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Behavioural Responses of the Australian Fur Seal (*Arctocephalus pusillus doriferus*) to Vessel Traffic and Presence of Swimmers in Port Phillip Bay, Victoria, Australia

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Abstract

A largely unregulated seal-swim industry exists in Port Phillip Bay, Victoria, Australia. This study has documented four fur seal behaviours in response to vessel traffic and presence of swimmers in order to determine the impact of tourism activities on Australian fur seals (*Arctocephalus pusillus doriferus*). Behavioural responses of fur seals to the presence of a total of 135 vessels (tour = 61 and recreational = 74) were collected on 42 research trips over the peak austral summer tourist period (November 2007 to February 2008). After considering all studied variables, vessel distance, the number of swimmers undertaking seal-swim activities, and the number of recreational vessels were found to influence seal behaviour. Aggressive behaviour displays by fur seals were influenced by the presence of recreational vessels within close proximity to the study site (< 200 m); haul-out events initially increased as a result of the presence of swimmers undertaking seal-swim activities; and occurrences of fur seals entering the water increased in response to the distance of approaching tourism vessels to the study site. Statistical analyses found no clear indicator influencing the number of threat postures displayed by fur seals. While a weak linear relationship was identified between the indicators (i.e., presence of recreational vessels, presence of swimmers, and the distance of tour vessels) and the three behaviours displayed by fur seals, *post hoc* tests failed to achieve significantly different means for each of the indicators. This preliminary research into the impact of swim-with tourism upon *A. pusillus doriferus* will provide valuable baseline data for the future. The long-term research into the effects of this particular tourism industry on fur seal behaviour may ensure wildlife managers develop appropriate regulations for seal tourism interactions that promote a sustainable marine tourism industry within Port Phillip Bay.

Key Words: behaviour, Australian fur seal, *Arctocephalus pusillus doriferus*, tourism, vessel traffic, seal-swim industry

Introduction

Tourism throughout the world has experienced unprecedented growth in the past two decades, making it one of the largest industries globally. A major contributor to the growth of tourism is the nature-based market, in particular marine-related activities (Miller, 1990; Orams, 1995). One facet of nature-based tourism is pinniped tourism. Pinnipeds make ideal candidates for tourism operations because they are colonial, and their presence and location are predictable (Scarpaci et al., 2005). Pinniped tourism currently includes observing seals from a motorised vessel (Boren et al., 2002; Kirkwood et al., 2003), viewing platform (Kirkwood et al., 2003), or kayak (Boren et al., 2002), and directly walking into their environment and swimming (diving or snorkeling) with seals (Scarpaci et al., 2005; Boren et al., 2009). This industry involves approximately two million visitors per annum with an economic value of more than $12.5 million USD in the southern hemisphere alone (Kirkwood et al., 2003).

Tourist activities are not always benign, and many studies have documented noticeable behavioural changes in pinnipeds due to the presence of tourism activities (e.g., Kovacs & Innes, 1990; Cassini, 2001). Short-term implications of pinniped tourism include changes in seal vocalisations (Terhune et al., 1979), reduction in mother-pup attendance, altered pup behaviour (Kovacs & Innes, 1990), and an increase in threat behaviours resulting from close proximity of tourists (Cassini, 2001). Increases in vigilant behaviours displayed by seals (e.g., sitting up, looking at tourists, moving farther up the beach) when tourists made loud noises have also been observed by some authors (Bonner, 1990; Martinez, 2003; Orsini et al., 2006). Other examples include avoidance behaviours in

the presence of tourists (Boren et al., 2009) and reduced foraging as a result of seal watching activities (SEWPaC, 2011). This study documents the swim-with-seal industry in Port Phillip Bay, Victoria, Australia, to determine if vessel traffic and tourists swimming with fur seals affect the behaviour of a local population of Australian fur seals (*Arctocephalus pusillus doriferus*).

The authors believe that this study is the first to document the behavioural responses of Australian fur seals to the combined effect of vessel traffic and presence of swimmers. The aim of this study was to determine if the swim-with-seal industry in Port Phillip Bay is affecting fur seal behaviour and will ultimately gauge the effectiveness of the current management strategies (code of conduct). The findings of this research will provide wildlife managers with information that may drive sustainable management of such industries by understanding the factors (vessel presence and swimmers) that influence seal behaviour.

Materials and Methods

To determine behavioural responses of the Australian fur seal to vessel traffic, observations were conducted from onboard a licensed tour-operator vessel (N = 39 trips) and from an independent research vessel (N = 3 trips). Australian fur seals were observed for a 10-wk period over the peak austral summer tourist period (November 2007 to February 2008).

Study Site

Chinaman's Hat (CH) (38º 17'15.62" S, 144º 43'37.17" E) is located in southern Port Phillip Bay, Victoria, Australia (Scarpaci et al., 2005). It was originally constructed in 1942 as a "magic eye" for a light beam during World War II as part of Victoria's defence strategy (Australasian Institute for Maritime Archaeology, 2002). Chinaman's Hat is a covered octagonal structure with a diameter of roughly 10 m that allows predominantly subadult fur seals an opportunity to haul out at a height of > 2 m above the sea surface (Figure 1). The site is now a haulout for subadult male Australian fur seals.

Standard Procedures for Approaching CH

Tour-operators utilising the fur seal population at CH undertook two site visits per day (weather permitting). On two occasions, the tourism vessel from which the majority of data were collected for this study undertook three site visits. Nature-based tourism is a competitive industry wherein customers are increasingly expecting a close interaction with wildlife (Kelly et al., 2004; Lusseau & Higham, 2004; Quiros, 2007). In order to ensure this, as tour operators approached the structure, the process for the impending swim was explained to customers, including some background information on the fur seals themselves. By approaching the structure slowly, the dive master was able to get the customers ready for the swim and also explain any necessary safety measures. Once the tour vessel arrived at CH, the captain circled the structure closely (≈10 m) to allow for photographic opportunities before moving out to allow swimmers room to enter the water.

Behavioural Data Collection

In many studies in which animal behaviour is documented, the researcher's presence is likely to have an effect (Williams & Ashe, 2007). Therefore, it is probable that tour operators felt their actions were under scrutiny, which may have caused them to alter their behaviour. As such, the actions undertaken and the processes documented in the current study were most likely to have been of the highest possible standard that aimed to limit potential impacts on the fur seals.

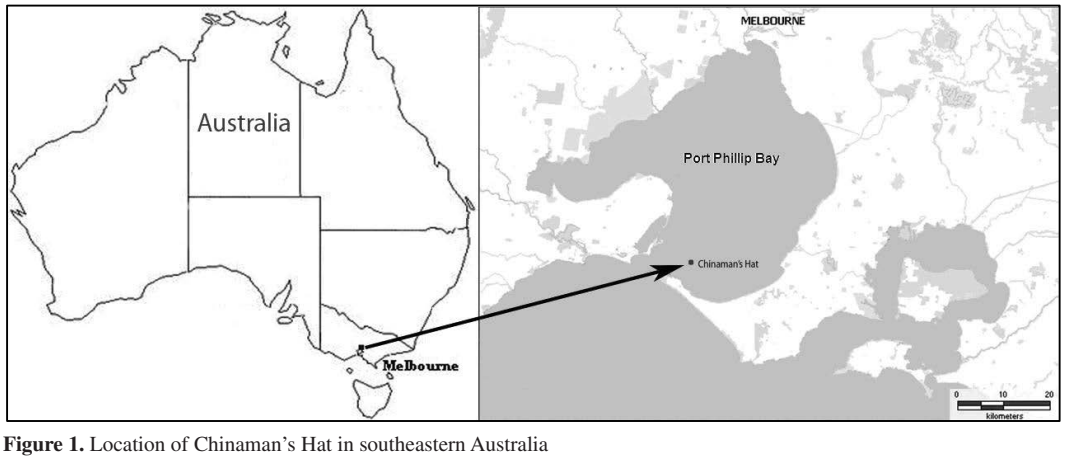

Figure 1. Location of Chinaman's Hat in southeastern Australia

Data collection from onboard the tourist vessel (n = 37) began once the vessel entered a 200-m radius surrounding CH and lasted until it departed to 200 m from CH. The 200-m distance was determined using GPS waypoint data and a Yardage Laser Pro 500 Rangefinder. Data were logged using two sampling techniques: (1) all occurrence sampling with continuous observations and (2) scan sampling. The process of all occurrence sampling, as described by Altmann (1974), allowed data to be collected on the entire social group for the chosen behaviours. This process was only possible due to the conspicuous nature of the behaviours being studied and the clear vantage point achievable from the vessel. Data collection occurred continuously in 45-s intervals once the vessel entered the 200-m radius and continued until it left to the same distance. In order to collect data on each of the eight variables during each 45-s interval, scan-sampling techniques were utilised as described in detail below.

Baseline Data Without Tour Vessels

While there were significant time constraints in this study, there was a need to provide a point of comparison between natural behaviour of fur seals and those behaviours potentially affected by tourism traffic. To achieve this, fur seal behaviour was documented in the morning (0900 h) when fur seals at CH had no contact yet with tourism vessels. A limited number of observations (N = 3 trips) were recorded from the research vessel. As the research vessel approached CH to a distance of 200 m, the engines were turned off and the vessel anchored, allowing the observer to document behaviours that were as close to natural as possible while minimising the effects of the presence of the research vessel.

This method was used to document seal behaviour and vessel activity data collection at distances of 200 m (average of 25 min/trip, SD = 1.4), 150 m (average of 21.7 min/trip, SD = 1.4), 100 m (average of 18 min/trip, SD = 1.4), and 50 m (average of 105 min/trip, SD = 18.4). The process of collecting data at each of these distances allowed for more accurate determination of critical distances for which a marked increase in each of the observed fur seal behaviours could be documented. It is likely that time of day may have an effect on fur seal behaviour; therefore, it should be noted that due to the need to observe fur seal behaviour in the morning (0900 h), data collected on these visits may have potentially been biased as providing a baseline for fur seal behaviour.

The following information was documented continuously throughout the 45-s scans using all occurrence sampling techniques:

- *Aggressive Behaviour* – Aggressive behaviour was defined as territorial disputes between two or more hauled-out fur seals. In this instance, the aggressor would often attempt to bite the face of the other seal. This behaviour was deemed to occur when the behavioural response continued for a period of > 2 s. Single barks or bites were considered normal behaviour and were not recorded as data.
- *Fur Seals Jumping onto CH (Hauling Out)* – The total number of fur seals that exited the water and hauled out onto the platform for refuge was recorded for each 45-s interval.
- *Fur Seals Entering the Water at CH* – The total number of fur seals that entered the water from the platform was recorded for each 45-s interval.

At the beginning of each 45-s interval, the following information was documented utilising scan sampling:

- *Threat Postures* – The definition of the threat posture for the Australian fur seal was taken from Stirling (1971). Every 45 s, the total number of threat postures was recorded.
- *Vessel Activity Within the 200-m Radius of CH* – Number of vessels at CH, vessel type (e.g., recreation, tour operator, jet ski), distance of research vessel/tour operator to CH, and distance of other tour operators/recreational vessels to CH were recorded.
- *Presence of Swimmers* – Number of swimmers in the water around CH participating in a swim-with-seal activity was documented.

Statistical Analyses

A normal distribution of data was confirmed via the Kolmogorov–Smirnov test (*SPSS*, Version 17.0). A stepwise linear regression (SLR) was completed also using *SPSS* to measure the degree of influence of the following independent variables on behaviour data: distance of research platform from CH, number of tour operators present, distance of tour operators from CH, number of recreational vessels present, distance of recreational vessels from CH, total number of vessels within 200 m of CH, and total number of swimmers in water at CH.

Following SLR calculations, further statistical procedures included a one-way ANOVA on seal behaviour and the resulting predictors of the SLR. *Post hoc* tests (Tukey's Honestly Significant Difference [HSD]) were also completed to identify significant differences between the means.

Results

A total of 25.84 h of vessel/seal behaviour data were collected over 42 research trips near CH from November 2007 to February 2008. The number of fur seals present averaged 23 individuals (SD = 6.6) per visit during the research period. A total of 135 vessels (tour vessels = 61 [multiple occasions of the same five] and recreational vessels = 74 [different vessels each with one trip per vessel]) were observed in close proximity of CH (< 200 m) for the intention of viewing fur seals. The average number of vessels interacting with seals at CH for each of the 42 research trips was 3 (SD = 2.0, min = 1, max = 10).

Data were analysed using the mean behaviour/vessel data documented on each of the research trips (n = 42). Five different tour operators (3 dolphin-swim operators and 2 dive operators) were observed repeatedly interacting with fur seals at CH during the research period (see Table 1). The average time that tour vessels were within 200 m of CH to view seals was 29.85 min (SD = 9.168 min); and for recreational vessels, the average time was 8.04 min (SD = 12.16 min). Swimmers were placed in the water on 39 of 42 visits to CH at an average rate of 19 swimmers per trip (SD = 9.2, min = 2, max = 39).

Mean vessel distances from CH during the research period were similar for both tour operators (= 11.63 m, SD = 35.80 m) and recreational vessels (= 11.09 m, SD = 31.22 m).

Aggressive seal behaviour was documented at the rate of 0.83 displays per 45-s scan (SD = 1.3, n = 1,717 instances of aggressive behaviour). Results of the SLR of aggressive behaviour indicate that the number of recreational vessels within 200 m of CH may have significantly increased the number of aggressive displays ($p < 0.016$; Figure 2), although this linear relationship was found to be weak (R^2 = 0.142). Further analysis using ANOVA and *post hoc*

Table 1. Number of occasions tour operators undertook site visits to CH and type of tour operation; seal-swim operator A was the primary research vessel.

	Seal-swim operators			Dive operators	
Operation type and identifier	A	B	C	A	B
Number of observed site visits	39	10	9	1	2

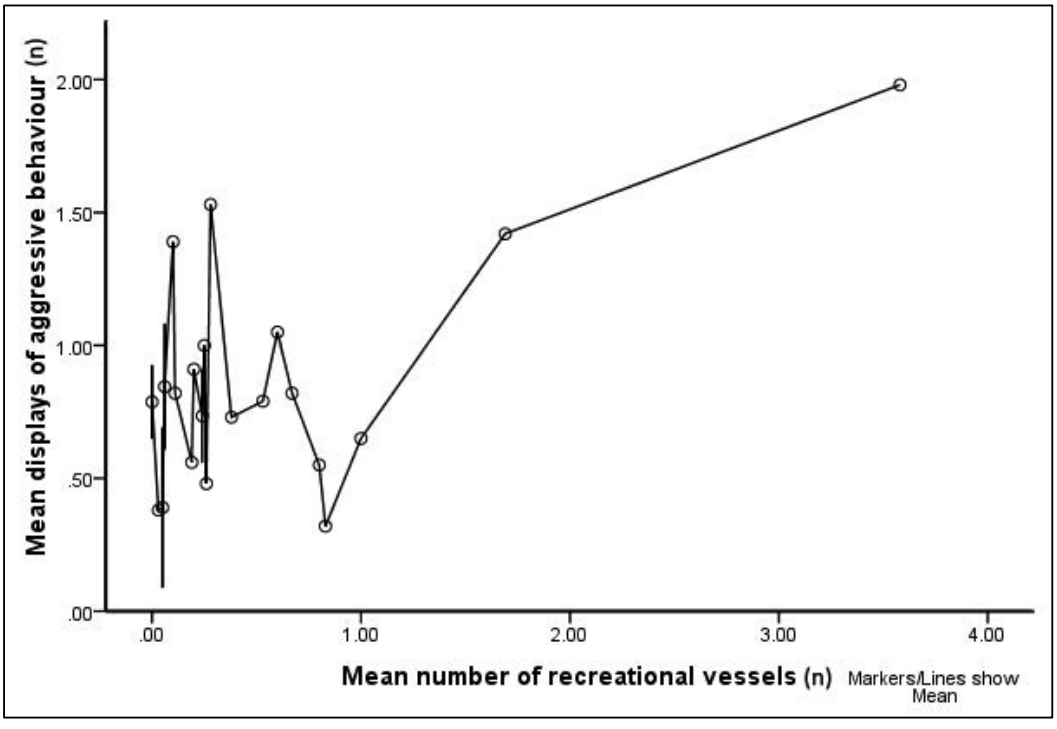

Figure 2. Mean displays of aggressive behaviour by *A. pusillus doriferus* at CH over the 42 research trips in response to the mean number of recreational vessels at CH; error bars indicate ±1 SE.

Tukey tests on the number of recreational vessels and aggressive behaviour data was unable to identify significant differences in the level of aggressive displays and the actual numbers of recreational vessels. Aggressive behaviour in fur seals was not found to be significantly influenced by number of tour operators present, distance of recreational vessels, total number of vessels, or presence of swimmers in the water.

Threat postures by fur seals were the most common behaviour displayed throughout this study and were documented at a rate of 2.24 per 45-s scan (SD = 2.584, n = 4,209 instances of threat postures). However, results of the SLR failed to identify any of the studied variables as having a direct influence on the display of threat postures. It is therefore likely that all variables documented in this study may have had an influence on this behaviour.

The rate of fur seals hauling out was documented at a rate of 0.32 per 45-s scan (SD = 0.663, n = 161 instances of seals hauling out). The number of swimmers undertaking seal-swim activities was determined to be the main influence on fur seals hauling out (p = 0.031; Figure 3); however, this linear relationship was found to be weak (R^2 = 0.117). Analysis of variance and *post hoc* Tukey tests, however, were unable to identify significant differences in the rate of hauling out and the actual numbers of swimmers present. The number of tour operators, tour operator's distance, number of recreational vessels, recreational vessel distance, and the total number of vessels were found to have no significant influence on the number of fur seals hauling out at CH in this study.

Fur seals entering the water were documented at a rate of 0.33 per 45-s scan (SD = 0.817, n = 683). Distance of tour vessels from CH was the only tested factor that was found to affect the number of fur seals entering the water per 45-s scan (p = 0.020; Figure 4); however, the linear relationship was found to be weak (R^2 = 0.134).

Analysis of variance and *post hoc* Tukey tests, however, were unable to identify significant differences in the rate of fur seals entering the water and the distance of tour operators. Number of tour operators, number of recreational vessels, recreational vessel distance, total number of vessels, or the presence of swimmers were not found to significantly influence the number of seals entering the water at CH.

Discussion

The results from this study indicate that the seal-swim tourism industry within Port Phillip Bay

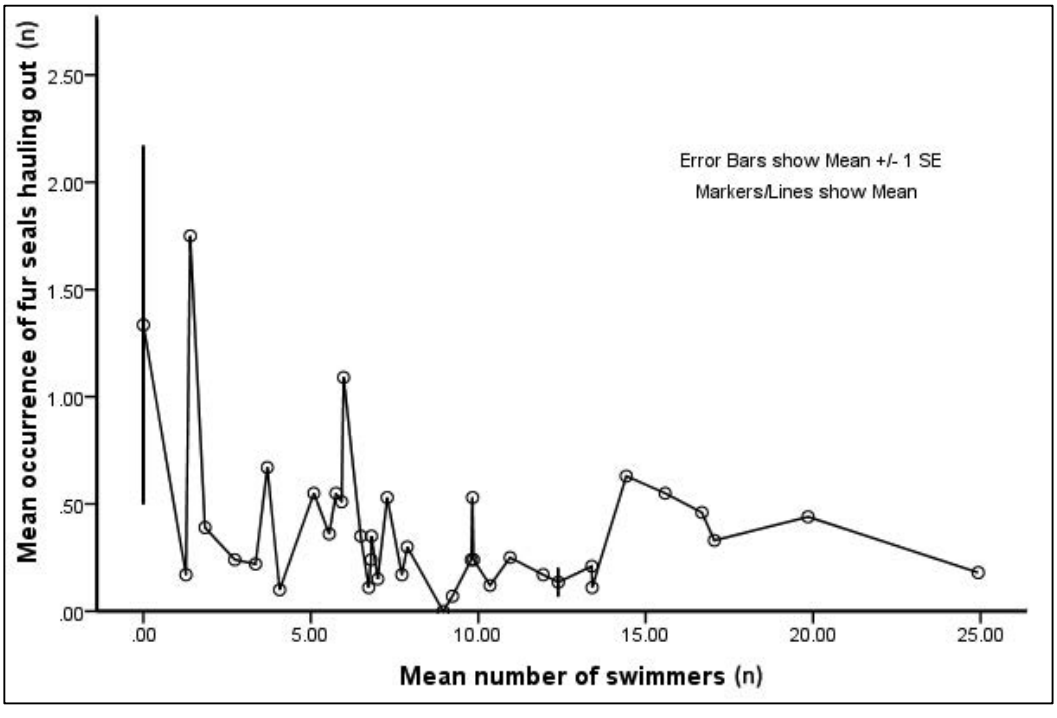

Figure 3. Mean incidence of hauling out by *A. pusillus doriferus* at CH over the 42 research trips vs the number of swimmers that participated in a swim-with-seal activity; error bars indicate ±1 SE.

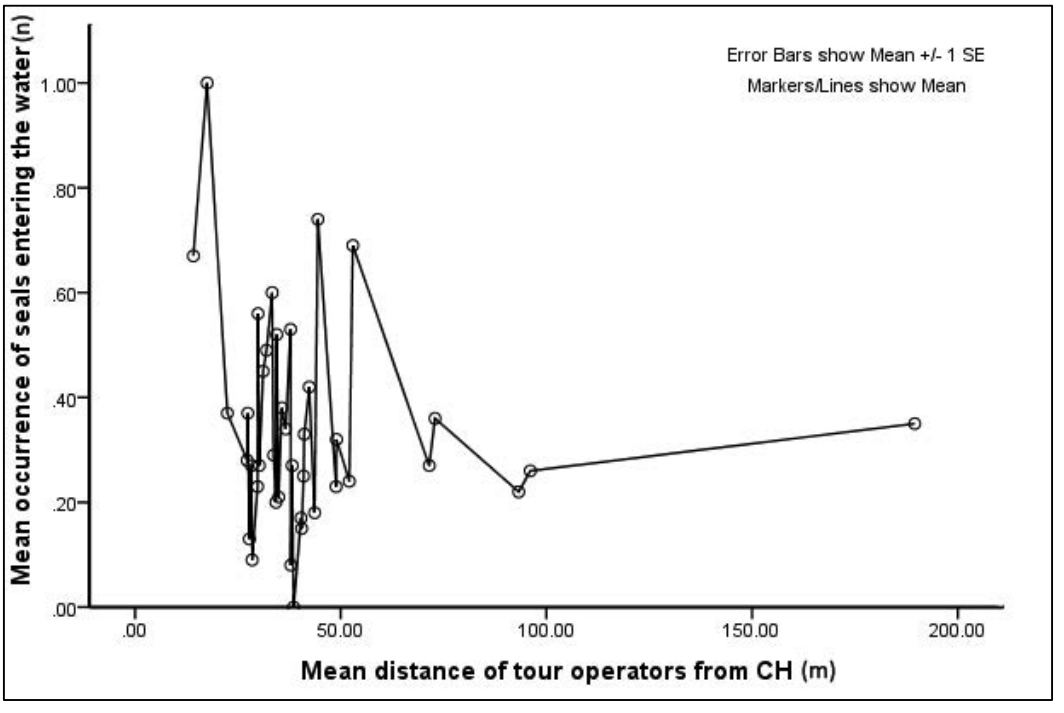

Figure 4. Mean rate of *A. pusillus doriferus* entering the water at CH over the 42 research trips in response to the mean distance of tour operators

has an impact on fur seal behaviour. In three of the behavioural states studied—(1) aggression, (2) fur seals hauling out, and (3) fur seals entering the water—the number of recreational vessels present, number of swimmers undertaking seal-swim activities, and the distance of tour operators caused short-term behavioural responses by the fur seals. These responses could be indicative of potential long-term implications (i.e., habituation, displacement, and hormonal responses) that could not be explored during this research. Ellenberg et al. (2007) indicated two ways that animals might behave towards stressors such as those that may be occurring at CH: (1) proactive, leading to increased aggression and territorial displays; and (2) reactive, wherein aggression is reduced and the animal becomes immobile. Due to the aggressive response of fur seals at CH to the presence of recreational vessels, these animals might be seen as displaying a proactive response to disturbance. The frequency of disturbance, level of aggression, and the resulting amount of stress placed on fur seals at CH could be increasing the energetic costs to those animals utilising the haul-out site. This could decrease their reproductive fitness or result in displacement of animals to a less favourable site. Alternatively, if the fur seals continue to use CH, physiological effects of sustained levels of stress on fur seals could lead to sustained high levels of hormones such as cortisol (Lidgard et al., 2008). The resulting effects of sustained high stress hormone levels include osteoporosis, cardiovascular disease, brain damage, lowered immune response to disease, reduced growth, and shortened lifespans (Fowler, 1999; Romero & Wikelski, 2002; Lidgard et al., 2008).

Fur seals hauling out represented the least common behaviour in this study. Two possible reasons why fur seals haul out onto land have been described by Jansen et al. (2006): (1) fur seals immersed in water have higher energy costs and (2) the risk of predation is greatly increased when fur seals are in the water. This behavioural response, therefore, has the least potential to negatively affect the fur seals at CH as seals are able to rest when out of the water. However, as fur seals were hauling out, they were often observed to become engaged in threatening or aggressive behaviour with dry fur seals on the structure. It was anecdotally observed that competition for haul-out space led to a number of aggressive encounters between fur seals; however, this behaviour was also observed during times of rest during which haul-out activity was not occurring. The results of the statistical analysis of the data collected on aggressive behaviour in this study

suggest that the presence of recreational vessels is likely to be a significant contributor to this aggressive behaviour. Chinaman's Hat is a freestanding structure that is accessible to boats on all sides; therefore, this behavioural response might be attributed to fur seals responding to the additional pressure of boat presence within close proximity to their haul-out site.

Altering haul-out behaviour of harbour seals (*Phoca vitulina*) as a result of vessel traffic has been documented in a number of studies (Mathews, 2000; Henry & Hammill, 2001; Jansen et al., 2006). Henry & Hammill (2001) observed that an increase in vessel traffic led to larger numbers of seals entering the water and being reluctant to haul out again. It is possible that while seals may be in closer proximity to vessels when in the water, this reluctance may be due to seals feeling their chance of escape is increased when they are immersed. This behaviour was also documented by Kovacs & Innes (1990) who state that fur seals have been observed to stampede during times of stress, which might occur when in close proximity to tourists.

While there has been little attention given to the effects of the presence of swimmers on seal behaviour, haul-out behaviour for harbour seals to approaching vessels has been documented at 167 m (Mathews, 2000), 100 m (Jansen et al., 2006), and > 91 m for stationary powerboats and kayaks (Johnson & Acevedo-Gutiérrez, 2007). The results of the current study indicate that while there was an observed increase in the number of seals hauling out in presence of one or two swimmers, overall, the rate of hauling out gradually decreased as the number of swimmers increased (Figure 3). Australian fur seals within the studied population were observed to be inquisitive towards swimmers, often mimicking the underwater actions of the tour guides. It is therefore likely that the studied population had become somewhat habituated to the presence of swimmers and could tolerate very close approaches (< 1 m). Furthermore, this industry has been in existence for over a decade within Port Phillip Bay (Scarpaci et al., 2005), and it could be suggested that tour operators have anecdotally determined that slow approaches equate to better human-seal swims. In addition, the predictable nature of Australian fur seals at CH allows for guaranteed close interactions (Kirkwood et al., 2003; Scarpaci et al., 2005).

Habituation of fur seals has been observed by Boren et al. (2002) who examined the effects of both land- and sea-based tourism on the New Zealand fur seal (*A. forsteri*); and while close approaches elicited behavioural responses, some level of habituation was observed during sea-based tours. Ellenberg et al.'s (2007) definition of *habituation* as a reduction in responses to an ongoing stimulus that is not a result of fatigue or adaptation sits well with the results of this study through which fur seals were found not to respond to either swimmers or vessels within close proximity. Port Phillip Bay is heavily utilised by a number of industries, including commercial shipping and recreational fishing charters. Habituation of fur seals to the presence of humans also has been anecdotally observed by the latter, wherein fur seals have been found to follow fishing charter boats within Port Phillip Bay in an attempt to take caught fish from the lines. Through a discussion with one charter operator, the researchers in this current study were informed that in order to deter fur seals, the operator would strike fur seals on the head with a hammer or other blunt object when they came in close proximity to their vessel. While the effects of these actions have not been studied, habituation of the resident population to tourism activities may be significantly endangering them when they come in contact with other industries utilising Port Phillip Bay.

Management

Results of this study suggest that the presence of vessels and tourists undertaking seal-swim activities in Port Phillip Bay have an effect on the short-term behavioural responses of the resident fur seal population. Variables such as presence and distance of vessels and the presence of swimmers in close proximity to fur seals at CH contributed to three of the four tested significant differences in fur seal behaviour, including increased aggressive responses and number of fur seals hauling out and entering the water. As a result of significant time constraints in this study, a limited sample size was achieved ($n = 42$), which may have accounted for a lack of clear findings through *post hoc* tests. In light of this, the authors recommend that further longitudinal studies be undertaken at the site. Such studies may assist in identifying distances at which vessel traffic could be having a significant influence on fur seal behaviour.

One area for concern from this study relates to a lack of restrictions on the number of vessels allowed to interact with fur seals at CH. While this study was unable to identify at what density of vessels fur seal behaviour is being affected, the protection of both the resident population and the tourists undertaking seal-swim activities should be considered. For example, during the study, the principle researcher anecdotally observed a number of incidences in which tourists were placed at risk as a result of the high numbers of vessels in the area. These included a tourist undertaking a seal-swim being struck on the head by a tour vessel; a swimmer panicking when a tour boat

moved in close proximity (< 1 m) to them; and on one occasion when a swimmer appeared to have a cardiovascular issue that was not attended to for at least 5 min. For the latter, the dive vessel responsible did not attend to the swimmer promptly due to vessel congestion in the area and several groups of swimmers participating in a seal-swim at the time.

The results of this study suggest that there is a need for further investigation into the effects of the seal-swim tourism industry on the behaviour of fur seals within Port Phillip Bay. Such studies will be crucial in highlighting thresholds for the number of vessels able to interact with fur seals and the distance to which they can approach to ensure the industry is able to protect its most important asset, the Australian fur seal population at Chinaman's Hat.

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