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Estimating the cumulative effects of the nature-based tourism in a coastal dolphin population from southern Kenya

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ABSTRACT

Due to the growth of nature-based tourism worldwide, behavioural studies are needed to assess the impact of this industry on wildlife populations and understand their short-term effect. Tourism impact on dolphin populations remain poorly documented in developing countries. This study investigates the effects of nature-based tourism on the behaviour of the Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) in southern Kenya. We used Markov chain models to estimate transition probabilities between behavioural states in the presence and absence of tourist boats, and assess the overall behavioural budgets. Based on these data and the tourism intensity in the area, we quantified the potential tourist boat disturbance over the period 2006–2013. Our results demonstrated that tourist boat interactions affected dolphins' behavioural budgets, with a significant decrease in the overall amount of time travelling and an increase in diving. The average duration of travelling and resting decreased significantly in the presence of boats. Although the cumulative tourism exposure was not significant for the dolphin population at their current levels, these impacts should be taken into consideration with the potential tourism growth in the area. This is particularly important if tourism reaches periods of high intensity, as we have shown that these periods could have a significant impact for the species, particularly where home-range and core areas are highly overlap by this activity. Understanding the effect of human disturbance variations from previous years may help to predict the consequences on dolphin populations, towards achieving a more ecological and economic sustainability of the activity.

1. Introduction

Over the last decades, the impact of human disturbance on wildlife populations has increased worldwide due to the growing of nature-based tourism, which involves tours to national parks and wilderness areas where a major percentage of the world's biodiversity is concentrated (Balmford et al., 2009; Olson et al., 2001). Consequently, human-wildlife interactions are becoming more common with potentially severe impacts on the conservation status of targeted species (e.g. Bejder et al., 2006).

In marine ecosystems, whale-watching is one of the main drivers of nature-based tourism, and the study of human disturbance on different aspects of the biology and ecology of those species have been the focus of growing attention in the last years (Higham et al., 2014). Indeed, increased exposure to high levels of boat-based tourism has been shown to cause behavioural disturbance, such as changes in breathing rates (Janik and Thompson, 1996), diving times (Ng and Leung, 2003), speed (Nowacek and Wells, 2001), swimming directions (Lemon et al., 2006), group formation (Bejder et al., 1999) and specific behavioural states (Christiansen et al., 2010; Lusseau, 2003). In addition, repeated short-term behavioural impacts can have cumulative negative effects on an animal's behavioural budget, which is directly related to its energy budget (Christiansen et al., 2013). Such cumulative

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effects can in turn lead to long-term negative effects on individual vital rates, such as decreased female reproductive success (Bejder, 2005; Tezanos-Pinto et al., 2013). At the population-level, negative effects of human disturbance, resulting from changes in vital rates, would depend on the proportion of the population that are subjected to the various levels of disturbance. However, as disturbances are likely to vary across space and time, it might lead to differences in impacts between individuals within a population, and also seasonally (Christiansen et al., 2015; Pirotta et al., 2014).

Whale-watching activities have grown globally at an annual rate of 12% through the 1990s, showing a much higher rate of increase than that of the overall tourism industry (Hoyt, 2001; O'Connor et al., 2009). The whale-watching industry had a total of 13 million whale-watchers globally in 2008, benefiting coastal communities with an estimated $US 2.1 billion, and generating more than 13,000 jobs (O'Connor et al., 2009). The increasing tourists' preference for whale-watching activities around the world suggests the further potential of this industry and the possible benefits for local communities. Indeed, Cisneros-Montemayor et al. (2010) pointed out that an extra $413 million and 5700 jobs could be generated within the current whale-watching industry, with half of these potential benefits created in developing countries (as defined by the UN; United Nations Development Programme, 2007). In Kenya, the whale-watching industry has grown from 8300 tourists in 1997 to almost 42,500 in 2013, which equals an annual growth rate in tourist numbers of nearly 11% (Kenya Wildlife Service, unpublished data). The highest number of tourists was recorded in 2006, when more than 60,000 visitors went whale-watching. However, due to political unrest in Kenya the tourism industry suffered multiple drops along the period between 1997 and 2013, with up to a 53% decline on visitors between some years (Kenya Wildlife Service, unpublished data).

A small population of Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) inhabiting Kisite-Mpunguti Marine Protected Area (KMMPA) is the main focus of the largest dolphin-watching industry in Kenya (Hoyt, 2005; Pérez-Jorge et al., 2015). This MPA attracts the largest number of visitors of all Kenya's marine parks and, in turn, this MPA provides the highest revenue along the Kenyan coast (Kenya Wildlife Service, 2013). Over 50% of these tourists were mainly interested in dolphin-oriented trips, highlighting the importance of dolphin-watching as one of the main economic activities for local communities (unpublished data; Emerton and Tessema, 2001). Dolphin tourism in KMMPA began in the early 1990s and has grown up to a total of 27 tourist boats registered in 2012, with the capacity to carry up to 48 tourists per trip (Kenya Wildlife Service, 2013). The industry has been operating year round, with peak seasons during the months of August and December-January, and a low season during the rainy period of April to June. In the early years of the dolphin-watching industry in KMMPA, the industry was developed with limited management control, as the dolphin-watching activity was perceived to be non-harmful to the animals, and therefore did not require additional regulations (Hoyt, 2008; O'Connor et al., 2009). Due to the rapid growth of the industry between 2004 and 2006, the Kenya Wildlife Service (KWS), in collaboration with international agencies, developed a voluntary code of conduct in 2007 (Convention of Migratory Species, 2007). This code recommended boat operators to keep a minimum distance of 100 m from dolphins and suggested a limit of two boats at any given time around the animals. The code of conduct also advised boats to spend no more than 20 min with the same dolphin group at a time, and also specified the best manoeuvres to approach the animals. Another major change for the dolphin-watching industry was the prohibition of swimming with dolphins. The code of conduct was implemented to mitigate possible impacts from the dolphin-watching activity. However, it was based on codes for other population from other parts of the world, and lacked scientific information on the targeted population.

We investigated the effects of the nature-based tourism on the behaviour of the Indo-Pacific dolphin population in southern Kenya. Specifically, we firstly used Markov chains analysis to estimate the probability of dolphins changing between different behavioural states (e.g., travelling, diving, socialising and resting) in the presence and absence of tourist boats, from which we estimated changes in the dolphins behavioural budget (Lusseau, 2003). Secondly, we investigated the effect of the current dolphin-watching intensity in KMMPA on the cumulative behavioural budgets of the dolphin population, and quantified the tourism intensity on the area for the 2006–2013 period, to evaluate the potential disturbances caused by this activity these years. Finally, we analysed the spatial overlap of dolphin and tourist boat distribution based on kernel density estimations in order to determine areas where tourist boat impacts could be more significant. Our study aims to assess the impact of nature-based tourism on the behavioural ecology of the Indo-Pacific bottlenose dolphin, and understand which effects must be managed to ensure that the local-dolphin industry is sustainable.

2. Material and methods

2.1. Study area

This study was conducted on the International Union for the Conservation of Nature (IUCN) data deficient population of Indo-Pacific bottlenose dolphins inhabiting the Kisite-Mpunguti Marine Protected Area (KMMPA, 04°04′S–39°02′E), in southern Kenya (Fig. 1). Recent capture-recapture modelling studies estimated a small population size for the area ranging from 20 (95% CI: 11–36) to a maximum of 102 individuals (95% CI: 77–138) (Pérez-Jorge et al., 2016). Abundance estimations remained roughly stable from 2006 to 2009, with a mean of 65 dolphins (SE: 7.06). The presence of this species in the study area is strongly influenced by dynamic (oceanic fronts) and static predictors (shallow areas, distance to reefs, distance to the 100 m isobath), with a significantly higher occurrence and abundance of dolphins within the KMMPA (Pérez-Jorge et al., 2015).

2.2. Data collection

Non-systematic boat-based surveys were carried out between the months of October and December 2011, 2012 and 2013. During this part of the year the sea is calm, the wind is light and rainfall is low, which makes the conditions ideal for behavioural surveys, as group-follows can be carried out for extended periods of time. Behavioural data from dolphin groups was collected from a 9.5 m dhow, a traditional wooden sailing vessel, with one 15 HP two-stroke outboard engine. A dolphin group was defined as the total number of individuals encountered, moving in the same direction or engaged in the same activity, within 100 m of each other (Wells et al., 1987). Once a group was sighted, the research vessel was operated in a careful way at slow speed, avoiding changes in gear and staying slightly behind or on the side of the dolphin group to minimise disturbance. Thus, focal groups were followed at a distance ranging from 20 to 100 m, both in the presence or absence of tourist boats.

The behaviour of dolphin focal groups was measured using focal-group scan sampling methods (Altmann, 1974). The behavioural state of each focal-group was sampled every 15 minutes and was determined by the activity of the majority (> 50%) of the