SCIENCE FOR ENVIRONMENT POLICY

Can eco-engineered tiles enhance biodiversity on artificial seawalls?

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A global increase in artificial seawalls has led to widespread losses of marine intertidal habitats. This habitat loss has resulted in a decline in marine biodiversity and ecosystem functioning in these shoreline areas. A study in Hong Kong explores whether eco-engineered tiles on artificial seawalls could enhance biodiversity.

More than 2.4 billion of the world's population currently live within 100 kilometres of the coast, which has meant an increase in sea-wall construction to protect these communities from sea-level rise and flooding events. Artificial seawalls are often plain concrete structures that are inhospitable for marine species, thereby negatively impacting the intertidal coastal community.

Small-scale, eco-engineered structures, which increase habitat heterogeneity are emerging as a potential solution to the loss of biodiversity and ecosystem functioning on seawalls. These can lower temperature, retain moisture and create hospitable habitats. A number of EU policies, including the EU Biodiversity Strategy for 2030, are directed towards marine biodiversity protection and integrated coastal management; while the EU Strategy on Green Infrastructure, which includes policies for the marine environment[1], aims to develop and preserve an infrastructure network to prevent the loss of biodiversity and maintain a connection between natural areas.

While seawalls are used by many European countries to adapt to and mitigate the impacts of current and future sea-level rise, retrofitting eco-engineered options may be worth considering to increase biodiversity[2]. Retrofitting seawalls with grooves and crevices has shown to increase biodiversity and enhance the abundance of epifauna (species living on the marine surfaces) in tidal zones. Seeding native oysters on vertical seawalls aids recruitment of oysters of the same species and other sessile species (those fixed to surfaces, such as barnacles and tubeworms) onto the wall. However, these two solutions to increasing biodiversity on artificial seawalls have not yet been combined in eco-engineered structures.

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Can eco-engineered tiles enhance biodiversity on artificial seawalls? (continued)

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This study merges these approaches to research whether increasing habitat heterogeneity — by seeding oysters and/or adding crevices onto eco-engineered tiles — can increase biodiversity and species cover on two vertical sea-wall sites in Hong Kong. The researchers used two study sites with vertical seawalls — Sham Shui Kok and Lok On Pai — where three different tile types were added to the surface of the walls: flat tiles and those with either a 2.5-cm-or 5-cm crevice depth. Some of each tile type were seeded with native rock oysters (*Saccostrea cucullata*) and some left unseeded. The researchers positioned five replicates of each tile type in the intertidal zone for 12 months. The tiles were placed 1.4 metres above Chart Datum (the water level that depths displayed on a nautical chart are measured from — i.e. the lowest astronomical tide or mean lower low water). Bare seawall at each site acted as a control, alongside a section of natural nearby rocky shoreline at each site.

During the twelfth month the tiles were photographed and sampled for biodiversity and percentage cover. At the end of the experiment, tiles were removed and all organisms on the tiles were identified and counted. The temperature of the tiles was monitored on-site to record the ambient air temperature at the tile surface (in the tile crevices and on exposed ridges). The researchers recorded species richness, sessile and mobile species abundance and percentage cover of the tiles, and used statistical analysis to establish the differences between the tile categories.

Species richness was greater across all tile treatments compared with the control sites. In total, 21 mobile species and five sessile species were found across all three categories of tile, with the maximum noted on one tile (a 5-cm crevice tile seeded with oysters) being 20 species. At the Lok On Pai site, species richness was increased separately by both tile enhancement and seeding with rock oysters; whereas at Sham Shui Kok, species richness increased as a result of the interaction of tile enhancement combined with oyster seeding.

Overall, tiles with crevices had greater species richness and cover of sessile epifauna than flat tiles. Seeding tiles with native oysters also facilitated natural recruitment of the same species. Adding crevices onto the tiles also effectively reduced the overall temperature of the tiles. However, there were only minor differences in biodiversity enhancement between the 2.5-cm and 5-cm crevice depths, suggesting that there is an inherent benefit of adding eco-engineered tiles with crevices of either depth, say the researchers.

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Can eco-engineered tiles enhance biodiversity on artificial seawalls? (continued)

The results show that eco-engineering can increase habitat complexity on existing artificial seawalls, enhancing the biodiversity of intertidal marine organisms on seawalls, say the researchers. By retrofitting creviced tiles seeded with native bivalves — in this study, rock oysters — to existing seawalls, intertidal marine biodiversity can be improved[3], they say. The researchers posit that the use of either treatment — alone or combined — can be an effective tool for increasing biodiversity on seawalls, and suggest that seeding bivalves may be a more practical and economical option for existing seawalls that may not allow retrofitting with eco-engineered tiles. When designing new seawalls, holes, crevices and pools can be incorporated, they say.

1. The Green Infrastructure strategy aims to ensure that current policies on marine spatial planning and integrated coastal zone management are put into practice, particularly programmes for sustainably managing coastal zones and making coastal defences more efficient.

2. Some parts of Europe, such as the Netherlands, Denmark, France, Germany and the UK, have encouraged 'managed realignment' — a strategy that aims to create space for coastal ecosystems to thrive by taking down seawalls and thereby encouraging coastal zones to keep their natural ecosystems.

3. Increasing species richness can also improve seawater, reduce nitrogen load and remove heavy metals and/or other pollutants.