FROM CITIZEN SCIENCES TO ENVIRONMENTAL QUALITY ASSESSMENT: THE PORTOFINO MPA CASE STUDY

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Abstract
The proposed Mediterranean Reef Check Species sensitivity (*MRC-Ss*) index, based on data provided by volunteer scuba divers, may represent a proxy of the mean sensitivity of the assemblages toward the natural and anthropic disturb agents indicated by the European Marine Strategy Framework Directive. Its application may represent the occasion to raise public awareness and enhance the collaboration between coastal management authorities (e.g., MPA managers) and dive centres, through a participatory approach.

Keywords: Bio-indicators, Coastal management, Conservation, Rocky shores, Ligurian Sea

Introduction
The involvement of citizens in environmental monitoring is increasing worldwide in the last decades [1]. Citizen science projects have spread up in marine environments, from tropical coral reefs (e.g., Reef Check tropical EcoDiver program and Coral Watch initiative) to temperate seas (e.g., Californian Reef Check and British and Irish Seasearch protocols). In the Mediterranean Sea, subtidal rocky shore and coralligenous concretions are among the most threatened marine habitats [2]. Environmental quality assessment tools for these habitats, based on integrity of marine communities, are not only urgent but also essential to answer to the European Marine Strategy Framework Directive (MSFD, 2008/56/EC). The aims of this study were the development of a biotic index based on data collected by volunteers and its application in the Portofino Marine Protected Area (MPA), Italy.

Material and methods
The proposed Mediterranean Reef Check Species sensitivity (*MRC-Ss*) index is based on data provided by volunteer scuba divers applying the Underwater-Coastal Environmental Monitoring (U-CEM) protocol developed and promoted by Reef Check Italia (RCI) non-profit organisation [3]. The protocol provides that the divers, after training and verification of their abilities, make independent observations on the presence / absence and abundance of 43 easily identifiable key taxa. The sensitivity scores of a subset of 25 taxa, toward twenty-four disturb agents indicated by the MSFD, were assessed following the Marine Life Information Network for Britain and Ireland (MarLIN; [4]) approach. Sensitivities scores were calculated by combining the intolerance and recoverability ranks based on benchmarks and available literature. The *MRC-Ss* index represents the mean sensitivity value of the sighted taxa weighted by their observed abundance classes. The index has been calculated for marine sectors larger than 0.25 km^2 including at least 30 observations carried out by four or more independent observers. The index value ranges between 0 and 5. The score increases with increasing of the mean sensitivity of the species sighted and, in less extent, changes with their abundance. Five sensitivity classes were identified using quintiles intervals calculated on the whole available dataset. The index was applied to the monitoring zones designed by the Portofino MPA authority.

Results
Based on the available data, it was possible to apply the *MRC-Ss* index to 8 of 19 monitoring zones in the Portofino MPA. Most of the assessed monitoring zones had assemblages with moderate sensitivity toward the considered disturb agents; two zones were characterised by assemblages with high sensitivity, and only one showed low sensitivity (Fig. 1).

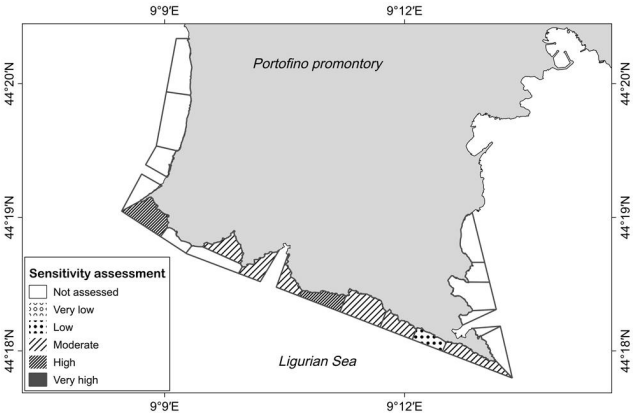

Fig. 1. Sensitivity assessment of assemblages living in Portofino MPA monitoring zones (Mercator projection, WGS84).

Discussion
The *MRC-Ss* index represents the first attempt to derive a biotic index from data collected by volunteers in the Mediterranean Sea. It primarily provides a proxy of the mean sensitivity of the assemblages living in a zone toward the main natural and anthropic disturb agents provided by MSFD. The abundance of very sensitive species testifies reduced pressures and therefore good environmental conditions. The assessed area appears to be in quite good condition although some disturbs, like high sedimentation, intense nautical and diving tourism and increasing urbanization may negatively affect the local assemblages. This index helps to identify areas that require management interventions. The need of many independent observations, in order to apply the index in the selected zones and in time, may represent the occasion to raise public awareness and enhance the collaboration between coastal management authorities (e.g., MPA managers) and dive centres (i.e. stakeholders), through a participatory approach.

References
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