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Is there a visitor effect on behaviour and enclosure use of mixed bird species in a zoo enclosure?

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Abstract

Potential visitor effects on captive animals are poorly understand, with most studies focused on non-human primates, it is an area of research which in recent years has become important as a way of understanding welfare in a captive environment. Research into how this effects birds in captivity is limited, therefore this study looks at whether visitor density effects behaviour and enclosure use in six different bird species including red-billed choughs, *Pyrrhocorax pyrrhocorax* northern lapwings, *Vanellus vanellus,* red-crested turacos, *Tauraco erythrolophus,* Madagascar teal, *Anas bernieri,* grey gulls, *Larus modestus* and one Palawan peacock pheasant, *Polyplectron napoleonis* all housed together in a mixed species aviary at Paignton zoo Environmental Park®. Observations were carried out over a 15 day period, with each bird being observed individually and visitor density being categorised into no visitors, low, medium and high levels. Visitor noise was also measured, however no difference was found between the results of visitor noise and number. Use of space within the enclosure was analysed using the modified Spread of Participation Index (SPI) value. Values varied with all individuals, however all used the enclosure unevenly with choughs CH3, CH4, teal MT2, the Palawan peacock pheasant and the turaco pair using one or two zones predominantly more than any other area in the enclosure. Using the chi-squared test of association, a significant association between visitor number and location within the enclosure was only found in the choughs and the grey gulls and a significant association between increasing visitor density and behaviour was found in all the birds except the Madagascar teal and the Palawan peacock pheasant. There does seem to be some effect by visitors on several of the birds behaviour and their choice of locations within the enclosure, however a reliable conclusion could not be drawn due to limited data collection. More research is needed to investigate further, however this study adds to our understanding of bird welfare in captivity.

Introduction

Concern for the welfare of captive animals has helped improve investigations into potential effects that the zoo environment may have. There is extensive literature available concerning the potential effects of visitors on captive animals, with the first studies into the subject beginning in the 1970's (Hediger 1970; Thompson 1976; Oswald & Kuyk 1977). Since then research has been conducted in zoos concerning the visitor effect, leading to the discovery that different visitor variables may have varying effects on a variety of species (Davey 2006). Mixed-species exhibits and the visitor effect have received very little attention which is a concern as these types of exhibits are becoming more common place in zoos and so understanding more about the welfare needs of the animals housed within them is extremely important. Mixed-species exhibits are commonly used for birds with a variety of bird species mixed together, sometimes alongside mammals and reptiles, with the aim of creating a more enriching experience for the individual animals and providing opportunities to interact with other species as they would in their natural habitat (Shepherdson 2003). These enclosures may also promote natural behaviour and maximise space utilisation (Ziegler 2002; Dorman & Bourne 2010) and are important as an educational tool for the public, to teach them about the natural ecology of the animals, as well as being aesthetically pleasing (Thomas & Maruska 1996). As zoos depend on the public to be financially viable, it is important that they understand the effect that visitors may have on captive animals to minimise any negative effects and to provide visitors with an enjoyable experience encouraging positive feelings towards animals and conservation (Hosey 2005; Davey 2006; Fernandez et al. 2009).

Although there is convincing evidence for the visitor effect, an equivalent hypothesis has been formulated known as the visitor attraction hypothesis. It is believed that changes in the behaviour of captive animals could be the cause of crowds gathering around enclosures as visitors appear to be attracted to active animals (Rybak 2002). Research regarding the visitor effect has been focused mostly on non-human primates and there has been little research into other species. Some studies in other species have shown no visitor effect, such as O'Donavon et al. (1993) who observed a group of Cheetah, *Acinonyx jubatus* which showed no significant differences in behaviour due to visitor presence. Other studies have shown potential negative effects of visitors, for example Shen-Jin et al. (2010) found that watching behaviour, which is an indication of stress, in captive Sika deer, *Cervus nippon* was positively correlated with visitor density. Conflicting results are also evident in primate studies regarding the visitor effect. During observations of Diana monkeys, *Cercopthecus diana diana* Todd et al. (2007) found that as visitor numbers increased, so did time spent playing and feeding in the animals, perhaps indicating that the visitors are stimulating and a form of enrichment. Primate studies concerning visitor effect have also shown negative impacts for example, in extensive studies on Golden-bellied managabeys, *Cercocebus galeritus chrysogaster* negative responses were observed in the mangabeys in the form of threat behaviour when visitors were present (Mitchell et al. 1987) and that male mangabeys directed most threat behaviours toward male human visitors and female mangabeys to female human visitors (Mitchell et al. 1992). One of the only examples of a visitor effect study on birds was conducted by Nimon & Dalziel (1992) where observations on a long-billed Corella, *Cacatua teriuirostris* at Adelaide zoo showed that the bird appeared motivated to interact with visitors when they were present. A second bird study by Keane (2005)

observed two captive citron-crested cockatoo, *Cacatua sulphurea* housed next to a children's playground. An increase in the bird's activity levels and social behaviours was observed when the children's playground was busy. Both studies indicate that the birds were influenced by visitor presence and visitor noise in what appears to be a positive way, which could be viewed as enriching.

The main purpose of the present study is to discover if there is an association between visitors and behaviour exhibited in a group of captive mixed bird species. The study looks at an aviary enclosure located at Paignton Zoo Environmental Park®, Devon which houses six different species of birds including; red-billed choughs, *Pyrrhocorax pyrrhocorax,* northern lapwings, *Vanellus vanellus,* grey gulls, *Larus modestus,* Madagascar teal, *Anas bernieri,* red-crested turaco, *Tauraco erythrolophus* and a Palawan peacock pheasant, *Polyplectron napoleonis.* Although housed together, each species originates from very different geographical locations and are mostly ecologically different in the habitat types in which they live. The purpose of the current study is also to find out whether the enclosure is used evenly by all individuals and to see if some aspects or sections of the enclosure are favoured over others. By measuring visitor variables such as density and noise it may be possible to see if each species is affected in any way by the visitors. While most studies have focused predominantly on non-human primates, this study will focus on birds, taxa which are very much under-represented in the literature. To date there have been some studies which have focused on the visitor effect on captive birds and these will be used in comparison along with similar studies which have focused on other taxa which may be potentially similar. This will further our understanding of captive bird welfare and may help improve enclosure design for mixed-species exhibits.

Methodology

Study species

The study subjects included 16 individuals from six different species of bird all housed in a mixed species grouping within Paignton Zoo Environmental Park ® in Devon in an enclosure named the Cottage Aviary (see Table 1).

Table 1: All study species housed within the Cottage Aviary enclosure at Paignton Zoo Environmental Park®.

Species	N*	Sex Ratio**	Place of Origin	Habitat Type	Conservation Status
Red-Billed Chough, *Pyrrhocorax pyrrhocorax*	4	2.2:0	Eurasia & North Africa	Coastal Seacliff's & Short-grazed Grassland	Least Concern IUCN Red List
Northern Lapwing, *Vanellus vanellus*	5	1:1:3	Eurasia & North Africa	Lowland Arable Farmland	Least Concern IUCN Red List
Grey Gull, *Larus*	2	0:0:2	South-Western South America-	Arid Desert & Coastal	Least Concern

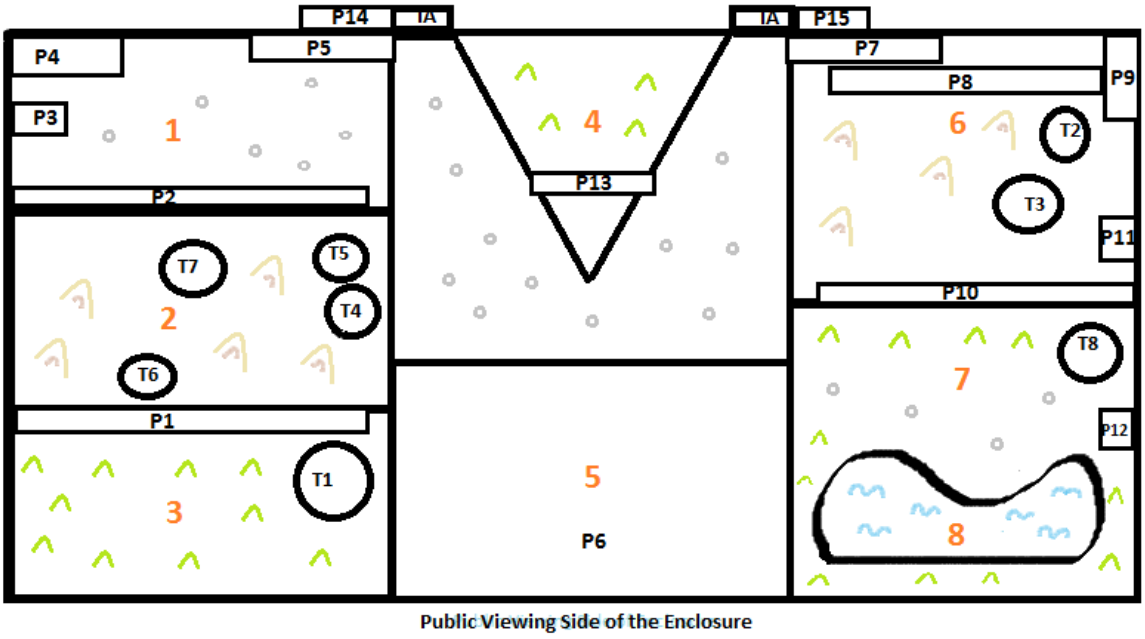
modestus			Chile to Ecuador		IUCN Red List
Red-Crested Turaco, *Tauraco erythrolophus*	2	1:1:0	Africa- Angola & the Demographic Republic of Congo	Evergreen & Riverine Forests	Least Concern IUCN Red List
Madagascar Teal, *Anas bernieri*	2	1:1:0	Western Madagascar	Coastal Mangrove Forests, Estuaries & Shallow Saline Wetlands	Endangered IUCN Red List
Palawan Peacock Pheasant, *Polyplectron napoleonis*	1	1:0:0	Palawan Island, Central Philippines	Humid Island Forests	Vulnerable IUCN Red List

*Number of Individuals **Male:Female:Unknown
(Del Hoyo et al. 1997; Gregory et al. 2002; Birdlife International 2004; Sheldon et al. 2004; Weichler et al. 2004; Sheldon et al. 2005; Boere et al. 2006; Crawford et al 2006; Birdlife International 2011).

Of all the individual birds, one red-billed chough male CHI and one northern lapwing LW3 (sex unknown) were hand reared. Age of all individuals is unknown; however the first individuals to be introduced to the enclosure were the grey gulls which arrived in 2001. The red-billed choughs had been present at the zoo for many years but were introduced to the cottage aviary in 2003. The northern lapwings were originally acquired for the Living Coasts Coastal Zoo ®, Torquay but it was decided that Paignton zoo would keep them and introduce them to the cottage aviary in 2005. The Madagascar teal were introduced next followed by the turacos which were moved from the forest aviary at the zoo. Lastly, the Palawan peacock pheasant was introduced. The breeding status of most of the species is active within the enclosure with all species excluding the Palawan peacock pheasant breeding previously. Choughs CH1 and Ch2 are a breeding pair as are CH3 and CH4. Although they have not bred this year they have been successful in previous years. Within the lapwing group, individuals have bred usually every year, however like the choughs they have not bred this year either. This is also the case for the red-crested turaco pair which has bred successfully in most previous years but has failed this year. The pair of Madagascar teal were moved into the enclosure from the main lake and are part of a breeding program which was initiated by the Durrell Wildlife Conservation Trust in 1993, however due to stud book orders the zoo has stopped them breeding for the moment. The lone Palawan peacock pheasant is relatively young and it is hoped that he will be introduced to a female, which is housed currently in a separate enclosure, in Spring 2011.

Study Enclosure

The Cottage Aviary enclosure is situated in the 'Primley' area of the zoo surrounded mostly by other aviaries and the Aldabra giant tortoise, *Geochelone gigantea* paddock. The enclosure was mapped during a preliminary visit and partitioned into eight separate zones with all significant features such as perches and variability in substrates noted (see Figure 1).



KEY					
Entrance to Indoor Area	**IA**	Zones	1-8	Grass	
Perches	P1-P15	Sandy Substrate		Pool	
Trees/Bushes	T1-T7	Gravel Substrate		**P6** Cage into enclosure, on top of which is perching access	

Figure 1: A representative map of the Cottage Aviary enclosure, separated into eight zones with key features included. The zones are defined within the eight large blocks with the zone number in the centre. The Cottage Aviary is 48ft in length, 36ft in width and 12ft in height with perches and the choice of indoor and outdoor access available 24 hours a day. Vegetation cover is also present and a variety of substrates throughout including a pond which is 9ft in length, 4ft in width and 6 inches in height.

Resource Use

Each time an individual was observed, the zone in which they were located was recorded along with the type of resource/substrate on which they were found, such as grass, perches, trees, gravel, sand or within the pool (see Figure 1).

Visitor Variables

Visitor Noise

Preliminary visits were used to develop categories of visitor noise levels (see Table 2) for later data collection. Background noise was excluded and the following categories used:

Table 2: Visitor noise categories and how they are defined.

Visitor Noise	Description
0	No noise, no visitors present
Low	Few visitors, quiet talking, not clearly audible
Medium	Few to several visitors talking at a normal conversational level
High	Several to large groups of visitors, raised voices including shouting

Visitor Numbers

Categories of visitor number (see Table 3) were also developed during preliminary visits:

Table 3: Visitor number categories and how they are defined.

Visitor Number	Description
0	No visitors present
<4	Low levels of visitors, one to four
5 to 10	Medium levels of visitors, between five and ten
10<	High levels of visitors, more than 10

Any instances of physical contact with the enclosure cage such as shaking the mesh or reaching through were also noted.

Data Collection Procedure

Behavioural Sampling

An Ethogram of all bird species behaviours was created during a pilot study visit (see Table 4).

Table 4: An ethogram categorising behaviours observed in all bird species within the Cottage Aviary enclosure.

Behaviour	Description
Locomotion	Any form of movement in a specific direction showing intent to move from one area to another, including flight.
Feeding	Foraging for and consuming food and drinking.
Bathing	Individual is coating feathers with water and may be submerged.
Beak Scraping	The side to side movement of the beak along a branch or perch in a wiping motion.
Resting Alert	Perched or standing on ground, with little movement and seeming alert.
Resting Inactive	Individual does not appear to be preforming any active behaviour and remains stationary.
Preening	Self-grooming using beak to manipulate feathers or using feet for scratching body.
Vocalising	Making any noise or sound.
Out of Sight	Subject under observations is no longer visible.

Behavioural Observations

The pilot study helped develop the method including sampling techniques and familiarised the birds with my presence. Each individual was identifiable by particular characteristics in morphology and/or by coloured leg bands. As the Grey Gulls did not have enough distinguishing features, only two of the group of 12 were chosen for observations as they were easily identifiable (see Table 5).

Table 5: How each study subject was successfully identified using an individual code, distinguishing features and leg bands.

Individual	Species	Distinguishing Feature	Leg Bands
CH1	Red-billed Chough	Twisted Feet	Green Left, Red Right
CH2	Red-billed Chough	None	Yellow Left, Silver Right
CH3	Red-billed Chough	Droopy Wings	No Bands
CH4	Red-billed Chough	Smallest	No Bands
LW1	Northern Lapwing	None	Green Right, Red Left
LW2	Northern Lapwing	None	No Bands
LW3	Northern Lapwing	None	Green Right
LW4	Northern Lapwing	None	White Right, Red Left
LW5	Northern Lapwing	None	White Right
PA1	Palawan Peacock Pheasant	Only One Individual	Only One Individual
TU1	Red-Crested Turaco	Slightly Larger	No Bands
TU2	Red-Crested Turaco	Smaller	Metal Ring Left Leg
GG1	Grey Gull	Young, Downy Feathers	No Bands
GG2	Grey Gull	Damaged Leg, Limps	No Bands
MT1	Madagascar Teal	Larger	No Bands
MT2	Madagascar Teal	Smaller	No Bands

Birds were chosen at random by mixing up their individual data sheets and choosing the top one. Each bird was observed for ten minutes with a new individual started every 12 minutes, allowing for two minute intervals between sampling individuals to locate the next study subject. Daily observations started at 11.00 am and finished at 14.23pm, with a half an hour lunch break between 12.26pm and 12.56pm. The birds were fed at 10.00am daily so these times were chosen to avoid feeding. A pre-printed data sheet was used to record the data and prior to each individual birds observations the date, time and weather conditions were noted. During observations any additional comments were also recorded here.

Focal sampling was used focusing on one individual and on every minute the behaviour of the individual was recorded, along with the number of visitors present, visitor noise level, the location in which the bird was situated and the resource/substrate on which the bird was found. Visitor number and noise were recorded only if visitors stopped briefly or for prolonged periods at the enclosure, those walking by were not counted. This was repeated for each individual for 15 days throughout August to October 2010. These included three weekdays and one weekend day in August, four weekdays in September and five weekdays and two weekend days in October.

Statistical Analysis

Behaviours were collapsed into categories active and inactive and visitor noise and visitor number were also collapsed to allow analysis using Chi-squared Test of Association using Minitab (see Table 6 & Table 7).

Table 6: Bird behaviours categorised into active and inactive categories

Behavioural Categories	
Active	**Inactive**
Locomotion	Out of Sight
Feeding	Resting Inactive
Bathing	Resting Alert
Beak Scraping	
Preening	
Vocalising	

Table 7: Visitor Noise and Visitor Numbers collapsed into four distinct categories.

Visitor Noise Categories		**Visitor Number Categories**	
Visitor Noise	**No Visitor Noise**	**Visitors Present**	**No Visitors**
Low	0	<4	0
Medium		5 to 10	
High		10<	

For testing visitor noise and location and visitor number and location, location was also categorised into Front, Back and out of sight. Zones 3, 5, 7 and 8 were classed as front and zones 1, 2, 4 and 6 were classed as back. Statistical analysis using Minitab was then carried out to see if there was an association between visitor noise and the location each bird was found, visitor number and location each bird was found, behaviour of individual birds and visitor number and finally behaviour of individual birds and visitor noise. Data collected for visitor noise levels and visitor

density were highly related and showed the same results statistically, therefore it did not warrant showing both, so visitor number and behaviour and visitor number and location were only shown. In each case, individuals within each species group were clumped together for analyse as data collection on an individual basis was not enough. Resource use could unfortunately not be tested statistically to see if there was an association between location within the enclosure and resources used as there was insufficient data collected with many categories having less than five counts of observed behaviour. These categories could not be collapsed further as previously done. Graphs were created to show the difference in resource use in the various zones of the enclosure and to also indicate where the birds spent most of their time within the enclosure.

To quantify the extent of enclosure utilisation a modified Spread of participation Index (SPI) was used. The modified formula allows for unequal zone size and can be more sensitive and accurate in determining enclosure usage (Plowman 2003).

The modified formula:

$$SPI = \frac{\sum |fo - fe|}{2(N - fe\ \min)}$$

Where fo is the observed frequency of observations in a zone, fe is the expected frequency of observations in a zone, based on zone size assuming even use of the whole enclosure, $|fo - fe|$ is the absolute value of the difference between fo and fe, $\sum$ summed for all zones, N is the total number of observations in all zones and fe min is the expected frequency of observations in the smallest zone (Plowman 2003).

The SPI value will fall between 1.0 and 0 with 1.0 indicating minimum enclosure usage, i.e only one zone is used and 0 maximum enclosure usage, i.e all zones are used equally (Plowman 2003).

Results

Spread of Participation Index (SPI) Value

As the SPI value ranges from zero to one, low scores indicate equal usage of many sites within the enclosure. The higher score means that the subject uses just a few sites. An index of 1.0 shows a subjects use of a single site. Ideally a good score would be between 0 and 0.2. The values, all between 0.3 and 0.8 indicate there was an uneven distribution of locational data for each of the birds (see Figure 2).

Figure 2: The SPI Value for all birds within the Cottage Aviary enclosure.

Resource Use and Enclosure Zone Location

The Red-billed choughs spent more time in zones one and six at the back of the enclosure and seemed to favour the perches over any other surface or substrate (see Figure 3).

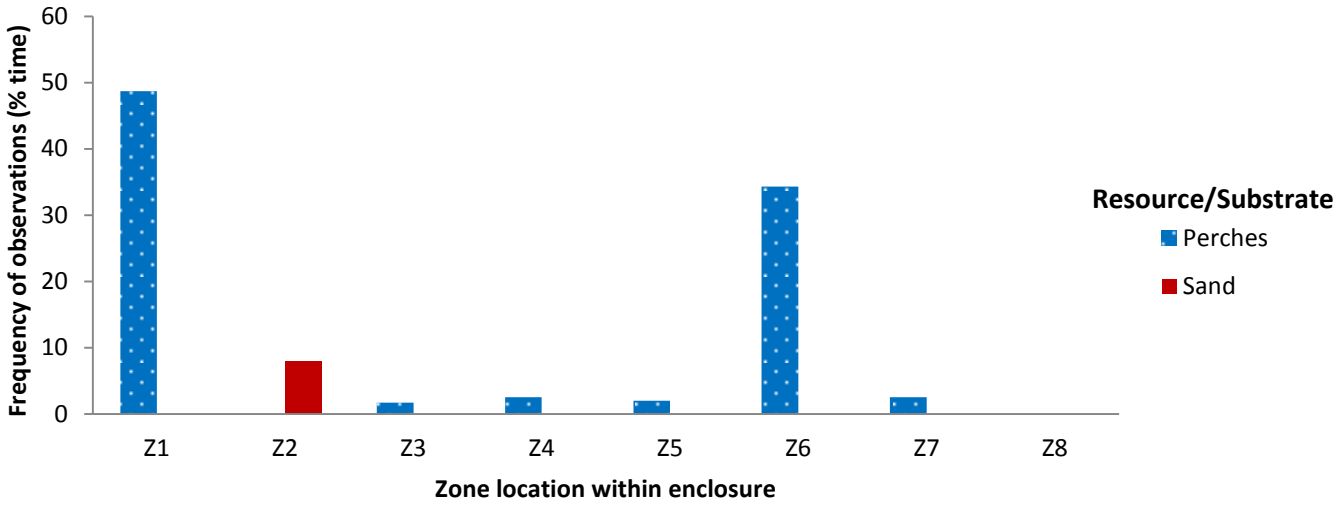


Figure 3: % of time spent on different surface types in each zone within the enclosure by the red-billed choughs.

The Grey Gulls favoured the front of the enclosure, particularly zone seven but did still spend a large amount of time in the back sections. They spent most of their time on the ground on gravel substrate (34.7%) followed by sand substrate (24.8%). They also spent more time on perches at the front of the enclosure (25.8%) compared to the back (2.8%) and did use the pond area some of the time (7.1%) (see Figure 4).

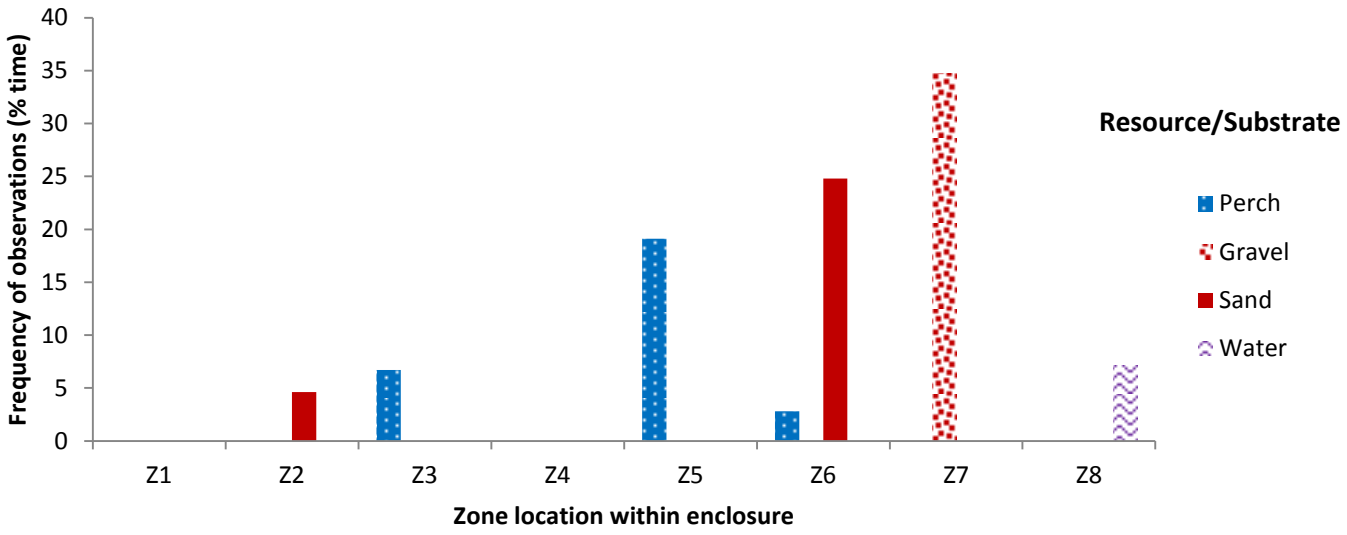


Figure 4: % time spent on different surface types within each zone of the enclosure by the grey gulls.

The Madagascar Teal also spent more time at the front of the enclosure but favoured the grass substrate (52.3%) followed by the pond (23.7%) and gravel substrate (15.3%). When found at the back of the enclosure the Teal were also seen on the sandy substrate (see Figure 5).

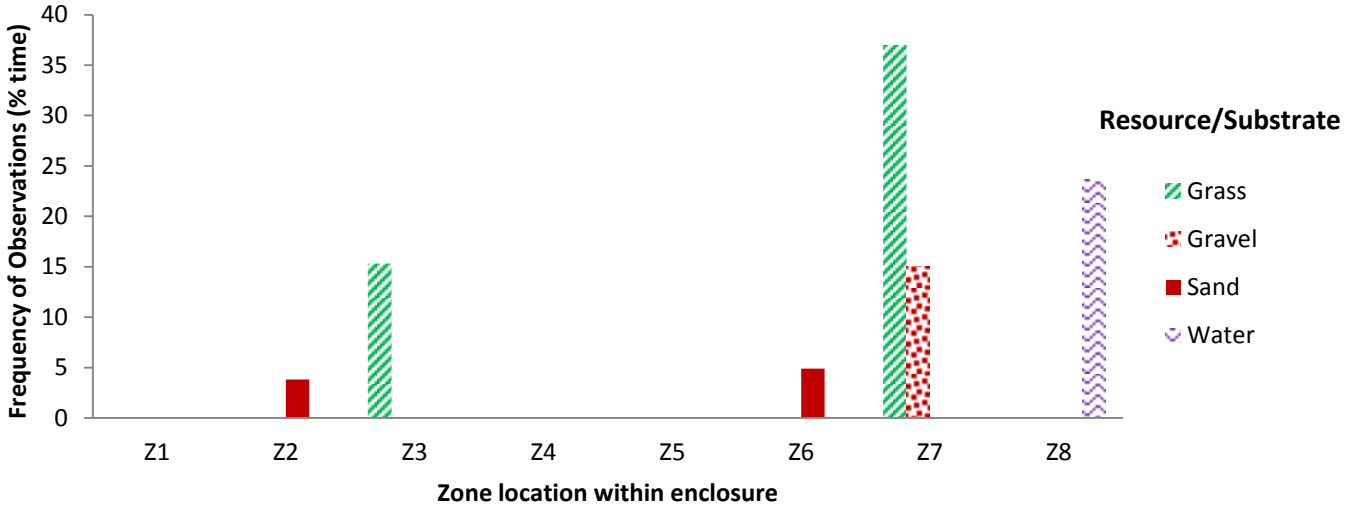


Figure 5: % time spent on different surface types within each zone of the enclosure by the Madagascar teal.

The northern lapwings as a group spent most of their time at the front of the enclosure on the gravel substrate (75.4%) with the second most popular substrate to the group being the sand (19.4%) at the back of the enclosure (see Figure 6).

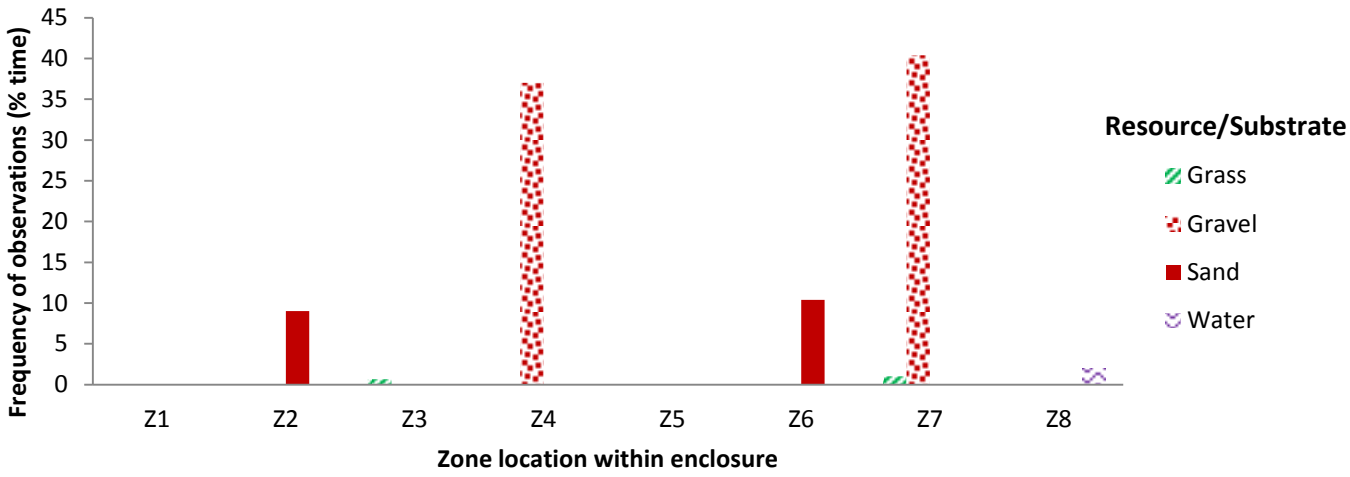


Figure 6: % of time spent on different surface types within each zone of the enclosure by the northern lapwings.

The red-crested turaco, like the choughs spent most of their time in the back sections of the enclosure. They favoured perches (79%) over sand substrate (8.1%) and trees (12.8%) (See Figure 7).

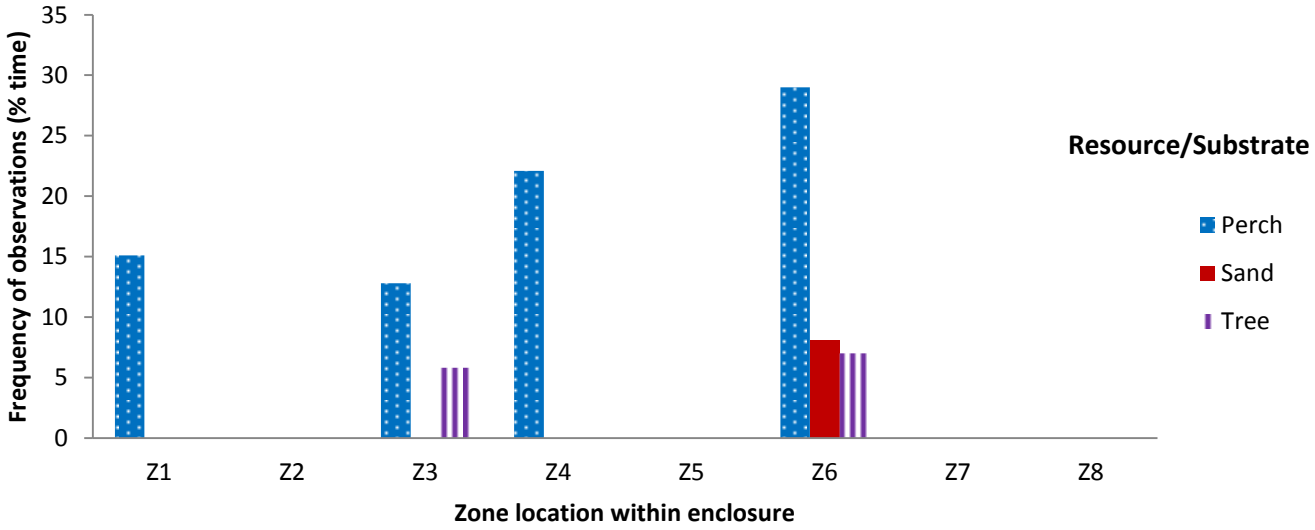


Figure 7: % of time spent on different surface types within each zone of the enclosure by the red-crested turacos.

Finally the Palawan peacock pheasant spent most of its time in the front sections of the enclosures in vegetation (71.25%). However it was also seen on sand, gravel and grass substrates briefly (see figure 8).

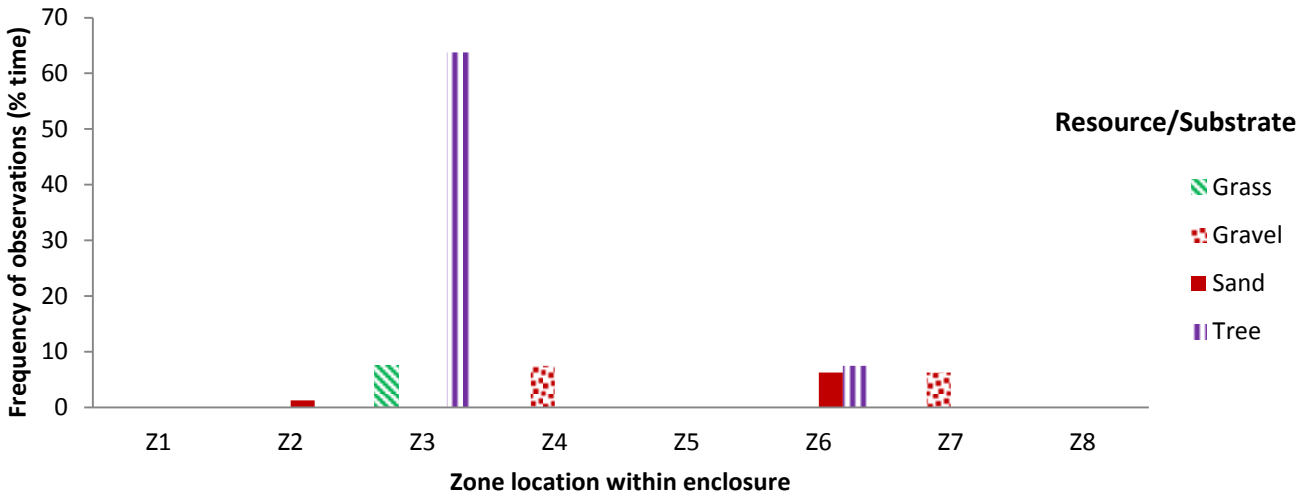


Figure 8: % of time spent on different surface types in each zone of the enclosure by the Palawan peacock pheasant.

Visitor Number and Location

The red-billed choughs as a whole showed a significant association (χ^2 = 10.513; df=2; P= 0.005) between visitor number and location. The largest chi-squared contribution was found between visitors present and the choughs being at the front of the enclosure and visitors present and the choughs being out of sight (see Figure 9).

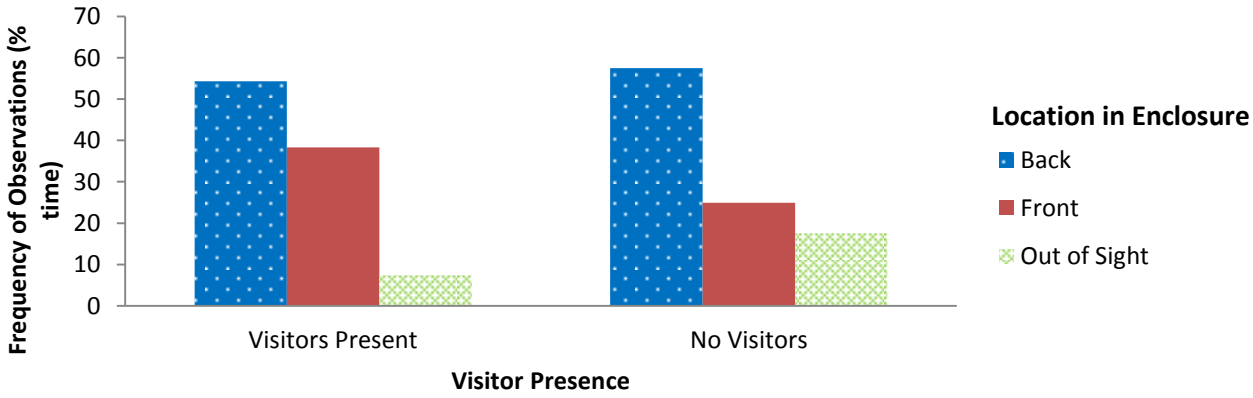


Figure 9: The association between Visitor presence and time spent (%) in each location by the Red-billed Choughs.

Lastly, a significant association (χ^2 = 8.328; DF= 2; P-value= 0.016) was found between visitor number and location for the grey gulls as a whole. The largest chi-square contribution was found between visitors present and the grey gulls being at the back of the enclosure and visitors present and the gulls being at the front of the enclosure (see Figure 10).

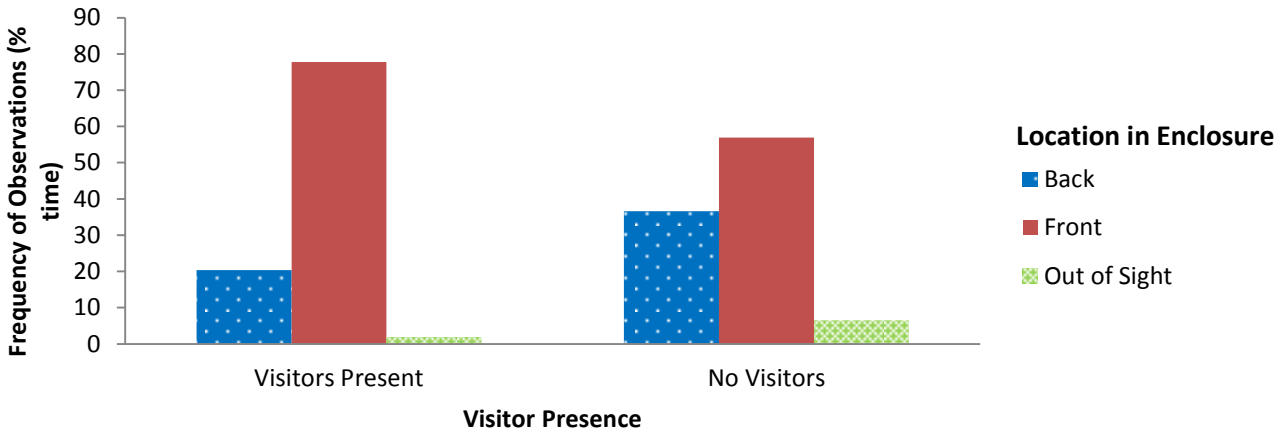


Figure 10: The association between visitor presence and time spent (%) in each location by the grey gulls as a whole.

Visitor Number and Behaviour

A significant association (χ^2 = 13.342; df=1; P<0.001) was found between visitor number and behaviour in the red-billed choughs as a whole. The largest chi-squared contribution was found between visitors' present and active behaviour, visitors' present and inactive behaviour (see figure 11).

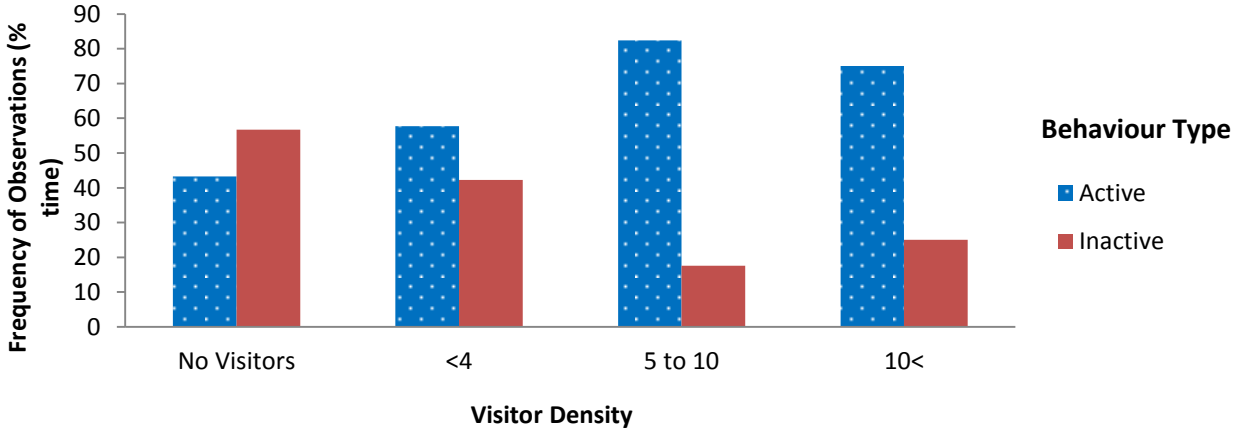


Figure 11: The association between visitor numbers and behaviour in the red-billed choughs as a whole.

The Northern Lapwings as a whole also showed a significant association (χ^2 = 6.385; df= 1; P= 0.012) between visitor number and behaviour. The largest chi-squared contribution was found between visitors' present and active behaviour, visitors' present and inactive behaviour (see figure 12).

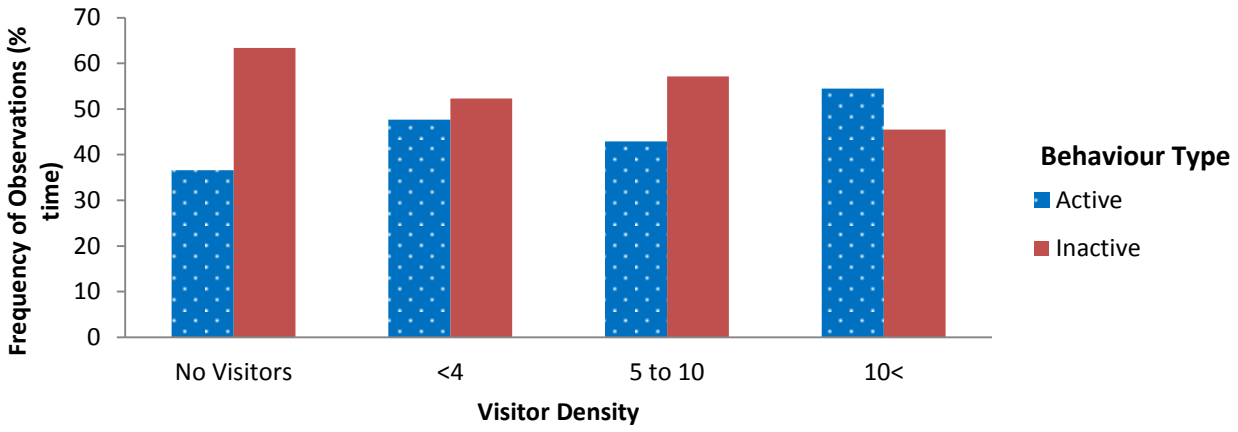


Figure 12: The association between visitor number and behaviour in the Northern Lapwings as a whole.

A significant association (χ^2 = 5.680; df= 1; P= 0.017) was also found between visitor number and behaviour in the Turacos combined. The largest chi-squared contribution was found between visitors' present and active behaviour (see figure 13).

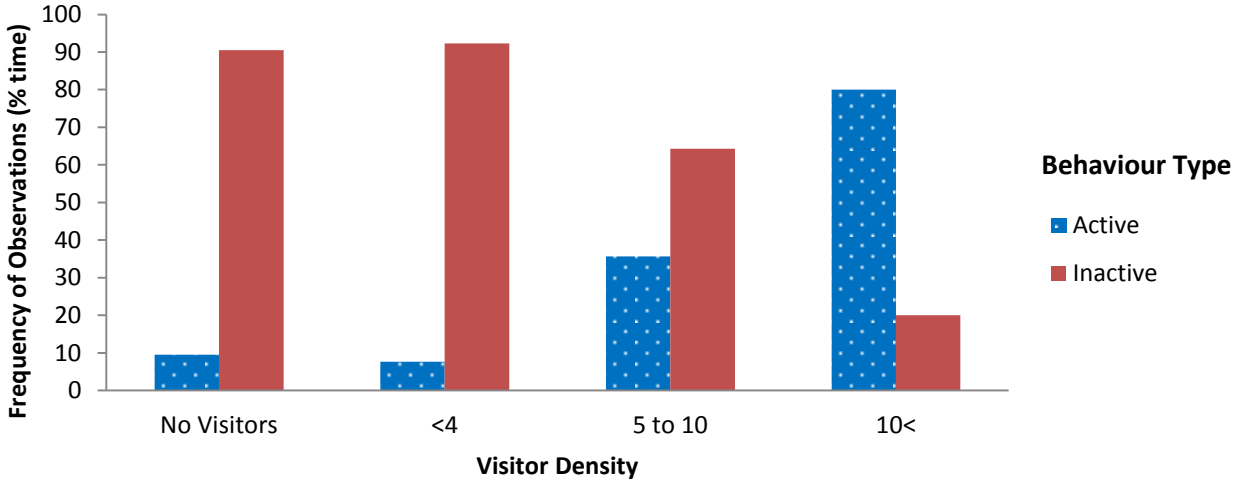


Figure 13: The association between visitor number and behaviour in the Turacos as a whole.

Lastly, the Grey Gulls as a whole showed a significant association (χ^2 = 9.150; df= 1; P=0.002) between visitor number and behaviour. The largest chi-squared contribution was found between visitors present and active behaviour, visitors present and inactive behaviour (see Figure 14).

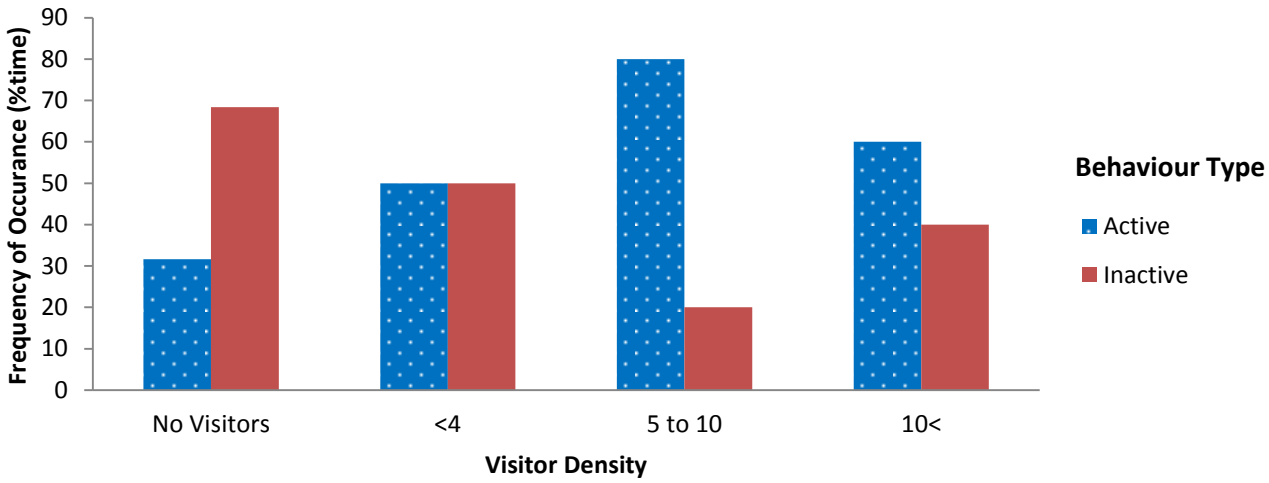


Figure 14: The association between visitor number and behaviour in the grey gulls as a whole.

Discussion

The main findings of the study suggest that all of the birds as grouped species, apart from the Palawan peacock pheasant and the Madagascar teal show an association between visitor numbers and behaviour. The red-billed choughs and grey gulls assembled into species groups both demonstrated an association between visitor number and the location which the bird was observed within the enclosure. The Spread of Participation Index (SPI) values indicated that all of the birds were not using the enclosure evenly, with some individuals showing a higher preference than others for particular zones within the enclosure. It was also found that there is some preference over the type of substrate surface used in each species.

The red-billed chough group displayed an increase in active behaviours and a decrease in inactive behaviours as visitor density increased. The chi-squared test for association found this to be significant as when there were no visitors present the choughs were more inactive, but when visitors were present the birds were more active. Wells (2005) similarly found from studying a group of captive gorillas, *Gorilla gorilla gorilla* that individuals rested less when visitor density was high and rested more and appeared relaxed when visitor density was low. However the study also found that individuals hid from visitors when visitor density was high which contradicts the findings of this study.

A behaviour categorised as active, observed in the choughs was beak scraping, a behaviour commonly seen in captive and wild parrots after eating to clean the beak of any food debris (Luescher 2006). This behaviour appeared frequent in all four choughs but interestingly occurred both after eating and at random times. Repetitive abnormal behaviour observed in inappropriate circumstances may indicate poor welfare (Mason et al. 2007). However this may not be directly caused by visitor variables but may be due to enclosure design or other factors. As the species is known for its acrobatic aerial displays the birds may feel confined as there may not be enough flight room in the enclosure. Another factor could be a lack of foraging opportunities, as in the natural state they forage and feed on invertebrates in grazed

rough grass with dung-associated invertebrates being a main component of their diet, (Kerbiriou & Julliard 2007) therefore the birds may be bored or frustrated. Enrichment would help create foraging opportunities and also stimulate the birds, as Corvids are highly intelligent, they need stimulation in captive environments (Cnotka et al. 2007). Visitors may actually be a distraction from this, however further research is needed.

The choughs in particular were seen significantly more in the front zones when visitors were present, compared to when they were absent, possibly indicating that the visitors had the opposite effect on the birds as they did on the primates in Wells (2004) study. The birds were also out of sight less when visitors were present which may indicate that the birds were attracted to the visitors as they were also more active when the visitors were present.

The choughs did not use the enclosure evenly and appeared to favour the back of the enclosure in zones 1 and 6. These two zones happen to have the most wooden perches which seemed to be their preferred substrate surface. SPI values were varied within the group which shows Individual differences, however small sample sizes may affect results (Kuhar 2008) and as the birds were assembled into species groupings it can be difficult to see where these individual differences arise. Similar to these findings, Sellinger & Ha (2005) found that male and female captive jaguar, *Panthera onca* housed together showed a difference in behaviours displayed when visitor levels increased. Interestingly, chough CH1 was hand-reared, but did not appear to show any obvious differences from the rest of its group.

The northern lapwings also showed a significant association between visitor number and behaviour, as like the choughs the lapwings were more inactive when no visitors were present, however they only showed higher levels of active behaviour than inactive when there were more than 10 visitors present. This is again consistent with some primate studies (Mitchell et al. 1991; Wells 2005) in particular a study by Todd et al. (2007) where Diana monkeys, *Cercopthecus diana diana* showed an increase in active behaviours such as playing and feeding while visitor density increased. Vocalising was categorised as an active behaviour and the lapwings were observed doing this quite often. An increase in vocalising may indicate stress as the lapwings appeared to be quite nervous birds and if any other species got too close they would move away quickly.

The lapwings had a lower SPI value than the other species but the value still indicated uneven utilisation of the enclosure. Across the five individuals their SPI values were very similar as they were observed almost always in close proximity to each other. They spent most of their time at the front of the enclosure on the gravel substrate, sometimes observed on the sand substrate also. They may have preferred this zone as it was adjacent to the pool, which they used regularly and there were no visual obstructions around them such as vegetation; as in the wild they are found in large flocks on open land (Sheldon et al. 2004). They appeared to be vigilant for a lot of the time and seemed aware of where their conspecifics were. Further study could focus on measuring vigilant behaviour as demonstrated by Shen-Jin (2010) where it was found that watching behaviour in Sika deer, *Cervus nippon,* thought to indicate stress, increased with visitor density.

The turaco pair also showed a significant association between visitors being present and active behaviour displayed. Levels of active behaviour increased and inactive behaviour decreased with increasing visitor numbers. However they were mostly inactive until there were more than 10 visitors present, during these periods they showed higher levels of active behaviour than inactive. However, there was no association found between visitor presence and location within the enclosure. This may be explained by them not using zones very often which do not have much vegetation cover as they are shy, arboreal birds inhabiting dense forested areas of the tropics (Sinclair & Hockey 2005). Not surprisingly the pair appeared to favour perches and trees over any other substrate and spent most of their time in zone 6 at the back of the enclosure. The pairs SPI value was close to 1, however they were out of sight most of the time, therefore it is hard to determine what zone they may have been in, but when observed out in the open they used zone 6 extensively.

The grey gulls' behaviour also appeared to be significantly influenced by increasing visitors. When visitors were absent the birds were more inactive more than active, however when one to four visitors were present there was no difference in levels of active and inactive behaviour. When visitor levels rose from five onwards they were more active than inactive. Both grey gulls also showed a significant association between visitor presence and location within the enclosure. They were found in the front zones of the enclosure more and at the back less when visitors were present. A study by Nimon & Dalziel found similar results when observing a single long-billed corella, *Cacatua tenuirostris* which spent 93.8% of its time at the front of the cage engaged in active behaviour when visitor presence was high. However, when visitor levels were very high the bird retreated indoors, this did not happen with any of the birds in the present study. Similarly, Keane (2005) found that a pair of captive citron-crested cockatoo, *Cacatua sulphrea* increased levels of activity when the playground adjacent to their enclosure was busy; however a pair of Molucian cockatoo, *Cactua moluccensis* in the same study spent most of their time at the back of their enclosure under the same circumstances.

The grey gulls used perches less and preferred to be on the ground, predominantly on gravel or sand substrate. The species inhabits the Atacama Desert in Chile for part of the year where they have to brave harsh conditions, making them very hardy (Guerra et al. 1988), this may be why they favoured this substrate. They did not use the zones evenly, however sandy substrate was only found in two zones and gravel in three zones. As Zone 7 was the area they spent the most time, which happened to be at the front of the enclosure, this may be one explanation as to why a significant association was found between visitor presence and the birds being located in this particular zone. The study only observed two of the twelve grey gulls due to difficulties in accurately identifying individuals. This may have affected results as the two individuals may not have been representative of the group as a whole.

The Palawan peacock pheasant showed preferential uses of certain zones, in particular it was observed most frequently in zone 3 under a particular tree. The Palawan peacock pheasant is similar to the turacos as it is a typically shy, forest dwelling bird and so due to its natural ecology spends most of its time amongst the vegetation, out of sight (Fuller & Garson 2000). For such a shy bird to be at the front of the enclosure seemed surprising, however the bird did not show any significant associations between visitor presence and location within the enclosure or visitor density and behaviour. In part, this behaviour may be a response to visitors, but it is

more likely that this is natural behaviour for the species. Morris (1964) stated that captive animals must be habituated to us, therefore we are of no consequence to them. However I do not believe this to be the case with this individual, as it was not handreared and was out of sight for most of the time, it may be hard to determine whether there is an effect. Again this may indicate that regardless to visitor presence, this section of the enclosure is preferred due to resources available. The Madagascar teal also showed high levels of unevenness in enclosure use as they favoured the grass over other substrates, however this was only available in zones 3, 4 and 7 and zone 7 was the area they were observed in most frequently. They did not appear to be affected by visitor presence.

As active behaviour was significantly higher in the choughs, lapwings, turacos and grey gulls when there were 10 or more visitors. It may be possible that these particular birds were affected most by visitor presence or this may be linked to the visitor attraction hypothesis, as it is thought that visitors may be attracted to active animals (Rybak 2002). Altmann (1988) found that highly active behaviour in captive bears resulted in an increase of visitor interest and Chamove et al. (1988) also found that zoo-housed primates directed behaviour at active audiences. It could be possible that those birds which increased active behaviour when visitor density was at its highest were attracting an audience. An increase in active behaviours may also be indicative of an enriching effect and a source of stimulation for the birds (Hosey 2000). In support of this, Glatson et al. (1984) found that Cotton-top tamarins housed in glass fronted cages compared to mesh showed more agnostic behaviours which may show that the birds in the present study did not feel threatened by visitors as the enclosure was surrounded by mesh. However, an increase in active behaviours such as locomotion could indicate a negative effect as the bird may be trying to retreat. Too much or too little activity may both be indicative of poor welfare (Birke 2002). However, all the species within the enclosure, apart from the Palawan peacock pheasant, have bred successfully in recent years, which shows to some extent that they are not under high levels of stress.

The overall difference in enclosure use across species could be described as a result of their natural biology and may have little or no connection with visitor presence (Clubb & Mason 2007). However Mallapur et al. (2005) found that a change in enclosure use was linked to visitor presence as captive lion-tailed macaques, *Macaca silenus* used enriched areas of the enclosure less when visitors were present, compared to when they were absent. This may contradict the present study, as all individuals used the zones expected, concerning their natural ecology. Hosey & Druck (1987) also found similar results in 12 captive primates. Future studies could possibly change around resources in the enclosure to maximise enclosure utilisation and to discover if it is the presence of these resources which makes the birds prefer particular zones.

Limitations were evident in using chi-squared test for association as small sample sizes limited abilities to carry out tests of significance with some variables, such as individual behaviours which could not be compared against visitor variables. This may be rectified in further studies by observing individuals for longer periods or focusing on smaller groups. Further studies could also look at how species interact with each other in a mixed-species enclosure and whether visitors effect intragroup interactions. Sekar et al. (2008) observed higher levels of intragroup aggression in captive Indian Gaur, *Bos gaurus* with higher numbers of visitors. Further

investigations into how species respond to social hierarchies and seasonal change as individuals could be useful in relation to visitor variables.

As the present study only looked at visitor presence, future research should include more accurate visitor categories such as age and gender to see if either of these variables have an effect. Hediger (1970) believed that different species had different perceptions of categories of visitors, which was proven in a study by Mitchell et al. (1992) concerning golden-bellied mangabeys, *Cercocebus galeritus chrysogaster* where male managbeys reacted with threat behaviour more towards male human visitors, female mangabeys to female human visitors and not at all to keepers. Visitor noise levels were recorded, but as it was found that there was no difference in how the birds reacted to visitor noise and presence, the results were not included. Further studies could define this further.

Conclusion

This study shows that there is a possible visitor effect on behaviour as some of the birds showed some differences in behaviour and differences in which areas of the enclosure they used in relation to visitor density. Grey gulls and choughs were the only two species that both showed significant association between visitor presence and location and behaviour. It could be possible that these species are the most affected, however it is difficult to determine whether the effect is positive or negative, this highlights the need for further research. Individual differences in birds and species interactions could be having an effect as well as different visitor characteristics, therefore further studies are needed to explain the meaning and importance of the findings. The value of zoo-based data cannot be underestimated as our understanding of how species respond to visitors and how well mixed species enclosures work can only improve animal welfare in captivity. By sharing data between zoos we can increase this knowledge.

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