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Multiscale Analysis of Megabenthic Communities off the Antarctic Peninsula

Background

Patterns in megabenthic community distribution and composition are regulated by a variety of environmental and biotic drivers, the importance of which vary with spatial scale. The multiscale nature of these fundamental cause-effect relationships has very rarely been explicitly addressed in marine polar research. However, it is generally known that these are very important for understanding ecological processes, as well as for developing evidence-based conservation and environmental management practices.

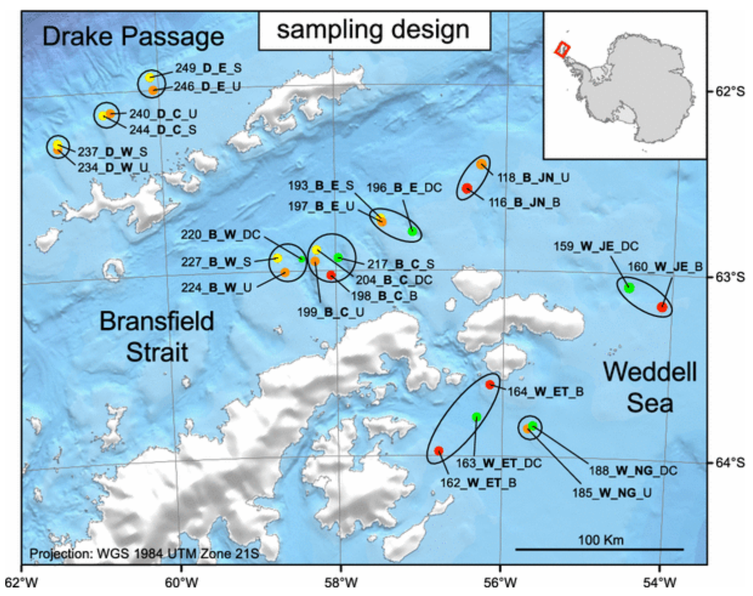

Fig. 1. Map of the study area (Gutt et al. 2016)

Approach

Moran's Eigenvector Mapping (MEM) was used to describe the multiscale nature of the megabenthic community (Borcard et al. 2011; Legendre & Legendre 2012). The ecological information were provided by a photographic survey (a total of 2799 seabed images taken with the Ocean Floor Observations System; Piepenburg et al. 2017).

Redundancy Analysis (RDA) and **Variation Partitioning** were used to link spatial structures and measured physical and biological factors at various spatial scales.

Taxa / Scales	Broad	Meso	Small	Fine
Mobile Polychaetes	■		■	
Filtering Holothuroids	■	■	■	
Detritivorous Holothuroids	■			
Solitary Ascidians	■	■	■	■
Compound Ascidians	■	■	■	■
Echinoids	■	■		
Crinoids	■		■	
Asteroids	■	■	■	
Ophiuroids	■			
Hemichordates	■			
Demospongia	■			
Hexactenellidae	■			
Anthozoa	■			
Hydrozoa	■			
Gorgonarians	■	■	■	■
Bryozoa	■			■
Infauna (indicator)	■			
Other epifaunal species	■			

Fig. 3. Bransfield Strait. Megabenthic taxa associated with broad-, meso-, small- and fine-scale MEM models. The significance level (strength of relationship) is indicated by cell color: black: $p \leq 0.001$, dark grey: $p \leq 0.01$, light grey: $p \leq 0.05$, white: not significant ($p > 0.05$).

Results

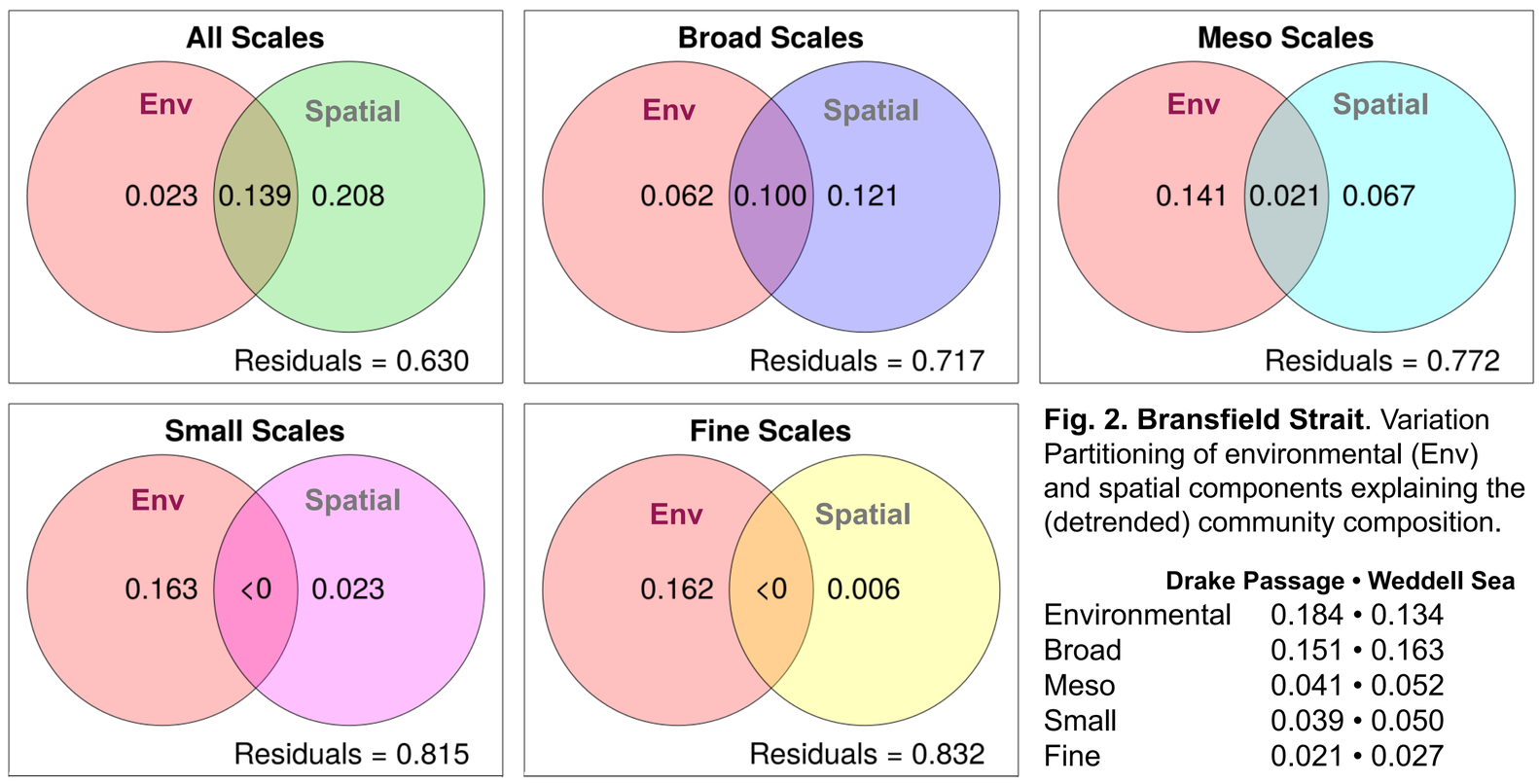

Fig. 2. Bransfield Strait. Variation Partitioning of environmental (Env) and spatial components explaining the (detrended) community composition.

	Drake Passage • Weddell Sea
Environmental	0.184 • 0.134
Broad	0.151 • 0.163
Meso	0.041 • 0.052
Small	0.039 • 0.050
Fine	0.021 • 0.027

Conclusions

Megabenthic communities off the Antarctic Peninsula are spatially structured at a wide range of scales, with variations reaching in extent from >50 km (large-scale) down to several meters and 2 km (fine- and small-scale, respectively). Most megabenthic taxa display nested spatial dispersion patterns at more than a single spatial scale.

At broad and meso- scales, most of the measured sea-floor and water-column variables have significant influence on the captured spatial megabenthic variation, with some variables having comparatively larger impact.

At small and fine scales, less measured environmental variables contribute to the captured spatial megabenthic variation, suggesting that at these scales biological interactions and/or other (not measured) environmental components are more important drivers.

References
Borcard, Gillet & Legendre (2011) Numerical ecology with R • Gutt et al. (2016) Macroepibenthic communities at the tip of the Antarctic Peninsula, an ecological survey at different spatial scales. Polar Biology 39 • Legendre & Legendre (2012) Numerical ecology, 3rd Edition • Piepenburg et al. (2017) Seabed images from Southern Ocean shelf regions off the northern Antarctic Peninsula and in the southeastern Weddell Sea. Earth System Science Data 9.

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