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Original Articles

Assessment of the impact of salvaging the Costa Concordia wreck on the deep coralligenous habitats

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ABSTRACT

The coralligenous habitats found in the Mediterranean Sea are hotspots comparable in biodiversity to tropical reefs. Coralligenous reefs are vulnerable to many human pressures, thus they are among the most threatened habitats in the Mediterranean Sea. In this study, we assessed the impacts on coralligenous habitats of activities associated with salvaging the wreck of the Costa Concordia cruise ship. After its partial foundering in 2012, the Costa Concordia remained adjacent to the eastern coast of Giglio Island (Tuscany, Italy), in the Tyrrhenian Sea, for over two years. Its salvage required high-impact engineering works, during the course of which monitoring of benthic communities was undertaken. We performed Rapid Visual Assessment (RVA) sampling (using recorded video) from 17 stations located between 35 and 76 m depth and characterized by coralligenous habitats. Sampling activity was performed during the summers of 2012, 2013, and 2014. In parallel, chemical and physical water parameters were measured continuously from summer 2012 to the end of summer 2014, in order to detect any perturbation in natural conditions caused by salvage activities. We assessed the ecological quality of coralligenous habitats by applying the COARSE (COralligenous Assessment by ReefScape Estimate) index, based on the RVA approach. Slight modifications were applied to one of the descriptors of the COARSE index in order to adjust for study site features. There was clear evidence of a reduction in coralligenous habitats quality. Assemblages, slope, type of pressure, and distance from the source of disturbance played a pivotal role in characterizing bottom quality. The index was shown to have an easy and cost-effective application, even in waters deeper than its calibration specification; furthermore, the modification reported here may increase its potential applications.

1. Introduction

Coralligenous habitats are biogenic reef formations endemic to the Mediterranean Sea. They are primarily produced by the accumulation of encrusting algae growing in dim light conditions and, secondarily, by bioconstructor animals such as polychaetes, bryozoans, and anthozoans (Ballesteros, 2006). Coralligenous habitats have been identified as the climax circalittoral Mediterranean biocenosis (Pérès and Picard, 1964), although they may be found in shallower waters if conditions allow coralline algae development (Martì et al., 2004; Romdhane et al., 2007). Even though coralligenous reefs have been recognized as the second most important 'hotspot' of biodiversity in the Mediterranean Sea, after *Posidonia oceanica* meadows (Ballesteros, 2006), there are few studies and estimates of the diversity of sessile and vagile macroinvertebrate species recorded in this community type (Antoniadou and Chintiroglou, 2005; Ballesteros, 2006; Ponti et al., 2010; Bertolino et al., 2013; Bedini et al., 2014; Poursanidis and Koutsoubas, 2015). To date, Coralligenous reefs studies have mainly used non-destructive sampling methods such as photographic and visual assessments, due to the operational restrictions imposed by scuba diving, conservation purpose, and the high heterogeneity and complexity of the habitat (Parravicini et al., 2010; Kipson et al., 2011; Trygonis and Sini, 2012; Zapata-Ramírez et al., 2013; Gerovasileiou et al., 2016). Considering their slow dynamics and longevity, coralligenous reefs are among the habitats most exposed to human impacts (Ballesteros, 2006; Teixidó et al., 2011; Giakoumi et al., 2013), and as such are safeguarded under environmental protection legislation. In fact, they were incorporated into the category 'reefs' under the EC Habitats Directive (HD, 92/43/EEC), and are therefore automatically included in the network of Natura 2000 sites (Council of the European Communities, 1992).

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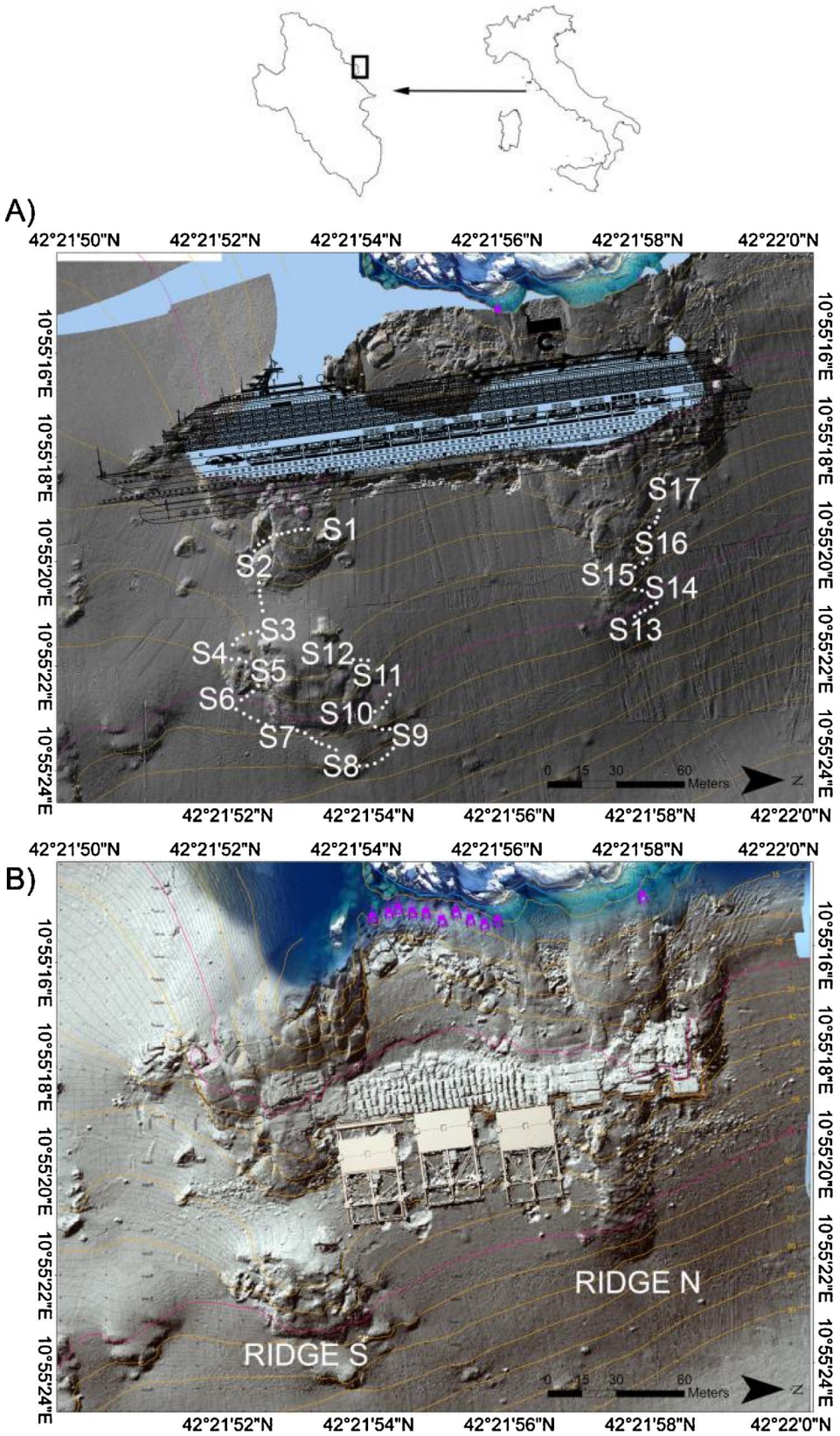

Fig. 1. Map of the study area (working area). (A) 2012 bottom topography, showing the positions of the monitoring stations. (B) 2014 bottom condition, once salvage activities were completed.