



**16<sup>th</sup> Annual BIAZA Research Symposium**  
**1<sup>st</sup> - 2<sup>nd</sup> July 2014**

**Blair Drummond Safari Park, Stirling**

**Programme and Abstracts**

## Programme

Tuesday 1 <sup>st</sup> July	
<b>8.45</b>	<b>Registration - Safari Park Restaurant, shuttle available from bus stop</b>
<b>9.30</b>	<b>Welcome - Blair Drummond House</b>
<b>9.40</b>	Field conservation by BIAZA zoos: how well are we doing? (2004-2012) <i>Andrew R. Marshall, Michael Darling, Nicolas J. Deere, Bethan Hindle, <u>Jessica Dangerfield</u> and BIAZA Field Programmes Committee</i>
<b>9.55</b>	An evaluation of Primley meadow restoration project <i><u>Alexandra Moore</u> and Tracey Hamston</i>
<b>10.10</b>	Use of a Holistic Indicator Selection Protocol for identifying measures of native biodiversity conservation success in zoos <i><u>Aydin Berkin</u> and Andrew R. Marshall</i>
<b>10.25</b>	Using conservation indicators to evaluate forest conservation in Tanzania <i><u>Hayley Blackwell</u>, Freddie Sutton, Jennifer Archer and Andrew R Marshall</i>
<b>10.40</b>	Seeing red? Evaluating the conservation status of zoos using the IUCN Red List <i>Stephanie Spiers and <u>Phillip Greenwell</u></i>
<b>10.55</b>	The origins of the captive population of golden mantellas in European zoos and recommendations for future management <i>Chris Tyrrell, , Holly Farmer, Mike Bungard and Andrew Bowkett</i>
<b>11.10</b>	<b>Tea/Coffee</b>
<b>11.40</b>	Captive population management: the effect of male castration on behaviour and group dynamics in the white-faced saki monkey, <i>Pithecia pithecia</i> <i><u>Emma Silcocks</u>, Holly Farmer and Matthew Webb</i>
<b>11.55</b>	Successful hand-rearing and subsequent post-fledging behaviour of the Java sparrow: a model Estraldid species at Paignton Zoo Environmental Park. <i><u>Bryony Baker</u>, Tom Tooley, Leslie Connor, Holly Farmer, Jo Gregson and Andrew Bowkett</i>
<b>12.10</b>	Investigating captive husbandry, diet and behaviour of <i>Pterocnemia pennata pennata</i> (Darwin's rhea). Improving breeding success and chick survival. <i><u>Tegan Sutton</u>, Judith Lock, Amy Plowman and Peter Smallbones</i>
<b>12.25</b>	Breeding behaviour and success of tufted puffins ( <i>Fratercula cirrhata</i> ): an investigation into the effects of husbandry and social environment <i><u>Jody Griffin</u>, Lisette Keetman and Holly Farmer</i>
<b>12.40</b>	Does flamingo behaviour and husbandry (pre-breeding season) influence the quality of their offspring. <i><u>Callum McLaren</u>, Lisa Bottell, Rudolf Nager, Andrew Owen, Wayne Mcloud and Andrea L. Fidgett</i>
<b>12.55</b>	<b>Lunch</b>
<b>1.55</b>	Do zoo visitors cause an increase in wounding aggression in captive chimpanzees and ring-tailed lemurs? <i><u>Geoff Hosey</u>, Dave Brunger, Isabel Formella, Samantha Ward, Vicky Melfi and Sonya Hill</i>
<b>2.10</b>	Does the behaviour of lions and tigers change in relation to presenter talk events? <i><u>Kalisha Sandland</u>, Amy Treanor, Harriett Kidd and <u>Sonya Hill</u></i>
<b>2.25</b>	Lemur feeding experiences: welfare and the effect of personality <i><u>Gwynneth Mayers</u> and Kathy Baker</i>
<b>2.40</b>	The effect of visitor feeding experiences on behaviour: do animals anticipate interactions and how do they respond? <i><u>Rosie Jackson</u>, Emma Footitt, Holly Farmer and Kathy Baker</i>
<b>2.55</b>	<b>Tea/Coffee</b>
<b>3.25</b>	Overview of the Elephant Welfare Group (EWG) <i>followed by</i> Characterising anticipatory behaviour in four Asian elephants ( <i>Elephas maximus</i> ) at Twycross Zoo before and after the clock change for daylight savings time <i><u>Isabelle Lawn</u>, Lucy Asher and <u>Lisa Yon</u></i>
<b>3.50</b>	A behavioural assessment of resting behaviour in captive Asian elephants ( <i>Elephas maximus</i> ) in three UK zoos <i><u>Ellen Williams</u>, Samantha Bremner-Harrison, Naomi Harvey, Emma Evison and Lisa Yon</i>
<b>4.05</b>	The social relationships between female African elephants ( <i>Loxodonta africana</i> ) at Knowsley Safari Park <i>Jennifer Riley</i>

<b>4.20</b>	Group composition and feeding activity affect agonistic and stereotypic behaviours in captive female Asian elephants, <i>Elephas maximus</i> <i>Sarah Chantry</i>
<b>4.35</b>	Development of liquid chromatography-mass spectrometry for the determination of ovarian activity in female Asian elephants ( <i>Elephas maximus</i> ) <i>Emma Campbell, Rebecca S Purcell, Tim Liddicoat and Susan L. Walker</i>
<b>4.50</b>	The importance of research in the development of our African Elephant welfare programme at Blair Drummond Safari Park. <i>Chris Lucas</i>
<b>5.05</b>	<b>Poster Session</b>
<b>6.30</b>	<b>BBQ in the Safari Park</b>

<b>Wednesday 2<sup>nd</sup> July</b>	
<b>9.30</b>	Cognitive enrichment in the context of the University of Stirling and Blair Drummond Safari Park <i>Hannah M. Buchanan-Smith, Chris Lucas and Alasdair Gillies</i>
<b>10.15</b>	A study of audio enrichment in a northern rockhopper ( <i>Eudyptes moseleyi</i> ) penguin colony at Edinburgh Zoo. <i>Tasha Cadman, AM Macri and TG McEvoy</i>
<b>10.30</b>	Is auditory enrichment actually enriching for zoo-housed chimpanzees? <i>Emma K Wallace and Katie E Slocombe</i>
<b>10.45</b>	Effects of environmental enrichment on foraging behaviour of emerald monitor lizards ( <i>Varanus prasinus</i> ) <i>Michael Orchard</i>
<b>11.00</b>	<b>Tea/Coffee</b>
<b>11.25</b>	Workshop – Help the BIAZA Research Committee to help you
<b>1.15</b>	<b>Lunch</b>
<b>2.00</b>	Behavioural effects of fruit-free diets for primates <i>Liz Reeve, Katherine Cowlard, Stephanie Britt and Amy Plowman</i>
<b>2.15</b>	Using research to help with management of the greater one-horned rhinoceros at Chester Zoo <i>James Sread and Sonya P. Hill</i>
<b>2.30</b>	Effects of UV light on the behaviour of purple jewel beetles ( <i>Smaragdesthes africana oertzeni</i> ) <i>Steven Powell</i>
<b>2.45</b>	Who's the top dog? A study of behaviour and paddock use of the African painted dog ( <i>Lycaon pictus</i> ) at Chester Zoo <i>Chloe Rose, Hayley Worsfold, Emma Caskie, Dave Hall, Tim Rowlands and Lisa Bottell</i>
<b>3.00</b>	<b>Tea/Coffee</b>
<b>3.25</b>	Aggression and calls during the breeding season of captive Gentoo Penguin ( <i>Pygoscelis papua</i> ) at Edinburgh Zoo <i>Ptolemy McKinnon</i>
<b>3.50</b>	Which age and sex instigates the most aggression in a captive troop of hybrid baboons and why? <i>Catherine Sayer</i>
<b>4.05</b>	Contagious yawning in bonobos? <i>Jeroen M.G. Stevens, Melissa Vandoninck and Nicky Staes</i>
<b>4.20</b>	<b>Summary and prizes</b>
<b>4.40</b>	<b>Finish</b>

### Field conservation by BIAZA zoos: how well are we doing? (2004-2012)

Andrew R. Marshall, Michael Darling, Nicolas J. Deere, Bethan Hindle, Jessica Dangerfield and the BIAZA Field Programmes Committee  
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The global zoo community is the third largest non-governmental contributor to wildlife conservation, however there are very few quantitative summaries of how funds are being spent, nor targets to help evaluate success. Here we present data from annual questionnaires circulated to 106 BIAZA member zoos between 2004 and 2012. We also present data on the direct conservation activities of 521 zoo-supported projects listed among questionnaire responses in 2011, as identified through subsequent internet searches for each project. Our aim is to use these data to quantify the financial conservation investment of BIAZA zoos, to enable the setting of targets and conservation priorities. The annual BIAZA zoo contribution to field conservation through commercial income and fundraising, has increased by more than £7 million since 2004, to nearly £13 million in 2012. However, the difficulty of defining field conservation and isolating conservation spend from other expenditure led to an underestimation of investment, so the actual contribution is certainly higher. The reported contribution was heavily skewed among members, with 97% of funding coming from 20 zoos. The total amount of money invested by a zoo was also significantly influenced by its size, hence evaluations based on percentage income or visitor numbers may be more useful. We found that BIAZA zoos contributed 3.4% of their mean income to field conservation, equivalent to a mean of £0.44 per visitor. However, the contribution of individual zoos was again highly skewed, and extremely varied, with median financial investment significantly lower than the mean, and the number of projects ranging from 1 to 215. Projects were spread across the continents, in collaboration with 371 partner organisations. Three-quarters of funding was split almost equally between projects in Europe, Africa and Asia. Projects were biased towards mammals and birds, but more than 100 projects focussed on education, human livelihoods, active field management, and more than 300 projects conducted research and monitoring. Overall the data suggest a substantial and diverse contribution by BIAZA zoos to field conservation. There is also huge potential for most members to increase their contributions, which may require expert guidance, training, new collaborations and target-setting by BIAZA.

## An evaluation of the Primley meadow restoration project

Alexandra Moore<sup>1,2</sup> and Tracey Hamston<sup>1</sup>

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Primley Park, owned by the Whitley Wildlife Conservation Trust (WWCT), is a south facing, mesotrophic meadow situated in Paignton, South Devon. The meadow was previously used as horse pasture, the outcome being highly fertilised soil, dominated by a few coarse grasses resulting in low biological diversity. Restoration of grassland on formerly arable land has become an important biodiversity issue in the UK and management of this site aims to increase floral diversity. This project aims to evaluate the current management through surveys of the vegetation community and measurement of phosphate levels and to suggest appropriate target areas to focus additional conservation management efforts. In order to achieve this, three distinct vegetation types within Primley were surveyed according to standard NVC (National Vegetation Classification) methods. These zones were chosen due to their contrasting prior treatments, including addition of *Rhinanthus minor* (yellow rattle), ground preparation techniques and annual hay cuts. The effect of these restoration methods were measured by comparing plant communities and species diversity, both within and between the zones. Diversity was calculated using Simpson's Index of Diversity using percentage cover of vascular plant species. Differences in vegetation community and diversity are expected to be affected by previous restoration techniques, such as a reduction in coarse grasses where the hemi-parasitic plant *Rhinanthus minor* has been sown. This allows the less competitive species to colonise and diversity is likely to be higher. Soil fertility was investigated by measuring phosphate levels at each quadrat. It is to be expected that a more floristically diverse vegetation sward exists where phosphate levels are lower. Preliminary results suggest diversity varies between these selected zones of the meadow, with coarser grasses dominating the areas where particular restoration techniques have been absent. Further targeted meadow restoration techniques would be valuable.

## **Use of a Holistic Indicator Selection Protocol for identifying measures of native biodiversity conservation success in zoos**

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Zoo Biodiversity Action Plans (Zoo BAPs) aim to set out actions for enhancing the biodiversity of habitats and priority species in and around zoological gardens. However, measures of success in conserving native biodiversity among zoos have not yet been established. The traditional biological approach to the selection of conservation indicators will overlook the socio-economic and management systems driving conservation success. Therefore, we here adopt a new Holistic Indicator Selection Protocol (HISP), previously trialled for a conservation project in East African tropical lowland forest, but not yet employed elsewhere. The aim is to use the HISP to select conservation indicators for monitoring the success of the first formal Zoo BAP at Flamingo Land. Besides being located in temperate rather than tropical climate, the Flamingo Land BAP differs from the previous HISP trial in East Africa, in that it has multiple biodiversity targets. The HISP method uses a conceptual model developed using the CMP Open Standards for Conservation Practice to develop a set of possible indicators. Expert opinion and conceptual model linkages are then used to rank the importance of indicators to aid selection for monitoring by managers. We found that although indicator ranks varied between different stakeholders and academics, they were mostly inter-correlated. However stakeholders placed more emphasis on pest species, while academics placed more emphasis on measures of biodiversity and management implementation. We found that the highest ranked indicators were generally consistent between four alternative HISP indices, but with some variation in the proportion of biological and social indicators. When conceptual model linkages to the biodiversity target were removed from the HISP calculation, social and cross-cutting indicators received greater ranking. Consequently, we propose the HISP as a versatile method that can be used by any conservation project, and would welcome its further trial in other settings and ecosystems.

## Using conservation indicators to evaluate forest conservation in Tanzania

Hayley Blackwell, Freddie Sutton, Jennifer Archer and Andrew R. Marshall

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Conservation strategies have traditionally been based on anecdotal sources and past experience, with little evidence as to whether they have been effective. Instead conservation organisations often report measures of implementation rather than outcomes. The Holistic Indicator Selection Protocol (HISP) is a new method for determining appropriate indicators for monitoring the success of conservation projects. The method uses the *Open Standards for the Practice of Conservation*, a framework developed by the Conservation Measures Partnership to help integrate strategic planning into conservation projects. The Udzungwa Forest Project (UFP), a tropical forest conservation project based in southern Tanzania, has used the HISP to develop a set of 44 biological and socio-economic indicators. This study aims to use these indicators to evaluate the success of conservation strategies implemented by UFP since 2007. Ecological indicators used include above-ground biomass, forest connectivity, tree sapling regeneration, and indicator species such as the Udzungwa red colobus monkey (*Procolobus gordonorum*) and Harvey's red duikers (*Cephalophus harveyi*). These ecological indicators have been directly affected by past impacts on the forest, such as unsustainable deforestation and hunting, and have shown a slow recovery time. Therefore, although they appear to be declining, the rate of decline has slowed or even begun to increase in the case of above-ground biomass. Progress has also been made in areas such as the number of children being reached by environmental education initiatives and the number of households using fuel efficient stoves, showing increased awareness of the importance of conserving forest. However, socio-economic indicators suggest that people are still reliant on the forest, as they are not aware of how to gain access to alternative resources, impeding the progress of the ecological indicators. We conclude that achievement of biodiversity targets is inextricably linked to the socio-economic development, and that indicators at both ends of the socio-economic/ecological spectrum are important for the monitoring of conservation success.

## Seeing Red? Evaluating the Conservation Status of Zoos using the IUCN Red List

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The conservation of non-domesticated species and natural habitats is widely accepted as being the core purpose of modern zoos, with many zoos now stating conservation as a priority in their mission statements. Zoos contribute directly to conservation by maintaining captive populations *ex-situ* and by supporting *in-situ* conservation projects. Zoos face difficulties in managing *ex-situ* populations effectively to maintain genetic diversity and limited available zoo space is suggested to be a major contributing factor, resulting in difficult decisions when prioritising species that require conservation resources. Despite this, there is a lack of research evaluating how zoo space is allocated based on conservation status, or evaluating *ex-situ* and *in-situ* conservation efforts. Therefore, the aim of this study was to assess the conservation status of zoos in terms of both *ex-situ* and *in-situ* conservation efforts.

A total of 15 zoos provided information regarding the species held *ex-situ* in 2012, which were given a conservation score between 1 and 6 according to their placement on the IUCN Red List (1 = Least Concern, 6 = Extinct in the Wild). A total of 10 zoos were included in the *in-situ* scores where species that are of focus to *in-situ* projects supported by each zoo were also scored according to their placement on the IUCN Red List (1 = Least Concern, 6 = Extinct in the Wild). A higher mean conservation score indicates a larger proportion of threatened species. Taxonomic bias and the representation of threatened and non-threatened species were also assessed using one-way chi-squared tests.

The results of this study demonstrate a significant difference between the *ex-situ* scores of individual zoos, but no significant difference in the *in-situ* conservation scores of each zoo. A significant over-representation of Least Concern species was demonstrated ( $\chi^2=5987.7$ ,  $N=4109$ ,  $P<0.001$ ) and additional information also suggests a significant over-representation of charismatic species in both threatened and non-threatened *ex-situ* collections ( $\chi^2=595.9$ ,  $N=737$ ,  $P<0.001$ ;  $\chi^2=1384.4$ ,  $N=2066$ ,  $P<0.001$ ). Results also indicated a significant over-representation of birds and under-representation of amphibians ( $\chi^2=1179.3$ ,  $N=4108$ ,  $P<0.001$ ). These results suggest that zoological collections may be biased towards publicly appealing taxa and species as opposed to focusing on threat status. Further research is recommended to quantitatively assess the impact of public preference on species composition. Furthermore, research incorporating other aspects of conservation such as education and research would be beneficial to fully evaluate the conservation status of zoos and the influence that these areas have on collection planning.

## **The origins of the captive population of golden mantellas in European zoos, with recommendations for future management**

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The golden mantella *Mantella aurantiaca*, a Critically Endangered amphibian species endemic to Madagascar, is a popular species in European zoos. Techniques for captive reproduction and husbandry have been developed since the 1980s and the current EAZA captive population stands at approximately 900. Despite this success, the Species Conservation Strategy (2010) focuses exclusively on wild populations with no mention of captive management. If captive populations are to play a role in the conservation of this species they require management to maintain genetic health for welfare, research and sustainability.

Using the 'Species Holding' function in the Zoological Information Management System (ZIMS), we accessed the records for every extant golden mantella within EAZA institutions and found 35 different holders. By tracing parentage and investigating 'Recent Transactions', we identified 13 independent origins in the EAZA region. These included wild-caught individuals or acquisitions from private holders. We defined lineages as all groups descended from independent imports. Our results indicated three main lineages: a wild-caught lineage originating from Genova, another from a confiscation at London Heathrow, and the London/Bristol Zoo lineage; the latter representing the majority of the EAZA captive population. Small numbers of individuals of unknown origin received from private breeders could also be combined for management purposes to form a fourth 'lineage'.

We recommend that each lineage be isolated to allow preservation of different alleles, with the exception of the London/Bristol lineage that could be further sub-divided based on geographic location and the addition of extra founders. A successful strategy needs to maintain genetic diversity while minimising inbreeding, which is why movement of individuals between holders should take place at regular intervals within the same lineage. There is an urgent need to expand under-represented lineages and undertake a genetic analysis to assess the representation of golden mantellas from the wild. Population management is essential to the viability of the European captive population and EAZA members must continue to work towards integrating conservation efforts for this species in captivity and in the wild.

## **Captive population management: the effect of male castration on behaviour and group dynamics in the white-faced saki monkey, *Pithecia pithecia***

Emma Silcocks<sup>1,2</sup>, Holly Farmer<sup>1</sup> and Matthew Webb<sup>1</sup>

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Captive breeding programmes provide an important safeguard population for endangered species. Studbook coordination requires intensive population management with specific demographic and genetic objectives to maintain a self-sustaining captive population. The European captive breeding programme (EEP) for white-faced saki monkeys (*Pithecia pithecia*) is managed by Paignton Zoo Environmental Park. Recent improvements in genetic knowledge of the population have led to management recommendations which include temporary and permanent forms of contraception. However, as for most captively managed species, there is little published evidence on the effect of contraception on individual and group behaviour. This study examines the behavioural effects of vasectomy of an adult male saki monkey at Paignton Zoo, which holds a four-member family group. The aims of the study were to determine behavioural changes in family group dynamics as a result of the procedure, focusing on social interactions. Behavioural activity budgets and enclosure use were determined using focal sampling prior to the operation and for three post-operative sampling periods. Individuals were observed in 20 minute blocks, four times a day for 10 days in each sampling period to determine behavioural effects, with a focus on aggressive and affiliative interactions. Results will contribute to future population plans and support evidence-based management recommendations for the species.

## Successful hand-rearing and subsequent post-fledging behaviour of the Java sparrow: a model Estrildid species at Paignton Zoo Environmental Park.

Bryony Baker<sup>1,2</sup>, Tom Tooley<sup>1</sup>, Leslie Connor<sup>1</sup>, Holly Farmer<sup>1</sup>, Jo Gregson<sup>1</sup> and Andrew E. Bowkett<sup>1</sup>

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The Java sparrow, *Padda oryzivora*, is a seed-eating finch commonly kept in captivity but listed as Vulnerable in the wild due to large scale trapping for the pet trade. Paignton Zoo is developing a hand-rearing protocol for this species as a model system for the intensive management of threatened Estrildid populations in the wild. Eggs and chicks of different ages were collected from the zoo's main group of approximately 40 sparrows housed in a large tropical mixed-species aviary and hand-reared. Data collected includes weight, brooder temperature and stages of development. These records can be used to determine the most suitable age for nest harvesting, the most successful diet and appropriate environmental conditions. Once fledged, the hand-raised birds were rung and released into the main group where behavioural observations were carried out in 10 pre-selected zones. Scan sampling was carried out every 30 seconds for 20 minutes daily in each zone for 20 days to record the number of individuals present, the height level occupied, whether individuals were hand-reared or not and the number of visitors present. Intra- and interspecific aggression and displacement events were recorded using all occurrence sampling. Preliminary results indicate that hand-reared birds do not associate preferentially with other hand-reared individuals and do not attempt to land on or steal food from visitors. Ongoing data collection will reveal whether hand-reared birds are less dominant during interactions with conspecifics or other species, and whether visitor numbers affect their visibility or feeding behaviour during observation periods.

## **Investigating captive husbandry, diet and behaviour of *Pterocnemia pennata pennata* (Darwin's rhea). Improving breeding success and chick survival**

Tegan Sutton<sup>1</sup>, Judith Lock<sup>1</sup>, Peter Smallbones<sup>2</sup> and Amy Plowman<sup>2</sup>

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Captive populations provide an opportunity to conserve species at risk of extinction *in situ*, however, there is huge variation in captive breeding success. One important aspect may be that the nutritional requirements of a species are not being met. *Pterocnemia pennata pennata* (Darwin's rhea), a relatively small ratite native to South America, now maintained at 33 EAZA/ESB institutes across Europe, is one example that is notoriously difficult to breed in captivity due to high infertility and low chick-survival rates. This study aimed to investigate this low breeding success using a two-pronged approach: firstly, a questionnaire to gather information on the husbandry, diets, rearing and past breeding/hatching success at each EAZA institute. Secondly, behavioural fieldwork was conducted at three zoological parks, Whipsnade Zoo (UK) and Mulhouse Zoo (France), each holding a single pair of birds, and Zlin-Lesna Zoo (Czech Republic), holding 11 birds. Instantaneous scan sampling was used to assess rhea behaviour every minute, for 5 hours, for 5 days per institute.

Questionnaire results showed positive effects of multi-species exhibits, including increased feeding frequencies and no adverse effect on egg-production. Dietary protocols across European institutes were found to be highly variable, reflecting the lack of official guidelines. All zoos were found to provide significantly lower crude protein levels compared to general ratite recommended guidelines. This could explain poor breeding success, because crude protein is vital for both adult reproduction and chick development. This suggests that the lack of research and specific nutritional requirements for this species is the most probable cause of infertility and low hatching/survivability success. This study also suggests that outdoor access is beneficial for chick survival.

Behavioural observations revealed that institute had significant effects on the frequencies of some behaviour, most probably due to enclosure-design and flock size/composition. Increased abnormal behaviours at one institute may also explain its poor breeding success and may be linked to feeding behaviours. Frequencies of observed behaviours also differed depending on bird gender and age.

Nutritional deficiencies and inappropriate dietary protocols remain the major challenge to overcome. This study highlights the need for further research on how to improve this species' reproductive success, focusing on species' nutritional requirements, which will have related effects on the welfare of animals in captivity.

## **Breeding behaviour and success of tufted puffins (*Fratercula cirrhata*): an investigation into the effects of husbandry and social environment**

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Living Coasts, Torquay, houses the only European population of tufted puffins (*Fratercula cirrhata*). In the last 10 years breeding success in the species has been limited. A recent study investigating the historical breeding records for *F. cirrhata* determined that the main influence on behaviour is disturbance during daily husbandry. In addition, the species is housed in a mixed-species exhibit with large flocks of other birds which may be influencing breeding and chick rearing success. The aim of the study was to investigate the effects of husbandry routines and social environment on behaviour prior to and during the breeding season. Three sessions of behavioural observations were carried out; one at the onset of breeding season and two during the breeding season. Instantaneous focal sampling was conducted to record activity budgets and enclosure use of all individuals ( $n=15$ ). Results aim to determine the effects of different husbandry techniques on behaviour in and out of the breeding season and to determine both intra and interspecies interactions. Findings will contribute to recommendations to improve the breeding success of *F. cirrhata* housed at Living Coasts and ultimately, a management plan to help improve breeding success in the species.

## Does flamingo behaviour and husbandry (pre-breeding season) influence the quality of their offspring

Callum McLaren<sup>1,2</sup>, Lisa Bottell<sup>1</sup>, Rudolf Nager<sup>2</sup>, Andrew Owen<sup>1</sup>, Wayne McCloud<sup>1</sup>  
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Chester Zoo's collection contains two species of flamingo, the Chilean *Phoenicopterus chilensis* and the Caribbean *Phoenicopterus ruber*. It is well documented that flamingos are unpredictable breeders both in the wild and in captivity, with many variables affecting reproductive performance. Metabolic bone disorder (MBD) is a term used to describe a number of conditions related to deformities of the bones; these disorders arise when there is a problem with the animals' metabolism and can lead to chick mortality. Both species at Chester Zoo have experienced difficulties with breeding and although MBD is linked with poor nutrition, all birds are fed the same diet. It seems likely that if there was something nutritionally deficient in the diet then we would expect effects to be seen more consistently throughout the flock. This prompted an investigation of the indirect effects that could be affecting the offspring's mortality.

The aims of the project were to provide a better understanding of the relationship between flamingo behaviours, husbandry and MBD. The study identified some of the risk factors for MBD and determined whether these factors could be influencing Chester zoo's flocks. To investigate the problem a three-pronged approach was used: record analysis, camera trap analysis and focal animal sampling.

i) To understand the differences in reproductive success and output between the two species records and behavioural data were collected via cameras and direct observations in the weeks prior to egg-laying.

ii) Following recent changes to flamingo husbandry keepers had raised concerns that the diet previously used was wasteful with other non-zoo birds being able to fly into the enclosure and compete for the scattered floating pellet. This prompted the change to a new diet with sinking pellets fed out in specially designed raised buckets. To determine whether the new husbandry regime was effective both at feeding the flock and repelling pests, camera traps were fixed on the feeding stations to examine the feeding patterns of both species. Time of day, frequency of feeds and details of other species using the feeding station were recorded and scored accordingly. The effects of both inter-specific and intra-specific competition and how this could influence the success will be suggested.

iii) Records revealed differences between and within the two species; with differing numbers of eggs laid and fertility being a key finding. Examination of the records allowed a sample of the population to be taken for further examining. Birds were chosen on the basis of having prior experience with chicks being attributed to them or having never had eggs or chicks attributed to them. Focal animal sampling was used to collect observations of the Caribbean flamingos (n=18). This part of the study aimed to reveal behavioural differences between the two sample groups which may affect offspring at the pre or post-hatching stages.

## **Do zoo visitors cause an increase in wounding aggression in captive chimpanzees and ring-tailed lemurs?**

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Aggression is an everyday part of primate societies in the wild, so we should not be surprised if aggression also occurs in captive groups. We would, however, be concerned if the captive environment caused an increase in aggression. Two laboratories in North America have reported that the number of wounds sustained by their chimpanzees are significantly higher on week days than on weekend days, and have attributed this to the stress caused by the presence of more people in the labs during the working week. Zoos are characterised by even higher numbers of people, with busiest times on weekend days. Here we test whether levels of wounding in zoo-housed primates are affected by increases in visitor numbers. We used ARKS/ZIMS data on wounding for two species in three zoos, and tested it against mean daily gate numbers for the zoos. Numbers of wounds on each day of the week were not correlated with mean gate number for those days for any of the primate groups. Significant differences in wounding totals were found between different days of the week, but they did not relate to visitor numbers, and we could find no housing and husbandry related variables that could account for the observed patterns. The annual temporal pattern of wounding in the lemurs showed a significant peak in November, their northern hemisphere mating season, implying that patterns of wounding are more linked to the natural behaviours of these captive-born animals than any housing and husbandry factors. We conclude that wounding rates, at least in these two species, are not increased by the presence of zoo visitors.

## Does the behaviour of lions and tigers change in relation to presenter talk events?

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As part of Chester Zoo's commitment to conservation education, the presenter team delivers species-specific talks to zoo visitors on pre-advertised days and times. These talks give visitors the opportunity to learn and ask questions about the animals and their natural history, as well as the conservation work that the zoo is involved in. It is useful to study the effects of such events on the animals, as part of continuous improvements to zoo animal management and the visitor experience. The zoo's animal team had highlighted some behavioural issues in the lions, which may or may not be linked to some aspect(s) of presenter talk events; they also noted that the behaviour of Sumatran tigers (*Panthera tigris sumatrae*), who are housed in an adjacent enclosure, might also be affected by these events at the lion enclosure. In order to monitor this, we investigated the behaviour and enclosure use of both of these species, comparing the periods before and after the presenter talks and on days when lions are fed during the talks or not. Data were also collected at similar times on matched control days, when no presenter talks occurred. The presenter talk events included several variables, such as the speaker system being switched on, the presenter being present, the approximate size of the crowd, and the keeper arriving with food. Such information is collected to help us determine if there is any association between these variables and the behaviours being seen. The results of this study will help the zoo to plan its presenter talk events in the future. In this presentation, we will discuss our preliminary findings in this ongoing study.

## Lemur Feeding Experiences: Welfare and the Effect of Personality

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Visitor feeding experiences, where members of the public have the opportunity to enter an animal enclosure and directly interact with those animals, are increasing in popularity in modern zoos. However, there has been very little investigation into the effect increased human interaction has on these animals. Previous research into the effects of zoo visitors on animals has suggested that visitors are a stressful influence, but these studies focus on only a few species and have produced conflicting results. Variables such as enclosure design and audience characteristics have been shown to affect results, as has individual characteristics of the animals, for example age, gender or personality.

The aim of this study was to determine whether visitor feeding experiences affected the behaviour of a breeding group of nine ring-tailed lemurs (*Lemur catta*) housed at Newquay Zoo and whether this effect was consistent between individuals in the group. Previous research on this group has suggested that feeding experiences have a neutral effect on the behaviour of the lemurs, but that the individual lemurs respond differently. The extent of this behavioural variation was unknown.

A total of 35 visitor feed sessions and 35 matched control sessions were observed. A focal individual was monitored for the duration of a visitor feed and for a thirty minute recovery period immediately after. A matched control keeper feed was then carried out on the next available day. Instantaneous sampling was used to determine state behaviours, enclosure use and proximity to visitors and keepers every thirty seconds whilst all-occurrence sampling was used to record event behaviours which may be indicative of increased stress.

Early results indicate that whilst some behaviours may be influenced during a visitor feed, all animals recover quickly, in terms of their behaviour returning to baseline levels within half an hour of the experience. The influence of personality on behaviour during experiences does not appear to be an important factor; other variables such as age of individuals seem to have a greater effect. It is hoped that these results will help shape the future feed protocol to improve the welfare for all individuals in the group.

## The effect of visitor feeding experiences on behaviour: do animals anticipate interactions and how do they respond?

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Visitor feeding experiences are a popular and important source of income for zoos, providing an invaluable opportunity for visitors to interact with both keepers and animals. The effect of zoo visitors on animal behaviour is well documented in the literature, however, there is limited research into the effects of visitor presence in keeper-areas or in an enclosure itself on animal behaviour and welfare. In addition, the performance of anticipatory behaviours can be an indication of a predictable feeding schedule which can act as a source of anxiety if there is a change in routine. The welfare of captive animals in terms of visitor interaction is of great importance, particularly for species that are involved in captive breeding programmes, as anxiety is suggested to inhibit reproductive success of captive animals. The aims of this study were to determine the effect of visitor feeding experiences on associated behaviour and general activity budgets and to determine whether animals anticipate these interactions.

Observations were conducted on a range of species at Paignton Zoo; Rothschild's giraffe (*Giraffa camelopardalis rothschildii*), black rhinoceros (*Diceros bicornis michaeli*), slender-tailed meerkats (*Suricata suricatta*), Aldabran giant tortoises (*Aldabrachelys gigantea*) and an African elephant (*Loxodonta africana*). Focal sampling was conducted on group individuals before, during and after experiences, and at the same time on the next available day without a feeding experience to provide a matched control. Behaviour and enclosure location of individuals were recorded alongside visitor noise and density outside enclosures and in addition, the demographics of the visitors and keepers involved in each experience were documented. Daily activity budgets were also recorded during experience and match control days. The use of focal sampling aims to facilitate assessment of individual differences within groups, focusing on the level of interaction with both keepers and visitors. Individual responses may have important implications for husbandry and potential human-animal relationships. Results will contribute to evidence-based management decisions for both husbandry and the design of the feeding experiences, including which species, animals and keepers are involved.

## Characterising anticipatory behaviour in four Asian elephants (*Elephas maximus*) at Twycross Zoo before and after the clock change for daylight savings time

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Anticipatory behaviour is described as a period of arousal, observed as goal-directed behaviour when a reward is expected but not apparent. Anticipatory behaviour has recently been investigated in other species to measure cognitive processing and assess welfare. The aim of this study was to characterise anticipatory behaviour and assess how alterations in the timing and predictability of husbandry routines impacted captive elephant behaviour. In particular, the impact of the end of UK daylight saving time on the expression of anticipatory behaviours was determined.

Behaviour was studied in connection with three events: (1) 'Scatter feed' at 1pm, (2) 'scatter feed' at 2.30pm, and (3) 'being let inside' for training and feeding at 4pm. Five behavioural categories were analysed by ethogram: Location, movement, feed searching, aggression and abnormal behaviour (including stereotypies). Behaviour was measured using scan-sampling technique every 20 seconds for 45 minutes before three husbandry events, for eight successive weekdays prior to the time change. Immediately after the clocks changed behaviour was recorded continuously from 8.30am to 4pm for eight days.

Presumed anticipatory behaviour in the elephants observed at Twycross was characterized by a low level of movement together with an increase in stereotypies and feed searching behaviours. As an event approached, the elephants moved towards a location associated with keeper activity. Elephants showed a variable anticipatory response to different events, which may be linked to the incentive value of the event. After the clocks changed, there was a one hour delay between the expected time for specific anticipated events and the occurrence of those events; there was an increase in stereotypies associated with these events. After the time change, feed searching, stereotypies, positive interaction and aggression increased, while movement decreased. Although there was no obvious behavioural shift to the new schedule within the short time frame of the project, there were indications that feed searching was beginning to occur in association with the new event timings. These preliminary findings suggest frustration and stress in zoo elephants may be best avoided by a gradual shift in time changes and new routines.

**A behavioural assessment of resting behaviour in captive Asian elephants  
(*Elephas maximus*) in three UK zoos**

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It is recognised that maintaining adequate welfare in captive elephants is challenging. Identifying appropriate measures of welfare are paramount to assessing and improving conditions for captive elephants. Previous studies have suggested that sleep behaviour can be used as an indicator of welfare, with reduced sleep indicative of poor welfare. In large herbivores, links have been made between duration of sleep and comfort in the environment. However, information on sleeping behaviour of captive elephants is limited, and further work is needed to identify whether factors which can be manipulated within the captive environment are affecting the frequency of recumbent rest. This study investigated the effect of environmental conditions (enclosure design, husbandry and management) on resting behaviour in captive Asian elephants (*Elephas maximus*). This information can be used to identify housing and husbandry conditions that both enable and encourage captive elephants to engage in increased periods of recumbent rest, on the assumption that this would improve their welfare.

Resting behaviour was analysed using video footage of 14 elephants (2.12) housed at three zoos within the UK (Zoo A: 14 nights, March to November 2012; Zoo B: 27 nights, June to July 2013; Zoo C: 46 nights, May to July 2013). Elephants spent up to 31% of night-time observations engaging in either standing or lying rest. Mean time each elephant spent resting per night ranged from 58 to 461 minutes. Environmental factors were assessed for their effect on type (standing or lying), duration and frequency of rest bouts. Time of night affected type ( $\chi^2=211.82$ ,  $p<0.001$ ,  $df=8$ ) and duration ( $H=252.64$ ,  $p<0.001$ ,  $df=8$ ) of rest; standing rest occurred throughout the night whilst lying rest predominantly occurred between 20:00h and 06:00h. Mean duration of rest was greatest between 00:00h and 04:00h. Lying rest was not observed on concrete or tiled flooring (available to 7/14 elephants). Where available, all elephants lay on sand flooring (11/14 elephants) whilst only two individuals lay on rubber flooring (available to 7/14 elephants). Apart from the sub-adult bull at Zoo B, elephants in each collection were housed together over night. Resting in the presence of at least one conspecific occurred significantly more frequently than when conspecifics were absent ( $p<0.001$ ). This study provides scientific evidence to support current British and Irish Association of Zoos and Aquariums (BIAZA) guidelines on flooring substrate and group housing. The results highlight the importance of housing compatible individuals together at night. The results of this study suggest that elephants should have access to sand flooring at all times and that compatible groups of cows and young should be housed together overnight.

## The social relationships between female African elephants (*Loxodonta africana*) at Knowsley Safari Park

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African elephants (*Loxodonta africana*) are renowned for their highly social lifestyle, with the importance of social behaviour well documented. A diverse repertoire of social interactions are used to maintain social relationships and group stability, vital for successful group living and survival. African elephants *ex situ* are regularly housed in unnatural social structures, with the presence of unrelated individuals and smaller group sizes. Appropriate housing of African elephants is important for social behaviours to be exhibited, enhancing social compatibility and promoting successful group-living.

The aim of this study was to compare the occurrence of social interactions between six female African elephants at Knowsley Safari Park, Merseyside, in order to assess the herds social cohesion and stability. The herd consisted of both related and unrelated individuals. It was hypothesised that there would be social preferences among the herd, with kinship being a primary influence. The elephants were studied for 56 hours in their outdoor enclosure. Instantaneous scan sampling was used at 30 second time intervals, and an ethogram defining both solitary and social behaviours was used. Spatial proximity and affiliative trunk-to interactions were analysed. A total mean for each interaction between dyadic pairs calculated and independent t-tests used to test for significant differences.

Data analysis showed the strength of social relationships varied, confirming the presence of social preferences. The two adolescent females were the most central individuals, indicated by high frequencies of social interactions with both relatives and unrelated individuals. The most subordinate adult female spent considerable amounts of time alone and had a distinct lack of trunk-to interactions, despite her level of kinship within the group. The remaining adults varied in their strength of social relationships with others. Using existing literature, the study suggests the social cohesion and stability of the herd is not distinctly evident. Dominance, kinship and familiarity seemed to influence relationships, consistent with literature based on herds *in situ* and *ex situ*. However results concerning particular individuals suggest social incompatibility. Analysing a greater number of behaviours throughout a longer study period would provide a greater insight into these relationships. This study may provide a broader understanding of social relationships within African elephants *ex situ*, leading to the development of more appropriate management programmes for successful group living.

**Group composition and feeding activity affect agonistic and stereotypic behaviours in captive female Asian elephants, *Elephas maximus***

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Activity budgets were studied in three female Asian elephants (*Elephas maximus*) at Blackpool Zoo (UK) for 40 hours, recordings were made between 10:00 and 14:30hr, during September and October, 2013. Twenty hours of observational data were collected under baseline conditions where all three females had access to each conspecific; and another 20 hours after the dominant individual had been separated from the subordinate elephant. No significant difference in the number of aggressive encounters was found ( $Z = -1.60$ ,  $p = 0.109$ ), contrary to the hypothesised decrease after the separation. Conversely, a significant increase in stereotypic behaviour was exhibited by subordinate individuals ( $t_4 = 2.90$ ,  $p = 0.044$ ,  $t_4 = 4.17$ ,  $p = 0.014$ ). These results indicate that management changes can affect the mental stability of an elephant in the early stage of social isolation. The dominant individual was also significantly more inactive in comparison to the subordinate females, spending 40% of the time budget resting. The introduction of greater unpredictability into management regimes, especially feeding times, may reduce the frequency of stereotypic and agonistic behaviour and increase general activity levels.

## Development of liquid chromatography-mass spectrometry for the determination of ovarian activity in female Asian elephants (*Elephas maximus*)

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Non-invasive faecal hormone monitoring is a vital tool to assess captive female Asian elephant reproductive health. This can be achieved using progesterone metabolite enzyme immunoassay's (EIA); however, a more efficient and direct method that is not reliant on antibodies, which can have sensitivity limits, reliability issues and unwanted cross-reactivity, is desired. The aim of this study was to determine whether liquid chromatography-mass spectrometry (LC-MS), which separates molecules dependant on their polarity and mass, could be utilized to identify specific progesterone metabolites in female Asian elephant faecal samples.

A subset of faecal samples were taken from those collected as part of routine reproductive monitoring [pregnancy (n=1; age 14), faecal samples (total n=25) taken twice per month over 92 weeks; oestrous cycles (n=4; 2 consecutive oestrous cycles from n=2 individuals; age 5 and 44): faecal samples (total n=60) taken 1-2 per week over 24 weeks per individual]. To develop the LC-MS techniques, first a pool of faecal material (n=2 oestrus cycle; n=1 pregnancy) was extracted with 90% methanol followed by purification via syringe filter (Titan 3, 30mm; Thermo Fisher Scientific) and solid-phase extraction (SPE: Hypersep C8 cartridges, Thermo Fisher Scientific) and separated via high performance-liquid chromatography (HPLC; 1 ml fractions over 80 minutes). Additionally, to determine ovarian metabolites, nine synthetic progestogen standards were also separated using the same HPLC methods. All fractions were analysed on the progesterone metabolite EIA which identified 5 $\alpha$ -pregnane-3,20-dione, 5 $\beta$ -pregnane-3 $\alpha$ -ol-20-one and progesterone as potential native faecal progesterone metabolites in both the oestrous cycle and pregnancy faecal samples. In the next step, the SPE method was refined by modifying the optimal priming and loading methanol/water concentrations and the assay parameters for the LC-MS were defined to target the 3 metabolites of interest. Using this refined method faecal extracts from one oestrus cycle (n=30) were analysed on 3 assays on the LC-MS; however, comparable hormone patterns (i.e. oestrus cycles) observed on the progesterone metabolite EIA were not observed on any of the LC-MS assays. Currently modifications in the faecal extraction procedure (increasing the faecal mass) and SPE techniques (testing different cartridges) are being explored to improve the purification of the extract to enable detection of hormone metabolites on the LC-MS assays.

In conclusion this study has defined the parameters for 3 ovarian metabolite LC-MS assays (5 $\alpha$ -pregnane-3,20-dione, 5 $\beta$ -3 $\alpha$ -ol-20-one and progesterone), laying the ground work towards the development of a quantitative LC-MS method for the determination of oestrus cyclicity and pregnancy in the Asian elephant.

## Using research for the development of our elephant management programme.

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Working as an elephant keeper for the last 11 year I have realised that it is quite easy to think you know what your animals get up to in their daily lives. However, what you think they do and what they actually do is often two very different things.

Through forming a good working relationship with several local universities we have been able to develop the husbandry management of the African elephants we house at the park. The use of undergraduate and Masters research projects has become an invaluable tool in the assessment of the day to day running of the large mammals department, as well as deciding what direction it should be steered in in the future.

## **Cognitive enrichment in the context of the University of Stirling and Blair Drummond Safari Park**

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There is good evidence that animals enjoy thinking and learning; they like to have control over their lives, to explore and understand their environment and object properties. This is why we do cognitive enrichment. Animals will seek out challenges that require them to learn to get the reward rather than take the same freely available reward and their heart rates increase when clear improvements in learning have been made. Providing opportunities to learn also has been shown to lead to reduced excitement and fear behaviour and is known to reduce cognitive decline. In this presentation we shall describe how we see the concept of environmental enrichment and animal husbandry evolving to be animal-led rather than keeper-led. We shall focus on how staff and students at the University of Stirling and the Safari Park have worked together to improve the welfare of animals, and how the theory behind what improves welfare has been applied in a practical context. The consequence has been to cognitively enrich both human and non-human animals, and has provided a sound evidence base for animal management decisions.

## A study of audio enrichment in a northern rockhopper (*Eudyptes moseleyi*) penguin colony at Edinburgh Zoo

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A study of effects of short-term audio enrichment was carried out in a northern rockhopper (*Eudyptes moseleyi*) penguin colony at Edinburgh Zoo (Latitude: 56°N). The rockhoppers' enclosure is ecologically relevant, with steep slopes and rocky outcrops, which encourage natural climbing behaviour and also allow penguins to avoid the enrichment. The enrichment sessions (n=26) were conducted between late January and mid-February. These sessions were evenly divided into scenarios in which music emanated from a protected ECOXBT bluetooth speaker located either in an aquatic (at surface of 0.8 m deep pool, 2 m from the pool edge) or in a terrestrial (ground-level, 5 metres from the pool edge) position. The music (consistently 'Black and Blue' by EZ83) was played at a moderate volume setting, sufficient to permit it to be heard by humans from a distance of 15 and 30 metres, for aquatic and terrestrial sessions respectively. Each session lasted 35 minutes and comprised 15 minutes of music, with 10 minutes of no music both before and afterwards.

Results indicate that the males were more likely than the females to stand near and to interact with the music source during terrestrial sessions, while there was very little interaction with the music source during aquatic sessions. Interaction with the music source occurred after placement of the container and during the first 5 minutes that the music was playing, with a mean of 3% of males (s.e. = 1.6%) interacting compared to 0.8% of females (s.e. = 0.8%) at 12.5 minutes after sessions began (2.5 minutes into enrichment). Males were more likely to stand near the music source during the first 7.5 minutes of the music episode, and females during the last 7.5 minutes. Time of day also affected the rockhoppers' responses, with less interaction following their afternoon feed. Audio enrichment did influence the incidence of vocalisations, with an increased number of vocalisations during enrichment. Data indicated that some individuals approached and interacted with the music source more than others. Those interacting individuals were also likely to be involved with aggressive behaviour, either as aggressor or as recipient. Aggressive behaviours included both bill displays, where the bill was fully open in display with the head raised or lowered in relation to the body, and bill duels, in which contact was made between the bills of duelling birds. Aggression, however, was only recorded in 3 of 13 terrestrial sessions, with no aggressive behaviours recorded during aquatic sessions. There was an increase in the incidence of positive behaviours, such as bathing and porpoising, during and after audio enrichment in the aquatic sessions. Notably, audio enrichment during aquatic sessions resulted in an increase in the number of birds swimming and a decrease in the number of birds standing near the pool.

Further studies could look at effects on penguin behaviour of (a) patterns of audio enrichment (e.g. constant or intermittent; regular or not; same or different audio track); (b) type of music or sounds used; and (c) loudness and other properties of the audio enrichment used.

## **Is auditory enrichment actually enriching for zoo-housed chimpanzees (*Pan troglodytes*)?**

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Many captive primates experience music; classical music for animal enrichment and pop/rock for caregiver enjoyment, however, whether music is actually enriching for the animals is not well understood. Our research investigated the welfare impact of classical and pop/rock music on 18 chimpanzees at Edinburgh Zoo. We first tested whether music affected their use of space and whether they approached/avoided areas where music was playing. We then tested whether music affected the behaviour of those chimpanzees who chose to listen; whether active behaviours were increased and whether aggression and stress behaviours decreased, indicating an enriching effect on behaviour. We addressed these research questions for both genres together, as well as examining if music type had differential effects on behaviour. The enclosure in Edinburgh comprises of three indoor 'pods', connected via tunnels, and a large outdoor enclosure, allowing the animals choice over where they spend time. Trials lasted one hour, comprised of 30 minutes silence and 30 minutes, with start times counterbalanced across trials, broadcasting music into just one pod so the chimpanzees could choose to avoid it. Over four months 38 trials were completed. Unfamiliar tracks of classical music with less than 90 BPM and pop/rock with more than 90 BPM were chosen. Music type alternated across trials. Instantaneous scan samples (Altmann, 1974) recording active, passive and stress behaviours of those present in the pod occurred every three minutes. The time at which individuals entered/exited the pod and the occurrence of aggressive events (aggressors displaying or chasing and/or hitting another individual) within the pod were recorded on an all occurrence basis (Altmann 1974). Chimpanzees spent significantly more time in the area during silence than when music was playing. There was a trend for a higher frequency of aggression when music was playing, compared to silence, but no difference in the frequency of either active or stress behaviours in music or silence. In addition, no differences in behaviour were found between music genres. These results do not suggest these types of music have enriching effects for captive chimpanzees. There are indications they choose to avoid music, particularly high BPM tracks, and they may be more aggressive in the presence of music. Previous research on animals that could not escape music suggested music has positive effects on primates (Howell et al., 2003; Videan et al., 2007). However, our findings support research by McDermott and Hauser (2007) that tamarins and marmosets preferred silence over music. We suggest that despite the ease and cost efficiency of playing music, this is not effective for captive chimpanzees and alternative types of enrichment should be employed. If facilities play music for staff, music with less than 90 BPM should be played preferentially and animals should be given the opportunity to avoid the music.

## Effects of environmental enrichment on foraging behaviour of emerald monitor lizards (*Varanus prasinus*)

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Research into environmental enrichment for reptiles to stimulate cognition and natural behaviours is lacking when compared to mammals and birds where enrichment is considered a vital part of animal husbandry (Burghardt, 2013). Monitor lizards are considered highly intelligent animals with the ability to show decision making behaviours and display advanced motor coordination (Greene, 2004). The *Varanus prasinus* complex is a group of arboreal monitor lizards containing several species. One of these, *Varanus beccarii*, is known to display complex behaviour involving the use of the forelimbs to extract food from holes and crevices too small to admit their head and snout. This is referred to as forelimb extraction (Mendyk & Horn 2011). Food sources are extracted by extending a forelimb anteriorly to the food source, attempting to grasp the food, and then flexing the forelimb to bring the food within reach of the snout. Most reptiles only use their mouths for prey manipulation making this a rare ability. With many monitor lizards being kept in captivity it is vital that enrichment is provided to allow them opportunities to express a wide range of natural and complex behaviours.

This study looked at emerald monitor lizards, *Varanus prasinus*, to study the impact of enrichment devices on foraging behaviour and to allow the subjects the potential to use their forelimbs to extract foods. Two devices were available to allow choice between different locations of enrichment. Behaviours were recorded continuously for the hour prior to any enrichment devices being introduced, an hour during which the enrichment was present and an hour following the removal of the enrichment. Data were recorded over twelve sessions between October and December 2013. Due to changes in the housing of the monitors for husbandry reasons it was only possible to record the behaviour of the male. Results showed that *V. prasinus* does indeed display forelimb extraction behaviour when given the opportunity using an enrichment device. Time taken to approach and interact with the enrichment device reduced with repeated exposures indicating a learned association of food with the device, regardless of food type offered. Behaviours associated with foraging, such as tongue flicking, increased significantly when the enrichment was available (t-test,  $p < 0.001$ ). Food was extracted using the snout or forelimb from any angle or position around the device. The subject also seemed to display preference for its left forelimb for extractions though it displayed no difficulty using its right. Results also appeared to show an increase in raking behaviour (using forelimb to scratch through substrate) in a period after the device had been removed. There was also an increase in time spent patrolling post device, although this did not reach statistical significance. This species readily used limbs and snout to gain food from enrichment devices.

## Behavioural effects of fruit-free diets for primates

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Many primates are classified as frugivorous and therefore fed fruit in captivity. However there is huge variation in the extent to which different species consume fruit in their wild diets and also a huge difference in the nutrient content between wild fruit and orchard-grown fruit, bred to be palatable to humans. Orchard grown fruit has a much higher sugar content and lower fibre and protein content than wild fruit. Dental disease and obesity, and associated diseases such as diabetes, are common in captive primates and are likely to be linked to the use of fruit in captive diets. At Paignton Zoo we have removed fruit from all primate diets and have recorded significant improvements in dental condition and weight management. In more recent studies we have started to look at the effects of fruit-free diets on primate behaviour.

Between 2012 to 2014 observational studies were conducted on four species of lemur and three species of callitrichid before and after diet changes at Newquay Zoo and Paignton Zoo Environmental Park. The primary diet change was the removal of all fruit from the diets thus reducing the content of readily digestible carbohydrate (sugar and starch). Fruit was largely replaced by vegetables, especially green leafy varieties. For tamarins and marmosets the new diets also included increased amounts of insects and gum. Results indicate that diet changes do affect behaviour with very clear reductions in aggressive and self-directed (SDB) behaviours in lemurs when fed the fruit-free diets. Results for the callitrichids were more mixed but overall indicate that behavioural welfare was improved when fruit was removed from their diet.

## Using research to help with management of the greater one-horned rhinoceros at Chester Zoo

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There is limited knowledge about the behaviour of the greater one-horned rhinoceros (*Rhinoceros unicornis*) currently. The aim in this study was to measure the behaviour and enclosure use of the adult male, adult female and their calf at Chester Zoo, to add to our knowledge about these animals. The study includes some periods when they share the paddock with two other species (blackbuck *Antelope cervicapra* and Burmese brow-antlered deer *Rucervus eldii thamin*), enabling us to monitor interactions that may occur between the rhinoceros and these other species. Observations of behaviour and enclosure use have been made non-invasively from public areas, and using video footage from remote cameras in off-show areas. It also allows us to make comparisons between periods when the female is in oestrus or not, and to attempt to identify behavioural signals of this. Furthermore, weights of each rhinoceros have been recorded weekly as part of routine husbandry, to help monitor the animals' health. Particular attention has also been paid to the condition of the soles of the adult male rhinoceros' hind feet, as he is prone to excess skin growth there and it is important for us to monitor and act upon this. For the foot monitoring, we have taken photographs of his back feet weekly, and reviewed and acted upon these as part of routine husbandry. This research is important as it will improve our limited understanding of the greater one-horned rhinoceros, and enables us to make informed decisions about the husbandry of the collection at Chester Zoo.

## Effects of UV light on the behaviour of purple jewel beetles (*Smaragdesthes africana oertzeni*)

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The necessity of providing UV light for the wellbeing of captive reptiles is well documented but other taxa have the capacity to perceive UV light and its biological function is less well understood. This study investigated the effects of UV on the behaviour of captive purple jewel beetles (*Smaragdesthes africana oertzeni*), a medium sized member of the family Scarabaeidae. Specifically, the enclosure use and behaviour of two populations, kept under different UV levels, were compared.

Two populations of 23 purple jewel beetles, 16 males and 7 females, were kept in similar vivaria under a UV emitting light, with a UV attenuating cover over one tank. An ethogram of behaviours was compiled following a baseline study. A scan sampling technique was used to record the behaviour and location of each of the beetles at two minute intervals over sessions of two hours, on one or two days per week between September and December 2013. The location in the vivarium was based on vertical height (top, middle, or bottom). During the study UV levels within the UV present tank were adjusted by raising both tanks closure to the UV source. Three UV levels (1.1, 1.2, and 1.5 as measured using a Solarmeter model 6.5) were used for comparison against UV 0. For analysis behaviours were grouped into 6 major categories; locomotion, feeding, basking, interaction, resting and out of sight. Results presented are based on 10 minute interval data to reduce the effects of pseudoreplication.

Enclosure usage showed that in all cases a higher percentage of observations occurred in the top third of the enclosure when UV was present. Where UV was attenuated beetles were more likely to be in the lower part of the enclosure, significant in a chi-squared test,  $p < 0.001$ . The data also showed a number of differences in the behaviour of the two populations. Basking behaviour was higher in enclosures where UV was present. Locomotive behaviour was higher in the enclosure where UV was attenuated. A Wilcoxon test was significant when comparing basking behaviour ( $p = 0.013$ ). These results indicate that UV does have an effect on the beetles with differences in both enclosure use and behaviour which may have implications for the welfare of captive beetles. However, the relationship requires further investigations into the biological relevance of UV for this species, such as effects on mate selection, competition and breeding success.

## Who's the top dog? A study of behaviour and paddock use of the African painted dog (*Lycaon pictus*) at Chester Zoo

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The African painted dog (*Lycaon pictus*) is one of the world's most endangered canid species due to habitat fragmentation, infectious diseases and predation. Pack size is strongly correlated with successful breeding, hunting and survival, and previous studies have demonstrated that a critical threshold of 5 pack members is necessary for successful re-introduction. Strong dominance hierarchies are present in both male and female pack members, which help to maintain cooperation between individuals. Position within the hierarchy directly influences both food access and individual reproductive success; high ranking males gain priority access to prey items and subordinate individuals forgo reproduction to help rear the offspring of the alpha male and female. In the wild packs commonly consist of 5 to 15 individuals, however constraints on space and funding can strongly influence pack size in captivity, which may in turn affect social dynamics and behaviour. Understanding social structure in captive packs is therefore important to promote the natural behavioural repertoire and potentially maximise success of conservation breeding programmes.

This project was identified following a suspected change in the hierarchy of the painted dog pack at Chester Zoo. An ethogram was developed with the principle aim of confirming social ranks and to record time budgets for each individual. As food delivery regularly occurred one hour before the scheduled feeding time, enclosure use was also recorded to monitor potential anticipatory behaviour by individuals. Observations were conducted before and during feeding time using instantaneous scan sampling methods at 1 minute intervals over a total period of 16 hours.

Individuals showed distinct differences in their behaviour, particularly during feeding. Three males consistently gained priority access to the carcass, which together with other behavioural observations, confirmed social rank positions of individuals within the pack. There was also evidence to suggest that members of the pack may anticipate keeper arrival prior to feeding, due to the changes observed in enclosure use following food delivery.

This project demonstrated that relatively short behavioural observations in and around feeding time can be useful when identifying the social rank of pack animals, as well as provide evidence to aid management decisions in captive collections.

## **Aggression and calls during the breeding season of captive gentoo penguin (*Pygoscelis papua*) at Edinburgh Zoo**

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Many animals breed seasonally, including penguins and with a change in hormones and ecology, comes a change in behaviour including calls, courtship and levels of aggression. Many studies state increasing aggressive interactions are caused by levels of testosterone in males and corticosterone and other sex steroids in females increasing. Aggression is less severe outside breeding season and acts to resolve minor disputes. However, once breeding season commences, individuals are very protective over resources and defend their territory when required. In monogamous species, both sexes initiate aggression to protect resources for reproduction as biparental care occurs in gentoo penguins (*Pygoscelis papua*). Within aggression, sexes will usually initiate to the same sex and similar is seen in age groups with adults initiating more aggression toward adults and juveniles to juveniles and this study set out to test this. Many studies have occurred in captivity on levels of aggression and other behaviours in different species and this study set out to discover how aggression and calls change during a 5 week period of the breeding season in the gentoo penguins at Edinburgh Zoo. Sex and age demographics of aggression were analysed to discover which groups initiated aggression more often.

It was found that aggression significantly increased over time as expected, but calls did not. There was no significant difference between the sexes, but there was between adults and juveniles in males and females. An analysis into the demographics of sex and age found both sexes initiated aggression significantly more towards the same sex than the opposite sex. In relation to age, adults and juveniles initiated significantly more aggression towards the same age group in both sexes. The study into aggression supported previous studies that found aggression increases due to the requirement to protect nests and other resources. The sex and age demographics also supported previous studies. In regards to calls, this study found no change over time, however further study would provide a better understanding of this topic.

## Which age and sex instigates the most aggression in a captive troop of hybrid baboons and why?

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The focal animals of this study of primate aggression were hybrid *Papio anubis hamadryas* (*P.anubis* x *P.hamadryas*) housed at Knowsley Safari Park. The troop stood at 280-300 individuals with an uneven sex ratio of two males to one female. The aims of the study were to determine which age and sex groups instigate the most aggressive encounters, to decipher reasons that may be behind aggressive behaviours and to provide results and possible solutions to the large amounts of aggression within the troop. Continuous recording was used to record all occurrences of five behaviours within 15 minute periods. The results showed that male baboons were the most aggressive; adult baboons were more aggressive than the sub adults age group; sub-adult male baboons were more aggressive than sub-adult females and the baboons showed more aggressive behaviour inside their house than outside in the enclosure. In addition, adult females were subject to more acts of aggression than males or sub-adults; and adult males, adult females and sub-adult females all express 'threat' significantly more than any other aggressive behaviour. There are several reasons behind the high levels of aggression in this troop, which include too small a space for the number of animals, a disproportionate ratio of sexually mature males, a high sugar diet and food distribution method.

## Contagious yawning in bonobos?

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Contagious yawning has been studied in various primate species, and has been interpreted as a signal of empathy. In the current study we investigate contagious yawning in a group of 9 captive bonobos at Planckendael, Belgium. In a first phase we did an observational study, where we observed when bonobos yawned and checked whether individuals that saw the yawning would also yawn ; in the second phase we showed movies of familiar yawning bonobos as well as control clips to individual bonobos, following a design by Campbell and de Waal (2011); in the third phase we projected the yawning clips of familiar individuals as well as control clips on a wall in the enclosure, following a design by Massen et al. (2012); in the fourth phase we projected yawning and control clips of unfamiliar individuals from other zoos on the enclosure wall. In the observational study we found a significant difference between yawns that were observed and control data, but the effect size was very small and very few cases of contagious yawning were observed. In the second phase bonobos showed very little interest in the movie clips, and no yawning was observed. In the third phase bonobos yawned when seeing the yawning movie clips, but there was no significant difference with the control movies. The response in the final phase, with unfamiliar individuals, did not differ from the previous phase. In short, we found little or no evidence of contagious yawning in our study. We discuss possible explanations and make suggestions for future research.

## Poster Presentation Abstracts

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### Development of an Education Evaluation Toolkit

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For modern zoos, simply displaying animals for recreational purpose is no longer sufficient and to be a member of BIAZA, EAZA and WAZA they must be seen to be partaking in conservation, research and education initiatives. At Paignton Zoo Environmental Park, and its sister zoos Living Coasts and Newquay Zoo, education and engagement is one of the main aims of the strategic plan, to enable learning and improve understanding with a view to implementing behaviour change. Evaluation is critical to allow assessment, improvement and consistency of both formal and informal education. A toolkit has been developed to provide resources to facilitate evaluation by zoo educators and researchers via a series of folders and documents that guide the user through the design of an evaluation study. It is delivered alongside extensive background information to provide an appreciation of the scale of the field.

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### Hot enough? Evaluation of heat provision for effective thermoregulation in three species of reptiles at Chester Zoo (Komodo dragons, Galapagos tortoises and red tailed racers).

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Unlike mammals, reptiles are unable to control their own body temperature and so rely on their surrounding environment to provide for their needs, such as moving from exposed basking areas to cooler shaded areas to avoid overheating, dehydration and to maintain their body temperature. All reptiles are able to maintain and regulate a preferred body temperature through the use of heterogeneous thermal environment. This was documented in Komodo dragons (*Varanus komodoensis*) showing that dragons of varying sizes were able to maintain a similar active body temperature regardless of their size by using their surrounding environment to regulate their body temperature. However, in dragons it was recorded that larger dragons took longer to heat up and cool down than smaller dragons. Larger animals may utilise warmer basking spots or environments to reach optimum body temperature while smaller dragons may use slightly cooler areas.

This study investigates the suitability of the heat provision with the enclosures for Komodo dragons (*Varanus Komodoensis*), Galapagos tortoises (*Geochelone nigra*) and red tailed racers (*Gonyosoma oxycephalum*) by recording and assessing ambient and basking spot temperatures and using camera traps for behavioural observations of the animals within the enclosures. This will allow for better observation of their behaviour and allow for better interpretation of how they utilise their environment to regulate their body temperature. While an animal's size may be irrelevant when it comes to optimum body temperatures it will affect a reptile's thermoregulatory behaviour and their behaviour in relation to basking.

The species chosen for this study were carefully selected by size and body shape. Komodo dragons with a linear anatomical structure, occupying a terrestrial habitat once fully grown gives a representation of thermoregulation of this body shape within its environment. The Galapagos tortoise is also a large reptile, however, it is a domed shaped animal and so will be affected by heat sources and basking much

differently than varanids. Its terrestrial nature also makes it a representation of all tortoise species as they all share a similar shape and ecological niche (terrestrial). Selection of the red tailed racers is to act as a representation of all snakes, similarly to the Galapagos tortoise, snakes are unlike both varanids and chelonians because they can assume various shapes depending on their position and/or activity and occupy multiple ecological niches both terrestrial and arboreal. This project will help to illustrate the importance of providing correct heat provision for a reptile and may help improve husbandry in zoo collections specifically for larger reptile species such as *V. komodoensis* and *G. nigra* and will form a template method of assessment which can be implemented in zoos.

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### **The effect of environmental enrichment on pacing in giant anteaters (*Myrmecophaga tridactyla*)**

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Giant anteaters (*Myrmecophaga tridactyla*) are a species that are growing in interest within animal collections, though there is very little research about the species. It has been shown that the species exhibit stereotypical pacing; therefore the aim of the study is to explore methods to reduce the occurrence of this behaviour in captivity. A pair of giant anteaters was observed at Blackpool Zoo during three periods (pre, during and post enrichment). A feeding device was constructed from bamboo and filled with different combinations of novel food. Behaviours were monitored and then analysed using a general linear model ANOVA or a Kruskal-Wallis test. A correlation was used to look at the effect of visitor numbers on pacing behaviours.

No significant differences were found in most of the behaviours, apart from when 'active' and 'inactive' behaviours were grouped. A significant difference was found in active behaviours through enrichment periods ( $F_{[2]} = 8.83$ ,  $P < 0.001$ ) and the individual day ( $F_{[2]} = 2.65$ ,  $P < 0.05$ ). The behaviour closest to significance was found to be the pacing behaviours ( $F_{[2]} = 2.92$ ,  $P = 0.07$ ). The results indicate that although pacing behaviours were not significantly reduced the environmental enrichment had an effect on reducing pacing behaviours in both individuals.

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### **Goats in the Gully**

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The Avon Gorge and Downs is regarded as one of the top three sites for rare plants in England. Thus the management of the grassland habitats found within the boundaries of the Avon Gorge is of great importance. Kashmir goats were introduced to the area known as the Gully in June 2011, as part of a conservation action plan devised to restore limestone grassland, but have not been studied systematically. The area is fenced to contain the goats within a defined area. The main objective was to observe and record the behaviours and locations of the animals over the autumn. Locomotion, foraging and stationary behaviours were used along with location and habitat use to determine any patterns in their behavioural routine and spatial use of the Gully. Foraging behaviour was particularly of interest as a browse frequency of greater than 90% is an indicator of good habitat quality and suitability (Papachristou, 1996). Furthermore a seasonal impact on feeding behaviours was expected.

Data were recorded using a scan sampling method to note the behaviour and location of each of the six goats at five minute intervals over two hour periods. The number of steps and bites in a 15 minute period were recorded for each goat each week. Recording sessions were conducted for between four and eight hours a day, once a week between 7<sup>th</sup> October and 4<sup>th</sup> December 2013. Time of day, air temperature and general weather conditions were also noted.

The results showed that the goats had a preference for particular areas within the gully where there was an abundance of diverse scrubby vegetation. Stance used for foraging was found to change over time with a shift from feeding while standing with the head below belly height to feeding with head above belly height around half way through the project. This was probably as a result of reduction in ground level foliage as autumn turned to winter. Browsing consistently constituted more than 90% of the feeding behaviours. Bite rates were consistently greater than 15 per minute, a figure considered to be a good indicator of habitat quality, (Mancila-Leyton *et al*, 2013). There was a strong, negative correlation between step and bite rates,  $p < 0.001$ . The foraging behaviours indicate that the habitat is of appropriate quality for the goats. They are likely to have the desired impact on the control of scrubby plant species in the area of the gorge within the fenced area. Type of plant cover and numbers of the rare plant species are being monitored by others over a longer time frame. This study will help to provide evidence of the contribution of the goats to the restoration of the limestone grassland.

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**Variations in behaviour in white rhinoceros, *Ceratotherium simum*, mothers and calves,  
and interactions and play behaviours observed in captivity:  
Implications for captive management and conservation**

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The white rhinoceros, *Ceratotherium simum*, is under serious threat of extinction in the wild. Understanding how a species' behaviour varies can prove vital for captive management and can also aid with conservation efforts. The aims of this study were to observe how *C. simum* behaviour varies and also observe interactions between individuals. Using focal instantaneous sampling, behavioural data was collected over a four month period on six individuals – three adult females and three calves (one female and two males). Variations in behaviour were compared between adult and calf, between different times of the day and between different weather conditions. Proximity between mother and calf was also recorded and compared over the data collection period. Furthermore, interactions and play behaviours observed were recorded. The main behaviours for all individuals were foraging and resting accounting for 70.4% of their total time budget. Statistically significant differences in behaviour were observed between adult and calf, but not between different times of the day or different weather conditions. Statistically significant differences in mother-calf proximity were found. The results show how a variety of different factors affect *C. simum* behaviour, which can be useful for planning husbandry procedures. They also indicate the importance of correct captive animal management.

## **Using behavioural data to monitor the success of husbandry changes on Bengal tigers at West Midland Safari Park**

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West Midland Safari Park has held tigers for many years, historically housing several groups and single animals in a series of neighbouring enclosures. As is common in many captive carnivores, pacing was observed in several of the cats held at the park. Causative factors had been tentatively examined in previous undergraduate projects with the presence of conspecifics in adjacent compounds and the lack of frequent enrichment suggested as possible candidates.

In 2012 the Research Department and the tiger section embarked on a longer term project to look for evidence of behavioural change as the keepers made adjustments to husbandry in order to improve welfare. Students from the University of Gloucestershire, using a pre-determined sampling method and ethogram, have carried out BSc dissertation projects on the tigers for the past two years. Logistical considerations have not allowed for a perfect study design but so far we believe we have found a balance between meeting the needs of the keepers and the students, generating valid scientific reports and providing information which can help guide husbandry.

Preliminary findings, focusing on a male/female pair of siblings (female with contraceptive implant) are presented. Between observations in July 2012 and observations in Sept 2013 changes were made to the cats' environment, including screening between their enclosure and the adjacent enclosure, the introduction of a more constant enrichment programme and the replacement of a female tiger in the adjacent enclosure with a male tiger. Comparison of behavioural data between 2012 and 2013 indicated that both focal cats showed more stereotypic behaviour when the cat in the adjacent enclosure was of the same gender. However the female paced more with an adjacent female than the male does with an adjacent male. The cats do respond and interact with most enrichments offered and enrichment does appear to have some success in reducing pacing.

Findings from the project have been fed back to the tiger section. Keepers are continuing and enhancing the tiger enrichment programme and have made the visual barrier between the enclosures more complete. Observations, following the same time scale and method are underway by this year's students from the University of Gloucestershire.

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### **Investigating paddock use and behaviour of Rothschild giraffe (*Giraffa camelopardalis rothschildi*) at Chester Zoo**

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As captive environments are required to fit the comprehensive guidelines set by the Animal Welfare Act (2006) and the Zoo Licensing Act (1981), zoos and safari parks are responsible for providing adequate space and resources to encourage naturalistic behaviour. Constraints and confinements of life in captivity can result in the performance of abnormal behaviours including stereotypies, prolonged inactivity, as well as over-grooming. Rothschild giraffe (*Giraffa camelopardalis rothschildi*) are herbivorous animals with specialised diets, and as a result home ranges in the wild can reach above 160km<sup>2</sup>. Paddock use and abnormal behaviour is therefore important to monitor in this species, to help inform future management decisions about resource provision and other husbandry measures.

This study investigated the behaviour and paddock use of individual animals in a herd of Rothschild giraffe at Chester Zoo. A pilot study was conducted over a two day period to design the most appropriate ethogram for the seven individuals studied. Paddock use was recorded by splitting the area into six sections, using landmarks within the enclosure as visual markers. Observations of individuals' behaviour and paddock use were conducted using instantaneous scan sampling methods at one minute intervals for multiple 60 minute sessions over a five month period. All live observation data was transcribed into Microsoft Excel at regular intervals and graphs were produced to provide a snapshot of individual time budgets and paddock use for use by the giraffe team. A spread of participation index was calculated to determine how the herd use the different areas of the enclosure and time budgets were calculated for individual animals. Generalised linear mixed models were also used to compare behaviours during the observation period, controlling for ambient temperature and weather conditions.

This project will demonstrate how Rothschild giraffe use the paddock area at Chester Zoo and the effects of environmental conditions on preferred locations, as well as time budgets for all individuals within the herd. These findings will therefore provide further evidence to aid captive management of Rothschild giraffe.

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### **Activity budget, enclosure use and interactions in captive Dhole (*Cuon alpinus*) at West Midland Safari Park over three seasons during 2013**

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The daily activity, enclosure use and interactions of four (3:1:0) captive dhole (*Cuon alpinus*), were observed at West Midland Safari Park (WMSP) across five months (three seasons) during 2013 (February-March, April-May, June). Several hours of preliminary observations were undertaken to create an ethogram (consisting of 8 behavioural states, 9 events and an out of sight category) and an enclosure map split into 'zones' based upon constant fixtures within the enclosure. Instantaneous, focal sampling at 15 second intervals took place in 30 minute sampling periods with scan sampling of the remaining three dhole taking place at one minute intervals. Immediately prior to observation and every five minutes throughout, the dhole location within their enclosure was documented on a zone map. Each dhole was observed as the focal animal for two, ½ hour periods a day. The day was split into an AM block and a PM block, with the order in which the individuals were the focal animal randomised for each observation block. Observed incidents of pro-social and aggressive behaviours, initiated and received were also recorded during focal sample observation.

The activity budget data highlighted; the variable activity levels of dhole at WMSP between observation days, individual differences in behaviour, the clan's preferences for certain areas within their enclosure, great variability between observation sessions in each of the dhole's pacing behaviours and a potential lack of consistency in dominance behaviours. Activity levels were found to be higher in the morning (AM) with more resting activities occurring in the afternoons (PM). Pacing occurred for all three of the male dhole, but not for the female dhole, who was considerably older than the males. One main area within the enclosure was favoured for the majority of the observation period for resting behaviours and pacing. Active behaviours tended to span across several of the zones within the enclosure. Exploratory behaviours within the dhole's enclosure were often preceded by the delivery of environmental enrichment in the form of food, training or activity bouts of patrolling keepers.

Previous research available on captive dhole populations has focused on reproductive success and vocalisations rather than activity budgets, interactions or enclosure use. The findings from this research could be used by zoos and safari parks as background captive behavioural data to help improve pre-existing dhole enclosures, and to inform establishments considering housing dhole populations. The information collected on pacing in the dhole at WMSP should make other parks more aware of the presence of pacing in captive dhole.

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### Working together to assess the welfare of captive reptiles and amphibians

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Reptiles and amphibians are well represented in captivity, both in zoos, labs and private collections, but very little is known about what factors impact their welfare, as welfare research is mainly focused on charismatic large mammals. To help fill scientific gaps in our understanding of reptile and amphibian welfare, we started a two year project in November 2013, combining forces from the academic (University of Antwerp & Kaho Sint Lieven) and the zoo world (Royal Zoological Society of Antwerp) and funded by the Belgian government. The project aims to evaluate non-invasive welfare indicators in captive reptiles by 1) providing an overview of which species are popular as pets in Belgium and how they are kept; 2) observing behaviour of reptiles in a zoo setting, e.g. under crowded versus non-crowded conditions; 3) conducting detailed non-invasive experiments, and monitoring corticoid stress response of three model species in the University. Here we report on the first results of the first part, where we conducted an on-line questionnaire among reptile and amphibian owners in Flanders.

Results suggest that reptiles may be more popular than amphibians since 56% of the owners keep reptiles versus 29% who keep amphibians. 15% own species of both taxa. Owners are mostly men, aged between 20 and 40 years old. When we focus on the 117 owners who keep at least one species of reptiles, owners house on average 12 individuals and 52% of them are members of a specialized club. Most popular species are the ball python (*Python regius*), Hermann's tortoise (*Testudo hermanni*), several species of geckos (e.g. leopard gecko, *Eublepharis macularius*) and bearded dragons (*Pogona vitticeps*). Mean number of terraria per owner is 10 and more than 90% of the described terraria include structures for hiding and/or climbing as enrichment. 39% of the owners handle their animals at least once a week, and 13% handle them daily. 60 owners had at least one species of amphibians (either only amphibians or in combination with reptiles). They keep on average 33 individuals and 48% of these owners are members of a club. Most popular amphibians by far are poison-arrow frogs (*Dendrobatidae*). 78% of amphibian owners keep these frog species. Mexican axolotls (*Ambystoma mexicanum*) represent 8% of the pet population and the colourful frog *Agalychnis callidryas* amount to 5%. Mean number of terraria per owner is 11 and 94% of the terraria include water features. 83% have structures for hiding and 71% contain climbing structures. 75% of the owners never handle their animals and 14% handle them less than once a month.

In the next phases of the project we will examine in the zoo and/or university how stress resilient these and other species are to stressor such as enclosure size, presence/absence of enrichment, handling. These joint efforts may ultimately lead to guidelines and legislation on how reptiles and amphibians should be kept and can lead to an assessment tool for the government. It shows how zoos and academia can work together to improve welfare of animals in our care.

## Looking for optimal intervals to sample time budgets and habitat use in grazers

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In behavioural research a variety of intervals is used when applying instantaneous scan sampling. To obtain an appropriate interval between two succeeding scans, time intervals should not be too long to avoid wasting time and inaccurate results. Adversely, time intervals should not be too short either, to avoid reduced observer alertness and reliability and to avoid dependence between successive data-points. Calculating mean bout lengths and standard deviations to determine the distribution of mean bout lengths is one solution. Another solution is suggested by Engel (1997) starting from a small continuously scored dataset. We used this method to evaluate the sample interval to score the activity budget and habitat use of two grazer species - Konik horses and Scottish Highland cattle - in a Belgian coastal dune reserve (see also Lamoot et al., 2004).

For 127 focal follows of 900 seconds with continuous scoring, a data entry was made every second on ingestive and locomotory behaviour states, vegetation types of the area and consumed food type. From this continuous protocol a lot of instantaneous pseudo-protocols are derived, each one with a longer sample interval than its predecessor. The relative frequency of the behaviour pattern under investigation in the continuous protocol and every pseudo-protocol is computed and the dependence between each data point is calculated. The optimum sample interval is graphically derived from on the one hand, the association of pseudo-protocols with different intervals and the continuous protocol (Spearman rank correlation coefficients) and on the other hand, the mean probability of sampling the behaviour statistically independent. The compromise for the optimal intervals of all the scored behavioural states, vegetation and food types was on average 90 seconds.

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## On crowded days the king, Macaroni and gentoo penguins stand and deliver

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We investigated the use of space, activity budget and visitor effect in a mixed species exhibit of penguins. The Antwerp Zoo (Belgium) houses king penguins (*Aptenodytes patagonicus*)(n=13), gentoo penguins (*Pygoscelis papua*)(n=6 - 9) and Macaroni penguins (*Eudyptes chrysolophus*)(n=9) in an indoor exhibit (105 m<sup>2</sup>) with a flat, rocky occasionally icy land area with a small cave and a pool (56 m<sup>2</sup>). Intra- and interspecific aggressions were scored continuously during 7 hours per day for a total observation time of 231 hours. The activity budget was scanned every 5 minutes, as well as the location of the penguins in the different exhibit areas to calculate the spread of participation index. To analyze the visitor effect we compared 10 days with the highest daily number of visitors (1000 – 5000 visitors) with 10 days with the lowest daily zoo visitor number (200 - 600 visitors) of our observation period.

The gentoo penguins were found to use more different areas than the Macaroni and king penguins. Overall, the three species swam very little (on average 10% of their time) in comparison to the natural activity budget and in comparison to another captive study group. Intraspecific aggression was more frequent than inter-specific aggression. Pointing made up half of all the aggressions. During inter-specific aggressions, the king penguins aggressed the other species most frequently, whereas the Macaroni penguins received aggression from both other species most frequently. Desired behaviors such as swimming and the use of different areas of the enclosure, occurred more frequently on days

with less visitors, potentially indicating a positive welfare state with fewer visitors. High visitor number made the penguins passive. On the other hand, aggression was also higher on days with less visitors, possibly due to the increased mobility of the penguins and higher probability of encountering others. So visitor numbers had a mixed effect on the behaviour of the penguins, and implications for welfare need to be further evaluated.

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### **Substrate preference in *Corydora's* catfish (*Corydora aeneus*)**

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With the popularity of keeping fish in home aquaria increasing, there is an urgent need to address our current lack of knowledge regarding the welfare of captive aquarium fish. While there is increasing scientific research into the welfare of fish housed in aquaculture conditions, there has been little research into the welfare of bottom feeding catfish. *Corydoras* catfish are a species which uses barbells to forage for food; these barbells can be easily damaged. As fish are dependent on their fish keepers in order to survive it is vital that conditions are optimal in order for them to have the best welfare possible.

A group of *Corydoras* (n=24) were put through a series of preference tests to investigate which substrates would benefit them in terms of their natural behaviour. A significant difference was found in amounts of foraging behaviour between substrates ( $F_{[2]} = 155.15$ ,  $P < 0.001$ ). The fish showed more foraging behaviour on the two loose substrates, sand and peat, than over the harder gravel substrate. The fish showed low frequencies of inactive resting behaviours on gravel based substrates. Providing *Corydoras* with loose substrate will allow the fish to perform their natural repertoire of behaviours and increase the animals' welfare.