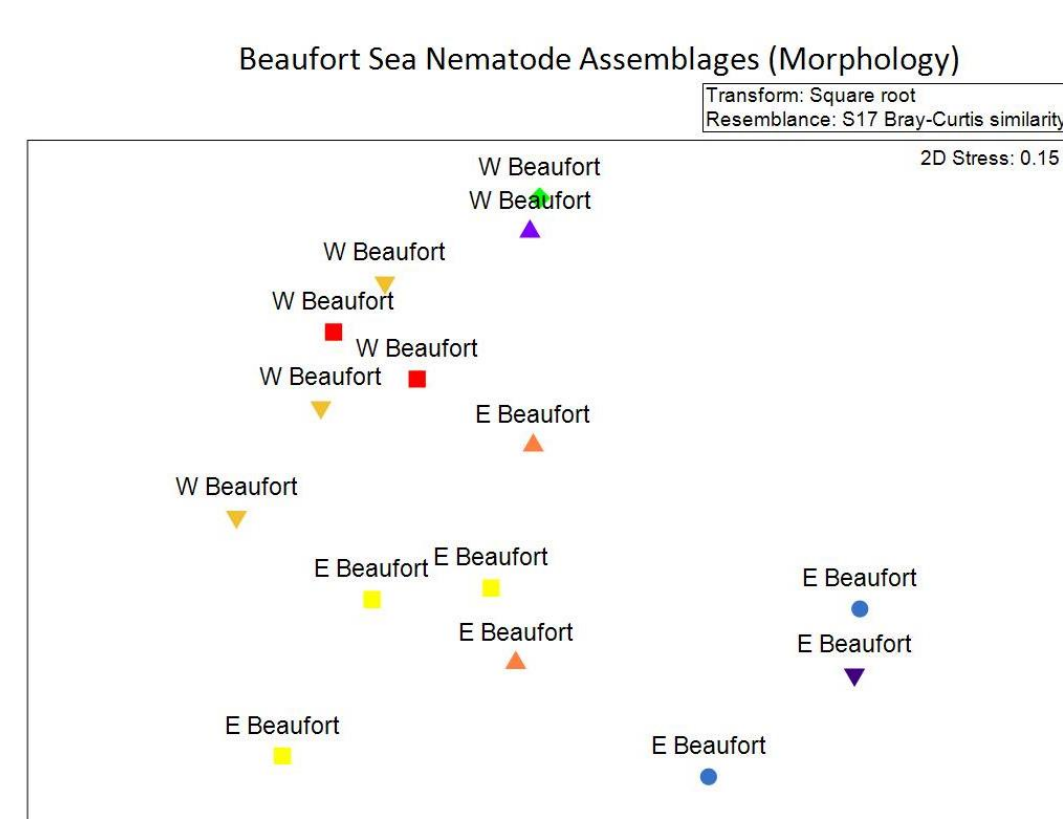
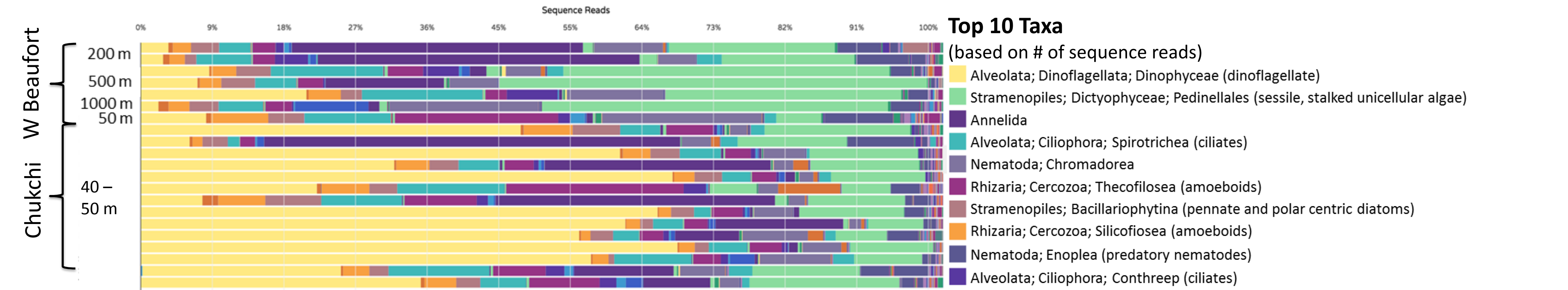
Several active leases for petroleum exploration are currently held in the Beaufort and adjacent Chukchi seas. Another lease sale is scheduled for the Beaufort Sea in 2017. At present, active production is only occurring on Alaska's North Slope coastline, but active exploratory drilling is expected to begin in summer 2015 in the Chukchi.



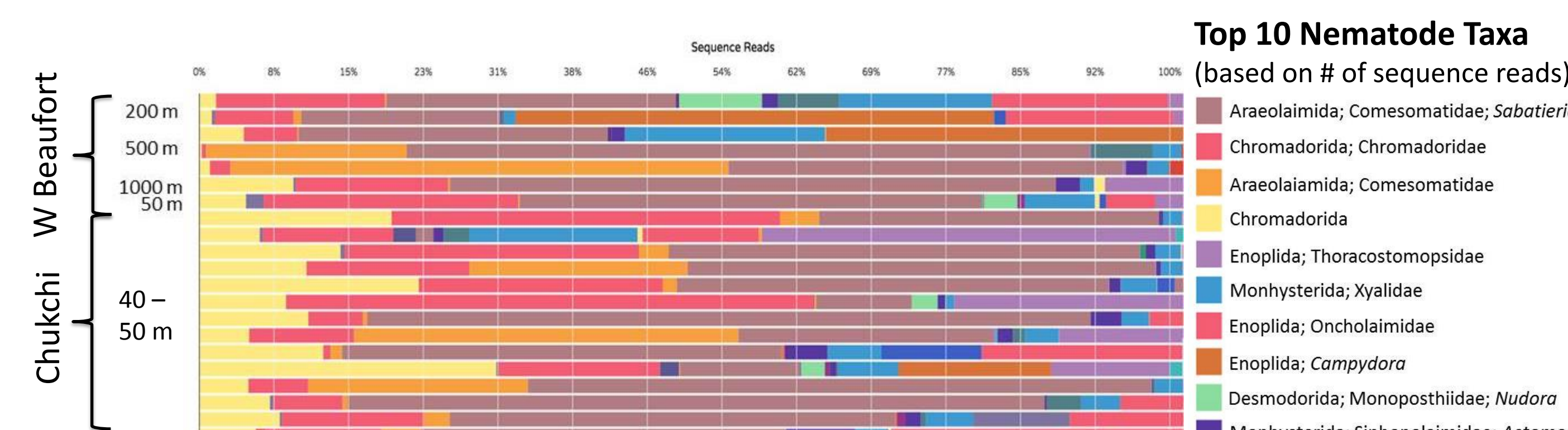
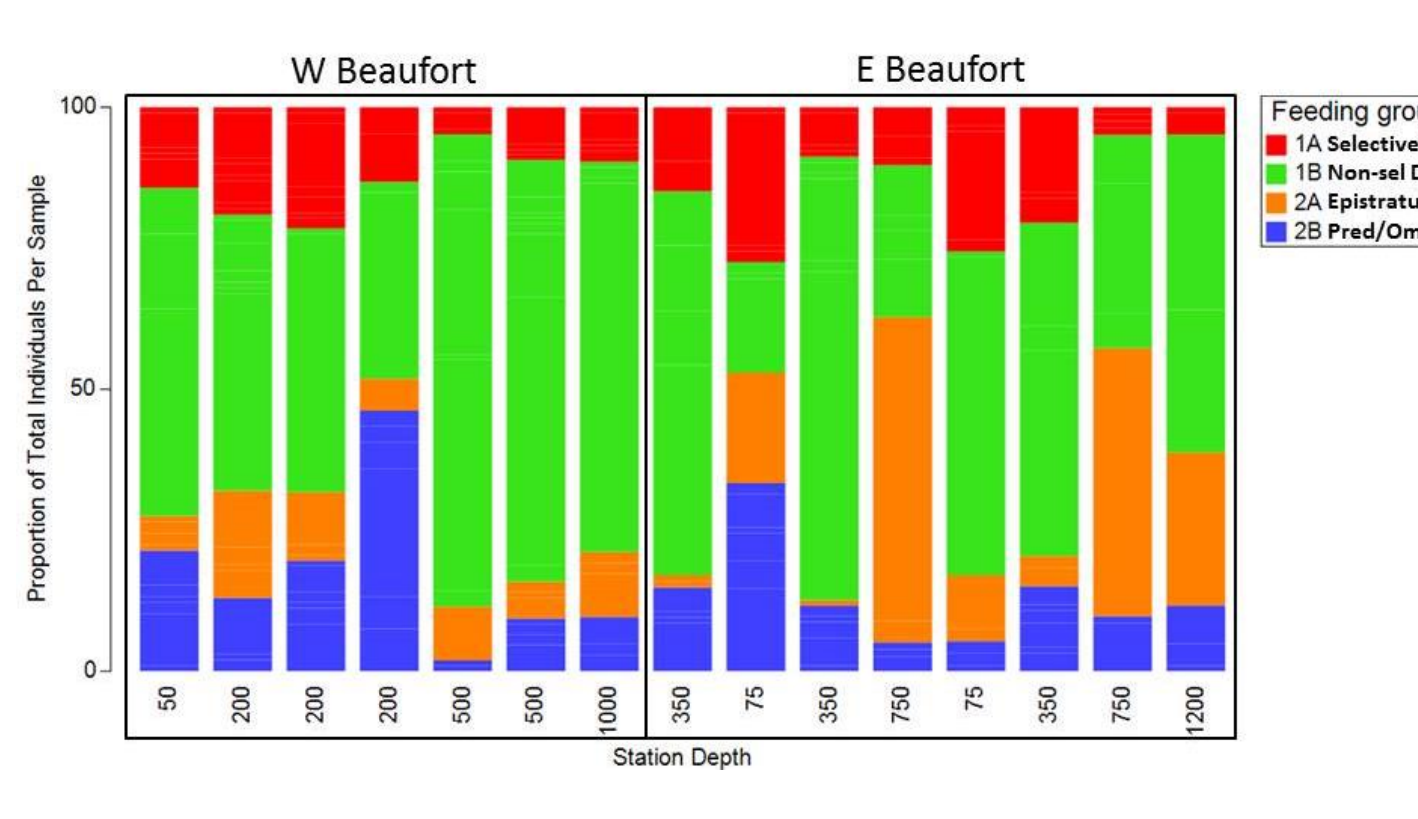
(Above) Exploratory rig en route to the Chukchi Sea. (Right) Active leases in the Alaskan Arctic

Meiofaunal Communities

Sediment community composition based on 18S amplicon-sequencing of environmental DNA highlights the importance of benthic protists, dominated by dinoflagellates in the Chukchi and Stramenopiles (including diatoms and the sessile Pedinellales) in the Beaufort. These groups may represent an unquantified source of production entering the food web, particularly at shallower locations.

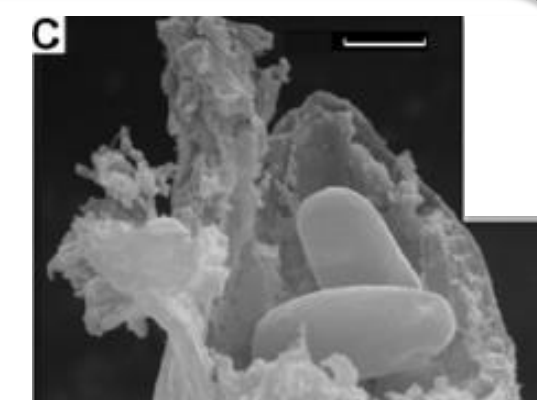


Beaufort nematode community structure based on morphology: (left) nMDS plot of abundance, showing E-W and bathymetric differences in. (right) Proportion of individuals attributed to major feeding groups [after Wieser 1953; 1]. Deposit feeders dominated at most sites, but epistratum feeders (possibly bacterivorous) were also very abundant at some deeper eastern sites receiving inputs of more heavily reworked carbon.



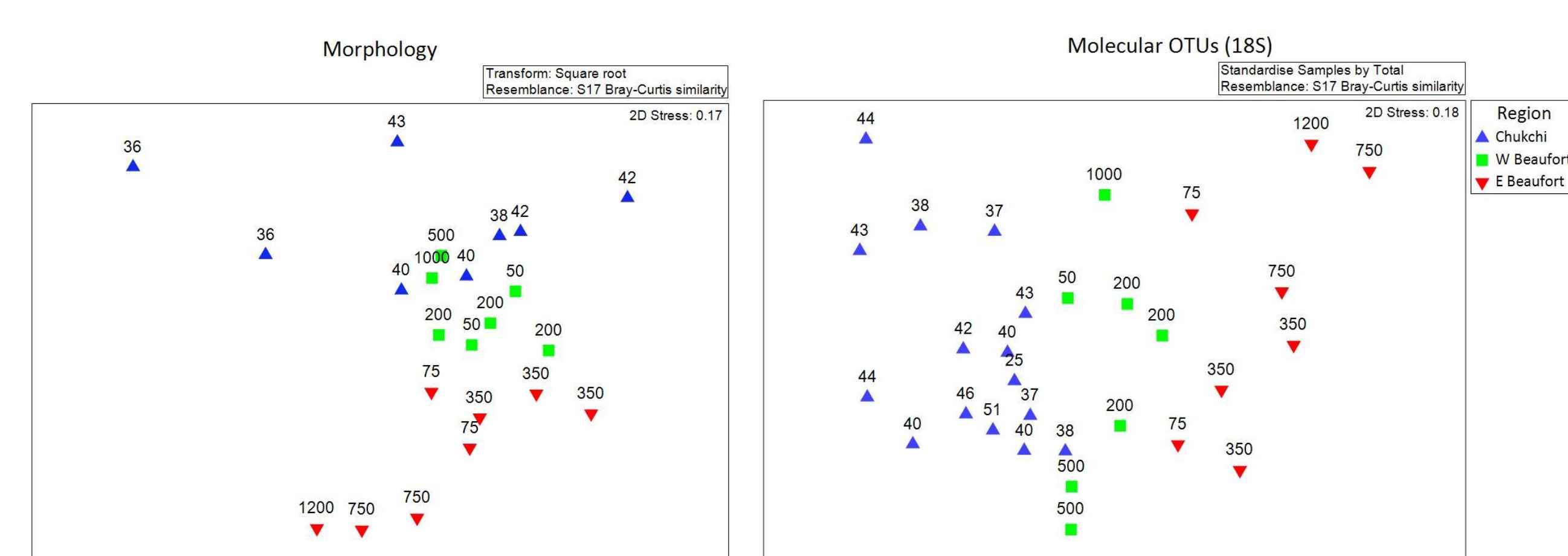
Top 10 Nematode Taxa (based on # of sequence reads): *Sabatieria*, a wide-spread genus described as opportunistic was by far the most abundant taxon in both molecular and morphological datasets. This non-selective deposit-feeding group is found to be common in disturbed environments elsewhere.

Astomonema contains several mouthless species with thiotrophic endosymbionts (shown here in the body cavity of *A. southwardorum*). [2]



Nematode community structure based on molecular OTU data: Taxa contributing to >70% of within-group similarity for each study region, based on SIMPER. Genus names listed reflect matches to GenBank records; those listed as "cf." refer to closest match for novel OTUs.

Chukchi	W Beaufort	E Beaufort	Family	Genus
			Comesomatidae	<i>Sabatieria</i> sp. OTU1
			Chromadoridae	<i>Neochromadora</i>
			Comesomatidae	<i>Setosabatieria</i>
			Comesomatidae	<i>Sabatieria</i> OTU2
			Chromadoridae	cf. <i>Chromadorita</i>
			Chromadoridae	cf. <i>Neochromadora</i>
			Comesomatidae	<i>Calomicrolaimus</i>
			Enopleidae	cf. <i>Campydora</i>
			Comesomatidae	<i>Sabatieria</i> OTU3

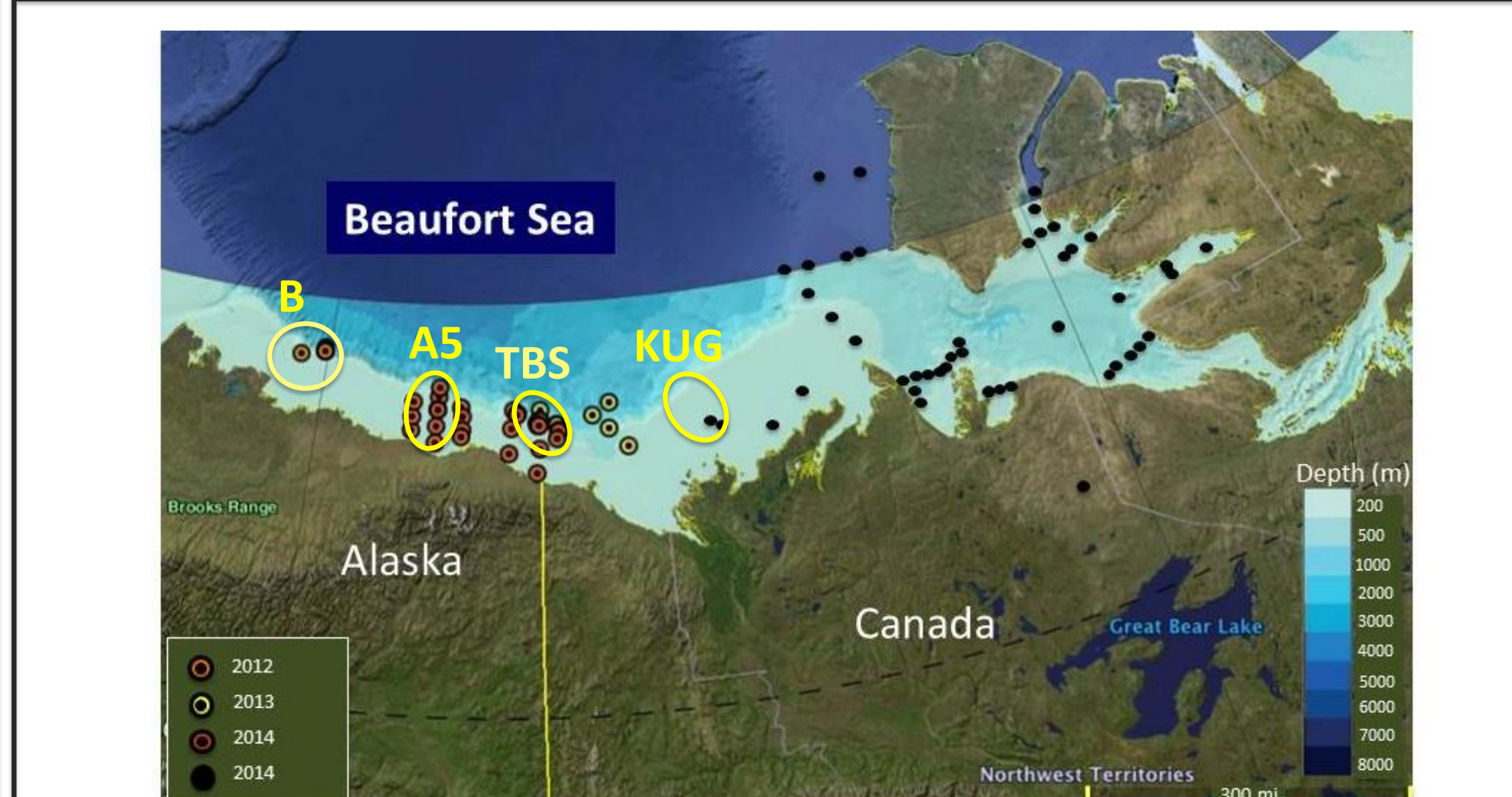
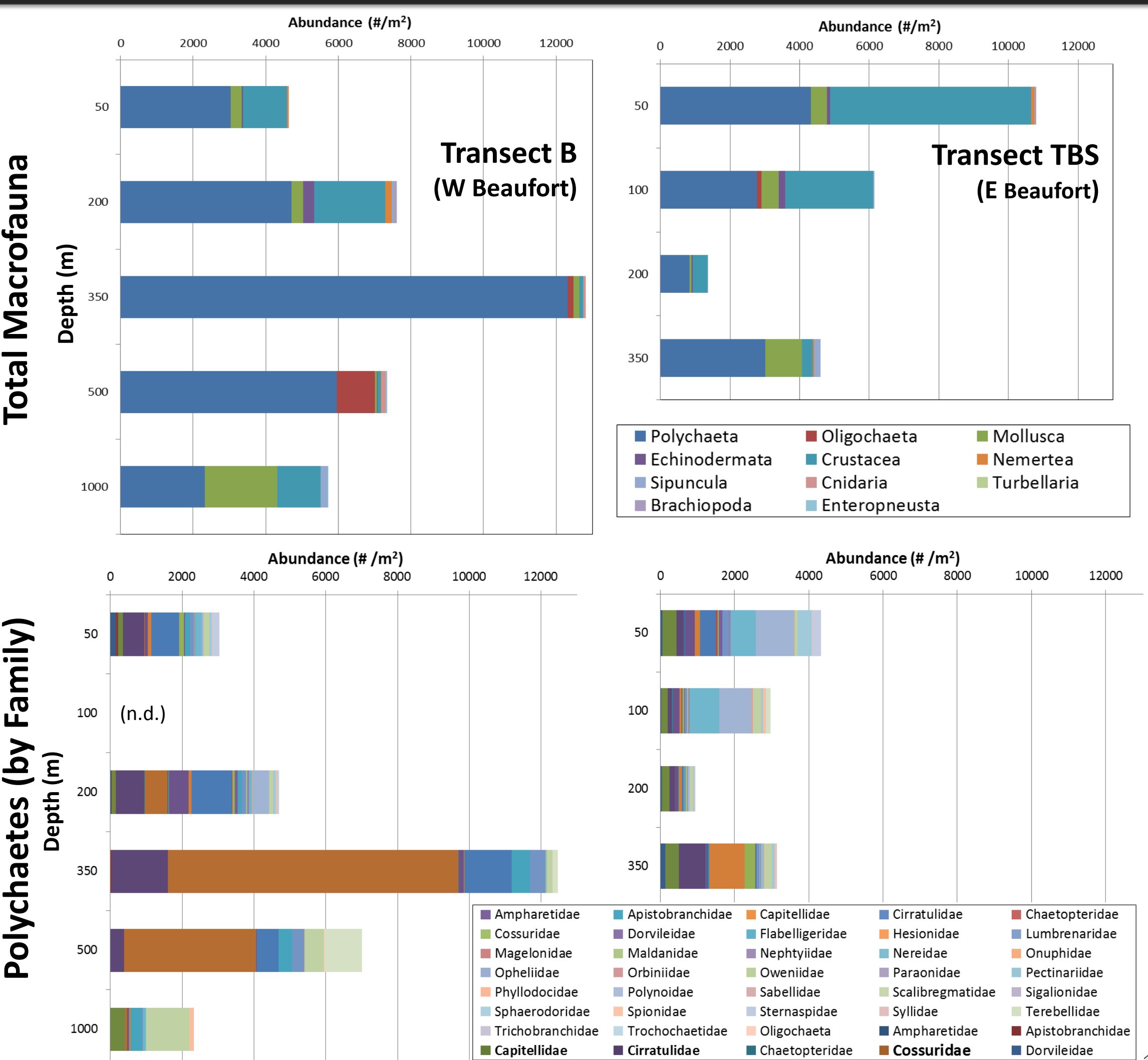
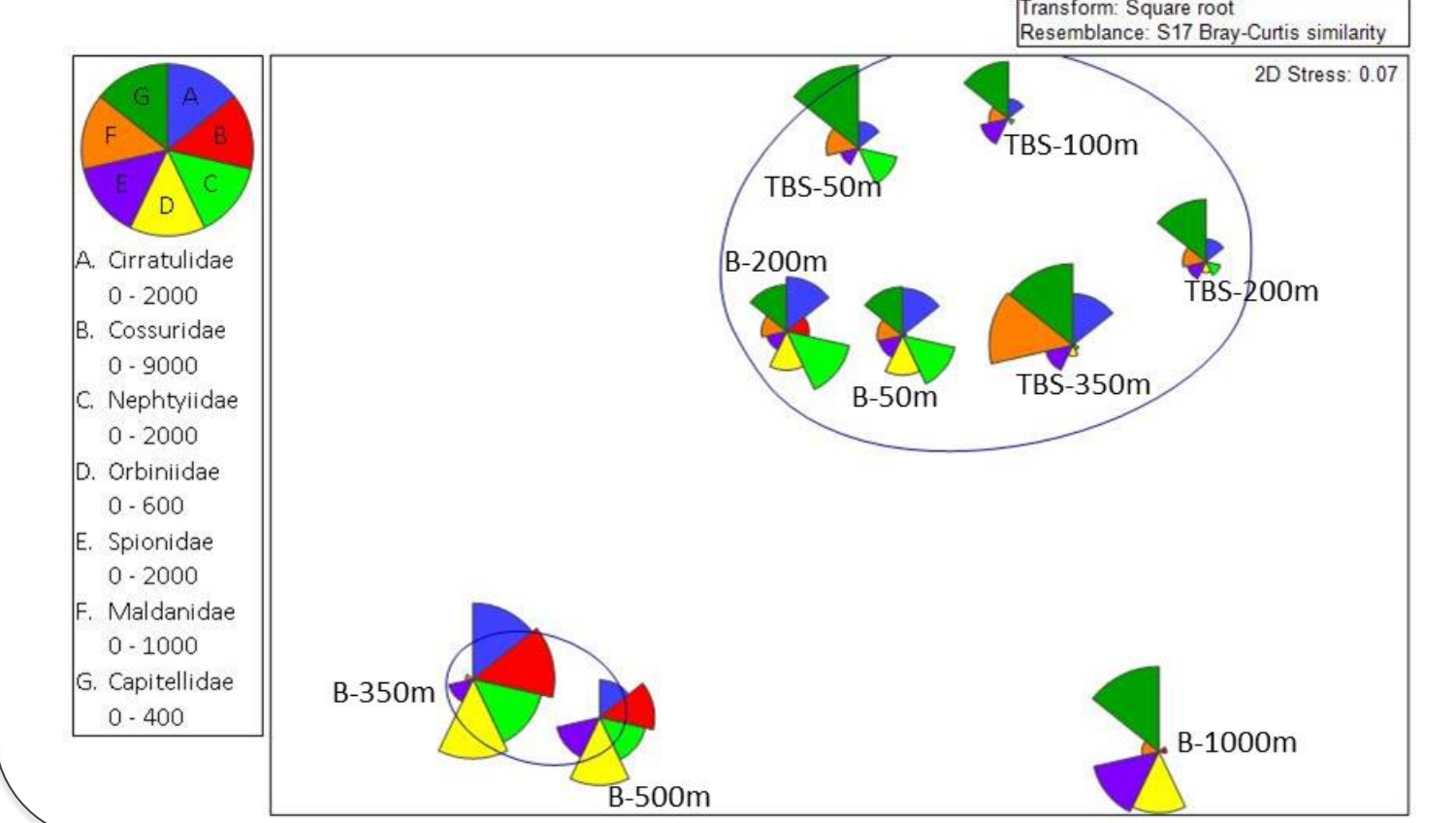


Comparing methods: nMDS plots of morphological and molecular OTU data for nematodes, colored by region; numbers next to each symbol indicate sampling depth. **Molecular and morphological approaches both showed significant differences in nematode community structure among regions, and among depths (when samples were pooled across region).**

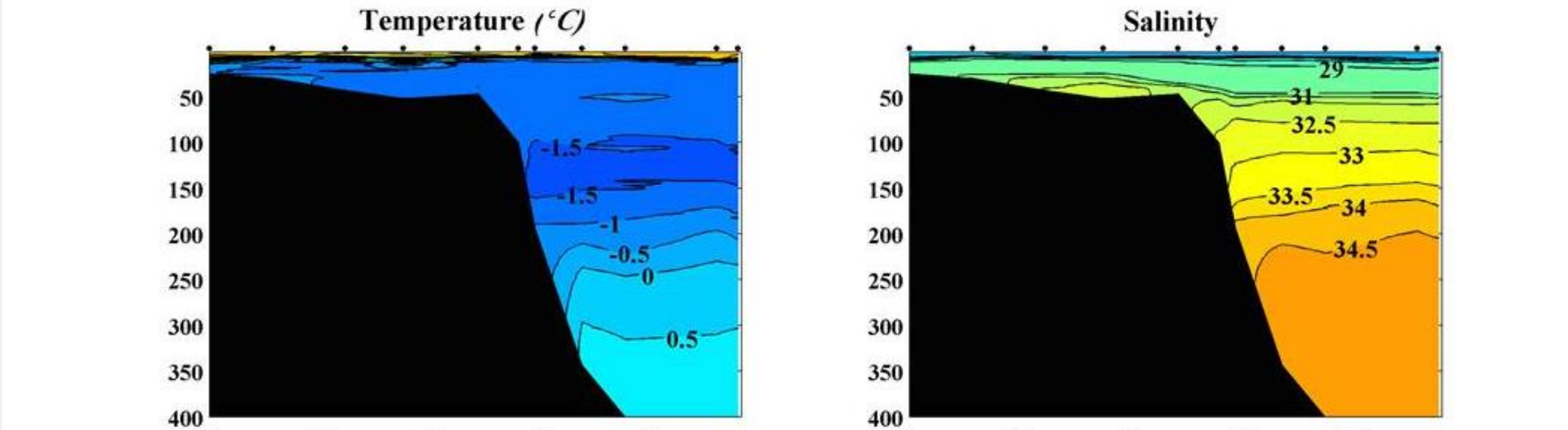
Macrofaunal Communities

Macrofaunal community structure: (top right) Total macrofauna and (bottom right) polychaetes, based on morphological data. High abundance and high dominance occur in the polychaetes coincident with maximum [Chl-a] at 350 m. TBS transect shows greater contribution of crustaceans to total abundance. A marked shift in composition occurs between 200 and 350 m depth in both areas; this boundary is also observed in larger epifauna.

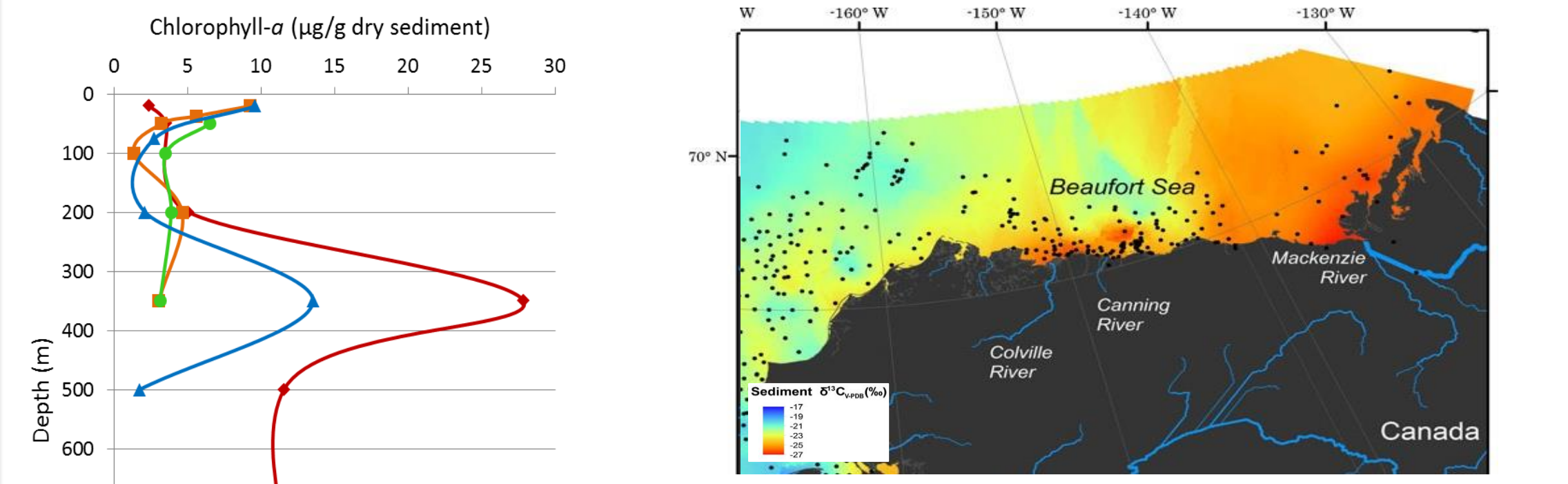
Polychaete community structure: nMDS plot showing relative abundance of taxa contributing the most to within-group similarity and/or dissimilarity between clusters. Ovals indicate significantly different clusters based on SIMPROF test. Labels indicate transect (B = west, TBS = east) and station depth.



Sampling locations in the Beaufort Sea (2012 – 2014). Macrofauna data are presented for transects B and TBS; meiofauna data are presented for a subset of the 2012 and 2013 Beaufort stations, and from additional sites in the NE Chukchi.



Representative temperature and salinity profiles (from transect TBS; see map above). Warmer, saltier water masses contact slope at depths >200m. Surface conditions are more variable in space and time, but are typically fresher and colder due to the influence of freeze/melt cycles.



(left) Chl-a concentration in the top 1-cm sediment layer along selected transects. (above) Carbon stable-isotope values show input of terrestrial OM by major rivers [3].

Methods

- Meiofauna (>63 μm) were subsampled from the top 1 cm of 0.1 m² Van Veen grabs and 0.25 m² box cores in 2012 – 2014 (see map above for Beaufort locations; depths 40 – 1200m).
- Macrofauna (>500 μm) were collected from box cores and grabs in the Beaufort Sea only.
- Additional sediments were collected from the same box cores, or from replicate grab samples, for measurements of food quality/quantity and grain size.



- Meiofauna samples were preserved whole upon collection. Meiofauna were later extracted from sediments via decantation.
- Decanted samples were subjected to environmental DNA extraction and 18S amplicon sequencing using the Illumina MiSeq platform.

References Cited:
 [1] Feeding groups reviewed by: Moens et al. (2013) Ecology of free-living marine nematodes. In: Schmidt-Rhaesa A (ed) Handbook of Zoology, vol 2, De Gruyter, Berlin, p 109-152
 [2] Image: Tchesunov AV, Ingels J, Popova EV (2012) Marine free-living nematodes associated with symbiotic bacteria in deep-sea canyons of north-east Atlantic Ocean. J Mar Biol Ass U K 92:1257-1271
 [3] Dunton KH, Schonberg SV, Cooper LW (2012) Food web structure of the Alaskan nearshore shelf and estuarine lagoons of the Beaufort Sea. Estuaries and Coasts 35:416-435
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