Runswick Bay Ecological Enhancement Report

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1. BACKGROUND

Ecological enhancement research is an emerging field which integrates ecology and engineering. The aim is to modify a site to increase and or improve habitat for plants and animals while protecting human health and the environment (Technology et al. 2004). Ecological enhancement can take many forms, usually as an additional feature or modifications to an already planned or existing structure or habitat, although can be applied as standalone projects. Ecological enhancement ranges from small scale alterations such as drilling pits into sea defence structures, to the placement or integration of new large scale modified habitats with ecological enhancement features such as BIOBLOCKs. For ecological enhancement to be successful, cross disciplinary research needs to be undertaken in order to understand how to create a multifunctional structures which are suitable for purpose. The aim of this preliminary trial was to determine if small scale modifications to existing granite boulder sea defences could be used to as an ecological enhancement technique for aiding colonisation of novel structures in the marine environment.

2. TRIAL ECOLOGICAL ENHANCEMENT :- HOLES AND GROOVES

Method

A preliminary trial was carried out to investigate ecological responses to creating two types of intervention (i) creation of holes and (ii) creation of grooves in granite rock armour at Runswick Bay, North Yorkshire. The rationale behind this was to increase surface heterogeneity, increase water retention and provide refuge for mobile fauna such as molluscs, fish and crustaceans. The rock armour located at Runswick Bay, North Yorkshire consists of 5-10 ton granite blocks sourced from the High Force Quarry in Middleton. The rock armour structure was constructed at Mean Low Water in 2000. Runswick Bay is a moderately exposed sandy shore, with large shale bedrock platforms approximately 100m to the north of the granite rock armour (Figure 1). Runswick Bay has a prevailing wind direction which is easterly. Tidal range is 5.6m during Spring tides and 4.2m during Neap tides and average sea surface temperature is 10^0C (NECO, 2016).

Figure 1. View of Runswick Bay showing granite boulder field and shale bedrock platform taken from north side.

Experimental design

In order to create a more complex surface texture and habitat for intertidal organisms on the boulders, two ecological enhancement treatments were evaluated:

(a) ‘Holes’: an array of four 20mm deep x 16mm diameter holes orientated to retain water at low tide to provide species with a moist refuge when the tide goes out. These were drilled into vertical and horizontal surfaces of boulders using a cordless hand drill (Fig 2a). At Runswick Bay, two arrays were created on each of six separate boulders located between Mean Tide Level (MTL) and Mean Low Water at (MLW).

(b) ‘Grooves’, to replicate the groove-microhabitat occasionally observed in rock armour defences that have been drilled to insert explosives in the quarrying process, an array of two, thin horizontal grooves (approx. 30-60cm long x 1cm deep) and one thicker, coarser groove (approx. 30-60cm long x 2cm wide) was cut in to the rock using an angle grinder saw (Figure 2b). The coarser groove was chiselled out, which created a rough surface texture on the base and sides of the groove. The reasoning behind creating grooves was to increase the surface texture of the rock and by creating two different sized grooves, it enabled a variation in habitat. At Runswick Bay, three arrays were created on each of six boulders located between MTL and MLW.

(a) (b)

Figure 2: Examples of (a) Holes and (b) Grooves, both thin and thick. Highlighting in red, one array of each type.

These trial areas were surveyed every 3 months and compared to areas on the same boulders where no intervention had occurred (control). By comparing both the non-intervention areas to the areas of holes/ grooves we aimed to establish if such intervention had a positive effect on colonisation.

Monitoring

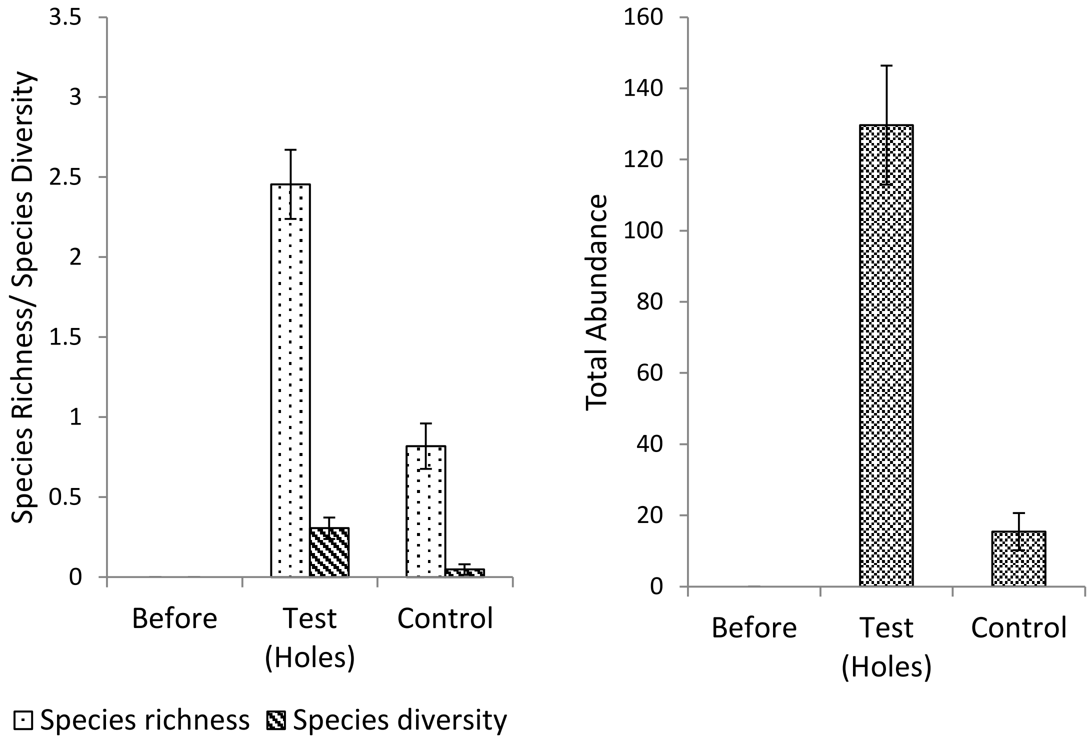
(a) *Holes:* all boulders and treatments were sampled before installation of adaptations in order to obtain data for before and after comparisons. Boulders were sampled using 20cm^2 quadrats placed over the array to record percentage cover of algae and count data for barnacles and mobile species including limpets, dog whelks and periwinkles. After the installation of adaptations the monitoring regime involved placing a 20cm^2 quadrat over each array of holes and the numbers of all organisms were counted and measured (including limpet shell height and width). Water retention and build-up of sediment was also recorded inside and outside of holes and treatments. As controls, quadrats were also placed in areas on independent boulders that had no treatment arrays using the same methodology.

(b) *Grooves:* Boulders were again sampled before adaptations were installed, the regime consisted of 9 x $20cm^2$ quadrats placed on each boulder to record percentage cover of algae and barnacles and count data for mobile species including limpets, dog whelks and periwinkles. After the adaptations were installed for the Groove experiment the sampling regime consisted of 3 x $20cm^2$ quadrats placed in the centre and at either end of the array (Figure 2). The number of barnacles, periwinkles and percentage cover of algae were recorded. Control quadrats were taken on independent boulders using the same methodology.

3. PRELIMINARY RESULTS OF TRIAL

The results displayed present the overall diversity and species richness of the communities established in the control bedrock areas and the experimental plots one year after intervention of holes and grooves. Figure 3.1 and 3.2 illustrate the significant increase in number of species (richness), species diversity and total abundance of individuals for both the holes and grooves interventions. For both treatments, holes (Figure 3.1.1) and grooves (Figure 3.1.2), the treatments enhance the abundance and number of species found when compared to the untreated rock surfaces. The existing boulders have very low species richness and diversity, therefore improvements to the habitat are important to encourage additional species. Figure 3.3 illustrates the utilisation of the holes and grooves in preference to the surrounding areas. The additional species which have colonised the holes and grooves are highlighted in Table 3.1, increased numbers of algae and marine snails species has been observed.

1) Holes



2) Grooves

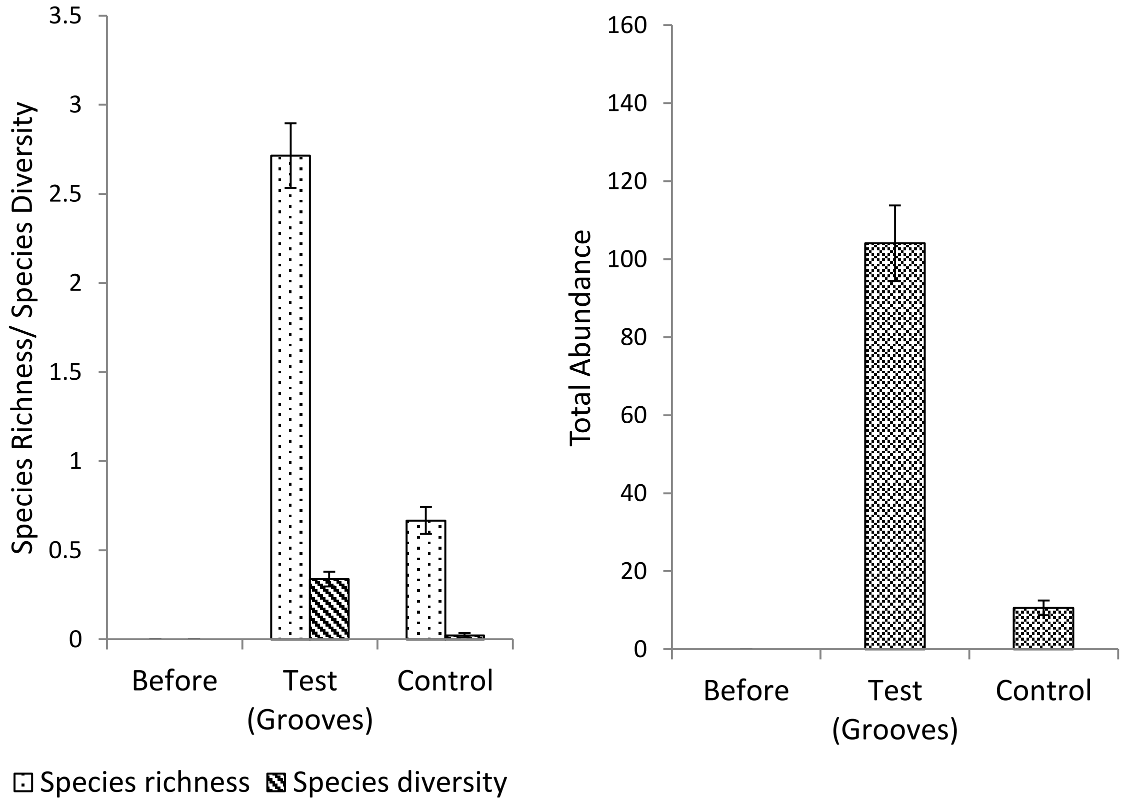


Figure 3.1: Mean species richness, total abundance and species diversity for before installation of holes and groves compared to the test and control after 1 year (+/- SE).

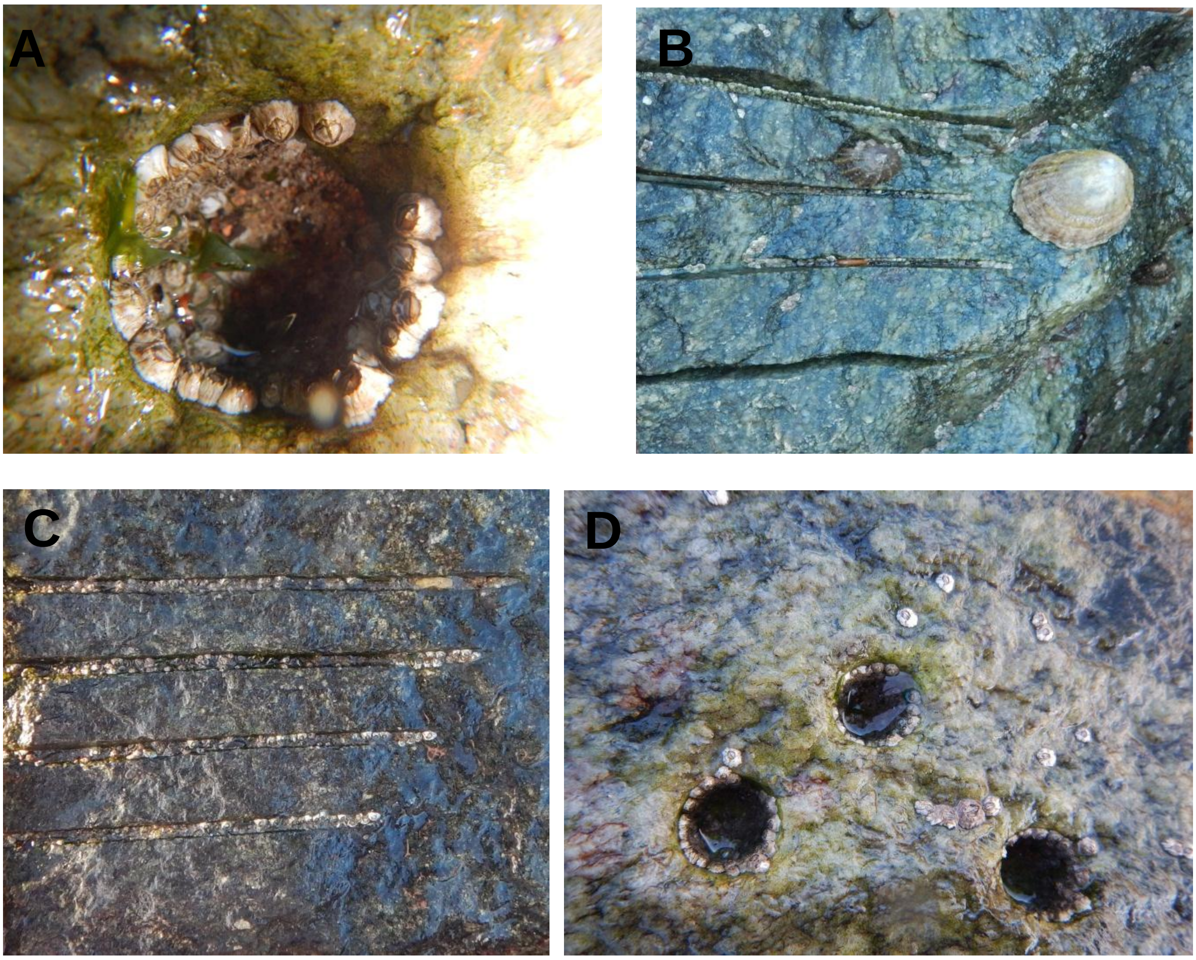


Figure 3.2: Images of the interventions after one year; A and D show the holes B and C show the grooves.

Table 3.1: Presence and absence of species before the treatment and after a one year period for the holes, grooves and controls (* indicates presence).

Species		Before	Holes	Grooves	Control
Semibalanus balanoides	Acorn Barnacle		*	*	*
Patella vulgata	Common Limpet		*	*	*
Littorina saxatilis	Rough Periwinkle		*	*	
Melarhaphe neritoides	Small Periwinkle		*	*	
Mytilus edulis	Common Mussel		*	*	
Fucus sp.	Wrack		*	*	
Ulva linza	Green Algae		*	*	*
Porphyra sp.	Laver weed		*	*	
Mastocarpus stellatus	Grape pip weed			*	
Rhodothamniella floridula	Sand Binder			*	

4. RECOMMENDATIONS FOR FUTURE SCHEMES:

- Due to the success of both the holes and groove treatments, it is recommended that this be repeated on a larger scale where possible. A variety of larger sized holes would be ideal in order retain larger amounts of water at low tide. Previous studies have used 10cm diameter core bits (Evans et al 2015).

- In addition, a novel idea would be to carve basins into the top of the granite boulders in order to retain water and encourage mobile fauna such as fish and crabs.
- Depending on tidal range, it is very possible that such enhancement would be more effective in the mid-shore. It is recommended that this treatment be repeated at all tidal heights on any placement of boulders.
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References:

Evans, A.J., Firth, L.B., Hawkins,S.J., Morris, E.S., Goudge, H., Moore, P.J., (2015) Drill-cored rock pools: an effective method of ecological enhancement on artificial structures. *Marine and Freshwater Research.* **67.** 123-130

NECO 2016. North East Coastal Observatory. www.northeastcoastalobservatory.org.uk