

Designing snorkeling **ecotouristic routes** at Marinha Beach (Algarve) and assessing their impact on the underwater system

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Objectives | Coastal ecotourism is recognised as one of the fastest growing leisure industries worldwide. Nevertheless, the use of coastal areas for human recreational activities has always been a concern for scientists, environmentalists and managers, due to obvious conflicts between recreational uses and nature conservation (Davis & Herriot, 1996; Apate *et al.*, 2005; Lim & Mcaleer, 2005). Snorkelling, as a touristic beach-based coastal activity, can be used as an enhancer of biodiversity sustainability, if developed within an environmental education framework. Considering the potential of the activity and its demand in the Algarve (south Portugal), this project aimed to implement three self-guided snorkelling eco-routes in Marinha Beach, a pristine beach part of the Portuguese national underwater ecological reserve. Snorkelling trips were conducted in the summer seasons of 2008/2009, under strict supervision, underwater guidance and advice of marine biologists. To assess the impact of users on the routes' underwater ecosystem and provide tangible input for biodiversity preservation, macroALGAE abundance and diversity were evaluated inside and outside route path limits.

Methodology |

Design and implementation of snorkelling routes

After carefully monitoring the swimming area of Marinha Beach from May to September 2008, the best three snorkelling spots were selected. Following Gonçalves *et al.* (2007, 2010), fauna and flora were assessed through visual censuses in the selected routes' areas, by stretching a 60m tape starting from a randomly selected point of each route. For flora

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composition, a 50x50cm steel quadrat was placed in three randomly selected points along the tape (10m 20m, and 40m of tape), to allow species' identification and coverage percentage analysis. For faunal composition, three different divers conducted visual censuses of demersal fishes, cryptic fishes, and benthic invertebrates. Three transects were conducted for each visual census and in each snorkelling spot. Photographic records were taken whenever in situ identification was unsatisfactory. Double sided acrylic slates were developed and deployed in specific places along the routes. Each plate showed the route map (with location of the next and previous slates), mean depth, substratum type, snorkeler localization within the path, and photos of eight most common sighted species. Posters, placed in wooden placards around the beach, also included the geographic definition of the routes, the most commonly observed species and other important information, like guidelines of safety and conduct. During the summer season, a support team, composed of marine biologists and lifeguards, provided support to tourists and guided the snorkelling tours. To describe socio-economic characteristics of the tourists, and to understand their perception towards the routes' outcome as a sustainability enhancer, every snorkeler visiting the routes was asked to complete a questionnaire under researcher supervision.

Impact assessment

For impact assessment, the most visited route was selected and visual census of macroALGAE was carried out. A 60m tape was stretched in four randomly spots on the edge of the route, and a new quadrat sample was taken every 5m to the inside and outside of the route. This procedure was done after the end of summer season to evaluate the impact of snorkelers on macroALGAE coverage by comparing species composition, richness and coverage percentage inside and outside routes' area.

Exploratory data analysis

Flora analysis included the calculation of mean coverage and species composition per phylum (%). Floral biodiversity and richness was based in diversity indices. Similarities between mean quadrat coverage of algae species and statistical comparison between samples was evaluated using non-metric multi-dimensional scaling (mds) and analysis of similarities (anosim) (primer 6.1.5 software), a multivariate non-parametric similarity statistical test (Clarke & Gorley, 2006).

Main results and contributions | The proposed snorkelling routes augment the touristic offer of the Marinha Beach, making it a more appealing, sophisticated and differentiated offer. Besides, information provided by ecotourists and researchers can, at the end of the day, be used for appropriate coastal management. Regarding snorkelling impact analysis, *rhodophyta* and *heterokontophyta* were the most represented groups, both in terms of mean coverage and species number. *Magnoliophyta* and *chlorophyta* are relatively poorly represented. Of the identified species, the *heterokontophyta halopitys incurvus* and the *rhodophyta coralina elongata* were the species with highest percentage of coverage. In general, data from the visual census indicated higher values of ALGAE coverage and diversity outside the underwater routes area, although these differences were minimal. A significant difference was found in the mean percentage of "no bottom coverage", which was superior inside the route area. The non-metric multi-dimensional scaling (mds) did not show any clear grouping in the samples, and the analysis of similarities (anosim) reported a global r of 0.036 with a significance level of 0.04.

Limitations | The implementation of underwater snorkelling eco-routes was delayed because of bureaucratic issues related with coastal management policies. In fact, it is difficult to enhance innovating eco-friendly activities, as enforcement entities apparently do not realize the advantages of environmental activities based on scientific knowledge. The increase in sustainability awareness by users does not appear to be a major concern for authorities responsible for management either.

Conclusions | Marine eco-routes, planned on the basis of expert guidance, and implemented with strict conduct rules, can preserve marine environments, enhancing eco-friendly tourism activities and reinforcing attitude changes in the Algarve beach tourism. Also, the analyses indicated no significant differences between the substrates of tested sites. The differences in algae cover between routes and adjacent areas are minimal and there is no evident impact on algae associated with snorkelling activities in the routes.

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