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A proposal for the use of unmanned aerial or aquatic vehicles to quantify the impact of whale watching

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Abstract

There is significant interest in understanding the potential impacts of whale-watching on various marine mammal species. A key component to determining whether impacts have occurred is understanding the behaviour of the species of interest in the absence of disturbance. This requires observations of animals when they are unaware of surveillance. Where appropriate, land-based surveys may be used, but often this sample would be of a different population of individuals than the one actually of interest. While some types of boat-based observations have been shown to minimally impact species' behaviour, they may be prohibitive to carry out and may still alter species' behaviour in subtle ways. Here we lay out a proposal for investigating an alternative method for studying marine mammal behaviour to avoid disturbance: unmanned aquatic or aerial vehicles.

Introduction

To assess impacts of whale-watching (and cetacean abundance estimation more generally) it is important to separate out the attractive/repulsive effects of that the observers have on the distribution of the animals from more general distribution patterns.

Decoupling these two effects requires "control" data, to show what the population's distribution was before being disturbed by whale-watching activity. This control data must be both co-located (in space and time) with the path of the whale-watching vessel and in neighbouring areas (up to a distance where acoustic models predict engine noise would affect animals).

Obtaining this data provides a set of interesting challenges because of the need to be in proximity to the species in order to record their behaviour, and such proximity may, itself, be a disturbance. As a result, such continuous monitoring has been hard to implement in practice, requiring either long-range observers (e.g. Williams et al 2002) on the whale-watching vessel (which would not be an independent platform), additional vessels (which would have to be relatively numerous to maintain good spatial coverage) or land-based observations (which are not possible at all locations). In this we present the possibility of an alternative approach, the use of unmanned aerial or aquatic vehicles ("drones"), to address some of these issues. However, like current approaches, the use of drones will have its own difficulties, limitations and logistical constraints, especially in the developmental phase.

Previous and alternative approaches

There are a number of other approaches that could be used to identify impacts, though we show below that each has their limitations.

A low-cost solution might be to use existing species distribution models (SDMs) along with records of observations from whale-watching cruises and attempt decouple spatial distribution from where the animals are observed via a complex statistical model. It is widely recognised that SDMs have large (and often poorly quantified) error attached to them. SDMs are often built using climatological, rather than contemporaneous or *in situ* covariates, so they may not accurately reflect distribution of animals while whale-watching is occurring.

Previous work has used an approach of an observer independent from the whale-watching boats (Williams et al 2002; Lusseau 2003), though only in a limited geographical area. The use of a high vantage point for shore observations that would not affect whale behavior is not practical for whale-watching further from shore or in the open sea, so other approaches are required (Lusseau 2003).

Alternatively, one might also envision a tag-based approach. The behaviour of previous tagged animals could be explored using experiments that exposed these known individuals to different levels, and types, of potential disturbance from whale-watching. These periods of known disturbance could then be compared with the individual's behavior in the absence of whale-watching vessels. Such an approach seems like poor value for money, as tags (and tagging) are expensive and it is hard to ensure that tagged animals are the ones seen on the watch. In addition, while the tagged animals may not be exposed to disturbance from whale-watching vessels outside a certain spatial area, they can be exposed to other forms of disturbance from recreational, commercial and other vessels and sources of noise (e.g., seismic surveys). If these potential forms of disturbance are not detectable by the tag then any failure to detect a difference in behavior due to whale-watching may be due to comparing the behavior of different periods of disturbance as opposed to undisturbed vs. disturbed.

Proposal

We seek to build on the successful use of aerial survey and photogrammetry data (e.g., Fearnbach et al. 2011, Sweeny et al. 2014) to develop a potential new approach to assessing the potential impacts of whale-watching activities. The recent interest in drones allows us an interesting opportunity to use low-cost technology (in comparison to manned aerial surveys) to survey whale-watching areas ahead of ship arrival and attempt to understand disturbance caused by vessels engaged in whale-watching cruises.

Drones are unlikely to cause as much disturbance as boats to the cetaceans being studied as their small engines are quiet and are generally very small in comparison to light aircraft usually used in aerial surveys. However, there has been some indication that light aircraft can disturb hauled-out seals depending on context and weather, so further investigation will be required. We propose that drones are sent out ahead of the whale-watching vessel (far enough to be ahead of any expected acoustic disturbance from the vessel) and used to assess the distribution prior to the disturbance caused by the larger vessel. Given the current constraints of non-military drone technology it may not be possible to observe the species of interest in the complete absence of any potential disturbance from a whale-watching vessel. This study will form a useful “proof of concept” study and, given the fast pace of technological advance in the area, such vehicles may be available soon to the public.

The precise technical details of the technology are left open for now, though a number of options present themselves using standard, affordable, "off-the-shelf", solutions currently available to hobbyists for initial testing. Different technology (e.g., “copter” vs. fixed wing aircraft) have different capabilities and may be more or less appropriate depending on the species being observed and oceanographic conditions. Initial testing would allow us to evaluate various combinations of technology along with the complications involved with launching and landing on a whale-watching vessel or the marine environment. As a result, a degree of experimentation will be necessary, so the involvement of government, industrial and academic partners will be necessary. Expert consultation would be required to ensure that optimal equipment and skilled operators are used. Given the usual conditions required for a whale-watch to take place, drones would not be confronting extreme weather and sea conditions.

Analysis of the drone survey data and data collected from the whale-watching itself could be use a combination of standard methods. The drone data, likely video, would use strip transect methodology (since all animals along the transect would be detected, if available; Buckland et al 2012). Data from the whale-watching vessel would require dedicated observers, likely using double-observer line transect methodology (“mark-recapture distance sampling methodology“; Burt et al 2014). In order to ensure that the bias incurred by the non-random sampling design, an explicit spatial model would need to be developed (Burt & Paxton 2006; Miller et al 2013). Finally comparison of resulting spatial models would need to be conducted to assess any differences in distribution potentially caused by the watch.

One extension to the above methodology would be to perform a full before-after-control-impact study, though this will be dependent on densities of cetaceans, number of trial whale-watching tours and potential technological limitations of the drones. Another possibility would be explicitly model behavioural state, though this requires much more work on behalf of both observers and modellers.

Wider applications

Although the primary use of such experiments will be to quantify the effects of whale-watching, it is likely that other insights regarding animal behaviour, body condition, group structure and local distribution can be assessed (e.g., Perryman & Lynn 2002). The perennial issues of error in group size estimation and responsive movement could also be addressed in such a study -- shedding light on two general problems that is often overlooked or ignored in cetacean distribution modelling.

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