

Citizen Science Combined with Environmental Education can be a Powerful Tool for Coastal-Marine Management

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Abstract

In many places around the world, there is a lack of staff for marine and coastal protected areas management. One way of helping scientists to collect useful data and helping managers in the decision making is to engage the general public in the scientific process. In this regard, citizen science actions combined with environmental education activities in coastal and marine areas in which the visitation is allowed can be powerful tools.

Keywords: Citizen science; Critical environmental education; Scientific process

Introduction

The possible impacts caused by tourist visitation in marine natural areas are well described in literature [1-11]. In addition, many studies show that briefing, environmental education and interpretation activities can significantly reduce the impacts to the organisms that occupy these areas [12-19].

In the case

of recreational diving, it is fundamental that MPAs search for sustainable visitation, which requires a constant monitoring of the impacts and also the introduction of preventive or corrective measures whenever necessary. Besides, sustainable visitation must maintain a high level of visitor satisfaction and ensure a meaningful experience to the tourists, raising awareness on issues of environmental sustainability and promoting sustainable tourism practices [20].

Marine trails have been considered as an efficient way of promoting environmental education directed at divers [21-25]. The marine environment can serve as an "outdoor laboratory" where tourists can view examples of ecological principles [26], which can increase the interest and the feeling for marine conservation. More than that, the divers can collaborate on data collection and monitoring, contributing to the conservation of various organisms, adding information about population structure, spatial distribution or behavior [27-30].

The United Nations Environment Programme (UNEP) recommends public involvement in the monitoring and management of the environment. The advantages of using such non-specialist volunteers include: 1) the supply of skilled manpower sufficient to conduct extensive research, while providing spatial coverage and putting research into their local context; 2) significant financial savings through voluntary work; 3) increase in scientific education, related to ecological problems, reaching audiences of different ages, through active participation in the ecological survey work; 4) providing a simple and low cost survey program, which can be continued using long-term experience and local funding [15,27,28,31]. This is important, for example, due to the fact that permanent monitoring can increase the chances of early detection and eradication of invasive species [30].

In this context, "Citizen Science", which is a method that places the public in gathering scientific information, thus contributing to scientific projects in various spatial and temporal scales [32], is inserted.

In terrestrial environments, cases of ecological projects involving

public participation have been reported as successful, such as ornithological studies. Birds are generally good biodiversity indicators and are easy to monitor because many are easily identifiable and because there are several potential observers [33]. In the case of the marine environment, beyond the voluntary training, there is still the need for the volunteers to be qualified as divers. Research and monitoring programs have requested divers as volunteers, making use of their natural interest in marine life, such as the "Coral Cay Conservation" [34], "Fish Survey Project", "Reef Check", "CoralWatch" and "Divers for the Environment: Mediterranean Underwater Biodiversity Project" [28,35-38].

Volunteers of the "Coral Cay Conservation" participate in an eight-day training program, which involves information on marine organisms (macroalgae, marine phanerogams, coral and other invertebrates, as well as specific interactions, taxonomy, physiology and coastal management) and research techniques, through lectures, practical exercises, individual tutoring, videos, slides and periodic evaluations. In the "Fish Survey Project", volunteers are classified as "beginners" or "experts" in identifying fish species according to the results of evaluations. The "Reef Check" recruits volunteers who undergo a training course involving research techniques and diving skills, and the participants carry out successive surveying (fish, invertebrates and substrate) in specific places, transects and depths, following a protocol and collecting biophysical and socioeconomic data under the mentoring of professional scientists. CoralWatch seeks to integrate education and global reef monitoring by examining coral bleaching, in which the participants simply match the colors of a chart to the coral color, record the codes, and enter the data via a website. In the "Divers for the Environment" project, non-specialist divers complete a questionnaire after diving, with the assistance of trained professional divers, in which they report the observation of plants, invertebrates and

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fish, as well as garbage.

Studies show that under appropriate conditions of recruitment and training, data collected by volunteers can be qualitatively equivalent to those collected by professional researchers and, therefore, useful for management [27-29,35,39]. For example, on the issue of global climate change, a study has been conducted using data obtained by volunteer divers, which allowed the identification of species that will likely present changes in their distribution limits in direct response to future global warming trends [40].

There are also huge educational and social gains of the involvement of citizen volunteers in scientific projects. Participation in citizen science projects provides a forum in which the participants are engaged in thought processes similar to those occurring in scientific research, and increase their knowledge of ecology and environmental issues [41].

The “self-education” of data collectors, the creation of a conservation force for transformation and the pride that citizen scientists present by helping in the advance of scientific knowledge and environmental protection are also recognized benefits [28].

Finally, the data collected by citizen scientists can allow scientists, managers, and policymakers to identify threats to and conservation priorities for MPAs [42].

In this context, we can think of a possible model for citizen science combined with environmental education in MPAs following the next steps:

- 1) The definition of the scientific questions that is of interest of scientists and MPAs’ managers;
- 2) Implantation of marine interpretative trails with an specific point of participative monitoring and collection of data;
- 3) The definition of basic protocols to be applied by citizen scientists;
- 4) Recruiting and training of citizen scientists;
- 5) Evaluation of citizen scientist’s affective and knowledge gaining;
- 6) Evaluation of the accuracy of the collected data.

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