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Investigating Visitor Activity on a Safari Drive

Matthew Lloyd, Naomi Davies Walsh and Bridget Johnson *

Knowsley Safari, Prescot L34 4AN, UK; mLloyd@bristolzoo.org.uk (M.L.); n.davies@knowsley.com (N.D.W.)
* Correspondence: b.johnson@knowsley.com

Abstract: Despite increasing studies focusing on the visitor experience in zoological collections, minimal attention has been paid to visitor activity when driving through safari parks. The dwell time of visitors at exhibits within a traditional zoo setting has offered a good method to measure exhibit and species popularity, but studying visitors on a safari drive offers a unique set of challenges, with factors such as road length skewing a basic dwell time measurement. Therefore, the current study proposes that average speed offers a robust means to investigate visitor activity on a safari drive. Average speed was found to be significantly different depending on species exhibited, with primates and felids eliciting slower speeds and bovids and cervids faster speeds. This result broadly mirrors that of traditional zoo studies where primates elicit longer dwell times. Future safari drive studies could help inform decisions made on a safari drive for aspects such a collection planning, drive layout and exhibit design. Harnessing tracking technology, e.g., GPS, alongside more diverse methodologies, such as questionnaires and multi-institutional approaches, would further allow more robust conclusions to be drawn.

Keywords: visitor experience; safari drive; zoo; drive-through

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1. Introduction

Visitors are an integral component of the functioning of zoological collections. As such, their importance has led to an area of research entirely devoted to the understanding of the "visitor–zoo" relationship. Visitors are motivated to come to collections for a variety of reasons, such as recreation, entertainment, bonding time with friends and family and for educational experiences [1–3].

Modern zoological collections (e.g., zoos, safari parks and aquariums) have four main roles: in and ex situ conservation, education, research and recreation [4]. Many collections have developed robust collection plans where the species they exhibit fulfil specific roles that reflect the role of the modern zoo, and may include adding educational value, promoting conservation breeding or facilitating research. At a wider regional level, the European Association of Zoos and Aquariums (EAZA) has developed dynamic Regional Collection Plans (RCPs) [5] to help ensure species housed across the entire region have defined regional roles and can be sustainably managed. Although a huge element of the legacy of zoological collections [6], the present reality of the value of entertainment and recreation cannot be overlooked [5]. Public interest is known to have an influence on the choice of species found within collections, and this appears to have resulted in many collections housing large charismatic mega-fauna, particularly mammals, to achieve higher visitor numbers [7,8].

Visitor experience in zoological collections is a developing research field and has recently been defined as "the overall, collective experience of visitors, which encompasses individual visitors' experiences and their perceptions, attitudes and behaviors towards the captive animals, enclosures, displays, signage, interactive programs, encounters, and conversations that they have while onsite" [9]. There have been numerous studies investigating the contributing factors to visitor perceptions of their visit to a zoological collection, with a recent review providing a comprehensive overview of all factors [9]. Most pertinent to our study, the relative popularity of different species is often influenced by taxonomic group. Zoo visitors have been shown to express a greater interest in larger species and are more likely to watch mammals in preference to other taxa [2,10,11]. Species visibility, proximity, behaviour and activity levels also appear to play a role in influencing visitors [10,12–14]. Enclosure design is also known to play an important role in how visitors connect with their experience [15].

Study methods applied in traditional zoo settings differ across the literature and include tracking visitors, recording dwell time or number of people at a given exhibit, categorising dwell time and combining proportion of visitors with dwell time [2,10–12], with novel methodologies such as monitoring online activity post zoo visit developing constantly [16]. Surveys are also frequently deployed directly to zoo visitors [17–19].

In contrast, research into visitor activity within drive exhibits of safari parks has been limited, although it has been noted that “type of collection”—i.e., zoo or safari park —is an important consideration for studies relating to species popularity [11]. A safari park is defined as “a large park where wild animals are kept and can move freely and can be watched by visitors driving through in their cars” [20]. While many safari parks have walk-around areas similar to traditional zoos, drive-through reserve exhibits are a defining feature, and within this specific area, visitor behaviour remains an understudied subject. Safari drive exhibits can be broadly split into two categories: the drive-through, where animals are free to roam amongst visitor vehicles, and the drive-past, where animals are behind a fence along a length of road.

Studying visitor activity on a safari drive offers a unique set of challenges, meaning the methods used in other zoo studies are not suitable. As visitors are required to follow a set route along a road through a safari park, tracking visitors is not suitable, as the element of free choice is removed and visitors will encounter every exhibit on their journey. Exhibits are generally large expanses of land with no defined stopping or viewing areas, meaning choosing a single location for observation is impractical. Exhibits are also of different sizes and have different lengths of road running through them, meaning visitor dwell time along or through an exhibit will not give an accurate indication of visitor interest, skewing interest in favour of exhibits with longer road sections.

We therefore aim to venture into the monitoring of visitor activity within drive exhibits of a safari park. In addition to developing novel methodologies to monitor visitor activity, we try to identify traits and features that impact visitor activity. Specifically, we look to answer the following research questions:

- Can the average speed of visitor vehicles be used to investigate visitor activity on a safari drive?
- Does average speed differ between exhibits on a safari drive?
- Can average speed be used to determine exhibit (and therefore species) popularity?
- What is the impact of different species traits and exhibit features on the average speed of cars on a safari drive?
- Are species traits comparable to findings made in traditional zoo studies?

2. Materials and Methods

2.1. Study Site

Data for the study were collected at Knowsley Safari. Knowsley Safari is split into two parts, the foot safari, and the drive safari where the study was conducted. The entire drive safari is five miles in length and split into seven large zones, within which six exhibits were designated for this study (Figure 1). Only exhibits with a looping road with the same entry and exit or a short enough road for entry and exit to be seen from one point were included in the study. Data were collected from October 2020 to May 2021 between 10:00 a.m. and 12:00 p.m. Data were only collected on low traffic days(weekdays outside of school and public holidays) to ensure volume of traffic did not affect visitor activity.

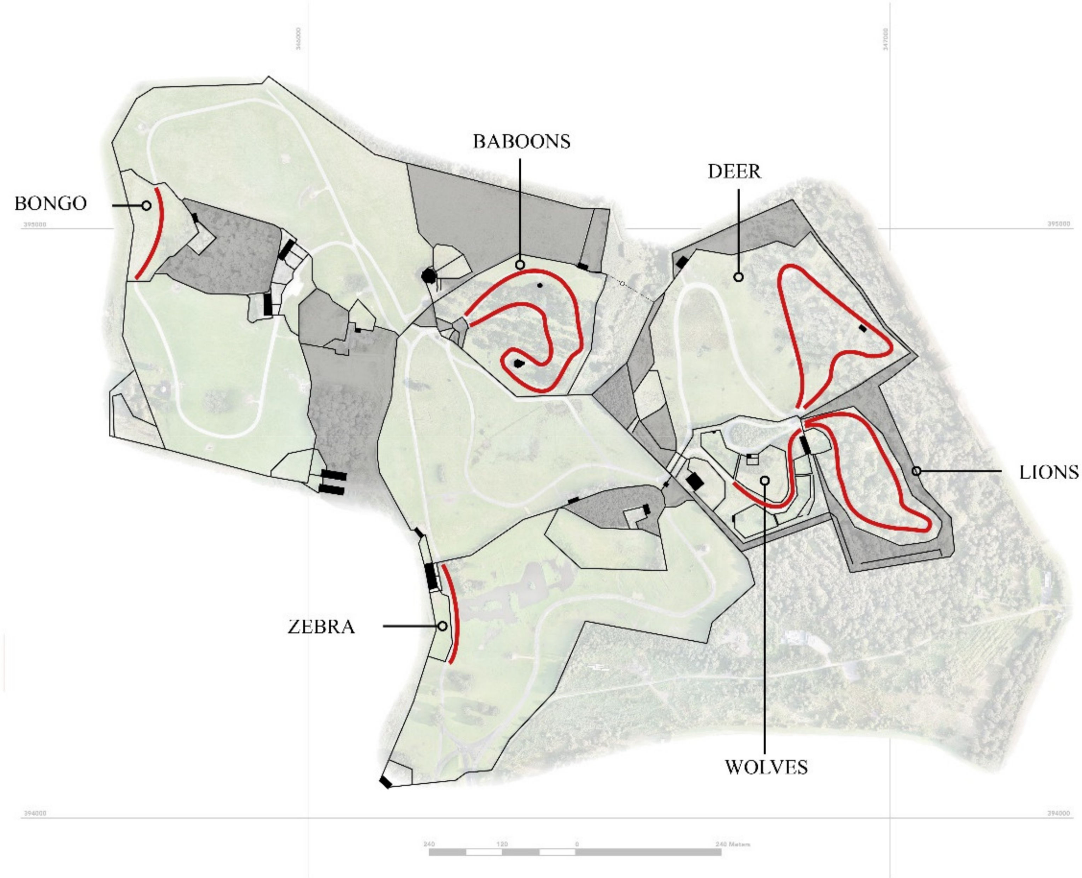

Figure 1. Map of safari drive at Knowsley Safari. Exhibits featured in the present study are annotated, and specific sections of road are marked in red.

2.2. Data Collection

One exhibit was studied at a time, cycling through a rota to ensure each exhibit was studied with the same frequency. Exhibits were chosen based on the species within them representing a wide diversity of mammal taxa (Equidae, Bovidae, Primate, Cervidae, Felidae and Canidae) and a mix of drive-through and drive-past. Species traits and exhibit features are defined in Table 1 and were recorded for each exhibit on one occasion at the start of the study (Table 2).

Table 1. Definitions of species traits and exhibit features explored in analysis.

Species Trait/ Exhibit Feature	Category	Definition
Visibility of species	Visible	Any one individual of species held in exhibit was visible to car at time of car passing.
	Invisible	No individuals of species held in exhibit were visible to car at time of car passing.
Exhibit type	Past	Animals are enclosed behind a fence along a road.
	Through	Animals are free to roam along a road.
Road length (m)	Continuous	Length of road in m as measured using Google Maps.
Species status	Flagship	The focal species of a particular safari zone/exhibit.
	Integral	A supportive species housed within or near a focal species zone/exhibit [2].
Species size (kg)	Continuous	Upper limit of male weight range [21–23].
Species activity level	Low	When visible, the species is inactive and/or displays a variety of inactive behaviours (e.g., sleep, sitting).
	High	When visible, the species is active and/or displays a variety of active behaviours (e.g., play, locomotion).

Table 2. Species traits and exhibit features recorded at the start of the study, as defined in Table 1.

Exhibit	Exhibit Type	Road Length (m)	Exhibit Species	Species Status	Species Size (kg)	Species Activity Level
Zebra	Past	112	Grévy's zebra (*Equus grevyi*) (2.0.0)	Flagship	450	High
Bongo	Through	175	Eastern bongo (*Tragelaphus eurycerus*) (2.0.0)	Integral	400	Low
Baboons	Through	845	Olive baboon (*Papio anubis*) (0.0.230)	Flagship	30	High
Deer	Through	714	Fallow deer (*Dama dama*) (0.0.56)	Integral	80	Low
Lions	Through	642	African lion (*Panthera leo*) (2.4)	Flagship	225	Low
Wolves	Past	272	Iberian wolf (*Canis lupus signatus*) (4.2.0)	Integral	62	High

Within the exhibit, one focal vehicle was studied at a time. The focal vehicle was the first vehicle to cross the threshold of the exhibit upon commencement of data collection. The time (mm:ss) the focal vehicle crossed the threshold of the exhibit (entry and exit) was recorded with a stopwatch. The last three characters of the focal vehicle registration plate were recorded as an anonymous means of identifying each individual vehicle on entry and exit. It was also noted whether the species in the exhibit were visible or not. Once the focal vehicle had exited the exhibit, the process was repeated for a new focal vehicle.

Data Analysis

The average speed of each focal vehicle was calculated using the following method. The duration of time (DT) each focal vehicle spent in an exhibit was calculated as follows:

$$\text{exit time (mm:ss)} - \text{entrance time (mm:ss)} = \text{DT (mm:ss)}.$$

DT was then converted into seconds (DTS)

$$((\text{DTmm} \times 60) + \text{DTss}) = \text{DTS}.$$

Finally, average speed (mph) was then calculated:

$$2.23 \times (\text{road length (m)}/(\text{DTS})) = \text{average speed (miles per hour (mph))}.$$

Analyses were carried out using the software R, version 4.1.0 (R Core Team, Vienna, Austria) [24]. We used a full-model approach throughout. Model fit and assumptions were verified by plotting residuals versus fitted values with the package "DHARMa" [25]. We determined the significance of the fixed effects using likelihood ratio tests. We fitted full and restricted models (models in which the parameter of interest, the fixed effect, are withheld, i.e., fixed to 0) and based test statistics on comparisons of the full model with the restricted models. A chi-squared distribution with the appropriate degrees of freedom was used to calculate the significance of the likelihood of the ratio test statistic. Post hoc tests were carried out using Tukey's HSD (honestly significant difference) tests, with the package "emmeans" [26]. Pseudo R-squared values were calculated following Nakagawa and Schielzeth [27] using the "sjstats" package [28]. All continuous predictor variables were z-transformed prior to analysis, and all statistical tests were two-tailed with α set to 0.05.

To determine if the average speed of focal visitor vehicles (mph) on a safari drive is affected by exhibit type, we fit a linear model, using the "lme4" package [29]. We log transformed the response variable (mph) to reduce the skew of the original data and specified exhibit (Table 2) as the fixed effect predictor.

To model the effect of species traits and exhibit features on the average speed (mph) of focal vehicles, we fit a linear mixed model (LMM), using the "lme4" package [29]. We log transformed the response variable (mph) and specified status, exhibit type, activity, length and size as fixed effect predictors (Table 2). To incorporate the dependency among observations of the same exhibits, we included exhibit as a random intercept. The final model run was log (Average Speed of Focal Vehicle) ~ Species Status + Visibility + Exhibit Type + Species Activity Level + Road Length + Species Size + (1 | Exhibit). A final model incorporating analysis of interaction between traits and features, e.g., visibility*status, was also trialled. No significant interactions between variables were identified and so they were not included in the model.

3. Results

In total, 625 focal vehicles were observed throughout the six exhibits. In each exhibit, 100 focal vehicles were observed apart from lions, in which 125 were observed.

3.1. Exhibit

The average speed (mph) of focal vehicles differed significantly by exhibit type (likelihood ratio test (LRT); $\chi 2(5) = 145.1$, $p < 0.001$, Figure 2). Post hoc testing revealed that except for the bongo/deer (Tukey HSD; $p = 0.505$) and lions/zebra (Tukey HSD; $p = 0.747$) comparisons, average speed differed significantly between all other exhibit types ($p > 0.0001$ in all cases except bongo/wolves where $p < 0.004$).

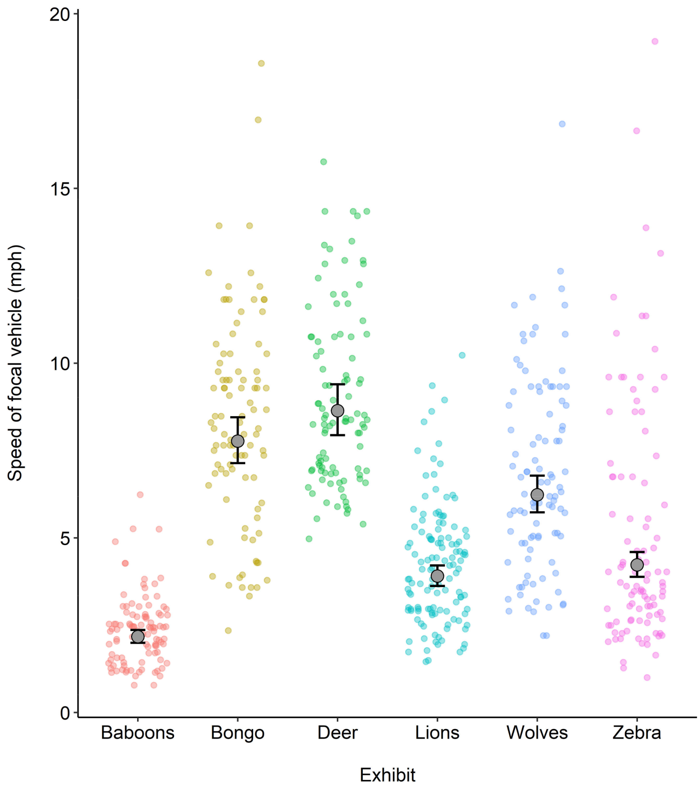

Figure 2. Average speed of focal vehicle across six exhibits on the drive at Knowsley Safari. All comparisons barring bongo/deer and lions/zebra are significant.

3.2. *Species Traits and Exhibit Features*

The r^2 value for the model was 0.553. The output from the model indicated a significant effect of all species traits and exhibit features on average speed of focal vehicle (likelihood ratio test (LRT; species status $\chi^2(1) = 60.674$, $p < 0.001$; visibility of species $\chi^2(1) = 25.464$, $p < 0.001$; exhibit type $\chi^2(1) = 50.268$, $p < 0.001$; activity level of species $\chi^2(1) = 24.263$, $p < 0.001$; road length $\chi^2(1) = 20.252$, $p < 0.001$; species size $\chi^2(1) = 16.897$, $p < 0.001$). See Table S1 for full model output. Speed was higher in exhibits that housed integral species, in species with low activity level and species of a larger size. Speed was higher when species were invisible to visitors, when visitors drove past enclosures and when the road length was longer (Figure 3).

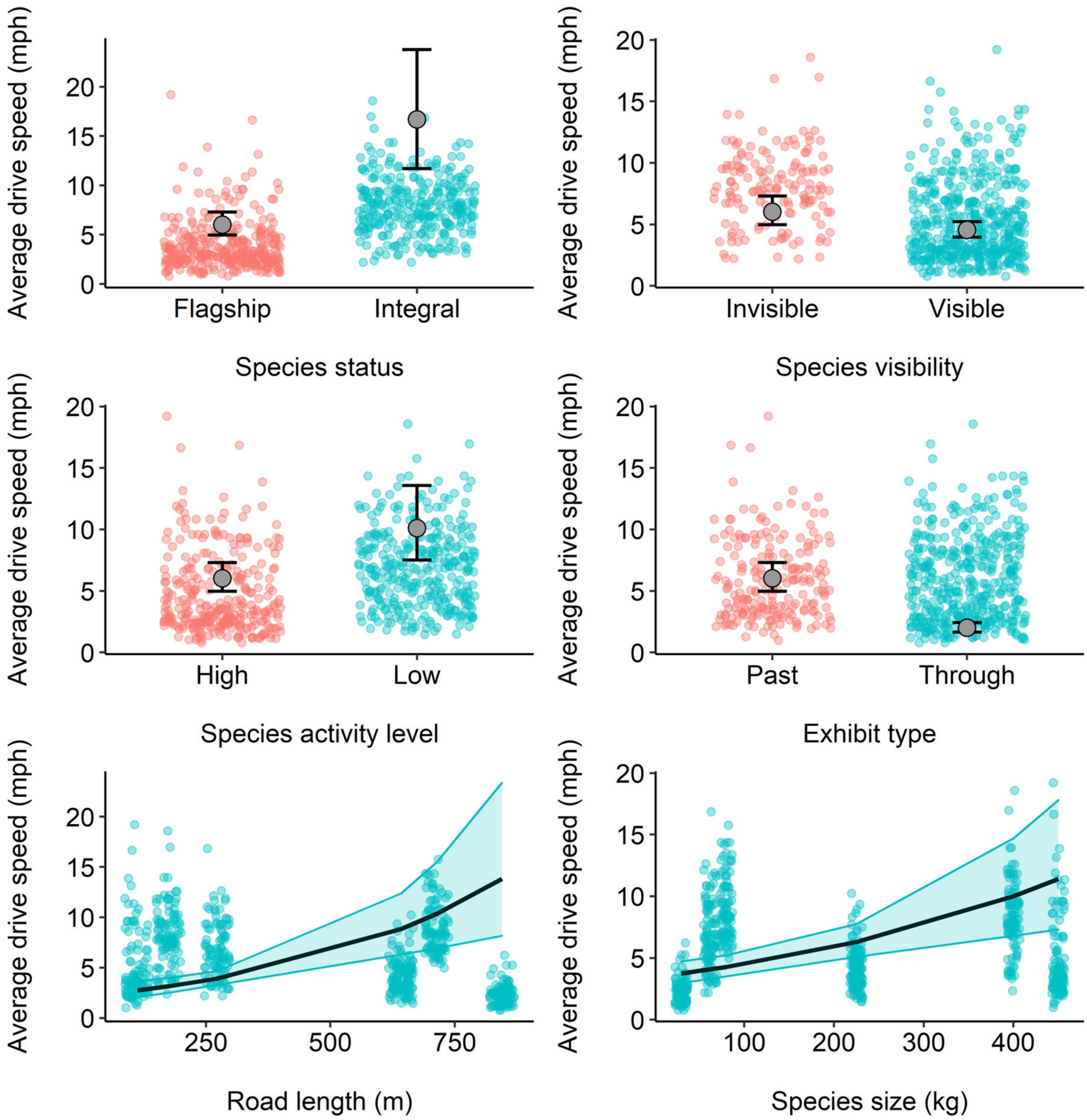

Figure 3. The effect of species traits and exhibit features on the average speed of focal vehicles (mph).

4. Discussion

We determined that it is possible to calculate the average speed of visitor vehicles through an exhibit by recording entry and exit times alongside road length. Therefore, for the first time, this research utilised average speed to explore the activity of visitors on a safari drive.

Average speed differed between exhibits. All bar one of the exhibits held only one species. The deer exhibit also held one Eurasian elk (*Alces alces*) and five European bison (*Bison bonasus*), but they were discounted from the study as a result of their enclosure use and management. It is therefore proposed that species present in the exhibit was one of the factors behind the speed differences observed. In regular road driving, slower driving speeds are associated with driver distractions [30]. If the species housed in an exhibit is treated as the "distraction" in the present study, then it can be implied that slower speeds are related to more attention being paid to the species than driving. This means that exhibits that stimulated slower average speeds held more popular species, and average speed is indicative of species popularity. Working with this hypothesis, olive baboon would be the most popular species, followed by African lion, Grévy's zebra, Iberian wolf, and Eastern bongo, with fallow deer having joint bottom place. This finding is relatively reflective of results in a species popularity ranking study where results relevant to this study ranked with primates in the top four positions, followed by zebra (6th), dogs and relatives (12th), big cats (13th), cervids (15th) and bovids (18th) [11]. The lower ranking of big cats in the previous work compared to their ranking of second place in the present study is a notable difference.

In addition to being consistent with the findings of many other studies that identify primates as popular species in zoological collections [2,11], there are species traits and exhibit features, identified in the present study as resulting in slower average speeds, that are true for the baboon exhibit. Baboons are a flagship species with high activity levels. These traits and features appear to override usual tendency for long roads to equate to higher speeds, as baboons have the longest road in the exhibit but the slowest average speed. There are also features that although not quantifiably examined in this study, may have contributed to the slow average speeds observed in baboons. The troop breed regularly, and there are always infants for visitors to see. Presence of infants is known to be a factor in increasing visitor interest [31]. Furthermore, it is known that the emotional response of visitors varies widely between taxonomic groups [32], with primates being more likely to elicit positive emotional responses because of their close similarities to humans [33]. This "closer connection" visitors have with primates further supports the popularity of this exhibit and species. In comparison with all other drive-through exhibits investigated, the baboon exhibit offers a unique and immersive experience. It has been noted that there are differences between immersive and more traditional second-generation zoo exhibits within wider zoo research [34]. Whilst in other exhibits, species may get close to cars, they do not interact with them. In the baboon exhibit, the species regularly jump, play and climb on visitor cars. This high and unique activity level and visibility may have artificially reduced the average speed, and the true average speed for this exhibit could be higher. However, given that primates appear to be the most popular mammal taxa in traditional zoos, it appears likely that the popularity of the species housed in the exhibit is a significant contributing factor to the slow speeds observed.

The lion exhibit taking the second slowest average speed is also generally reflective of previous work identifying them as popular species [35,36], although there have been occasions of big cats ranking lower than the present study would suggest [11]. The slow average speeds through the lion exhibit suggest that the flagship status of the species overrode the low activity levels and long road lengths that this study associates with higher speeds. Slow speeds are also related to the drive-through experience offered by lions.

Zebra and wolves regularly appear to rank in the middle region of the various studies looking into zoo species popularity in terms of charisma, adoption number and appealing traits and characteristics, and these results largely represent the findings of the current study [1,35,36]. Zebra and wolves are the only drive-past exhibits featured in this study, a feature we associate with slower speeds. Particularly for the zebra, this may have overridden the flagship nature of the species and exacerbated the high speeds associated with exhibits featuring integral species such as wolves. The drive-past element may also have resulted in their high activity levels not resulting in the slower speeds suggested by the model.

The fastest average speeds observed in the bongo and deer exhibits suggest that the species held in these exhibits were the least popular with visitors. This may be a result of cervids and bovids being integral species, displaying less traits and characteristics that visitors find appealing when compared with the other species presented in this study [11]. Similar findings are presented in studies of these species within a zoo setting [11,35,36]. Although both exhibits are drive-through, which is a feature associated with slower speeds, the integral status of both these species appears to have resulted in slower speeds.

The visibility of species in an exhibit had a significant impact on average speed, with exhibits with species not visible to visitors being moved through, or along, more quickly than when exhibit residents were visible. This reflects previous work in traditional enclosures at zoological collections that discussed the risk of reduction in visibility in turn reducing the attractiveness of an exhibit for visitors [37].

Significant differences in average speed were identified between exhibits holding species of different body sizes, with a bigger body size being associated with a higher speed. This is in contrast with previous studies in which it was noted that an increased size increases visitor interest [2,10,12]. However, there is a fundamental difference between the study sites where increased size was a significant factor and the present study site. Within a traditional zoo, visitors have access to a wider range of species in terms of body size. For instance, within previous studies, incorporated species ranged in size from leaf cutter ants to Asian elephants [2]. It is not possible to incorporate this range of body sizes into a safari drive study, as these institutions predominantly only exhibit large mammals and ratites, and, therefore, the smaller diversity in body sizes may have limited the value of the inclusion of this factor.

Study Limitations and Future Work

The present study was limited to exhibits that had a looping road with the same entry and exit or a short enough road for entry and exit to be seen from one point, as only one individual was available to collect data. Two observers in radio contact, one at the start of an exhibit road and one at the end, would have permitted the inclusion of a more diverse range of exhibits. Harnessing technology, e.g., Bluetooth, GPS trackers and remote sensing, would allow more accurate and diverse visitor tracking opportunities [38,39]. The methodology of the present study also means it is impossible to understand the true motivations behind the speed of visitor vehicles. If the observational data had been coupled with a questionnaire to determine most popular exhibits, species and factors contributing to these choices in the opinion of the visitors, more robust conclusions could have been drawn. This would also enable demographic information to be recorded in order to determine whether visitor activity varies between different groups of visitors.

Multi-institutional studies would hugely benefit this area of research, although the methodology would need further development to be appropriate for assessing the popularity of species when there is more than one species from a diverse range of taxa in one exhibit. Not only would this enable more robust conclusions to be drawn, but studies involving other institutions would also allow the incorporation of more taxa.

Supplementary Materials: The following are available online at https://www.mdpi.com/article/10.3390/jzbg2040041/s1, Table S1. Full output from linear mixed model to determine the effect of species traits and exhibit features on the average speed of focal vehicles (mph).

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editing, B.J. and N.D.W.; visualization, B.J. All authors have read and agreed to the published version of the manuscript.

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Informed Consent Statement: Consent was waived due to no personal or identifiable information about the visitors being recorded and observational nature of the study.

Data Availability Statement: Data are available upon reasonable request from the corresponding author.

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