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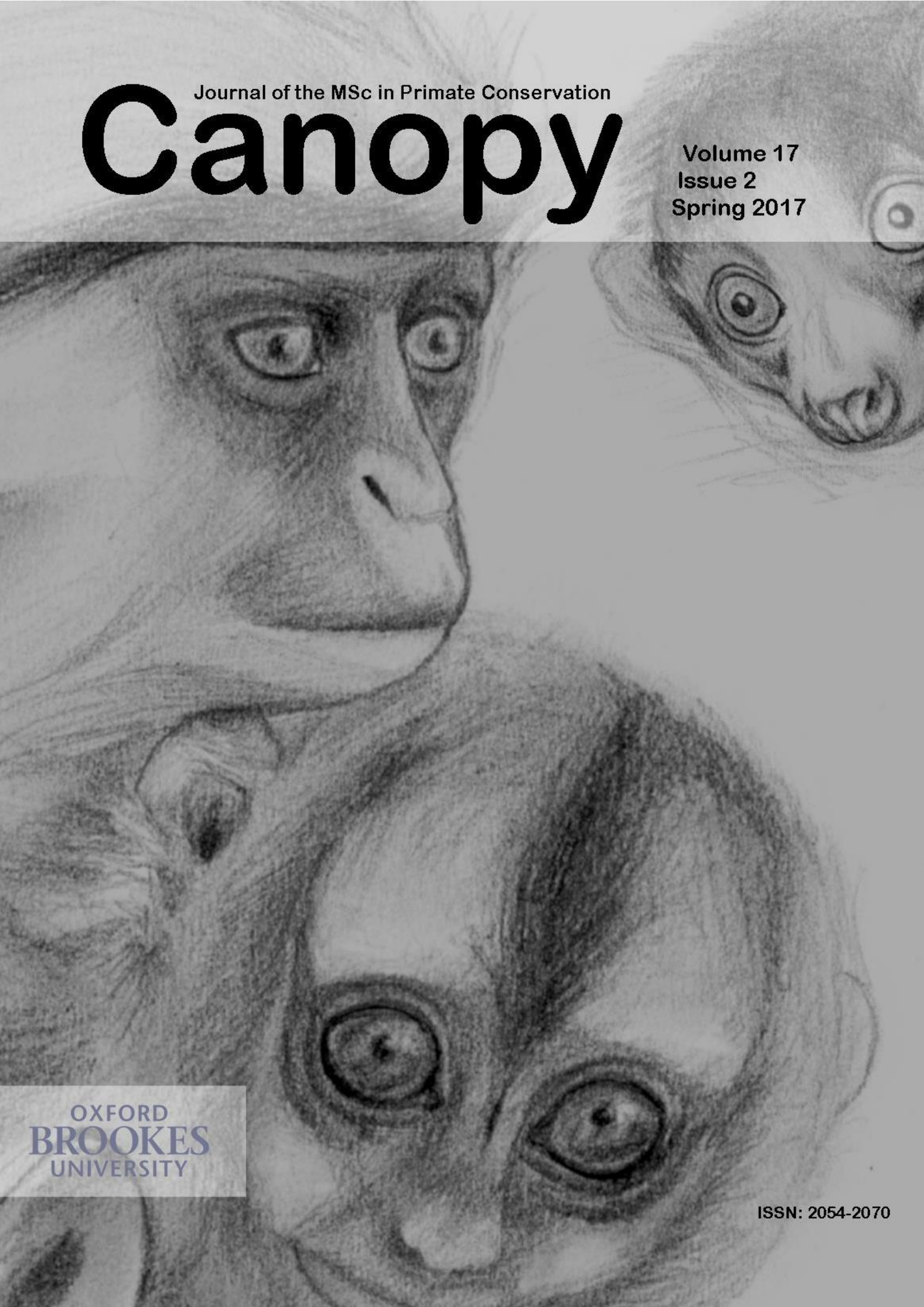

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Letter from the editors

Welcome to the spring 2017 edition of Canopy, the official in-house journal of the MSc Primate Conservation course at Oxford Brookes University.

The theme for this edition of Canopy is the behaviour and care of primates within captive facilities, in zoos, sanctuaries, and rehabilitation centres. Although a commonly debated topic, the widespread captivity of primates is an undeniable reality which is certain to continue for the foreseeable future. Across the world, hundreds of thousands of captive primates are kept in zoos, sanctuaries, laboratories, and in the homes of humans as pets. In present times, as a consequence of habitat loss and hunting by humans, some primate species, such as the ring-tailed lemur (*Lemur catta*), have become more prevalent in captivity than in the wild.

Because of the high levels of cognition and the unique dietary, physical, and social needs of many primate species, maintaining the psychological and physical health of primates in captivity often presents a formidable challenge. Some species of primates appear to thrive in captivity, while others may suffer from disease, and stress resulting in the development of stereotypic behaviours. Captivity can also cause significant alterations in the behaviour of primates, such as an increase in social behaviour in primates which are semi-solitary in the wild.

Fortunately, the modern, accredited zoo no longer focuses solely on providing entertainment to visitors, but predominately engages in endangered species breeding programmes, conservation education, and in-situ species field research. Sanctuaries provide a life to primates rescued from the pet trade or other inadequate living conditions, and rehabilitation and re-introduction centres work to re-establish primate populations in areas where they were once extant. With the overall increase in knowledge of how to properly manage primates in zoos, sanctuaries, and rehabilitation centres, captivity stands to contribute greatly towards primate conservation and welfare.

From the play behaviours of juvenile Bornean orangutans (*Pongo pygmaeus*), to public perception of the conservation work enacted by zoos, to breeding patterns in captive lemur species, this edition of Canopy covers a highly diverse array of topics related to captive primates. We would like to thank all of the researchers who have contributed to this edition, as well as the organisations which have helped make their research possible.

Sincerely,

The editors

Carter, Clare, Magdalena, Robyn, Ben & Jennie

Letter from the Module Leader

Welcome to the latest issue of Canopy, the journal for Primate Conservation. This issue focusses on captive care of primates in zoos, and rescue and rehabilitation centres and the implication this has for primate welfare and conservation.

The authors, all alumni of the MSc in Primate Conservation, present studies on how people perceive the conservation efforts by zoological gardens, studies on how to improve the lives and welfare of primates in captive settings as well as how primates actually fare in the captive conditions. While many zoos no longer aim to house the largest variety of species and often have a strong focus on certain taxa a surprisingly large number of species are kept in captive settings. The papers included in this issue reflect this wide range of species, and focus on lemurs, marmosets, macaques, colobines and orangutans, amongst others.

Our primate conservation programme prides itself at being taxonomically and geographically broad – that is students are encouraged to learn and conduct research on a wide range of primate species, in a wide range of habitats, in captive and natural settings, and facing a multitude of threats and challenges. From the coming academic year, however, we have introduced three new pathways. These pathways allow students to focus on specific taxa and specific conservation issues. The first pathway, Apes in the Anthropocene puts the spotlight on our closest relatives, the gibbons, orangutans, gorillas, bonobos and chimpanzees and how we best tackle the unique challenges they face. Second is the Human-Primate Interface pathway takes an ethnoprimatological approach. Here students focus on how humans and primates interact, how primates live in human-dominated landscapes, and how primates are exploited and used in various ways. Finally, the third pathway, Lemurs and Nocturnal Primates, builds on our expertise in studying nocturnal primates.

Prof Vincent Nijman
Lecturer in Primate Conservation

Public perception of conservation work carried out by zoos

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In view of the importance given to conservation and education in zoo mission statements (Patrick *et al.,* 2007) it is essential to study the public's awareness of zoos as conservation centres and knowledge of the conservation practices in which zoos participate. In equal measure, it is also important for zoos to understand public expectations, whether their practices fulfil them and whether their visitors learn anything from zoo visits themselves. Studies have found that the public believe zoos spend more on conservation programmes than they do in reality (Born Free, 2007); and that perceptions of zoo conservation work differ between zoo visitors and non-zoo visitors (Reade & Waran, 1996). In this article I present findings from a survey that I conducted in order to evaluate the opinions, perceptions and knowledge of zoo visitors (ZV) and non-zoo visitors (NZV) in relation to zoo practice and conservation work.

For this study, I focused on the use of surveys which have previously been used in studies relating to visitor interest, knowledge and motivations whilst visiting zoos and aquariums (Reade & Waran, 1996; Briseño-Garzón *et al.,* 2007; Puan & Zakaria, 2007; Gusset & Dick, 2010). What is apparent from the literature is that there are limited studies which focus on the motivations of both visitors and NZV and their understanding of the role of zoos in the 21st Century and for this reason I chose to collect primary data from surveys. I designed the survey online using SurveyMonkey (www.surveymonkey.com) and it was administered from May 1st 2014 to August 1st 2014. Participants included both ZV and NZV and the survey was sent to email contacts and posted on Facebook, so that contacts could in turn disseminate to their contacts to increase the response rate. All data were collected online using SurveyMonkey's 'Select' plan, which was chosen due to its more advanced functionality. This enabled me to download multiple custom reports and filter and cross tabulate all responses by custom criteria (such as ZV and NZV). The survey consisted of five sections and contained 22 questions.

In total, 212 surveys were collected using SurveyMonkey and 51.7% had and 48.3% had not visited a zoo in the last 2 years. The most popular reason for visiting the zoo was 'for an entertaining day out' (202 points). Choices that ranked 2, 3 and 4 were 'the location of the zoo' (141 points), 'a great day out for my children' (113 points) and 'to learn something new about a species' (105 points). For NZV, the top four reasons for not visiting were 'I just don't go' (224), 'I'd rather do something else' (203 points), 'they are too far away' (173 points) and 'they're

cruel' (124 points). Respondents were asked to rank categories that related to zoo activities and the highest scoring answer for both ZV (263 points) and NZV (271 points) was 'providing the best care for the animals'. The category 'breeding animals that are threatened in the wild,' was also the second preference for both. ZV (219 points) and NZV (214 points). A Mann-Whitney U Test was performed against the null hypothesis that the distributions of both groups (ZV and NZV) are identical. Across the 12 categories analysed, there was no statistically significant difference between the two groups and so the null hypothesis holds true for each category.

When asked to name a UK species that zoos have helped 15.9% (ZV) and 11.4% (NZV) recorded an answer. Of these answers which were correct, 25.0% (ZV) and 66.6% (NZV) answered correctly; these results were not significant ($X^2(1) = 1.054$, p= .305). When asked to name a non-UK species, 67.0% (ZV) and 47.7% (NZV) recorded an answer and 94.1% (ZV) and 97.6% (NZV) were correct in their answer these results were not significant ($X^2(1) = 1.114$, p= .291). When asked if they knew of any threatened primates in zoos, 40.9% (ZV) and 23.9% (NZV) answered 'yes' and of those 84.8% (ZV) and 100% (NZV) were correct in their response; these results were also not significant ($X^2(1)=1.386$, p=0.239). Finally, respondents were asked whether they knew of any zoos that contribute to conservation programmes that help save threatened primates. Findings showed that 46.6% (ZV) and 18.2% (NZV) thought they knew about this and 89.7% (ZV) and 80% (NZV) recorded correct answers. These results were statistically significant, confirming an association between a correct answer and whether respondents were a ZV or NZV ($X^2(1) = 15.356$, p=<0.001). The final parts to this section asked participants whether they believed that primates are safe if kept in zoos and if they were aware of any captive breeding programmes at zoos. When asked about the IUCN status of primates in zoos, the highest scoring answers showed that 23.3% (ZV) believed that 20-29% of primates in zoos are threatened and 25% (NZV) thought that over 50% are threatened; although 'don't know' also scored highly for NZV (23.9%). Responses to question 16 about captive breeding programmes were low and there were only 59 people who answered the question (in its entirety), providing an explanation of captive breeding. Out of 212 people, 34 (ZV) and 25 (NZV) answered of which 58.8% and 40.0% respectively were correct; these results showed no significance ($X^2(1)=0.344$, p=0.558).

ZV and NZV thought 10-19% (of annual income) was spent by zoos on conservation; although a high number of NZV also chose 'don't know' (25%). When asked how much they would like zoos to spend, ZV opinions ranged widely from 20-29% to over 50% and NZV (31.8% of sample) thought that zoos should spend over 50%. The final section assessed opinions in relation to enclosures and when asked how much zoos should spend on enclosures, 31% (ZV) chose

£1million-£5million and 40.7% (NZV) chose £500,000 - £1million (the most popular categories). The final question assessed what aspects of enclosure design are most important and the results for both ZV and NZV were very similar. The top four ranked answers were the same for ZV and NZV and were as follows: 1) the needs of the animals should come first (ZV: 250; NZV: 249), 2) it should reflect the environment the animals comes from (ZV: 220; NZV: 246), 3) plenty of space for the animals to explore (ZV: 95; NZV: 131) and 4) the enclosure should provide a lot of variety for the animals (ZV: 68; NZV: 49). A Mann-Whitney U Test was performed against the null hypothesis that the distributions of both groups (ZV and NZV) are identical. Across the 13 categories analysed, there were no statistically significant differences between the two groups in 12 categories, but there was a statistically significant difference in choice 8 'plenty of space for the animals to explore' ($U=2971.5$ $p=0.037$).

For the purpose of this paper, it is impossible to provide a discussion on all of the aspects of the survey results and so key points are highlighted; for further information and clarification please refer to my final project. So why do some people choose to visit a zoo and others do not? The primary reason given was for 'an entertaining day out', which supports a similar study by Reade and Waran (1996). Whilst their study found only 4% of people visited the zoo to learn something new about a species, results from my study indicated that this reason was considerably higher (ranked fourth). I believed this could indicate the improvement in exhibit design and presence of more pedagogical materials from people to learn from, despite other studies having shown how people spend more time looking at animals than engaging with educational materials (Ross & Lukas, 2005; Ross & Gillespie, 2009). The primary reason for not visiting a zoo given by NZV was 'I just don't go' (224 points). What was interesting about these results was that although the category, 'they're cruel' was ranked 4th, the category, 'they do not contribute to conservation,' scored very low with only 34 points. Perhaps people see some value in zoos as conservation centres, even if they feel animal welfare is poor and may think that animals are therefore the 'greater good' of their species. This is concordant with the study by Reade and Waran (1996), which found that NZV believed zoos did a lot for conservation. Both ZV and NZV felt strongly that animal care was the priority of zoos and both also believed that breeding threatened animals was important. Results showed that there was no significant difference between ZV and NZV choices ($p>0.05$) and NZV's interest in captive breeding is slighting surprising given that some believed zoos to be cruel - why would they therefore want more animals to be bred in captivity? I also expected conservation projects to have ranked higher for NZV, for the same reasons although conservation now encompasses captive breeding to some degree (Puan & Zakaria, 2007). Arguably, this highlights

that more should be done, both to promote UK species conservation and to educate people that captive breeding is not the first and only solution, but a supportive measure of conservation and protection of habitat, only to be used when other viable options have been exhausted (Snyder *et al.,* 1996).

How do the public perceive the role of zoos in conservation and the status of their collections and how much do people know about conservation and indigenous and non-indigenous species? Results indicate that perceptions vary depending on whether a person visits a zoo or not. NZV may hope that zoos house many threatened species as this is an area on which they believe zoos should focus strongly, along with animal care. Survey results suggest that NZV know more about UK species conservation programmes than ZV. When considering non-UK species conservation programmes, there were more responses by ZV, although correct responses were very similar in number in both groups. There were no significant associations when comparing data from both these questions. Whilst more knowledge may be gained by a zoo visit about the threatened species zoos keep, these results further highlight that there are different methods through which people learn. Of the non-indigenous species named, the majority were large charismatic flagship species (such as gorillas and pandas), a result similar to a study by Balmford *et al*., (2007). It was interesting that when asked about threatened primate species, NZV provided approximately 15% more correct answers. Although not significant, this does support Margodt (2000) who proposed that zoos are educationally redundant. In contrast, more ZV could actually name a zoo that contributed to primate conservation programmes (these were significant ($p<0.001$) findings), which may demonstrate that zoos are conveying the appropriate messages to highlight their conservation work; It must also be underlined, however, that asking about a specific order, such as primates, restricts the answers an individual can provide and may not reflect their knowledge regarding zoo practice as a whole.

When asked how much zoos should spend on enclosures, most ZV thought that £1million-£5million and NZV thought £500,000 - £1million should be spent on enclosures. On the whole neither of these are a reflection of zoo spending, as more projects are now spending over £5million on their enclosures. The final aspect of welfare and enclosures related to the design of an enclosure and both ZV and NZV and the only significant finding ($p<0.005$) was in relation to the option 'plenty of space for the animals to explore,' where NZV placed a higher importance on this category. This may be that NZV have a more negative view of animal welfare in zoos and thus would like the animals to have plenty of space, which compliments findings by Reade and Waran (1996). Finally, both ZV (81%) and NZV (80%) thought that zoos spent more than they do in reality on conservation (using data from a 2007 study by Born Free).

Although captive breeding is an important and recognised part of zoo practice, it is not compulsory for most zoos and there are other areas as outlined in the EC Zoo Directive (Council Directive 1999/22/EC) where zoos contribute and make a difference to safeguarding the future of many species. This should again be communicated much better to ZV and NZV, both of whom identified captive breeding of threatened species as a priority for zoos. Survey results also suggested that both ZV and NZV have high expectations of zoo practice in both the percentage of threatened species and monetary contributions to *in situ* conservation and these are not being met. I do believe that less focus should be placed on captive breeding, certainly in portraying it as a primary conservation strategy of zoos and more emphasis should be directed towards *in situ* conservation programmes and educating people in these. For people to intensify these types of efforts, less should be spent on expensive new enclosures (also substantiated by ZV and NZV alike) and keeping non-threatened species; monies saved from this can then go directly to *in situ* efforts. Entertainment is still the primary motivation for a zoo visit and zoos are in a difficult position in that they need to operate as a business whilst contributing to species conservation and education and at times they do not portray an image of a 21st century conservation centre, when trying to balance these two aspects. London Zoo for example hosts 'Zoo Lates' which are entertaining evenings of comedy, dancing and shows which help raise money for conservation projects. I do not believe this initiative portrays the correct image of conservation and calls into question animal welfare; reportedly people have poured beer over tigers and attempted to swim with the penguins (Vaughn, 2014). Above all, I think zoos need to be consistent in the way they communicate and display messages about conservation, captive breeding and sustainable practice as they are in a unique position to reach millions of people a year. Only through collaborative efforts will zoos ever be able to really make a difference to conservation and more needs to be done to improve their efforts in this.

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Interventions to alleviate behavioural pathologies in captive primates

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Despite the best efforts of caregivers, some captive primates exhibit behavioural pathologies, including excessive aggression, self-injury, appetitive disorders (e.g. coprophagy, regurgitation and reingestion), motor stereotypies (e.g. rocking, pacing, bar-biting) and hair-pulling of self or conspecifics. Such behaviours arise due to trauma, disease, social changes, management changes, or as a legacy of past treatment, particularly in former pet or laboratory primates (Novak *et al.,* 2006; Coleman & Maier, 2010).

There are numerous reasons for attempting to extinguish such behaviours. In welfare terms, behaviour pathologies may lead to physical injuries or interfere with homeostasis (Novak *et al.,* 2006). For research, Melfi (2005) asserts zoo populations are vital, but for zoo-obtained research to be applicable to wild conspecifics, captive animals must be as closely matched as possible so behavioural pathology presence is an impediment. Behavioural pathologies also dilute educational messages. Visitors are more likely to contribute to conservation when they see animals engaging in wild-like behaviours, and more likely to reject zoos as conservation authorities when witnessing negative behaviours (McPhee & Carlstead, 2010). In terms of direct conservation consequences, in animals due for release for re-population purposes, behavioural pathologies may lead to

reduced survival likelihood (Mathews *et al.,* 2005; Guy *et al.*, 2013). Not just individuals are affected; abnormal behaviours may be imitated by conspecifics and offspring (Hook *et al.*, 2002). Maintaining generations of animals with behaviourally normal (wild-like) profiles is essential to the 'ark' role of zoos.

In humans, behavioural pathologies are treated with lifestyle changes, psychological therapies (counselling), and psychiatric therapies (psychoactive pharmaceuticals), usually initiated by psychiatric professionals. In primates, analogues of the same methods exist but decisions are made by veterinary and keeping staff based solely on behavioural cues. There may be biases or barriers to certain interventions. To investigate this, I conducted a survey of primate caregivers. Questions covered knowledge and experience of behavioural pathology interventions and perceptions of barriers to their implementation. Interventions presented were: environmental changes to enclosures and enrichment; social adjustments; formal training sessions; informal human interactions; prescription of pharmaceuticals; and provision of evidence based alternative therapies, e.g. herbs (Cousins, 2006), and non-evidence-based, e.g. homeopathy (BVA, 2011). At the close of the survey 104 responses were received.

I found no association between demographic factors and experiences or opinions, with two exceptions. Female respondents were more likely than males to use alternative therapy interventions (χ^2=13.2, p=0.0003). Research shows that in humans, female patients are more likely to try complementary therapies than are males (e.g. Tindle *et al.*, 2004), but reasons for this are unknown. Veterinary-trained respondents were more likely to agree to try pharmaceuticals than respondents with other occupations (χ^2=9.7, p=0.002). I attribute this to veterinary training in the safe use of pharmaceuticals and understanding of the biological mechanisms by which they work.

Figure 1 shows the behavioural pathologies reported as seen by respondents in the taxa present at their facilities. 85% of respondents had seen behavioural pathology in at least one primate.

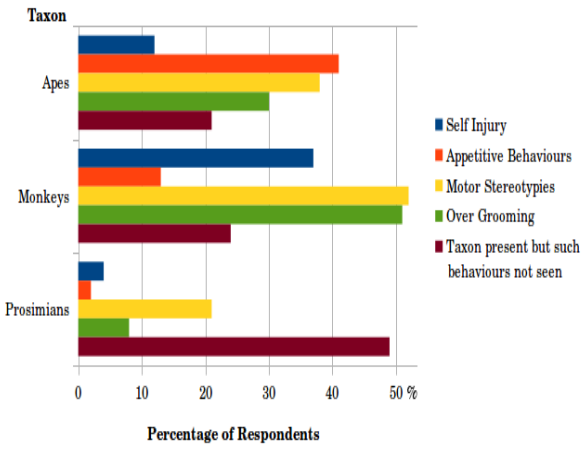

Figure 1: % of respondents working at facilities where taxon is present, who report having witnessed certain behaviours at least once in the taxon (n=104).

There are taxon differences in behaviours. Specifically, a significantly higher percentage of respondents reported having seen:

- monkeys self-injure than apes (χ^2=12.0, p=0.0005) or prosimians (χ^2=25.0, p=4.2x10^{-7})

- apes express appetitive behaviours than monkeys (χ^2=15.9, p=0.00007) or prosimians (χ^2=32.8, p=1.0x10^{-8})

- monkeys performing motor stereotypies than prosimians (χ^2=13.2, p=0.0003)

- over-grooming in apes and monkeys than in prosimians (χ^2=12.7, p=0.0004; χ^2=31.0, p=2.2x10^{-8}).

Prosimians were significantly more likely to be reported as never displaying abnormal behaviours than monkeys and apes (χ^2=15.1, p=0.0005).

Within taxa, respondents reported seeing;

- apes self-harming significantly less than displaying other behaviours (χ^2=16.8, p=0.0008);

- monkeys displaying appetitive behaviours significantly less than other behaviours (χ^2=25.9, p=1.0x10^{-6});

- prosimians performing motor stereotypies significantly more than other behaviours (χ^2=24.6, p=0.00002).

Respondents have witnessed the use of environmental, social, and training interventions more frequently than pharmaceutical and alternative therapy interventions. They were much more likely to agree to try environmental, social, and training interventions than pharmaceutical interventions (χ^2>150, p<10^{-33} in all cases); or alternative therapy interventions (χ^2>50, p<10^{-11} in all cases). They were more likely to agree to try alternative therapy interventions than pharmaceutical interventions (χ^2=12.4, p=0.002).

It is impossible to know which alternative remedies people considered when responding. Regardless, caretakers should never assume that 'natural' remedies are safer than synthetic remedies. Between 2004 and 2012, there were 273 recalls of human dietary supplements that could cause 'serious adverse health consequences or death' (Harel *et al.,* 2013). Some remedies also cause dangerous interactions: St. John's wort can interact with the anti-clotting drug warfarin (AAOS, 2011).

As for pharmaceutical interventions, responses show these are used in zoos, yet case studies are rarely presented in literature, perhaps due to reluctance to disclose such information. In human medicine, use of psychiatric medication is stigmatised (Corrigan, 2004). Such stigma may be reflected in caregiver opinions on primate pharmaceutical use since significantly fewer respondents agreed they would try pharmaceuticals than other interventions.

Figure 2 shows responses concerning whether there are significant barriers to the implementation of interventions. Significantly more respondents identified barriers for social and pharmaceutical interventions than for environmental interventions (χ^2=16.0, p=0.00006; χ^2=13.2, p=0.0003), but all other comparisons show no significant difference in the numbers agreeing there are barriers. Significantly more respondents were unsure of

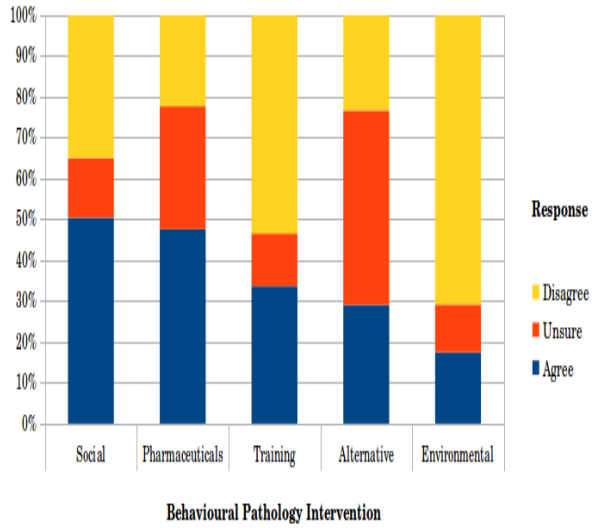

Figure 2: Responses to the question of whether there are significant barriers to the implementation of each intervention (n=104).

whether there were barriers to pharmaceutical and alternative therapies than the other interventions (χ^2>5.6, p<0.02; χ^2>2.4, p<0.00002).

Common barriers may be summarised as a lack of keeper time, keeper knowledge, space and money. Ways to overcome these barriers could be an avenue for future research. The greatest uncertainty exists around pharmaceutical and alternative therapy methods, making these areas for possible keeper education.

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Tailored enrichment strategies and stereotypic behaviour in captive individually-housed macaques (*Macaca* spp.)

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When housing animals in a captive environment it is essential to understand the biological and behavioural needs of each animal in order to avoid unnecessary stressors and improve individual and group welfare. One of the recognized sources of stress in captivity is the inability to engage in species-typical behaviours for which the animal has a "behavioural need" (Morgan & Tromborg, 2006). These behaviours are characterized as being highly internally motivated, which individuals are driven to perform regardless of environmental conditions (Mench, 1998). Inability to engage in natural behaviours can be detrimental to animals' well-being (Friend, 1989), and can often lead to redirection of these needs in the form of stereotypic or self-injurious behaviour such as hair-pulling or autogrooming, licking or chewing of non-food objects, self-biting, pacing, rocking, or digit-sucking (Mason & Rushen, 2008). As a result, presence of stereotypic behaviour is a commonly used indicator of compromised well-being (Shyne, 2006).

Behavioural expression can be affected by a host of external variables (Mason, 1991), so using additional measures of stress is necessary to gain a full understanding of any visible behavioural abnormalities and their underlying causes. Cortisol levels are a common physiological measure of stress in human and nonhuman primates, since cortisol is the primary glucocorticoid released when the hypothalamic-pituitary-adrenocortical (HPA) axis is activated during stressful events (Novak *et al*., 2013). Both of these methods, behavioural and physiological, have been frequently used to calculate the success of enrichment programs designed to decrease expression of stereotypic behaviour by providing opportunities for natural expression of species-typical behaviours (Clark *et al*. 2012; Kaplan *et al*. 2012). Very little attention, however, has been given to the individual needs, history, and preferences of each animal, which may be a main reason behind the failure of some unsuccessful enrichment programs aimed at reducing stereotypy (Coleman & Maier, 2010). In this study, I combine both physiological and behavioural measures of well-being to comprehensively assess the unique needs of individually-housed captive macaques (*Macaca* spp.) at OPR Coastal Primate Sanctuary in Longview, WA, with the aim of developing tailored welfare strategies.

Nine macaques (seven *M. fascicularis,* two *M. mulatta*), housed at OPR Coastal Primate Sanctuary in Longview, WA, served as subjects

for this study. They consisted of five males and four females and ranged in age from 2.5-21 years (X=11.7 years, SD=5.98). Monkeys were individually housed in enclosures consisting of indoor and outdoor areas partitioned into two sides by a guillotine door, each measuring approximately 3.65x3.65x2.44m. Each enclosure had built in ledges, climbing structures, durable toys, and a view of a colour television.

Behavioural and hormonal data was collected for each individual under two conditions: (1) baseline conditions under a normal care routine, and (2) individualized daily enrichment. The enrichment assigned to each individual was chosen based on the specific activity budget and stereotypic behaviours each animal displayed under baseline conditions. Although particular attention was given to decreasing the occurrence of stereotypic and self-injurious behaviours, enrichment was widely determined based on abnormalities in overall activity budget. Each individual received 2-3 items of enrichment per day in addition to any basic enrichment they may have received as part of their normal care routine. Individuals were allowed a minimum of one hour with the enrichment before behavioural observation began in order to discern changes in overall activity budget, and not simply an immediate reaction to an enrichment device.

Behavioural data were collected under each condition for five consecutive days. Each individual (n=9) was observed at varying times between 12:00 p.m. and 5:00 p.m. Continuous focal sampling was used, with one 20-minute session per individual per day (Martin & Bateson, 1993), comprising 100 minutes of observation per monkey under each condition or 200 minutes per individual in total. Individuals were observed remotely via video, to minimize observer interference.

Faecal samples were collected on days 3-5 of behavioural data collection under each condition. Samples were only collected on days 3-5 to compensate for a 24-hour delay in hormone excretion found in faecal samples (Weingrill *et al*., 2004). One sample per individual per day, or 6 samples per individual in total, was collected and stored at -20°C until shipment (Clark *et al*., 2012). Samples were shipped on dry ice to the German Primate Centre in Goettingen, Germany for analysis.

The percent of time individuals engaged in stereotypic behaviours significantly decreased from the baseline condition to the enrichment condition ($z=-2.314$, $p=0.021$, $n=9$). Faecal cortisol levels decreased in 7 out of 9 individuals from the baseline condition to the enrichment condition, and the overall decrease in cortisol levels approached significance ($z=-1.836$, $p=0.066$, $n=9$).

The data demonstrates that targeted and individualised enrichment strategies decreased the time engaged in stereotypic behaviour and promoted species-typical behaviours in captive macaques with compromised rearing backgrounds. These results agree with reports from previous studies on the effects of

enrichment, indicating that providing opportunities for the expression of natural behaviours that are typically restricted in captivity can improve the overall well-being of captive primates (Swaisgood & Shepherdson, 2008). For example, individuals stuffed their cheek pouches with food and retreated to higher ground. This behaviour, common in the wild to avoid food competition and lower predation risk (Smith *et al*., 2008), is an indication of an increase in species-typical behaviours under the enrichment condition.

Through a meta-analysis of zoo-based research, Swaisgood and Shepherdson (2008) concluded that different enrichment methods lead to varied results, and recommended that enrichment be tailored to each specific group of animals. Similar to this study, they also found that in no case was stereotypic behaviour eliminated completely, showing that current enrichment practices can still be improved upon. By tailoring enrichment to each individual's specific behavioural needs, instead of applying a blanket enrichment program to an entire group, insufficiencies in each monkey's activity budget were addressed in this study, increasing the likelihood of improving individual welfare.

The restrictions of captivity have been shown to have a wide range of effects on the well-being of captive animals, frequently leading to the expression of stereotypic behaviour. These behaviours signal that an individual's natural behavioural needs are not being adequately met. Currently, most enrichment plans enacted through zoos, laboratories, and sanctuaries, or as part of research protocols, do not effectively account for individual variability. This study is unique in the fact that it has incorporated each monkey's history, preferences, and behavioural needs as an integral part of enrichment planning and results show that tailored welfare strategies can successfully decrease time allocated to stereotypic behaviours in captive primates. Keeping in mind the physical and financial restriction of the facility, both researchers and caregivers are encouraged to incorporate individual assessment into future study and rehabilitation practices.

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Breeding patterns in captive lemur species

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Initially, zoos were simply a menagerie of animals, where exotic collections were put on display for viewing, lacking all regard for the welfare of the individual or the conservation of the species. Conversely, the modern zoo is now a multifaceted establishment, which promotes conservation through the use of captive breeding (Cuaron, 2005). However even when the interests of the animal are taken in to consideration, keeping animals in captivity can have numerous effects on, not only the wellbeing of an animal, but also their species-specific behaviours, due to the constraints of the artificial captive environment (Morgan & Tromborg, 2007). The aims of this study were to (1) establish the breeding patterns of lemurs in captivity, including litter size and inter-birth intervals, and (2) To determine the effects of photo-period on birthing patterns of captive lemur species.

Data was taken from the 2011 ISIS/WAZA Studbook Library DVD, for nine species of lemur; Daubentonia madagascariensis, Eulemur macaco, E. macaco flavifrons, E. fulvus, E. rufus, E. rubriventer, V. variegata subcincta, V. v. variegata, and V. rubra. Data was collected from thirteen studbooks (Gibson, 2006; Moisson & Prieua, 2007; Porton, 2009a,b; Becker, 2010; Roullet, 2011) covering 168 institutions worldwide, with a total of 2061 births. Zoos from both Northern and Southern hemispheres were included in this study, and as a result, it was not suitable to use the month of the year to test for seasonality. Therefore, as in many

previous primatological studies, seasonality of births was determined by testing for uneven frequencies of births across the months of the year, translated into hours of daylight. The hours of daylight was calculated for each month of the year for the 180 institutions.

Due to the symmetrical day-length variations between Southern and Northern latitudes of the same value, (i.e. +40° and -40° have the same day length variation), Southern latitudes were converted to a positive value for the purpose of this study. In order to reduce the effect of small numbers, and to allow for clearer comparison, the zoos were divided into three groups according to latitude. The groups were split as follows: Group 1: 0° to 20°, Group 2: 21° to 40°, Group 3: 41° to 60°

Birth interval was calculated to the nearest month for each species, for all females which had more than one litter recorded. Data was collected on the litter size of each birth by noting the number of individuals born to one mother on the same day of the year. The number of single births, twins, triplets, quadruplets and litters over quadruplets was recorded, and translated into a percentage of the total number of births so that comparisons could be made between the species. Correlation between the latitude value of a zoo and the number of daylight hours at which births occurred was tested, and comparisons were made between the nine species and the three genus. Inter-birth interval and litter size in captivity were studied for the nine species. For all statistical analysis, the software IBM SPSS Statistics 19 was used, with Microsoft Excel being used to produce some of the accompanying figures. P values equal to or less than 0.05 were considered to be significant.

The further North or South a zoo was located, the more variation there was in the hours of daylight at which births occurred (Fig 1, $r= 0.355$; $p<0.01$; $n=2601$).

Daubentonia were born at shorter day lengths (mean: 11.3hours +/-1.38, n=12) when compared with Eulemur (mean: 12.7hours +/-1.38, n=1544) and Varecia (mean: 14.1hours +/-1.28, n=1036). Births for Daubentonia occurred on average during periods of the least daylight hours (mean: 11.3hours +/-1.38, n=12), with Eulemur slightly higher (mean: 12.7hours +/-1.38, n=1544), and Varecia giving birth during the highest average hours of daylight (mean: 14.1hours +/- 1.28, n=1036). A Kruskall-Wallis test indicated a significant difference between the three genus ($p<0.01$). The inter-birth interval was shortest for Varecia and significantly longer for Daubentonia (Fig 2, Mann-Whitney U: $Z= -3.56$, $p<0.01$, $n= 131$). The difference was statistically significant between all combinations of the three genus: Daubentonia and Eulemur ($Z= -2.99$, $p<0.01$, $n=221$), Daubentonia and Varecia ($Z= -3.56$, $p<0.01$, $n= 131$), and Varecia and Eulemur ($Z= -3.45$, $p<0.01$, $n=344$). Litter sizes were significantly larger for Varecia (Kruskall-Wallis: $p\leq0.01$, $H(8)=25.548$), with litters of up to 6 individuals (fig 3). Daubentonia gave birth to only singletons as is found *in situ*.

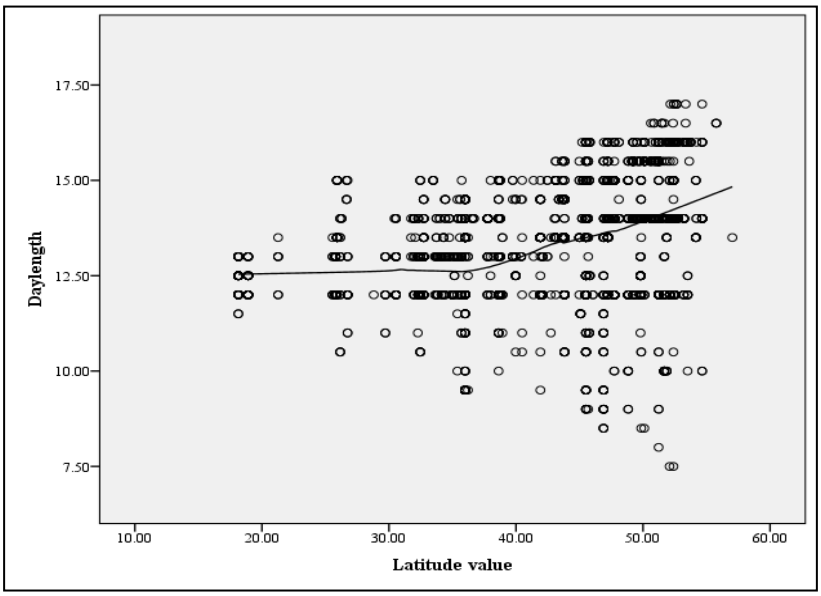

Fig1: Relationship of the hours of daylight for each birth, and the latitude value at which the zoo is situated, for captive lemur species world-wide. The curve shows the Loess fit to the entire data scatter. (Pearson correlation: r= 0.355; p<0.01; n=2601; two-tailed)

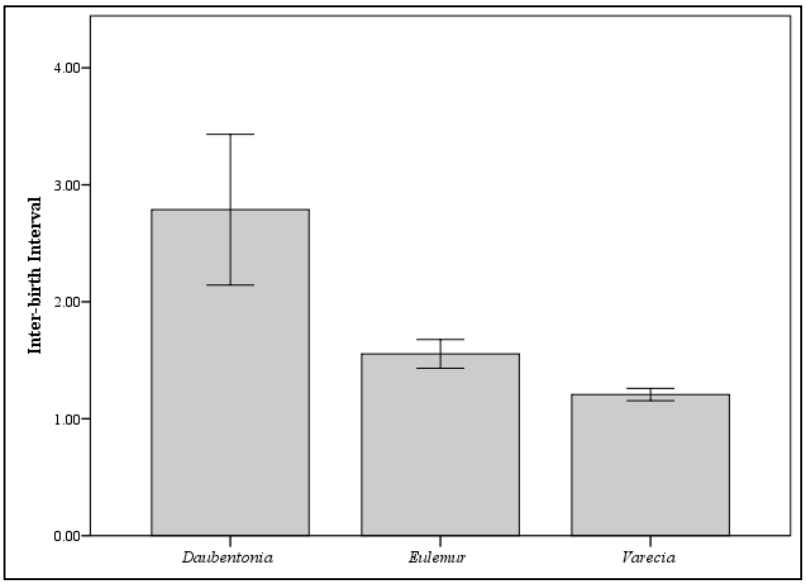

Fig 2: Inter-birth intervals for captive lemur genus world-wide (mean +/- SD; Kruskall-Wallis: p<0.01, H(2)=22.23)

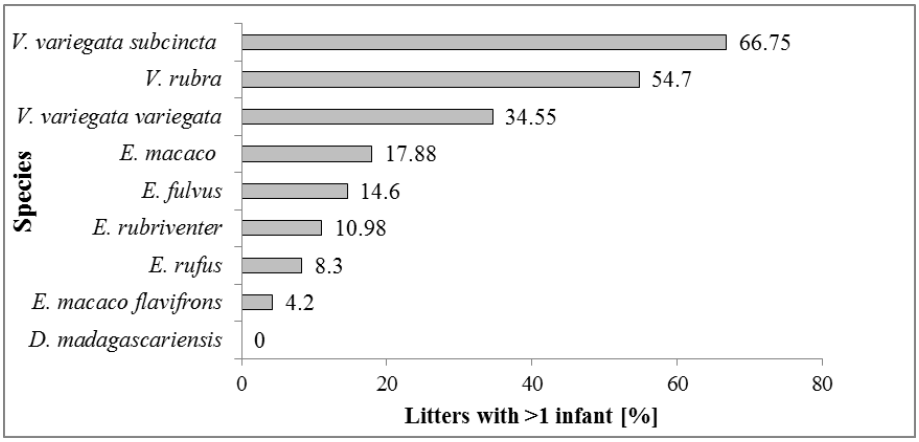

Fig 3: Proportion of litters with more than one infant, for captive lemur species

The ability to change breeding seasonality with a change in latitude, coupled with the shorter inter-birth intervals and the larger litter sizes suggest that the genus Varecia may be more flexible with regards to breeding in captivity when compared with Eulemur and Daubentonia, whose patterns remained closer to those seen in their wild counterparts. Whilst all species were seen to deviate away from the mean day length of 12 hours, there still remained a clear peak of births for months at which 12 hours was the average day length. There was little difference in the inter-birth intervals between captive and wild counterparts, however, Varecia was able to rear litters of proportionately large sizes over consecutive years, which is uncommon in the wild. As expected, Daubentonia produced no litters with more than one individual. Although breeding seasonality appears to change with a change in latitude value, it remains unclear as to whether photoperiod is the responsible mechanism.

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Play behaviours and personality in juvenile Bornean orangutans (*Pongo pygmaeus*) at an Indonesian rehabilitation centre

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Though the literature on play in non-human animals is extensive, there is no consensus about why animals engage in this behaviour. Reviews of the literature have summarised what we know and do not know about play (Bekoff, 1976; Chick, 2001). Even when we start with the understanding that play may have evolved independently in different species, and that it may possibly serve multiple functions in the same species, much of our understanding of the purpose of play, how it came to be, and why it is important for development remains unclear (Bekoff, 1976; Chick, 2001).

Studies on orangutan play behaviours tend to focus around captive animals (Poole, 1987; Tobach *et al.,* 1989; Ross *et al.,* 2008; Gruber, 2013). However, the wild studies that do exist agree that social play is almost always seen between juveniles, but juveniles have very few opportunities to interact. Of greater prevalence in the wild is solo play, which can take up large portions of a juvenile's daily activity budget. However, in captive environments adult orangutans housed together have been known to engage in solitary and social play behaviours (Poole, 1987; Tobach *et al*., 1989). It is this social flexibility that makes understanding play in orangutans even more complicated. If orangutans don't engage in social play in the wild in large frequencies (Van Noordwijk *et al*., 2009) can it be used as an indicator of adequate welfare when they do play commonly in captivity? This is one of the central questions this paper will be exploring. For the purpose of this paper, social play refers to all play involving two or more individuals, and auto play refers to all solitary play including object play.

Figure 1. Juvenile *P. pygmaeus* at play

Given the understanding that personality is heritable in humans, studies on primate personality can be used to understand links between humans and our closest relatives (Weiss *et al.,* 2006). However, the study of personality also has a practical application in understanding wild populations, addressing the welfare of captive primates and managing captive populations (Gold & Maple, 1994;

Mcdougall *et al*., 2006; Weiss *et al*., 2006). Essentially, the goal of assessing the personalities of individual primates housed in captivity is to predict behaviours (Murray, 2011). It has also been suggested that personality may aid in predicting immunity and hormone activity (Anestis, 2011). The use of personality assessments has gained some support as a tool for managing captive populations in zoos (Gold & Maple, 1994) in the form of predicting which individuals will make the best surrogate mothers, or which individuals will be best for introduction to a new group. Personality assessments have also been used with captive populations bred for conservation where it is critical to monitor generational shifts in personality in order to ensure wild animals are not becoming domesticated and natural wild behaviours are retained (Mcdougall *et al*., 2006).

As useful as this sounds, there are many complications involved with personality assessment. Today, the most common methods for assessment are behavioural coding and behavioural rating (Freeman *et al*., 2011). Behavioural coding involves using a sampling technique to record all instances of behaviour. These instances can then be calculated to find the exact levels of each behaviour associated with personality traits. Behavioural rating asks animal caretakers familiar with the individuals to rate the animals based on a set of traits or adjectives. This can either be done based on the caretaker's overall knowledge of the animal's behaviour (cumulative), based on a particular stimulus of experiments (test), or based on their daily behaviour over a set period of time (naturalistic)(Freeman *et al*., 2011).

The human five factor model (HFFM) is one of the more popular methods for assessing primate personality using behavioural rating. The HFFM groups all personality traits across human cultures into five major categories linked to genetics: Neuroticism, Extraversion, Openness to Experience, Agreeableness, and Conscientiousness (Digman, 1990). Studies using this model involve answering questions about numerous individual personality traits, each of which is linked to one of the five factors (Digman, 1990). Various versions of the FFM have been derived for different primate species, including the OFFM, which was used here. The five factors of the OFFM are Extraversion, Dominance, Agreeableness, Neurotic, and Intelligent. It is notable for not including Conscientiousness, although the Chimpanzee Five Factor Model does (Weiss *et al.,* 2006).

Subjective wellbeing has also been correlated with personality factors, and therefore personality assessment may be a viable tool for assessing captive welfare. This has practical application for captive management as a tool to predict which incoming individuals will flourish and which individuals may need special attention (Weiss *et al*., 2006).

Research questions

1) What are the rates and types of play observed by juvenile orangutans housed with agemates in a rehabilitation centre and how do they

compare with what we know about wild juveniles?

2) Given the assumption that captive juvenile orangutans engage in social behaviour at a much greater rate than wild ones, and given the constraints of raising an orangutan in captivity, are there any differences in social development between these captive juveniles and their wild counterparts?

3) Can determining the major personality traits of individuals in captivity help us predict how an individual will progress developmentally in this particular captive environment?

A total of 14 juvenile Bornean orangutans (*Pongo pygmaeus)* were observed over 9 months at International Animal Rescue's orangutan rescue centre in West Kalimantan, Indonesia. Personality questionnaires were given to 33 keepers. The captive orangutans were found to engage in social play more frequently than juveniles in the wild, and they engaged in solitary play less frequently than juveniles in the wild. The personality questionnaire was found to be ineffective, and it is recommended that OFFM be adapted to better suit juvenile behaviour. Long-term monitoring of behaviour is recommended from intake to several years post release in order to determine if there are any links between success and behavioral trends in orphaned orangutans.

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Does the rearing history of common marmosets (*Callithrix jacchus*) and black-eared marmosets (*C. penicillata*) affect behaviour within captive enclosures?

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As primates are social mammals they often rely on learned behaviour from the parent or troupe in order to survive (Cheney *et al*., 1987). Hand rearing an individual in isolation, or two juvenile marmosets together would therefore allow none of this learned behaviour from an adult to occur. Marmosets are known to adapt well to a captive environment (Stevenson & Rylands, 1988; Rylands *et al.,* 1997). Fostering a marmoset into a pre-existing marmoset social group may be beneficial, depending on the duration of time previously spent being hand reared and the age of the individual. In the wild marmosets live in stable groups of approximately between three and ten individuals (Lazaro-Perea *et al.,* 2000), while at International Primate Rescue (IPR) social groups were made up of two, three or four marmosets.

IPR, near Pretoria in South Africa, was started in 1996 as a sanctuary for mentally unstable captive common marmosets (*C. jacchus*). The primates residing at the sanctuary are unable to be returned to the wild but are cared for, for the rest of their lives, leading to the sanctuaries statement "Giving Hope to Homeless Primates" (IPR, 2014). The captive common marmosets (*Callithrix jacchus*) and black-eared marmosets (*C. penicillata*) were assessed and using past records was classified relating to their rearing histories. Group 1 were hand reared in isolation; Group 2, hand reared with another juvenile marmoset; Group 3 hand reared and moved to a marmoset "foster family"; Group 4 were subjects which were parent raised. 24 behaviours from a prepared ethogram were studied allowing observations to then be compared to the rearing history. In this study individuals were randomly sampled once a day for 15 minutes. Every 30 seconds the behaviour and enclosure were recorded. A five-minute interval was left between observations to allow the observer time to move between one enclosure and allowed the new focal individual sufficient time to settle to the presence of the observer before the sample started. The observer sat approximately two metres away from the focal enclosure so as not to affect the behaviour of the focal individual. If two of the study marmosets were in the same enclosure they could both be simultaneously observed. As well as recording the behaviour that was carried out, the marmoset's location within the enclosure (enclosure zone use) and the substrate being touched (enclosure substrate

use) was recorded. Once fully analysed will be offered back to the sanctuary so that they will be informed as to each marmosets' preference in enclosure height and substrate use. These recommendations may lead to enclosure modification in order to support an individual's preference or encourage alternate enclosure use. Locations were divided into the four zones shown below in figure 2. Instantaneous observations were carried out (Altmann, 1974), recording 11 types of substrate and within 4 height zones within the enclosure. It is possible that the enclosure may not be large enough or sufficiently complex to be mentally stimulating for the marmosets.

The major goals of most modern zoos include good animal welfare, conservation, research and entertainment including education for both children and adults. However, conflict can occur, as visitors to captive environments generally want to be in close proximity with the animals, without considering the welfare implications to the animals themselves. If this proximity is permitted, it often leads to increased levels of stress, particularly in primates. Several studies support the idea that high human presence around captive primates leads to lowering in social behaviours, more aggression and the primates to become more active (Chamove *et al.,* 1988; Wells, 2005). Dawkins (2004 Pp S4) defined behaviour as being "the result of all of the animal's own decision-making processes", which supports the idea that we must offer captive primates sufficient options, in food availability and enclosure enrichment, to allow them to make their own decisions. In the wild, common marmosets are active for approximately 12 hours a day. After leaving the sleeping site they will usually feed vigorously for an hour, before spending the rest of the day socialising, feeding and resting (Stevenson & Rylands, 1988). Kinzey (1997) approximates that marmosets spend 53% of the day stationary and 10% in social activities.

If these studies are correct and stressed primates are more active, then this indicates that the marmosets at IPR have low levels of stress as results show that approximately half of the observed time slots were "stationary". Results can be interpreted differently however as Bassett *et al*. (2003) suggested that more time spent in active behaviours could be a measure of increased stress, while Manciocco *et al*. (2009) proposed that less time spent in resting or inactive behaviours would therefore lead to increased time spent in social interactions, such as in positive play behaviour and grooming.

The term "environmental enrichment" was first used in 1991 in the Animal Welfare Regulations (US Department of Agriculture, 1991), where it was put forward that species-typical activities must be offered, which are non-injurious and risk free.

However environmental enrichment may not be the most suitable term, as Baumans *et al*. (2007) suggested, as we offer captive animal the best possible environment to support their

behavioural requirements, while not actually 'enriching' it. The enclosures at IPR contain enrichment that is regularly supplemented by new objects. The enrichment includes sticks and branches that are linked together in many different directions, with as few as possible touching the ground of the enclosure. This is done in order to encourage the arboreal marmosets to spend as much time as possible in the upper sections of the enclosure. Other forms of enrichment include hanging baskets, hammocks, poles and platforms. New enrichment was added to each enclosure every few days (personal observation 2014) to encourage mental stimulation for the marmosets.

Statistical analysis compared Groups 1 - 3 to Group 4, which, being as near to that agreed to be the most "natural", was classified as the control group. The one-way ANOVA had only one significant comparison, being the stationary behaviour between Group 1 and Group 4.

The results obtained in this study indicate that rearing history does not affect either enclosure use or behaviour. However, there are several reasons that should be taken into consideration. Ideally the control group for the study would be wild marmosets or those still being hand reared.

Group 4 was used as due to being parent raised, it was expected to be the most socially stable.

The marmosets in this group however are still raised in captivity, which in spite of being parent raised could still lead to abnormal behaviour.

Observing wild marmosets would allow a better comparison for natural behaviour, whereas marmosets kept as pets would show the extremes of stereotypical behaviour.

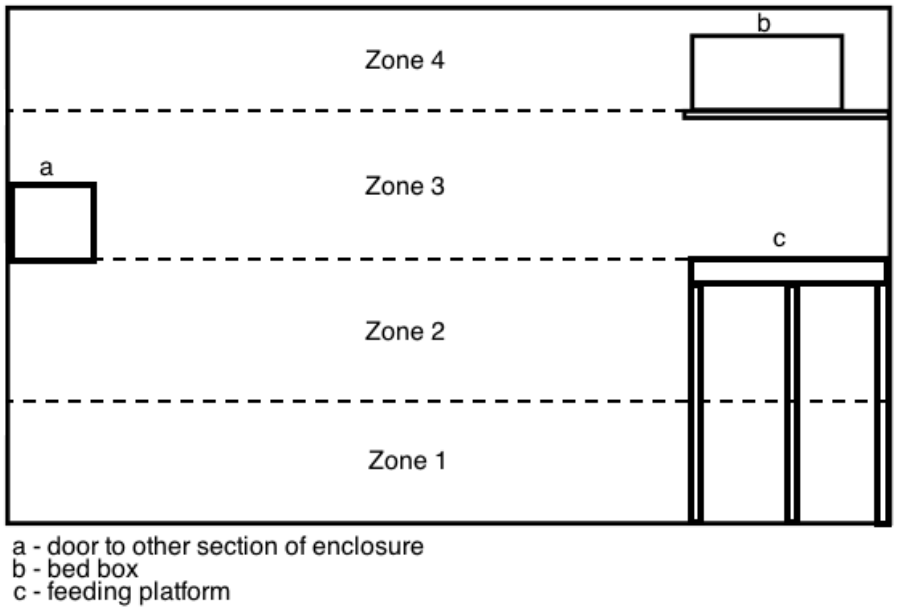

Figure 1: Enclosure at International Primate Rescue divided into 4 zones. All enclosures were different however, the basic outline was similar. Zones were marked out approximately by observer before each sample.

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Rescue-Enrich-Release: The environmental enrichment program for three species of captive primates at Colobus Conservation, Kenya

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It is widely known that the psychological well-being of captive animals can become compromised by a captive environment that lacks proper environmental stimulation. The amendments to the animal welfare act in 1985 lead to an increase in interest and use of a solution called environmental enrichment to counteract the effects of a captive environment. Environmental enrichment is defined as a dynamic process in which changes to a structure and husbandry practice are made (Nelson & Mandrell, 2005). This change in animal husbandry is done with goals of increasing behavioural choices available to animals, and increasing species' appropriate behaviours and abilities, therefore enhancing animal welfare (Kulpa-Eddy *et al*., 2005; Nelson & Mandrell, 2005). Evidence for the benefits of environmental enrichment can be seen in research conducted on non-human primates that show a reduction in stereotypic behaviour and reduced aggression. Evidence can also be found in veterinarian research and nutritional research (Mowry & Campbell, 2001; Young, 2003). Environmental enrichment is used for many different types of animal species, not just non-human primates, and has had great success in large felids, dolphins, small mammals and avian species (Swaisgood *et al*., 2001; Ruskell *et al*., 2015). Environmental enrichment can be found in zoos, laboratories, sanctuaries and anywhere else that cares for captive animals (Brent & Belik, 1997; Young, 2003).

Environmental enrichment programs have become the norm in captive environments yet research conducting evaluations on the effectiveness of certain enrichment programs is lacking (Young, 2003). It is important to have this empirical evidence supporting enrichment devices for many reasons. Firstly, some enrichments may be better suited for certain species. Secondly, some may cause harm to the individuals using it, causing an actual decrease of welfare (Young, 2003). Lastly, most places holding captive species are stretched thin in terms of staff and resources so an ineffective enrichment program can be a waste of time and money. As more research is conducted in this area improvements can be made to husbandry programs and this information can be shared

across the world through programs such as the Pan African Sanctuaries Alliance (PASA), which was created to improve communication between sanctuaries (Schoene & Brend, 2002).

My research was designed with the purpose of evaluating the environmental enrichment program at a rehabilitation facility in Kenya. Rehabilitation sanctuaries also provide an excellent environment for enrichment evaluation. With their interesting behaviour cases, animal histories, and great variety of enclosures and programs they allow for a great chance to compare and evaluate (Brent, 2007). Since rehabilitation programs are becoming a more accepted tool for conservation, this research is incredibly important (Guy & Curnoe, 2013). Colobus Conservation is a rehabilitation program for three species of captive primates and has been in operation since 1997 (Colobus Conservation, 2012). It rehabilitates the black and white colobus monkeys (*Colobus angolensis palliatus*), the vervet monkeys (*Cercopithecus aeithiops*) and the sykes monkeys (*C. mitis mitis*). The enrichment program at Colobus Conservation consists of 10 enrichments that occur on a repeated schedule. They consist of both feeding/foraging enrichment and manipulative enrichment.

Activity budgets created for my study showed the captive primates at Colobus Conservation have activity budgets similar to those of their wild conspecifics. On top of that there were very little occurrences of aggression and only one case of stereotypic behaviour amongst the primates at Colobus Conservation. My study showed that there was a species specific preference for enrichment type (Figure 1). The most commonly used enrichments across the whole group were the leaf litter, branched floors and sand piles. The most utilized enrichments differed between species showing that the colobus monkeys preferred the hammocks and ice block enrichment whilst the sykes and vervet monkeys preferred the leaf litter, branched floors, sand piles, elevated forage and the rock piles. These results agree with literature that shows that husbandry routines dealing with the psychological well-being of non-human primates will have different environmental needs between species including those that may be closely related (Boinski *et al.*, 1994; Seier *et al*., 2011). As well as the species type, dominance hierarchy within each enclosure affected the use of each enrichment agreeing with the literature that dominant individuals have priority access to resources. This is important to consider because any enrichment that can be dominated by a higher ranking individual is ineffective at allowing other individuals to benefit. Furthermore, the literature shows that these dominance hierarchies affect resource use

more so when a resource is limited (Jones, 1980).

This would suggest that the hierarchy affect is stronger on enrichment use when there is less enrichment in an enclosure. Preventative measures need to be considered in enrichment programs so that all the individuals can benefit from the program. Shared access was more common in enrichments that were more abundant, or more dispersed in the enclosure which is supported by the argument above, that limited resources are more easily monopolized by dominant individuals (Jones, 1980). The way that primates share access to their resources (enrichment) plays important roles in their social stability (Sushma & Singh, 2006). Social stability is especially important in groups of primates living in captivity undergoing rehabilitation for release (Guy *et al.,* 2012; Guy *et al*., 2014). Therefore, within an enclosure the enrichment should promote the social group by encouraging affiliative behaviours such as sharing. Similarly, literature on certain foraging models show that the more plentiful the resource that an individual has the more likely it will be shared, or that the others in a social group will have access.

Based on results from my study it can be concluded that enrichment type will have an effect on its use because certain species have a different preference for enrichments. As well, my research adds to the literature that enrichment should be species specific and designed with a large knowledge of the natural history and the specific demands of each animal.

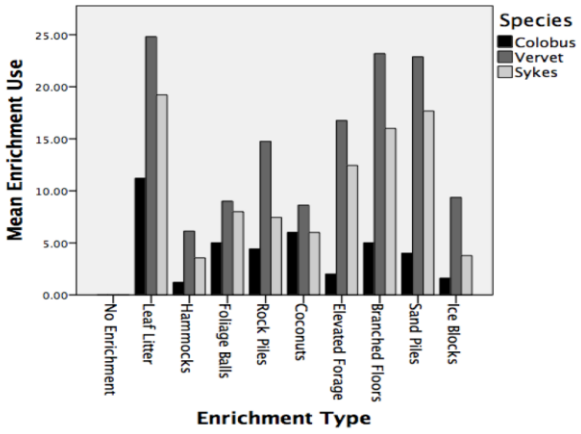

Figure 1: Mean use of enrichment between the enrichment types compare between the 3 species.

The low levels of stereotypic behaviours, aggression and high enrichment use support the idea that the enrichment at Colobus Conservation is highly affective. I will add that research suggests that the psychological well-being of an individual non-human primate is affected by the enclosure size, control of the environment, social system, and enclosure complexity (Schapiro *et a*l., 1997; Seier *et al*., 2011). Therefore, the apparent well-being of the primates at Colobus Conservation is not only due to the enrichment program, but also the size and complexity of the enclosures, the fact that enrichment is rotated, and the fact

that they are socially housed primates. In conclusion, my study showed that the enrichment devices in Colobus Conservation's enrichment program are inexpensive, easy to obtain and create or purchase and most importantly, effective.

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