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Is there a visitor effect on Abyssinian Ground Hornbills (*Bucorvus abyssinicus*), Papuan Wreathed Hornbills (*Aceros plicatus*), Wrinkled Hornbills (*Aceros corrugatus*) and Toco Toucans (*Ramphastos toco*) in a captive zoo environment?

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2008

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Abstract

Research into the possible effects that zoo visitors have on the captive animals they come to visit is still relatively poorly understood. Most of the studies all ready completed have used non-human primate subjects, but there is a distinct lack of studies using non-primate species. One of the groups that are in particular need of this kind of research is birds. This study examines a potential visitor effect in captive Abyssinian Ground Hornbills (*Bucorvus abyssinicus*), Papuan Wreathed Hornbills (*Aceros plicatus*), Wrinkled Hornbills (*Aceros corrugatus*) and Toco Toucans (*Ramphastos toco*) at Paignton Zoo Environmental Park®. This study also investigates the evenness of enclosure use, using the original Spread of Participation Index. Chi-Squared Association Tests revealed conflicting potential visitor effects on behaviour within the Abyssinian Ground Hornbills. Significant associations were also seen in a number of individuals between height (m) and visitor number and location and visitor number, with the majority of individuals appearing in the outside zones more frequently with increasing visitor density. However, this study could not establish what aspect of visitor presence was causing these effects. All the birds, with the exception of Abyssinian Ground Hornbill 1 and 2 showed unevenness in enclosure use. Establishing a potential visitor effect can be beneficial with regards to the welfare of the subject animals. Should a stressful effect be seen, then changes can be implemented to reduce this and improve living conditions and health for the animals.

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1. Introduction

There is growing interest into the effect that the zoo environment has on captive animals (Cooke & Schillaci 2007). Effects that zoo visitors potentially create are being seen through investigations carried out mostly on captive non-human primates. However, only a handful of articles exist concerning non-primate species. For example, O'Donovan et al. (1993) found that visitors did not significantly affect behaviour of female cheetahs (*Acinonyx jubatus*). In addition, Nimon & Dalziel (1992) provide one of the only examples of bird-visitor relationships in a zoo-setting. The investigation concluded that long-billed corella (*Cacatua tenuirostris*) seek interactions with visitors, due to interactive behaviour only seen when visitors are present with more effort being put into these interactions on quiet days. It is of great importance that more studies are completed using non-primate species, including as many species as possible (Hosey 2000). Even though more studies have been completed since Hosey (2000), this is still relevant.

Non-human primates are the most observed with regards to the visitor effect, but within these studies, conflicting results have been observed. Some studies have reported no effect, for example Synder (1975) as referenced in Hosey (2000) suggests that an animal will become habituated to visitor presence and will not be affected. Other studies have stated an enriching effect, such as Fa (1989) and Cook & Hosey (1995) who both found that their prospective study animals' were initiating interactions with visitors to obtain food that was being thrown into the enclosure by the visitors. This, however, leads to nutritional welfare implications (Hosey 2000). Most of the studies, however, have reported a negative visitor effect. Birke (2002) found that captive orang-utans (*Pongo pygmaeus*) were placing sacks over their heads and infants were clinging to adults' significantly more when visitor numbers were high. Wells (2005) found there was an increase in unusual behaviours, for example, intragroup aggression and stereotypies in Western Lowland Gorillas (*Gorilla gorilla gorilla*). Other

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examples include Chamove et al. (1988); Davis et al. (2005); Mallapur et al. (2005) and Cooke & Schillaci (2007).

When addressing a potential visitor effect, it is important to interpret results correctly (Hosey 2005). For example, exhibition of stereotypic behaviour is generally seen as an indicative of poor welfare (Hosey 2000; Garner et al. 2006). However, in some examples (Jeppesen & Falkenberg 1990; Korhonen et al. 2001) changes were implemented in enclosure design that could be perceived to aid better welfare for the subject animal, and yet stereotypies continued, and in some cases, even increased (Mason & Latham 2004). There is also the issue of cause and effect where visitors may be attracted to unusual behaviours rather than being the cause of them (Birke 2002). However, Hosey (2000) states that even if this is the case, it is likely that at least some behaviours are being influenced by the visitors' presence. Other variables may also be an influence such as species temperament, animal perceptions and differences in housing (Hosey 2000). Visitor presence is a condition; meaning that it is important to distinguish which aspects of the audience presence causes which behaviour, if any (Hosey 2005; Wells 2005). Studies to date report audience activity (Hosey & Druck 1987; Mitchell et al. 1991); perceived height (Chamove et al. 1998) and noisiness (Birke 2002) to be potential aspects influencing behaviour of animals (Wells 2005).

This paper provides one of the first investigations into the potential visitor effect that can arise in captive birds. Other investigations address welfare issues, such as Garner et al. (2006) who observed stereotypies in Orange-winged Amazon parrots (*Amazona amazonica*) and Collins et al. (2008) who investigate welfare in small cage birds. However, whilst looking into welfare, they are not done with regards to zoo visitors. In this study, the species in question will be the Abyssinian Ground Hornbill (*Bucorvus abyssinicus*), Papuan Wreathed Hornbill (*Aceros plicatus*), Wrinkled Hornbill (*Aceros corrugatus*) and the Toco Toucan (*Ramphastos toco*). These previous studies on primates can be used to investigate a potential visitor effect due to the similarities between primates and some hornbills, such as similarities in socials systems and cognitive abilities

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(Rainey et al. 2004). It is possible that similarities may also arise in the way they react to visitors audiences in captive conditions.

2. Methodology

2.1. Bird measures

2.1.1. Subjects

The subjects were a total of 10 individuals from four species, all part of the collection at Paignton Zoo Environmental Park® in Devon. The four species studied were the Abyssinian Ground Hornbills (*Bucorvus abyssinicus*), the Papuan Wreathed Hornbills (*Aceros plicatus*), the Wrinkled Hornbills (*Aceros corrugatus*) and the Toco Toucans (*Ramphastos toco*).

2.1.2. Enclosure and location

There were a total of 8 enclosures containing the subject birds (Table 1), spread out in several areas across the zoo site. Enclosures 1-3 were found in the 'Primley' part of the zoo, whilst enclosures 4-8 were found in the 'Aviaries'.

Table 1

The species and individual(s) present in each enclosure.

Enclosure	Species and Individual(s) within enclosure
1	AGH 1
2	AGH2
3	AGH3
4	WH1*
5	TT1, TT2
6	PWH1
7	PWH2*
8	WH2, WH3

*During initial sampling, this bird was alone in the enclosure, but a mate was introduced at some point during the sampling period. These introduced individuals were not included in the sampling.

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Each enclosure and its significant features were drawn onto a representative map, which was then partitioned into 4 or 6 zones (Diagram 1 and 2).

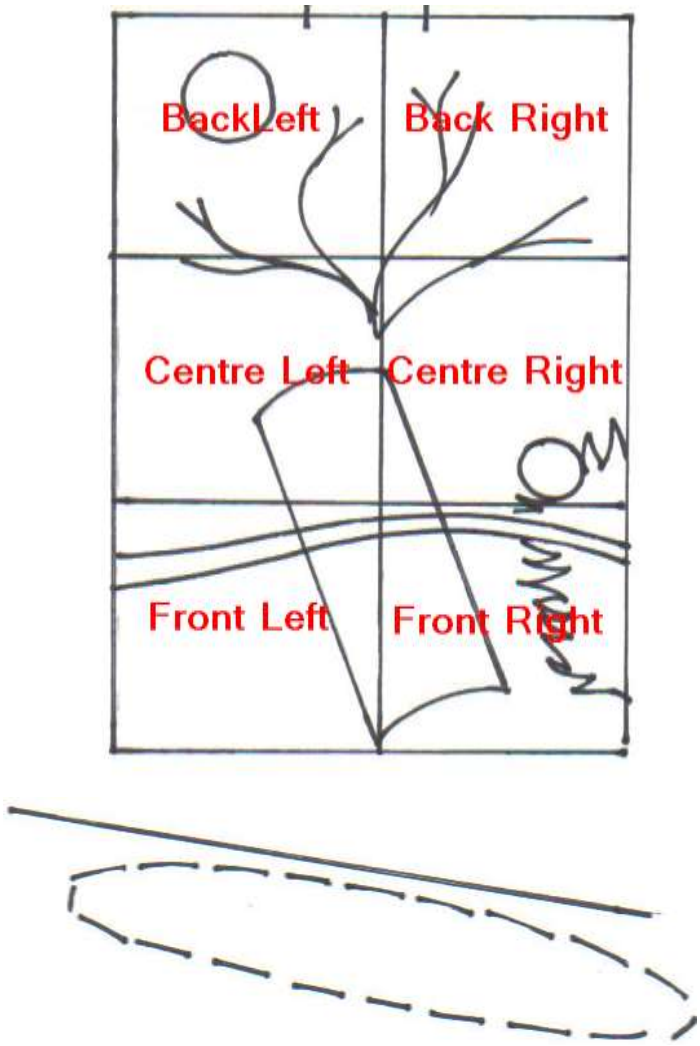

Diagram 1. A partitioned representative map, divided into 6 zones for the Toco Toucan enclosure.

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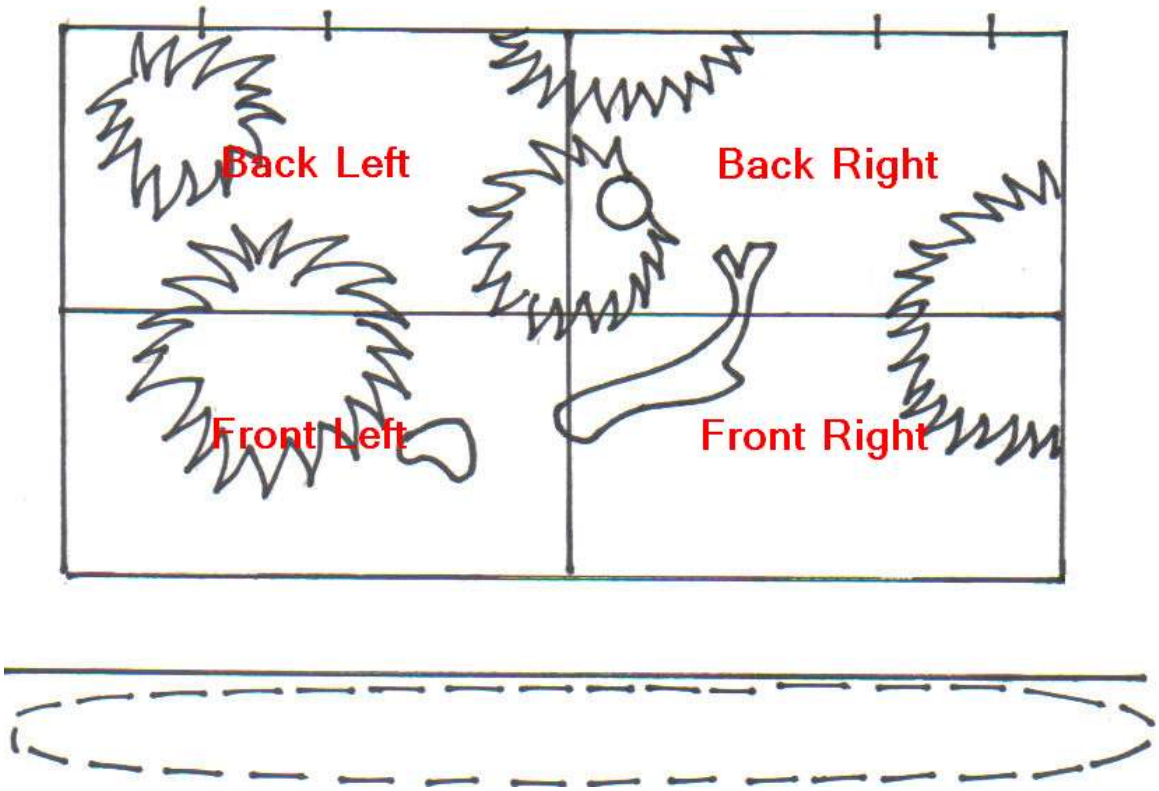

Diagram 2. A partitioned representative map, divided into 4 zones for Abyssinian Ground Hornbill 2 enclosure.

Height of enclosure and significant features, for example, frequently used branches were noted too.

2.2. Visitor measures

2.2.1. Visitor numbers

Exact visitor numbers within the main visitor congregation area (the area where visitors gathered to look into the enclosure) were recorded. Presence of children, pushchairs and wheelchairs were also counted to allow for potential tests to observe if they had any influence on the birds. The exact numbers were then put into categories of visitor density: 0 (None); 1-5 (Low); ≥6 (High).

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2.2.2. Noise

The noise level was also monitored using the following scale:

1. Very quiet, no visitors
2. A few visitors, talking quietly.
3. Average, not too loud, not too quiet, talking normally.
4. Relatively large group of visitors with the majority talking, some children shouting.
5. Very noisy, for example, a school field trip.

All background noise was excluded, as there was always some present.

2.3. Behaviour sampling

Behaviour was classified into numbered categories (Table 2). Most of the categories were established during preliminary visits; any new behaviour was noted and was then added when collating the results.

Table 2

Behaviour codes

Number	Behaviour
1	Inactive
2	General Locomotion
3	Preening
4	Bar Tapping/ Chewing
5	Feeding/ Drinking
6	Calling
7	Foraging
8	Fighting
9	Beak Scraping
10	Scratching
11	Mating
12	Chewing on Foliage
13	Pecking Tree

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2.4. Procedure

A pilot study showed the peak visitor times and the main areas of visitor congregation. It also allowed for the birds to become familiar with my presence, to lessen my effect on them.

The order of observation was random (done by pulling a name out of a hat). Each bird was observed for a total of 20 minutes, with a new one started each half hour- the extra ten minutes was used to travel to the next enclosure. The first bird was recorded at 11:10am and that last at 4:10pm (none were recorded between 12:30pm and 1:00pm due to a break for lunch). The date, time, weather conditions and the species and individual were also noted on a pre-printed data collection sheet.

Every minute, the number of visitors, children, pushchairs and wheelchairs were recorded. So were the noise level, location, height (m), and the behaviour. Any additional comments were also noted.

The method was repeated for each individual, each day, for a total of 16 days over a 3 month period (July to October 2007). Three days (1 weekday, 2 weekend days) were carried out in July, seven days (1 weekday, 6 weekend days) in August, and 6 days (all weekend days) in October.

2.5. Data analysis

Data sets (for example visitor number and behaviour) were analysed using a Chi-Squared Association Test on the computer statistical system ‘SPSS’. Data sets were tested for each individual bird apart from the two Toco Toucans who were treated as a whole due to not being able to tell them apart during sampling. A Spread of Participation Index (SPI) was used to calculate the evenness of enclosure use. The original Dickens (1955) formula was used (Plowman 2003).

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3. Results

3.1. Number of children and behaviour

Only Abyssinian Ground Hornbill 1 showed a significant association (Chi-Squared= 75.096[a]; df= 30; P<0.001) between the number of children present and the behaviour exhibited. A general increase in inactivity with a decrease in locomotion was seen with increasing numbers of children (Fig.1.).

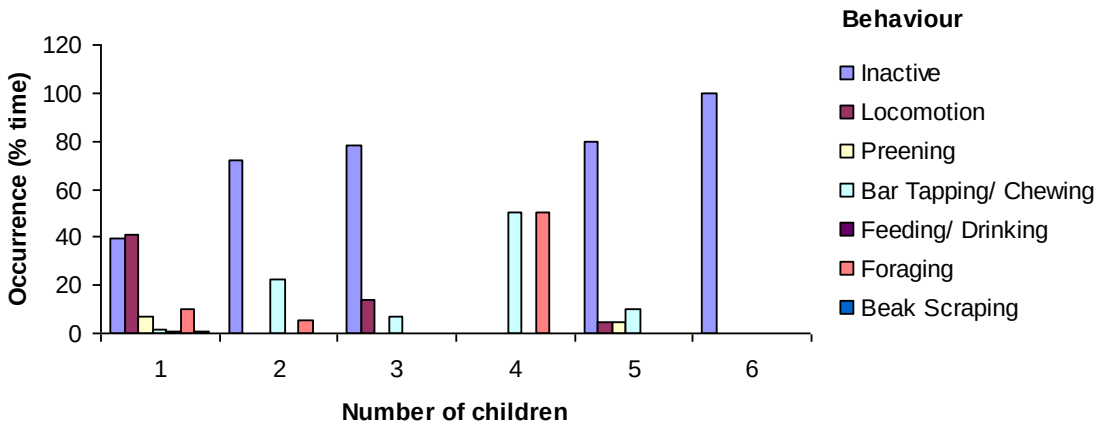

Fig.1. The association between the number of children present and the occurrence (% time) of each behaviour exhibited by Abyssinian Ground Hornbill 1.

3.2. Visitor number and behaviour

Abyssinian Ground Hornbill 1 (Chi-Squared= 60.930[a]; df= 12; P<0.001) and Abyssinian Ground Hornbill 3 (Chi-Squared= 42.967[a]; df= 14; P<0.001) were the only birds to show a significant association between the number of visitors and the behaviour exhibited.

Abyssinian Ground Hornbill 1 was showing increasing levels of inactivity and decreasing levels of locomotion with increasing visitor numbers. There are more incidents of bar tapping/ chewing with visitor presence, though this is not consistent. There is a slight decline in occurrences of foraging and slightly lower levels of preening with increasing visitor numbers (Fig.2.).

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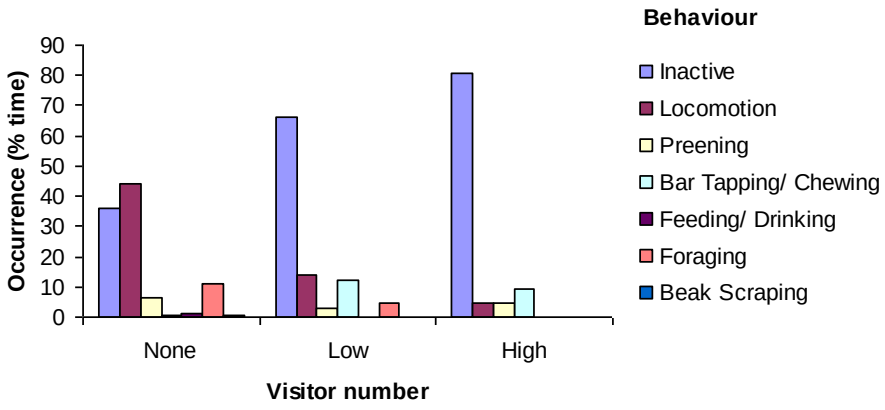

Fig.2. The association between the number of visitors present and the occurrence (% time) of each behaviour exhibited by Abyssinian Ground Hornbill 1.

Abyssinian Ground Hornbill 3 seemed to show a decrease in inactivity and an increase in locomotion with higher visitor numbers. Preening was also seen to decrease (Fig.3.). There was only one incident of high visitor numbers with this enclosure, therefore bar tapping/ chewing occurs 100% of the time as this is what the bird was doing when this one situation did occur (Fig.3.). This cannot reveal much, more data would be needed for higher visitor numbers to establish any potential patterns.

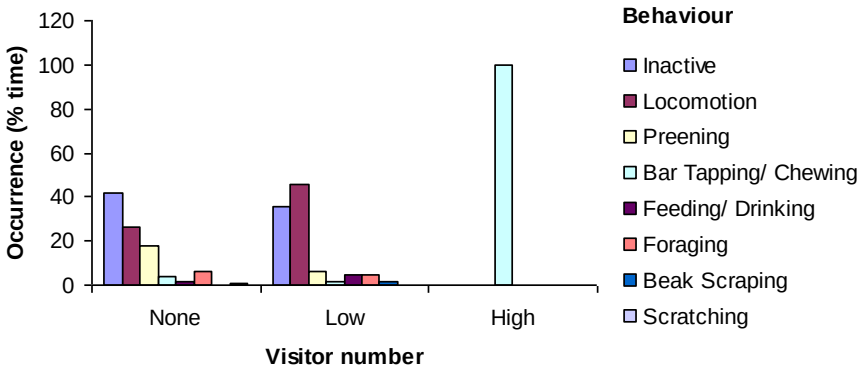

Fig.3. The association between the number of visitors present and the occurrence (% time) of each behaviour exhibited by Abyssinian Ground Hornbill 3.

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3.3. Visitor numbers and location

Papuan Wreathed Hornbill 1 showed a significant association (Chi-Squared= 27.006[a]; df= 8; P=0.001) between visitor number and location. The bird spent most of its time inside (78.7%), but as visitor number increased, the bird appears to be retreating inside less and occurring in the Back Right zone more (12.5% total). It is using the other zones, just not as frequently (Fig.4.).

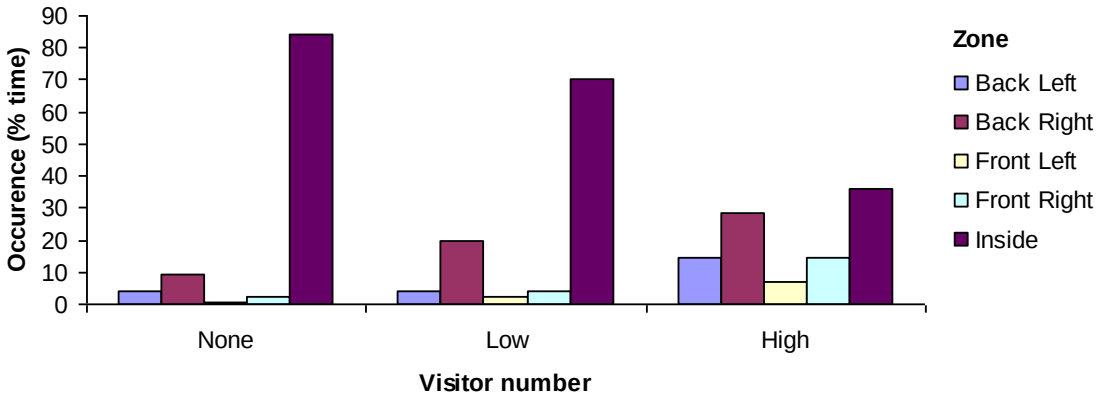

Fig.4. The association between number of visitors present and the occurrence (% time) in each zone of the enclosure for Papuan Wreathed Hornbill 1.

A significant association (Chi-Squared= 93.470[a]; df= 12; P<0.001) between visitor number and location was also seen for the Toco Toucans as a whole. They seemed to spend more time inside (80.9%) when no visitors were present, as a result, were seen less in other zones (Fig.5.). As the birds spent most of their time inside (76.1%), there is no evidence to suggest that they are using one zone more than another; more data would be needed to establish any potential patterns.

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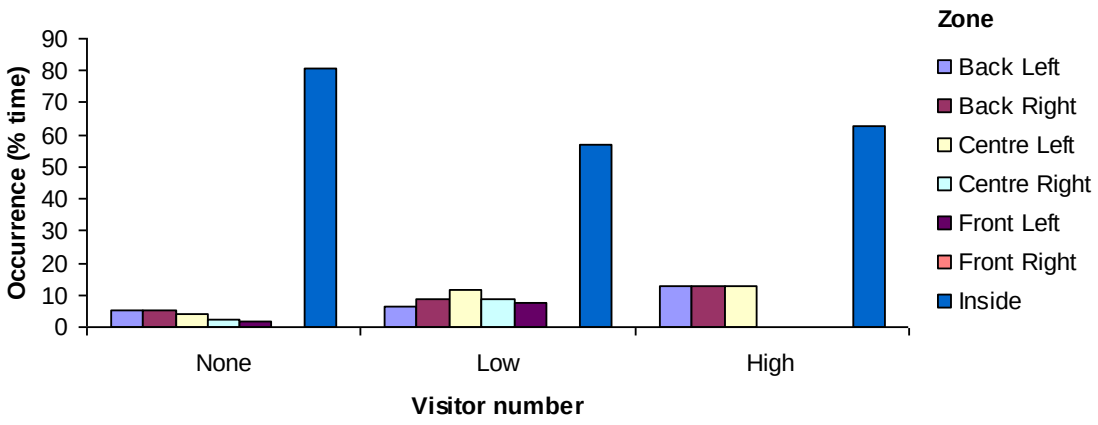

Fig.5. The association between number of visitors present and the occurrence (% time) in each zone of the enclosure for the Toco Toucans (whole).

Wrinkled Hornbill 2 also showed a significant association (value= 38.991[a]; df= 4; P<0.001) between visitor numbers and location. Similarly to Papuan Wreathed Hornbill 1 and the Toco Toucans, there were a large percentage of observations (62.5%) of the bird occurring inside when no visitors were present (Fig.6.). More time is spent in the Centre Left zone when there are no visitors present (15.2%) but more time is spent in the Back Left zone (21.65%) at low visitor numbers (Fig.6.). The bird did not use the two Front zones at all; there were also no observations for high visitor numbers, as the situation did not arise. More data would be needed to establish what was happening with high visitor densities.

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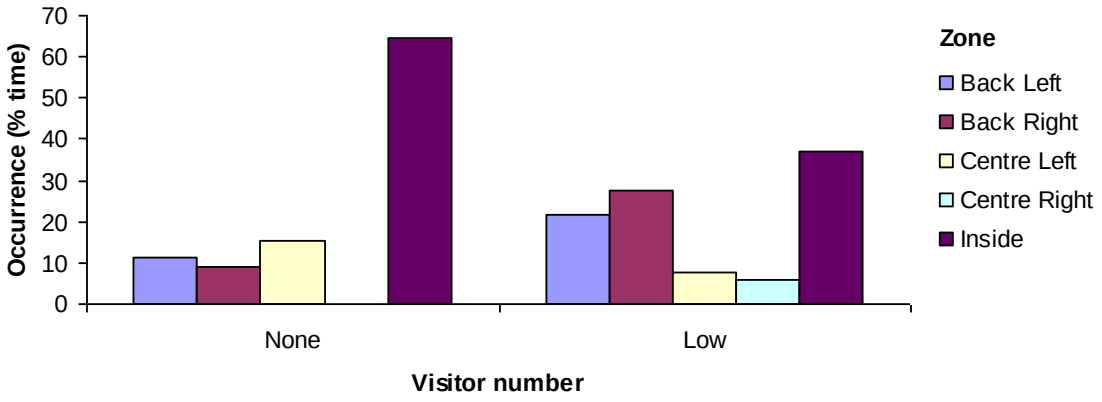

Fig. 6. The association between number of visitors present and the occurrence (% time) in each zone of the enclosure for Wrinkled Hornbill 2.

A significant association between visitor number and location was also observed for Abyssinian Ground Hornbill 1 (Chi-Squared= 89.574[a]; df= 8; P<0.001). Overall, relatively equal amounts of time are spent in all of the zones when no visitors are present, with a slight increase of occurrence in the Back Right zone (Fig.7.). When low visitor numbers are present, the bird spends most of it's time in the Front Right zone (51.4%) in addition to less time inside (7.1%) (Fig.6.). The two Back zones are the outside zones with the least amount of time spent in them (34.8% combined), whilst the two Front zones are the outside zones with the most time spent in them (49.1% combined). When there were high visitor numbers, no time was spent in the Back Right zone, but the other zones seemed to be used equally (all 4.5%) (Fig.7.).

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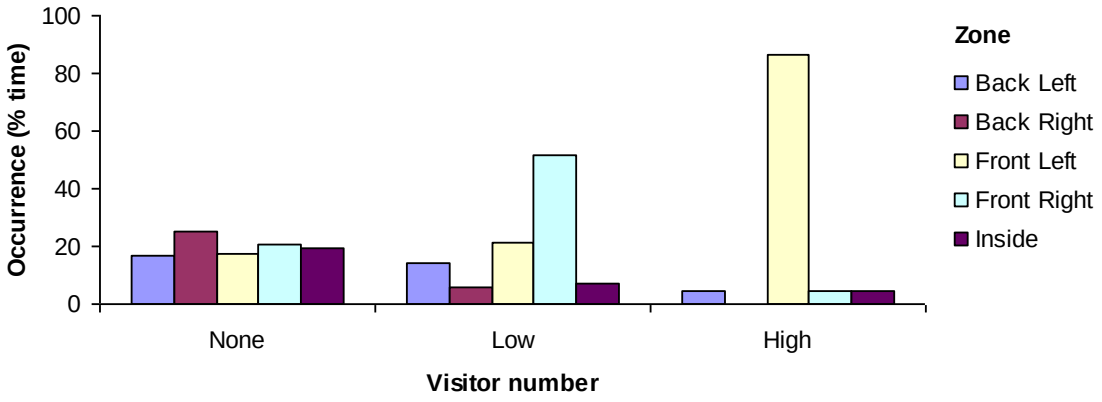

Fig.7. The association between number of visitors present and the occurrence (% time) in each zone of the enclosure for Abyssinian Ground Hornbill 1.

The last bird to exhibit a significant association between visitor number and location was Abyssinian Ground Hornbill 3 (Chi-Squared= 22.534[a]; df= 8; P<0.005). There is an increase in occurrence in the Back Right zone with increasing numbers (Fig.8.), but as there is only one incident of high visitor density, then it is difficult to support this- more data would be needed to establish what happens with high visitor numbers. There is a decrease of time spent in the Front Left zone with decreasing visitor numbers, whilst there is an increase in the Front Right zone (Fig. 8.) but again, it is difficult to support any definite conclusions due to lack of data for high visitor numbers.

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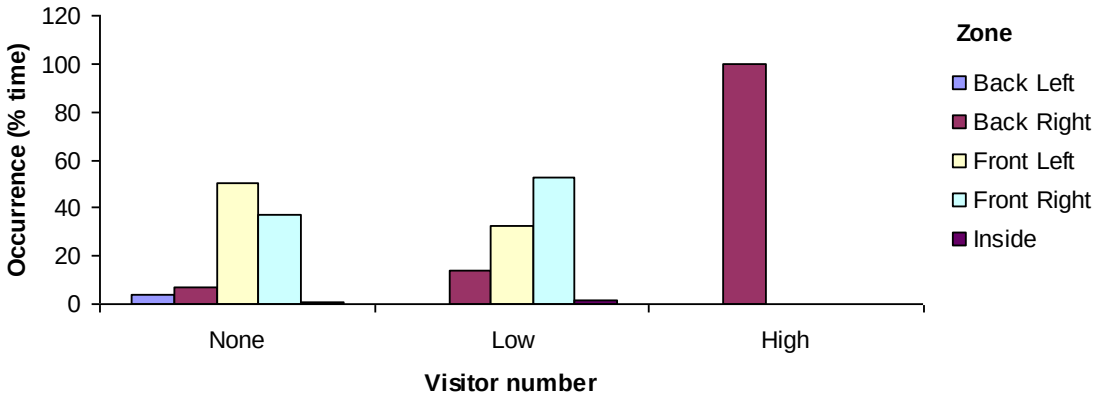

Fig.8. The association between number of visitors present and the occurrence (% time) in each zone of the enclosure for Abyssinian Ground Hornbill 3.

3.4. Spread of Participation Index (SPI)

The Spread of Participation Index (SPI) was used to evaluate the evenness of enclosure use of the subject birds (Table 3). The following Dickens (1955) formula was used:

$$SPI = \frac{M\,(n_b - n_a) + (F_a - F_b)}{2(N - M)}$$

The SPI value will fall between 0 and 1:

0= The enclosure is used to a maximum, with all zones being used equally.
1= The enclosure is used to a minimum, with only one zone used.
(Plowman 2003)

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Table 3

The SPI Value for all birds

Species and Individual	SPI Value
Abyssinian Ground Hornbill 1	0.1
Abyssinian Ground Hornbill 2	0.1
Abyssinian Ground Hornbill 3	0.5
Papuan Wreathed Hornbill 1	0.5
Papuan Wreathed Hornbill 2	0.5
Wrinkled Hornbill 1	0.5
Wrinkled Hornbill 2	0.6
Wrinkled Hornbill 3	0.5
Toco Toucan (whole)	0.3

3.5. Visitor number and noise level

There was a significant association between visitor numbers and noise level occurring for all the categories with each individual (Table 4).

Table 4

The Chi-Squared Association values between visitor number and noise

Visitor number	Chi-Squared	df	P-Value
Abyssinian Ground Hornbill 1	83.703[a]	6	P<0.001
Abyssinian Ground Hornbill 2	46.362[a]	6	P<0.001
Abyssinian Ground Hornbill 3	51.294[a]	4	P<0.001
Papuan Wreathed Hornbill 1	159.287[a]	8	P<0.001
Papuan Wreathed Hornbill 2	60.634[a]	6	P<0.001
Wrinkled Hornbill 1	226.625[a]	8	P<0.001
Wrinkled Hornbill 2	58.411[a]	3	P<0.001
Wrinkled Hornbill 3	62.059[a]	3	P<0.001
Toco Toucan (whole)	219.222[a]	8	P<0.001

This suggests that noise was proportional to the number of visitors. Therefore it is difficult to establish whether it is visitor presence, noise, or something else that could potentially affect the birds. Further studies, for example, playing different volumes of noise to the animals, without the presence of visitors could attempt to establish if noise is affective.

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3.6. Visitor number and height (m)

Wrinkled Hornbill 2 showed a significant association (Chi-Squared= 15.281[a]; df= 4; P<0.005) between visitor number and height (m) and seemed to spend a relatively equal amount of time at 1.5m (50%) and 2.5m (44.9%). The bird spends hardly any time at 2.75m (3.1%) and 3m (0.8%) with no and low visitor numbers present (Fig.9.). At low visitor numbers, most of the time is spent at 2.5m (78.1%) but as visitor numbers increase, time spent at 2.5m increases but occurrence at 1.5m decreases (Fig.9.). No occurrences of high visitor numbers occurred and so it is difficult to derive any definite patterns. More data would be needed to do this.

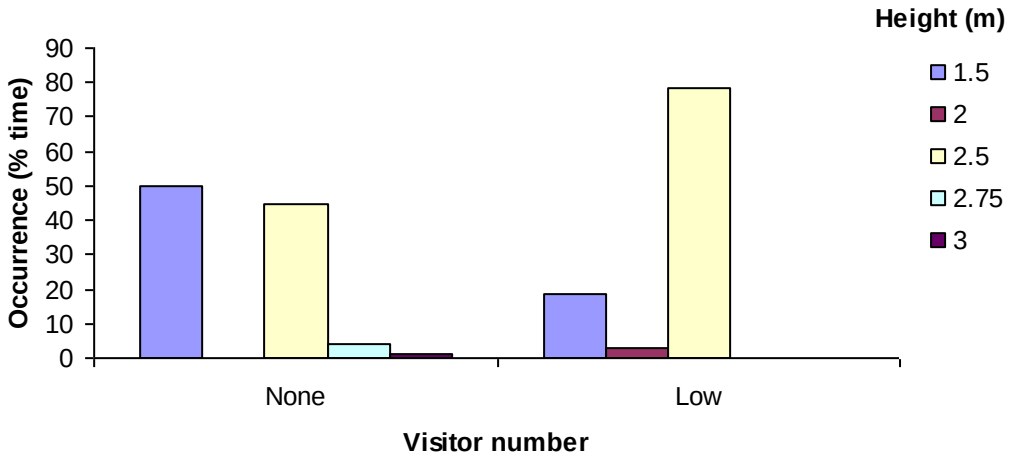

Fig.9. The association between the number of visitors and the occurrence (% time) at height (m) for Wrinkled Hornbill 2.

Abyssinian Ground Hornbill 1 also shows a significant association (Chi-Squared= 28.087[a]; df= 4; P<0.001) between visitor number and height (m). It spends most of its time at 0m (96.8%) but 3.6% is spent at 0.5m only when no visitors are present. Occurrences spent at 0.25m was 9.5% when there are high visitor number, though this is only seen twice and so may not be reliable- more data is needed (Fig.10.).

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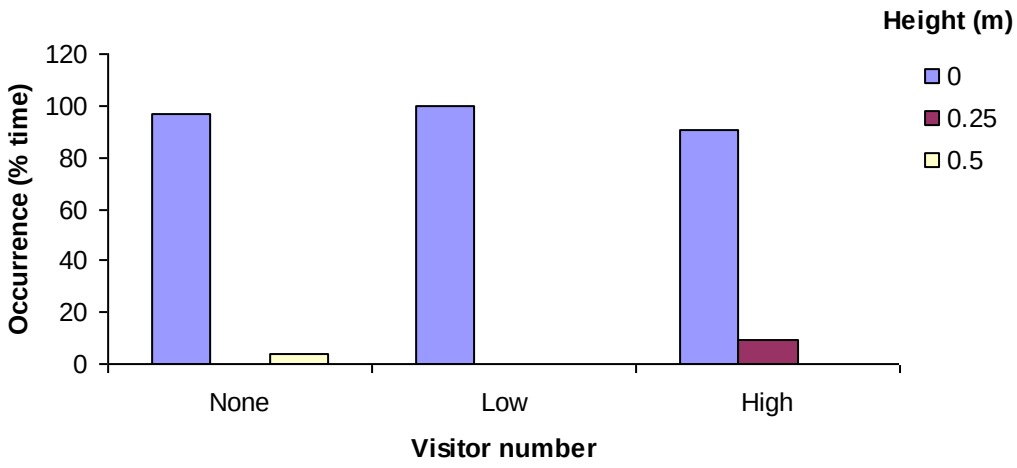

Fig.10. The association between the number of visitors and the occurrence (% time) at height (m) for Abyssinian Ground Hornbill 1.

Abyssinian Ground Hornbill 2 was the final bird to exhibit a significant association (Chi-Squared= 20.248[a], df= 6; P<0.005) between visitor number and height (m). It was spending more time above the ground (0m) with increasing visitor numbers (Fig.11.). Only one incident of high visitor numbers was seen and so, again, the data may not be reliable- more data is required.

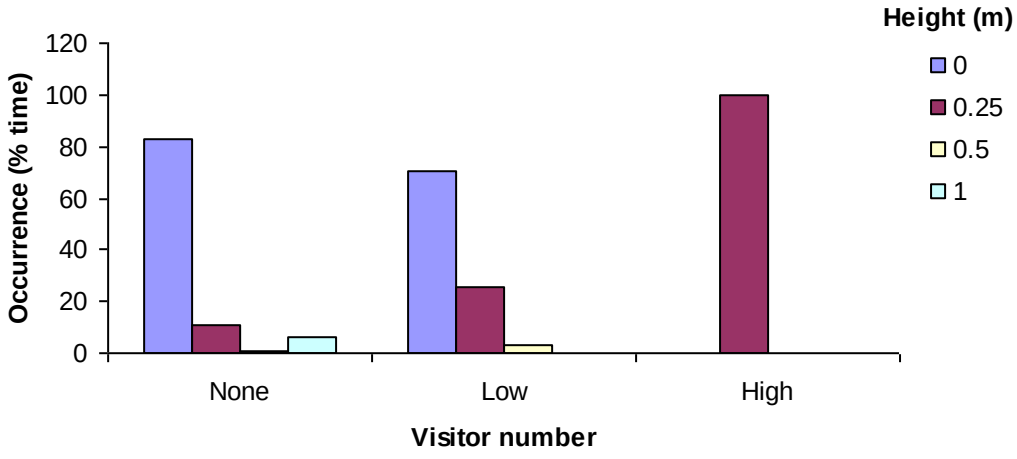

Fig.11. The association between the number of visitors and the occurrence (% time) at height (m) for Abyssinian Ground Hornbill 2.

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4. Discussion

The main findings from this study were Abyssinian Ground Hornbill 1 and 3 were the only two birds to show an association between visitor numbers and behaviour. Papuan Wreathed Hornbill 1, the Toco Toucans, Wrinkled Hornbill 2 and Abyssinian Ground Hornbill 1 and 3 all demonstrated an association between visitor number and location within the enclosure, with some occurring more often in the outside zones with increasing visitor number. An association was also seen with regards to height (m) and visitor number for Wrinkled Hornbill 2, Abyssinian Ground Hornbill 1 and 2. All of the birds were not using their enclosure evenly, with some worst than others.

Abyssinian Ground Hornbill 1 showed a similar pattern in behaviour when exposed to numbers of children and visitors; this could suggest that the bird was not influenced by the type of visitor, but rather one or more aspects, for example noise or activity. This study cannot define which aspects of the visitor condition are causing a significant change in behaviour- further studies would be needed to establish this.

The Spread of Participation Index (SPI) value for Abyssinian Ground Hornbill 1 showed that the bird used the enclosure relatively equally; however, the Chi-Squared Association Test indicated that it was spending more time in the Front Left and Front Right zones when visitors were present. This is contradictory to some studies on primates, such as Wells (2005) who found individuals of western lowland gorilla (*Gorilla gorilla gorilla*) were hiding when presented with large numbers of visitors. Wells (2005) also suggests that the gorillas were resting less when high visitor numbers were present, which is also contradictory to Abyssinian Ground Hornbill 1's behaviour. This behaviour is indicative of a hypothesis that has been put forward suggesting that the presence of visitors may be enriching and a source of stimulation for some captive animals (Morris 1964; Hosey 2000). More examples are needed to support this theory, but as of yet, the majority of studies indicate negative effects.

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Abyssinian Ground Hornbill 1 displayed an increase in inactivity and a decrease in locomotion with increasing numbers of children/ visitors. Results suggest that the bird is mostly stationary when visitors/ children are present and increasing in number. When presented with visitors and children, the bird seemed to approach the Perspex window as if to 'investigate' the situation. This increased time that the bird is spent inactive is compromising all other behaviours, and so, the bird is exhibiting a less diverse array of behaviours with increasing visitor numbers. Some natural behaviour, such as foraging and preening is also decreasing with increasing visitors. It seems that the presence of visitors is distracting to the bird from performing its natural behaviours suggesting a possible welfare issue (Hosey 2000). The bird however, shows increasing incidents of tapping on the Perspex window with increasing visitor numbers. This type of activity has been seen to be of a stereotypic nature, and could suggest poor welfare (Hosey 2000; Garner et al. 2006). Exhibition of stereotypic behaviour does not necessarily mean poor welfare, as discussed in the introduction and other behaviour and location of the bird suggest a positive influence. The bird's natural destructive behaviour may be coming out in the form of window tapping. This type of behaviour seemed to be appealing to the visitors; perhaps they felt as though they were interacting with the bird, as he would often tap if they put their hand on the glass. For Abyssinian Ground Hornbill 1, it could be other factors causing this behaviour, for example, aspects of enclosure design. Abyssinian Ground Hornbill 1 is only able to see visitors through the Perspex windows, and so, it may feel less exposed, thus not treating the visitors as a threat. This species is destructive in confined conditions, and the enclosures does not allow for large amounts of flying. There is also a relatively small amount of dead wood, and other items to allow for foraging, and so the bird may be bored or frustrated with this and so, the presence of visitors may be a source of alternative stimulation for it. Further research is needed to establish the cause (Hosey 2000).

The behaviour of Abyssinian Ground Hornbill 3 appeared to be significantly affected by visitor density. Abyssinian Ground Hornbill 3 showed

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increasing locomotion with increasing visitor numbers, which shows a consistency with results of some primate studies (Mitchell et al. 1991; Wells 2005). The enclosure for Abyssinian Ground Hornbill 3 is different to that of Abyssinian Ground Hornbill 1. The enclosure was smaller, and was almost always in the shade, which could limit some natural behaviour such as sunning and flying. It also had wire mesh rather than a wall with windows- perhaps the bird felt more exposed. This, and not being able to perform natural behaviours, could also explain increased locomotion, possibly from frustration or boredom as the bird did seem to be pacing in the Back Right and Front Right zones a large amount of the time. Pacing can be seen as a stereotypic behaviour and could indicate poor welfare (Garner et al. 2006). Too much and too little activity is a possible cause for concern, and so, it may be useful to establish optimum levels; however this is very difficult (Birke 2002). Abyssinian Ground Hornbill 3 was not affected by children. This could be due to a number of reasons. Chamove et al. (1988) found that for some arboreal species, having the enclosure elevated higher than the visitors was beneficial and reduced stressful effects. Although not an arboreal species, perhaps Abyssinian Ground Hornbill 3 liked to be higher up (i.e. on the 1m elevated dead logs) that the children and thus, was not affected by them. Individual differences could also be the reason that differences arise between Abyssinian Ground Hornbill 1 and 3 in how they react to children and visitors. This is important when considering visitor effects, especially when small samples are used as there is a greater probability that individual differences will affect results (Kuhar 2007). This occurrence can be seen in examples in primates and non-primates such as Vrancken et al. (1990) who found that that only one female of the five subjects of eastern lowland gorillas (*Gorilla gorilla graueri*) seemed to be affected by visitor presence, as she proceeded to sit near the observation glass in the presence of visitors, whilst the others did not seem to be affected. Sellinger & Ha (2005) looked at the responses of a male and female jaguar (*Panthera onca*) to visitor density and intensity, and found that the female demonstrated increased pacing, whilst the male showed increased aggression

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towards visitors with increased visitor density and intensity. However, little research has been done on this so far (Kuhar 2007).

It is interesting that all three Abyssinian Ground Hornbills seem to demonstrate an example of one of the three hypotheses put forward regarding the visitor effect and behaviour. Abyssinian Ground Hornbill 1 seems to demonstrate a positive visitor effect, Abyssinian Ground Hornbill 2 does not seem to be significantly affected by visitors or children and Abyssinian Ground Hornbill 3 seems to exhibit negative behaviours consistent with some primate studies that have shown a negative visitor effect. Other aspects that could be could possibly influence behaviour include outdoor access (Baker & Ross 1998; Hoff et al. 1997), management differences (Lambeth et al. 1997) and temperature (Stoinski et al. 2004) and seasonal change (Yamagiwa et al. 1994; Remis 1997; Poulsen & Clark 2004 in Ross et al. 2007). It is possible that the change in temperature and weather over the three month period may have affected the behaviour of some of all of the individuals. However, it would be difficult to establish what aspect, for example, cooler temperatures or fewer visitors because of the cooler temperatures might be causing the changes.

Some species were exhibiting significant changes in location and height (m), but not all. Most of the species, with the exception of Abyssinian Ground Hornbill 1 and 2 seemed to be using their enclosures relatively unevenly. Mallapur et al. (2005) provides evidence of individuals alternating their enclosure usage with visitor density, with enriched locations being used more when “off-exhibited”. This can also be seen in petting zoos, where captive animals are purposefully using areas in such a way that they avoid visitor interactions (Anderson et al. 2002). The birds exhibiting a significant association may be adapting a similar strategy.

Some individuals of the same species were showing differences, but this could again, be linked to individual differences. In a captive situation, the success of a species and the level they react to different stimuli will very much depend on various aspects of their natural biology (Clubb & Mason 2004; Clubb & Mason 2007) and could also include that of the animals’ history (i.e. if it was captive born

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or caught from the wild). Animals raised in a captivity are perhaps more accustomed to humans and sometimes do not show skills such as cognitive ability than those that were raised in the wild (Birke 2002). This could explain why the Wrinkled Hornbills were using their enclosures unequally and also seemed to not use the front two zones at all, and why the SPI value shows uneven enclosure usage. These animals are naturally shy and so, they may not want to get too close to the visitors.

The Toco Toucans and Papuan Wreathed Hornbill 1, both popular with visitors- particularly the toucans, seemed to spend most of their time inside, but seemed to appear out in the outside zones more when visitors were present. This could be an example of the cause and effect issue. Visitors often moved on quickly if the bird was not out, and did not wait for it to appear.

The behaviour of the birds housed in pairs may have been influenced by the presence of another individual within the enclosure. This could explain the differences within the Papuan Wreathed Hornbills- between the singly housed bird and the pair housed bird. Group differences have been seen in ape studies, such as Kuhar (2007) where differences between groups of captive gorillas subjected to identical conditions was most likely explained by demographic makeup. Though perhaps not as intricate as a family group of gorillas, pair differences may be worth looking into for future studies, in addition to why there are individual differences between species in response to visitor numbers and enclosure use (Kuhar 2007).

This study provides the foundation evidence of a possible visitor effect on a selection of captive birds. There have been some significant outcomes which may provide possible subjects for elaboration in the future, for example, noise and species, group and individual differences. More data is definitely needed, particularly when analysing the effects with high visitor numbers. Results from studies similar to this can be used to make changes in aspects such as enclosure design that could promote a positive impact on animal welfare at the zoo (Kuhar 2007).

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5. Conclusion

In this paper, the potential effect visitors have on a range of species of hornbill and toucan has been investigated. The Abyssinian Ground Hornbills seemed to demonstrate more visitor effects, but were conflicting. Little research has been done on the visitor effect and birds, and this study provides a possible starting point for future research. It seems likely that species, group and individual differences are acting on these results and would be worth future investigation. The more knowledge gained on the visitor effect, the more changes can be implemented to make a day at the zoo more pleasant for both visitors and animals alike.

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References

Anderson, U.S., Benne, M., Bloomsmith, M., Maple, T., 2002. Retreat space and human visitor density moderate undesirable behaviour in petting zoo animals. Appl. Anim. Welfare Sci. 5, 125-137.

Baker, K.C., Ross, S.K., 1998. Outdoor access: the behavioural benefits to chimpanzees. Am. J. Primatol. 45, 166.

Birke, L., 2002. Effects of browse, human visitors and noise on the behaviour of captive orang-utans. Anim. Welfare 11, 189-202.

Chamove, A.S., Hosey, G., Schaetzel, P., 1988. Visitors excite primates in zoos. Zoo Biol. 7, 359-369.

Clubb, R., Mason, G., 2004. Pacing polar bears and stoical sheep: testing ecological and evolutionary hypotheses about animal welfare. Anim. Welfare 13, S33-40.

Clubb, R., Mason, G.J., 2007. Natural behavioural biology as a risk factor in carnivore welfare: How analysing species differences could help zoos improve enclosures. Appl. Anim. Behav. Sci. 102, 303-328.

Collins, S.A., Archer, J.A., Barnard, C.J., 2008. Welfare and mate choice in zebra finches: effect of handling regime and presence of cover. Anim. Welfare 17, 11-17.

Cook, S., Hosey, G.R., 1995. Interaction sequences between chimpanzees and human visitors at the zoo. Zoo Biol. 14, 431-440.

ISSN 1754-2383 [Online]

Cooke, C.M., Schillaci, M.A., 2007. Behavioural responses to the zoo environment by white handed gibbons. Appl. Anim. Behav. Sci. 106, 125-133.
Davis, N., Schaffner, C.M., Smith, T.E., 2005. Evidence that zoo visitors influence HPA activity in spider monkeys. Appl. Anim. Behav. Sci. 90, 131-141.
Dickens, M., 1955. A statistical formula to quantify the "spread of participation" in group discussion. Speech Monogr. 22, 28-31.
Fa, J.E., 1989. Influence of people on the behaviour of display primates. In: Segal, E.F. (Ed.), Housing, Care and Psychological Well-Being of Captive and Laboratory Primates. Noyes Publications, Park Ridge, USA, pp. 270-290.
Garner, J.P., Meehan, C.L., Famula, T.R., Mench, J.A., 2006. Genetic, environmental, and neighbour effects on the severity of stereotypies and feather picking in Orange-winged Amazon parrots (*Amazona amazonica*): An epidemiological study. Appl. Anim. Behav. Sci. 96, 153-168.
Hoff, M.P., Powell, D.M., Lukas, K.E., Maple, T.L., 1997. Individual and social behaviour of lowland gorillas in outdoor exhibits compared with indoor holding areas. Appl. Anim. Behav. Sci. 64, 359-370.
Hosey, G., 2000. Zoo animals and their human audiences: what is the visitor effect? Anim. Welfare 9, 343-357.
Hosey, G., 2005. How does the environment affect the behaviour of captive primates? Appl. Anim. Behav. Sci. 90, 107-129.
Hosey, G.R., Druck, P.L., 1987. The influence of zoo visitors on the behaviour of captive primates. Appl. Anim. Behav. Sci. 33, 249-259.
Jeppesen, L.L., Falkenberg, R., 1990. Effects of play balls on pelt-biting, behaviour and levels of stress in ranch mink. Scientifur 14, 179-186.
Korhonen, H., Niemela, P., Jauhianinen, L., 2001. Effect of space and floor material on the behaviour of farmed blue foxes. Can. J. Anim. Sci. 81, 189-197.
Kuhar, C.W., 2007. Group differences in captive gorillas' reaction to large crowds. Appl. Anim. Behav. Sci. xxx, xxx-xxx.
Lambeth, S.P., Bloomsmith, M.A., Alford, P.L., 1997. Effects of human activity on chimpanzee wounding. Zoo Biol. 16, 327-333.
Mallapur, A., Sinha, A., Waran, N., 2005. Influence of visitor presence on the behaviour of captive lion-tailed macaques (*Macaca silenus*) housed in Indian zoos. Appl. Anim. Behav. Sci. 94, 341-352.
Mason, G.J., Latham, N.R., 2004. Can't stop, won't stop: is stereotypy a reliable animal welfare indicator? Anim. Welfare 13, 57-69.
Mitchell, G., Herring, F., Obradovich, S., Tromborg, C., Dowd, B., Neville, L.E., Field, L., 1991. Effects of visitors and cage changes on the behaviour of Mangabeys. Zoo Biol. 10, 417-423.
Morris, D., 1964. The response of animals to a restricted environment. Symp. Zool. Soc. Lond. 13, 99-118.
Nimon, N.J., Dalziel, F.R., 1992. Cross-species interaction and communication: a study method applied to captive siamang (*Hylobates syndactylus*) and long-billed corella (*Cacatua tenuirosris*) contacts with humans. Appl. Anim. Behav. Sci. 33, 261-272.
O'Donovan, D., Hindle, J.E., McKeown, S., O'Donovan, S., 1993. Effect of visitors on the behaviour of female Cheetahs *Acinonyx jubatus* and cubs. Int. Zoo Yb. 32, 238-244.
Plowman, A.B., 2003. A note on a modification of the spread of participation index allowing for unequal zones. Appl. Anim. Behav. Sci. 83, 331-336.
Poulsen, J., Clark, C., 2004. Densities, distributions, and seasonal movements of gorillas and chimpanzees in Swamp Forest in Northern Congo. Int. J. Primatol. 25, 285-306.
Rainey, H.J., Zuberbühler, K., Slater, P.J.B., 2004. The responses of black-casqued hornbills to predator vocalisations and primate alarm calls. Behaviour 141, 1263-1277.
Remis, M.J., 1997. Western lowland gorillas (*Gorilla gorilla gorilla*) as seasonal frugivores: use of variable resources. Am. J. Primatol. 43, 87-109.

ISSN 1754-2383 [Online]

Ross, S.R., Lonsdorf, E.V., Stoinski, T., 2007. Assessing the welfare implications of visitors in a zoo setting: A comment on Wells (2005). Appl. Anim. Behav. Sci. 102, 130-133.

Sellinger, R.L., Ha, J.C., 2005. The effect of visitor density and intensity on the behaviour of two captive jaguars (*Panthera onca*). J. Appl. Anim. Welfare Sci. 8, 233-244.

Snyder, R.L., 1975. Behavioural stress in captive animals. In: Research in Zoos and Aquariums 41-76. National Academy of Sciences, Washington, DC, USA.

Stoinski, T.S., Hoff, M.P., Maple, T.L., 2004. The effect of structural preferences, temperature, and social factors on visibility in western lowland gorillas. Environ. Behav. 43, 493-507.

Vrancken, A., Van Elsacker, L., Verheyen, R.F., 1990. 1990. Preliminary study on the influence of the visiting public on the spatial distribution in captive eastern lowland gorillas (*Gorilla gorilla graueri* Matchsie, 1914). Acta Zool. Pathol. Ant. 81, 9-15.

Wells, D.L., 2005. A note on the influence of visitors on the behaviour and welfare of zoo-housed gorillas. Appl. Anim. Behav. Sci. 93, 13-17.

Yamagiwa, J., Mwanza, N., Yumota, T., Maruhashi, T., 1994. Seasonal change in the composition of the diet in Eastern lowland gorillas. Primates 35, 1-14.

ISSN 1754-2383 [Online]