Bottom trawling at Whittard Canyon: Evidence for seabed modification, trawl plumes and food source heterogeneity

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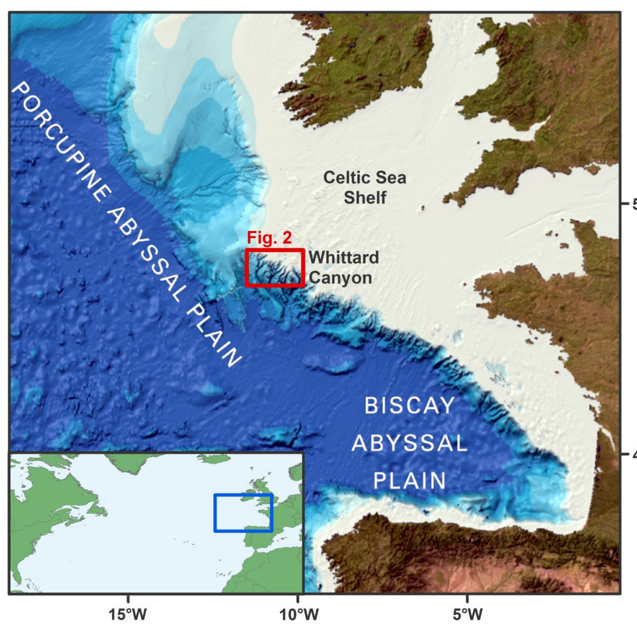


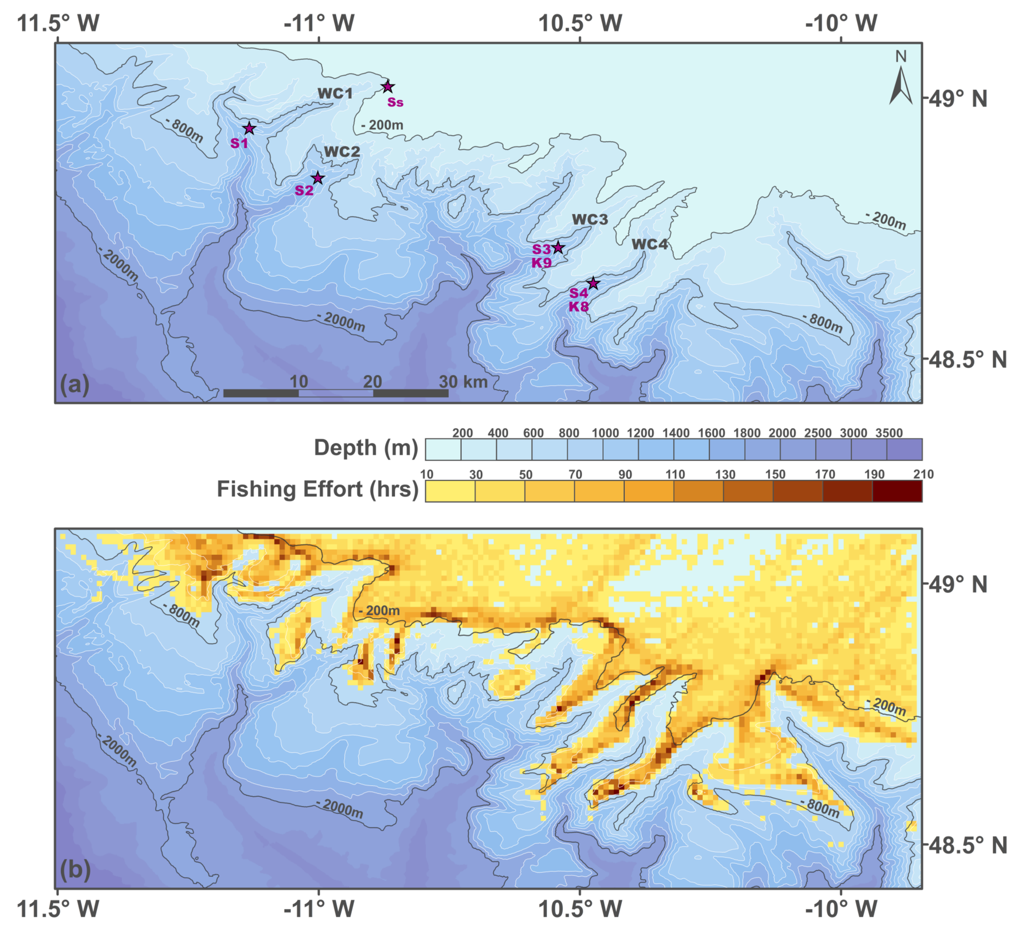
Fig. 1. Above, Whittard Canyon area located off the south west Celtic Sea

Fig. 2. Across, **(A)** bathymetry map showing individual canyon branches and sample locations. **(b)** VMS fishing effort (ten years: 2006 - 2016) imposed on bathymetry.

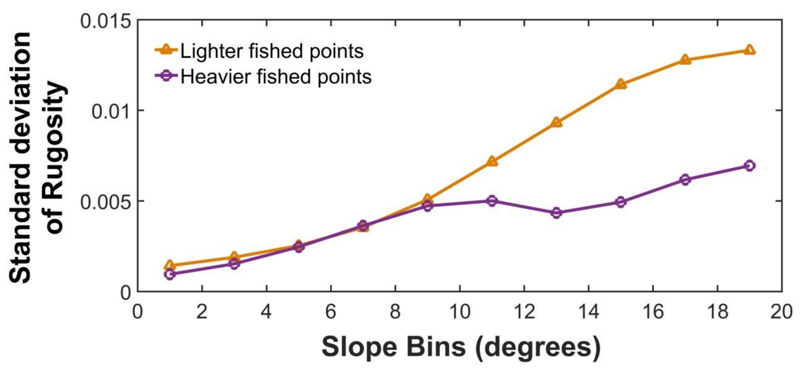
Whittard Canyon: An Area of Issues and Interest

Along the southern-most extent of the Irish continental margin, the Whittard Canyon system is a large dendritically shaped arrangement of submarine canyon branches that are land detached by the span of the Celtic Sea shelf (***Fig.1***). This area provides an array of habitats for many diverse fauna, from cetaceans to deep sea fish to cold water coral reefs (e.g. Johnson et al., 2013). It also provides a hunting ground for an international fleet of fishing trawlers, intent on catching their various target species for supply to the lucrative sea-food industry. As per EU regulations these vessels must be tracked using a Vessel Monitoring System (VMS) through satellite communication (Gerritsen et al., 2013) and fishing intensity can be subsequently mapped from this data (***Fig. 2***).

Following from a Griffith Project funded study, Daly et al. (2017) looked at three aspects of bottom trawling effects on the Whittard Canyon system: seabed, sediment plumes and quality of benthic food supply.



Trawl Gear: A Seabed Being Modified?



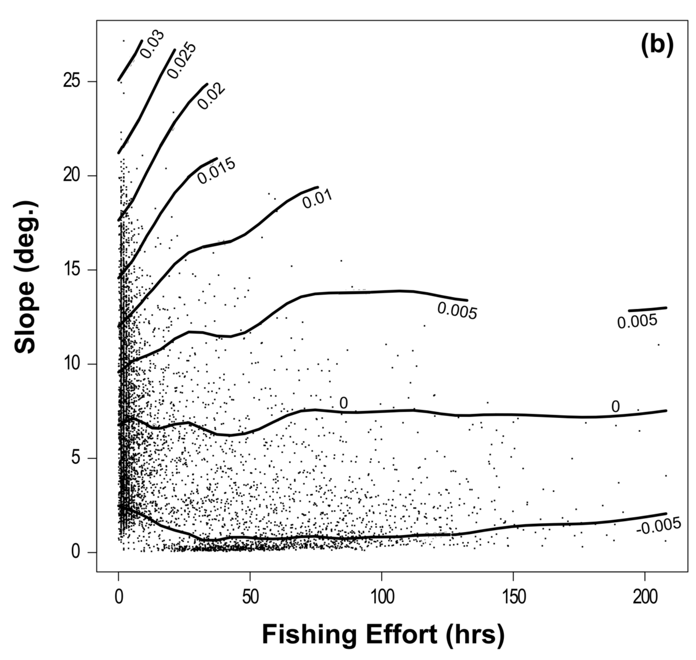


Fig. 3. Above, Standard deviation of rugosity split by median fishing values and gathered over 2 degree slope bins

Fig. 4. Right, GAMs model output of rugosity contours on a plot of the independent (interacting pair) variables of slope against fishing effort

The effects of heavy trawl gear on seabed roughness were examined by building a rugosity index through GIS and correlating it with VMS fishing effort. Standard deviation of rugosity can be viewed as a proxy for the heterogeneity of seafloor roughness, where heavier fished areas were found to be smoother over slopes grater than 8 – 10 degrees (***Fig. 3***). Further to this, by using a Generalised Additive Model (GAMs) analysis, it was found that fishing effort and slope, along with latitude and longitude, correlated convincingly with rugosity. In ***Figure 4*** contours of rugosity would be horizontal if there was no relationship with fishing. Although this does not quite prove cause and effect, it certainly points to the strong possibility that bottom trawling is altering seafloor roughness. Future plans are to carry out a 'before and after' study of rugosity in the region using up to date bathymetry data, gathered in 2017 with the support of INFOMAR, and to correlate any changes with fishing effort.

Tracking Trawl Plumes with Turbulence

Trawl plumes of exceptionally high Suspended Particulate Matter (SPM) can be described as Enhanced Nepheloid Layers (ENLs) and result from heavy trawl gear throwing up sediment, which in turn advects and sinks down canyon (Wilson et al., 2015). These plumes have been investigated here using density profiles from high resolution (0.25 m) CTD casts, to derive density overturns (vertical eddies) and turbulent energy dissipation. A CTD mounted transmissometer measured SPM. Results for the most heavily fished canyon branch clearly show an ENL around 1200 m deep (***Fig. 5***). ***Figure 6*** contrasts normal canyon conditions to that of a trawl plume event, using (***A***): derived contours of SPM and (***B***): individual CTD profiles of SPM representing values before and after trawling occurred.

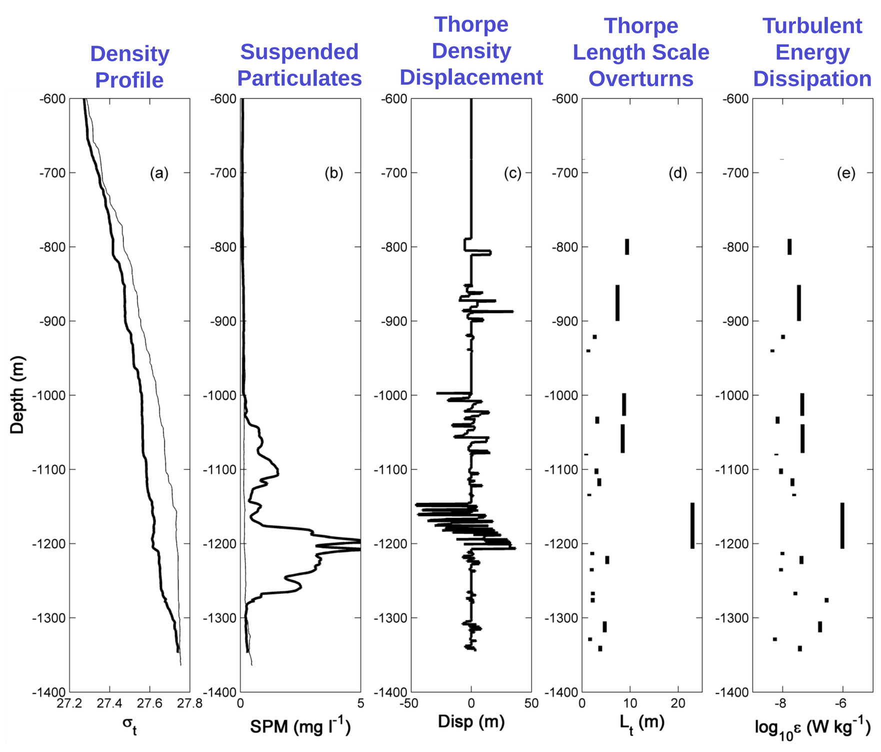


Fig. 5. Results of SPM and density profile analysis.

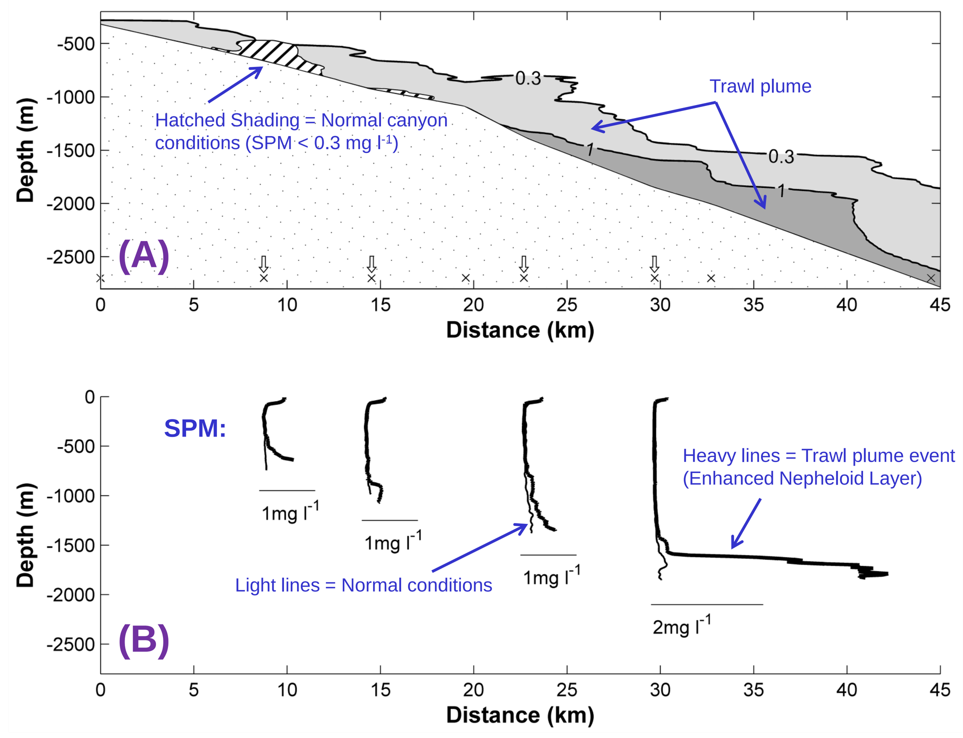


Fig. 6. (A) Canyon axis section of SPM contours. (B): SPM profiles from individual CTD casts.

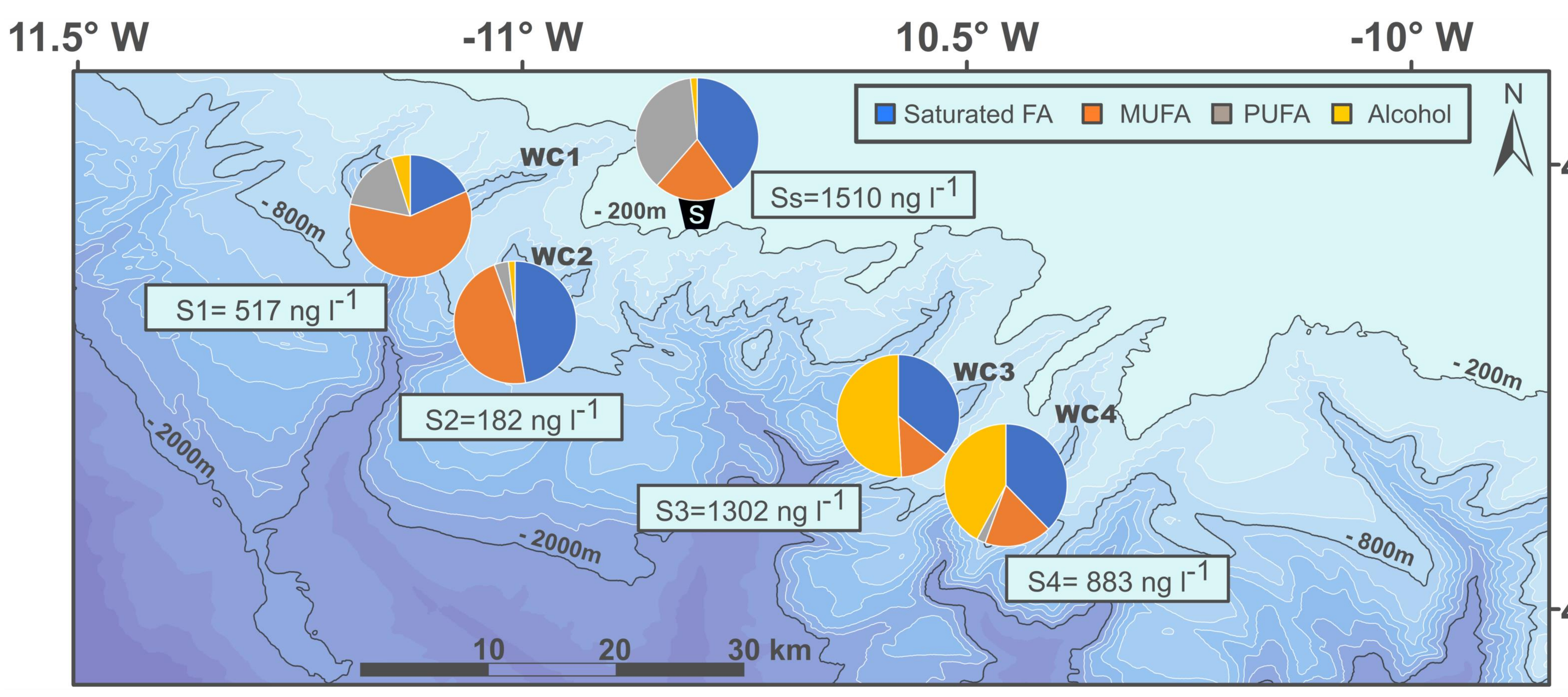


Fig. 7. Map image showing total lipid concentration (labelled values) and constituent fatty acids and alcohols at each branch (WC1 to WC4) sampling point and surface sample (top of map).

Biogeochemistry: An Altered Food Source

Benthic life forms habiting the Whittard Canyon, including a diverse assemblage of cold water corals, depend on a food supply from above as organic particles drop out through the water column. Plumes of trawl induced SPM alter the quality and quantity of this food input. By examining pumped seawater filters collected from these plumes using elemental (CHN analysis) and molecular (GC-MS) analysis, a biogeochemical study was made, focussing on suspended Particulate Organic Matter (sPOM) and Carbon/Nitrogen (C/N) values. Zonal differences in lipids (total fatty acids and alcohols) were found between the lesser fished western branches (which held a lower concentration) and the heavier fished eastern ones (which held a less complex composition) (***Fig. 7***). Western branches had dramatically lower alcohol content, higher contributions of both monounsaturated and polyunsaturated fatty acids (MUFAs & PUFAs) and a lower C/N ratio. This indicated that material in the eastern branches is more recently suspended/transported and fresher.

Conclusion

Dragging heavy fishing gear across the seabed alters seafloor roughness, increases SPM concentration and sediment transport down canyon across the continental margin, while altering the amount and quality of available food for benthic fauna. This will impact on habitat suitability for resident ecosystems; the effects of which are a function of regional variation in fishing intensity.

References:

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