Whittard Canyon's eastern branch: zooming in from tidal models to fine-scale photogrammetry

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The complexity of submarine canyons is well known and in order to address how this heterogeneity affects species spatial patterns, it is important to consider this habitat in three dimensions and at multiple scales. At the broader scale, the accidented topography results in an array of benthic habitats, but also significantly affects the hydrodynamics of the overlaying waters. At the finer-scale, complex three dimensional features such as vertical and overhanging cliffs are colonized by a wide diversity of organisms, often including vulnerable marine species such as cold-water corals. In this study, we build on previous work which had used ROV video surveys to predict spatial patterns in abundance, species richness and diversity across the four main branches of Whittard Canyon. However, these past studies were mostly carried out at an intermediate scale and focused on the importance of bathymetry (ship-mounted) and derived terrain variables. We now revisit these predictions, and demonstrate the importance of also considering hydrodynamic variables. Investigation of the M2 internal tide in the canyon, using the Princeton Ocean Model, showed clear differences in internal tidal energy between the canyon branches. The inclusion of the resulting internal tide driven currents (magnitude and direction) helped increase the amount of variation explained in predictive habitat models of species richness and diversity. In addition, the habitat predictions highlighted the importance of vertical structures, we employed recently developed photogrammetry approaches (structure from motion) to reconstruct sections of canyon walls in three dimensions from ROV video footage. These very high resolution reconstructions were used to position very accurately in three-dimensional space individual organisms and derive terrain variables on scales similar to those experienced by megabenthic individuals (<20cm for sonar and <1cm for photogrammetry). Using this information we explore fine-scale spatial partitioning of cliff environments for a variety of organisms including Acesta clams, the cold-water coral Lophelia pertusa and a few different morphotypes of soft corals. The large amount of work having been carried out within Whittard Canyon allows for the integrated multi-disciplinary studies needed to examining the complex biological spatial patterns often observed within submarine canyons.

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