Effects of man-made structures on sedimentary oxygenation: extent, seasonality and implications for offshore renewables.

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Introduction and methods

Marine renewable energy devices (MREDS) are *de facto* artificial reefs. As many as 30 – 50,000 MREDs may be constructed in EU waters over the next 40 years. Hydrodynamic interactions between the reef-structure and the local current regime will result in localised changes in patterns of erosion and deposition. This interaction could include the deposition of organic material (phytodetritus) suspended in the water column around the reef structure. The deposition of phytodetritus has implications for organisms living at the reef-seabed interface partly via the changes it induces in sediment oxygenation.

The oxygenation status of sediments can be measured using redox probes. Normally redox is measured on the surface following sample collection (remotely or by hand). Such collection methods have insufficient spatial accuracy for examining fine-scale impacts (~10 cm resolution) or are very time-consuming so a diver-held underwater redox probe (Fig. 1) was developed and used, *in situ*, underwater (n=1740).

Hypoxic sediments (redox <0 mV) are characteristically of low-diversity. However, moderate enrichment (redox typically 0 – 100 mV) is usually associated with enhanced productivity. The objective of this research was to assess the extent and magnitude of changes in redox occurring at the perimeter of man-made structures and determine how this varied between seasons.

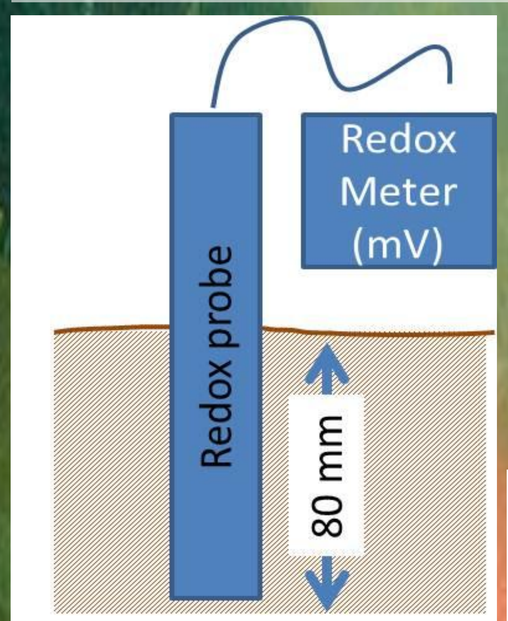

Figure 1 – illustration of diver-held redox probe inserted 80 mm into sediment.

This work was conducted around experimental reefs (Fig 2) in Loch Linnhe (Fig 3). At each sampling time, 180 measurements were taken (10 reps per distance, 3 distances (0, 1, 4 m), 2 modules per reef group, 3 reef groups) and this was repeated 11 times over 19 months.

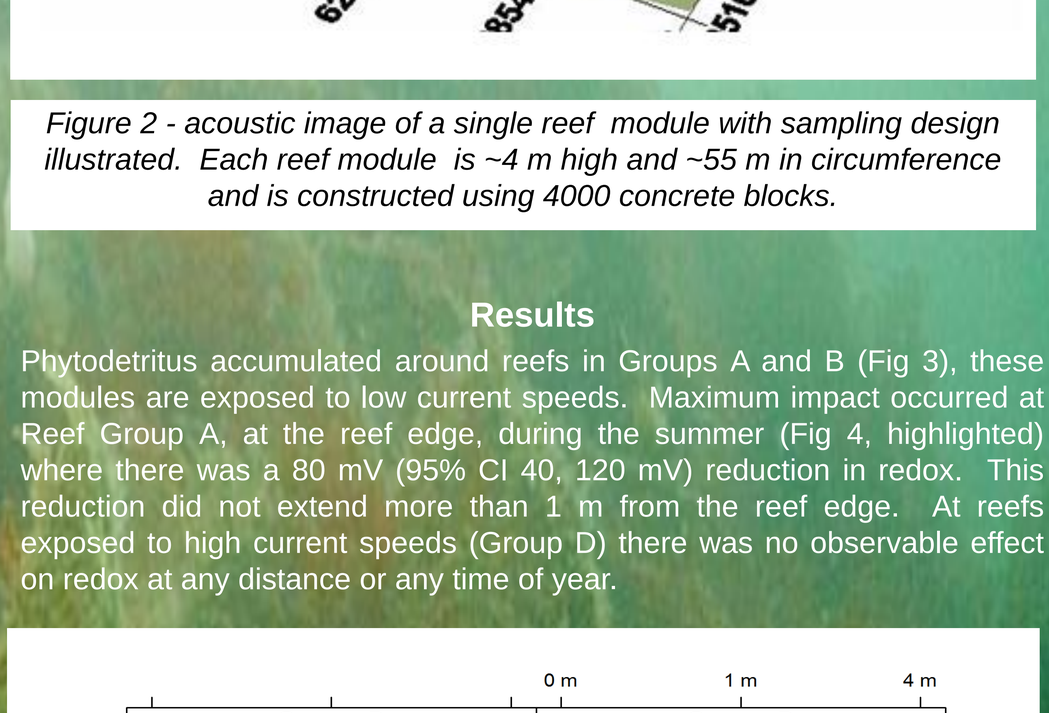

Figure 2 - acoustic image of a single reef module with sampling design illustrated. Each reef module is ~4 m high and ~55 m in circumference and is constructed using 4000 concrete blocks.

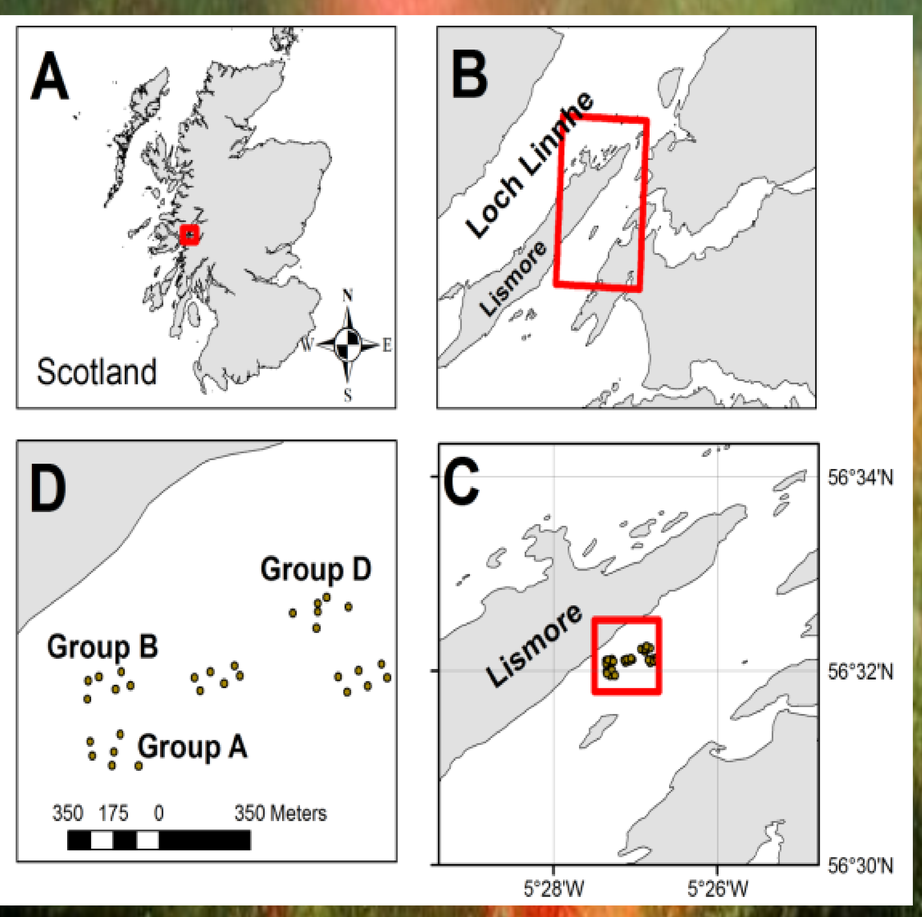

Figure 3 - location of reefs.

Results

Phytodetritus accumulated around reefs in Groups A and B (Fig 3), these modules are exposed to low current speeds. Maximum impact occurred at Reef Group A, at the reef edge, during the summer (Fig 4, highlighted) where there was a 80 mV (95% CI 40, 120 mV) reduction in redox. This reduction did not extend more than 1 m from the reef edge. At reefs exposed to high current speeds (Group D) there was no observable effect on redox at any distance or any time of year.

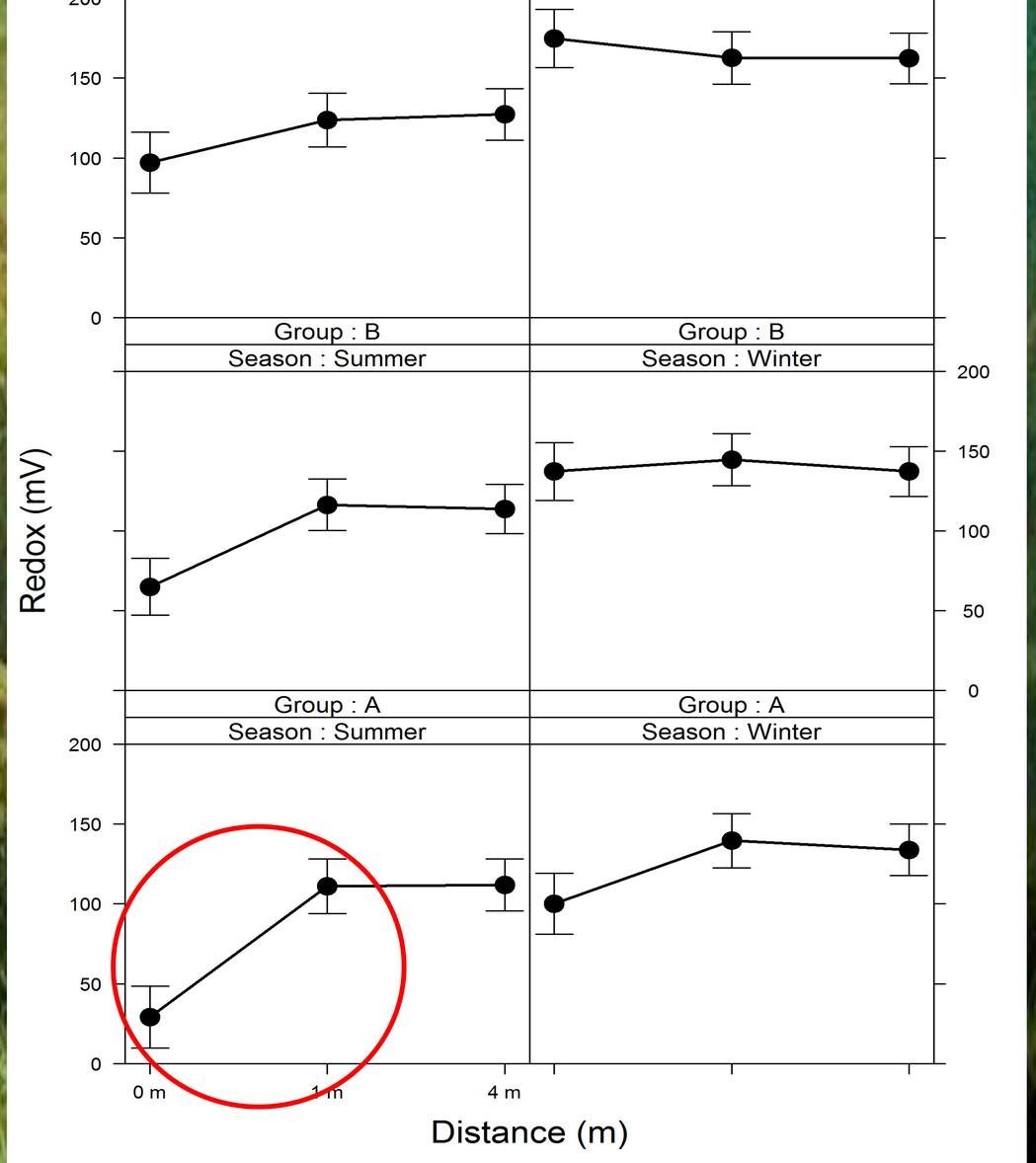

Figure 4 - redox reduction as a function of distance, season and reef group (A and B = low current exposure, D = high current exposure).

Conclusions

Effects on redox were clear and indicate a moderate degree of assemblage modification. However, the change was of limited extent (< 1 m in most cases). Organic accumulation around man-made structures, as indicated here, may enhance localised productivity including species of commercial interest such as lobsters. However, these results suggest that where located on sediments already oxygen stressed, the organic material trapped by artificial structures is likely to exacerbate hypoxia leading to localised declines in macrobenthic productivity and diversity[1].

Dr Tom Wilding is a benthic ecologist specialising in impact prediction and assessment particularly in relation to aquaculture and renewables.

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References

1. Wilding, T. A. (2014). Effects of man-made structures on sedimentary oxygenation: Extent, seasonality and implications for offshore renewables. Marine Environmental Research.

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