Possible effects of pebble beach nourishment on benthic assemblages

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Introduction

The nourishment of sandy beaches to counteract coastal erosion and the loss of economic value is a very common practice (e.g. Handon et al., 2012; Cooke et al., 2012). The alterations of benthic assemblages at different spatial scales caused by massive interventions have been well studied and, although several authors have proposed guidelines for good practices, there is a general consensus among scientist on their ecological negative effects (e.g. Leewis et a., 2012; Schlacher et al., 2012). Despite all this, the possible effects of small nourishment projects on gravel or pebble beaches have not been well studied (e.g. Jackson et al., 2007). The pebbles nourishment intervention realized in Portonovo (Ancona, IT; Fig. 1) in June 2011 offered the opportunity to study these possible effects.

Material & methods

The area of Portonovo belongs to limestones and marly limestones in pelagic facies (Palaeogene - Upper Cretaceous). The beach is made by boulders and pebbles landslide, reworked by waves, and finer sediments from surrounding areas. In June 2011, a pebble nourishment intervention was made along a small stretch of coastline, where an unaffected zone has been reserved in the middle (Fig. 1). The benthic assemblages were investigated with photographic sampling twice a year in 2 sites subjected to nourishment (A and B) and in 2 control sites (C and D; Fig. 1). The photographs were used to identify organisms by comparison with species reference collection, obtained by collected voucher specimens and macro pictures (Fig. 2). Percent cover of sessile organisms was estimated by superimposing a grid of 400 equal-sized cells (i.e. ±0.25% each) and identifying all taxa visible within each cell using the PhotoQuad software (Trygonis & Sini, 2012).
Species richness (number of taxa, *S*), species diversity (Shannon's index with log base 2, *H'*) and the corresponding evenness component (Pielou index, *J'*) were calculated for each replicate sample (Magurran, 2004). Differences in assemblage structure, species abundance and diversity indices, were assessed by uni- and multivariate permutational analysis of variance (PERMANOVA; Anderson & Robinson, 2001; Anderson & ter Braak, 2003).

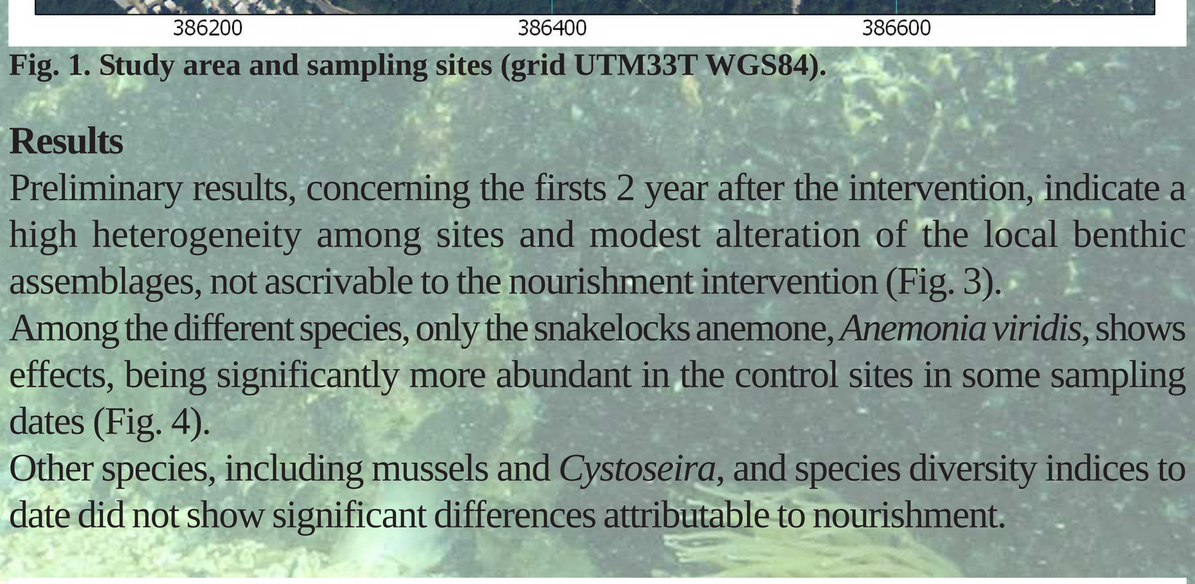


Fig. 1. Study area and sampling sites (grid UTM33T WGS84).

Results

Preliminary results, concerning the firsts 2 year after the intervention, indicate a high heterogeneity among sites and modest alteration of the local benthic assemblages, not ascrivable to the nourishment intervention (Fig. 3).
Among the different species, only the snakelocks anemone, *Anemonia viridis*, shows effects, being significantly more abundant in the control sites in some sampling dates (Fig. 4).
Other species, including mussels and *Cystoseira*, and species diversity indices to date did not show significant differences attributable to nourishment.

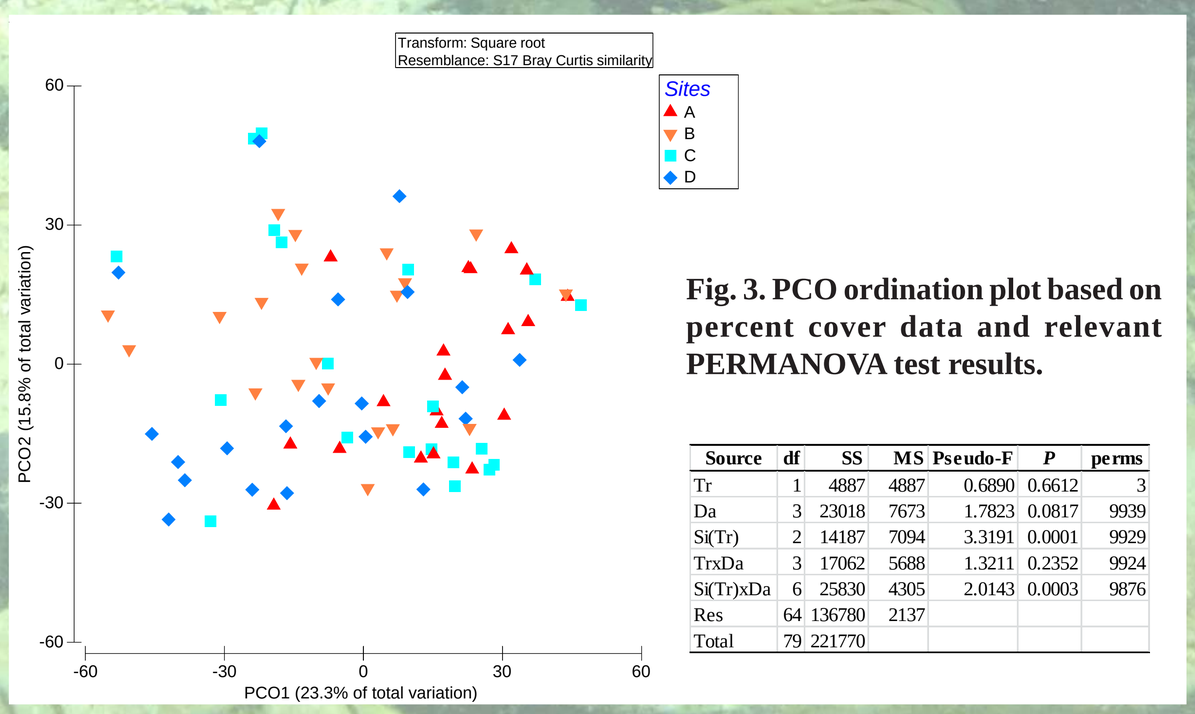


Fig. 3. PCO ordination plot based on percent cover data and relevant PERMANOVA test results.

Source	df	SS	MS	Pseudo-F	*P*	perms
Tr	1	4887	4887	0.6890	0.6612	3
Da	3	23018	7673	1.7823	0.0817	9939
Si(Tr)	2	14187	7094	3.3191	0.0001	9929
TrxDa	3	17062	5688	1.3211	0.2352	9924
Si(Tr)xDa	6	25830	4305	2.0143	0.0003	9876
Res	64	136780	2137			
Total	79	221770				

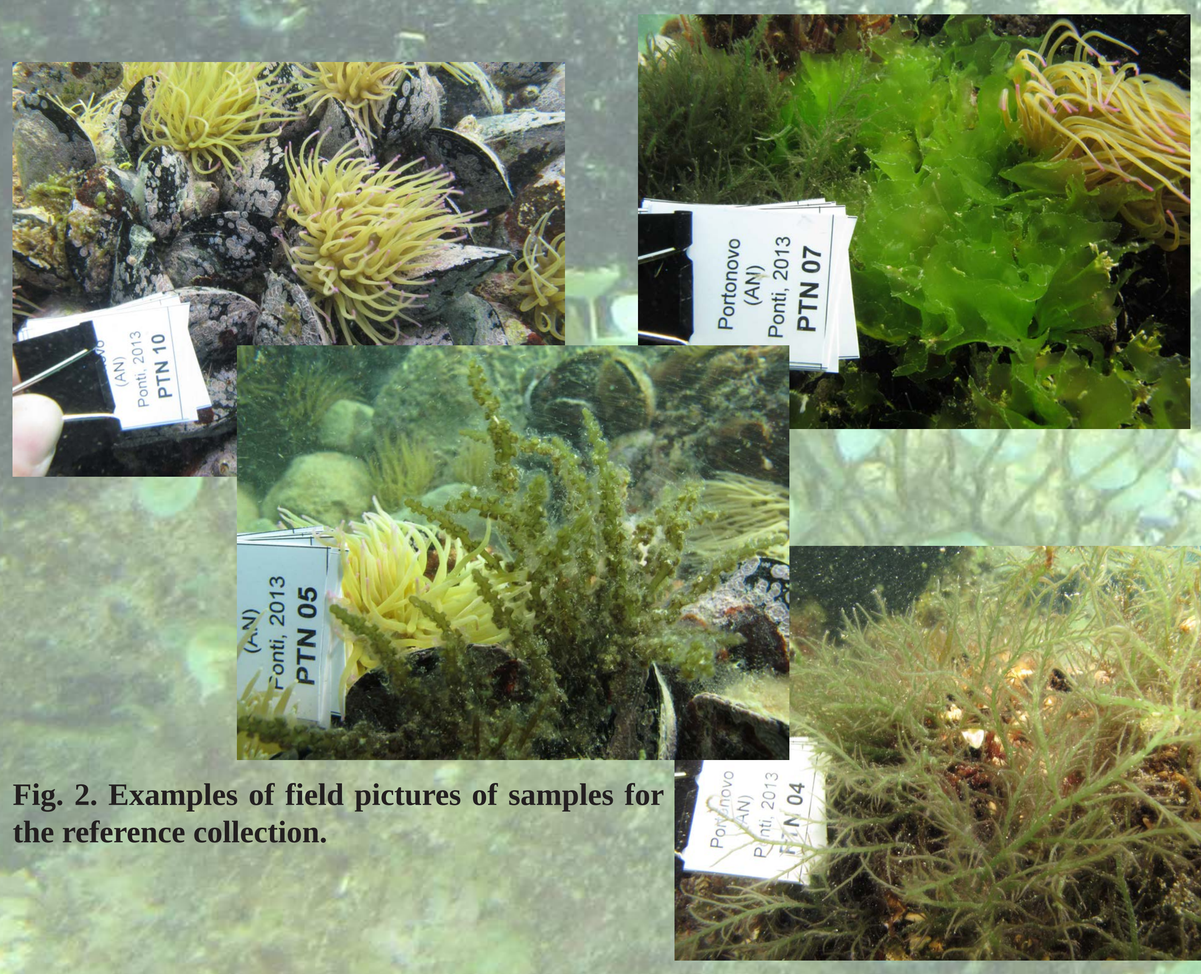
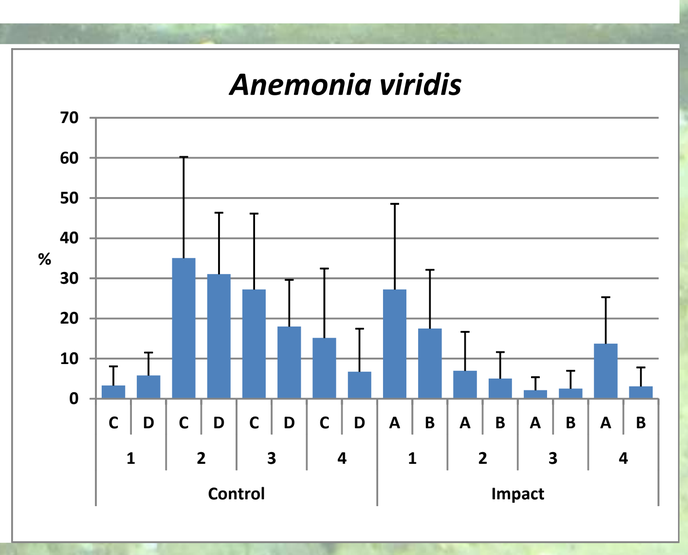


Fig. 2. Examples of field pictures of samples for the reference collection.

Fig. 4. Abundance of the snakelocks anemone in different sites (A, B, C, D) and dates (1, 2, 3, 4), and relevant PERMANOVA test results.

Source	df	SS	MS	Pseudo-F	*P*	perms
Tr	1	1287	1287	4.8490	0.1573	3
Da	3	1036	345	4.6189	0.0622	9959
Si(Tr)	2	531	266	1.5064	0.2288	9944
TrxDa	3	6043	2014	26.9510	0.0013	9956
Si(Tr)xDa	6	448	75	0.4241	0.8637	9944
Res	64	11280	176			
Total	79	20626				



Discussion

Although results are preliminary and more samples are to be analysed, it seems that the little nourishment intervention has not produced large effects on local benthic communities. Nevertheless, massive and frequent pebble-beach nourishments may produce greater and extended effects. Counteract the natural evolution of the coast is a losing battle from the start (Paoli et al., 2013). Despite this, short-term local economic interests tend to prevaricate management decisions. A proper integrated coastal zone management should be forward-looking and based on solid knowledge of the possible effects of each kind of intervention, both on short- and long-term.

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