On the Reliability of Whale Watching as a Source of Scientific Research

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Introduction

The industry of whale watching has grown exponentially in the past decades (E Hoyt, 2001) as the focus on whales went from one of overexploitation to conservation. Whilst still posing important issues (ECM Parsons, 2012), this industry focusing on non-consumptive use of cetaceans shows much promise in the domains of business and science alike. Whale watching data has already been used alongside whaling data to estimate population levels of cetacean species (N Vieira & C Brito, 2009) and the literature on the effects of whale watching, positive and negative, is extant (C Wilson & C Tisdell, 2003; C Richter, S Dawson & E Slooten, 2006). This form of nature tourism is booming and has been estimated at several billion dollars a year. The rules and regulations enforced upon whale watching companies include investing in conservation and local community growth. This investment in conservation is often invested in research in the form of money or access to boats for data collection (H Hoarau & C Kline, 2014). This has given marine mammal scientists a new platform from which to study from. However, most of the research has been focused on the species themselves or the effects of whale watching on the latter.

Here, I have carried out a three month long survey of all cetacean species in the bay of Plettenberg Bay. This survey has led to a study of the reliability of this new research platform. I have considered the ways in which whale watching may bias or has been known to affect data and tested their impact on the cetacean populations Plettenberg Bay. I have considered how the logistics of using whale watching boats may affect results, as well as cetacean reaction to whale watching boats and the variation of behaviour when boats are present or absent.

Materials and Methods

Study area

The data for this study was collected over the three months period corresponding to winter in the Southern hemisphere (29th June to 21st September) in the town of Plettenberg Bay, one of South Africa's famous whale watching destinations. This period coincides with the local whale watching industry's "whale season", meaning that the large migratory species (the humpback and southern right whales) come into the area and business is at its peak with up to five boats going out per day. Thus enabling me to gather the maximum amount of data from whale watching trips. The study was carried out from two platforms: whale watching boats of Ocean Blue Adventures, one of the two permitted boat based whale watching companies in Plettenberg Bay, and from shore at Signal Hill (34°3'S, 23°22'E) the highest, most central point of the bay. This viewpoint was ideal to spot whales as it offers a complete view of the bay up to 8 nautical miles out to sea. Observation from land was done with binoculars for spotting and a theodolite to estimate the whale's position and confirm the identity of the species. Land observations were carried three times a week between 2 and 4 hours and boat observations were carried out between two and four times a week for 1.5 hours. The exact number of observations per week was not constant as weather conditions in Plettenberg Bay are highly susceptible to change and wind and rain can make observation too complicated to gather any data. Thus, when visibility was deemed too poor (5 nautical miles or less) or beaufort was at 3 or higher, observation efforts were abandoned.

Tracking

Tracking of whales from boats was done from the crow's nest atop a 14m boat at about 3m above sea level. Observations started as soon as a whale was spotted and the species identified. Records of the time, weather conditions and location were kept for each observation. ID photos were taken where possible to help other research in the area. Behaviour of the animals were recorded (Table 1) as well as direction of travel. Presence of mother-calf pairs was recorded along with juveniles. Reaction to boat was also recorded (neutral: no net reaction to presence of boat, behaviour unaltered; avoid: apparent reaction and effort to shake off pursuit, long dive time intervals and consistent change in direction of travel; friendly: interruption of ongoing behaviour followed by deliberate movement towards the boat). Tracking from land was more difficult as some information could not be gathered due to the distance from the animal and usually shorter observation periods. However, the same information was gathered where possible along with presence or absence of an observing boat.

Data analysis

A series of two-tailed t-tests were carried out to analyse the animals' reaction to the presence of a boat using both the datasets from land and boat observations. Reaction to boat in the presence of a calf was also analysed to test for the effect on the animals' behaviour when travelling with calves. Mean observation number for land and boat based datasets were calculated separately along with the mean, variance and standard deviation for all observed

Table 1. Definition of behavioural states observed in all cetaceans found in the waters of Plettenberg Bay.

Behaviour	Description
Travelling	Animals in movement making consistent progress in a specific direction with regular dive intervals.
Socialising	Animals observed engaging in various interactive behaviours with other individuals (such as: copulating and/or any other form of physical contact).
Foraging	Animals engaged in a recognisable form of chasing for prey (such as: lunge feeding and/or cooperative deep diving)
Resting	Animals observed in tight configuration with little to no movement with surfacing bouts slow and predictable.
Milling	No net directional movements, animal facing in different directions and not gaining any headway in a particular direction.

behaviours. Two-tailed t-tests were carried out to compare mean number of observations and sighting rates between land and boat based observations. T-tests were also used to compare means of each observed behaviour. A general linearized model was used to compare which behaviour was most commonly observed from land and from boat respectively. All statistical analysis were done using the statistical software R.

Results

In the whole of the study period, a total of 69 boat trips where cetaceans were sighted were recorded (103.5 hours of observation) and 36 land based surveys were conducted (108 hours of observation) in order to obtain a similar sampling effort for both datasets. The mean sighting rate of land observations was at 1.59 and that of whale watching trips was at 1.50. A two-tailed t-test showed no significant difference in mean sighting rates across methods of survey.

Over a total of 52 boat encounters by cetaceans recorded, 16 resulted in an avoidance behaviour from the animals, 10 displayed friendly approach behaviour and 26 showed neutral reactions to the boat. I tested for the effect of calf presence on cetacean reaction to boats. Results can be seen in figure 1. Proportion of observed friendly behaviour is seen to increase when calves are present and avoidance decreases whilst proportion of neutral reaction remaining constant. Two-tailed t-tests showed non-significant differences in mean reaction between avoidance and friendliness ($t=-1.36$, $df=99.6$, $p\text{-value}=0.178$) but neutral reaction was found to occur significantly more than friendliness ($t=-3.45$, $df=96.7$, $p\text{-value}=0.000828$) and avoidance ($t=2.02$, $df=101$, $p\text{-value}=0.0462$). Thus, overall animals were significantly more likely to remain neutral to the presence of the boat although avoidance was more predominant than friendliness, to the exception of cases where calves were present.

Differences in observed behavioural states were analysed by comparing the mean behaviour of that of all other by two-tailed t-tests. Significant results were found only for travelling and socialising behaviours. Travelling was observed highly significantly more than all other behaviours: socialising ($t=-17.04$, $df=251$, $p\text{-value}<2.2e-16$), milling ($t=-22.7$, $df=254$, $p\text{-value}<2.2e-16$), resting ($t=-23.5$, $df=250$, $p\text{-value}<2.2e-16$) and foraging ($t=-3.25$, $df=204$, $p\text{-value}=0.00143$). Socialising was also observed significantly more than the remaining three behaviours: milling ($t=-2.28$, $df=235$, $p\text{-value}=0.0236$), resting ($t=-2.51$, $df=228$, $p\text{-value}=0.0129$) and foraging ($t=-3.25$, $df=204$, $p\text{-value}=0.00134$). The highly significant figures associated with travelling are linked to the very little number of observations where other behaviours were observed compared to the large repository of observations when animals were on the move. Social behaviour is also recorded more often in sightings of odontocete species.

I ran general linearized models on the data to test for differences in observed behaviour between land and boat based observations. These models were run for all five behaviours independently and compared the datasets of boat based to land based observations. No significance was found in the different models, showing a lack of variation in behaviour when cetaceans were observed from different platforms.

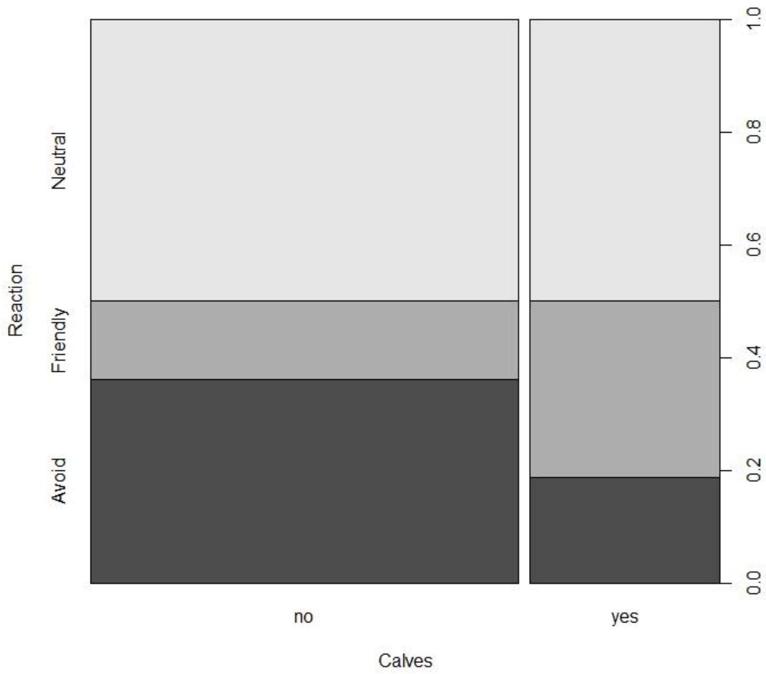

Figure 1. Cetacean reaction to whale watching boat presence when in company of one or more calves.

Discussion

The whale watching industry can play a significant role in scientific research and help increase our limited knowledge of cetacean species tremendously by offering large amounts of easily accessible, cheap data for researchers. However, the question of how much of the data collected during whale watching tours can be seen as reliable is open. My work lacks any analysis of the weather patterns, times or sea conditions affecting marine mammals, as such work would be severely biased by any data collected whilst on a whale watching trip. Indeed, whale watching trips have fixed times (7h30, 9h30, 12h00, 14h00 and 16h00 in the case of Ocean Blue Adventures in Plettenberg Bay) making any analysis of daily activity of cetaceans severely biased towards the whale watching timetable of the business. Further analysis of cetacean behaviour in relationship to weather and sea conditions cannot be done with whale watching tour operators as health and safety reasons push them to cancel trips when conditions deteriorate, creating a whole in the potential dataset. However, whale watching companies can be, and have been (H Hoarau & C Kline, 2014), used to study aspects of whale and dolphin behaviour as well as to survey local populations.

My results show that neither land nor boat based observation were significantly more successful at spotting animals. In fact the sighting rates are surprisingly similar, suggesting that any of the two are as reliable to observe wild marine mammals. However, this may be due to the fact that boat trips are often guided by land observers to maximise chances of spotting whales to satisfy paying customers. Furthermore, the area where the study was carried out is an enclosed bay where most cetaceans can be found within the calmer waters and easily spotted. Moreover, as boat trips tend to take place on the nicest days, whale and dolphin spotting becomes easier and sighting rates increase.

Research on cetaceans worldwide have shown that whale watching boats may disturb animals in the wild and provoke avoidance behaviours similar to predator-prey dynamics, where the observed animals acts as the “prey” (A Schaffar et al., 2009). Species often sighted off South Africa have been proven to show such behaviour (Table 2). Such avoidance techniques can result in behavioural changes which do not correspond to natural cetacean behaviour, thus making behavioural studies from whale watching boats inaccurate. My results show very little avoidance of whale watching boats. Neutral reactions tend to predominate, whilst friendly reactions are rarer. The latter is not due to age effects as we would expect individuals travelling with calves to increase evasive behaviour (R Williams, A Trites & D Bain, 2002) and the opposite reaction is observed in this study. This may be due to the majority of cetaceans travelling with calves being dolphins and dolphins being more likely to engage in friendly behaviour towards boats than larger whales. The amount of neutral behaviour can be explained by the biology of most of the species observed in this study. Large mysticetes such as humpback whales only pass through the bay as part of their migration and smaller odontocetes such as indo-pacific humpback dolphins are known to be a shy species, making them less likely to interact with boats.

Table 2. List of common species of Plettenberg Bay and behaviour affected by the presence of whale watching boats (based on: ECM Parsons, 2012)

Affected behaviour	*Species*
Surfacing/Diving	Indo-Pacific Bottlenose Dolphin
	Indo-Pacific Humpback Dolphin
	Humpback Whale
Active (eg:tail slapping,…)	Humpback Whale
Acoustic	Humpback Whale
Swimming speed	Indo-Pacific Bottlenose Dolphin
	Humpback Whale
Swimming direction	Indo-Pacific Bottlenose Dolphin
	Indo-Pacific Humpback Dolphin
	Short-Beaked Common Dolphin
Feeding or resting	Indo-Pacific Bottlenose Dolphin
	Humpback Whale

Behavioural research is likely to be affected the most by the effects of whale watching boats on cetaceans as they have been shown to change behavioural states when approached by whale watching boats, where socialising and foraging decrease whilst travelling appears to increase (D Lusseau, 2003; K Stockin et al., 2008). I have tested observed behaviours of all species in this study and the results show that travelling is seen highly significantly more than any other behaviour, as expected. However, socialising is also seen significantly more than the last three. The large amounts of travelling observed may also be due to the biology of the observed species as humpback whales are known migrators in the area and large pods of oceanic dolphins swim through the bay on the lookout for food. The apparent high levels of socialising may also be due to the very frequent sightings of the highly social bottlenose dolphin. The general linearised models failed to show any difference in observed behaviour due to the platform used to record the data. This suggests that whale watching was not having an effect on the behavioural budget if the observed species. However, the current study encompasses too many different species with different biologies and life histories to accurately describe whether behaviours were affected by the presence of the boat. Furthermore, it has been proven that whale watching boats may increase underwater noise and affect behaviour (C Erbe, 2002). Investigating such effects will require the use of hydrophones and cannot be included in this study but serve to show that whale watching may be modifying cetacean behaviours on more levels than we believe.

The results presented in this study support the idea that whale watching can be used as an efficient method of collecting data for scientific research. Indeed, cooperation between the two has been successful in the past as scientists often struggle for funds and whale watching companies offer a cheaper alternative to gain access to cetaceans. Nevertheless, the effects of whale watching remain a concern (P Corkeron, 2004) and regulations need to be kept in place to ensure sustainability. Strict scientific rigor is required when using whale watching boats for the purpose of research as data can easily be biased by the nature of the business. I suggest that more effort be put in studying the effects of whale watching and the species of Plettenberg Bay as whale watching in the area only consists of two boats and efficient management could maintain preserve the area for insightful future research. Later research will have to focus on specific species to discriminate between anthropogenic effects and life history of species.

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