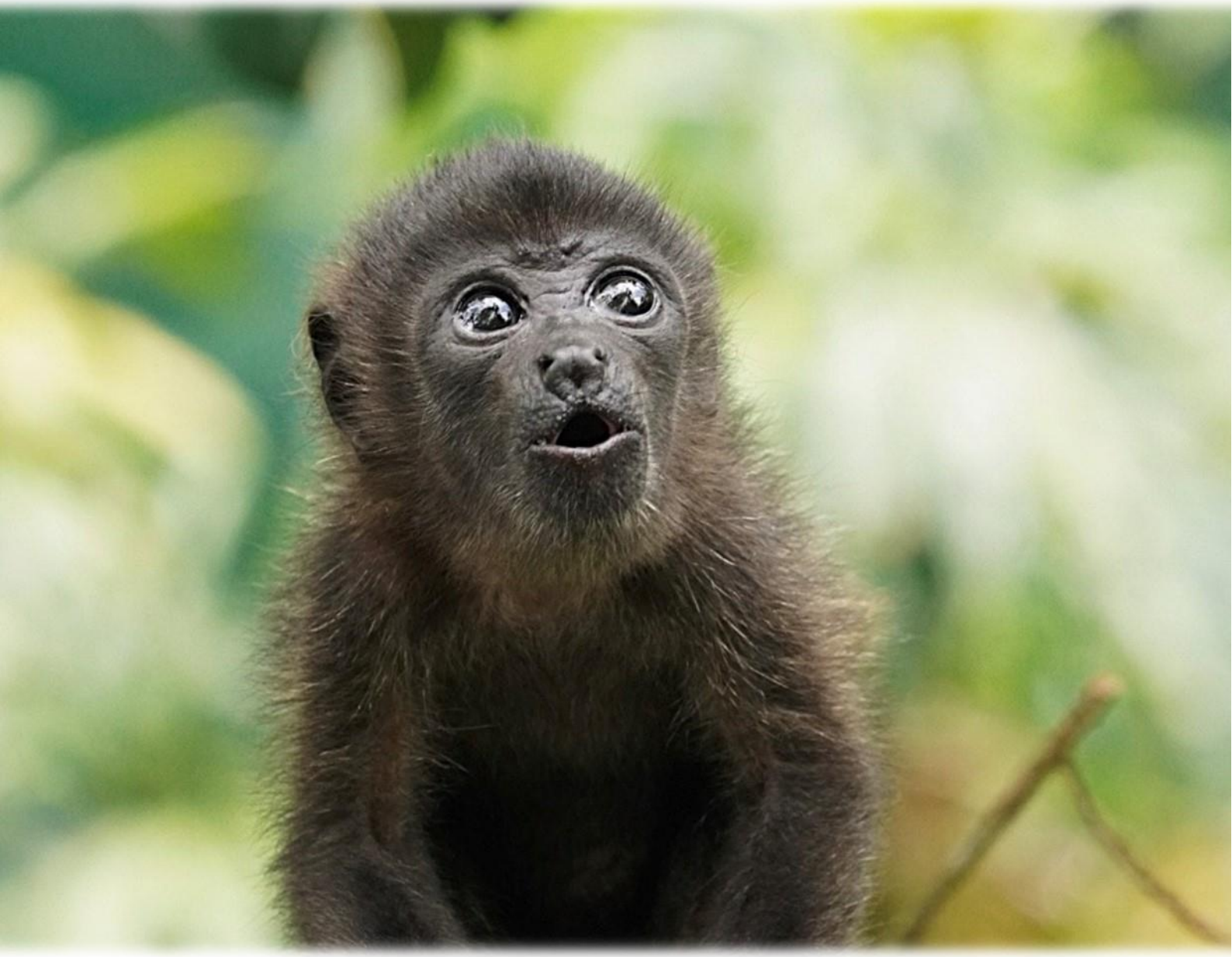
Journal of the MSc in Primate Conservation

Canopy

Volume 25
Issue 2
Spring 2025



OXFORD BROOKES UNIVERSITY

Canopy
Journal of the Primate Conservation
MSc and MRes Programmes
Oxford Brookes University

ISSN
2054-2070

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Front Cover
Infant howler monkey (*Alouatta paliatta*) in Costa Rica

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Letter from the Editors

Welcome to the Spring 2025 edition of Canopy, Oxford Brookes University's journal dedicated to showcasing the passion and expertise of our MSc and MRes Primate Conservation students.

This issue explores the complexities and challenges of primate welfare in captivity, with a particular focus on improving their well-being. While natural habitats remain the ideal environment for these intelligent and social animals, the reality is that many are held in captive settings, whether for conservation, research, or educational purposes. Captivity can have significant impacts on the physical and psychological health of primates, especially when their environmental needs are unmet. However, through innovative approaches to environmental enrichment, research, and behavioural management, we can mitigate the effects of captivity and enhance the lives of primates who cannot live in the wild.

The articles in this issue, drawn from the work of past students, explore various facets of primate welfare — from cognitive and physical enrichment to understanding the social dynamics within captive groups. This research underscores the need for continued efforts to improve captive environments in ways that respect primates' complex needs and promote natural behaviours.

We extend our sincere gratitude to the dedicated researchers, staff, and mentors at Oxford Brookes University for their ongoing commitment to educating and inspiring the next generation of primatologists. As we explore these critical topics, we are reminded that improving captive welfare, while essential, must always be viewed in the context of the broader goal: ensuring that primates thrive in their natural habitats. While captivity is not ideal, studying primates in these environments can provide valuable insights that help us better understand their needs and improve efforts to protect them in the wild.

We hope this issue encourages reflection on how we, as primatologists, can advocate for improved welfare, with the ultimate goal of ensuring a future where primates thrive in the wild.

Warmly,

Tesa, Louisa, Mia and Hannah

Letter from the Module Leader

Welcome to another issue of Canopy, the official journal of the MSc in Primate Conservation and the MRes in Primatology and Conservation. In fact, this is issue 2 of volume 25, and with mostly one volume being produced a year it means we started Canopy 22 years ago, in the third year the MSc in Primate Conservation was running. In the first years Canopy was a print version only journal, but now it has an online presence as well, and even its own ISSN (that is International Standard Serial Number, an 8-digit code used to identify newspapers, journals, magazines and periodicals both in print and electronic).

This issue comprises of articles written by former students of the MSc and the MRes, and is typically based on their final research project or, less common, research conducted as part of one of the taught modules students have to take. The focus of this issue is primate welfare in captivity, and issue very close to my heart. Over the years I have joined students to numerous zoos and primate sanctuaries in the UK (Twycross Zoo, Shaldon Zoo, Cotswold Wildlife Park, Monkey World, Howlett's Zoo) and indeed elsewhere in Europe (Apenheul in the Netherlands), and seeing first-hand how primates are kept and how their welfare is maintained in the zoos is an important aspect of the learning experience. In my own research, often conducted with MSc, MRes or PhD students, we have also assessed the welfare of primates (and indeed other animals) in zoos. While the zoos we visit with the students here in the UK have high welfare standards, many of the zoos we have surveyed throughout Asia are lacking behind in this respect. Recently, with alumni of the MSc in Primate Conservation, we assessed 255 zoos in Southeast Asia and found that no less than 225 offered animal-visitor interactions (e.g., feeding gibbons, selfies with macaques, or tea with orangutans) (Fourage et al. 2024, *Animals* 14(22):3167). Far from ideal from a primate welfare perspective.

The articles that have been included for this issue show a few important aspects. 1. Primate welfare affects all taxa, and here we included studies on for example pottos (Kizito), gibbons (Mrozowski) and chimpanzees (O'Brien & Stitt). 2. Students studied primate welfare in zoos and in rescue centres, in countries without native primates (UK and Spain) and in primate range countries (Zambia, Spain, Thailand). 3. The methods and aspects that one can focus on varies from behavioural assessments during the formation of new social groups, observations of both the primates and the public at zoo enclosures and how the public affects primate welfare, social network analysis, and assessments of captive diets and comparing it with what has been observed in the wild.

Finally, as also stated in in the previous letter and alluded to in the opening sentences of this letter, we are entering our 25th year of the MSc in Primate Conservation (and our 9th year of the MRes in Primatology and Conservation), and this is both cause for celebration and reflection. We strive to bring as many of the current and past students together as part of this milestone, and ideally of course, share this with prospective students and future generations of primate conservationists. The best way to follow us is through our social media – TikTok, Instagram (@primate_conservation_obu) and Facebook (@PrimConsOBU).

Prof Vincent Nijman
Module leader, Primate Conservation

Behavioural adjustments during chimpanzee (*Pan troglodytes*) integration at Chimfunshi Wildlife Orphanage

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Cohort 2023-2024
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Chimpanzees (*Pan troglodytes*) are an important study species in conservation for both their ecological and cultural importance, but their populations are in continued decline due to anthropogenic activities. Chimpanzees face a myriad of threats from bushmeat hunting, the illegal pet trade, habitat destruction and degradation, disease and climate change (Humle *el al.,* 2016). These threats have created a need for sanctuaries to provide rehabilitation of rescued chimpanzees and potentially lifetime care when individuals cannot be reintroduced into the wild (Ghobrial *et al.,* 2010). These sanctuaries, such as Chimfunshi Wildlife Orphanage (hereafter Chimfunshi) in Zambia, offer opportunities not only for rehabilitation, but also for research into chimpanzee welfare and social dynamics in captive conditions. Chimpanzees are a highly social species, primarily living in multimale-multifemale fission-fusion groups where subgroups regularly break off temporarily (Goodall, 1986). In captivity, group composition is much more stagnant, with changes only resulting from individual births, deaths or management decisions, like integrations. As many of the individuals in sanctuaries have been rescued from devastating situations, individuals may have trauma or engage in stereotypical behaviours that impact their ability to socialize successfully (Ross & Leinwand, 2020). Many individuals rescued from the pet trade, such as those assessed in this study, were kept in isolation and had limited or no interactions with other chimpanzees in their earjuly years. Integrations are naturally stressful events, but successful integration is crucial for the long-term welfare of individuals living in captivity.

By tracking the proportions of time individuals and groups spend on certain activities, we gain insights into their physical and mental well-being (Inoue & Shimada, 2020). Behavioural studies using activity budgets are invaluable for understanding chimpanzee interactions and welfare in both periods of stability and of change (Inoue & Shimada, 2020). These methods can be used to monitor changes in behaviour, stress and social bonds during and after integration periods (Pascual *et al.,* 2023). Some abnormal behaviours, such as coprophagy, have been potentially linked to early isolation in captive chimpanzees (Cronin *et al.,* 2016). By examining affiliative behaviours such as grooming, which reinforces social bonds, alongside abnormal or stress-related behaviours that indicate welfare concerns, care managers can make informed

decisions about group dynamics (Fultz *et al*., 2023). This study explores the general behavioural and social adjustments observed in a group of chimpanzees during the integration of new individuals, providing insights into the challenges and dynamics of managing social groups and welfare in captive environments.

Chimfunshi houses over 150 chimpanzees, including both those who have been rescued and individuals born at the sanctuary. Non-invasive behavioural observations were conducted across three periods (before, during and six months after integration) using 10-minutes scans (Altmann, 1974). The study group, named the Sudan group, is composed of 11 individuals, eight residents who have been housed at Chimfunshi since 2018, and three new individuals who arrived in 2023. The group consists of five males and six females, ranging in age between 6-14 years old. Activity budgets were compared across time periods and individuals to assess how integration affects activity proportions and how we can use these measures to determine welfare. These activity budgets used categorized activity types (feeding, locomotion, stereotypy, etc.). Stereotypical behaviours and social behaviours were also analysed. The group-level data post-integration was compared to the wild activity budget set forth by Pruetz and McGrew (1997).

Across all periods, several shifts in activity proportion occurred, particularly with social interactions, resting and locomotion. Interactions increased on both the group and individual levels following the integration, suggesting the formation of new and increased bonds within the group. Overall, the group engaged in low levels of stereotypical behaviours, but almost all individuals engaged in some atypical behaviours. Several individuals, including some of the newly integrated individuals, showed increases in stereotypy six months after, highlighting the need for continued monitoring of this group. Increased affiliative behaviours, such as grooming and social resting indicated positive social bonds throughout the group (Fultz *et al.*, 2022).

The Sudan group and wild populations show several notable differences and some promising similarities in their daily activity proportions. In wild populations, foraging and feeding typically account for a significant portion of daily activity, with Pruetz and McGrew (1997) finding that wild chimpanzees spend around 27.5% of their day foraging and feeding. Feeding activities tend to be less frequent in captivity. The Sudan group spent only around 9.55% of their time on these activities, as they are provisioned with food several times a day. Locomotion between wild and captive groups was similar, with both spending around 6-8% of their time moving around. The large, naturalistic enclosures at

Chimfunshi likely encourage movement, as most of the group individuals patrol or explore their five acre enclosure throughout the day. Socializing tends to be more frequent in captivity. In the wild, chimpanzees balance their time between socializing and other activities like foraging and traveling, while in captivity, individuals have more time to dedicate to social interactions. This may explain why socializing behaviours were more frequent in the Sudan group compared to their wild counterparts. The nature of captive environments creates a setting where individuals are in unavoidable proximity for longer periods, potentially increasing the need for stable social bonds to maintain group cohesion (Goodall, 1986).

Variations in activity patterns can be expected for several reasons including seasonality, frequency of tourist visits, and, of course, changes in group composition (Pascual *et al.,* 2023). Variation is itself a good marker for welfare (Talbot *et al*., 2023). Following the integration, all individuals are engaging in meaningful social interactions with multiple other individuals, and the increase in social interactions indicates that the group has adapted relatively well. Most of the differences between wild populations and Sudan group are likely explained by the nature of captivity, and the similarities show that Sudan group is behaving in many ways that reflect what we would expect in the wild. One of the new individuals, Aime Love (female, age 6), shows highly similar activity proportions to the resident group members. She appears to be the most well-integrated from this data as well as day to day observations. The other two new individuals, Vicky (female, age 12) and Fidelou (male, age 6), show much more solitary rest than the rest of the group and have not yet joined the daily dispersals through the enclosure with the resident group members. Vicky and Fidelou may need more time and more environmental enrichment while they grow more confident in their new group and enclosure. Activity budgets, along with comparisons to wild populations, provide valuable insights into the welfare of captive chimpanzees by highlighting variations in how chimpanzees spend their time. This study highlights that while changes in behaviour during integration periods are normal, continuous monitoring is crucial to ensure that captive chimpanzees engage in species-specific behaviours at levels similar to their wild counterparts.

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Andalusian Zoos: Analysis of the captivity conditions of primates housed in ten different zoological centres in the South of Spain

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Cohort 2018-2019

Zoological centres in Europe have experienced substantial changes towards conservation efforts and appropriate husbandry and animal welfare standards (Directive 1999/22/CE, 1999; Hava García, 2011). The situation in Spain has likewise followed this path (Law 31/2003, 2003; Escoda Llorens *et al.,* 2013; Acosta Infante & Canós Darós, 2017), as well as Andalusia (Law 11/2003, 2003; Order 65/2012, 2012). This region is, as of today, the one that features the most zoos in the country. News on negligent zoos and animal abuse present in regional festivities raise concerns about the presence of an animal welfare consciousness. We have to consider that Spain's location makes it a bridge country for illegal wildlife trade going into Europe (OECD, 2016; van Uhm, 2016). Improving the presence of conservation education here is, therefore, of dire importance, especially in the zoos due to their role in this matter.

The reason for carrying out this project was precisely to highlight how welfare guidelines are being implemented in zoological centres in the area, what are the actual conditions of the zoos today, and how animal well-being is reflected in the zoos' aims and facilities. For those reasons, the main goal of this study was to determine the enclosure characteristics of

the primates at the zoos studied and how they fit with the established requirements for their facilities.

I visited ten Andalusian zoos: Zoo Cordoba (Cordoba), 7 days; Mundo Park and La Reserva del Castillo de las Guardas (Seville), 7 days; Zoo Botánico de Jerez and Zoo de Castellar (Cadiz), 17 days; Selwo Aventura Estepona, Selwo Marina and Bioparc Fuengirola (Malaga), 7 days; BioDomo at Ciudad de las Ciencias (Granada), 4 days, and Oasys Mini Hollywood (Almeria), 3 days.

In order to assess the welfare and captivity conditions of the primates housed there, I developed a template with a series of categories to be filled attending to the Five Freedoms established by the Farm Animal Welfare Committee or FAWC (FAWC, 2009; Mellor, 2015; Mellor & Beausoleil, 2015). Traditionally, this Five Freedoms model has been deemed inefficient due to its focus on what was missing in the animals' captive conditions rather than also considering the positive aspects of the animal's ability to adapt to captive settings (Botreau *et al*., 2007; Ohl & van der Staay, 2012; Fennell, 2013). The following definitions were elaborated to further understand and expand on the categories used and evaluated for the project:

• Hunger and thirst: diets. Presence of food and water. Foraging behaviours.

• Discomfort: description of inside enclosures.

• Pain, injury or disease: health status/situation of the individuals. Injuries, limping or other visible bad health conditions.

• Express normal behaviour: housed alone or not. Description of the outside enclosure.

• Fear and distress: hiding spaces available, visibility condition from visitors. Potential stereotypic, abnormal or repetitive behaviours.

The focus of this study was the assessment of the appropriateness of the outside enclosures of the primates housed at each zoo (Bracke & Hopster, 2006; Salas & Manteca, 2016). This was defined by their compliance with the enclosure requirements stipulated by the Andalusian Government (Order project, 2012 – Junta de Andalucía).

In Table 1, we can see the percentages of compliance assigned to each zoo on a species' enclosures' appropriateness basis. Since my focus here lies on the conditions in which the primates were housed regarding their enclosures' design, the zoos that displayed the lowest percentages of compliance to the freedoms from "discomfort", "to express normal behaviour" and "fear and distress" were, in order from lowest to highest score: Mundo Park (MP), Zoo de Castellar (ZdC), Zoo Botánico de Jerez (ZBJ), Selwo Aventura Estepona (SAE), Zoo Cordoba (ZC), Bioparc Fuengirola (BF), Selwo Marina (SM), BioDomo (BD), Oasys Mini Hollywood (OMH) and La

Reserva del Castillo de las Guardas (RCG) (Table 1).

Zoos	Freedoms				
	H&T	D	PID	ENB	F&D
ZC	100%	22.2%	100%	88.9%	44.4%
MP	50%	12.5%	100%	12.5%	12.5%
RCG	66.7%	66.7%	100%	100%	66.7%
ZBJ	73.3%	0%	93.3%	80%	46.7%
ZdC	46.2%	0%	0%	46.2%	23.1%
BF	12.5%	12.5%	100%	100%	87.5%
SAE	60%	10%	100%	90%	40%
SM	100%	0%	100%	100%	100%
BD	0%	0%	100%	100%	100%
OMH	100%	100%	100%	75%	25%

Table 1. Percentages of compliance to the Five Freedoms used and described in this project, assigned to each zoo studied.

The overall deficiencies encountered at the zoos could be condensed as inside enclosure inadequacies (e.g., hard flooring, not appropriate heights for the primates' sleeping behaviours, lack of diverse or complex 3D structures, lack of comfortable surfaces or nesting/bedding elements, lack of heating lamps, lack of privacy from visitors) (Boere, 2001; Junge *et al.,* 2009, Miller, 2011). Together with that, many outside enclosures' designs clearly suggested a prevalence of preference towards an entertaining enclosure rather than an enclosure that observes the primates' locomotive and daily budget needs (Hosey, 2005; Margulis *et al.,* 2005; Davey, 2007; Fernández *et al.*, 2009; Claxton, 2011, Sha Chih Mun *et al.,* 2013). This exemplifies the still narrow commitment to animal welfare strategies and legislation.

Two specific zoos showed less compromise towards appropriate animal stewardship: Mundo Park and Zoo de Castellar. Concerning Mundo Park, I would like to discuss the case of the chimpanzee female. As it appears on their website, the owner founded the zoo to house his former exotic and domestic animals that he kept and trained to perform in the media. The chimpanzee was one of them, and it is shown on their website that she was completely humanised. Not only the captive situation of the chimpanzee is objectively deficient (chimpanzees, like all primate species, must not be housed alone, as they are highly social species that need interactions with conspecifics – Boere, 2001; Lopresti-Goodman *et al.,* 2013), but the narrative they present promotes the illegal pet trade of primate species, and their use in the media. Apart from that, the enclosure lacks complexity, comfortableness and hiding spaces (Hosey, 2005; Margulis *et al.,* 2005; Fernández *et al*., 2009; Claxton, 2011).

Moving on to Zoo de Castellar, three specific events of stereotypic/repetitive behaviours were observed: first, was the red-handed tamarin performing continuous tongue-flicking gestures towards the visitors and following them; second, was soliciting food from visitors and pacing behaviour from the ring-tail lemurs housed at their first enclosure; and third, the capuchin monkeys performing several stereotypic and repetitive behaviours. Regarding the first one, this repetitive behaviour can be understood when we take into consideration that all tamarins

and marmosets lacked outside enclosures, except for some grille tubes that went around the zoo (Boere *et al.,* 2003, Fernández *et al*., 2009). This lack of space can very likely trigger abnormal behaviours in captive primates (Sha *et al.,* 2016), especially if housed alone and placed at the entrance of the zoo where the visitor effect is considerably higher (Hosey, 2005; Margulis *et al*., 2005; Bassett & Buchanan-Smith, 2007; Buchanan-Smith, 2011; Miller, 2011; Sha Chih Mun *et al*., 2013).

The second stereotypic situation can be explained by the cancellation of the photoshoot event: they might have been used to receiving food from visitors. After the cancellation, this demanding behaviour could have continued, and without an outlet for it, pacing to counteract the frustration from not receiving either the interaction or the food becomes a potential explanation (Hosey, 2005; Bassett & Buchanan-Smith, 2007; Dishman *et al*., 2009; Junge *et al*., 2009; Claxton, 2011; Miller, 2011). If this is not the case, another reason could be the lack of hiding spaces and elevated visitor pressure (Boere, 2001; Margulis *et al*., 2005; Davey, 2007; Fernández *et al*., 2009; Miller, 2011). Finally, the third stereotypic event with the capuchin monkeys. Food demanding, pacing and turning, and eyebrow-raising towards visitors were observed during every visit to the zoo. The hitting teeth behaviour was only observed when the eyebrow-raising was reciprocated by one of the visitors and was performed repetitively, alternating with more eyebrow-raising.

This pattern suggests a stereotypic behaviour developed to cope with the stress, excitement or overstimulation of the interaction (Ferreira *et al.,* 2015). Many elements explain this abundance of abnormal behaviours. For starters, this was the only enclosure with a tube specifically placed so that the visitors could feed the monkeys (Davey, 2007; Claxton, 2011; Rimpley & Buchanan-Smith, 2013). The fact that the enclosure's design featured a fenced door within arm's reach from the visitors' path, as well as gaps between the security glasses and the stone walls that fit a capuchin hand, did not reduce the occurrence of these feeding interactions. Together with this design, the outside enclosure lacked appropriate 3D structures for the species' needs, especially with the number of individuals housed at the moment, and the structures present were very poor (Boere, 2001; Margulis *et al*., 2005).

Even though stereotypic behaviour does not necessarily mean negligent captivity conditions (stereotypies and repetitive behaviours are sometimes developed in captivity as a coping mechanism to this foreign situation, and are, therefore, positive as long as they do not involve self-harm or harming others; in fact, removing this specific types of stereotypies can provoke negative outcomes, since there is no outlet for accumulated stress – Davey, 2007), in the

case of this zoo this seems to be the situation. What raises more concerns, though, is the fact that neither Mundo Park nor Zoo de Castellar established communication with me or agreed to contribute to the project.

To conclude, I could assess that there was a certain lack of transparency and availability from the zoo institutions. This situation limits the information flow and, therefore, the tools and knowledge available for them, as well as potential constructive criticism to improve their facilities – also raising suspicion on the welfare status of the animals housed there, as was seen during the study. Also, the "entertainment" factor of the zoos' descriptions is noticeably more relevant in the majority of these centres than the "conservation" or "animal wellbeing" concepts. Although their intentions may not be completely negligent in these aspects, a lack of communication and room for improvement blocks the ability to adapt to the most recent global trends and consciousness related to animal husbandry.

All these situations happen in a context in which political corruption in the south of Spain has meant that the amount of financial investment in animal welfare has been low or very difficult to achieve (Hava García, 2011). This, in turn, implies slower transformations and improvements in the zoos' facilities and welfare policies. There is also a failure to enforce existing legislation advocating for better animal husbandry and captivity conditions. As stated before, political corruption trumps many potential improvements that can be made. However, private institutions that do not comply with the existing legislations and captivity guidelines are not facing the consequences from the appointed authorities with sufficient efficiency.

These factors combined explain the absence of conservation education amongst the public. The south of Spain is one of the most problematic areas of the country regarding animal well-being (Serrano Tárraga, 2004), and this is reflected in the way many visitors interact with the primates (and animals, in general) at the zoos. These misbehaviours can be easily linked to a lack of knowledge on the topics of conservation and animal welfare, as well as a lack of interest in such matters. This illustrates the ineffective educational incentives from the zoos visited (Almeida *et al.*, 2017). Of the ten zoos researched, the ones that engaged the least in these aims were also the ones that showed higher rates of stereotypical or abnormal behaviours in their primates, as well as most deficient housing conditions. Collective efforts from the governments, private organisations, zoos and researchers are the only way to proceed. One of the following actions I will carry out after the completion of this project will be to reach out to the zoos and submit my observations and improvement suggestions. Further and bolder steps have to be taken in order to

continue improving the present zoos, their animals and their compromise with conservation.

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Visitor frequency at potto enclosure in Birmingham Wildlife Conservation Park and its implications for potto welfare

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Half of the world's land-dwelling vertebrates are nocturnal species, and their cryptic nature makes them difficult to observe in the wild (Fuller, 2014). Nocturnality in mammals is considered widely as mammals' ancestral activity cycle (Prugh & Golden, 2014). Around 44% of the extant mammals are nocturnal and 29% are cathemeral or crepuscular (Prugh & Golden, 2014). There are at least 110 nocturnal primate species, ten species of haplorhine of superfamily Tarsiformes, 28 Lorisiformes (galagos, pottos, and lorises), 62 species of Lemuriformes (aye-aye and lemurs) and one genus of true monkey, *Aotus* (Burnham *et al*., 2013).

Pottos are prosimian, nocturnal primates endemic to mainland Africa with a wide distribution in West, Central, and East Africa. Their bodies are compact, with woolly coats, large rounded protuberant eyes, short muzzles, and a vestigial index finger, along with a scapula shield on the dorsal side of the body. They also display sexual monomorphism (Nekaris & Bearder, 2007; Oates, 2011). Currently, three species are recognised by the IUCN Red List, *Perodicticus*

edwardsi, and *P. ibeanus* which are of Least Concern and *P. potto* which is Near Threatened (de Jong *et al*., 2019; Svensson & Pimley, 2019; Svensson *et al*., 2020).

Addressing welfare needs for wild animals in captivity is challenging because of the differences in the species, population, and individuals, and interventions that increase behaviours for one species, population, or individual may fail for others (Talbot *et al*., 2023). For the successful maintenance of a captive population, ensuring the psychological and physical well-being of animals is crucial for zoos, and zoos have developed theoretical and practical frameworks to evaluate animal welfare and understand their well-being (Hosey, 2005). Studies on the behaviours of zoo primates and the presence of zoo visitors on the behaviours of captive populations have been prioritised to understand the stress factors of human presence in captive populations for successful reproduction and breeding of captive primate populations (Hosey, 2005).

Visitors are a fundamental aspect of zoos, and zoos benefit from attracting visitors while ensuring they have a positive experience (Sherwen & Hemsworth, 2019). This is crucial because visitors play a significant role in achieving many of the conservation goals set by zoos. Visitors are the primary audience for educational and advocacy campaigns to reduce human-induced threats to wildlife. (Ballantyne *et al*., 2007; Sherwen & Hemsworth, 2019). Visitors play a significant role in the environment of zoo animals, often engaging in frequent and sometimes close and intense interactions (Sherwen & Hemsworth, 2019). The differing reactions of zoo animals to visitors can be attributed to species-specific variations, the nature and intensity of visitor interactions, differences in the physical characteristics of enclosures, and individual animal traits (Sherwen & Hemsworth, 2019).

This study aimed to understand the group sizes and frequencies of visitors entering the Moonlight House where the pottos' enclosure was located at Birmingham Wildlife Conservation Park. The enclosure housed two pottos, one female aged 17 years and one male aged 18 years. The data on visitor group sizes and frequencies was recorded from 10 am to 4 pm during the behavioural data collection for a comprehensive analysis of behavioural repertoires of captive pottos (*Perodicticus potto* sensu lato) at Birmingham Wildlife Conservation Park. The group size of visitors entering the Moonlight House in July 2024 were categorised into three categories, Small (1-5 people), Medium (6-10 people), and Large (>10 people).

There was variation in the group sizes of the visitors that entered the Moonlight House for the four weeks of observation. Week 1 had the lowest group size frequency and week 3 had the highest. The highest group size frequency was observed in small groups of

one to five people and lowest in large groups of greater than 10 people (Fig. 1). Large groups of more than 20 people were often observed during school visits.

Visitors had a good impression of the pottos and were fascinated by their ability of suspensory walking. However, very few had an idea of which animal they were. Most of them thought it was a “baby sloth” due to the enclosure of Linne’s two-toed sloth (*Choloepus didactylus*) being located in the same Moonlight House as that of the pottos. Those closest to an idea of what the animals were, referred to them as lorises. Unfortunately, during my study period, the screen showing the overview description of the pottos wasn't working.

Although there was a signpost at the entrance of the Moonlight House stating not to turn on flashlights inside, the lower visibility inside made some visitors turn on their phone flashlights to have a clear view of the pottos and other nocturnal animals. When the flashlight was directed into the pottos' eyes it made them retreat to darker areas within the enclosure. Retreating occurred when the pottos were active, either travelling or foraging, but when inactive - resting or grooming - the head orientation was changed to face away from light.

Many mammals that are active 24 hours, as well as some nocturnal and crepuscular mammals, possess a highly reflective layer behind their photoreceptive cells called the *Tapetum lucidum* and this layer enhances the amount of light that reaches the cells (Beier, 2006). Pottos have a restricted number of cones, one cone for 300 rods (Goffart *et al*., 1976). Nocturnal mammals with a reduced number of cones are temporarily blinded by bright light due to their rods becoming unresponsive (Beier, 2006). Reducing pupil size is the main defence mechanism for mammals with few cone cells to prevent rod saturation in bright light (Beier, 2006; Perlman & Normann, 1998). However, this method is only slightly effective in lessening the blinding effect of the light (Beier, 2006; Perlman & Normann, 1998). To avoid excessive light entering the pottos' eyes, they had to turn away from the light source by either changing the head orientation or locomoting away.

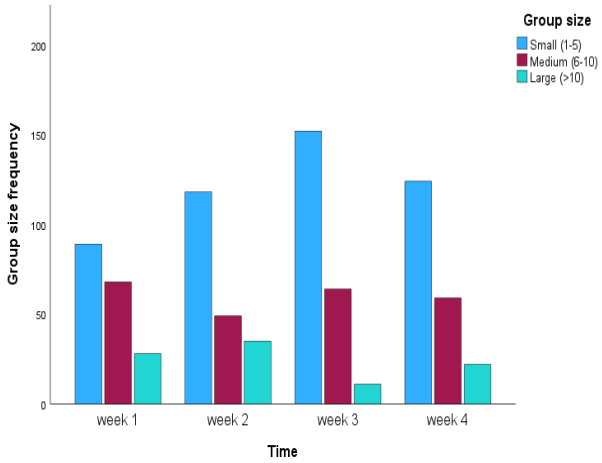

Figure 1. Graph showing the frequencies of the different size groups of visitors that entered the Moonlight House for four weeks of July.

The display screen for showing an overview of pottos needs to be made functional so that visitors can identify the pottos and know briefly about their biology for their improved

welfare. Also, the conservation park needs to install interactive displays such as videos and animations near the potto enclosure that explain the negative effects of flashing lights on nocturnal animals.

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The importance of novel and cognitive enrichment for captive chimpanzees (*Pan troglodytes*) and the use of activity budgets and social network analysis to assess welfare

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As species known for their intelligence and dynamic social lives, primates may often struggle with the artificiality and boredom of life in captivity, and many zoo-living primates will frequently demonstrate abnormal, self-directed and maladaptive behaviour patterns (Birkett & Newton-Fisher, 2011). As the operations of many zoos move towards an ethos of conservation and animal welfare, curbing these behaviours is often a prime concern for primate keepers in public zoo settings - not only to ensure the well-being of the animals but also to project a positive image to multitudes of zoo visitors. Environmental enrichment is a frequent method of reducing abnormal behaviour in primates and may even promote more species' typical behaviour, such as foraging and decreasing inactivity overall (Csatádi *et al.,* 2008). Cognitively stimulating enrichment is particularly important for captive primates and may offer these animals the chance to utilise their tool-use capabilities and problem-solving skills. Research has shown that environmental enrichment that stimulates foraging behaviour and/or offers a cognitive challenge for captive primates can decrease the frequency of abnormal behaviour and promote locomotor behaviour, environmental exploration, and reduce time spent in inactivity (Meehan & Mench, 2007). Due to the ubiquity of abnormal behaviour in captive primates, such enrichment is vital to ensure their well-being.

The success of environmental enrichment in improving captive primates' quality of life is often measured through the use of activity budgets, which measure the daily proportion of time that an animal spends engaged in different behaviours such as resting, walking, grooming, or scratching (Yamanashi & Hayashi, 2011). The aim of enrichment is oftentimes to decrease the proportion of daily time spent resting or engaged in abnormal or self-directed behaviours such as excessive scratching or hair-plucking.

However, activity budgets are not the only method of evaluating animal welfare through behavioural observation. Social network analysis (SNA) is increasingly used as a means of determining the welfare of an animal (Krause *et al.,* 2007). Social network analysis uses behavioural data to measure the connectedness between individuals based on factors such as proximity or affiliative interactions. A primate's position within its

social group may reveal a great deal about its condition and individual needs in captivity.

I introduced foraging enrichment with a cognitive component to a group of six captive adult chimpanzees living at ZSL Whipsnade Zoo in Dunstable in the United Kingdom. The group was composed of four males and two females, with five of the individuals being related. I conducted preliminary behavioural observations for 13 days spread over a four week period (June 8-July 7, 2019). I introduced enrichment devices I designed during the latter 13 days between July 8-August 8, 2019. Scan data collection, as explained by Altmann (1974), was used to collect behavioural observations. Four enrichments were introduced, including 1) a scent-based scavenger hunt, 2) a rotating tube maze (Fig. 1), 3) a termite-fishing simulation task and 4) a magnet maze (Fig. 2).

All enrichments contained food rewards to simulate foraging behaviour in the wild. Each enrichment required the use of either problem-solving (magnet maze), tool-use (termite-fishing simulation task), spatial understanding (tube maze), and cause-and-effect learning (scent scavenger hunt). Following the end of the observation period on August 8, 2019, behavioural data were analysed to 1) create daily activity budgets for certain behaviours of interest, 2) examine any significant changes in activity between the pre-enrichment introduction phase and during the enrichment introductions, and 3) to construct social networks for the chimpanzees based on proximity and affiliative interactions, and 3) to compare these social networks to individual use of the introduced enrichment.

Figure 1. Tube maze; attaches to bars of enclosure and spins on an axis; can be filled with small food rewards. Animals physically spin the device to move food out through the tubes.

Figure 2. Magnet maze; attaches to outside of enclosure and filled with small food reward. Using outside magnet, food can be moved through the Plexiglas screen by moving a magnet block inside the maze to direct the movement of food rewards to an opening at the bottom of the maze.

All individual chimpanzees in this study interacted with the introduced enrichment. This may be evidence that captive primates benefit from the novelty of enrichment, and may be motivated to investigate new and novel objects in their environment. Specifically, new enrichment introduced to captive primates may benefit from stimulating the cognitive abilities of the animals, and the design of new ways to accomplish this is vital to expand our understanding of what it means to be cognitively stimulated. Lastly,

Social Network Analysis may prove to be a valuable method of understanding and interpreting captive primate welfare, and more research is needed using SNA as a method of assessment for welfare.

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A systematic review of the effects of musical enrichment on captive mammals

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Environmental enrichment of captive environments is a practice that has shown to greatly reduce stereotypic behaviour, reduce aggression, promote affiliative behaviour and reduce stress, as indicated through specific physiological markers such as cortisol and noradrenaline (Newberry *et al*., 1995). Music is a type of auditory enrichment, which has demonstrated differing effects both between various species and within the same species. However, the impact of classical music has been more widely investigated, and evidence suggests that various elements of music, including the genre of music have a correlation to the effect it elicits (Snowdon, 2018).

In this systematic review I assessed the evidence for the effect that listening to human music has on captive mammals examined across zoological, laboratory and rescue centre settings. Animal studies which used an identifiable genre of human music as well as a non-music control setting to test a predetermined response variable were included in the review. Keyword searches were performed in five databases (Web of Science Core Collection, MEDLINE, ScienceDirect, Academic Search Complete and eBook Open Access (OA) Collection (EBSCOhost). Bias was assessed using the Systematic Review Centre for Laboratory Animal Experimentation's risk of bias tool for

animal studies (SYRCLE's RoB tool) (Hooijmans *et al*., 2014).

Fortytwo studies examining physiological, behavioural and cognitive mammalian responses to music were identified, with 38.1% of those studies focusing on primates. The studies identified included 23 mammalian species across six animal orders (Artiodactyla, Carnivora, Perissodactyla, Primates, Proboscidea and Rodentia). The most commonly tested music genre was classical music, with 64.3% of articles focusing solely on the effect of classical music, and another 23.8% of studies including it in addition to other genres. A beneficial effect of music was identified in 76.2% of studies, out of which 87.5% examined the effects of classical music.

A statistical significance analysis was performed in SPSS v29.0, using a Chi-Square Test of Independence. The statistical testing revealed that the musical genre had a significant influence on the effect of music on captive mammals and showed that classical music resulted in a significantly higher proportion of positive effects (χ^2(1, N=69)=4.695; p=0.016). Testing whether music in general had an effect on the measured parameters between primates and non-primates, the statistical test demonstrated a significant effect of the mammalian order on the effect of music (χ2(1, N=69)=17,259; p<0,001). A larger proportion of experiments on non-primates resulted in a more positive effect, while a larger proportion of experiments on non-primates resulted in no effect or a negative effect. The final statistically significant test revealed that there was a significant correlation (χ^2(1, N=38)=15.555; p<0.001) between the effect of classical music and different animal orders, i.e. a larger portion of non-primates experienced positive effects after enrichment with classical music, compared to primates, which had a larger proportion of results where a statistically significant effect of classical music was not found or there was a negative effect.

While this systematic review had identified significantly positive effects of (mainly classical) music on various mammalian species and highlighted the complexities in the auditory discrimination and preferences of non-human primates, the evidence base for understanding the effects of human music on animals is still expanding. Although this study did not include music specifically designed for different species, more recent studies suggest that tailoring each auditory enrichment method to the specific sensory system of the species in question might be more likely to produce the desired effect (Snowdon, 2021).

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Ethical implications of observing captive gibbons

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Behavioural studies are an important asset to increase understanding of the complex needs and behaviours of animals. They are an invaluable part of the rehabilitation process. However, conducting behavioural research on animals in confinement raises ethical questions. Researchers have a responsibility to balance the potential benefits with any negative consequences (ASAB Ethical Committee, 2020).

Gibbons, or Hylobatidae, are non-human primates comprising four different genera including 20 different species, many of which are Endangered or Critically Endangered (Brockelman & Geissman, 2020; Rawson *et al.,* 2020). Most species occur in Southeast Asia and show a decrease in population trend according to the International Union for Conservation of Nature (IUCN) due to a variety of causal factors such as habitat loss and fragmentation, hunting, medicinal purposes (IUCN, 2024).

Another important factor contributing to the reduction of wild populations of gibbons is the illegal pet trade. Gibbons are sourced from the wild from an early age, often orphaned as the parents will be shot from the treetops to obtain the clinging infants. There is still a relatively high demand for gibbons as pets in Southeast Asia, and many of them will end up in confinement even after their confiscation or rescue (Eudey, 1994: Rainer *et al*., 2020). Besides lives as pets, these primates are frequently used as tourist attractions and photo props.

Gibbons in the wild are territorial species who reside in small family groups with no more than five individuals comprising of a mated pair and their offspring. Most species of gibbons perform intricate songs and duets, and are almost completely arboreal, residing in the upper canopy layer of the forest. Gibbons are omnivorous and spend a substantial amount of time foraging. All these complex needs make replicating a suitable captive environment particularly complicated (Marriner & Drickamer, 1994; Mallapur & Choudhury, 2003; Mootnick *et al.,* 2006).

Due to the conservation challenges faced by many of these primate species, captive populations are quite extensive. However, they provide a controlled setting for in-depth behavioural observations.

When observing gibbons in captivity, it is important to consider a few factors. Aside from obtaining necessary permits and approvals from the relevant institutions and organizations involved in the study, it is important to be mindful of animal welfare protocols. The Association for the Study of Animal Behaviour, ASAB, is a British organization promoting the study of animal behaviour, has regularly updated guidelines in place for animals in behavioural research (ASAB Ethical Committee, 2020). These guidelines stipulate that investigators should be familiarized with local legislation on animal welfare and threatened or endangered species and take measures to mitigate stress and disturbance to observed animals. This can be done by not interacting with the animal, observing the apes from a safe distance, wearing camouflaged clothing, limiting observation time, being aware of noise pollution, hiding behind natural elements, etc. Observers should strive to be minimally invasive for the individual and/or population and prioritize the gibbons' physical and psychological well-being.

When studying captive gibbons, the presence of an observer can substantially impact natural behaviours, an important consideration especially during behavioural studies. Gibbons, being highly sensitive to confinement (Marriner & Drickamer, 1994, Mallapur & Choudhury, 2003), may experience exacerbated stress levels due to factors such as frequent or intrusive observation, and noise pollution by human voices and activities. Especially when animals aren't fully habituated to humans, the presence of an observer may lead to changes in their activity budget (Cheyne, 2009), including resting less frequently, hiding more, locomoting more, or the exhibition or exaggeration of abnormal behaviours (pers obs.). These abnormal behaviours can include posterior presenting directed at the observer, exhibiting misplaced sexual attention. This could be due to excessive human contact (Cheyne, 2006). Another possible cause suggested by Mootnick *et al.* (2006) is aggression potentially triggered by human presence.

Conversely, prolonged exposure to observers can lead to habituation, potentially disrupting their natural behaviours and social interactions. Gibbons can adapt to human interaction and may demonstrate unnatural behaviours as well, such as begging. This should be addressed proactively with the institution housing the gibbons prior to any observation.

It is crucial that the data be collected ethically, and that caregivers or staff working with the gibbons remain anonymous.

Lastly, caution must be exercised when publishing or disseminating sensitive information. It is equally important the research contributes to the understanding and improvement of captive gibbon welfare and the rehabilitation practices. Collaboration can be fostered by ensuring the research aligns with the goals and priorities of the rescue centres or zoos where the study takes place. This approach results in mutual benefits and could potentially enhance the rehabilitation process for gibbons in the future.

By addressing all these ethical concerns, behavioural research on captive gibbons can contribute to their well-being and ultimately, their preservation.

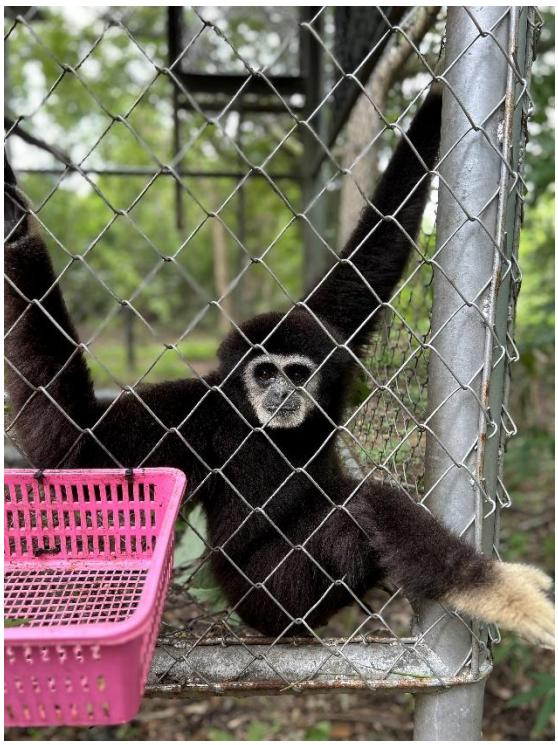

Figure 1. Image of a male, white-handed gibbon begging (directed towards the observer)

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