



18th BIAZA Research Conference

28th – 29th June 2016

Yorkshire Wildlife Park

Programme and Abstracts

Tuesday 28th June 2016	
8.30	Zoo gates open, registration
8.50	Welcome address
Special Session – Veterinary Research	
9.00	Keynote speaker OVAG – The Orangutan Veterinary Advisory Group: one health solutions in orangutan conservation medicine through empowerment of those working in the front line <i>Steve Unwin, Fransiska Sulisty, Raffaella Commitante, Ricko Jaya, Yenny Jaya and Citra Nente</i>
9.45	Gastrointestinal foreign body surgical outcomes in captive Gentoo penguins (<i>Pygoscelis papua</i>) <i>Romain Pizzi, Simon Girling, Donna Brown</i>
10.00	Are hot penguins ill? Detection of Aspergillosis in captive Gentoo Penguins (<i>Pygoscelis papua</i>) by means of corneal thermography <i>Stuart McGeachie, C Tatchley, D Brown, J Elliott, Y Martinez Pereira and R Pizzi</i>
10.15	A detailed and standardised investigation into great ape cardiovascular pathology <i>Victoria Strong, Sharon Redrobe, Malcolm Cobb, Kate White and Kerstin Baiker</i>
10.30	Initial assessment of the possible reproductive potential of rescued female Malayan sun bears (<i>Helarctos malayanus</i>) in Cambodia <i>Romain Pizzi, Kirsty Officer, Nev Broadis, Chris Girling and Matt Hunt</i>
10.45	Tea/coffee break
Session 2	
11.10	An Enclosure Design Tool to enable zoos to create integrated, wild-type enclosures for great apes <i>Susannah Thorpe, Nardie Hanson, Julia Myatt, Claudio Tennie, Charlotte MacDonald, Simon Childs, Kirsten Pullen and Jackie Chappel</i>
11.25	Happy or Sad? Determining welfare in Aquaria Cephalopod species <i>Kerry Perkins</i>
11.40	Challenging Cetaceans: Cognitive Enrichment for Bottlenose Dolphins <i>Fay Clark</i>
11.55	Variations in the behaviour and enclosure use of blind and sighted guillemots (<i>Uria aalge</i>) <i>Carrie Ellis, Toni Erikson and Sarah Collins</i>
12.10	An investigation into the feeding behaviour and enclosure usage of Bactrian camels (<i>Camelus bactrianus fesus</i>), with and without the provision of browse <i>Ashleigh Bell and Samantha Ward</i>
12.25	Ready for an Island life? Assessing the impact of moving Sumatran orangutans (<i>Pongo abelli</i>) <i>Katherine Finch, Claire Parry, Andy Lenihan, Nick Davis, Tim Rowlands and Lisa Holmes</i>
12.40	Lunch

Session 3	
1.25	Poster presenters speed presentations part 1
2.00	Animal hair as evidence in wildlife crimes: linking research to casework Claire Gwinnett , David Bailey, Laura Wilkinson, Danique Prinsen, Bene Amery and Naomi Watt
2.15	Establishing a standardised method of measuring Komodo dragon (<i>Varanus komodoensis</i>) body temperature Amber Flewitt , Lisa Holmes, Gerardo Garcia, Ben Baker, Ryan Boyle, Matt Cook and Andrea L. Fidgett
2.30	Changes during captivity in a zoo-based population of Partula snails Aimee Farndale , Heidi Mitchell and Mark Chapman
2.45	Evaluating the habitat of the critically endangered Kipunji monkey Andrew R. Marshall, Ricardo J.R. Lemos de Figueiredo , Yahya Abeid, Antje Ahrends, Eiblis Fanning, Trevor Jones, Jon C. Lovett, Cara J. Marshall, Tim Davenport
3.00	Selecting conservation indicators for assessing a Zoo Biodiversity Action Plan Joshua Sammy , Aydin Berkin, Sarah Bond and Andrew R. Marshall
3.15	Tea/coffee break
Session 4	
3.40	Dietary Manipulation to Reduce Hypercholesterolaemia in Meerkats Amanda Ferguson and Laura Scott
3.55	Evaluating the diets of captive black rhinos in European zoos, with particular emphasis on iron content Katherine Keates , Becca Biddle, Mark Pilgrim and Andrea L. Fidgett
4.10	The influence of age, sub-species and gender on the gastrointestinal microbiota of <i>Panthera tigris</i> Olivia Moore
4.25	The effects of probiotics on captive primates. Louise Cox , Francis Cabana and Amy Plowman
4.40	The relative importance of grey or red squirrels in the diet of pine martens Vicki Breakell , Emma Sheehy, Christine Reed, Rachel Brydon and John Gurnell
4.55	Poster presenters speed presentations part 2
5.30	Poster Session
6.30	Evening safari and BBQ

Wednesday 29th June 2016

8.45	Zoo gates open
Session 5	
9.00	Relaxin: A Giant Panda (<i>Ailuropoda melanoleuca</i>) marker of placental development Kirsten Wilson, A.F. Howie, W.C. Duncan and I Valentine
9.15	Seventeen years of baboon research: analysis of a long term dataset of self-directed behaviour and reproductive parameters in a zoo population of Hamadryas baboons (<i>Papio hamadryas</i>) Gwen Wirobski, Joanna Newbolt, Kathy Baker and Amy Plowman
9.30	We're all in this together: Encouraging each individual contributes in the fight for a species survival. Sally Holt and Angus Carpenter
9.45	Evaluating Husbandry Influences on Conservation Breeding of an Extinct-in-the-Wild Antelope Holly A. Little, Tania C. Gilbert, Marie L. Athorn and Dr. Andrew R. Marshall
10.00	The reproductive behaviour of Edwards's pheasants in captivity: potential implications for reintroduction to Vietnam. Nikkita Bhatia, Jo Gregson and Andrew E. Bowkett
10.15	Breeding behaviour and success of tufted puffins (<i>Fratercula cirrhata</i>): an investigation into the effects of husbandry Samantha Pacynko, Francis Cabana and Amy Plowman
10.30	Tea/coffee break
Session 6	
10.55	The evaluation of training as a method of species-specific feeding in a mixed-species aviary at Newquay Zoo Luke Pearce and Kathy Baker
11.10	Factors influencing interactions in zoos: animal-keeper relationship, animal-public interactions and solitary animal's groups Giovanni Quintavalle Pastorino, Rosica Stoycheva, Richard Preziosi, Paul Pearce-Kelly and Mariangela Albertini
11.25	An evaluation of the behavioural changes demonstrated by meerkats (<i>Suricata suricatta</i>) before, during and after interactive sessions with humans Arran Wilson, Geoff Hosey and Samantha Ward
11.40	Personality assessment and feline-keeper's relationship in lions (<i>Panthera leo</i>) Nuno Rafael Passarinho Soares, Giovanni Quintavalle Pastorino, Richard Preziosi, Silvia Mazzola, Paul Pearce-Kelly and Mariangela Albertini
11.55	A comparison of the personality dimensions of wild and captive Sulawesi crested black macaques (<i>Macaca nigra</i>) Grace Hussey, Joanna Newbolt and Kathy Baker
12.10	Investigating the effects of ultra violet light levels on captive brown spider monkeys, <i>Ateles hybridus</i> Naomi Appleby, Kathy Baker and Joanna Newbolt
12.25	Lunch

1.20	Workshop – Social Research. Andy Moss
3.00	Tea/coffee break
Session 7 - behaviour	
3.15	Making a 'song and dance' about environmental education in zoos <i>Sarah Spooner, Andy Marshall and Eric Jensen</i>
3.30	Understanding the effectiveness of trails for visitor led learning in informal education settings <i>Bridget Murray</i>
3.45	Do public perceptions of birds change after educational flying displays at Colchester Zoo? <i>Rosie Brigham</i>
4.00	Red-billed choughs: measuring the behaviour of an unfamiliar species in captivity, and its use as a public engagement tool for a proposed reintroduction project. <i>Lawrence G. Sampson, Jennifer Riley and Angus I. Carpenter</i>
4.15	Long term learning retention in zoo education <i>Rebecca Simpson, Amy Cox, Marianne Freeman, Alaina Macri and Simon Riley</i>
4.30	Are keeper talks effective at transmitting educational messages about environmental enrichment within zoos? <i>Emma K Wallace, Bridget Waller and Katie Slocombe</i>
4.45	Summing up and prizes for best and commended speakers and posters
4.55	End and depart

Oral Presentation Abstracts

OVAG - the Orangutan Veterinary Advisory Group: one health solutions in orangutan conservation medicine through empowerment of those working in the front line

Steve Unwin, BSc, BVSc, Dipl ECZM, MRCVS1*, Fransiska Sulisty, DVM, MVS2, Raffaella Commitante, PhD3, Ricko Jaya, DVM4, Yenny Jaya, DVM5 and Citra Nente, DVM, MVS6

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Despite five decades of conservation attention for the orangutan, there has been frustratingly little progress in co-ordinated research to assist. Lack of communication between field conservation projects, sanctuaries, zoos, academia and Government in range countries has been exacerbating this conservation issue. Many NGO's working in orangutan conservation work by themselves on their own projects and rarely co-ordinate their activities with those of other groups. The way forward for orangutan conservation requires a more holistic approach. In 2009 the Orangutan Veterinary Advisory Group (OVAG) was formed, creating a collaboration between Orangutan Conservancy and Chester Zoo. Since its inception OVAG have encouraged local expertise involvement, especially in research and higher education achievement, as the participation of young conservationists is critical for the programme to succeed. By addressing the animal health issues across all aspects of orangutan conservation the OVAG programme is hoping to lead by example and show that orangutan conservation management and research in general must be better integrated to improve impact.

Animal health was chosen as the focus topic because:

- 1.Risk of disease spread was seen as an as yet unacknowledged risk factor in orangutan conservation by decision makers, despite mounting evidence of a threat to the conservation of great apes in Africa
- 2.Potential partners in sanctuaries and orangutan release projects work at the crossroads between wild and captive orangutan health, increasing the risk of pathogen spread between captive and wild populations.
- 3.Sanctuaries were facing substantial animal welfare issues due to disease within their facilities, often because of a lack of understanding of the disease issues in wild populations, as well as overcrowding due to the unexpected high numbers coming into centres.
- 4.Most importantly, it is acknowledged that management of health issues of wildlife are not the sole prevue of veterinarians and we must follow One Health principles by promoting cross-sectoral collaborations and a 'whole of society' treatment of health hazards, as a systemic change of perspective in the management of risk.

OVAG provides expert training on One Health principles, relevant disease investigation techniques and an appreciation of conservation management on a global scale. The centerpiece of the OVAG program is an annual, locally organised 5-day, intensive training workshop. OVAG offers this professional training free of charge to delegates' employers to strengthen the partnerships between wildlife veterinarians, wildlife biologists, project managers and Government officials. By working with international universities, OVAG is also currently developing postgraduate training courses to further increase and share knowledge and foster collaboration between the UK, USA and Indonesia.

By broadening our collaborations both in situ and beyond, OVAG members and affiliates hope to contribute to orangutan species longevity and well-being and welcomes new partners in this endeavour.

Gastrointestinal foreign body surgical outcomes in captive gentoo penguins (*Pygoscelis papua*)

Romain Pizzi, Simon Girling, Donna Brown

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Analysis of veterinary records in zoo species that are maintained in large groups over a long time period can allow sufficient statistical power to determination a robust evidence base for specific future veterinary interventions. Gentoo penguins (*Pygoscelis papua*) are a common species kept in European zoological collections. The species is inquisitive and prone to foreign body ingestion, particularly by young birds in outdoor exhibits. A total of 101 surgical interventions were performed over 1703 penguin/years; a 5.87 % (95% confidence interval of 4.8-7.1%) risk of any surgery being required in an individual Gentoo penguin in a year. 37% of cases involved the surgical removal of gastrointestinal foreign bodies. Gastrointestinal foreign body surgery had a mortality rate of 32.4% (95% confidence interval of 19.6-48.5%). However, cases managed non-surgically had a high mortality rate of 93% (n=147). The number needed to treat was 1.48 (95% confidence interval of 1.2-1.8), with an absolute risk reduction of 0.68 (95% confidence interval of 0.55-0.84). The high mortality rate without surgery highlights the need for rapid surgical intervention should non-surgical interventions such as stomach flushing and gastroscopic foreign body removal not be successful. This evidence base helps balance the likely surgical outcomes, costs, and value of an individual bird, to allow robust decision making, particularly in large penguin collections which may require a number of surgical interventions.

Are hot penguins ill? Detection of Aspergillosis in captive Gentoo Penguins (*Pygoscelis papua*) by means of corneal thermography

McGeachie, S1, Tatchley, C2, Brown, D1, Elliott, J1, Martinez Pereira, Y3, Pizzi, R1

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3) University of Edinburgh, Royal (Dick) School of Veterinary Studies, Easter Bush, Roslin, EH25 9RG, UK

Aspergillosis, a respiratory infection caused by *Aspergillus* species fungi, is a common health problem in captive penguin species (*Spheniscidae*). Veterinary detection and diagnosis of the infection may be stressful and invasive to an individual bird. Therefore, rapid, low cost, hands-off screening method for detection of infected birds would hold benefits for collections holding captive penguins, whether in a zoological collection, or a wildlife rehabilitation situation. Aspergillosis would be expected to induce an inflammatory response, as in other avian infections, which may result in systemic alterations, such as increased core body temperature. Accurate non-invasive determination of body temperature in birds can be difficult, but it is possible that increased core body temperatures, due to an inflammatory response, could be detected via thermography, such as utilised in the medical screening of airport passengers, to detect human infectious disease of concern. Penguins are covered in dense insulating feathers, and the feet of penguins are unsuitable due to their thermoregulatory role. The cornea is an obligate thermal window, potentially applicable to thermography screening. This study investigated whether determination of corneal temperatures via hand held thermography in an outdoor enclosure, could be useful in the hands-off diagnostic screening of captive penguins. Median maximum corneal temperatures of Gentoo Penguins (*Pygoscelis papua*), were correlated with other diagnostic modalities for Aspergillosis, including protein plasma electrophoresis, to assess inflammation. Analysis of 98 and 78 (infected:healthy)

temperature measurements found thermography to have a sensitivity of 81.3% (95% confidence interval of 57.0-93.4%) and a specificity of 64.3% (95% confidence interval of 38.8-83.7%), when compared with plasma protein electrophoresis, and using a cut off of 30.0°C corneal surface temperature. Corneal temperatures determined by thermography appear to correlate well with Aspergillosis diagnosis by other methods. The technique is likely to be even more accurate in indoor housed penguins, and warrants further investigation.

A detailed and standardised investigation into great ape cardiovascular pathology

Victoria Strong,^{1,2} Sharon Redrobe,² Malcolm Cobb,¹ Kate White,¹ Kerstin Baiker¹

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A recent study reviewing mortality among zoo-housed great apes in Europe has identified cardiovascular (heart) disease as a major cause of death among bonobo, chimpanzee and gorilla. However, the underlying aetiologies and pathophysiology involved in disease development and progression are poorly understood. The same study also identified great variation with regards to the approach to the necropsy of animals in zoos across Europe. Specifically, post-mortem examination of the cardiovascular system is performed with variable consistency; macroscopic and histopathological examination of the heart are not performed in every great ape death. When they are performed, there is inconsistency with regards the expertise of the individual performing the examination, the extent of the examination conducted, the samples taken, the terminology applied, and the quality and quantity of information provided in the report. Similar issues and limitations have also been identified across North American zoos (GAHP, white paper). These factors limit the potential for large-scale international studies investigating great ape cardiovascular pathology across numerous institutions. The identification of trends and comparison of similarities/differences between the taxa is therefore not possible. A protocol for a standardised approach to examination and sampling of the heart was developed and disseminated to zoos across Europe. In the event of a great ape death, zoological collections examined and sample the heart according to this protocol before formalin fixing it, and sending it to The Ape Heart Project (Twycross Zoo/University of Nottingham) for full and detailed examination. The approach used and analysed data from a total of 18 hearts. This examination included both macroscopic and histopathological assessment and is based upon that performed in the investigation of sudden cardiac death in humans.

Initial assessment of the possible reproductive potential of rescued female Malayan sun bears (Helarctos malayanus) in Cambodia

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Phnom Tamao Wildlife Rescue Centre in Cambodia houses the largest captive population of Malayan sun bears (MSB) in the world. The genetic potential of this population of wild born bears may be regarded as an "Ark" for the species. Previous exportation of adult female MSBs from Cambodia to international zoological institutions has however had mixed results. An initial reproductive assessment of 16 adult female sun bears, ranging from 3 to 21 years of age was undertaken under anaesthesia. No bears had any evidence of cervical cysts (95% confidence interval 0-19%), in contrast to a previously reported point prevalence of 35% (95% CI of 17-59%) in captive nulliparous MSBs in

Europe and Thailand. On transrectal ultrasonography 64% (n=9/14; 95% CI 39-84%) had some signs of likely ovarian activity, while 36% (n=5/14; 95% CI 16-61%) had no evidence of any ovarian activity on the day of ultrasonography. MSBs are polyoestrus nonseasonal breeders, and spontaneous ovulators, with an estimated interestrus period in nonpregnant bears of 140-216 days. Further work to correlate these ultrasonographic ovarian findings with hormonal cycles is needed. Until this is performed, it remains possible that point prevalence ovarian ultrasonography findings do not truly reflect an MSB's actual reproductive activity or potential. While significance could not be demonstrated statistically with this preliminary study size, one initial interesting finding is that MSBs with ovaries demonstrating likely signs of activity on ultrasound, appeared to have been younger when rescued or confiscated than those MSBs with no evidence of any ovarian activity (median age of 0.65 years versus 4.48 years). It is possible that good nutrition husbandry, environment, and lower stress environment provided by the Wildlife Rescue Centre allows more normal reproductive development of these females, in contrast to bears that were hand-reared illegally and hence confiscated or rescued at an older age.

An Enclosure Design Tool to enable zoos to create integrated, wild-type enclosures for great apes

Susannah Thorpe¹, Nardie Hanson, Julia Myatt¹, Claudio Tennie¹, Charlotte MacDonald², Simon Childs², Kirsten Pullen³, Jackie Chappell¹

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Holding a species for survival in modern zoos must go beyond simply preserving animals for their genetic material to conserving the whole organism - the behavioural traits and physical adaptations that are a vital part of what defines each species and determines their ability to survive in the natural environment. Great apes are, however, some of the most difficult species to keep successfully in captivity due to their large size, enhanced intelligence and the problems of replicating structurally and mechanically complex arboreal environments in captive conditions. Zoos need to be empowered with effective tools to ensure healthy, wild-type captive populations within a range of budgets.

We are creating an Enclosure Design Tool (EDT) that will enable zoos to develop independently effective strategies to ensure captive great apes are able and motivated to express and maintain wild-type behaviours. We are currently working with chimpanzees but will expand the EDT to all great apes over the next 5 years. The web-based tool will allow zoos to automatically compare the behaviour of their chimpanzees to wild chimpanzees, and it will then make zoo-specific recommendations about how to modify the enclosure to elicit wild-type behavioural profiles. The EDT will give zoos: 1) easy functional access to latest research data on wild chimps (& other apes); 2) an evidence-based method to measure the effectiveness of habitat changes and 3) an approach to enclosure design based on the mechanical behaviour of forest canopy and the physical and cognitive challenges it poses to wild chimpanzees.

In this presentation we will show how the tool works and discuss some of the problems we have encountered with defining wild-type behavioural repertoires. We welcome feedback from zoos on how we can improve the EDT and match it to zoo requirements.

Happy or Sad? Determining welfare in Aquaria Cephalopod species

Kerry Perkins

Sea Life Brighton/ University of Sussex

Cephalopod's have been kept in aquaria for over 100 years, however it has not been until the last 50 years that people have started try to create ethograms and behavioural index's in relation to these animals. With the change in legislation of research animals Directive 2010/63/EU for the inclusion of cephalopod's a greater importance has been placed on determining behaviours and an overall welfare index. In this presentation we will use Giant Pacific Octopus (*Enteroctopus dolfeini*) and Nautilus (*Nautilus pompilius*) as examples of how welfare can be determined in public aquaria. By using a novel approach, we hope to demonstrate the possibility of using staff members and even members of the public in the future to help gain a broader data set on the behaviours of these creatures.

Challenging Cetaceans: Cognitive Enrichment for Bottlenose Dolphins

Dr Fay E Clark

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The well-being of captive cetaceans is currently a hot topic, particularly owing to the recent 'Blackfish' docu-film. Ironically, there have been very few scientific studies on cetacean well-being and these are required to inform and influence the debate. Hundreds of cetaceans (particularly bottlenose dolphins, *Tursiops truncatus*) live in zoos and aquariums worldwide. Positive reinforcement training and participation in public demonstrations may be stimulating, but other forms of enrichment have received little attention. In particular, despite over 60 years of research into dolphin cognition, we have done little to challenge the known cognitive abilities of dolphins in the underwater realm; instead relying on the provision simple floating objects or 'toys'. Furthermore, there has been very little research on how dolphin well-being should be assessed objectively (for example using positive and negative behavioural indicators). Here, I present research undertaken with two captive populations of dolphins at Six Flags Discovery Kingdom, USA, working at the interface of animal cognition and well-being. A cognitive challenge device (focussing on underwater cognition) was designed for dolphins based on their natural history and evolved cognitive skills. Dolphins employed a range of novel problem-solving skills to access food and non-food rewards. The device impacted repetitive circular swimming patterns and also stimulated social behaviours. I will discuss how cognitive studies on cetaceans and other taxa can help influence the design of cognitive enrichment devices in zoos and aquariums, and how such devices can be evaluated using both positive and negative indicators of well-being.

*My colleague Professor Kuczaj is recently deceased but as a sign of respect I would like to list him as my co-author.

Variations in the behavior and enclosure use of blind and sighted common guillemots (*Uria aalge*)

Carolyn Ellis¹, Toni Erikson¹, Sarah Collins²

1. MSc Zoo Conservation Biology postgraduate students, Plymouth University,

2. Associate professor (senior lecturer) in animal behaviour and welfare,
Plymouth University

Evidence-based husbandry and welfare practices are becoming the norm in zoos and other captive-animal facilities around the world, yet research into the benefits of these practices for animals with disabilities remains sparse. To date, very few studies have been conducted which examine the behaviour of blind animals in comparison to their sighted conspecifics. For this study, a colony of 32 common guillemots (*Uria aalge*) was used to explore the behavioural variations of two sight impaired individuals (N=2) that have been diagnosed with partial to full blindness as a result of age-onset avian cataracts. State behaviour and enclosure use data were collected using instantaneous focal sampling methods over a period of 2 months. Analysis revealed significant differences in behaviour and enclosure use between the sight-impaired and sighted conspecifics. Both sight impaired guillemots spent significantly more time resting ($F_{2, 77} = 6.9, p = 0.002$), less time in the water ($X^2 = 22.56, df = 2, p < 0.001$) and utilized less of their enclosure than the sighted individuals. Recommendations for maintaining the welfare of sight-impaired individuals include provision of adequate rest/hiding spaces and reliably accessible feed sources. Limitations of the study such as small sample size, age, and seasonal variations in behaviour will also be discussed.

An Investigation into the feeding behaviour and enclosure usage of Bactrian camels (*Camelus bactrianus ferus*), with and without the provision of browse

Ashleigh Bell¹ and Samantha Ward¹

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The Bactrian camel (*Camelus bactrianus ferus*) is a key umbrella species within its natural habitat. However, over the past century, populations have undergone drastic decline; reducing by an estimated 70%. As such, the world population of Bactrian camels is now less than that of the Giant Panda (*Ailuropoda melanoleuca*). Due to this, many zoological institutions house domestic Bactrian camels (*Camelus bactrianus*) to act as ambassadors for their wild cousins. At present however we know little of their captive behaviour and lack the scientific literature to support current husbandry practices. The aim of this study was to observe any changes in feeding behaviour and enclosure usage, with and without the provision of browse, of three Bactrian camels housed at Blackpool zoo. Instantaneous scan sampling was used to monitor behaviour and enclosure usage, for 90 minutes twice a day for 22 days on 11 of which browse was present. Data was then analysed using paired t-tests to produce for each individual mean behavioural and Spread of Participation Index (SPI) values. For one individual stationary behaviour significantly decrease ($t_{32} = 2.906, P < 0.01$) whilst another used significantly more of the enclosure ($t_{10} = 2.623, P < 0.05$) with the provision of browse. The results also showed a significant food preference for browse over grazing over hay with ($t_{10} = 2.769, P < 0.05$) the provision of browse and a preference for grazing over hay without ($t_{10} = 5.195, P < 0.01$);

t₁₀ = 2.756, P < 0.05) browse provision. The results supported expectations that browse provision is a successful management technique, as it caused a significant difference in the individual's behaviour and enclosure usage, which was similar to seasonal behavioural changes seen in wild Bactrian camels. Hence studying captive camel behaviour can have implications for management techniques and husbandry practices.

Ready for an Island life? Assessing the impact of moving Sumatran orangutans (*Pongo abelli*)

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Islands is one of the most ambitious zoo design projects ever completed in the UK, replicating the habitats of six South East Asian islands over 15 acres. As a result of this zoo expansion, many species were moved from the existing zoo into new exhibits within Islands. Here we look at the behavioural impact of an enclosure move on the zoo's family group of Sumatran orangutans, *Pongo abelli*. This charismatic species are popular with visitors whilst also having an important education role due to the destruction of their natural habitat by the unsustainable planting of palm oil. As a result of this, this species is critically endangered and the need to highlight the plight of their wild counterparts to the public is crucial.

This project forms part of a long-term monitoring plan for key species that have moved to Islands. The data were collected using continuous focal sampling methods whereby each individual is monitored for 30 minutes per session; this provides us with a rich data set which captures subtle behaviours including short, social interactions. Detailed and accurate activity budgets for each individual in the group have been constructed, from which behaviours of interest can be extracted and analysed more closely to assist with management of the species. Individual visibility was also recorded to compare viewing opportunities of the two exhibits from a visitor's perspective.

This pre- and post-move comparison of behaviour is crucial in determining how well the orangutans settled into their new habitat, both on an individual and a group basis. In this talk we will discuss how this behavioural data will be used to determine the success of the new Islands exhibit, how it may contribute to management decisions and what we can learn and gain by using continuous focal sampling methods.

Animal Hair as Evidence in Wildlife Crimes: Linking Research to Casework

Dr Claire Gwinnetta, Mr David Bailey^b, Miss Laura Wilkinson^a, Miss Danique Prinsenc, Miss Bene Ameryd, Miss Naomi Watta.

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b: ForensicVet, Northern Ireland,

c: Avans University, Breda, The Netherlands,

d: University College Leuven Limburg (UCLL), Leuven, Belgium

Wildlife and animal crimes are a diverse and multibillion pound transnational issue which are traditionally difficult to tackle. These crimes are extensive and include animal abuse, poaching, illegal import and export of endangered animal products, hare coursing, deer carting and badger baiting, to name just a few. These crimes, which mainly use policing methods to investigate, also regularly seek input from the forensic science field in order to provide information about evidence seized from scenes, confiscated items and from suspects. Due to the cost effectiveness of

microscopical hair analysis compared to DNA analysis, this is a common form of evidence used for species identification and identification of source level information. Animal hair analysis can provide valuable information in the investigation of these crimes. Such information includes species and sub-species identification and activity level information regarding the crime scene or incident. The latter of these can identify the 'what?', 'when?', 'where?' and 'how?' of a case whereas the former attempts to establish the 'who?'. Ultimately, to answer these questions in a case of wildlife or domestic animal crime, knowledge and experience of animal hairs must be underpinned by sound research. At Staffordshire University, the Forensic and Crime Science Department work closely with forensic veterinarians, wildlife parks and the Criminal Justice System in order to conduct research and criminal casework within the area of forensic animal hair analysis. This presentation will provide an overview of forensic animal hair analysis and its uses in investigating crimes whilst providing examples of the research conducted at Staffordshire University into species identification and detection of certain types of abuse in animals from hairs. This presentation will also discuss the importance of collaboration of zoological parks in the generation of forensic reference collections and will invite collaboration with Staffordshire University.

Establishing a standardised method of measuring Komodo dragon (*Varanus komodoensis*) body temperature

Amber Flewitt^{1, 2}, Lisa Holmes¹, Gerardo Garcia¹, Ben Baker¹, Ryan Boyle¹, Matt Cook¹ and Andrea L. Fidgett¹

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It is well documented that reptiles are ectotherms, and use their environment to adjust their body temperature. Each species of reptile has an optimal body temperature, which is vital for tissue and cellular functions to occur. The optimal internal body temperature of Komodo dragons is between 34-35.6°C. Komodo dragons (*Varanus komodoensis*) are the largest of the lizards, are popular in zoos, and much has been studied on them in captivity and in the wild. While there have been studies already on body temperature and thermoregulation in Komodo dragons, there is no standardised way of measuring their body temperature, leading to uncertainties and discrepancies between studies. We know what their optimal internal temperature is, but no one knows if this is reflected by measuring the external temperature of the animal. This study aims to solve this issue, by establishing a standardised method of measuring Komodo dragon body temperature externally that reflects internal body temperature. Three dragons of different age and size ingested data loggers within a feed, measuring the core body temperature of the animals until excreted. External temperature measurements were taken from the dragons over the same time period, allowing comparisons between internal and external temperature measured using a thermal imaging camera and infrared thermometer. Variation in temperature was observed in different life stages of dragon, on different locations of their bodies and between the infrared thermometer and thermal camera. Results also highlighted potential heating issues in the enclosures, and has allowed recording of the temperature as large and small food items pass through the digestive track, and duration of gut passage time, which has not been previously documented. These data may inform future thermoregulation studies in Komodo dragons and other reptiles, and improve welfare of captive animals by providing a measurable way of assessing heat provision.

Changes During Captivity in a Zoo-based Population of Partula Snails

Aimee Farndale; Dr Heidi Mitchell; Dr Mark Chapman
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Genetic adaptation to captivity takes place when captive populations become suited to a life in zoos, and therefore are no longer viable as a potential population for reintroduction. This is a critical issue for cooperative breeding programmes based in zoos, which manifests as a loss of genetic diversity and therefore a loss in phenotypic diversity, including behaviour traits.

Our study was based at Marwell Wildlife and sought to understand whether loss of behavioural traits within a captive population of partulid snails (*Partula varia*), which have been extinct in the wild for over 20 years, had occurred. This might have occurred because of two decades of zoo-based breeding programmes. Partulid husbandry is standardised across zoos and is based on a housing configuration that is widely different from the natural system in which these species have evolved.

In collaboration with the breeding programme, we altered the husbandry of a sub population of *Partula varia*, to provide increased environmental complexity and opportunity for natural behaviour (e.g. climbing and sheltering from bright light), which provided two husbandry treatments and a control. DNA analysis was undertaken on individuals from the wild, the founder populations and captive snails, and suggested that there had been a loss of genetic diversity over generations from wild-caught to captive bred, which could have an adverse effect on ongoing reintroduction efforts. Our behavioural assays, however indicate that the ability to climb has been retained even though there is no need for the behaviour in captivity.

As an aside, this study used a non-invasive method of extracting DNA from slime. The development of this method is an important step in extracting DNA from endangered molluscs for future studies in this area, and avoids the need to remove sections of the foot or shell or sample only deceased individuals.

Evaluating the habitat of the critically endangered kipunji monkey

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Effective conservation of threatened species requires full understanding of their habitat. Most primates are threatened by tropical forest loss. One population of the critically endangered kipunji monkey, *Rungwecebus kipunji*, occurs in and around a single valley, Vikongwa, in southern Tanzania. This restricted range is something of an enigma. We collated woody vegetation data to assess habitat quality in Vikongwa compared to other nearby forests. Habitat quality in Vikongwa was high compared to other regional and African forests, in that tree stem density, basal area, species richness and availability of kipunji dietary species were all comparatively high. However, the nearby Sanje forest, where the kipunji was absent, had comparable habitat to Vikongwa. We concur with previous research that the kipunji is dependent on old growth forest. However, the availability of comparable vegetation in at least one nearby forest suggests that habitat is not the only reason for the kipunji's restricted range.

Selecting Conservation Indicators for Assessing a Zoo Biodiversity Action Plan

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Time and resources have been significant limiting factors in the success of conservation work, and hence efficient and effective conservation has become an urgent priority. A method designed for selecting conservation indicators, the Holistic Indicator Selection Protocol (HISP) has recently been developed for efficient conservation planning and monitoring. This method, previously developed for a tropical forest, is here applied to the conservation of biodiversity in a theme park and zoo, Flamingo Land Resort, North Yorkshire. Importantly, the method includes social, biological and policy indicators and we here compare findings between the two contrasting settings assessed to date, also considering resources available. We found the highest rated indicator of conservation success at Flamingo Land to be the awareness of staff of biodiversity practice, with a HISP score of 90.5, followed by the highest-rated biological indicator of BAP invertebrate presence, with a HISP score of 86.8. This contrasts with the previous work in Tanzania, where above-ground biomass was ranked highest with 86.5 (conversely, above-ground biomass was ranked 26 out of 50 in Flamingo Land, with 57.9). In general, indicators that addressed people were ranked lower than in Tanzania, with 3

of the top 10 being social/policy indicators, while in Tanzania 4 of the top 10 were social/policy indicators, with 3 of the remaining being cross-cutting indicators. However, weighting each indicator based on sampling time and available resources resulted in a significant re-ordering of indicators and priorities. The work shows clearly that the most important types of conservation indicators vary considerably across ecosystems, and cultures, in relation to available resources and the needs of local stakeholders.

Dietary Manipulation to Reduce Hypercholesterolaemia in Meerkats

Tai Strike & Amanda Ferguson (ZSL)

Meerkats are a popular and charismatic species displayed in many zoos with over 3000 currently held in ISIS institutions yet are known to suffer from cholesterol related disease. In 2006 two animals euthanased at ZSL were found to have cholesterol granulomas in the calvarium and high serum cholesterol levels at the time of death of 29.5 mmol/L and 23.1 mmol/L compared with the 'typical' level in the ISIS population (10 mmol/L) and in the wild (5 mmol/L). This prompted a review of the diet, which was then based on vertebrate food sources, and reformulation to lower the amount of cholesterol and fat presented to the animals. A new diet based on a complete cat food with additional produce and live food was found to have a significant positive effect on lowering cholesterol serum levels. Blood cholesterol is monitored annually and in 2014 the level was seen to rise again. Additionally, the animals were a higher weight than ideal (group average=1.25kg, wild=600-800g). The possible reasons for this are discussed and the results of further diet manipulations using a bespoke formulated insectivore pellet are presented. The results will inform future diet formulation for this species.

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Meerkats kept in zoos often have issues with obesity and high cholesterol, alongside the many health issues which accompany these. This study explores a diet change in zoo-housed meerkats and takes a holistic approach to examining the effect of said change. We investigated both the behavioural and physiological effect of a transition from a relatively high fat content, meat and mealworm based diet, to a lower fat, commercial cat food and cricket based diet. We found that this specific change in diet is able to reduce cholesterol levels by an average of 42.9% in a three-month period, as well as significantly increasing the occurrence of active behaviour. We present our findings as a case study for how diet changes can be monitored and adapted in response to health concerns.

Evaluating the diets of captive black rhinos in European zoos, with particular emphasis on iron content

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Black rhinos (*Diceros bicornis*) are a critically endangered species and population numbers in the wild have been severely reduced from poaching. Consequently, captive populations have become increasingly important and in recent years there has been concern regarding high iron accumulation in some captive black rhinos leading to iron storage disease. Accumulation of iron in certain tissues can result in pathology of major organs such as the liver. The majority of iron within the body originates from the diet and therefore it is important to monitor iron content in each food item and within the diet as a whole. This project aims to establish the current diets of black rhinos in Europe, to compare them with recommended guidelines and to identify any diets with high iron content. Information regarding the dietary management of these collections will be determined including whether any individuals are screened for iron storage disease. Of the 21 EAZA collections holding 83 black rhinos so far 12 have responded and this accounts for 59% of the surveyed population. Of these 12 responses 3 have diagnosed iron storage disease in their collection. Preliminary analysis of the diets show over 60 different food items being offered and of these at least 20% do not have available analysis detailed enough to reveal iron content. Diets from each collection will be analysed further to look at diet composition and nutrient quantities to be compared to recommended guidelines.

The influence of age and sub-species on the gastrointestinal microbiota of *Panthera tigris*

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Gastrointestinal microbial communities play a fundamental role in maintaining health and homeostasis within host species. Therefore, it is essential to gain knowledge of the characteristics of bacterial communities, and how levels may fluctuate throughout an organism's life, in order to fully understand the symbiotic relationship between bacteria and their hosts. This is particularly the case when breeding and caring for captive endangered species such as tigers, as changes in microbial communities can act as an indication of gastrointestinal disease, failing health or nutritional imbalances. This study provides a baseline for characterising the dynamics of bacterial communities within the gut of tigers, using FTIR and VFA analysis to measure the concentrations of metabolites and fermentation end products, specifically the short chain fatty acids acetate, propionate, and butyrate, produced by gut microbes. Results show very little variation in metabolite and fatty acid concentrations in the faecal samples of tigers, dependant on sub-species (DFA $p=0.123$). However significant differences were present in the metabolite concentrations in faecal samples from young, adult and old tigers (DFA $p=0.001$), with analysis of fatty acid concentrations showing higher levels of acetate, propionate, and butyrate present in young tigers when compared to geriatric tigers. This suggests that the microbial communities found within the gut of tigers fluctuate over the course of a tiger's life, with significant differences in faecal metabolite concentrations between old, adult and young individuals.

The effects of probiotics on captive primates

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Traditionally, antibiotics have been given to animals to increase growth and improve overall health, but the need for alternatives has risen due to the increase of antibiotic resistance. Probiotics live, voluntary bacteria which are usually ingested to assist microbes in the gastrointestinal tract. They

are thought to be non-pathogenic and have few, if any, side effects allowing them to be safe alternatives to antibiotics and vaccinations. Suggested health benefits of giving probiotics in farming and aquaculture industries include improved growth rates, increased immunity and lower mortality rates.

Many zoo animals are regularly prescribed probiotics for similar reasons but little research has been conducted on their effectiveness in zoo animals. Primates often live in a hierarchy and as such can be subject to competition over food etc., potentially leading to stress. Chronic diarrhoea is common in captive primates, and is costly to treat. Therefore, potential preventative treatments should be researched to improve animal welfare.

This study investigates the protective effects of probiotics on 10 primate species, specifically assessing faecal score, food intake, and behaviour. In addition, for two lemur species we have investigated the apparent digestibility of major nutrients. Species were split into two groups of 5 species, with each group given a different probiotic in a double-blind study. Pre-treatment observations were undertaken over 15 weeks from November 2015 until March 2016, with each species being studied every 5 weeks, creating 3 weeks of data per species. Probiotic treatment commenced in March 2016, with a 2-week acclimatization period, before a further 15 weeks of observations will be completed. A post-treatment observation phase is also planned.

Preliminary results have shown an overall significant increase in 'ideal' faecal scores. Further faecal score analysis will be presented, along with results comparing food intake and behaviour between phases before and during probiotic treatment. Any potential effects of probiotics will be interpreted in the light of impact on primate welfare and the cost of this treatment.

The relative importance of grey or red squirrels in the diet of pine martens

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Recently, the issue of pine marten reintroduction has gathered much interest, due, in part, to potential concomitant impacts upon grey squirrel populations resulting in beneficial outcomes for red squirrels. It is unclear what mechanisms are involved, though theories have postulated direct pine marten predation effects, grey squirrels exhibiting a 'landscape fear' response, among alternative tactics. This presentation will present data from investigations into pine marten prey preference trials. These data will include the correction factors used to determine the relative importance of grey squirrel in the diet of pine martens resulting from two methodologies: 1/molecular techniques to detect prey DNA in scat samples 2/directly quantifying prey remains in scats. These data were supported by further feeding preference trials, utilising a different methodology that examined the selection process and behavioural response by pine marten individuals when presented with a number of natural food types. Provisional analyses of data from the study have been able to allow the calculation of correction factors for prey species, which are 30 for grey squirrel and 27 for mice – but a lot of work is still required. We will also be showing prey preference of pine marten and foraging behaviour responses from captive pine marten, such as the caching response to certain conditions. The presentation will also show how enclosure design was a problematic factor for this study. The results of this study provide essential, new, knowledge that would greatly help assist with current and future conservation initiatives and any proposed planning for pine marten reintroduction projects.

Relaxin : A Giant Panda (*Ailuropoda melanoleuca*) marker of placental development

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With fewer than 3000 giant pandas remaining worldwide, efforts are strong in reproductive conservation. Research has been complicated by the species' use of several reproductive traits including displaying mono-oestrus, a variable length delayed implantation and pseudopregnancy. Key endocrinological advances have aided in overcoming the issues surrounding the mono-oestrus cycle, however there are few studies monitoring a potential pregnancy.

Relaxin is a reproductive hormone with ovarian and uterine production. It is also produced abundantly by the placenta during pregnancy in a species specific manner. A role in implantation has been postulated however relaxin presence has not been confirmed in the panda. We hypothesise that relaxin detection in the panda will identify implantation and allow for monitoring of the foeto-placental unit.

Urine samples from five oestrous cycles were collected from two female giant pandas (housed at Edinburgh Zoo, Scotland and Smithsonian National Zoo, Washington DC) between 2013 and 2015. Two cycles resulted in successful pregnancies. SDS-PAGE and western blotting were undertaken for relaxin detection.

This is the first identification of urinary relaxin through western blotting in giant panda urine, and relaxin was detected in all oestrous cycles. In a live twin birth, relaxin was detected from 4 weeks until birth. Relaxin peaked at 3 weeks until birth and steadily declined until the day of birth. Relaxin appeared after peak progesterone production, and was still present after progesterone had returned to baseline. Deviation from this pattern was assumed as an indicator of post-implantation loss, which was identified in the oestrous cycles from the Edinburgh Zoo panda.

We conclude that relaxin can be detected in giant panda urine, and that presence indicates foeto-placental health. Although a role in implantation could not be determined, results suggest the placenta to be fully functioning for at least four weeks.

Seventeen years of baboon research: Analysis of a long term dataset of self-directed behaviour and reproductive parameters in a zoo population of Hamadryas baboons (*Papio hamadryas*)

Gwen Wirobski^{1,2}, Joanna Newbolt¹, Kathy Baker¹, Amy Plowman¹

Long-term behavioural studies and biological records provide an opportunity to create large datasets for analysis, and can often provide more information than is possible in a single student project. The troop of Hamadryas baboons (*Papio hamadryas*) at Paignton Zoo, have been observed for the last 17 years, providing a large dataset, particularly focusing on self-directed behaviour (SDB) and reproductive parameters. SDB (or displacement behaviour) has been suggested to be a behavioural measure indicative of stress, and includes acts of self-maintenance, like self-scratching, self-grooming, yawning, and body shaking. SDB levels have been found to increase in situations where higher levels of social stress and anxiety are expected.

Over the course of 17 years, a total of 69 (25:44) adult baboons were observed during three observation periods each year: autumn, winter and summer. All individuals were observed in their main enclosure and in a smaller off-show enclosure where they were kept during cleaning times. Focal instantaneous sampling was used for state behaviours while continuous all-occurrence sampling was applied to event behaviours (SDBs). Alongside this, data were collected on female reproductive parameters.

Results show significant effects of factors such as sex, enclosure type and season on SDB rates, including an interaction between sex and enclosure type, in which males display significantly higher levels of SDB in the off-show enclosure (i.e. crowded condition) than in the main enclosure.

While there was no relation between female SDB rates and mean cycle lengths, gestation lengths, post-partum anoestrus lengths, or inter-birth intervals, we found that lactating females showed significantly lower SDB rates than cycling or pregnant females. This will be discussed as a possible effect of hormonal changes during lactation.

This study demonstrates the value of analysing long-term datasets, and gives further validation of non-invasive stress assessment using SDBs in Hamadryas baboons in order to enable evidence-based population management decisions.

‘We’re all in this together’: Encouraging each individual to breed in the fight for a species survival

Sally Holt and Angus I. Carpenter
Wildwood Trust, Kent

The presentation will discuss how the successful breeding of the Scottish wildcat (*Felis silvestris grampia*) at Wildwood Trust supports much wider conservation objectives in helping to save the species from extinction.

Due to the extremely low number of ‘good’ quality wildcats in captivity, potentially as few as 100, it is important to maximise the breeding capacity of every ‘good’ individual. Hence, it is important to ensure all ‘good’ individuals are breeding, and where they are not breeding, every factor explored to encourage the individual to breed. The main focus of the presentation will be a case study on how to turn non-breeding in to breeding individuals. Experiencing a once unproductive cat, attention was focused on variable factors that were manipulated to encourage it to breed. Detailed information will be concentrated on specific variables and the series of conditions that, ultimately, lead to its successful breeding and recruitment of young to the adult population. The factors discussed will cover enclosure furniture and keeper routines.

Ultimately, the presentation aims to raise awareness of our declining native felid, the ‘Highland Tiger’, and supplies breeding advice that could facilitate an increase in the number of Scottish

wildcats globally, supporting its fight against extinction, whilst also, potentially, having the ability to be applied to other small cat felids of conservation concern.

Evaluating Husbandry Influences on Conservation Breeding of an Extinct-in-the-Wild Antelope

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With the number of threatened species increasing globally, conservation breeding is vitally important now more than ever. However, no previous study has attempted to determine how the varying conditions across worldwide zoos have influenced breeding by an extinct-in-the-wild species. We therefore use questionnaires and studbook data to evaluate the influence of husbandry practices and enclosure design on scimitar-horned oryx (*Oryx dammah*) breeding success. Regression models were used to identify the variables that best predicted breeding success among 29 zoos across a five-year period. Calf survival decreased with herd age and when soft substrates were used for the hardstand area. Smaller herd sizes and lower feeding heights were also found to decrease calf survival, although these were less influential. Unlike previous enclosure design studies, no variables influenced birth rates. Thus this is the first example of a situation where zoos are already providing high quality conditions for breeding success in a species that is entirely reliant on captive breeding for its future survival. Our work therefore suggests that extinct-in-the-wild species stand a greater chance of survival with empirical design of zoo enclosures and husbandry methods.

The reproductive behaviour of Edwards's pheasants in captivity: potential implications for reintroduction to Vietnam.

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The critically endangered Edwards's pheasant (*Lophura edwardii*) is endemic to three provinces in Central Vietnam, where its habitat has become severely fragmented due to agricultural and political pressures. Although individuals were found and taken from the wild in the late 1990s, subsequent surveys have not located any birds and the species is possibly extinct in the wild.

Edwards's pheasants breed readily in aviculture and the captive population stands at over 1,000 birds worldwide with plans in development to reintroduce the species to Vietnam in the next five to ten years. However, pheasants are often managed intensively in captivity with some aspects of husbandry, such as housing pairs adjacent to one another and hand-rearing chicks, which may not be suitable for reintroduction programmes.

Therefore, this study investigated the behaviour of two pairs of Edwards's pheasants established in 2015 and housed off-show at Paignton Zoo. The pheasants were observed remotely using cameras set up in their enclosures, for periods of 1.75 to 2 hours per day during November to December 2015 (non-breeding) and February to May 2016 (breeding season). Spatial use of the enclosures, proximity, state and event behaviours were recorded. The proportion of time spent in active state behaviours, such as locomotion, was higher in the breeding season although there were differences in activity budget between males and females. Event behaviours associated with courtship, predominantly displayed by males, also increased in the breeding season.

Other results indicate that captive Edwards's pheasants are strictly diurnal, respond behaviourally to other pairs, even in the non-breeding season, and are able to produce fertile eggs in their first breeding season as a pair when housed in close proximity to other pheasants. Only one pair was able to hatch chicks and is the subject of ongoing observations. Results will be discussed in the context of typical pheasant reproductive behaviour and the field of reintroduction biology.

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

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Tufted puffins (*Fratercula cirrhata*) are pelagic seabirds found in the North Pacific Ocean. Although they are classified as Least Concern by the IUCN, their population numbers in the wild are estimated to be decreasing. Ten tufted puffins are currently housed at Living Coasts zoo and aquarium in Devon. This group of puffins has had limited breeding success since they were introduced to the site. Between 2003 and 2015 the puffins have had a hatching success rate of only 20%, and only 58% of hatchlings have survived past 30 days, whereas wild tufted puffins can be expected to have a hatching success rate of 63-64% and a fledgling success rate of 64-71%. Consequently, it is important to understand why the puffins at Living Coasts are not breeding successfully. This is the third year of this research project into the effect of husbandry and disturbance on the breeding behaviour of the puffins. After the first year it was suggested that keeper disturbance during daily husbandry was causing the birds to vacate their nest boxes, possibly impacting breeding success. In the second year, husbandry practices were altered to decrease the level of disturbance, and, although the effect on breeding behaviour was reduced, breeding success did not improve. However, some of these changes were only implemented late in the year so their full effects may not have been achieved. In this third year the ongoing effects of husbandry changes were investigated. Behaviour was observed during 20 minute focal follows on each individual, recording state behaviours instantaneously every minute and event behaviours continuously, several times per day between October 2015 and July 2016. Results indicate that husbandry and visitor disturbance do influence social resting behaviour (a key behaviour during the breeding season) but not nest box occupation. Other breeding behaviour was recorded too infrequently to make conclusions. The enclosure changes have resulted in more nest boxes being used by the puffins but only one fertile egg has been laid this breeding season indicating that there are still other factors influencing the low breeding rate in this group.

The evaluation of training as a method of species-specific feeding in a mixed-species aviary at Newquay Zoo

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The Tropical House mixed-species aviary at Newquay Zoo is home to many different insectivorous passerines that have similar diets and compete for resources. During the breeding season it is important that each species can access enough food for their chicks, but with so many species sharing an enclosure this can be difficult to guarantee. Therefore, the aim of this project was to train four species: the grosbeak starling (*Scissirostrum dubium*), blue-crowned laughing thrush (*Garrulax courtoisi*), white-rumped shama (*Copsychus malabaricus*) and Pekin robin (*Leiothrix lutea*), to feed from species-specific feeding devices, which took the form of long wooden canes with D-cups fixed to one end. The birds were initially introduced to a white feeding stick filled with wax moth larvae. After all, four species had acclimated to the novel feeding device, new sticks were introduced that were painted different colours for each species. All training sessions were recorded with a dictaphone, and behaviour was observed before, during and at the end of training.

Training was considered successful if at least 80% of all bird interactions over the final five training sessions were with the desired stick. By this criterion only the blue-crowned laughing thrush and Pekin robin were trained successfully. However, by quickly removing the sticks when a bird attempted to feed from the wrong one, the investigator was able to control, to some extent, which birds fed from which feeding device. Therefore, it was decided that the feeding sticks themselves would be deemed successful feeding devices if 80% of total food taken by each species over the last five training sessions were from the desired stick. Since all four study species received more than 80% of their food from the correct stick, the sticks were considered viable training devices. It was concluded that training had no significant effect on state behaviours; however, it may have influenced the boldness of the newly hatched white-rumped shama chicks which were observed flying in and around the public viewing area; behaviour not seen in adult conspecifics.

Factors influencing interactions in zoos: animal-keeper relationship, animal-public interactions and solitary animals groups

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Interactions that animals experience can have a significant influence on their health and welfare. These interactions can occur between animals themselves, but also between animals and keepers, and animals and the public. Human and non-human animals come into contact with each other in a variety of settings, and wherever there is contact there is the opportunity for interaction to take place. Interaction with companion animals are well known, but human–animal interaction (HAR) also occurs in the context of farms, laboratories, zoos and even the wild. This project proposes a novel monitoring approach to record animal-human interactions and animal-animal interactions in zoos. This was accompanied by a survey of animal personality for welfare, husbandry, breeding programs and reintroduction purposes. The pilot project was based on direct monitoring of animal behaviour, use of camera traps and animal personality questionnaires completed by experienced keepers. The goal of this project is to create a network between zoos to explore the aforementioned interactions to produce husbandry protocols and explore personality and behavioural traits in multiple species. We present data regarding Sumatran tigers and Asiatic lion (ZSL London and Whipsnade zoo) interactions with humans and conspecifics. These data is collected across a broad range of environmental conditions and outlines the monitoring protocols developed to collect this data. The first two years' data show the great adaptability of these species to ex situ environments, low or absent negative impact of visitors' presence and the relevance of individual personality in these interactions.

An evaluation of the behavioural changes demonstrated by meerkats (*Suricata suricatta*) before, during and after interactive sessions with humans

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The subject of human-animal interactions (HAIs) and relationship formation is applicable to a variety of contexts, however research into exotic species is particularly underdeveloped. There are, for example, very few studies of HAIs between exotic animals and people during shows or close encounter sessions. This study considers the effects of direct interactions between humans and meerkats across two different interactive session types set up by Zoo2u through an evaluation of changes in behaviour. Meerkats have grown in popularity within zoo collections over recent years and several studies suggest they are an appropriate species for captivity, as they appear to thrive in captivity and show low impacts attributable to the visitor effect. A total of 12 hours and 15 minutes of focal behavioural observations were carried out on three male meerkats at five different encounter events. Locomotory and social behaviours of the meerkats were observed and the implied positivity or negativity of changes in these was determined. The results showed no significant differences in positive, negative or neutral behaviour expression from before, during and after interactions, suggesting no clear welfare impacts upon the animals. It was concluded that the encounter sessions did not adversely affect the animals' welfare, but conversely that they were not enriching either, supporting past research which highlights their tolerance to the visitor effect. This research also suggested that personality and natural history should be taken into consideration for HAI and HAR research, as these appeared to be important influences within this study.

Personality assessment and feline–keeper's relationship in lions (*panthera leo*)

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Animal personality is a growing research area due to the increasing evidence of the impact that it has on welfare, health and management of animals in captivity. Therefore, understanding, testing and improving existent methodologies, as well as develop new ones, to access animal personality is an important step towards improvement of welfare, health and longevity of captive animals. Lions (*Panthera leo*) were chosen for this study because the species is understudied compared to other felidae species in personality matters and because it displays a vast, diverse and well known behaviour repertoire that makes possible the study of personality. Behavioural observations were conducted in ZSL Whipsnade zoo with the purpose of assessing personality in African lions (*Panthera leo*) and test new methodologies to achieve that goal. Complementarily to the observations, keeper-animal interactions were recorded and a personality questionnaire was given to the keepers for them to rate 28 personality traits. Methodologies as sociogram, composite sociality index (CSI) and spread of participation index (SPI) were also used to assess personality traits. Seven profiles of 11 personality traits were produced based on the observations conducted and the potentialities and limitations of the methodologies used were assessed. Statistical analyses were used to prove distinctiveness between and within coded behavioural groups in the time budgets and personality profiling through traits. For that purpose, Kruskal-Wallis and Bonferroni test were used and a p value of < 0.05 was considered statistically significant. More data is needed to achieve conclusions about the extent of the usefulness of keeper-animal interactions to access personality, but a sociogram was successfully used to access personality traits.

A Comparison of the Personality Dimensions of Wild and Captive Sulawesi Crested Black Macaques (*Macaca nigra*)

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Animal personality, defined as “consistent individual behavioural differences over time and across situations”, is an emerging tool for the captive management and conservation of endangered species. It has long been established that the maintenance of wild-like behaviour and characteristics in captive animals are desirable, therefore the aim of this study was to compare the personality dimensions found in zoo-held *Macaca nigra* across Europe with those deduced by a recent assessment of personality in their wild counterparts.

The 54-adjective ‘Hominoid Personality Questionnaire’ was distributed to 25 European Zoos holding *M. nigra*, and responses from 8 zoos allowed us to obtain ratings for 58 individual macaques. Multiple raters from 5 zoos allowed assessment of inter-rater reliability, which yielded a mean ICC (3, k) score of 0.68 for the 54 items on the questionnaire. A principal component analysis revealed a five-dimension structure of personality in captive *M.nigra* consisting of Aggressiveness, Friendliness, Shyness, Withdrawnness and Stability dimensions, for which each individual macaque was assigned a score based on their questionnaire trait ratings.

A comparison between captive and wild (Adams et al., 2015) personality dimensions revealed that Aggressiveness and Friendliness dimensions were consistent across wild and captive contexts. Whilst

Shyness and Stability dimensions did not appear to be present in wild macaques, they are related to dimensions that represent opposite ends of the spectrum: Confidence and Excitability respectively. In order to assess construct validity for these dimensions, we next examined correlations between dimension scores and behavioural data collected on a focal group of 10 *M. nigra* at Paignton Zoo. Behavioural data was obtained through 15 hours of basic focal observations on each macaque and their reactions during novel object testing.

This research concludes that personality dimensions found in wild *M. nigra* are retained in captive macaques. The efficacy of personality assessment methodology and the comparison of personality dimensions will be discussed.

Investigating the effects of ultra violet light levels on captive brown spider monkeys, *Ateles hybridus*

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Ultraviolet B (UVB) radiation is necessary for metabolic processes including, but not limited to, the production of vitamin D. There is a range of research into the links between ultraviolet light and vitamin D deficiency, although much of this work is focussed on reptiles. Wild animals from many taxa are known to self-regulate their exposure to UVB through basking behaviours. Whilst there is some research into the vitamin D requirements of mammals there is a lack of studies that look at whether the provision of UV light in captivity has any effect on behaviour.

Many collections cannot offer their animals the levels of natural UV exposure that their wild counterparts would be exposed to due to climatic differences or physical constraints (e.g. indoor enclosures). The purpose of this study was to collect empirical evidence to assess the effects of artificial ultraviolet light provision on the behaviour of captive spider monkeys.

Five brown spider monkeys (*Ateles hybridus*) were observed at Paignton Zoo during four conditions of differing UV provision: a control period (using bulbs which emit UVA but no UVB) and three treatment periods of increasing UVB intensity. Each UV set up was used for 6 weeks. 40 hours of observations took place across 25 days during each condition, giving a total of 160 hours of data. Data were collected in 20-minute observation sessions using instantaneous scan sampling of state behaviours and enclosure use each minute, and continuous focal sampling of event behaviours (one focal individual per session).

We will discuss the results of GLM analysis to investigate any differences in behaviour and enclosure use between the different UV conditions. Recommendations for future research will be made.

Making a 'Song and Dance' about Environmental Education in Zoos

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With over 700 million visits annually to zoos worldwide, zoos have great potential to educate a wide audience. Over eighty percent of these visitors are families, making them the primary target audience. Pro-environmental beliefs and attitudes are thought to develop in childhood and go on to

affect adult behaviour. Providing information which can be understood by children is therefore crucial for developing positive attitudes towards conservation. Despite this, shows designed specifically for children are not always present in zoos and their impact has not been considered. This study examines a conservation theatre production designed for three- to six-year-olds. We investigate its effectiveness at delivering basic animal facts and associated conservation messages. The show employed songs from popular culture, digital media, and hand and rod puppets to teach children. Simulated post-repeat testing (n=186) and repeated measures testing (n=29) were used to examine learning. A similar positive trend was seen using both methods. Respondents were able to answer 20% more correct answers after the performance than when compared to pre-performance baselines with 50% increase in animal diet knowledge, 30% increase in knowledge of where the zoo works outside United Kingdom, and a 20% increase in knowledge of the zoo's conservation actions. Increases in knowledge of animal facts were found to be highest where the information had been repeated throughout the show and where it was incorporated into songs. We conclude that presenting information using theatre, music and puppets is highly effective within the zoo context and can be used to convey ideas to young children.

Understanding the Effectiveness of Trails for Visitor Led Learning in Informal Education Settings

Bridget Murray
Knowsley Safari

Trails are a popular piece of interpretation available to visitors in many informal education settings, particularly museums and art galleries. Trails are also used in zoos and aquaria, but their use and effectiveness in these settings is generally overlooked in the literature. The aim of a trail is to enhance a visitors learning by providing some structure in an otherwise free choice learning environment. One such trail was developed by the Royal Zoological Society of Scotland (RZSS) to run at RZSS Edinburgh Zoo for the duration of the visit of the temporary exhibition, "Dinosaurs Return" in 2015. The trail had the aim of helping visitors make links between the dinosaur exhibition and the rest of the living world, represented by their living collections. This specific aim, as well as the success of the trail in general was evaluated by means of established theoretical design criteria, observational surveying and face to face surveying of visitors.

It was found that overall uptake of the trail was low, with only 28% of visitors given the option of participating actually following the trail. A variety of factors contributed to this result, e.g. length of trail and being "too busy". However, of those visitors who did undertake the trail, 85% strongly agreed or agreed it helped them "have fun", and 92% felt they had learnt something when using it. Nevertheless, when considering the low uptake, compared to high uptake seen elsewhere, questions were raised about why success of trails varies between settings. It appeared completing a trail did not comply with the personal motivations behind a visit to the zoo, but would comply with personal motivations for a visit to another informal education setting. These findings have implications for the development of future visitor led learning resources for use in a zoo/aquarium environment.

Do public perceptions of birds change after educational flying displays at Colchester Zoo?

Rosie Brigham
Nottingham Trent University

Previous studies regarding Zoo education have had a large focus on cognitive changes, with very few studies investigating alterations in attitudes and the impact educational displays have on this. Most

UK Zoos provide some form of animal display, often involving birds. Despite this, research on the perceptions of birds has rarely been done. This study focuses on a gap in knowledge regarding public perception changes in birds after educational displays. Data was collected using pre and post questionnaires before and after Colchester Zoos bi-daily displays. The sample size included 140 participants and the data collected focused on attitude alterations, knowledge alterations and a general evaluation of the display. Results found there to be an increase in perceptions towards birds, ratings rising from 2.93 to 2.59, with 5 being the more negative score. Conservation knowledge increased significantly after the display, whilst the ability to state a fact about birds decreased significantly. The reasons behind this are discussed, with distraction from the birds flying close by being a major theory towards knowledge decrease. The display rated high with the public and the increase in attitude is thought to be due to the high ratings of enjoyment. Studies have shown there to be a link between enjoyment and interest; though this would need to be proven in this particular area through further research. Implications of the study revolve around independent variables and the inability to gain a pre and post questionnaire from the same person. Suggestions for further studies include the same person filling out a pre and post questionnaire, as well as testing theories involving why attitude and knowledge changed. Repeating the same study on a larger scale would also result in data that represented the Zoo population.

Red-billed choughs: Measuring the behaviour of an unfamiliar species in captivity, and its use as a public engagement tool for a proposed reintroduction project.

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With ever increasing interest in the reintroduction of previously native species, this presentation offers a unique opportunity to investigate two areas of concern.

Firstly, an important precursor to any species reintroduction is an evaluation of local public attitudes. Attitudes towards unfamiliar species are expected to be more plastic. Therefore, caution should be taken when considering a species, since attitudes may change when the reintroduction project is underway. This study considers an unfamiliar species within the study area, the red-billed chough, which is being considered for reintroduction to Kent. The study compares visitor attitudes at Wildwood Trust, both before and after the arrival of Chough to the park. All 130 participants were given basic information about Chough conservation, ecology and shown an image of the bird. In addition, half were also shown the newly acquired birds. On viewing the birds, participants generally responded more positively, and this effect was larger for people with less knowledge of British Birds. The study shows how seeing live specimens of an unfamiliar species can increase positive attitudes towards its reintroduction, even when these people have limited knowledge of a species' conservation and ecology.

Concomitantly, there are important parallel considerations to be made with new species to a zoo collection, such as providing information on enclosure suitability and animal welfare. This may be particularly important when considering species that are unfamiliar to keepers, or are being housed with other species. The arrival of red-billed choughs at Wildwood Park was eagerly awaited, and modifications to a pre-existing, mixed aviary were made under recommendation from external keepers experienced in keeping choughs. However, several unknowns remained, such as the likely interaction with the other birds, as well as other novel features of the aviary. The presentation would summarise an ongoing study of captive chough behaviour at Wildwood.

Long term learning retention in zoo education

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University of Edinburgh
Edinburgh Zoo

Although outdoor learning is largely celebrated, there is an inconsistency in the literature regarding learning outcomes in the zoo environment. RZSS Edinburgh Zoo delivers a class for 9-12 year olds called the Cycle of Life. This workshop introduces reproduction with regard to zoo animals before being brought into a human context. This combines sex education, which is undisputedly vital, with outdoor learning. This study aims to assess both cognitive and affective outcomes for learning in this zoo based session. A total of 522 pupils across 10 schools were involved in this study. Pupil engagement and affective learning during the RZSS Edinburgh Zoo Cycle of Life (CoL) session was monitored through class observation. Long term learning was assessed cognitively by visiting schools both 3 weeks and 1 year after their zoo session to administer follow up questionnaires. Control groups of pupils who had not attended CoL but had received their sex education solely in the classroom also completed the questionnaire to compare outdoor learning to the classroom setting. CoL attendees performed significantly better on follow up questionnaires than classroom control groups ($p < 0.0001$). Pupils retained information well both 3 weeks and 1 year after the session; showing little decline between time points. Pupil engagement and interest with the session was clear. Pupils overcame embarrassment with the subject and realised that it has relevance in the wider context of the natural world. CoL provides an engaging setting to teach primary school pupils sex education which benefits both their long term learning and personal development.

Are 'Keeper Talks' effective at transmitting educational messages about environmental enrichment within zoos?

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Modern zoos are concerned with conservation, education and research. In the UK, signage, sessions with school groups and 'keeper talks' are used to educate visitors. However, signs are not always read and education sessions target only a small percentage of visitors. 'Keeper talks' can increase knowledge and create positive attitudes towards animals. Many studies have investigated their educational value but none have assessed their efficacy for transmitting messages that are counter to popular beliefs. Enrichment research findings do not always match public opinions, with visitors generally preferring natural looking enclosures and activities, even though technology, like

touchscreens, can be positive for animal welfare. We aimed to see if 'Keeper Talks' can change existing misconceptions about enrichment, especially touchscreens, in zoos by conducted a questionnaire study of adults visiting chimpanzees at Edinburgh Zoo. We collected data from visitors in three experimental conditions; visitors who heard the standard chimpanzee 'keeper talk', those who heard an extended talk with more enrichment specific information and visitors who did not hear a talk. We used Linear Mixed Models to analyse data from 167 participants. Visitors attending the extended talk had more positive views of touchscreens as enrichment than the other two groups. However, visitors from all three groups believed enrichment should look natural, suggesting that visitors did not learn this general concept from the extended talk. We believe that 'Keeper Talks' can change public misconceptions when specific examples are given but do not seem to change widely held opinions relating to general concepts.

Poster Presentation Abstracts

The effect of visitor sound levels on the behaviour and enclosure use of captive Linné's two-toed sloths (*Choloepus didactylus*)

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This research monitored the interactions between visitor sound levels and sloth behaviour and enclosure positioning. Zoos must have stringent welfare standards through both husbandry routines and enclosure design. Visitor effects are frequently questioned, however, efforts to assess these implications are often hampered due to differences in species, measures and enclosure design. Indices such as the spread of participation index and electivity index have been used to assess this but do not attribute enclosure use to visitor effects. Visitor sound level effect in particular is understudied, despite being a common physical stressor in animals, and little is known about captive sloths and their requirements in comparison to other captive species. Therefore, evidence on sound and behaviour will provide information to improve captive sloth welfare. An observational study of Linné's two-toed sloths (n=9) took place at four zoos from a variety of enclosure types. Each collection was observed for three days with six hour-long recording sessions a day. Instantaneous scan sampling, at three minute intervals, was used to record sloth behaviour, enclosure position, and visitor sound levels. A novel matrix system was then used to analyse enclosure positioning and draw comparisons to sound levels. There was an overall general trend that as sound levels increased, activity levels also increased. However, there was a more variable trend for the only walk-through enclosure in the study. Therefore, this multi-enclosure study shows no welfare implications arose from captive two-toed sloths being exposed to varying sound levels, suggesting it is acceptable for their welfare to be housed in a walk-through style enclosure. However, this area remains understudied and species-specific studies using the newly established matrix system could be conducted to assess the welfare implications of sound levels and the effect this may have on how a variety of species are housed.

Human-animal interactions in zoos: the effect of visitor feeding experiences on behaviour of a group of Rothschild's giraffes (*Giraffa camelopardalis rothschildi*)

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A modern zoo's goals, education, conservation, and research, depend greatly on the zoo's ability to attract and entertain visitors. It is often suggested that zoo visitors want to experience close contact with animals during their visit. In this context, visitor feeding experiences have become an integral part of many zoos and often represent an important source of income for those institutions. The welfare of the animals involved is of great importance and should be monitored closely. It could be argued that feeding experiences provide enriching diversion from daily husbandry routines. However, interacting with unfamiliar people may also cause stress and anxiety and there is limited research on such close proximity visitor presence.

The aim of this study was to evaluate the effect of feeding experiences on individual members of a group of Rothschild's giraffes (*Giraffa camelopardalis rothschildi*). Behavioural observations were carried out over the winter and spring period using instantaneous scan sampling for state behaviours and continuous all-occurrence sampling for event behaviours. 20-minute-observation sessions took place throughout the day, and specifically before, during and after experiences, with matched control observations on the next available day without a feeding experience. Data were collected on a total of 28 days, comprising of 14 experience days, and 14 matching control days.

Giraffes showed individual differences in their response to the feeding experiences. Highest rates of animal-visitor interactions were recorded for the dominant male and two hand-reared young females. The proportion of time the group spent ruminating was significantly higher before experiences compared to the same time on control days ($p < .001$), while feeding was significantly higher during experiences than at the same time on control days ($p < .05$). There was no significant effect of feeding experiences on the performance of oral stereotypies.

The present study suggests that giraffe feeding experiences at Paignton Zoo have no negative impact on giraffe welfare, and it is possible that some individuals may find the experiences enriching as they readily chose to take part.

Effects of environmental enrichment and enclosure design on the behaviour of captive red pandas (*Ailurus fulgens*)

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Red pandas (*Ailurus fulgens*) are now classified as endangered in the wild by the IUCN due to reductions and fragmentation in their wild population. The captive enclosures for red pandas have been improved greatly as the knowledge about their management has developed and this has led to a great increase in breeding success. Information about the wild environment has been used to help design enclosures in recent years and has also helped provide information about the requirements needed to maintain these animals in captivity. This has resulted in a captive population of 755 individuals in zoos around the world but some issues including stereotypical behaviours have been identified, indicating potential issues with their captive management. This study looked at the effect of environmental enrichment and enclosure design on the behaviour of the two pandas housed at Shepreth Wildlife Park. The main focus of this was to try and reduce the amount of stereotypical behaviours exhibited by one of the individuals by altering factors including enrichment, enclosure design, routine and training. A behavioural monitoring form and behavioural ethogram were used to observe the individuals before and after the addition of new changes to evaluate how they responded. A number of different enrichment items and enclosure addition were evaluated

including puzzle feeders, scent enrichment, ice lollies, novel items, planting and climbing structures. The results of this study found that there was no significant change in the individual's behaviour when environmental enrichment and enclosure design alterations were made. The results also found no significant difference in stereotypical pacing behaviour after the introduction of environmental enrichment, enclosure alterations, routine changes and training duration variation. Although no significant results have been identified observations and the descriptive statistics identified that box training, routine changes and enclosure additions had some effect on pacing behaviour. This could identify these areas as contributing factors that need further development and research with these individuals. The study results will help provide information to assist with developing the management program of these individuals in the future but as only two individuals were involved the wider implications are limited.

Causes of stereotyping in an Amur leopard

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Stereotyping in captive mammals can be viewed as a sign of stress. Identifying the causes of such behaviour in an individual may help collections to improve the welfare of the animal. In addition, such behaviour can be concerning for members of the visiting public. This study attempted to identify external influences associated with the stereotyping of a male Amur leopard (*Panthera pardus orientalis*) at Yorkshire Wildlife Park. Leopard behaviour and visitor numbers were recorded every 5 min, with other events such as the presence of keepers, visitors, school groups and behaviour of other animals, recorded as they occurred. The number of visitors was not associated with the duration of stereotypical behaviour ($p = 0.866$). Similarly, the onset of stereotypical behaviour was unlikely to happen when loud school groups were present. There were too few occurrences of other species being active to assess the effect on the leopard's behaviour. However, six of the eight times that keepers were observed in the off-show area of the enclosure, coincided with the onset of stereotyping. This suggests efforts to screen the enclosure from the visitors, such as planting hedges, are not necessary. Whereas keeper's distracting the leopard before cleaning the off-show area might see a reduction in stereotyping.

Evaluating enclosure use in the sun beetle *Pachnoda marginata*: implications for welfare

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Enclosure use and design has developed into an evidence-based science with the potential to improve animal welfare for a range of species. Enclosure use analysis methods could be used to objectively improve enclosure design for small zoo species, such as invertebrates.

Enclosure use was investigated in a colony of sun beetles (*Pachnoda marginata*) over a nine-month observation period. Overall enclosure use values were calculated using the modified Spread of Participation Index (SPI). The effects of temperature, humidity and light provision were investigated, revealing that sun beetles selectively used elevated enclosure zones when basking lights were switched on ($p < 0.001$). A Pearson's correlation revealed that enclosure temperature showed a weak yet significant positive correlation (0.23) with SPI ($p < 0.001$), indicating that smaller, rotten log zones

were used preferentially during increased temperatures. Time of day, by contrast, showed no significant correlation with SPI ($p=0.456$).

The outcomes of this study have implications for best practice enclosure design for *P.marginata*. The research also provides a foundation from which a wider range of invertebrate studies may be developed.

Is public visitation of zoos effected by zoos' participation in conservation projects?

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Askham Bryan College

Within the industry, zoos are credited with the efforts they invest in conservation projects. However, it remains unclear whether a zoo's conservation efforts are valued by the public and if this plays a part in motivation to visit a collection. Through the use of a questionnaire distributed within the UK, this study aimed to establish if people thought conservation was an important role of zoos; ascertain which collections the public chose to visit and whether this was associated with higher numbers of conservation projects undertaken by these organisations. A high number of respondents (70%) said involvement in conservation work made a "good zoo". These visitors who regarded conservation as contributory to a "good zoo" were not more likely to visit zoos that supported a large number of conservation projects. The results suggest that while the public recognise that zoos should be involved in conservation, they still visit zoos primarily for other reasons such as entertainment purposes.

Effect of spatial crowding on the behaviour of a group of ring-tailed lemurs (*Lemur catta*).

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In winter, zoo animals are often confined to indoor enclosures which are usually smaller than outdoor enclosures.

The effects of spatial crowding have already been extensively studied in rodents, who show an increase of aggression under crowded conditions, as well as in gregarious apes and monkeys, who show more flexible coping strategies, but to our knowledge has never included Prosimians. Ring-tailed lemurs rarely show reconciliatory behaviour and grooming is considered to serve hygienic rather than social functions. Therefore, it is interesting from both a purely scientific, and from an applied angle whether this species adapts its behaviour in crowded conditions. We conducted a spatial density study in Planckendael Wild Animal Park (Belgium) on a group of 7 ring-tailed lemurs, keeping the number of lemurs constant, but changing the amount of available space. In summer, the animals had access to an outdoor enclosure ($\pm 525 \text{ m}^2$). During winter, the animals were housed in a

heated indoor enclosure ($\pm 20,6\text{m}^2$). The cleaning and feeding routines are similar for both conditions. We collected data from August 2015 till January 2016, with a total of 62 days. 56 observation sessions were made in the outdoor condition and 57 in the indoor condition, with a total of 138 observations per animal. Focal (10 min) and scan sampling was conducted with all occurrences during feeding sessions of social and aggressive behaviours.

We found that the ring-tailed lemurs showed significantly more social behaviour (grooming and huddle) and significant less aggressive behaviour (chase) in the crowding condition. These results correspond with a tension-reduction strategy rather than conflict avoidance or inhibition strategies; the ring-tailed lemurs seem to adapt their behaviour and show more social and affiliative behaviour, to prevent or lower the intensity of the aggression.

Agonistic interactions within a group of California Sea Lions (*Zalophus Californianus*) and its effect on training participation

Emma Myers

Animal talks and displays play an important role in the modern zoo, serving to educate the public as well as providing entertainment. In the UK, there has been an increase in the popularity of interactive animal displays in zoos in recent years, including sea lion displays. With these increasing human-animal interactions occurring within zoos it is important to ensure animal welfare remains the priority. Despite this, there has been a relatively low number of studies conducted which look into what influences an animal's willingness to participate in these displays. Ten California Sea Lions (*Zalophus Californianus*) at Blackpool Zoo were observed over a 9-month period prior to and during the daily displays in order to determine what factors influenced non-participation or aggression during the display, and in particular whether agonistic interactions before the display had an effect. The results indicate that agonistic interactions were initiated by the same few individuals each time. There was found to be no association ($p=0.2935$) overall in the four sea lions who regularly take part in public displays, between agonistic interactions before the display and non-participation or aggression during the display. Whilst these are the best results we could hope for as animal keepers and trainers, the non-participation or aggression that occurs in some displays has not yet been explained, and therefore the research continues.

Welfare of Zoo housed Chimpanzees (*Pan troglodytes*) with special attention to Regurgitation and Reingestion (R/R)

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In non-human primates, displacement behaviours, such as self-scratching and yawning, are markers of anxiety and stress and Regurgitation and Reingestion (R/R) is an abnormal behaviour, which has negative consequences for physical health and is indicative of poor mental health. Previous studies suggest that R/R may be linked to boredom, sources of stress, type of food and limited opportunities to eat throughout the day. We aimed to examine whether R/R, scratching and yawning were

influenced by group social dynamics, feeding factors, visitor numbers or visitor behaviour. We conducted 20-minute focal observations on 18 adult chimpanzees at Edinburgh Zoo, UK in addition to scan samples of visitor numbers and all occurrence samples of flash photography, screaming and banging on the glass in the exhibit. We analysed 158 hours of data and Generalised Linear Mixed Models revealed that yawning was significantly more likely if the period since the last feed was long, when there were more visitors and if children screamed. Scratching was significantly more likely to occur if visitors used flash photography. R/R occurred most within 40 minutes of a feed, but was not affected by the inter-feed interval preceding that feed, positive or negative social interactions or visitor numbers or behaviour. These findings have implications for welfare interventions aimed to reduce R/R and/or anxiety behaviours in captive populations.

Behaviour and personality of bears at Whipsnade Zoo

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Animal personality has been studied for some time now but recently, it has increased in interest as more researchers accept the presence of personality in animals. Although a number of studies have shown the complexity of animal personality in different species, literature regarding bear personality constitute of only one research on wild brown bears. In this study behavioural observations were conducted on brown bears, *Ursus arctos arctos*, and sloth bears, *Melursus ursinus inornatus*, in order to see captive behaviour but also to be able to create personality profiles for each individual. Behaviour was identified using an ethogram in order to produce activity budgets and identify zone usage and an aspect of social behaviour. This in turn was used to discover possible stereotypic behaviours and evaluate the welfare of the animals. Personality profiles were created with behavioural observations and with questionnaires that were given to the keepers to give out two personality profiles for each individual. The behavioural observations indicated a number of stereotypic behaviours from sloth bears but not brown bears. Statistical analyses were used to suggest distinctiveness between and within coded behavioural groups in the time budgets and personality profiling through traits. For that purpose, Kruskal-Wallis and Bonferroni test were used and a p value of < 0.05 was considered statistically significant. The uniformity of zone usage was calculated to indicate if the enclosure size and features were adequate for use, and a social aspect of solitary animals was also identified. Personality profiles were compared briefly between methods but not between individuals. This is because the study is not a comparison between different personality types but an effort in creating valid methodology in order to assess personality in bears since very little is available in the current literature.

A low cost set-up to measure underwater spectral irradiance in aquaria

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Animal species that are housed in aquaria have specific biological demands with regard to light spectra and illumination. Their vision may be adapted to certain levels of illumination or spectra and these properties may be crucial for normal foraging behaviour, communication and mate selection, as well as physical health, growth and longevity. Spectral irradiance expresses incident radiant power per unit area and per wavelength on a surface and is determined by the emission spectrum of the light source, the reflective properties of surfaces in the environment and the absorption properties of the water. An evaluation of the irradiance under water is necessary for optimizing welfare but this entails a significant technical challenge. An experimental set-up to measure visible light spectral irradiance at the bottom of an aquarium was designed and built from relatively low cost components. The set-up consists of a waterproof irradiance probe that is connected by an optical fibre to a CCD mini spectrometer. A laptop computer is used to control the spectrometer and to store and process the data. The irradiance probe, optical fibre and spectrometer are mounted on a rigid frame that can be partially immersed in the water tank. The frame limits the mechanical load on the optical fibre and on the connection of the fibre to the spectrometer, thus making sure the calibration of the system is not lost by handling of the set-up. In order to yield accurate measurement data, the system requires three separate calibrations: a wavelength calibration and a spectral irradiance calibration which are performed in air with standard calibration light sources, and a calibration including the wavelength dependent immersion effect which is performed under water. The set-up was used in a study on the effect of different lighting spectra and illumination levels on the behaviour and growth of European crayfish (*Astacus astacus*).

The Introduction of an Unfamiliar Conspecific as a Social Enrichment Strategy for a Bengal Slow Loris (*Nycticebus bengalensis*) at Shaldon Zoo: A Collaborative Case Study with Monkey World Ape and Rescue Centre

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An individual female Bengal slow loris (*Nycticebus bengalensis*) has been housed for over 15 years in a mixed-species exhibit at Shaldon Zoo without a conspecific. In February 2015 she was introduced to an unfamiliar same-sex conspecific who was suspected to have been rescued from the illegal wildlife trade. The study's aim was to observe the introduction as a form of social enrichment by analysing the individual's behaviour and enclosure use, along with determining possible compatibility of the pair. Behavioural time budgets were recorded using instantaneous sampling on the individual pre and post-introduction and results found a significant difference in behaviour, particularly in social behaviour ($P < 0.001$) with a 20.99% increase post-introduction. Compatibility was indicated due to a variety of affiliative behaviour being seen with infrequent agonistic behaviour, which resulted in no serious consequences. Social interaction comparisons during the introduction process and post-introduction indicate significant differences in social behaviour ($P < 0.001$) with an increase in affiliative behaviours post-introduction ($n=24$), suggesting familiarity. A significant difference in affiliative behaviour between the 10 days' post-introduction suggest social behaviour changed with time and stability. The modified spread of participation index (mSPI) was used to analyse enclosure use, indicating that the enclosure was used less equally post-introduction (mSPI=0.44) than pre-introduction (mSPI=0.32), suggesting the new conspecific had an effect on

enclosure utilisation. There was however, no significant difference between mSPI scores ($P= 0.499$). Zone frequency data indicated enclosure preferences, suggesting modifications to exhibit design may encourage equal enclosure use. Overall, the results indicate that this type of social enrichment was successful for the individual at Shaldon Zoo and that the same-sex pair are compatible.

The influence of feeding regime on the gastrointestinal microbiota of the tiger, *Panthera tigris*

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Changes in diet can affect the microbial communities found within the gastrointestinal tracts of mammals. Understanding the association between these communities and the host are important, especially within captive populations of endangered species, such as the tiger (*Panthera tigris*) where this information can be used to design suitable diets and prevent diseases.

Captive tigers are fed intermittently to reflect the fluctuating kill rates of wild tigers; however, no research has investigated the effect of intermittent feeding on the tiger's gut microbiota. To investigate the stability of the microbiome in regards to size of daily feed, we undertook Fourier Transform Infrared (FT-IR) spectroscopy alongside an analysis of the microbial metabolites known as volatile fatty acids (VFA) on faecal samples from tigers housed in four UK zoos. Five samples from each tiger were collected from separate days to allow temporal differences to be analysed.

Here we show that the gut microbiome of the tiger *Panthera tigris* does not change significantly due to variations in feeding regime. Discriminant function analysis (DFA) showed no significant clustering of FT-IR spectral data due to feeding regime ($p=0.997$). Total VFA concentration did not differ between starve and feed days ($p=0.185$), though total Butyric acid was shown to be significantly reduced ($p=0.025$) on starve days (30.4mM) compared to feed days (62.7mM) suggesting only a minor change in fermentation activity.

In conclusion, we found that the tiger's gut microbial community is stable from day to day, with little effect of intermittent feeding on community composition or fermentation activity. This implies that tigers have a stable core bacterial community present within the GI tract, as identified within other species. Further research will be needed to confirm the microbial species composition of this community.

Animal experiences in BIAZA collections

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Zoo visitors potentially have positive, negative or neutral effect on animals' welfare. Most research on the 'visitor effect' has focused on normal zoo visitors however there has been a rapid rise in the number of zoological collections offering animal experiences. These experiences allow greater interaction with animals and, at their most extreme, can involve visitors entering animal enclosures and having physical contact with them. These experiences offer financial benefits for the zoological collections, and may provide valuable educational opportunities for the public. However, they also have the potential to impact animal welfare and there is currently very limited evaluation in this area.

The aim of this study was to evaluate the prevalence of animal experiences in BIAZA collections and offer guidelines for best practice when managing and evaluating these experiences. A survey was distributed to all BIAZA collections that offered any kind of animal experience via SurveyMonkey[®]. Questions related to, i) logistics; e.g. who books and carries out these experiences, ii) the feeding experience; e.g. what extent do people have direct contact with the animals and iii) evaluation; e.g. what formal or informal evaluation of experiences has taken place. If collections ran more than one animal experience they were requested to fill in a separate survey for each one.

Data on 63 types of feeding experience from 22 zoos has been received so far. Initial results indicate that, i) the most popular species used for these experiences are lemurs, meerkats and penguins but there is a wide range of species used covering multiple taxa, ii) there are varying degrees of direct contact with animals but many experiences involve visitors entering animals' enclosures, and iii) there is limited formal evaluation of these experiences. The implications for further evaluation and management of animal experiences in BIAZA collections will be discussed.

Assessing enclosure utilisation and pack behaviour of captive dholes, (*Cuon alpinus*) at West Midland Safari Park

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Understanding a captive animal's utilisation of space assists animal managers in making necessary modifications to the enclosure to promote good welfare.

This study examined enclosure utilisation of captive dhole (categorised as endangered) at West Midland Safari Park and compared this to a similar study completed in 2014.

Focal and scan samples of the 5 adults and 3 juveniles were taken in Aug-Sept 2015, with a total of 17 study days, 4-5 hour per day. The enclosure was split into 14 zones and the enclosure features of each zone mapped.

Analysis of variance on adult focal samples found a significant difference in zone usage between individuals, $F(13) = 16.88$, $MSE = 29.12$, $p < 0.001$. However, looking at the individual profiles of enclosure use all adults spent the majority of their time in two adjacent zones (1 and 3).

Chi squared tests on scan sample data showed that as a group the adults spent a significantly different amount of time in each zone, $X^2_{13} = 5062$, $p < 0.001$, with an apparent preference for zone 1 (45%). The pups also spent a significantly different amount of time in each zone, $X^2_{13} = 5185$, $p < 0.001$, also showing a preference for zone 1 (49%). The zones where the pack spent most time contain several features which promote feeding, maintenance and resting behaviours (pool, platform, trees where enrichment is fixed).

Comparison of the individual enclosure use profiles of the adult dhole between 2014 and 2015 indicate that one female who was often isolated from the established pack in 2014 has since become more integrated. It is suggested that this may be linked to the birth of the pups, with this female finding a new role as helper within the group.

Activity patterns, social interactions and visitor effects in three groups of captive meerkat (*Suricata suricatta*)

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Data collection took place at West Midlands Safari park over 3 months in 2015. This is the first behavioural study of the meerkat groups at WMSP and has indicated areas for further investigation.

Three separate groups (Mixed group of 13 individuals, male group 5 individuals and female group 4 individuals) were observed using instantaneous focal and scan sampling. Focal samples were conducted in 30 minute blocks choosing an individual picked at random, alternating between groups. In addition, ad lib observations of social interaction and response to visitors were made. Weather, temperature and the number of visitors within a 1m distance of the enclosures were recorded during each observation session.

Kruskal-wallis tests did not find significant differences across the three meerkat groups in the proportion of time engaged in any behaviours performed. All of the groups appeared to respond to aerial stimuli a relatively similar number of times. Recordings of dominance however differed; males in the all-male group performed this interaction 50% less than the females and mixed groups. In addition, an absence of a sentry was not observed in the males whereas the females and mixed group lacked a sentry about a third of the time. There was also evidence of huddling behaviour being more common in bad weather and general activity levels being higher at mid-high temperatures and lower at low and above average temperatures. Some behaviours which may be classed as stereotypic behaviour (low levels of pacing and repetitive foraging without an apparent outcome) were observed and merit more research.

Visitor number and time spent vigilant had a significant negative relationship (Spearman's rank correlation: $r_s = -0.794$, $N = 22$, $P < 0.01$). Similarly, with increasing visitor number, meerkats decreased the proportion of time engaged in social interaction, (Spearman's rank correlation: $r_s = -0.744$, $N = 22$, $P < 0.01$).

The Effect of Visitor Density On the Behaviour of Southern White Rhinoceros (*Ceratotherium simum simum*) At West Midland Safari Park

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West Midlands Safari Park

Numerous studies have highlighted the negative stress related effects associated with high visitor density in zoos. The captive population of southern white rhinoceros (*Ceratotherium simum simum*) is unsustainable due to poor breeding success. Populations in national parks show disturbance at the approach of vehicles, with close approaches causing flight. The links between anthropogenic disturbance, stress and poor breeding success in captive rhinos justifies further analysis of the effects of routine exposure to safari park visitors.

This study aimed to determine the behavioural changes associated with high visitor density for five southern white rhinoceros at West Midlands Safari Park. Subjects were monitored over four months from August 24th until November 4th, 2015. A total of 103 hours and 20 minutes of data was

collected. Continuous focal sampling was used to record behaviour, whilst instantaneous focal sampling was used to record location within the enclosure and in relation to roads and conspecifics. High visitor density was found to cause a reduction in feeding duration ($Z= 15.000$, $n=5$, $P= 0.043$) and an increase in resting behaviour ($Z= 0.000$, $n=5$, $P= 0.043$), however no significant change in aggression, locomotion or olfactory behaviour was seen. The modified spread of participation index indicated more even enclosure use during lower visitor density. Spearman correlation revealed a positive correlation between vehicle density and distance of the rhino from the road ($r_s= 0.065$, $N=6753$, $P= 0.000$) a negative correlation between vehicle density and distance from nearest conspecific ($r_s= -0.136$, $N=5273$, $P< 0.000$). Certain behavioural changes observed might be viewed as consistent with increased stress levels at high visitor densities, however correlations were weak and the behavioural changes observed only suggest a visitor effect, rather than poor welfare. Future study incorporating physiological measures would assist in identifying the cause of behavioural changes. An understanding of visitor effects in southern white rhinoceros may facilitate potential improvements in husbandry, management and consequently welfare.

Long term assessment of the daytime enclosure use by a group of Humboldt penguins at West Midland Safari Park

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This study is ongoing and brings together the work of researchers, keepers and research students. There are four types of substrate in the WMSP penguin enclosure (water, render, sand and pebbles). Husbandry guidelines state that prolonged periods on concrete/render can increase the likelihood of poor foot health in penguins.

Previous research at WMSP suggested that time of year, age, visitor type and number and location of enrichment all influence the enclosure use (and time on different substrates) of the penguin group at the park. A long term multi-dimensional investigation has begun to help better understand these influences and to assist animal managers understand what factors may be affecting foot condition in this group.

In this poster we present the results of two studies which took place in the winter of 2015: a research project using continuous, focal sampling to observe eight individuals and a project aimed (a) to look at differences in group behaviour and enclosure use between open and shut periods of the park, and (b) to use researcher data to validate the use of infrequent sampling by keepers of enclosure use.

Individual differences were found between penguins in the focal group, both in terms of behaviour and enclosure use. This suggests that care needs to be taken when drawing conclusions purely based on group behavioural observations for these penguins.

There was also found to be marked difference in enclosure use and activity between open and shut conditions with the penguins spending more time swimming when the park was open and visitors were present than during closed times when they spent the majority of time on land.

Comparison of researcher and keeper data demonstrates that infrequent scan sampling data collected as part of the keeping day does give useful information in that it can reliably show how the penguins are using their enclosure.

Investigating the effects of keeper presence on begging behaviour in captive Asian short clawed otters (*Aonyx cinereus*)

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While research has been conducted on otter behaviour, and 'begging' behaviours have been observed frequently ex situ, little or none has been published looking into the underlying cause. Asian short clawed otters adapt well to routines, learn the precise time of feeding each day and vocalise at feeding time. However, repetitive behaviours such as circling and jumping at a certain place, constant loud calling, twisting neck backwards (some characteristics of begging behaviour) are seen as behavioural problems. Chester Zoo houses two Asian short clawed otters, *Aonyx cinereus*, (1 male, 1 female), which have been observed exhibiting begging behaviours around feeding time. Begging behaviour is seen as undesirable as it is hypothesised to be a result of boredom, stress, or hunger. It is accounted for in husbandry guidelines for the species, but no cause or solution is suggested. The aim of this project was to understand the trigger of this behaviour, and in particular, the role of keeper presence. Following a qualitative observation session and background research, an ethogram encompassing begging behaviours was designed. Observations in accordance with the ethogram, were carried out at 15 set feeding times. Chester Zoo's otters are fed at four approximate times throughout the day. Observations were distributed across these feeds equally. Behaviour and location within the enclosure was recorded using a scan sample for each individual every minute approximately 45 minutes prior to, and 15 minutes after the feeding time. Additional data such as feeding location, weather, and other potential variables were recorded. This study found that instances of begging were relatively infrequent, although were associated with a particular area of the enclosure. Additionally, begging behaviours were not exhibited exclusively when a keeper was present. It can be concluded that begging is not a major behavioural issue in these individuals.

Social interactions in a mixed-species exhibit of Slender-tailed meerkats and Cape porcupines

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Chester Zoo houses a mixed exhibit of two species, Slender-tailed meerkats and Cape porcupines. In the wild meerkats live in social groups of between ten to thirty individuals and can consist of one to three breeding females, and up to four adult males, several yearlings and the rest being that years offspring. Cape porcupines are large, nocturnal hystricomorph rodents who attain sexual maturity at two years of age and live in extended family groups for 20 years in captivity. As in any mixed-species exhibit there is potential for aggression between and within each species due to competition for food, space and other resources. In addition to this we know that meerkats can use competitive behaviour to maintain the social hierarchy, particularly when groups become larger after successful breeding.

The aim of this project was to develop an effective method of monitoring levels of competitive behaviour between the two species and within the meerkat group. Two methods were utilised: firstly, camera traps were positioned to monitor interactions between the two species outside of zoo opening hours (when porcupines are most active), while behavioural observations were undertaken to monitor competitive behaviour between meerkats before and after feeding events (when most aggressive behaviour is generally observed). Camera traps were positioned in the indoor section of the exhibit and programmed to take 30 second video clips every minute. Live observations were conducted during zoo opening hours using 60 second instantaneous scan sampling methods over a 30-minute period.

Initial results revealed very few negative interactions between the porcupines and meerkats and generally low levels of aggression between the meerkat group. During the study there were a number of changes to the meerkat group, with individuals born and some exported to other collections, which likely influenced the amount of negative social interaction observed. Weather conditions, time of day, visitor presence and food type offered were also accounted for.

Asian elephant bonds: How do herd mates physiologically respond when there is a birth within the group?

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Zoos endeavour to provide the greatest husbandry possible for the animals in their care, which includes meeting all biological needs. However, captive Asian elephant populations are challenged with issues related to reproduction, physical health and behaviour, all of which threaten population sustainability. For elephants in particular, social bonds between individuals are particularly important due to the strong hierarchy naturally experienced in the wild.

Routine reproductive and adrenal monitoring was conducted on four females of reproductive age and following analysis a large adrenal response in all related individuals, but not in an unrelated individual, was revealed following the birth of two calves. Long periods of elevated adrenal activity is often associated with stress and disease, however elevated concentrations can also be associated with learning and excitement. The aim of this study was to investigate whether parturition and the birth of a new calf into the herd was associated with increased adrenal activity and if this response differed between related and unrelated individuals within the same herd.

To determine if heightened adrenal response was consistent following a new birth, we analysed previously collected faecal samples (n=715) from 8 female captive Asian elephants at 2 different institutions (Zoo A = Chester Zoo; Zoo B = Copenhagen Zoo) 60 days before and 60 days after parturition. In this study 7 birth events (of which 2 were stillbirths) were included. For each birth event, samples from the pregnant female as well as 3 herd members were analysed for faecal glucocorticoid (FGC) metabolites using an enzyme immunoassay. Relatedness (to the pregnant female), birth success (live or stillborn) and date were added as factors during analysis. It was found that FGC metabolites in related individuals peaked following a birth event, whereas, unrelated individuals showed no increase.

Social interaction between a baboon troop (*Papio anubis hamadryas*) and Safari Park visitors

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A captive group of hybrid baboons (*Papio Anubis* x *Papio hamadryas*) at Knowsley Safari Park were observed for a period of five months from November 2015 to March 2016. The troop standing between 240-260 individuals mostly made up of juveniles has an uneven sex ratio of three males to one female. The purpose of the study was to therefore, determine if there would be an effect on aggressive behaviours displayed amongst the troop particularly juveniles in the presence of visitors or when the safari park was closed. The null hypothesis being tested was that no significant difference would be found in the levels of aggressive behaviours displayed between the troop when the visitors were present or not. An ad libitum sample method was used to identify the aggressive behaviours whenever they were displayed. Observations were carried out twice a week, one during the week and one on the weekend when the Safari Park was open to the public. The observations were carried out between 11am-1pm and again at 2-4pm. During the five months, it was found that there was a significant difference ($P < 0.05$) between 'chasing' and gender ($H = 13.18$, $DF = 2$, $P = 0.001$) and also a significant difference ($P < 0.05$) between 'chasing' and visitor presence ($H = 4.55$, $DF = 1$, $P = 0.033$). In juveniles it was found that there was a 46.5% increase in the 'chasing' behaviour when visitors were not present. There was also an increase of 10.9% in 'rough behaviour' displayed by juveniles when no visitors were present. The results show that the visitors had a significant impact on the troop providing mental stimulation and reducing the aggressive behaviours towards one another. Further analysis is needed to determine any influencing factors on vehicle type and visitor numbers present.

White rhinoceros (*Ceratotherium simum*) activity budgets and winter body condition in a safari park setting

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The current IUCN classification of the white rhinoceros (*Ceratotherium simum*) is near threatened due to degeneration caused by a number of anthropogenic factors. Analysis of species behavioural patterns enables animal keepers to develop management strategies, which can assist conservation efforts and aid husbandry routines in order to promote animal welfare. In conjunction with behavioural observations, strategies developed by institutions can only succeed by ensuring individual animals are healthy. Body condition scoring is a non-invasive method of assessment and can provide a general indication of an animal's health and energetic state. The aims of the study were to observe variations in activity budgets of the rhinoceros situated at Knowsley Safari Park, Prescot, England, whilst recording winter body condition scores. Activity was recorded in ten minute observations during 60 minute periods using instantaneous sampling with an interval time of two minutes between each ten-minute period. An adaptation of a white rhinoceros' body condition assessment devised by van den Houten (2011) was used and consisted of four categories. Various areas of the rhinoceroses were assessed. Visitor effect appeared to have a significant impact on behaviours, particularly in relation to locomotory behaviour of the rhinoceros ($P = 0.000$), standing and grazing ($P = 0.001$) and following behaviour ($P = 0.015$). Managing routines by observing activity budgets and how diet composition affects body conditioning can provide information to establish an appropriate management strategy, particularly for breeding individuals. Due to the current near threatened status of the species, evidence suggests more research is needed.

The Effect of Ecologically Relevant Auditory and Olfactory Stimuli on Captive Iberian Wolves (*Canis lupus*)

Philip Lewis

The wolf pack at Blackpool zoo, consisting of two adult females and two sub-adult males, has a history of frequent agonistic behaviour. The primary aim of this study was to address this problem by decreasing agonism, increasing affiliative behaviour and increasing exploratory behaviour within the Blackpool pack. Two ecologically relevant enrichment treatments were introduced to the wolves, 6 days per treatment. An olfactory treatment featured the presentation of 4 rabbit-scented ropes to the enclosure at the start of each day. An auditory treatment featured playing the wolves a pre-recorded howling, twice daily, of an unrelated pack. Kruskal-Wallis tests were performed on sniffing, agonistic and affiliative behaviour data to determine whether differences between baseline, olfactory and auditory phases were significant. Mann-Whitney tests were then performed to determine where significant differences lay. Comparisons of observed to expected enclosure use revealed that the wolves preferred certain areas within the enclosure. Spread of participation index (SPI) tests showed that the wolves' use of zones within the enclosure improved as the study progressed, mirroring the pups' development and integration into the pack. A significant increase in exploratory behaviour was observed during the olfactory treatment and there was no evidence of the animals habituating to this stimulus. Rabbit-scented ropes can therefore be part of an enrichment regime for captive wolves. A significant decrease in agonistic behaviour occurred during the auditory treatment. However, no significant increase in affiliative behaviour occurred during this treatment. Howling as an auditory stimulus had moderate success in addressing this pack's behavioural problem. The effects of playing different types of howling to captive wolves need to be explored before this treatment may be incorporated into an enrichment program.

Building sustainable veterinary capability for bears in South East Asia: from basic health checks to brain surgery

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Zoological collection veterinary departments contributing knowledge and expertise to wildlife projects in developing countries need to engage and support local veterinarians if these projects are to succeed in the long term. The transfer of veterinary knowledge and skills needs to be planned to ensure that local veterinary capacity is maintained once the project is completed. The Royal Zoological Society of Scotland has assisted Free The Bears wildlife rescue centres in Cambodia, Laos, and Vietnam to develop their local veterinary capacity over the last 7 years. Local wildlife veterinarians have been taught skills which they have been supported in maintaining and developing throughout this period. These include the performance of standardised health checks of bears, the safe use of inhalation anaesthesia as routine, dental care and extractions when indicated during health checks, abdominal ultrasound examinations, laboratory skills, and general surgical techniques. Specialists in disciplines such as anaesthesia, ophthalmology, reproduction, and surgery

make annual or bi-annual trips for specific cases and projects, and perform additional training, to support and encourage the further development of local veterinary skills and experience. Cataract surgery, keyhole surgical removal of diseased gallbladders, and even brain surgery have all been successfully performed by external specialists, but with an increasingly high standard of local veterinary support, comparable to standards in many Western zoological collections. The institution and maintenance of sound protocols and good record keeping practices also allows clinical veterinary research and the determination of a locally applicable evidence base. This continuing program highlights the role that zoological collections can play in veterinary capacity building and skills maintenance in wildlife programs in developing countries, as well as developing clinical veterinary research, provided the program is designed with long-term sustainability in mind from the beginning.

Does a walk through aviary at Edinburgh Zoo effect the behaviour of Java sparrows (*Padda oryzivora*)?

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Java sparrows (*Padda oryzivora*) are small granivorous birds and are vulnerable on the IUCN Red List mainly due to the pet trade. Edinburgh Zoo has a walk through aviary housing 12 species of exotic birds, including 9 Java sparrows (6 females and 3 males). Zoos are interested in the welfare of their animals but also aim to provide visitors with a good experience. Therefore, this study investigated if the environment had an effect on Java sparrow behaviour. Instantaneous scan sampling was used to collect data on enclosure usage and behaviour and focal sampling was used to measure aggressive and mating events.

Results showed that when visitors were present Java sparrows were significantly more likely to be up high and out of view. When visitors were absent the birds used the enclosure more equally. In contrast, there was no change in the feeding or stationary behaviour when visitors were present. Results show that males were more aggressive than females and there was more aggression in feeding zones than non-feeding zones. Homosexual behaviour was common in this population however, male-female sexual behaviour still existed.

Results suggested that a visitor effect may be present and visitors may be a source of stress for the birds.

Aggression levels were expected as there could be resource competition and territoriality and the homosexual behaviour could be because of the female skewed sex ratio or linked to the conditions in which the birds were raised (which was unknown). Overall, some behaviours were affected by the environment at Edinburgh Zoo and further research could reveal more detail about visitor effects. This research is beneficial for animal welfare but also, using species suited to immersive exhibits enhances visitor experiences which is good for zoo revenue.

Effects of protein level in larval diet on growth and development rates in the flower beetle (*Eudicella aethiopica*)

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Nutrition, and in particular the levels of protein, in the diet of larvae of scarab beetles can have an effect on their growth and rate of development. Some species will not pupate until a size threshold is reached. Larval diet can also influence the development of secondary sexual characteristics such as horn size in males.

The aim of this study was to compare the growth and development rates of groups of flower beetle larvae fed on different diets, and if possible within the timescale of a dissertation project, to compare the horn sizes of any adult males that subsequently emerged.

Larvae were housed individually in containers with a plant-based medium (a commercial mix of shredded bracken with well composted farmyard manure) and maintained within Bugworld breeding rooms at Bristol Zoo Gardens. Thirty second or third instar larvae were randomly allocated to one of three groups which had either no additional nutrients, or medium or high protein dog biscuit added. A second group of twenty-nine first instar larvae were treated in a similar manner to increase group size for each nutrition group. Larvae were weighed weekly and measurements of the lateral and anterior-posterior dimensions of the head capsule were also recorded. Dates of pupation and emergence of adults were also recorded.

Rate of weight increase was higher in the groups with added dog biscuit. The no protein group were also delayed in reaching pupation. The results will be discussed in terms of both the nutritional effects on the development of the larvae and maintaining this species in captivity.

Browse Preference of Colobus Monkeys (*Colobus guereza*) at Cotswold Wildlife Park

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In the wild Black and White Colobus monkeys (*Colobus guereza*) have a wide and varied diet. They display specific food preferences and select young leaves and foodstuffs with a high protein to fibre content. They will also travel long distances to access browse with specific nutrients. The Colobus diet in captivity usually consists of vegetables along with leaf eater pellets which does not match the structure of their diet in the wild. Browse is also used to enrich the diet and stimulate natural foraging behaviours. The objective of this study was to identify the browse preference of the Colobus troop held at Cotswold Wildlife Park. Four commonly available species were used (Hawthorn (*Crataegus monogyna*), Birch (*Betula pubescens*), Lime (*Tilia platyphyllos*) and Bramble (*Rubus fruticosus*). The browse was presented in paired comparisons, and the Bradley-Terry method was used to analyse and rank this selection. The preference order for most of the study cohort was Hawthorn>Birch>Lime>Bramble and the number of visits and time spent feeding on the preferred browse was greater than for the non-preferred browse. While the predominant preference was for browse with low fibre content, which agreed with other studies in captivity, the second preference was for Birch, which had the highest fibre content. Furthermore, the top two preferences have a high carbohydrate and thus a high energy content. Therefore, preference may be related to the need for more energy in a colder climate for heat conservation. Alternatively, preference may be

based on selection of younger leaves which contain a higher nutritional content, or preference for a species that is provided less regularly. Alternatively, their diet may supply all required dietary requirements so preference may be related to palatability. This knowledge of preference for browse type can be used when developing the dietary management of Colobus in captivity.

