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Ecologically Enhancing Coastal Infrastructure

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Hard engineering structures continue to proliferate in the coastal zone globally in response to increasing pressures associated with rising sea levels, coastal flooding and erosion. These structures are typically plain-cast by design and function as poor ecological surrogates for natural rocky shores which are highly topographically complex and host a range of available microhabitats for intertidal species. Ecological enhancement mitigates some of these negative impacts by integrating components of nature into the construction and design of these structures to improve their sustainability, resilience and multifunctionality.

In the largest UK ecological enhancement trial to date, 184 tiles (15x15cm) of up to nine potential designs were deployed on vertical concrete coastal infrastructure in 2016 at three sites across the UK (Saltcoats, Blackness and Isle of Wight). The surface texture and complexity of the tiles were varied to test the effect of settlement surface texture at the mm-cm scale of enhancement on the success of colonisation and biodiversity in the mid-upper intertidal zone in order to answer the following experimental hypotheses:
• Tiles with mm-scale geomorphic complexity will have greater barnacle abundances
• Tiles with cm-scale geomorphic complexity will have greater species richness than mm-scale tiles.
A range of methods were used in creating the tile designs including terrestrial laser scanning of creviced rock surfaces to mimic natural rocky shore complexity as well as artificially generated complexity using computer software. The designs replicated the topographic features of high ecological importance found on natural rocky shores and promoted species recruitment and community composition on artificial surfaces; thus enabling us to evaluate biological responses to geomorphic complexity in a controlled field trial.

At two of the sites, the roughest tile designs (cm scale) did not have the highest levels of barnacle recruits which were instead counted on tiles of intermediate roughness such as the grooved concrete with 257 recruits on average (n=8) at four months' post-installation (Saltcoats) and 1291 recruits at two months' post-installation (Isle of Wight). This indicates that a higher level of complexity does not always reflect the most appropriate roughness scale for some colonisers. On average, tiles with mm scale texture were more successful in terms of barnacle colonisation compared to plain-cast control tiles (n=8 per site). The poor performance of the control tiles (9 recruits, Saltcoats; 147 recruits, Isle of Wight after 4 and 2 months, respectively) further highlights that artificial, hard substrates are poor ecological surrogates for natural rocky shores. One of the sites, Blackness, was an observed outlier to the general trend of colonisation, likely due to its estuarine location. This factor may contribute to why every design, including the control tile, had high abundances of barnacles.

Artificially designed tiles with cm-scale complexity had higher levels of species richness, with periwinkles and topshells frequently observed to utilise the tile microhabitats in greater numbers than found on other tile designs. These results show that the scale of geomorphic complexity influences early stage colonisation. Data analysis is being carried out between now and the EGU – these advanced analyses would be presented.