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How citizens can encourage scientific research: The case study of bottlenose dolphins monitoring

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ABSTRACT

Citizen science projects are an advantageous method to carry out research in the marine environmental field, especially concerning high mobile and often elusive species like cetaceans, allowing the collection of data in wide spatial-temporal scale. This project aims to validate the feasibility and accuracy of cetacean monitoring program through the citizen science approach and to test the efficiency of this method to large scale study area. In this work data obtained by researchers monitoring were compared with data coming from citizen, which followed specifically developed protocol. Data collected were used to investigate the presence and distribution of bottlenose dolphins (*Tursiops truncatus*) in the Sicilian Channel and to evaluate the contribution of citizen scientist to improve knowledge about species, in this case for bottlenose dolphin a vulnerable species listed in the Annex II of Habitat Directive (92/43 CE). The results show that citizen dataset contributes to increase the distribution map of the 22% more than only research data were considered. Citizen science programme results useful to gain information in small areas not monitored by scientific programs, such as in this study, and they would be very useful if applied at large-scale. The promotion of citizen science programs in specified small areas could be helpful to cover unmonitored zones, to gain preliminary results and bridge the gap of knowledge about species occurrence and distribution. For this reason, citizen support might help competent authorities to answer to the environmental policies as Habitat Directive and Marine Strategy Framework Directive. This study is a demonstration of how citizen can encourage scientists to start long-term research project in not regularly monitored areas.

1. Introduction

The study of large-scale natural environments represents a big challenge for researchers due to the feasibility of effort required. The main problem is the necessity of a great deal of data to be collected across a variety of locations and habitats over years or decades. From this point of view citizen science could be helpful in the study of ecosystems and conservation practices. Citizen science is a research technique that engages common people in gathering scientific information at continental or global scale (Bhattacharjee, 2005). In a citizen science project, a wide network supports professional researcher using specifically developed protocols. The public plays an important role in data collecting in wide areas (and often, for extended period of time), with the intention of answering questions raised by researchers (Cooper et al., 2007; Ellwood et al., 2017). Volunteers can include participants from school-aged children to adults. Public may be involved in many different activities including project design, data collection, processing and analysis, and dissemination of information to the community (Tulloch et al., 2013; Theobald et al., 2015).

The advantages of using volunteers include the provision of sufficient manpower in order to conduct extensive surveys covering multiple areas simultaneously. Moreover, involving citizen can lead to an increase in the level of public awareness of ecological issues (Goffredo et al., 2010). Citizen science has also the advantage to be suitable for many applications and frameworks and several possible outcomes at different levels (e.g. scientific, societal and individual). The degree to which the outcomes can be achieved is different and dependent on the model of citizen science applied (Vann-Sander et al., 2016).

However, data fragmentation, data inaccuracy, and lack of participant objectivity could be a disadvantage in the application of this method (Whitelaw et al., 2003). The lacking of experimental design of some studies and thoughtlessness of issues such as adequate sample size

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may affect consideration and credibility that scientific and government community put on these data. Information collected by volunteers are often not taken seriously by decision-makers due to problems about not only credibility but also the non-comparability and completeness of the data (Gouveia et al., 2004; Bradshaw, 2003). Besides, some researchers have doubts about the training level of the volunteers, especially to prevent both false positive and false negative data (especially in the case of biological identification) (Royle, 2004). To make sure that the scientific community accepts and utilize the data collected by citizen scientists, it is necessary to ensure quality and validity of these initiatives through compliance to rigorous scientific methodology (Boudreau and Yan, 2004). A certain effort level should guide the volunteer programme, reaching a sufficient statistical power to be applied in conservation issues managing (Embling et al., 2015).

Acceptance by the scientific community would also allow the participation of additional attendee to in bio-monitoring programs, and thereby increase biological knowledge about species by creating large standardized spatial and temporal datasets (National Audubon Society, 2006).

The success of the citizen science projects is, among others, linked to the accessibility of the monitoring area. For example, more easily accessible places have greater potential success than less accessible places. Regarding the sea, the success of citizen science has been demonstrated in dive sites where divers were, for example, involved in collecting reports on the possible presence of alien/invasive species (Boudreau and Yan, 2004; Mannino and Balistreri, 2018). For how concern cetaceans, being in an environment not easily accessible, few studies have been conducted, often exploiting dolphins and whale watching activities (Tonachella et al., 2012; Bruce et al., 2014) and shore-based surveys (Bristow et al., 2001; Bailey et al., 2012; Camphuysen, 2011; Tonachella et al., 2012; Embling et al., 2015).

Given the scarcity of knowledge related to the use of citizen science in cetacean monitoring and its probable implication in the study of ecosystems and conservation practice, this work aims to validate the feasibility and accuracy of cetacean monitoring program through the citizen science approach. Cetaceans are highly mobile and often elusive species that spend most of the time underwater coming on the surface to breathe; they are not easy to see neither to approach. In addition, surveys are expensive and usually cover only a small fraction of a species' range even due to the expanse of the marine environment (Kaschner et al., 2006). Thus, it is convenient to involve a large number of people covering a wide sea area in different moments. This aspect highlights the need to implement citizen science programmes to increase the possibilities of observing cetaceans.

Furthermore, this study wants to measure the value of citizen science programme at large scale (among 1:5000). For this reason, the experiment was conducted in a small area in which regular cetacean monitoring was never conducted before, it represents a pilot study that test how citizen can contribute actively to gain preliminary information about species occurrence in understudied areas, not only at continental or global scale but even on local scale. This choose derives from the observation that exist numerous cases all around the world in which small areas are not monitored, or monitored with low effort, while neighboring areas have regular monitoring programme, resulting in not uniform distribution of the species. In other words, distribution maps of cetaceans in many cases, reflect the concentration of effort rather than a concentration of occurrence (Kenney and Winn, 1986; Kaschner et al., 2006). Citizen science at local-scale was applied in some cases, mainly in land project such as the project RiverBlitz in which citizen scientists survey the River in the City of Santee and San Diego for invasive plants, trash and site condition issues. While neighboring areas have regular monitoring programme, in the marine environment citizen science approach is widely employed for the monitoring of Marine Protected Area by scuba-divers (Mannino et al., 2016; Mannino and Balistreri, 2018; Turicchia et al., 2016).

With this goal, bottlenose dolphin (*Tursiops truncatus,* Montagu, 1821) was chosen as target species, being the more reported by citizen who mainly navigate in coastal area. Indeed, bottlenose dolphin is a coastal species, inhabiting waters of the continental shelf. Due to the wide continental shelf (up to 12 nm from the shoreline) and the related low depths of the studied area, bottlenose dolphin has been the most reported cetaceans species.

Data coming from citizen scientist were used to investigate presence and distribution of bottlenose dolphins in the Sicilian Channel and to evaluate the contribution of citizen scientist to improve knowledge about species distribution. To achieve the last mentioned objective, the technique of geostatistic through kriging model was applied to elaborate core-areas maps separately to the sightings reported by citizen and the ones obtained by scientific monitoring in order to compare the results. Kriging is a technique applied in different scientific fields for non-stationary spatial and temporal variables (Carrat and Valleron, 1992; Baume et al., 2009), its distinguishing feature is that it minimizes the error variance (Isaaks and Srivastava, 1989). In biological contexts, kriging has been applied to define species densities and identify areas of high presence and use (Steffens, 1993; Garcı'a & Dawson, 2003; Rufino et al., 2005; Monestiez et al., 2006; Alessi and Fiori, 2014). Moreover, this technique resulted suitable to be applied to all species that do not exhibit static behaviour (Rufino et al., 2005; Pittiglio et al., 2018), including cetaceans and seabirds (Monestiez et al., 2006; Alessi and Fiori, 2014; Cafaro et al., 2015), and can be used to obtain accurate and unbiased high resolution maps even using heterogeneous data, collected using different sampling strategies (Monestiez et al., 2005; Alessi and Fiori, 2014).

This work contributes also to increase knowledge on bottlenose dolphin (*Tursiops truncatus*) as required by Habitat Directive. The species, in fact, is listed in the Annex II which requires to select, designate, and protect sites (called Special Areas of Conservation - SACs) that support the species with the aim of creating a network of protected areas across European Union known as Natura 2000 (European Commission, 2008).

2. Material and methods

2.1. Data collection

The study area was located in the waters in front of the Agrigento province extending from 37.0° to 37.4° N latitude and to 13.1°–14.0° E longitude and covered about 780 km^2.

The Sicilian Channel is classified as Ecologically or Biologically Significant Areas (EBSA), means that the area is important for the good functioning of the oceans and the related ecosystem services. It is a key feeding area for at least 30% of the global population of Scopoli's shearwater (*Puffinus diomedea diomedea*), 10% of the global population of the vulnerable Yelkouan shearwater (*Puffinus yelkouan*) colony, and the colony of the endemic Mediterranean subspecies of storm-petrel *Hydrobates pelagicus melitensis* (Defos du Rau et al., 2012; Derhé, 2012; Thévenet, 2012).

The area was investigated through scientific surveys conducted by professional researchers and through citizen survey in order to test the *citizen science approach* as an instrument to gain preliminary information about cetacean presence and distribution in an understudied area of the Sicilian Channel. Indeed, the studied area before 2016 had no regular monitoring programme of cetaceans, while its northern border [between Capo Feto and Capo San Marco] (Papale et al., 2016; Alessi et al., 2017) was regularly monitored, as well as the waters around Lampedusa Island (Pulcini et al., 2010), a small island and marine protected area under the jurisdiction of the province of Agrigento but 115 nm far from its coasts.

2.1.1. Research survey

Data were collected from June to September 2016 during 18 daily surveys during which 654 nautical miles (nm) were crossed at an