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Dolphin conservation can profit from tourism and Citizen science

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ABSTRACT

Population studies of marine mammals are costly and time-consuming. Nevertheless, many people are happy to use their own resources to apply similar procedures to those necessary to evaluate dolphin populations in dolphin watching tourism. This offers a unique opportunity to collect sufficient data on dolphins to allow for conservation status evaluation by means of Citizen Science, a trending method. Here we crossed information on which species are targeted by tourism and which were lacking important population and ecology data, returning a list of 16 dolphin species which could benefit from dolphin watching tourism to assemble population data with conservation value. We make the case for engaging tourists and tourism agencies in a citizen science effort to raise data on dolphin species. For that, we offer suggestions for dolphin population analyses applicable by non-scientist personal.

1. Introduction

Dolphins are charismatic animals that play important roles in the marine environment (Balance, 2009), many of these marine mammals' populations face a decline due to habitat destruction, climate change, pollution and by-catch (Vollmer and Rosel, 2013). Studying size and distribution of cetacean populations is difficult because they spend long periods of time underwater and because many live in relatively low-density groups scattered over large ocean areas (Marques et al., 2009). There are many methods for estimating cetacean populations, but they are usually time and resource consuming due to the need to cover large areas of the sea, usually based in visual (Barlow, 2006; Gomez-Salazar et al., 2012) and acoustic (Stafford et al., 2007; Marques et al., 2009) analyses, the latter being funded on the hardly supported assumption of a direct correlation between animal calls and number of individuals (Anderson, 2001). More extensive quantifications of cetacean populations are needed for conservation purposes, but those data are also difficult to collect. While, until 2017, about 15% of the animal species were listed as Data Deficient by IUCN (Bland et al., 2017; IUCN, 2017), we calculated that more than 34% of the dolphin species were in this category (16 out of 47 species), a common trend in cetaceans in general (52% Data Deficient species, Parsons, 2016). Even species outside this category lack many population data, impairing adequate conservation measures.

Whale watching tourism has been developing quickly (Fernandes and Rossi-Santos, 2018). Ten years ago, it had escalated from nine million to 13 million people in a decade, employing 13,200 people and generating € 2.1 billion to 119 countries (O'connor et al., 2009), and a growth rate of 7% was expected for the following years (World Tourism Organization (UNWTO), 2017). Ecotourists, people travelling to natural areas and committed to environmental conservation (Geffory et al., 2015), are engaged citizens, which contribute to environmental development by funding conservation measures, sharing their awareness or learning more about the species (Deng and Li, 2015). The 8 million people visiting natural areas annually (Balmford et al., 2015), and this does not include

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marine tourism such as dolphin watching, are in general interested in conservation and willing to cooperate (Filla and Monteiro-Filho, 2009). Citizen science could add to the interest in specific dolphin watching companies, becoming interesting for tourism agencies too.

Numerous tourists frequently watching understudied dolphin species provide an emerging opportunity for a meaningful citizen science project. With as little as five volunteers per day, trends in activity period and distribution could be detected in dolphins (Embling et al., 2015), developed tourism destinations can provide for much more volunteers. Citizen science recruits and instructs the general public to collect data in large quantity, which will later be used by scientists (Silvertown, 2009). It has become a trending topic lately (Follet and Strezov, 2015), with a 10% annual growth for over two decades (Pocock et al., 2017). Despite its growth, there are many concerns about the validity of citizen science data that should be addressed by interested researchers (Burgess et al., 2017). That been taken care of, citizen science is considered a significant tool for biodiversity monitoring and conservation (McKinley et al., 2017) that has already been used in cetacean population evaluations in different ways (Giovos et al., 2016; Lodi and Tardin, 2018). Although there are studies based on data collected from commercial vessels (Williams et al., 2006; Dawson et al., 2008), they were done by a limited number of scientists, while dolphin watching could offer a much larger number of observers. Dolphin watching potential has not yet been fully exploited.

2. Citizen science, tourism, dolphin research, and conservation

In this discussion, we propose a citizen science monitoring system to collect the necessary data to evaluate dolphin conservation. For that, we crossed data from dolphin species targeted by tourism with IUCN red list. We used “Web of Science” and “Google Scholar” platforms to search for papers with a combination of the following keywords: “tourism + dolphin” or “dolphin watching”, resulting in a list of 5860 studies published in the last five years covering all continents and oceans. These studies reported 22 dolphin species as tourism targets. We also checked the conservation status of 46 dolphin species in IUCN red list. These species belonged to three families with small Odontoceti (our definition of “dolphin”): Delphinidae (38 spp.), Iniidae (1 spp.) and Phocoenidae (7 spp.). From the 46 species of dolphins listed there, four are considered data-deficient (IUCN, 2019) and all others have at least some population or ecology data lacking, with 12 of them having been only excluded from the Data Deficient category in this most recent version of the red list. The two lists, tourism targeted dolphin species and dolphin species lacking population and ecology data, overlapped in 16 valid species (Table 1).

These 16 dolphins, or at least the 13 species that are not threatened by tourism, as reported by IUCN, would largely benefit from a citizen science monitoring program with citizen scientists collecting population data on them. For that, scientists could train tourists (and boat crew members or tourism agents) to collect data properly. This could be done with videos explaining to the citizen scientists what their main questions are and, if something other than a population survey is being held, what their objectives and hypotheses are. Informing the public is another important role of citizen science (Bonney et al., 2009), so this introductory video, that could be played at the beginning of the boat trip or in the tourism agency, could also include information on the focal species. The same video should explain what data should be collected and how to provide the most complete and reliable information. A standardized form should be produced by researchers and a point by point explanation of this form should be included in the video. Simple forms are more easily filled and engage more users (Kim et al., 2013), so a limited number of questions free from jargons is preferable. Similarly, if you request any category, make sure you use easily recognizable terms. For instance, do not try to use many categories between newborn and adult. Many estimates of cetacean populations are based exclusively on visual surveys of the number of individuals, counted during a transect by airplane or boat, or counts from a stationary point (Jewell et al., 2012). The mere count of individuals, their precise GPS location and observation time, number of individuals in a group and occurrence of calves should already provide valuable data to provide a better understanding of dolphin species.

The internet and smartphones may be good allies in that matter. Scientists with little programming skills can build a mobile app that will integrate a form and allow for the collection of location data, identity, and photographs by each enlisted user (Kim et al., 2013). Apps such as “Wild about Whales”, by Environment and Heritage, already offer some of these tools and can serve as a basis. Another possible choice is “iNaturalist” (Matherson, 2014), which has a built-in relatively accurate species identification algorithm (Van Horn et al., 2018) and allows users to create projects in its homepage to direct data collection on a specific dolphin species. Even if an internet connection is not available in the field, which is often the case, it will only be necessary during the downloading of the app and for delivering the collected data. Citizen scientists' training and the introductory video mentioned previously could also be part of this app or part of the tour operator website such that tourists could be more prepared to collect data.

If a mobile app is chosen, some aspects must be considered. 1) The design must prioritize clarity with high contrast, short texts and multiple choice being preferable to typed responses. 2) Users' privacy must be a concern since the app should use the mobile's GPS to locate the user, the user must be confident his tracking will not continue after the dolphin watching expedition ends. 3) Citizen Scientist's dedication will be proportional to how much acknowledgment they receive, remember to name contributors somewhere. 4) Data quality can be reinforced by redundancy with other simultaneous users sharing the same boat or field trip (Kim et al., 2013). Digital tools are an excellent way to guarantee data precision, reduce the efforts in data transmission from volunteers to researchers and to simplify and qualify data collection.

Tourism agencies, their employees and boat crews should be personally trained by the research team. Boat crew must be trained to tell different species apart and evaluate dolphin life stage, which will be useful when they are guiding tourists. In this face to face contact, the importance of the agencies and their role in data collection should be stressed. Linear transects produce more reliable data and allow for relative abundance extrapolations (Braulik et al., 2018), but this must be agreed with the dolphin watching boat crew. Similarly, coverage of different areas may be agreed between researchers and crew. A mobile app can provide information on

Table 1
Dolphin species exploited by dolphin-watching tourism with deficient population data (IUCN, 2019), including their distribution, conservation status, what kind of data is lacking, and conservation measures listed by IUCN that could be aimed by citizen science projects. The IUCN categories listed are DD = Data Deficient; LC = Least Concern; NT = Near Threatened; VU = Vulnerable; EN = Endangered; CR = Critically Endangered. We also pointed species which IUCN indicated that tourism is an important threat as threatened by tourism (TT). For these, our proposal should be only considered with parsimony.

Dolphin species	Area of occurrence	Conservation Status	Missing data	Needed conservation measures
Cephalorhynchus heavisidii	Southwestern Africa, from Angola to South Africa.	NT, TT	Pop. size, distribution & trends Life History & Ecology Habitat trends	Systematic population monitoring Awareness & Communication
Inia geoffrensis	Northern South America (Rivers)	EN	Pop. size, distribution & trends Life History & Ecology Habitat trends	Systematic population monitoring
Lagenorhynchus australis	Southern tip of South America	LC	Pop. size, distribution & trends Life History & Ecology Habitat trends	–
Lagenorhynchus obscurus	Southern Atlantic, Indian and Pacific Oceans	LC	Pop. size, distribution & trends Life History & Ecology Habitat trends	Systematic population monitoring
Lissodelphis peronii	Southern oceans around the world	LC	Pop. size, distribution & trends Life History & Ecology	–
Neophocaena asiaeorientalis	Japan, Korea, China	EN	Pop. size, distribution & trends Life History & Ecology Habitat trends	Systematic population monitoring
Phocoena dioptrica	Southern oceans around the world	LC	Pop. size, distribution & trends	–
Phocoena spinipinnis	Argentina, Brazil, Chile, Peru and Uruguay	NT	Pop. size, distribution & trends Life History & Ecology	Systematic population monitoring
Platanista gangetica	South Asia in Indus Basin (Rivers)	EN	Pop. size, distribution & trends Life History & Ecology	Systematic population monitoring Awareness & Communication
Sotalia fluviatilis	Northern South America (Rivers)	DD	Pop. size, distribution & trends Life History & Ecology Habitat trends	–
Sotalia guianensis	Western Atlantic Ocean, from Brazil to Nicaragua.	NT	Pop. size, distribution & trends Life History & Ecology Habitat trends	Awareness & Communication
Sousa chinensis	Northern Indic Ocean, From India to Hong Kong	VU, TT	Pop. size, distribution & trends Life History & Ecology	–
Stenella clymene	Tropical and Subtropical Atlantic Ocean	LC	Pop. size, distribution & trends Life History & Ecology	Systematic population monitoring
Stenella frontalis	Southern Brazil to West United States and East Africa.	LC	Pop. size, distribution & trends	–
Stenella longirostris	Tropical and Subtropical regions, mainly Oceanic Islands in the tropics	LC	Pop. size, distribution & trends Life History & Ecology Habitat trends	–
Tursiops aduncus	Tropical and Subtropical Indo-Pacific	DD, TT	Pop. size, distribution & trends	–

boat trajectory so that only field trips that adhered to this protocol are used in such calculations. Researchers aiming to employ this source of data must be ready to spend time in training and networking with tourism agencies that will work directly with tourists on their behalf. Acknowledging these agencies is essential as well.

There are many simple data that can be delivered by tourists and that are key to understanding dolphin biology. The number of individuals observed will allow for the estimation of population size. It could be presented as the minimum (How many individuals were seen emerged at the same time?) and the maximum (How many different individuals do you estimate?) number of individuals per observation (Braulik et al., 2018). The location of each dolphin encounter will provide important data on habitat use and requirements, such as geographic distribution, depth, bottom slope, water temperature; or threats, such as overlap with ship routes or fishing vessels (Braulik et al., 2018). Citizen scientists could also recognize calves and offer data on breeding season, natality rate and duration of maternal care (Papale et al., 2017). Also, group sizes can be used to infer sociality and ecology information, such as food availability and fission-fusion dynamics. Although in the present mobile phone cameras seldom have enough definition to allow for large digital zooming, with time photographs provided by citizen scientists can serve as a basis for individual photo identification, permitting more precise population and habitat use measures (Cheney et al., 2013), some resources, such as iNaturalist, also allow for the upload of photographs taken with other, more powerful, cameras. These data easily provided by tourists acting as citizen scientists will elucidate some crucial aspect for appropriately evaluating dolphins, namely population size and trend, distribution and threats (Butchard and Bird, 2010).

3. Citizen science potential and caveats

The scientific establishment is beginning to recognize citizen science as a powerful data source in conservation and ecology studies (Silvertown, 2009; Chandler et al., 2017; McKinley et al., 2017; Pocock et al., 2017). To solidify such studies, proposers of citizen science dolphin watching projects must validate the data derived from citizen scientists with their own observations and further techniques unavailable to tourists, such as satellite imaging (Vukelic et al., 2017) or underwater sonograms (Wedekin et al., 2014). Unexperienced dolphin watchers counting individuals, evaluating their age and indicating their location will hardly equate to carrying out systematic surveys by professional scientists.

Some of the recognized biases in this approach relate to operators targeting preferred areas, with easier and closer navigation or higher chance of dolphin encounters. Data collection and experimental design must be standardized and clear to everyone involved, as should scientific hypotheses and assumptions (Silvertown, 2009). Contributors must be recognized and have access to the results of their efforts to increase adherence, making datasets openly available is also an important aspect (Silvertown, 2009; Kim et al., 2013). Nevertheless, safety and convenience prerogatives may create biases in study areas, time of observation and sea conditions (Sequeira et al., 2014). This intrinsic problem in our proposal could be alleviated by widening contributions to different dolphin watching destinations and companies and, possibly, negotiating different routes and schedules with long-term partner agencies. Well-trained citizen scientists with a relevant topic in mind guided by a reputed research team are more likely to have their data published and their results are more often taken into consideration for policy making (Burgess et al., 2017).

Certainly, there are limits to the quality of data citizen scientists can offer to researchers. But some of these limitations can be corrected by either having scientists direct their effort to areas in which citizen scientists have indicated interesting possibilities or having the volume of data provided by citizen scientist self-correct. Moreover, previous studies have shown that the difference between data quality collected by professional and by citizen scientists is not as discrepant as one might expect (Alessi et al., 2019; Der Velde et al., 2017; Kosmala et al., 2016). Some citizen science projects have already provided important ecological and conservation data (reviewed in Kobori et al., 2016, and in Ellwood et al., 2017 and other articles in the same special issue of *Biological Conservation*). In birds, in special, some programs have been widely used to generate substantial population data for conservation using online apps operated by birdwatchers (Walker and Taylor, 2017) or using more diverse methods (Devictor et al., 2010; Pocock et al., 2018).

Another caveat to be avoided is causing a citizen science program to add to the already intense deleterious effects of whale-watching tourism, many of which are already beyond carrying capacity (Fernandes and Rossi-Santos, 2018), the amount of people a tourist attraction can hold, originally just a matter of space to fit all people, but that actually also considers environment and fauna impacts as well (McCool and Lime, 2001). We identified three dolphin species in which dolphin-watching is recognized as a threat by IUCN (Table 1). In such species, we recommend only applying our proposal with strict control by the scientist group, on populations less harmed by tourism and partnering with more committed dolphin-watching agencies.

4. Conclusion

In 2015, a large team of researchers proposed a list of research themes to promote cetacean conservation (Parsons et al., 2015). Recruiting dolphin watchers in evaluating populations engages in at least six of their themes: prioritizing optimal use of funds and efforts, bridging science and the public, exploiting multiple methods and unconventional data, monitoring main cetacean populations for conservation, fostering sustainable activities, and managing population data (Parsons et al., 2015).

Only long-term studies will provide enough data for population trends evaluation in dolphins. Such studies demand huge efforts, some as long as 36 years (Monteiro-Filho et al., 2018) and robust demonstrations of population decline are rare and complicated (Azevedo et al., 2017). Since a global sampling effort will not suffice to detect large-scale populational trends in cetaceans, repeated surveys of specific geographic regions are also necessary (Jewell et al., 2012), ecotourism citizen science could provide both the wide-range and the long-term survey of dolphin populations. Therefore, we urge researchers to apply well-designed citizen science projects partnering with dolphin watching tourism agencies to produce the extremely necessary data that will fill important knowledge gaps in the population ecology of tourist-targeted dolphin species. While we focused on dolphins, our suggestion can be widely expanded to include other animals of interest, such as other marine or land mammals.

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Appendix A. Supplementary data

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