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Research Article

The influence of zoo visitor numbers on the behaviour of harbour seals (*Phoca vitulina*)

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Abstract

We investigated the influence of zoo visitor numbers on the behaviour of a group of eight harbour seals at Antwerp Zoo. The behaviour of the seals was monitored using instantaneous scan sampling. Visitor presence at the enclosure was also monitored instantaneously. Additionally, daily visitor numbers for the zoo were gathered. We related seal behaviour to both the number of visitors present during the instantaneous sampling and to the daily visitor attendance. Both analyses showed that under increasing visitor numbers, more seals submerged under water. While behavioural changes are clear and it appears the seals were hiding from increasing visitor numbers by diving under water, it remains hard to assess whether visitors compromise the welfare of seals in captivity

Introduction

Since the 1970s, several studies have shown that the presence, number and behaviour of zoo visitors can all influence the behaviour of the animals (reviews in Hosey 2000; Davey 2007). The presence of visitors can influence animal behaviour in zoos negatively (Chamove *et al.* 1988; Davis *et al.* 2005; Hosey, 2000) or positively (Cook and Hosey 2005). However results are somewhat ambiguous (Hosey 2000) due to several confounding factors, such as animal size, visitor behaviour and enclosure design (Davey 2007; Ross *et al.* 2007). Most studies into visitor effects have been done on primates (e.g. Hosey and Druck 1987: Mitchell et al., 1992; Wells, 2005) ungulates (Thompson, 1989) and carnivores (Margulis *et al.* 2003). Within the primate group there is a general trend for negative effects (Hosey 2000). For other animal groups, data are scant and more research in more different groups of animals is needed before conclusions on the relationship between visitor numbers and animal welfare can be made (Hosey 2000; Davey 2007).

One of the methodological considerations in visitor studies is the discrepancy between instantaneous evaluation and daily evaluation (Kuhar 2008). Instantaneous evaluations are usually based on interval sampling (Martin and Bateson 1993) throughout the day to score animal behaviour and visitor characteristics. Thus crowd size at the animal enclosure is accurately measured and can vary throughout the day. However, successive intervals are not independent of each other, cumulative effects of varying visitor numbers cannot be measured and the behaviour of the animals can influence visitor numbers, so that causality is hard to detect (Kuhar 2008). It has been pointed out that more active animals will attract more visitors, and thus increased visitor density may be a consequence rather than a cause of changes in animal behaviour (Hosey 2000). This has been labelled the “visitor effect/visitor attraction confound”, which can influence the results of instantaneous evaluations (Kuhar 2008, p. 378; Hosey 2000).

In daily evaluation, the number of visitors entering the park or passing in front of the enclosure is used as the independent variable in the analysis, which takes into account cumulative effects and can be used to avoid the visitor-effect/visitor-attraction confound (Kuhar 2008). However, no detailed information on interactions between visitors and animals is gathered in this method. Therefore, a combination of both methods seems useful to study the impact of zoo visitors on animal behaviour.

Seals seem likely to be influenced by visitors. Studies on different species of seals in the wild show effects of human presence on seal behaviour. Harp seal (*Phoca groenlandicus*) mothers and pups showed increased alertness and rested less when tourists were present (Kovacs and Inness 1990). Cassini (2001) reports that wild fur seals (*Arctocephalus australis*) retreat when tourists approach them closer than 10 meters. So in wild seals there seems to be a clear threshold distance. On the other hand, Wedell seals (*Leptonychotes weddellii*) habituated very easily to repeated pedestrian approaches, resulting in less looking up at approaching humans (Van Polanen Petel *et al.* 2008). In zoos, seals are a highly popular species for the public and some preliminary studies indicate that a visitor effect exists. Taylor *et al.* (1988) report that seals show increased vigilance behaviour when confronted with an unfamiliar observer, but they were quickly habituated to a familiar observer. Morgan and Tromborg (2007) cite unpublished data that show increased vigilance in harbour seals with increasing visitor numbers and noise. The authors do not indicate whether visual scanning is a sign of negative or positive visitor effects.

Our aim is to use a combination of instantaneous evaluation and daily evaluation to investigate to what extent zoo-born harbour seals are habituated to the presence of crowds of zoo visitors and whether a positive or negative visitor effect exists for this species.

Methods

Study group and enclosure

We studied a group of eight harbour seals, four males and four females, at Antwerp Zoo, Belgium. All seals were captive born and six of them were born in Antwerp Zoo. The seals were housed in a 162 m² kidney shaped pool with a beach. In the enclosure, balls barrels and platforms were provided as environmental enrichment. The backside of the enclosure was formed by a high wall of artificial rockwork. The visitors only had access to the front of the enclosure, alongside the pool and alongside a small part of the beach. On average, visitors were standing about one to 1.5m above the water level and so looked down on the seals. There were no further barriers between the seals and visitors that would create any additional distance; apart from a small patch of shrubs alongside half of the beach.

Observation protocol and ethogram

The second author observed the seal group on 24 weekdays over a period of six weeks between February and April 2008. No observations were made during the weekends. Each day, two to three observation sessions of ten minutes each were carried out semi-randomly throughout the day between 10.00h and 17.00h, with a minimum interval of 60 minutes between two subsequent observations on the same day (Margulis and Westhus 2008). In this way, a total of 61 observation sessions, totalling ten observation hours, was carried out. Within an observation session, we used instantaneous scan sampling (Altmann 1974) with 30-second intervals. The seals were difficult to individually distinguish, especially when swimming under water. Therefore we did not note individual identities, but simply recorded the number of animals performing specific behaviours in each sample. On each scan we scored a) how many visitors were standing alongside the seal pool b) how many seals were in each of the following behavioural categories (after Hunter *et al.* 2002). The behavioural categories were identical for both instantaneous and daily analyses, and were defined as follows:

1. Swimming under water: body and head of the seal are totally submerged in the water
2. Swimming with head above water: seal actively swims with head (partly) above the water
3. Visually scanning the environment: seal hangs vertically in the water with head above the water, clearly scanning the environment by looking around.
4. Resting (partially) on land: seal lies on the beach area of the enclosure (Hunter *et al.* 2002: “resting hauled out”)
5. Social interactions: seal engages in social activities including categories of breeding behaviour and aggressive behaviour described in Hunter *et al.* (2002)

Only visitors that were actually standing still, with two feet on the ground and visually oriented towards the seals, were counted; i.e. visitors walking past the enclosure were not counted as present. The observer was never counted as a visitor.

Statistical analyses

We investigated the influence of daily visitor attendance on seal behaviour and the instantaneous effect in two separate Multinomial Regression Models in SAS (vs9.0). For the daily evaluation, we obtained the daily number of visitors in the zoo from the ticket office. We chose the seven days with the highest number of visitors (“high visitor attendance” mean number of visitors per day= 3756 ± 464.2) and compared this sample with the seven days of the lowest visitor attendance (“low visitor attendance” mean number of visitors per day = 669.5 ± 48.0 visitors). The other 10 days were left out of these analyses. For each of the 14 sample days, two full observations (with 21 scans each) were chosen. We used the proportion of seals recorded in each behavioural category as dependent variable and 2 independent variables: the test condition (small crowds versus large crowds) as well as maximum daily temperature.

For the instantaneous evaluation, we performed a Multinomial regression model on the full dataset of 1279 scan samples and for each sample noted how many visitors were present at the enclosure (continuous independent variable) , and the proportion of seals scored in each behavioural category as a dependent category. Temperature was not considered for the instantaneous evaluation as it was not measured at each individual sample. After the multinomial regression we did separate regression models for each behavioural category, to look for more specific effects.

Results

Daily evaluation – visitor attendance and seal behaviour

When comparing maximum daily temperatures for low visitor attendance and high visitor attendance, we found a non-significant difference between the two periods (t-test: $t = 2.01$; $p = 0.07$). When we compared days of high visitor attendance versus low visitor attendance, we found that the behaviour of the seals was significantly influenced by condition ($\chi^2 = 18.21$, df = 1, $p < 0.0001$; Fig 1.) but not temperature ($\chi^2 = 0.39$, df=1, $p=0.53$). Post hoc tests for each behavioural category showed that more seals spent time under water at high visitor attendance compared to low visitor attendance ($\chi^2 = 11.37$; $p = 0.0007$). On the other hand, on high visitor attendance days, significantly fewer seals were scanning the environment ($\chi^2 = 28.92$ $p < 0.0001$) and resting on land ($\chi^2 = 91.69$ $p < 0.0001$). We found no significant differences between the two conditions in the number of seals swimming with their heads above the water ($\chi^2 = 0.66$; $p = 0.23$) or engaged in social behaviour ($\chi^2 = 3.23$, $p= 0.07$).

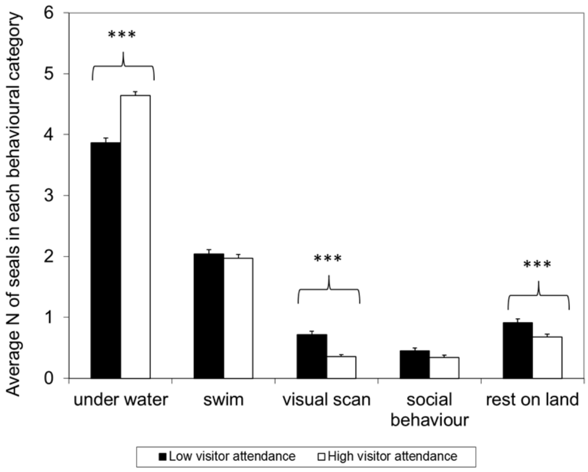

Figure 1. Average number of seals in each behavioural categories on low visitor attendance days (black: < 853 visitors in zoo) and on high visitor attendance days (white: > 1800 visitors in zoo) + Standard error of means. Triple asterisks indicate significant differences p< 0.001

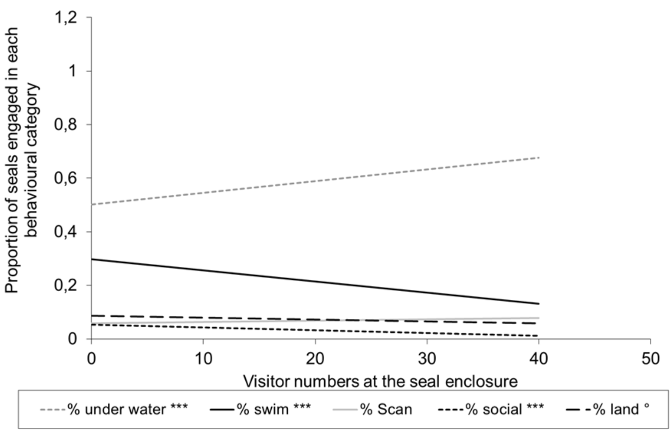

Figure 2. Instantaneous evaluation of seal behaviour in relation to number of visitors standing in front of the enclosure. Triple asterisks indicate significant differences p< 0.001; ° indicates a trend with 0.05 < p < 0.10

Instantaneous evaluation - Visitor presence and seal behaviour

Overall, we found that the absolute number of visitors standing around the enclosure had a significant effect on the behaviour of the seals ($F_{1,1253}$ = 59.30, p < 0.0001, Fig 2). The analyses per behaviour separately showed that as the visitor numbers increased, more seals were seen swimming underwater (χ^2 = 22.92; p < 0.0001), fewer seals were seen swimming with heads above the water (χ^2 = 40,95; p< 0.001), fewer seals were seen in social behaviour (χ^2 = 14.66, p < 0.0001). There was only a statistical trend that showed fewer seals resting on land (χ^2 = 3.74; p = 0.053), and no significant effect of visitor numbers on the number of seals scanning the environment (χ^2 = 2.58; p = 0.11).

Discussion

We used both daily evaluation and instantaneous evaluation to measure the impact of zoo visitors on seal behaviour. Both methods provided more or less similar results: under increasing visitor numbers, more seals spent their time submerged. We could also show that maximum daily temperature did not have a significant effect on the behaviour of seals in our study. While both methods yielded similar results for underwater swimming, social behaviour and resting on land; there were minor differences between the two methods for swimming with heads above the water and for scanning the environment. The first showed no effect of visitor numbers in the daily evaluation, but a significant decrease under increasing visitor numbers for the instantaneous evaluation. For scanning the environment the exact opposite was found, with a significant decrease in the daily evaluation and no significant effect of visitor numbers in the instantaneous evaluation. This may be a reflection of the random criterion to compare large crowds with small crowds. In the daily evaluation we only compared the seven days with highest visitor numbers with the seven days of lowest visitor numbers but we did not include the seven days in between, to measure only extremes (see also Kuhar 2008), but the cut off points were chosen randomly, and the effect size is in fact very small. On the other hand the discrepancies between daily and instantaneous evaluation do not seem to be caused by the "visitor effect / visitor attraction confound" since it is unlikely that increasing visitor numbers would be attracted by a less social interactions.

Ideally, physiological measures of stress should be included in analyses to evaluate animal welfare. Although we could not measure the direct impact of visitors on stress physiology of the seals, as in many studies on visitor effects (Davey 2007), our results did show that the seals were at least influenced by the number of visitors at their enclosure, both on an instantaneous and a daily scale. Including cortisol measures to evaluate stress in seals has happened in the wild (Constable *et al.* 2006) and this might be a fruitful approach to evaluate whether increasing visitor numbers cause increased stress, a method that has been applied to other zoo-housed mammals (Davis *et al.* 2005), but to our knowledge this has not yet happened in studies of captive seals.

It seems the seals in our study tried to avoid increasing visitors, by diving underwater, which in itself can be a means to reduce stress. Studies of visitor effects in other species have also reported reduced visibility under larger crowd conditions (Kuhar 2008). However, this finding is in contrast with other studies on the impact of visitors on seal behaviour, where increased visual scanning was observed under increased visitor numbers (Morgan and Tromborg 2007). Visual scanning can be considered as a positive visitor effect, or seals could perhaps be monitoring the environment, or begging for titbits. In our study, scanning gave somewhat inconclusive results: based on the daily evaluation we found that fewer seals scanned the environment under high visitor numbers.. In the instantaneous evaluation we did not find a significant influence of visitor numbers on the proportion seals that engaged in scanning behaviour.

We hypothesize that enclosure design is a crucial factor that influences scanning behaviour. In our study, scanning behaviour was relatively rare. The visitors were standing 1-1.5 m above the water level. It is possible that scanning occurs more when visitors are more at 'eye-level' of the seals. Similarly, swimming under water may be less useful for seals to evade visitors in exhibits with under-water viewing windows, which were not present in our study. Unfortunately no details on exhibit design are provided in the other studies of seals (Taylor *et al.* 1998; Morgan and Tromborg 2007). Interestingly, a study on captive Humboldt penguins also found more penguins submerged under higher visitor numbers (Condon *et al.* 2003). However, the authors consider this a positive visitor effect and suggest the penguins were attracted to the large and noisy crowds standing in front of an under-water viewing window. In the current study no such window was present, thus dispelling this explanation at least for the seals. We suggest that complex enclosures with visual barriers could be constructed to give seals a chance to move out of visitors' view if they choose, similar to what has been proposed for other species (Hosey 2000). Future research on visitor impact on seal behaviour, should focus experimentally providing and removing hideouts for seals, to assess the impact of such hideouts on seal behaviour. Ideally, measuring the hypothalamic-pituitary-adrenal axis activity to measure stress in captive seals should complement behavioural studies. In conclusion, the behaviour of seals in captivity seemed to be influenced by the number of visitors, both on a daily basis and an instantaneous level as seals hide underwater from increasing visitor numbers, but more information is needed to assess the effects of visitors on real welfare.

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