Zoo Biology 29 : 715–731 (2010)

RESEARCH ARTICLE

Visitor Interest in Zoo Animals and the Implications for Collection Planning and Zoo Education Programmes

Andrew Moss[1]* and Maggie Esson[2]

[1]Education Research Officer, North of England Zoological Society, Chester Zoo, Chester, United Kingdom
[2]Education Programmes Manager, North of England Zoological Society, Chester Zoo, Chester, United Kingdom

As zoos have sought to further their conservation missions, they have become powerful providers of environmental education. Outside of "formal" education initiatives, such as those designed for school and other organized groups, or structured public talks programmes, much of the learning potential that the zoo has to offer is around the viewing of animals and the response of visitors to them. In this, zoo learning is a very personal construct, develops from the previous knowledge, and experiences and motivations of each individual. In this article, we make the assertion that learning potential, although difficult to quantify, is very much related to the attractiveness of animal species and the interest that visitors show in them. Using standard behaviorist measures of attraction and interest (the proportion of visitors that stop and for how long), we analyzed the relative interest in 40 zoo species held in a modern UK zoo and the variables that are significant in predicting that popularity. Further to this, the suggestion is made that the zoo collection planning process could use such information to make more informed decisions about which species should be housed for their educational value. Taxonomic grouping was found to be the most significant predictor of visitor interest—that is, visitors were far more interested in mammals than any other group—although body size (length), increasing animal activity and whether the species was the primary or "flagship" species in an exhibit or not, were all found to have a significant bearing on visitor interest. Zoo Biol 29:715–731, 2010. © 2010 Wiley-Liss, Inc.

*Correspondence to: Andrew Moss, Education Research Officer, Discovery and Learning Division, North of England Zoological Society, Chester Zoo, Caughall Road, Chester CH2 1LH, United Kingdom.
E-mail: a.moss@chesterzoo.org

Received 28 August 2009; Revised 14 January 2010; Accepted 5 February 2010

DOI 10.1002/zoo.20316
Published online 23 March 2010 in Wiley Online Library (wileyonlinelibrary.com).

Keywords: environmental education; zoo animals; visitor interest; popularity; zoo

INTRODUCTION

Twenty-first century zoos have not only positioned themselves as ex-situ and in-situ conservation institutions [Miller et al., 2004; Conway, 2003; Hutchins and Smith, 2003; Mallinson, 2003; Tribe and Booth, 2003] but also as providers of conservation and environmental education [Ballantyne et al., 2007; Falk et al., 2007; Randler et al., 2007; Swanagan, 2000]. Studies have found that people visit zoos (and aquariums) for a variety of reasons and that many visitors see the zoo not only as a place of family enjoyment, entertainment, and social activities [Reading and Miller, 2007; Hyson, 2004; Turley, 2001] but also as an educational destination [Falk et al., 2008; Briseno-Garzon et al., 2007; Packer and Ballantyne, 2002].

The primary reason for people choosing to visit zoos and other wildlife attractions is the attraction of the living animal, species they would not normally see in their daily lives [Turley, 1999]. Zoos exhibit a wide range of different species across many taxa. As a result of this diversity, there is a safe assumption that, in general, some species are more "popular" with visitors than others. From an educational perspective, it is easier to promote learning through subjects or subject matter in which the learner has a personal interest [Rennie and Johnston, 2004], or an emotional affinity [Ballantyne and Packer, 2005] hence, in this study, we make the assertion that the educational potential of a species is intrinsically linked to its popularity with visitors. If the catalysts that promote and develop interest in specific species were fully understood, could zoos raise the educational value of their collections by planning them more strategically?

There have been a number of studies that have looked at the relative popularity of zoo animals and the factors that influence visitor behavior but the findings appear to differ across throughout the literature. Bitgood et al. [1988] conducted a large, multi-institution study that uncovered that species size, activity, and proximity to visitors were all important predictors in their measure of visitor interest; namely, the time spent viewing animals. Balmford et al. [1996] disagreed over the relationship between the popularity of species in relation to body size and found no significant relationship between the two, although this study used a different measure of visitor interest; in this case, the number of people at various enclosures over a given time period. In a direct response to this study, Ward et al. [1998] undertook visitor research that agreed with Bitgood et al. [1988] over body size and popularity, although again, a different measure was used; here, visitors were split into three groups: those who did not stop at an enclosure, those who stopped for less than 10 sec, and those who stopped for more than 10 sec. These conflicting studies leave the question over species popularity and the correct measure to quantify visitor interest frustratingly unresolved.

Balmford et al. [1996] raised the important notion that, if species body size has no influence on visitor preferences, then why not dedicate more zoo space to the conservation of smaller species that are, in many cases, easier to breed and more cost-effective to maintain. This is indeed an important issue. From their inception, zoos have exhibited large, impressive (mainly) mammal species as their centrepieces of visitor appeal [Conway, 1986]. If visitors have no previous preference for large species, then zoos could be directing their resources more effectively towards greater numbers of smaller species. In most developed countries, the conservation role of the zoo is a legal requirement [for example, in the UK see DEFRA, 2004] and the world's governing body of zoos concurs in the publication "The World Zoo and Aquarium Conservation Strategy" [WAZA, 2005]. Indeed, within this document, it is stated that "*not only do zoos and aquariums have the ability to become models of integrated conservation*," *but the fact is*, *they must*." [WAZA, 2005, p 10] More specifically, chapter five of this work covers the role that education has to play in global conservation, namely: "*The educational role is to interpret living collections to attract*, *inspire and enable people from all walks of life to act positively for conservation*." [WAZA, 2005, p 35] It is crucial, therefore, to understand visitor preferences more fully, from both a conservation education and a direct conservation perspective. This study is primarily focussed on the relative educational benefits of keeping animals in zoos and is set within the growing landscape of criticism of zoos regarding their abilities to evidence the delivery of environmental and conservation education [Balmford et al., 2007; RSPCA, 2006]. Of course, criticism of zoos is not new. Many previous works have developed diverse arguments based on animal welfare [Margodt, 2000], cultural and moral issues [Malamud, 1998] or more general works analyzing the self-reported roles of zoos [Hosey et al., 2009; Jameison, 1985] but, for this study, the specific criticisms of zoo education cited above were seen as more relevant.

Not only does this criticism of educational measures in zoos impact directly on planned learning (for example, school groups or public presentations/talks given by trained educators) but also on the "free-choice" learning that occurs in zoos as well as in many other social environments [Briseno-Garzon et al., 2007; Falk, 2005; Storksdieck et al., 2005; Falk and Adelman, 2003]. As visitors are more likely to view zoo animals in an unstructured and unsupervised way, any learning undertaken will be motivated by visitors themselves, and therefore be "free-choice" by definition. This line of thought underlines the varied nature of learning, where learners arrive at a destination (such as a zoo) with their own, potentially disparate, previous knowledge, and visit agendas.

The preference to view certain animals over others (should such a phenomena exist) is also related to an individuals interests and motivations. Do certain species attract more visitors than others? Does the time visitors spend viewing animals also vary across species? If animal viewing preferences are found to be inconsistent empirically, then there is a scope for investigation into each species' place within a collection. In other words, if a statistically significant proportion of visitors find some animals more appealing than others, then there is perhaps room to suggest that these species are more valuable from an educational point of view. And this may have a follow-on effect on the entire zoo collection planning process.

This, of course, depends entirely on the designation of the species within a zoo's collection plan. The British and Irish Association of Zoos and Aquariums (BIAZA) is the overarching body for zoos in the UK. In its "Institutional Collection Plan" guidance, it suggests that formal "roles" should be designated for each species in a collection [BIAZA, 2007]. These roles might include conservation value (in relation to captive breeding), ex-situ conservation value, research, and education. Species can fulfill a number of roles but they are usually assigned a "primary" role within the collection plan. For the role of education, BIAZA recommends that this should only be assigned to species that have "*exhibit value* (*does this species make a good exhibit that the public like to see*?), *taxonomic uniqueness or interesting physical or physiological adaptations*" [BIAZA, 2007]. This would appear to be self-explanatory; that is, for a species to have a significant educational role within a collection it has to be of interest to, and be consistently visible to visitors.

This leads to the methodological decision as to how best to measure visitor interest in zoo species. In this study, we have adopted the tried and tested approach to quantifying visitor behavior, namely using unobtrusive observations of visitors in exhibit settings [see Serrell, 1998 for an extensive description of these techniques]. Although this method was developed in the museum studies field, it has also been widely used in wildlife attractions [Yalowitz and Bronnenkant, 2009; Zwinkels et al., 2009; Moss et al., 2008; Ross and Lukas, 2005; Ross and Gillespie, 2009; Nakamichi, 2007; Bitgood et al., 1988] increasing our confidence in the validity of implementing such an approach. Although, it must be added that the authors recognize other approaches that can be used to assess relative popularity of zoo animals, such as semantic differential scales [Sommer, 2008; Fraser et al., 2006] or conversation analysis [Clayton et al., 2009; Tunnicliffe, 1996], for example.

Our chosen method involves the use of two measures: a measurement of the proportion of visitors that stop at a point of interest (such as a museum gallery piece or, as in zoos, an animal enclosure) and second, an empirical measurement of sustained interest following a stop—the time spent in active engagement with the point of interest. The second measure, in particular, we believed, was the most precise way to explore the relative visitor interest in zoo animals as it measures a variable of visitor choice. That is, it is the interest level of the visitor in question that dictates the length of the stop (albeit allowing for additional variables such as visitor crowding and fatigue, for example). We must be clear that we infer no further meaning than this. It is clearly understood that behaviorist measures, such as this cannot, by themselves, give a direct insight into more complex phenomena, such as learning [Doering and Pekarik, 1997; Shettel, 1997]. We simply postulate that a visitor will stop for longer at an animal if they find interesting (in some way) than one that they do not. And, in theory, this relationship should be proportional, to a point—the more interested, the more time spent, and the greater the opportunity for learning.

Research Aims

- To investigate the predictors of animal popularity of a range of zoo species, using well-established measures of visitor interest.
- To put these findings into the context of the modern zoos' education mission and the way that collections are planned.

METHODS

Study Site and Species Selection

Chester Zoo is a large zoo with a diverse collection of species housed in second and third generation exhibit environments. It is also the most visited zoo in the UK—in 2008, it attracted more than 1.4 million visitors. Species chosen for inclusion in this study were located across the 45-hectare zoo in differing styles of exhibit.

These ranged from traditional reptile ''houses'' with rows of viviariums to fully modern 21st century immersive experiences.

Data were collected between October 2008 and April 2009, with the bulk of observations made between March and April 2009. This long collection period allowed for the fluctuations in visitor numbers that are often experienced in zoos. Within this, we also included the, very much busier, school holidays but avoided data collection on national, public holidays as visitor crowding on these days is extremely high and this has been found in other studies at Chester Zoo [Moss et al., 2007] to be significant in altering visitor behavior. We believed that this would not represent ''normal'' visitor patterns found in the zoo generally. Only members of family groups and couples were selected in this study, as these represent the typical visitor to Chester Zoo. School children (whether accompanied by teachers or not) were not included in the study. In total, 1,863 visitors were observed at 40 different animal viewing areas, with a minimum sample size of 30 at each viewing area.

Species were chosen to represent the widest possible diversity of taxa that are housed at Chester Zoo, including representatives from all Vertebrate Classes as well as one invertebrate Phylum (namely Arthropoda). Effort was also made to select species that we perceived to have a lesser or greater appeal. Some of the species chosen were ''flagship'' species within an exhibit (i.e. the focal species for that particular exhibit), whereas others were ''integral'' or ''supporting'' species (i.e. those that are housed within the exhibit of a flagship species—integrals are usually illustrative of the same habitat/geographical location of the flagship species). The full species list can be found in Table 1.

Procedure

Data collection was designed to assess the level of visitor interest in different zoo species and, as far as was practical, to take account of the variables that may affect this. Visitor interest was measured as the proportion of visitors that stopped at an animal viewing area (''attracting power'') and, when stopped, the length of time in seconds that they viewed the animal (''holding'' or ''viewing'' time). Balmford et al. [1996] recorded numbers of visitors at exhibits over set time periods, whereas Ward et al. [1998] classified visitors into one of three groups; those who did not stop, those who stopped for <10 sec, and those who stopped for >10 sec. We believed that by recording attracting power as well as a precise, interval, measure of interest (holding time), we could gain a more complete picture over visitor behavior. Unobtrusive observations were made on randomly selected visitors as they approached a viewing area. Once a visitor was selected, we recorded whether they made a definite stop at the viewing area in question or not. If they did, the time they spent viewing the animal(s) was also recorded. Once the researcher had completed the observation of one visitor, they selected the next available visitor that was approaching the viewing area. Data were recorded with pen, paper, and stopwatch—techniques commonly used in unobtrusive visitor studies [see Serrell, 1998 for many examples]. Observations were only recorded when the animal species was clearly visible. The researcher, although a staff member, wore ''plain'' clothes and not a uniform in an effort to blend-in more effectively although no attempt was made to hide the fact that research was being undertaken. If approached, visitors were told about the exact nature of the study.

TABLE 1. Variety of species used in the study, including binomial names

Mammals	Birds	Reptiles	Amphibians	Fish	Invertebrates
Asian Elephant (*Elaphus maximus*)	Scissor-billed Starling (*Scissirostrum dubium*)	Reticulated Python (*Python reticulatus*)	Axolotl (*Ambystoma mexicanum*)	Isok Barb (*Probarbus jullieni*)	Red-kneed Tarantula (*Brachypelma smithi*)
Asian Short Clawed Otter (*Aonyx cinerea*)	Rhinoceros Hornbill (*Buceros rhinoceros*)	Salvador's Monitor (*Varanus salvadorii*)	Rio Cauca Caecilian (*Typhlonectes natans*)	Common Clown Fish (*Amphiprion ocellaris*)	Madagascar Hissing Cockroach (*Gromphadorhina portentosa*)
Chimpanzee (*Pan troglodytes*)	Tarictic Hornbill (*Penelopides panini panini*)	Komodo Dragon (*Varanus komodoensis*)	Splendid Leaf Frogs (*Cruziohyla calcarifer*)	Australian lungfish (*Neoceratodus forsteri*)	Peruvian Black Velvet Stick insect (*Peruphasma schultei*)
Jaguar (*Panthera onca*)	Timor Zebra Finch (*Taeniopygia guttata guttata*)	Philippine Crocodile (*Crocodylus mindorensis*)	Green and Black Poison Dart Frogs (*Dendrobates auratus*)	Red-tailed Catfish (*Phractocephalus hemioliopterus*)	Spiny Stick Insect (*Aretaon asperrimus*)
Sumatran Tiger (*Panthera tigris sumatrae*)	Milky Eagle Owl (*Bubo lacteus*)	Galapagos Tortoise (*Geochelone nigra*)	Lake Zacapu Salamander (*Ambystoma andersoni*)	Lake Barombi Cichlids (*Pungu maclareni*)	Leaf Cutter Ants (*Atta cephalotes*)
Red river hog (*Potamochoerus porcus*)	Humboldt's Penguin (*Spheniscus humboldti*)	Tuatara (*Sphenodon punctatus*)	Amazonian Horned Frog (*Ceratophrys cornuta*)		
Spotted Grass Mouse (*Lemniscomys striatus*)		Green Mamba (*Dendroaspis angusticeps*)			
Rothschild's Giraffe (*Giraffa camelopardalis rothschildi*)		Mountain Horned Dragon (*Acanthosaura capra*)			
Turkish Spiny Mice (*Acomys cilicicus*)		Emerald Tree Boa (*Corallus caninus*)			

Additional information was also recorded during the visitor stop, such as the relative activity of the animal species in question (on a scale of 1–5; 1 being essentially sessile or asleep and 5 being extremely active, perhaps stimulated by keeper feeding or presence) and the proximity of the visitor to the animal being viewed (recorded on a scale of 1–6 as follows: $1 \leq 1$ m; $2 = 1$–2 m; $3 = 2$–5 m; $4 = 5$–10 m; $5 = 10$–20 m; and $6 = > 20$ m).

Descriptive data for each species were also collated for possible use as predictor variables. In this case, the body length and body mass of each species were recorded. This information was obtained from a variety of standard reference texts as well as renowned online academic sources (see separate reference section for descriptive species data). However, wherever possible, the International Species Information System (ISIS found at www.isis.org) was consulted, as this allowed us to record the exact size and mass of the individual zoo animals being viewed, rather than general figures reported in texts.

Analyses

Hierarchical and stepwise Multiple regression analyses were employed to uncover any significant predictors in visitor interest (holding time in this case). Initial regression models were constructed to look for significant predictors. A final model was produced based on the findings of these. In addition, further exploration was undertaken using one-way Analysis of Variance procedures (ANOVA) along with associated post-hoc tests.

All data were analyzed using the SPSS statistical package.

RESULTS

The principle measure of visitor interest used was the time spent by visitors watching the species in question. This is the measure referred to as "holding time." The large, interval data set ($n = 1{,}863$) and the collection of a range of possible predictor variables facilitated the use of exploratory multiple regression analyses. Initial stepwise models yielded four potential variables that could be significant in accounting for the variation in holding time. These were: taxonomic group ($\beta = 0.325$; $t = 2.375$; $P = 0.024$); body size—length in meters ($\beta = 0.417$; $t = 2.818$; $P = 0.008$); animal activity level ($\beta = 0.291$; $t = 2.233$; $P = 0.032$); and whether the animal in question was an integral or flagship species ($\beta = 0.275$; $t = 2.372$; $P = 0.024$). The variables that were discarded from the analysis at this stage were animal proximity ($\beta = 0.051$; $t = 0.307$; $P = 0.761$) and body size—mass in kilograms ($\beta = -0.072$; $t = -0.457$; $P = 0.651$).

A final regression model was constructed using only the four significant independent variables from the initial model. Previous research [Bitgood et al., 1988] has suggested that variables, such as taxonomic group, animal activity, and body size, are significant in influencing visitor behavior in zoos. It was decided, therefore, that this final model would be run in a hierarchical manner, with these three variables added in blocks. The integral/flagship species variable was also added as a separate block.

Taxonomic group accounted for 40.4% of the variation in holding time ($R^2 = 0.404$). The remaining variables accounted for a further 22.6% of the variation ($R^2 = 0.226$). Therefore, the total model could account for 63% of the total variation in holding time ($R^2 = 0.630$) and was found to be significant in predicting this dependent variable ($F = 14.877$; $P < 0.001$). The model coefficients pointed toward taxonomic group having the most significant effect on holding time ($\beta = 0.636$; $t = 5.077$; $P < 0.001$) although the three remaining variables were also found to make a significant contribution (body size: $\beta = 0.403$, $t = 3.668$, $P = 0.01$; activity level: $\beta = 0.286$, $t = 2.317$, $P = 0.026$; integral/flagship species: $\beta = 0.277$, $t = 2.526$, $P = 0.016$). From these initial findings, further within-group explorations were undertaken to help uncover the impact of these four variables on holding time.

Taxonomic Group

Figure 1 explores visitor interest purely on the basis of taxonomic group. By plotting residuals of attracting power and holding time, it can be seen that mammals in particular appear to be of most interest to visitors, relative to the other taxonomic groups. In segment (b) in Figure 1 (indicating that they achieved above average attracting power and holding time), 6 of the 10 species are mammals. Only three species are found in segment (a), suggesting that species that are not necessarily as attractive to visitors (in terms of % stopping), can hold attention for above average lengths of time. There are nine species found in segment (d), where although visitors found the species attractive enough to stop, holding time was below average. The remaining 18 species were all found in segment (c) where both attracting power and holding time were below average.

By paring these data down into group-only results (Fig. 2), the pattern is much clearer: only mammals achieve both positive attracting power and holding time scores. Amphibians and, to a lesser extent, fish have above average attracting powers, but holding time is below average for all the other groups. The difference in

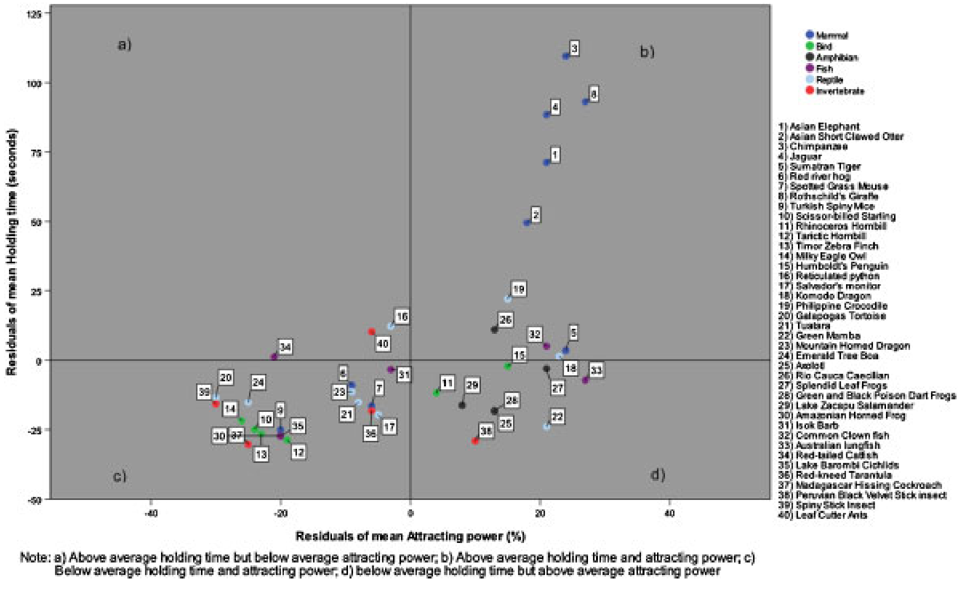

Fig. 1. Relationship between the residuals of attracting power (%) and holding time (sec) in the 40 species studied. See Table 1 for the detailed list of the species studied, including binomial names.

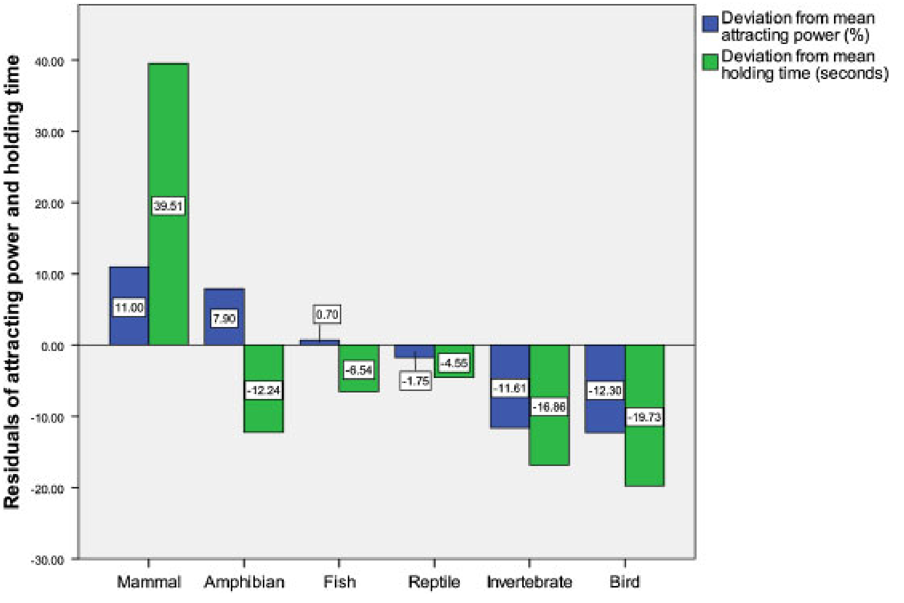

Fig. 2. Taxonomic group-level analysis of the residuals of attracting power (%) and holding time (sec).

TABLE 2. ANOVA post-hoc testing between taxonomic groups in relation to visitor holding time

		Subset for α = 0.05		
Taxon	*N*	1	2	3
Gabriel[a,b]				
Bird	182	17.94		
Invertebrate	149	20.81	20.81	
Amphibian	181	25.43	25.43	
Fish	151		31.13	
Reptile	352		33.12	
Mammal	276			77.18
Sig.		0.752	0.076	1.000

Means for groups in homogeneous subsets are displayed.
[a]Uses Harmonic mean sample size = 194.695.
[b]The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

holding time across these groups is significant ($F = 61.955$; $P < 0.001$) with post-hoc testing (Gabriel test used because of unequal sample sizes), suggesting three homogeneous subsets (Table 2) with mammals clearly in a subset on their own (subset 3). There is some overlap between the other two subsets with birds scoring the lowest of the six groups.

We performed a second series of tests but without any of the mammal data. The results of the one-way ANOVA still reported significant differences in holding time between the remaining taxonomic groups ($F = 15.234$; $P < 0.001$). Post-hoc

TABLE 3. ANOVA post-hoc testing between taxonomic groups (excluding mammals) in relation to holding time

		Subset for α = 0.05			
Taxon	*N*	1	2	3	4
Gabriel[a,b]					
Bird	182	17.94			
Invertebrate	149	20.81	20.81		
Amphibian	181		25.43	25.43	
Fish	151			31.13	31.13
Reptile	352				33.12
Sig.		0.952	0.525	0.235	0.997

Means for groups in homogeneous subsets are displayed.
[a]Uses Harmonic mean sample size = 183.863.
[b]The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

testing revealed a slightly more difficult picture to categorize (Table 3) although birds were again located in the first subset (with invertebrates). The overall pattern in Table 3 would hint toward there still being significant differences in species popularity among visitors, even if mammals were not contained within a collection.

Animal Activity Levels

Holding time differs significantly in relation to different relative activity levels ($F = 38.568$; $P < 0.001$). The general pattern is that holding time increases with increasing animal activity (Fig. 3) although activity level 5 does not promote as high a holding time as activity level 4.

Post-hoc testing revealed three homogeneous subsets (see Table 4)—one containing activity levels 1 and 2, the second containing levels 2 and 3, and the third containing levels 3, 4 and 5. There was some overlap between levels.

Body Size

A weak positive relationship was revealed between body size (length) and holding time ($R^2 = 0.212$). The results are plotted on Figure 4.

Integral/Non-Integral Species

We found a significant difference in holding time between integral and non-integral species ($F = 4.548$; $P = 0.039$) although this difference looks more clear-cut on Figure 5.

DISCUSSION

It is clear from these data that the taxonomic group to which a species belongs is the most significant predictor in visitor interest. Within this variable, mammals were found to be significantly more popular than any other group. The conclusion from this is that mammals are more popular than any other taxonomic group within the zoo environment, and indeed, from on-the-ground experience, the authors concur with this. However, it is also worth entertaining some alternative reasoning

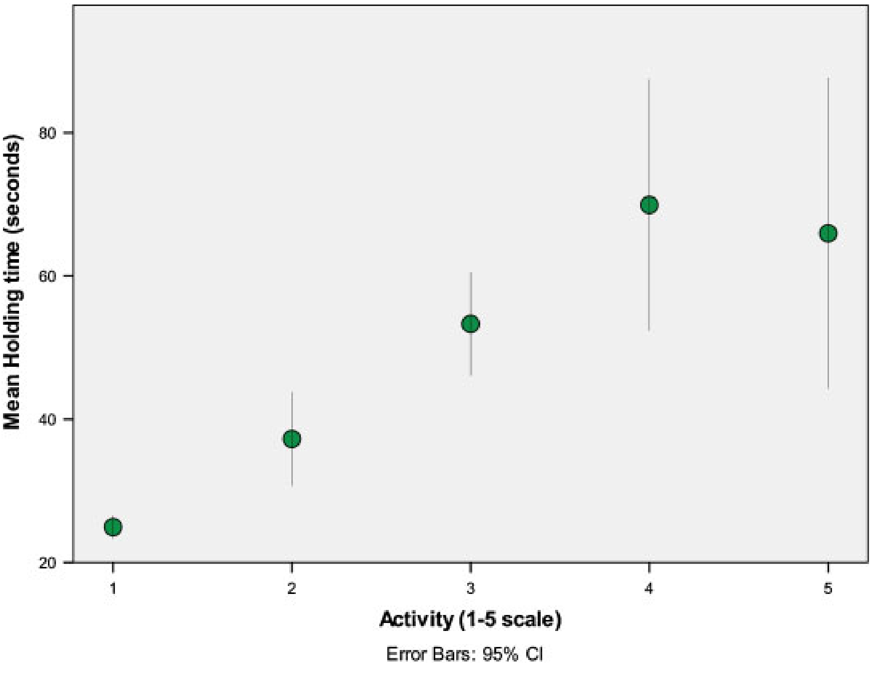

Fig. 3. Relationship between increasing animal activity level (1–5 scale) and mean visitor holding time (sec). Error bars show 95% confidence levels. Note that holding time at activity level 5 is less than that of level 4.

TABLE 4. ANOVA post-hoc testing between animal activity levels and visitor holding time

		Subset for $\alpha = 0.05$		
Activity (1–5 scale)	*N*	1	2	3
Gabriel[a,b]				
1	698	24.94		
2	162	37.25	37.25	
3	288		53.30	53.30
5	40			65.95
4	103			69.91
Sig.		0.380	0.092	0.071

Means for groups in homogeneous subsets are displayed.
[a]Uses Harmonic mean sample size = 109.203.
[b]The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

that could perhaps explain this finding. First, there may be some visitor favoritism toward large mammals, as it is these species that have traditionally been part of the zoo "experience" right from the origins of zoos as visitor destinations. So there is an argument to suggest that visitors come already primed with an expectation to see certain species, which happen to be large mammals and research shows that pre-visit agendas drive the visitor experience [Falk et al., 2008; Falk et al., 1998]. There is also the possibility, that zoos more prominently exhibit and market their mammal species

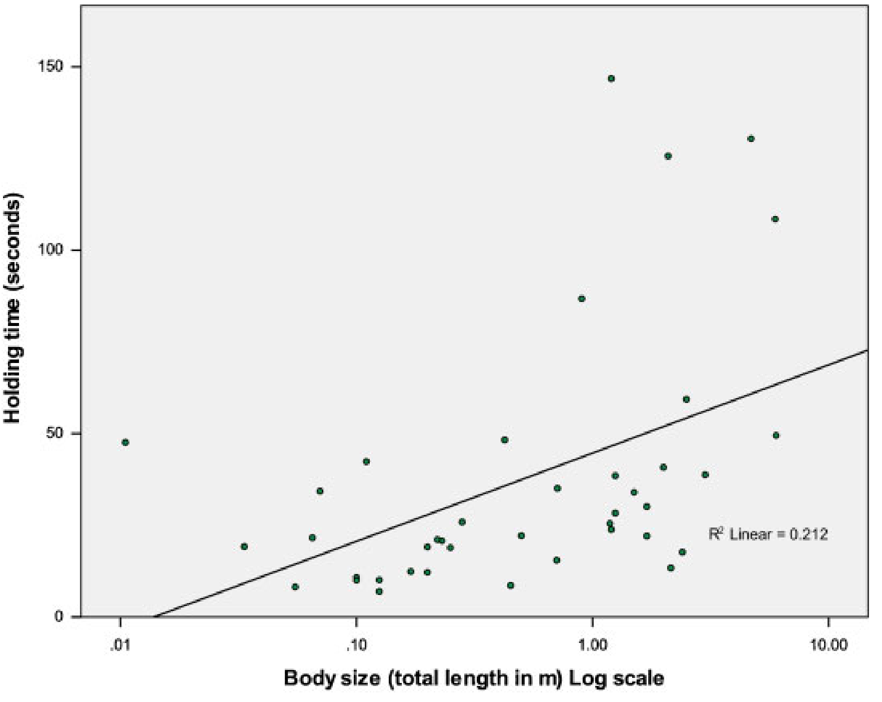

Fig. 4. Relationship between body size (length in m) and visitor holding time (sec). Note that a Log10 scale was used for *x*-axis because of the large variation in body size between the species.

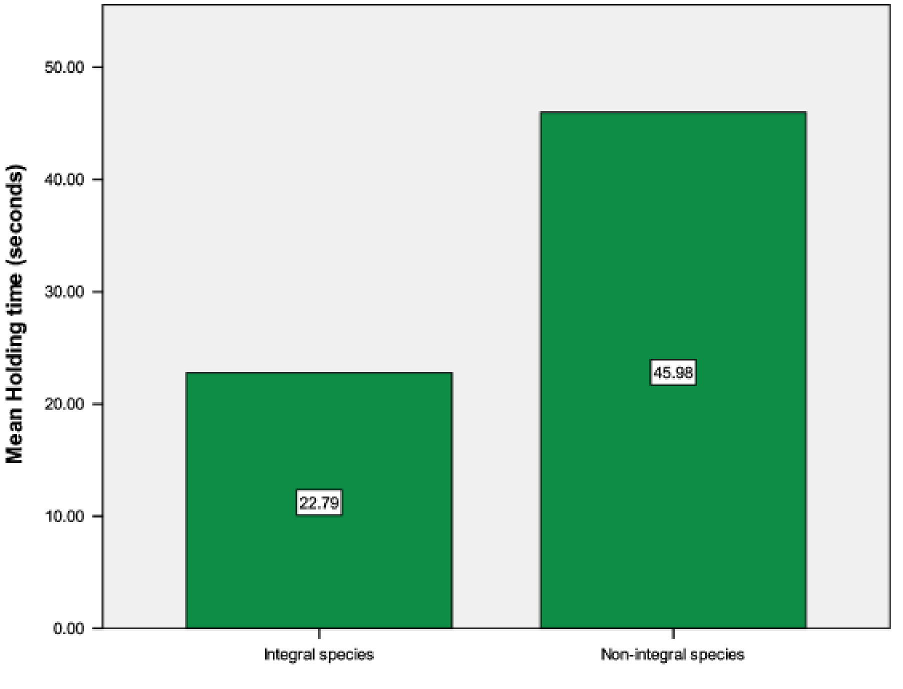

Fig. 5. Difference in visitor holding time (sec) between "integral" and "non-integral" species.

more aggressively than other taxa. A quick analysis of six of the world's most well-known zoos (Australia Zoo, Bronx Zoo, London Zoo, Rotterdam Zoo, San Diego Zoo, Singapore Zoo) revealed that an average of just over two-third (67%) of exhibits or attractions listed on their respective websites were either solely or predominantly related to large mammal species. Although more research would have to be conducted in this area, it seems at least possible that zoos themselves may be promoting the perception that they are places where large mammals can be seen, and that visitors are perpetuating this same, mammal-centric expectation of zoos.

In comparison with the other vertebrate classes and invertebrates birds, were found to incite very little interest from visitors. The residuals of attracting power and holding time (Fig. 2) in birds were the lowest of all the taxonomic groups. We were surprised by this finding, as our expectation (perhaps falsely guided by a kind of taxonomic prejudice, where mammals and birds are commonly referred to as "higher" vertebrates) was that birds would be relatively popular with visitors. This was clearly not the case. Although it must be said that invertebrates, fish, reptiles, and amphibians also compared unfavorably to the popularity of mammals. These leads to the suggestion that perhaps without mammals, a different picture of species popularity might be observed—that is, one where visitor interest is spread more evenly through the taxonomic groups. This hypothesis, that visitor-viewing behavior would be altered if mammals weren't present, is, of course, hard to test as all zoos contain mammal species. Simply precluding mammal exhibits from the study does not account for the fact that visitors may have already viewed mammals on their visit. However, as a best approximation, some of our analyses were re-calculated without any of the mammal data included, but still we found significant differences in holding time between the remaining groups ($F = 15.234$; $P < 0.001$).

If we refer back to the initial premise that visitor interest can be measured, at least to some extent, by the time spent watching or attending to the point of interest, then we can say with some degree of authority that mammals are the most popular group of animals at Chester Zoo. While some studies claim to make a correlation between time spent doing something (in this case, watching animals) and learning [Borun, 1996; Raphling and Serrell, 1993; Balling and Falk, 1980], it is a difficult phenomenon to show conclusively, particular as many researchers disagree on exactly what "learning" is [Hooper-Greenhill and Moussouri, 2000]. However, it would be incorrect to think that, over a large sample such as this, time spent watching animals is not somehow intrinsically linked to personal choice and interest levels.

The logical extension to this premise is that there is a greater potential for learning at those species that visitors are most interested in and therefore spend most time watching. This is quite a useful guideline as it could be used to inform practice in zoos, particularly when assigning species roles in institutional collection plans. It is our assertion that species should only be assigned the collection role of "education" if they can provoke a certain "minimum" interest level in visitors. This seems logical as learning is unlikely to take place if visitors show little or no interest in viewing. There will be some exceptions to this—for example, species that are not necessarily immediately attractive to visitors but might have an intriguing set of adaptations or be part of an exciting conservation story.

To boost the interest levels of these species, additional educational initiatives could be implemented, such as an increased amount and/or modes of interpretation, or the inclusion of the species in a public talks programme. Further work would have to be undertaken to look at the potential effectiveness of this approach. Overall, we are suggesting that evidence be provided for whatever primary role a species is assigned within an institutional collection. Species selected for their conservation value are routinely evidenced in collection plans (International Union of Conservation of Nature, IUCN status, breeding programme, in-situ work, etc). We feel that this rigor should be applied to all assigned species roles, otherwise zoos lay themselves open to justified criticism.

The other significant predictors of visitor interest were animal activity, body size (length), and whether the species in question was a flagship or integral species. These variables should also be considered if improvements in visitor interest levels are to be achieved. As perhaps expected, flagship species were shown more interest than the integral species. It is unrealistic to expect an integral species to provide the same levels of visitor interest as the species that the exhibit was designed around (or even named after!) and indeed there is a significant difference in holding time ($F = 4.548$; $P = 0.039$) One point worth noting is that apart from the Reticulated Python (*Python reticulatus*) in this study, the integral species were smaller than the flagship species, and this resonates with body size as a predictor of visitor interest. In this study, we found a positive relationship (albeit fairly weak: $R^2 = 0.212$) between body size (length) and visitor interest (holding time), which supports the findings of Ward et al. [1998] and Bitgood et al. [1988] and not those of Balmford et al. [1996]. As a consequence, we cannot support the notion that visitation to zoos would not be adversely affected by exhibiting greater numbers of smaller species, although as mentioned above, different data collection methods were used in each of these studies, including our own, so comparisons between the studies should be approached with caution. It is also worth noting that in our data set there are a number of outliers (Fig. 4) that it could be argued are affecting this relationship disproportionately. To reinforce our earlier assertions about the significance of taxonomic groupings, these outlier data are almost all related to mammals, again highlighting the large difference in interest between mammals and all other taxa. One final point is that only body length and not body mass of a species was found to affect visitor interest significantly. A possible interpretation of this is that people may find it easier to perceive the size of something by its visible proportions (length, width, and depth) rather than its mass (as this is more easily perceived by physically holding the object in question—clearly this is not feasible with zoo animals). This could potentially account for the difference between the two measures although the relative thickness of body coverings (e.g. fur might make animals look bigger than scales) could also alter the apparent size of different species.

Increased animal activity would also seem to be a logical promoter of increased visitor interest. In this study, we have shown this to be the case (Fig. 3) and indeed, previous work has also highlighted this as important in determining visitor behavior [Ridgway et al., 2005; Johnston, 1998; Bitgood et al., 1988]. In our data, we found a roughly proportional increase in visitor interest with increasing activity although it is worth noting that on the five-point activity scale, level four created more interest than level five (Fig. 3). It is probably fair to assume that there is some intrinsic relationship between increasing activity levels and increasing visitor interest, but the activity scale used in this study is fairly simple (and subjective), so more rigor would have to be applied to explore this relationship further. It would perhaps be interesting to look at visitor expectations of activity levels in different species. For example, do visitors understand that species such as Reticulated Python (*Python reticulatus*) or Philippine Crocodile (*Crocodylus mindorensis*) are fairly inactive for a good part of the day and, as a consequence, are visitor expectations of activity already lower to begin with? Or, conversely, do visitors have high expectations of activity from species, such as Chimpanzees (*Pan troglodytes*) or other primates? And if activity levels did not match these expectations, would visitor interest decreased more rapidly?

In relation to zoo management, could visitor interest be increased by managing species in a different way to encourage activity levels to increase? There may be some welfare implications to this as it would be inappropriate to promote activity beyond what is normal for a species, but there could well be some scope for incorporating certain feeding and/or enrichment techniques into husbandry practices to assist in increasing activity levels, which could be beneficial to both species and visitor alike. This might prove particularly useful for those species (as mentioned above) that perhaps have an interesting educational story but are not themselves normally immediately attractive or interesting to visitors—Bird species may especially benefit here. If activity levels in these species could be increased at a time when visitors are likely to view them and then combined with an intensive educational intervention (interpretation, public talk, etc), then the educational role of a species within a collection (even if it is not normally popular) could be more appropriately evidenced.

CONCLUSIONS

Taxonomic group (specifically mammals), activity level, body size (length), and whether a species is a flagship or integral species or not were all shown to be significant predictors of visitor interest (measured by visitor holding time). Even when mammals were excluded, the analysis still showed significant differences between the taxonomic groupings with birds being least interesting to visitors. Increased body size (length) significantly increased visitor interest, which supported some previous studies [Ward et al., 1998; Bitgood et al., 1988] but not others [Balmford et al., 1996]. Similarly, increasing animal activity levels also increased visitor interest; flagship species were more popular with visitors than integral species. It is recommended that species brought into animal collections primarily for their perceived educational value should be carefully selected based on their relative popularity with visitors.

REFERENCE SOURCES FOR DESCRIPTIVE SPECIES DATA

Texts: Grzimek B, Schlager N, Olendorf D, McDade MC. 2004. Grzimek's animal life encyclopedia. Detroit.: Thomson Gale. 17 v.

Websites: http://amphibiaweb.org/search/index.html, http://www.birdlife.org/datazone/index.html, http://www.fishbase.org, www.isis.org, and http://www.iucnredlist.org/

REFERENCES

Ballantyne R, Packer J. 2005. Promoting environmentally sustainable attitudes and behaviour through free choice learning experiences: what is the state of the game? Environ Educ Res 11:281–295.

Ballantyne R, Packer J, Hughes K, Dierking L. 2007. Conservation learning in wildlife tourism settings: lessons from research in zoos and aquariums. Environ Educ Res 13:367–383.

Balling JD, Falk JH. 1980. A perspective on field trips: environmental effects on learning. Curator 23:229–240.
Balmford A, Mace GM, Leader-Williams N. 1996. Designing the ark: setting priorities for captive breeding. Conserv Biol 10:719–727.
Balmford A, Leader-Williams N, Mace GM, Manica A, Walter O, West C, et al. 2007. Message received? Quantifying the impact of informal conservation education on adults visiting UK zoos. In: Zimmermann A, Hatchwell M, Dickie L, West C, editors. Zoos in the 21st century: catalysts for conservation? Cambridge: Cambridge University Press.
BIAZA. 2007. BIAZA Guidance on Institutional Collection Planning. Available at http://www.biaza.org.uk/resources/library/images/icpmarch07.pdf.
Bitgood S, Patterson D, Benefield A. 1988. Exhibit design and visitor behavior: empirical relationships. Environ Behav 20:474–491.
Borun M. 1996. Families are learning in science museums. Curator 39:123–138.
Briseno-Garzon A, Anderson D, Anderson A. 2007. Entry and emergent agendas of adults visiting an aquarium in family groups. Visitor Studies 10:73–89.
Clayton S, Fraser J, Saunders CD. 2009. Zoo experiences: conversations, connections, and concern for animals. Zoo Biol 28(5):377–397.
Conway W. 2003. The role of zoos in the 21st century. Int Zoo Yearbook 38:7–13.
Conway WG. 1986. The practical difficulties and financial implications of endangered species breeding programmes. Int Zoo Yearbook 24: 210–219.
DEFRA. 2004. Secretary of State's Standards of Modern Zoo Practice. Available at http://www.defra.gov.uk/wildlife-countryside/protection/zoo/standards.htm.
Doering ZD, Pekarik AJ. 1997. Why time is not quality. Curator 40:249–252.
Falk JH. 2005. Free-choice environmental learning: framing the discussion. Environ Educ Res 11:265–280.
Falk JH, Adelman LM. 2003. Investigating the impact of prior knowledge and interest on aquarium visitor learning. J Res Sci Teaching 40: 163–176.
Falk JH, Moussouri T, Coulson D. 1998. The effect of visitors' agendas on museum learning. Curator 41:106–120.
Falk JH, Reinhard EM, Vernon CL, Bronnenkant K, Deans NL, Heimlich JE. 2007. Why zoos and aquariums matter: assessing the impact of a visit to a zoo or aquarium. Silver Spring, MD: American Association of Zoos & Aquariums.
Falk JH, Heimlich JE, Bronnenkant K. 2008. Using identity-related visit motivations as a tool for understanding adult zoo and aquarium visitors meaning making. Curator 51:55–79.
Hooper-Greenhill E, Moussouri T. 2000. Researching learning in museums and galleries 1990–1999: a bibliographic review. Leicester, UK: Research Centre for Museums and Galleries, University of Leicester, UK.
Hosey G, Melfi V, Pankhurst S. 2009. Zoo animals: behaviour, management and welfare. Oxford: Oxford University Press.
Hutchins M, Smith B. 2003. Characteristics of a world-class zoo or aquarium in the 21st century. Int Zoo Yearbook 38(1):130–141.
Hyson J. 2004. Education, entertainment, and institutional identity at the zoo. Curator 47: 247–251.
Jamieson D. 1985. Against zoos. In: Singer P, editor. In defense of animals. New York: Basil Blackwell. p 108–117.
Johnston RJ. 1998. Exogenous factors and visitor behavior: a regression analysis of exhibit viewing time. Environ Behav 30:322–347.
Malamud R. 1998. Reading zoos: representations of animals and captivity: New York: University Press.
Mallinson JJC. 2003. A sustainable future for zoos and their role in wildlife conservation. Hum Dimensions Wildl 8:59–63.
Margodt K. 2000. The Welfare Ark: suggestions for a renewed policy for zoos. Brussels: Vub Brussels University Press.
Miller B, Conway W, Reading RP, Wemmer C, Wildt D, Kleiman D, et al. 2004. Evaluating the conservation mission of zoos, aquariums, botanical gardens, and natural history museums. Conserv Biol 18:86–93.
Moss A, Francis D, Esson M. 2007. The measurement of visitor density and its effect on visitor behaviour in zoo exhibits. BIAZA Res News 8: 2–3.
Moss A, Francis D, Esson M. 2008. The relationship between viewing area size and visitor behavior in an immersive Asian elephant exhibit. Visitor Studies 11:26–40.
Nakamichi M. 2007. Assessing the effects of new primate exhibits on zoo visitors' attitudes and perceptions by using three different assessment methods. Anthrozoos 20:155–165.
Packer J, Ballantyne R. 2002. Motivational factors and the visitor experience: a comparison of three sites. Curator 45:183–198.
Randler C, Baumgartner S, Eisele H, Kienzle W. 2007. Learning at workstations in the zoo: a controlled evaluation of cognitive and affective outcomes. Visitor Studies 10:205–216.
Raphling B, Serrell B. 1993. Capturing and measuring affective learning. Current Trends Audience Res Eval 7:57–62.
Reading RP, Miller BJ. 2007. Attitudes and attitude change among zoo visitors. In: Zimmermann A, Hatchwell M, Dickie L, West C, editors. Zoos in the 21st century: catalysts for conservation? Cambridge: Cambridge University Press.
Rennie LJ, Johnston DJ. 2004. The nature of learning and its implications for research on learning from museums. Sci Educ 88:4–16.

Ridgway S, Livingston M, Smith S. 2005. Visitor behavior in zoo exhibits with underwater viewing. Visitor Studies Today 8:1–9.

Ross S, Lucas K. 2005. Zoo visitor behavior at an African Ape exhibit. Visitor Studies Today 8:4–12.

Ross SR, Gillespie KL. 2009. Influences on visitor behavior at a modern immersive zoo exhibit. Zoo Biol 28:462–472.

RSPCA. 2006. Evaluation of the effectiveness of zoos in meeting conservation and education objectives. In: The Welfare State: Measuring Animal Welfare in the UK 2006. Horsham, West Sussex, UK: Royal Society for the Prevention of Cruelty to Animals. p 95–98.

Serrell B. 1998. Paying attention: visitors and museum exhibitions. Washington DC: American Association of Museums.

Shettel HH. 1997. Time—is it really of the essence? Curator 40:246–248.

Sommer R. 2008. Semantic profiles of zoos and their animals. Anthrozoos 21(3):237–244.

SPSS Inc., an IBM Company Headquarters, 233 S. Wacker Drive, 11th floor Chicago, Illinois 60606.

Storksdieck M, Ellenbogen K, Heimlich J. 2005. Changing minds? Reassessing outcomes in free choice environmental education. Environ Educ Res 11:353–369.

Swanagan JS. 2000. Factors influencing zoo visitors conservation attitudes and behavior. Journal of Environmental Education 31:26–31.

Tribe A, Booth R. 2003. Assessing the role of zoos in wildlife conservation. Hum Dimensions Wildl 8:65–74.

Tunnicliffe SD. 1996. The relationship between pupils' age and the content of conversations generated at three types of animal exhibits. Res Sci Educ 26(4):461–480.

Turley SK. 1999. Exploring the future of the traditional UK zoo. J Vacation Marketing 5:340–355.

Turley SK. 2001. Children and the demand for recreational experiences: the case of zoos. Leisure Studies 20:1–18.

Ward PI, Mosberger N, Kistler C, Fischer O. 1998. The relationship between popularity and body size in zoo animals. Conserv Biol 12:1408–1411.

WAZA. 2005. The World Zoo and Aquarium Conservation Strategy: building a future for wildlife. Berne, Switzerland: World Association of Zoos and Aquariums.

Yalowitz SS, Bronnenkant K. 2009. Timing and tracking: unlocking visitor behavior. Visitor Studies 12:47–64.

Zwinkels J, Oudegeest T, Laterveer M. 2009. Using visitor observation to evaluate exhibits at the Rotterdam zoo aquarium. Visitor Studies 12:65–77.