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Research Presentation Abstracts



Oral Presentations

The challenges of welfare auditing: illustrated using two case studies

Paul Perrins¹ and Kirsten Pullen^{1,2}

¹Whitley Wildlife Conservation Trust (Paignton Zoo Environmental Park), ²BIAZA
kirsten.pullen@biaza.org.uk

Animal welfare is of great importance in modern zoos and as a result there is a growing need for effective methodologies for auditing the psychological welfare of a variety of animals. As our knowledge about animal behaviour expands we are becoming aware that animal groups once perceived as unsophisticated and behaviourally limited, such as reptiles, may not be as adaptable to captivity as previously thought. This has led to BIAZA identifying a need to develop a robust methodology for assessing welfare in captive animals.

Welfare audits of captive mammals are relatively common and established applied methodologies exist for them. An example is a study carried out to investigate whether an operation to remove a lens and restore the vision of a captive African elephant improved the animal's welfare. The subject was observed on a rota over the course of successive weeks, before and after her treatment. The frequencies of abnormal behaviours and stereotypies were used as reasonable indicators of welfare. Concurrently a second method was carried out which used faecal samples to test for corticosteroid levels before and after the operation. The results of the two methodologies suggest different outcomes and present a less than clear picture of her state of welfare.

Compared with elephants current knowledge regarding assessment of reptile welfare is poor. This, coupled with BIAZA questioning the exhibit sizes and complexity of large captive snakes, prompted research to develop a means to assess large snake welfare. After extensive literature research a set of possible stress response behaviours were identified for reptiles. Testing the efficacy of these behaviours as stress indicators was essential. If they are appropriate then they can be used in a non-invasive welfare audit that utilises behavioural cues. The effectiveness of the selected behaviours as indicators was tested by comparing their frequency between busy visitor days and quiet visitor days. Of three study species, none showed any statistically significant differences in their overall activity budgets, or in the rates of target stress response behaviours. This is possibly because there really were no differences in stress levels between busy and quiet days (perhaps busy days were not busy enough or the snakes are adapted to the presence of visitors) or because the target behaviours are not good indicators of stress.

The aim of this talk, is to outline just a few of the challenges that are faced by the zoo community in establishing effective audits for the welfare of zoo housed animals. The two case studies effectively demonstrate different problems with regard to our current perceptions and methods, and will hopefully provide an impetus for further research and collaboration in order to resolve them. With zoos increasingly under fire from the public domain it has never been more important to establish a robust methodology for assessing welfare that will enable us to demonstrate good practice and high standards of welfare, to counter any welfare related backlash.

The effects of herbal medication on a Heck's macaque (*Macaca hecki*) suffering with self-injurious behaviour

Sarah Jackson and Amy O'Brien

Howlett's Wild Animal Park

doll_drop1990@hotmail.co.uk

Howletts Wild Animal Park holds the only two Heck's macaques (*Macaca hecki*) outside of Indonesia; they came to this Park in 2007 and were both suffering with behavioural problems. Both the male and female were pacing on a regular basis and the male, Cimot, showed self-injurious behaviour (SIB) daily. The pacing behaviour in both individuals was significantly reduced by introducing a varied enrichment program at Howletts. The SIB has been harder to control and enrichment seemed to have no effect on this behaviour. During 2011 Uly, the female, gave birth to a male, due to complications during the birth he had to be hand-reared, but was successfully reintroduced to his mother later. Due to Cimot showing aggression towards the infant he was separated off, with Uly given access so she could spend her time between Nantu, her son, and Cimot. Unfortunately Nantu died in infancy and Uly was then placed back with constant access to Cimot all day and his aggression was then directed not just to himself but also Uly. It would obviously be beneficial to both individuals to address these behaviours but the main focus of this project is to prevent his SIB as this is more common.

SIB is relatively common in captive macaques and studies have shown the cause has been linked to the environment the macaque was kept in as a juvenile. It has also been shown that SIB is more common in males than females. In terms of prevention of SIB a range of drugs have been tested as well as behavioural studies to see if this behaviour can be addressed. Recently more work has been done on the brain and hormones, to work out what happens within the brain that starts this behaviour and what is released into the blood that causes the behaviour to stop. This study looks to test the effect of herbal medication on such behaviour.

Over 28 weeks the effects of two different types of herbal medication on the behaviour of Cimot have been studied. The first medication was a mixture of Valerian, passion flower, wild lettuce and skullcap. The second being Kava Kava which was administered at two different doses, 16 and 30 drops per day. As a control he was also studied when receiving no medication. Observations were done in 3 x 20 minute focal follows daily; one during the morning feed, one during the afternoon feed and at a random interval during the day. SIB rates during all conditions were highly variable with some unexpected behavioural differences between no medication and treatments. Furthermore, the results show that more research is needed in the area of preventing SIB in captivity without using drugs. From this study we know more is needed to help alleviate the SIB displayed by this male macaque, not only for his wellbeing but also for the wellbeing of his mate.

Pygmy slow loris (*Nycticebus pygmaeus*) natural diet replication in captivity

Francis Cabana

Whitley Wildlife Conservation Trust (Paignton Zoo Environmental Park)

francis.cabana@paigntonzoo.org.uk

In captivity, the pygmy slow loris (*Nycticebus pygmaeus*) population suffers from poor reproduction, dental diseases, facial abscesses and various other health problems which collectively result in their population being far from self-sustaining. The dietary recommendations are anecdotal at best and good evidence-based diet guidelines are urgently needed for this vulnerable species. New evidence suggests that wild *N. pygmaeus* are primarily exudativores and consume nectar and gum daily from a variety of tropical plant species, alongside a large variety of insects. Fruits are eaten opportunistically when in season. The average diet in captivity is fruit, a concentrated pellet and some insects as enrichment. The aim of this study is to analyse the behavioural activity budget of one male *N. pygmaeus* at Paignton Zoo on his original diet and compare it to his activity budget on a naturalistic diet of mainly gum and nectar.

Two night vision camera traps were used to film the loris' activity for 10 seconds every two minutes. Behaviours were recorded continuously. Results of a linear general mixed model analysis show that abnormal ($\chi^2_{(1,2)}=8.67$, $p=0.013$), traveling ($\chi^2_{(1,2)}=6.11$, $p=0.047$), and feeding ($\chi^2_{(1,2)}=79.68$, $p<0.0001$) behaviours all vary significantly with diet. The addition of gum, nectar, insects and removal of fruit from the loris' daily diet expanded and diversified his activity budget and decreased the performance of abnormal behaviour patterns. This evidence-based diet change suggests that a naturalistic approach to feeding this *N. pygmaeus* promoted high welfare.

Physiology of meerkats in zoos

Katy Scott and Michael Cant

University of Exeter

ks334@ex.ac.uk

Meerkats are a very popular attraction in zoos and are also amongst the most well-studied small mammals in the wild, making them an ideal study species when considering the effect of the various aspects of captivity on the behaviour and physiology of zoo animals. We compared two aspects of wild and captive meerkats' physiology: their physical size and the levels of glucocorticoid hormones in their faeces.

In wild meerkats, glucocorticoids have been linked to behaviours which are very important to a social species, including babysitting, pup feeding, dispersal away from the group by males and repression of reproduction in subordinate females. Prolonged elevation of glucocorticoid levels are also a marker of chronic stress, resulting in a blunted response to acute stressors and increased abnormal behaviours: signals which can be used to assess captive animals' welfare. By collecting and analysing the glucocorticoid levels in faecal samples from 32 meerkats in 10 different social groups we were able to analyse the predictors of high glucocorticoid levels, and assess the link between glucocorticoids and behaviour, which will be discussed.

The balance between avoiding malnutrition and preventing obesity in captive animals is a key challenge faced by zoos. Growth rates and fluctuations in weight have been studied in detail in wild meerkats, but previously this knowledge has not been applied to their captive conspecifics. We collected data on meerkats' weights from over 100 meerkats in nine zoos and used a recently developed model to describe meerkat growth rates. We found that meerkats in captivity grew faster than those in the wild and continued to grow for longer, therefore reaching a higher asymptotic weight, which varied between zoos. Overall, 33 of the 41 fully-grown animals in the sample (80.5%) were recorded at least once weighing more than two standard deviations heavier than would be expected of their wild counterparts. While this may be partly due to a more nutritional diet allowing animals to reach their full growth potential, it also suggests that obesity in captive meerkats is a serious threat of which zoos should be aware.

This study highlights the value of wild data to zoo-based research, and illustrates that multi-zoo studies can inform management decisions to promote wild-type physiologies.

The effect of temporally predictable feeding on zoo animal behaviour

Joanna Bishop^{1,2}, Phil Gee² and Vicky Melfi^{1,3}

¹Whitley Wildlife Conservation Trust, ²Plymouth University, ³Taronga Conservation Society Australia

joanna.bishop@paigntonzoo.org.uk

There is much evidence to suggest that animals can adapt their behaviour according to the timing of events in their environment, such that their behaviour anticipates those events. There are many events in the captive environment (e.g. feeding or cleaning) that can occur in a predictable pattern. However, there is no consensus in the literature on the effect of such predictability on animal behaviour and welfare. There is also little research on the effects of predictability in zoo environments, where events such as feeding may become predictable as a result of regular keeper routines, or fixed feeding times for visitors.

Here we give an overview of a series of case studies aimed at investigating the effect of predictability on behaviour in a zoo environment. Firstly, a pair of tigers, accustomed to a regular feeding time was observed using one-zero sampling. Patterns of behaviour analysed over the day suggest an increase in certain behaviours such as locomotion as the time approached the feed time. These results suggest that tiger behaviour changed in the approach to, and in anticipation of a predictable event. A second study, this time involving manipulation of feeding times, was carried out using a pair of meerkats. Data were collected using instantaneous scan sampling of behaviour during weeks of unpredictable and then predictable feeding times. Results were more variable than expected and no behaviour showed clear indications of anticipation. It is suggested that environmental variability and visitor presence may have had an interfering effect on predictability. In contrast, a final study involving a comparison of gecko behaviour prior to predictable and unpredictable feeding times revealed significant differences in gecko behaviour with e.g. increased locomotion (RSS = 0.059, $p < .05$), and head movement (RSS = 0.047, $p < .05$) prior to predictable feeding times.

These three case studies each with slightly differing methods have demonstrated that the timing of events such as feeding can have an effect on animal behaviour in zoo environments, even in species such as geckos where such effects have not previously been documented. These studies have also highlighted important considerations for research into predictability including the method involved and additional factors that can influence an animal's response to predictability. The topic of predictability and the timing of events is an area worthy of further study and consideration in captive animal management.

Effect of personality on welfare of captive baboons

James Stranks^{1,2}, Kathy Baker¹, Holly Farmer¹ and Kirsten Pullen³

¹Whitley Wildlife Conservation Trust (Paignton Zoo Environmental Park), ²University of Manchester, ³BIAZA

kathy.baker@newquayzoo.org.uk

Suites of behaviours that are consistent within individuals across both time and contexts can be called personalities in animals. Primate personality is a rapidly growing area of research and may be of particular relevance to zoos as personality has been linked to welfare and breeding success in captive institutions. Self-directed behaviours (SDBs), such as scratching, have been shown to be reliable indicators of underlying anxiety and social stress in primates and may be useful as welfare indicators. This study investigated the influence of personality on the welfare of a Hamadryas baboon troop at Paignton Zoo, using rates of SDBs observed over a number of years and current personality assessments of individual baboons. If there is a relationship between personality dimensions and SDB rates, zoos could manage their captive primate populations based on their personality to reduce the overall group anxiety and improve welfare standards.

The baboons' personality was assessed using two methods: behavioural observations and the Hominoid Personality Questionnaire. Personality dimensions were derived from each dataset using Principle Component Analysis and their effect on the rate of SDBs was examined using a Generalised Mixed Linear Model.

Three personality dimensions, Dominance^Q, Extraversion^Q and Agreeableness^Q were derived from the questionnaire and two dimensions, Dominance^B and Social Anxiety^B, were obtained from the behavioural observations. Extraversion^Q ($\chi^2_{[2]} = 18.99$, $p < 0.001$) and Social Anxiety^B ($\chi^2_{[2]} = 9.47$, $p = .002$) both had a significant positive relationship with the rate of SDBs. This would suggest that personality assessment could be an effective management tool for controlling social stressors and anxiety.

An assessment of learning from zoo animal signs

Michael Darling and Andrew R. Marshall

CIRCLE (University of York and Flamingo Land)

circle@flamingoland.co.uk

Engagement of people is central to achieving biodiversity conservation. All five goals of the UN Convention of Biological Diversity goals include substantial human elements. As recognised by their involvement in the development of the UN biodiversity goals, zoos play a crucial role in educating the public about environmental issues. British zoos are visited by more than 20 million people annually, including formal education of more than 1 million school children. However, little research has been carried out to evaluate their effectiveness for understanding and ensuring attitude change. Here we present a study carried out at Flamingo Land in North Yorkshire, that aimed to establish the level of basic learning by zoo visitors reading animal exhibit signs. Exhibit signs were selected for investigation as they are a common feature across zoos, thus providing findings that are globally applicable. Visitors were interviewed before entering a section of the zoo regarding their knowledge of animals and their conservation. A second sample of visitors was also asked the same questions after they were seen reading signs.

Results suggested that signs are ineffective in educating the public because (a) most people did not read them, (b) those that did read them did not typically recall information regarding conservation of the animals, and (c) in those that did recall information, they showed understanding but no awareness of how they could help. The results emphasise that more actively engaging education activities undertaken by zoos are likely to be more appropriate for ensuring significant influence on both public understanding and behavioural change. We expect our study site to be a notable outlier among zoos because the majority of visitors attend the site for its theme park rather than the zoo, and hence are unlikely to be representative of typical zoo visitors. Much more research is required to determine the influence of visitor demographics, visit motivation and education methods on information transfer and behavioural change, preferably with longitudinal assessment to determine long-term effects.

Bad relationships or no relationships? Attacks on keepers and visitors by zoo animals.

Geoff Hosey¹ and Vicky Melfi²

¹University of Bolton. ²Taronga Conservation Society Australia.

gh2@bolton.ac.uk

There are now a number of studies which appear to show that the presence of zoo visitors may, under some circumstances and with some species, be stressful to zoo-housed animals. But the relationship is more complex than this, as some studies appear to show that sometimes visitors have no such effect, and may even be enriching. Similarly, although one or two studies indicate that animals may be wary of keepers, there is now a lot of evidence that good relationships set up between animals and their keepers can have positive effects on the welfare of both. How, then, do we account for those rare cases where animals attack people in the zoo, sometimes fatally? The data on such attacks are often sparse and unsystematic, but here we use available data about the circumstances of these attacks to test hypotheses about the development of negative relationships, derived from a previously published model of human-animal relationships. The data broadly support the model, but also indicate that we should be cautious in our interpretations of the animal's understanding of particular human-animal relationships.

The effects of visitor feeding experiences in a zoo environment: are they enriching or not?

Danielle Buss^{1,2} and Kathy Baker²

¹University of Sheffield, ²Whitley Wildlife Conservation Trust (Newquay Zoo Environmental Park)

danielle.buss@hotmail.com kathy.baker@newquayzoo.org.uk

Animal welfare is considered to be the subjective state of well-being of an individual determined by both its physical and psychological condition. Promoting positive animal welfare is one of the leading missions for all BIAZA institutions but these institutions must often find a balance between offering visitors an exciting and informative wildlife experience, whilst maintaining a high level of positive welfare for all captive animals. Visitor feeding experiences, offering visitors a chance to get closer to zoo animals, occur in many BIAZA zoos but there is very little previous research on these types of experiences and the majority of experiences are set up blind (i.e. with no research input). This means the affect the experiences are having on the animals involved has rarely been studied. The Whitley Wildlife Conservation Trust (WWCT) comprises three zoological institutions; Paignton Zoo, Newquay Zoo and Living Coasts. Across the three sites there are a range of visitor feeding experiences that take place with many different species covering a range of taxa. One important benefit of the experiences is economic; funds generated can then be used to anchor conservation projects or aid enclosure refurbishments. The aim of this study is to gather information to inform future practice on the various welfare implications these experiences can have upon the animals involved.

The study took place at Newquay Zoo using three species: ring-tailed lemurs *Lemur catta*, Humboldt penguins *Spheniscus humboldti* and meerkats *Suricata suricatta*. Each species was investigated at the individual level; focal follows were conducted throughout a feeding experience and then repeated during a matched control (i.e. the same time period) the following day when no visitor experience was taking place. State behaviour was recorded every 30secs and all occurrences of event behaviours were recorded. Three measures of maintenance of proximity were also recorded, this included the distance between the focal individual and the keeper or visitor throughout the experience period. Behavioural indicators of both positive welfare (allo-grooming, allo-resting and play) and negative welfare (aggression, vigilance and excessive self-grooming) were compared between experience and non-experience days using generalized linear models.

At the group level results for *Lemur catta* suggest there was no significant difference in either positive or negative welfare indicators between experience days and match control days. This suggests there is no evidence to believe the feeding experiences are causing a negative impact on group welfare within this group. However there is no evidence to suggest the experiences are positive for the welfare of the animals either, an increase in social activities such as play behaviour could also be investigated; this may be particularly interesting at the individual level. There is evidence that other variables such as the keeper that is taking the experience may affect behaviour and these findings will be discussed further. Data collection for *S. humboldti* and *S. suricatta* is still on-going

Future research will look at the effects of visitor feeding experiences at the individual level (e.g. taking specific animal personalities into account) and what effect the experiences have on the visitors. The results to date suggest there is a neutral affect on *L. catta* thus they could potentially be important flagship species to create connections between visitors and animals promote pro-conservation attitudes and behaviour.

Ensuring visitor adherence to “Do Not Feed” signs

Abigail Summers and Andrew R. Marshall

CIRCLE (University of York and Flamingo Land)

circle@flamingoland.co.uk

Unauthorised public feeding of zoo animals has been implemented in reduced animal welfare. Previous research has highlighted potential impacts including obesity, immune-deficiency, disease transfer and behavioural disruption. Existing data on the impacts of visitors on zoo animals are limited and strongly biased towards primates and big cats. Research quantifying the frequency of public feeding is particularly limited. Standard “Do Not Feed” warning signs may not be adequate for changing public behaviour as they do not convey the welfare implications, but previous research has not been conducted with statistical rigour. No studies have quantified the nutritional impacts of unregulated feeding. This study therefore aimed to determine the effectiveness of zoo signs for improving the nutritional quality of slender-tailed meerkats (*Suricata suricatta*) at Flamingo Land. Objectives included (1) quantification of unauthorised nutrient loads passed to a group of meerkats through direct observational sampling and (2) assessment of the effectiveness of two alternative forms of sign for reducing public feeding. The meerkats consumed significantly higher quantities of food on average per day than they were expected to receive from their regulated zoo diet. Public feeding was also found to significantly affect meerkat behaviour, causing an increase in aggression, activity and response to humans during and immediately after feeding. It was found that the presence of warning signs was effective in reducing the number of visitors feeding the animals, both with and without extra information on the welfare implications. We discuss priorities for activities and research to ensure that strict dietary requirements are met in zoos in the face of continuing public desire to feed animals.

The effect of visitors and their possessions on a group of captive squirrel monkeys, *Saimiri sciureus*, in a free roaming exhibit

Sarah Chantry

Blackpool Zoo

research@blackpoolzoo.org.uk

The visitor effect on a group of captive squirrel monkeys, *Saimiri sciureus*, in a free roaming exhibit was studied at Blackpool Zoo over March – May 2013. Data collection took place during visitor hours on a number of low and peak season days during this period. Visitor numbers were recorded on each day and coded according to their age (Adult/Child) and whether they had visible food or a pram on their possession. The intensity of the squirrel monkeys reaction was then noted in correspondence to the relevant visitor(s). The Amazonia exhibit is a mixed species enclosure containing various birds and primate species and the project was undertaken as an aid to attaining a buggy park outside of the exhibit. The hypothesis of the study was that there would be higher levels of human-animal interaction in the presence of visitors with either food or prams than with those without. The data collection was carried out in high and low peak seasons to determine whether the percentage of human-animal interaction was due to just large visitor numbers, or whether the *S. sciureus* had an increased intensity of reaction to visitors with specific possessions. To prevent any agonistic behaviour towards humans, a buggy park would therefore be highly beneficial. The collected results have proved an interesting find.

Hanging around: a study of the visibility, enclosure use, and behaviour of Chester Zoo's Bornean and Sumatran orangutans

Nicholas Simpkin and Sonya P. Hill

Chester Zoo

research@chesterzoo.org

Chester Zoo has a large, naturalistic orangutan exhibit, 'Realm of the Red Ape' (RoRA). It comprises five on-show interconnected areas for Sumatran orangutans (*Pongo pygmaeus abelii*), and the Bornean orangutans (*Pongo pygmaeus pygmaeus*) have access to one or two on-show interconnected areas with several off-show areas. As expected with these kinds of enclosure, there are plenty of opportunities for animals to move out of sight of zoo visitors (and each other). This is important for good animal welfare, but it can result in issues with animal visibility from a public perspective, with potential knock-on effects for the success of the animals' roles in the zoo's Collection Plan, and engagement of visitors with its RoRA field conservation programme. Where concerns are raised about animal visibility, it is useful to assess the situation and, if appropriate, determine ways to encourage animals to make fuller use of their enclosures, through provision of additional, species-appropriate resources. In this study, we investigate the orangutans' time budgets enclosure use, and visibility from public areas, to help inform future management decisions about resource provision and other husbandry measures (Sumatran orangutan study subjects: N=6; Bornean: N=5). The location data will allow us to record how much time the animals spend in different areas of the enclosure, and what behaviours they are doing there. It can also be used to assess their degree of arboreality, as we know that orangutans are predominantly arboreal in the wild, and RoRA was designed such that most of the public viewing areas are at "canopy" height. Amongst other things, it is important that animals are given appropriate stimuli to encourage them to make optimal use of their habitat, allowing them to express a more naturalistic behavioural repertoire; part-way through the study, new sway poles will be added to the enclosure, providing additional opportunities for arboreal locomotion in areas visible to the public. Observations are being carried out using instantaneous scan sampling at 5-min intervals for multiple 30-min sessions at pre-determined viewing locations. The behaviour and location of each orangutan is recorded, as well as several other variables such as visitor numbers and weather. Preliminary data will be presented and the implications of these discussed.

Personality assessment of three species of captive monkey *Macaca nigra*, *Macaca sylvanus*, and *Saimiri sciureus*: cross-species comparisons of primate personality

Kathy Baker¹, Stephen Lea² and Vicky Melfi^{1,3}

¹Whitley Wildlife Conservation Trust (Newquay Zoo Environmental Park),

²The University of Exeter, ³Taronga Conservation Society Australia

kathy.baker@newquayzoo.co.uk

The study of animal personality, i.e. consistent individual differences in animal behaviour, is a rapidly growing research field. The construct of personality has been studied in many different scientific disciplines including ethology, behavioural ecology, psychology, animal management and physiology. Studying personality using a comparative framework is important for establishing whether phylogeny and/or ecology are a driving force in personality development. In the current study personality was investigated in three primate species, Sulawesi black crested macaques (*Macaca nigra*), barbary macaques (*Macaca sylvanus*) and common squirrel monkeys (*Saimiri sciureus*). The two macaque species are closely related, being from the same genus, but show some differences in their ecology and behaviour while *S. sciureus* are phylogenetically distinct but exhibit some similarities to the two macaque species in certain aspects of their ecology and behaviour. The aim of the current study was to establish whether phylogeny or socioecology has an impact on the development of personality structure by comparing the study species with other previously studied primate species.

Personality was assessed using the trait rating method. Questionnaires consisting of 38 personality traits, with accompanying definitions, were sent to all European institutions holding any of the study species. Keepers were required to rate animals on each trait using a 1 – 7 interval scale. Personality assessments were tested for inter-observer reliability. For each species a Principal Components Analysis (PCA) was carried out using only traits that exhibited good inter-observer reliability and scores for animals on each of the resulting components (personality dimensions) were calculated.

When reliable traits were entered into a PCA for each species, results revealed three personality dimensions for *M. nigra*, Sociability, Dominance, and Emotionality; four personality dimensions for *M. sylvanus*, Sociability, Dominance, Emotionality and Human-Animal Sociability (HA-Sociability); and three personality dimensions for *S. sciureus*, Sociability, Dominance, and Cautiousness. When comparing the three study species with other primate species, the Sociability and Dominance dimensions were comparable with previous research on non-human primates (NHP), except that aggressive-type traits found in other studies were not present in the Dominance dimension in *M. nigra* and *M. sylvanus*. This may be attributed to data suggesting they have more tolerant social systems compared to other primate species. The Emotionality dimension was similar across the two macaque species and was comparable to analogous dimensions in other NHP species. The Cautiousness dimension in *S. sciureus* was found to be similar to dimensions such as fearfulness and bold/shy in other NHP species. The HA-Sociability dimension found in *M. sylvanus* could not be compared with other primate studies as, to date, there has been limited investigation of human-directed personality dimensions in captive primates. Quantitative analyses using partial Mantel tests were conducted to evaluate if either phylogenetic similarity or similarity in socioecological variables significantly correlated with similarities in personality structure for 11 primate species (including the three study species). The results of this analysis were inconclusive as neither phylogenetic similarity nor socioecological similarity had a significant correlation with personality similarity. However the effect of socioecology was approaching significance, indicating that, selection pressures related to socioecology may play an important role in shaping personality structure but further data collection on a wider range of species is needed to explore these relationships further.

Using social network analyses to understand zoo animal behaviour

Paul Rose¹, Rebecca Lee² and Darren Croft¹

¹University of Exeter, ²WWT Slimbridge Wetland Centre

p.rose@exeter.ac.uk

It is important to distinguish between the concepts of species being gregarious or social; simply living in the same space as others or investing in specific aspects of sociality. Captive animals can be kept in social groupings that may not always mirror those of their free-living counterparts. Management decisions taken at population level can also disrupt important social ties and these may have long-lasting effects on the future viability and productivity of a species within the zoo. As such, it is important to measure the relevance of social bonds that may exist between individuals within a group, as well as evaluate how much these individuals invest in their relationships with others. Social Network Analyses (SNA) provides a useful tool for fine-scale investigation of each individual's overall importance to a social group's structure and function. Preferential assortment and non-random associations between individuals suggest relationships that are invested in and hence may have important health, welfare and fitness benefits for the individuals involved. Network theory denotes individuals with a group as "nodes" that are connected via lines (termed "edges") to make up a pattern of all the relationships over a given time. The attributes of the population can be inputted into the nodes to illustrate the relative significance of each specific animal to how the group is structured, organised and held together. Similarly, the edges can be directed to show flow of information or who is investing in whom, and weighted to give an idea of the stability and strength of associations. This presentation focuses on the application of SNA to populations of (potentially) highly-social, commonly-occurring zoo birds, flamingos, and aims to show how SNA can provide an illustration of the patterns of association and interaction that occur within flamingo flocks. Comparison between species, flocks, institutions and housing-type identifies management effects on flamingo behaviour, breeding success and welfare as well as consistently important social behaviour that all flocks appear to share. Such information can influence husbandry decisions relating to movement of individual birds, when to prepare enclosures for breeding, how to encourage the performance of biologically-relevant behaviour and how to evidence-base exhibit design. Availability of resources and competition induced by them, as well as space allowance can all affect (positively or negatively) the relationships between birds in a flock and the overall welfare experience of the flamingo in the captive environment. Whilst a comparatively novel research method in the zoo world, it can be demonstrated that SNA can have far-reaching and highly-relevant uses for those wishing to advance the biology of zoo animal management.

A study of “abnormal” behaviour in zoo-housed bonobos

Jeroen M.G. Stevens^{1,2}, Steffi Matthyssen², Evelien de Groot¹, Nicky Staes^{1,2} and Hilde Vervaecke^{1,3}

¹Royal Zoological Society of Antwerp, ²University of Antwerp, ³KAHO University College

Jeroen.stevens@kmda.org

A recent study by Birkett and Newton Fisher (2011) reports on the occurrence of abnormal behaviour in a sample of 40 zoo housed chimpanzees. The authors found that all chimpanzees in the study displayed at least two abnormal behaviours and concluded that abnormal behaviour is endemic in captive chimpanzees. Here we report on a preliminary study of 26 female and 17 male bonobos, all older than six years of age, living in six zoos. Each of the bonobos was studied by focal animal sampling, totalling between 13h and 20h of focal observation per individual. We present data on prevalence (proportion of individuals in a group that show behaviour), diversity (number of types of behaviour), frequency and duration of behaviours that were listed as abnormal in literature.

We recorded a total of 22 abnormal behaviours. The number of abnormal behaviours in each group ranged from five to twelve (median = 8) and was not correlated with group size. The individual repertoire varied from 1 to 8 (median = 3). There was no significant difference in repertoire size between males and females. Age did not have a significant effect on repertoire size or proportion of time spent in abnormal behaviour. Wild-born bonobos had a higher repertoire size, but did not spend more time in abnormal behaviour than mother-reared or hand-reared individuals. In conclusion, the bonobos in our sample show less abnormal behaviours compared to the chimpanzees in the study by Birkett and Newton-Fisher. This may be a consequence of different background of the individuals (no bonobos in our study had laboratory backgrounds) or past and/or current management practices: including more naturalistic group sizes and group dynamics. We discuss the appropriateness of the term “abnormal” behaviour.

**Aggression and mating behaviour in a breeding group of captive
Hartmann's mountain zebra (*Equus zebra hartmannae*)**

Laura Salanki

Blackpool Zoo

research@blackpoolzoo.org.uk

The Hartmann's Mountain Zebra (*Equus zebra hartmannae*) are the lesser known subspecies of zebra and are categorised as Vulnerable on the IUCN Red List. Blackpool zoo is only one of two zoos in the UK, who have successfully bred this rare species of equid; though there has been a problem with the stallion's extensive aggression towards one of the females. Captive mountain zebras show similar behaviour patterns as in the wild, which are the least tolerant of the presence of other group members and exposure to bad weather for extended periods. Within a mating herd, stallions are dominant over all individuals and have an unpredictable nature towards mares, with mating rituals being particularly aggressive. The social hierarchy amongst females also causes frequent conflicts as aggressiveness is positively correlated with dominance. As a result of these common agonistic encounters, the management and successful breeding of *E. hartmannae* in captivity is difficult.

The study was conducted to assess the aggression and mating behaviour between individuals of the herd, and whether this changes with the presence of a foal. The data collection for the study took place over two years, through four different time scales, observing the group over the birth of two foals.

Comparisons of behaviours between traditionally housed and multi-male groups of spider monkeys (*Ateles spp.*)

Eleanor Sowerby¹ and Kirsten Pullen^{2,3}.

¹Plymouth University, ²Whitley Wildlife Conservation Trust (Paignton Zoo Environmental Park, ³BIAZA
ellie_sowerby@hotmail.com

Female-directed male aggression is the most frequently reported type of aggression amongst wild spider monkeys. A recent study reports a different pattern of aggression in captivity compared to the wild. The amount of male-male aggression reported in captivity exceeded what was expected (Davis et al., 2009). The unnatural social and physical environment in which spider monkeys are kept in captivity may increase the occurrence of male-male aggression. Males are often relocated between zoos, which does not match the pattern of migration seen in the wild where females disperse (Davis et al., 2009). This leads to unfamiliar males being housed together increasing the likelihood of aggression.

We designed an observational study to see which factors affected level and intensity of aggression in captivity. Observations were carried out across six institutions. Traditional zoo housed groups, made up of one adult male, one sub-adult male and multiple females, were compared to multi-male groups. Surplus males from the European Endangered species Programme (EEP) are housed in these multi-male groups, along with females and their offspring. The study included three species of spider monkey: variegated (*Ateles belzebuth hybridus*), Columbian black (*Ateles fusciceps robustus*) and red-faced (*Ateles paniscus*). Data collection concentrated on aggressive and affiliative behaviours.

Sub-adults were found to be more aggressive and less affiliative than adults. These results contradict data from the wild where adults are the most aggressive. Wild data also shows sub-adults to participate in more affiliative interactions to strengthen bonds. Data from this study suggests captive adults have stronger bonds compared to sub-adults. Sub-adult males showed the least duration of affiliative behaviour, suggesting weaker bonds. No severe or lethal aggression was recorded during observations; only low levels of non-injurious aggression were seen in either multi-male or traditional groups. However, multi-male groups were found to have a higher frequency and duration of non-injurious aggressive interactions compared to the traditionally housed groups. In captivity there is no opportunity for inter-group aggression. The lack of rival males could reduce the value of male relationships in multi-male groups, resulting in higher levels of intra-group aggression. Red faced spider monkeys were more aggressive and less affiliative than the other species studied. This result differs greatly compared to anything else reported on species differences. Previous work suggests there is little difference across species in terms of behaviour (Davis et al., 2009). Across all variables affiliative behaviour was higher than aggressive behaviour.

From these findings we can suggest management techniques are adopted to reduce the levels of low intensity aggression seen, enabling multi-male groups to be kept in captivity. This will help solve the problem of surplus males. Groups could be kept within vocalisation or visual range of each other to try to promote strong male bonds due to rival males.

Reference: Davis, N., Schaffner, C. M., Wehnelt, S., 2009. Patterns of injury in zoo-housed spider monkeys: A problem with males?. *Appl. Anim. Behav. Sci.* 116, 250-259.

Male initiated socio-sexual behaviour in same species and mixed species groups of three *Oryzias* species (Beloniformes: Adrianichthyidae).

Thomas Hodgkinson and Frankie Kerridge

University of Bolton

F.Kerridge@bolton.ac.uk

Most species of the genus *Oryzias* (ricefishes) are thought to be endemic to few or even single localities on Sulawesi many kilometres apart. Several are vulnerable or endangered and two new species have been described since 2009. This study was conducted in order to assess whether three geographically isolated *Oryzias* species were behaviourally isolated to the extent that hybridisation would not take place. Same species and mixed species groups of *O. woworae*, *O. kendari* and *O. sarasinorum* were observed and the pattern and frequency of male initiated socio-sexual behaviours were recorded. Five male-male behaviours and five male-female behaviours were seen in all species combinations although there were small species differences in the form of the behaviours. In same species pairings *O. kendari* males performed significantly more socio-sexual behaviours than *O. sarasinorum* males. *O. woworae* males were intermediate and not significantly different to the other two. In mixed species pairings *O. sarasinorum* males were the least discerning – they performed higher frequencies of seven behaviours to the other two species females than to their own species females although differences were not significant. *O. kendari* males were most discerning; they performed seven behaviours least often to the least morphologically similar females. *O. kendari* males performed significantly more behaviours to same species females than to *O. woworae* females but there was no significant difference between frequency of behaviours to same species females and *O. sarasinorum* females. Despite these differences in behavioural frequencies females in all mixed species pairs produced fertile eggs apart from the *O. kendari* male – *O. sarasinorum* female pair which produced one infertile egg. These results indicate that these species are not fully behaviourally isolated and that hybridisation may take place both in the wild and in captivity should the opportunity arise. However it should be emphasised that the male fish were not given a choice of females to mate with and therefore less vigorous hybrid offspring may be better than no offspring at all.

Using faecal corticosterone and behaviour as an indicator of success for the social introduction of Amur tiger, *Panthera tigris altaica*

Louise Bell

Myerscough College and Blackpool Zoo

lbell@myerscough.ac.uk

The ability to be able to monitor stress in captive *Panthera* species is an essential focus of successful reproduction and welfare. Research suggests that individuals experiencing a stressful event, for example, the introduction to a novel enclosure will experience a stress response to enable them to 'cope' resulting in elevated stress levels and potentially poor welfare. Physiological and behavioural indicators are often used to assess the level of stress an individual encounters and to identify and reduce particular stressors (Young, 2003). Glucocorticoids (GC) (cortisol or corticosterone) often used as a physiological indicator, are released by an individual in response to an environmental stressor. Heightened levels of corticosterone in faecal samples can be measured non-invasively, thus providing a suitable means of determining stress within the zoo environment. Furthermore, faecal GCs are useful for determining stress levels in felids as a high percentage of GCs are excreted via faeces (Wielebnowski *et al.*, 2002; Palme *et al.*, 2005). Behavioural observations commonly used within the zoo environment are also useful for providing a multidisciplinary approach to assessing stress in captivity (Hosey *et al.*, 2009) however the efficacy of both can be considered questionable due to other influencing factors.

Faecal samples and behavioural observations were analysed from two Amur tigers Alyona and Zambar at Blackpool Zoo following the introduction of Alyona as part of an EEP breeding recommendation. Faecal samples were analysed using a standard ELISA to determine the levels of corticosterone (ng/g) prior to and following the introduction phases. Behavioural observations were collected continuously for 5hr intervals for both tigers for a prolonged period prior to and following their introduction to determine heightened corticosterone levels. Differences were noted between both individuals in both faecal corticosterone and behavioural observations thus, influencing the need for greater consideration of attributing factors for example, sample collection and abiotic factors.

The development of hierarchy structure throughout the introduction of a male in a captive Iberian wolf (*Canis lupus signatus*) pack

Rachel Milburn

Myerscough College

rachelmlbrn4@google.com lbell@myerscough.ac.uk

Social interactions are determined by social, submissive and aggressive behaviours being performed by individuals to establish a rank system. Wolves are one of the most social members of the *Canidae* family resulting in a complex social structure. A captive Iberian wolf (*Canis lupus signatus*) pack was observed over ninety hours in three intervals at Blackpool zoo, identifying dynamic fluctuations throughout the study. The behaviours performed in each interval were compared to establish if the presence of the male influenced the dynamic structure of the females. Interval one observations showed no significant difference ($P>0.05$) between the behaviours performed by the three females. Interval two was split into two sections, observations of the subordinate females in the external enclosure and the introduction of the dominant female to the male in the internal enclosure. This enabled the effects of the removal of a pack member to be observed on the subordinate females. The observations of the subordinate females showed a significant difference ($P<0.05$) between wolf behaviour in regards to food dominance. No significant behaviours ($P>0.05$) were observed by the dominant female and male in the internal enclosure. Sufficient evidence of the influence of the male on the hierarchy structure of the females was established in interval three, providing a highly significant difference in scent marking behaviour ($P<0.01$). When analysing the behaviour performed by each wolf throughout the ninety hour observation period significant evidence of the ranking structure throughout the periods was found, however this could have been due to unexpected variables that arose, rather than the influence of the male being introduced to the female Iberian wolf pack.

Olfactory and auditory enrichment suggests loss of anti-predator behaviours in captive lemurs

Rebecca Fuchs and Lucy Baillie

University of Bolton.

F.Kerridge@bolton.ac.uk

Wild lemur populations continue to be threatened by deforestation, habitat fragmentation and other anthropogenic factors. In one protected area of Madagascar the wild black and white ruffed lemur population has been augmented by the introduction of captive bred individuals and it is foreseen that other reintroductions will be necessary in the future. However reintroduction programmes are costly and low survival rates of the introduced individuals have been documented. Britt, Welch & Katz (2002) reported a loss of 5/13 reintroduced black and white ruffed lemurs to their native predator, the fossa.

Three captive lemur species were exposed to either audio or olfactory cues in order to evaluate their anti-predator behaviour. A group of 9 male black and white ruffed lemurs at South Lakes Wildlife Park were exposed to fossa, giraffe and lion faeces. Comparison to baseline data showed that the animals did not differ significantly in their activity budget (rest, feed, move, other) when exposed to any of the olfactory stimuli. Further comparison of the continuously recorded data also showed that the animals did not differ in marking, scratching, sniffing, self-grooming and social interaction when exposed to the different scents. Nearest neighbour distance and height were also not significantly affected throughout the experiment. Therefore it was concluded that the observed group of black and white ruffed lemurs did not recognise the fossa scent. A further investigation was undertaken using three species of lemur; ring tailed, black and white ruffed and red ruffed, to analyse their behavioural changes when confronted with the vocalisations of their native predator, the fossa. Results showed that lemurs preferred certain areas of their enclosure and there was a significant change in enclosure use when vocalisations were played: all three species moved up and away from the vocalisations. However, the activity budget data showed no significant difference between baseline and auditory enrichment indicating that the lemurs' behaviour was mostly unaffected by the fossa vocalisations. Some continuously recorded behaviours were found to change significantly under the enrichment condition. When the fossa vocalisations were played ring tailed lemurs and red ruffed lemurs sniffed significantly less frequently and ring tailed lemurs and black and white ruffed lemurs vocalised significantly less often. These outcomes indicate that these individuals have at least partially lost their anti-predator behaviour and further investigation of other lemur groups in other settings is suggested to evaluate how wide ranging a problem this is.

The effect of neighbouring African lion (*Panthera leo*) roaring bouts on the behaviour of an Amur tiger (*Panthera tigris altaica*)

Alastair Kember

Dartmoor Zoological Park and Plymouth University

alastair.kember@postgrad.plymouth.ac.uk

Anecdotal evidence from Dartmoor Zoological Park suggested that a captive Amur tiger (*Panthera tigris altaica*) was responding to neighbouring African lion (*Panthera leo*) roaring bouts with calls of her own. A 3-month investigation was carried out to see if the lion roaring bouts affected the behaviour of the Amur tiger. During the investigation the male lion was unfortunately euthanised, giving the opportunity to investigate the effect this would have on the vocalisation behaviours of the tigress and the remaining lioness. Data analysis for association imply that tiger vocalisations were found to occur more often during lion roaring bouts and stereotypical pacing behaviour was seen more often immediately after a lion-roaring bout. Findings also show that mean calling bout length of both the tiger and lioness were seen to increase after the death of the male lion. These findings suggest that the lion roaring bouts were having a negative effect on the neighbouring tiger's welfare.

This study found that the roaring bouts of a pair of captive African lions (*Panthera leo*) did have an effect on the behaviour of the neighbouring Amur tiger (*Panthera tigris altaica*). The behaviours most affected were the tiger's 'loud moan call' and pacing. The loud moan call was performed most often as an 'answer' during a lion roaring bout. Pacing was seen more often immediately after a lion-roaring bout. It also showed that the death of the dominant male lion had a significant effect on the mean bout length of both the lioness and the tigress.

These findings suggest that the territorial vocalisations of one captive species can have a negative impact on the welfare of another neighbouring species and that considerations need to be made when housing animals with loud vocalisation behaviours in close proximity. This emphasises the importance of the audio-landscape within a zoo and raises practical questions regarding animal welfare and management and the location of certain species within a zoo. Limitations of the study are discussed.

The use of risk assessment methodology to generate evidence based decision making in zoo animal disease management

Matt Hartley

Zoo and Wildlife Solutions

matt@zooandwildlifesolutions.com

Risk analysis is a tool intended to provide decision makers with an objective, repeatable and documented assessment of the risks posed by a particular course of action. It is a tool now routinely used to guide policy making and disease control planning by governments and international organisations such as the OIE (World Organisation for Animal Health). Risk analysis is intended to answer the questions:

- What can go wrong ?
- How likely is it to go wrong ?
- What would be the consequences of it going wrong ?
- What can be done to reduce the likelihood or the consequences of its going wrong?

This technique is rarely used to aid decision making in managed zoo captive breeding programmes. Risk analysis has significant potential to support Taxon Advisory Groups to formulate evidence based policies for issues where there is an element of uncertainty, confusion or controversy, as this technique is designed to present fully referenced information in a structured and transparent way. It is particularly useful as qualitative rather than quantitative techniques can be used where numerical or statistical data is not available or is of limited value, due to small population sizes, for example.

Sustainable food procurement in BIAZA

Jonny Hanson

Queen's University Belfast (now University of Cambridge)

jh847@cam.ac.uk

Food and farming are of strategic importance for the future of biodiversity. Building on work by Townsend (2009) on general sustainability in zoos, this study aimed to assess the commitment to sustainable food procurement (SFP) among BIAZA members, comparing front-of-house (human) with back-of-house (animal) operations. It examined food purchasing practices and priorities, as well as the drivers of and barriers to these activities.

A quantitative, cross-sectional approach was adopted, involving the use of a web-based questionnaire to gather relevant information from 41 BIAZA members. The questions in the survey were ordered to effectively meet the research objectives, with one section of the survey addressing human food and another section animal food.

Economic sustainability was found to be the highest scoring section of SFP, followed by environmental and then social. The overall levels of SFP were found to be equal for human and animal food operations. Nevertheless, numerous disparities between these two supply chains were found to exist for individual issues. In most cases, food procurement practices did not match food procurement priorities, with the exception of socially sustainable food procurement where there was an exact correlation. Statistically, levels of SFP were found to be significantly higher in charity zoos, zoos with accredited sustainability standards, and zoos whose human food operations were not contracted to external operators. Cost savings were identified as the most important driver of SFP, followed by adequate financial support and improved product quality. In terms of barriers, the three highest ranked issues were increased costs, other issues taking priority, and a lack of alternative suppliers.

Seven recommendations were made to improve the level of SFP within BIAZA. Internally, these included implementing policies and audits, ensuring consistency across all areas of zoo operations, and utilising food certification schemes. Externally, the recommendations involved engagement with food suppliers, partnerships for SFP, as well as higher standards for contracted food operators. Guidelines for self-assessment were also included to allow individual zoos to compare their SFP scores with the mean figures from the study.

The originality of this study lies in its comparison of two parallel but separate supply chains within zoos and aquariums. Also of relevance is the link between organisational values and purchasing activities.

Management evaluation of Clennon Hill, a calcareous grassland site in Torbay

Victoria Lawler^{1,2} and Tracey Hamston²

¹University of York, ²Whitley Wildlife Conservation Trust (Paignton Zoo Environmental Park)

tracey.hamston@paigntonzoo.org.uk

Clennon Hill is an unimproved calcareous grassland situated within the grounds of Paignton Zoo Environmental Park, which is managed by Whitley Wildlife Conservation Trust. The size of the grassland has decreased over the years with the encroachment of scrub and other non-grassland species. As a Torbay BAP priority habitat, practical management is employed on site with the aim of restoring the grassland to a desirable state, following the decline in grassland quality. This project aims to assess any changes in the plant and invertebrate community over time and thus evaluate the current management regime. Twenty-one vegetation quadrats along three permanent transects have been monitored on-site bi-annually since 2008, with a number of factors being recorded. The changes in vegetation during this period will be analysed, with concentration on: change in diversity over time; the association between diversity and sward height; and the presence of negative and positive indicator species. The invertebrate community has also been sampled, focussing on Caribidae and Araneae, through the use of pitfalls to determine their relationship with the vegetation present, and to test whether they could be used to quickly assess the state of the grassland. Data collection is on-going, findings will be discussed.

The effect of soil disturbance on the invertebrate and plant assemblages at Loworthy, a potential re-introduction site for the large blue butterfly (*Maculinea arion*).

Nicholas Berkley^{1,2} and Tracey Hamston²

¹Plymouth University, ²Whitley Wildlife Conservation Trust (Paignton Zoo Environmental Park)

nicholas.berkley@paigntonzoo.co.uk

Loworthy is part of the Slapton Ley National Nature Reserve which is owned by Whitley Wildlife Conservation Trust (WWCT) and managed by the Field Studies Council (FSC). Due to the sites topography it has been suggested that the Loworthy field site, 'Hedgelands', may be suitable for the re-introduction of the vulnerable large blue butterfly (*Maculinea arion*). The butterfly's historical range also encompasses the site. Landscape topography is an important factor in the large blue's ecology due to the butterfly's dependence on the ant *Myrmica sabuleti*. *M. sabuleti* requires a warm microclimate, south facing slopes in the south of England are therefore necessary for its establishment. This project involved the collection of baseline data on the invertebrate assemblages currently present at 'Hedgelands', both within soil scrape regions and undisturbed grassland. Soil scrapes have been used to reduce soil fertility, alter the seed bank and increase habitat heterogeneity. Such scrapes are also likely to benefit *Myrmica* populations which favour a shortened sward height with areas of bare ground. Invertebrate studies were focused specifically on spiders (Araneae) and ground beetles (Carabidae); sampling was carried out on a weekly basis using pitfall traps. Ants (Formicidae) were sampled using a pooter with *Myrmica* colonies identified to species level using chemical analysis of the exocuticle. Vegetation assemblages were also monitored using point quadrats and soil analysis carried out. Having begun in May, data collection is currently ongoing, however preliminary findings have shown that the scraped regions support a more diverse vegetation assemblage and that low numbers of *Myrmica sabuleti* are present on site although there is no evidence that soil scrapes increase their abundance.

The role of UK Zoos in raising the awareness of native biodiversity to visitors

Jessica Waldron
Plymouth University
jess.m.waldron@gmail.com

This research study aimed to investigate the extent to which, if at all United Kingdom (UK) zoos are currently raising the awareness of native biodiversity to visitors. This was achieved using five objectives to examine the importance of native biodiversity to UK zoos; to establish whether native biodiversity is incorporated into zoo education programmes, to ascertain the type of activities and events zoos run to promote native biodiversity to visitors, and to determine the degree of information available to visitors about native biodiversity around the zoo site. The last objective involved providing recommendations for both the British and Irish Association of Zoos and Aquariums (BIAZA) and UK zoos in terms of future developments within this area.

Questionnaires, interviews and a website analysis were used to obtain both the quantitative and qualitative data that would fulfil the aim of this study. The questionnaire sample was made up of 42 UK zoos from a possible 88 zoos within BIAZA, which provided a response rate of 48%. Three interviews were conducted with conservation organisations and a further website analysis was used to evaluate the 88 BIAZA websites in terms of native biodiversity awareness. This study found that a significantly low proportion of information on native biodiversity was available within zoo educational programmes. However, many of the zoos within the sample were providing native biodiversity activities and events for visitors although these varied with zoo size and the zoo environment. The main uptake barriers that were highlighted by zoos were cost, time and lack of resources. Posters were the predominant source of information available about native biodiversity around the zoo sites which are known to be an ineffective form of conveying information.

This study has highlighted that although zoos are actively contributing to raising the awareness of native biodiversity there is still room for a significant amount of improvement. A national campaign highlighting the importance of native biodiversity conservation within UK zoos and zoos themselves forging ties with local conservation organisations, schools, universities and other local groups could help promote this area further.

Preliminary results from a comparison of demographic statistics between two populations of *Muscardinus avellanarius* (L), in the north of its UK range

Sarah Bird

North of England Zoological Society, Chester Zoo

s.bird@chesterzoo.org

Mark and recapture monitoring of *Muscardinus avellanarius* at two sites, towards the north of the species UK range, has been undertaken by the Northwest Dormouse Partnership between 2005 and 2015. The study sites are in Denbighshire (a natural population) and in Cheshire (a reintroduced population). Previous UK research on the species has focused in the south of England; populations in the north of England and north Wales were thought to be small, scattered and fragile.

With over 850 animals marked in 7 years, and 34% recaptured, this is one of the largest UK studies of this type with this species. The population in Wales shows demographic statistics comparable to populations in Europe, and appears to be stable. Multiple litters and breeding in young of the year have been recorded; events which the literature would indicate were unlikely in the north of the UK. In contrast, the reintroduced Cheshire population appears extremely fragile.

A test of optimal window sticker placement for reducing bird strikes

Kelly Osborne and Andrew R. Marshall

CIRCLE (University of York and Flamingo Land)

circle@flamingoland.co.uk

Bird window strikes are thought to contribute to urban population declines, and are potentially the second largest man-made cause of global bird mortality (Klem 2008). Window stickers for deterring birds are sold globally, and are assumed to be an effective method for preventing strikes. Little is known about sticker size or material choice for preventing strikes. Previous research has suggested that a 5-10cm spacing of stickers is needed to prevent strikes (Klem, 2009). Alternative research has suggested that window stickers may not be an effective preventative measure at all, and hence 100% strike reduction could only be achieved by complete coverage of windows (Dunn, 1993).

Here we trial different densities, sizes, shapes and reflectance of window stickers for reducing bird strikes in zoos. Many zoos have large glass sheets to enable clear public viewing, and hence may contribute significantly to this global problem. By testing different window stickers at Flamingo Land zoo in North Yorkshire, we have determined that:

1. Bird of prey silhouettes were no more effective than simple geometric shapes.
2. There was no difference in effectiveness between UV, black or white stickers.
3. Narrower sticker spacing led to significantly fewer strikes; however 10cm grids were still not completely effective at preventing strikes.
4. Maximising the dispersal of stickers across the window was seen to be more important for reducing strikes than maximising the proportion of window surface covered.
5. Confounding factors such as weather, light levels and orientation influence the rate of strikes more than the stickers.

Using our findings, we make recommendations for minimum standards for zoo prevention of bird strikes, and for further research.

How can zoos help conserve native amphibians and reptiles?

Jim Foster

Amphibian and Reptile Conservation

jim.foster@arc-trust.org

British amphibians and reptiles (herps) have suffered significant declines and their recovery requires concerted conservation action. Potentially, British zoos could play an important role in this conservation response, and indeed some are already helping. The traditional view of zoo contributions to conservation focuses on captive breeding, and there is a small-scale role for this activity for British herps. We feel, however, that the most important roles are for improving awareness and understanding, increasing public involvement in conservation, and assisting with research. There is massive potential for more zoos to improve understanding of natural history and conservation messages on native herps. In addition we think it's important to guide visitors towards practical actions they can take to help herps after their visit. Whilst most zoos focus on exotic species, we would like to see more emulate the fantastic native species work of some collections. We think there is great potential here, regardless of whether zoos are able to actually house native stock. Clearly there are some barriers to achieving all of this, and ARC is developing a new project to help address these. Using captive stock, zoos can also play an important role in improving our evidence base on ecology and behaviour, as well as applied aspects such as how people interact with captive exhibits. We are also keen to encourage the trend for zoos to engage with *in situ* conservation projects, and to make links back to the visitor experience. In many ways native amphibians and reptiles present an ideal group for zoo involvement in conservation, and we actively seek comments from BIAZA members to help us develop our proposals.

Perch Choice Preference of Indian Stick Insects (*Carausius morosus*)

Robin Love

Myerscough College

robin.love@live.co.uk lbell@myerscough.ac.uk

Observational studies into the cryptic abilities of insects have shown that insects have an acute awareness of their environment and ability to reduce their own visual appearance through crypsis. Colour background matching behaviour has proven to be a detrimental factor at reducing visual appearance for prey species that depend on selecting the most suited substrate or background in a heterogeneous environment. The Indian Stick insect *Carausius morosus* is a commonly kept species of insect known for its mimicry. However, the lack of research focusing on their environmental preferences leaves for a considerable gap in their welfare as a commonly kept pet. In an attempt to improve the current understanding of this species, a study was carried out testing colour background matching behaviour together with height and orientation behaviour. The trial involved 20 insects divided equally between nymphs ($n=10$) and adults ($n=10$). Both age groups were analysed independently and together to look for differences. Fixed interval sampling performed over a 10 week period measured the frequency of samples found on a choice of 6 colour perches of green and brown. Height and orientation trials were carried out over a 6 week period using wooden poles and perches at set heights and angles. Results concluded that both adults and nymphs showed a strong preference in colour and height; and could significantly express orientation behaviour.

The effects of zookeeper and visitor presence on the behaviour of Amur leopards (*Panthera pardus orientalis*) in the captive environment

Ciara Fleming, Kerry Hunt and Paul Rose

Sparsholt College Hampshire

paul.rose@sparsholt.ac.uk

It is known that visitors have an effect on a number of captive species, which in some cases can be enriching, stressful or neutral, however research documenting the effect of visitors on large felids, in particular Amur leopards (*Panthera pardus orientalis*), is limited and contradictory. Coincidentally, the effect of stockmanship on the behaviour of domestic species has been well studied whilst research concerning the impact of zookeepers on the behaviour of animals' in their care is still not fully understood. Research regarding the effect of visitors on the behaviour of primates, in most cases, suggests that this effect is stressful. If this is also true for big cats then husbandry and management practices as well as enclosure design may need to be altered to accommodate this. Understanding how an animal's behaviour may change as a result of captivity is important when assessing welfare and reviewing an individual's value to the conservation of wild counterparts. The Amur leopard is classified as Critically Endangered and conservation breeding programmes are vital to ensure the future viability of wild populations. This research investigated the effects of visitor presence and density, as well as zoo keeper presence on the behaviour of Amur leopards in a captive environment.

Data were collected at Colchester Zoo and the Wildlife Heritage Foundation, Kent, over a period of 18 days. Eight hours of observation were undertaken each day giving rise to 180 hours of observational data. Individual observation times were alternated to allow for differences in time of day and visitor levels. Instantaneous scan sampling was utilised to record state behaviours at five minute intervals and continuous sampling was employed to record event behaviours. One-factor chi-squared analyses identified significant differences between observed behaviours and expected behaviours in the presence of visitors for state and event behaviours including resting ($X^2=433.83$, $DF=1$, $P\text{-Value}<0.001$), the majority of which decreased in the presence of visitors. 39.7% of the leopards' activity budget comprised of resting behaviours however, this decreased by 33.87% in the presence of visitors suggesting the presence of visitors induces a stress response in Amur leopards. The same trend was recognized at different densities of visitors, where the majority of behaviours decreased in frequency as visitor levels rose. Significant differences were identified between observed behaviours and expected behaviours, for state and event behaviours in the presence of a zookeeper including stereotypic head rolling ($X^2= 351.94$, $DF= 1$, $P\text{-Value}<0.001$), with frequencies of all behaviours decreasing in the presence of a zookeeper.

A significant decrease in the frequency of stereotypic head rolling suggest zookeepers have an enriching effect on the animals in their care whereby abnormal behaviours are reduced or eliminated in their presence. Although the results of this investigation allow for the effect of visitors and keepers to be speculated, further research will need to be undertaken in order to conclusively identify if the effect is positive, negative or neutral. Further research may also determine the impact of visitors and zookeepers on welfare and the impact on adaptive traits when considering and implementing conservation breeding or reintroduction programs.

Flamingo exhibit design for optimising behaviour and breeding

Katy Moreton, Steve Nasir and Andrew R. Marshall

CIRCLE (University of York and Flamingo Land)

circle@flamingoland.co.uk

Despite a prolific number of scientific publications produced by zoos, published research into exhibit design is limited. Furthermore, continued emphasis on minimum husbandry standards in zoos has led to fears of stagnation in zoo exhibit design. Husbandry guidelines for the care of animals are typically not supported by empirical testing and rarely incorporate measurable indicators of exhibit success.

The traditional measure of animal welfare has been breeding success, under the assumption that animals will only breed if living in surroundings that are suitable for their overall welfare. Indeed, high rates of breeding success may well indicate that animal groups exhibit a natural range of social, courtship and parental behaviours. However, both research and extensive animal management experience now recognise that animal behaviour is also an important indicator of enclosure suitability. For instance, high levels of animal activity, social interactions and behavioural diversity may indicate good physical well-being. Conversely, negative behaviours such as inactivity, aggression, fear, and repetitive stereotypes may indicate sub-optimal exhibit design.

The six flamingo species are known for having little success breeding in captivity, but little is known about their behaviour in captivity, and there have been no peer-review studies of exhibit design. Here we outline findings from a two-part study, including (a) questionnaire results from a national survey of exhibit design features and breeding success, and (b) behavioural observations from a survey of a mixed-species flock containing both Caribbean and Chilean flamingos. Results outline several features of exhibit design that are closely related to breeding success, including size, substrate, pool design and flock composition, with only partial agreement to previous studies. The results further emphasise that visitor influence, inter-specific interactions, and exhibit design all have strong influence on behaviour.

We emphasise that an appropriate evidence-based framework for ensuring animal welfare in zoo exhibit design would incorporate measures of behaviour, space use, and breeding success. Further studies are required across taxonomic groups for the development of optimal standards in the monitoring and assessment of zoo exhibit design.

Investigating current enrichment techniques for three species of lemur

Carolyn Ma^{1,2} and Holly Farmer²

¹Manchester University, ²Whitley Wildlife Conservation Trust (Paignton Zoo Environmental Park)

holly.farmer@paigntonzoo.org.uk

This study investigated the effectiveness of a range of enrichment types, food-based, sensory, manipulative and auditory, for three species of lemur (ring tailed lemur [*Lemur catta*], red ruffed lemur [*Varecia rubra*] and red fronted lemur [*Eulemur rufus*]) at Paignton Zoo Environmental Park. The aims of this work were to determine whether the current enrichment programme, providing the same enrichment devices to all three species of lemur, was effective. A second aim was to provide evidence for the addition of auditory enrichment into the enrichment programme, a husbandry technique which for vocal primates, in particular lemur species, is relatively understudied.

Behavioural activity budgets and detailed responses to enrichment types (latency to respond and immediate behavioural responses) were recorded. Playback experiments investigated the responses of study animals to a range of sounds (conspecific calls, rain and white noise as a control). During auditory enrichment experiments, behavioural data were collected before, during and after playback and three categories of response to each sound were also recorded; orientation towards the speakers, approaching the speakers and vocalisation to further determine efficacy. There was significant difference in the interaction of different interactive and auditory enrichment between species, suggesting that the enrichment programmes for captive-lemurs need to accommodate for species differences. There was a significantly greater response from *L. catta* and *V. rubra* during conspecific call playbacks and also playbacks in general significantly reduced stereotypical behaviours of *E. rufus*. This suggests that auditory enrichment may have some value for captive-lemurs, although further playbacks to a larger sample size in other zoos is needed to reach a firm conclusion.

Enriching native species in captivity; a case study on common seals (*Phoca vitulina*)

Tori Gibbons, Paul Rose and Kerry Hunt

Sparsholt College Hampshire

paul.rose@sparsholt.ac.uk

In captivity it is important for animals to have choice and control over their environment, because this decreases the degree to which the uncertainty of behavioural outcomes influences the animal's behaviour and can be achieved through novel enrichment. The use of novel enrichment in captivity has been shown to reduce the prevalence of stereotypic behaviour, whilst increasing the expression of a more natural time budget. Enclosure design has been shown to influence activity budgets, and can increase stereotypic behaviours in barren or unsuitable environments. As such this is an area of animal husbandry that is being researched further to improve animal welfare. The common or harbour (*Phoca vitulina*) is one of two species of seal native to the United Kingdom and is the most widespread of all pinniped species. Seals are highly intelligent animals spending a considerable amount of time foraging in the wild. This can lead to the development of abnormal behaviours in captivity because captive environments often lack the complexity of the wild and behaviours are restricted. Research on enclosure utilisation has only been conducted on a small number of species and as such more focussed research is needed in this area.

This study was carried out at Weymouth Sea Life Adventure Park lasting for a period of 15 days. The three seals were observed for six 60 minute periods each day resulting in a total of 90 hours of observations. Instantaneous scan sampling of a focal individual was used to record state behaviours at five minute intervals, whilst continuous sampling was used for event behaviours. Five different novel enrichment devices were presented to the seals and the state behaviours were recorded alongside of the area of the enclosure they were occupying. State and event behaviours were analysed using a Friedman test allowing for the data to be compared and differences to be identified in the presence of different enrichment conditions. Activity budgets were produced for state behaviours and rate of occurrence for event behaviours to determine if the addition of enrichment resulted in the exhibition of more natural behaviours. Results did not show a more natural time budget after enrichment was added, mainly because the seals were already engaging in natural behaviours, variation between the different conditions was observed. Five behaviours were shown to be significantly different between the enrichment conditions including; swimming on back ($S=13.00$, $DF=6$, $P=0.043$), interacting with object ($S=17.20$, $DF=6$, $P=0.009$), and sniffing air ($S=13.14$, $DF=6$, $P=0.041$). A modified spread of participation index (SPI) and a Chi-squared test were used to determine if the seals were biased towards a particular area of the enclosure. The enrichment resulted in two of the seals utilising the enclosure more evenly once enrichment was added. Variation was observed in behaviours exhibited and enclosure utilisation between the three seals highlighting the need to observe animals as individuals when measuring their welfare.

Despite the seals housed at Weymouth Sea Life Adventure Park displaying little stereotypic behaviour and thus already having good welfare, the results did show that enrichment led to a change in behaviour and this may be of benefit to other *P. vitulina* and pinniped species whose welfare is not of such a high standard.

Investigating the effect of aggression, dominance and sociality in bachelor herds of giraffe

Jack Gradidge and Paul Rose

Sparsholt College Hampshire

paul.rose@sparsholt.ac.uk

Wild animal collections often have difficulty with the amount of space available to them which limits carrying capacity of populations. The composition of groups can also be limited due to the demographics of captive animals. Surplus males are common in many group-living ungulates where captive groups can only contain one male. It is for this reason that bachelor groups were formulated and serve as an important population management tool. Bachelor herds of giraffe (*Giraffa camelopardalis*) are becoming more common in captivity as hybridised males, which cannot be bred from under EEP (European Endangered Species Programme) recommendation, are housed in these groups to avoid further impurity of subspecies. Male giraffe are known to aggregate in these groups in the wild although their social behaviours are unknown. Sociality is recognised in female giraffe and social bonds have been found to exist in captivity. It is important to understand and consider social behaviour due to the continued movement of animals between collections for breeding and management purposes, which could be detrimental to the formation of social bonds. This research aimed to determine association patterns, identify partner preference and detect a dominance hierarchy within a bachelor herd. Comparisons were also made to data collected on captive female giraffe to distinguish differences.

A total of 86 hours of behavioural data were collected using instantaneous scan sampling at five minute intervals and continuous focal animal sampling on a herd of five captive male giraffe housed at Folly Farm Adventure Park and Zoo. Results supported the hypothesis that giraffe in a bachelor herd associate in a non-random manner due to a significant difference in social interactions between group members ($X^2_{(4)}=33.87;P<0.001$). The amount of time each giraffe spent alone was also significantly different ($X^2_{(4)}=394.43;P<0.001$) indicating differences in time spent socialising. It was also noted that an older bull spent the most time alone, indicative of a wild bulls solitary roaming. Partner preference was identified and weaker bonds existed between individuals with a greater difference in age. A linear hierarchy was found from analysis of aggressive interactions using Landau's index of linearity (h), it is suggested that dominance is influenced by age. Results indicated differences between male and female social behaviour with more aggressive interactions noted in the male giraffe ($t_{(7)}=-3.69;P=0.008$) and thought to be exhibited as a manifestation of dominance. Further research in wild populations, such as hierarchal position of males and formulation of social bonds would be beneficial for comparison to captive groups and could prompt change in management strategies. Research between animal collections housing bachelor groups would also be beneficial to compare and develop a full understanding of the social behaviour exhibited in these same-sex groups.

Poster Presentations

An investigation into the effect of visitors on the behaviour of ring-tailed lemurs (*Lemur catta*) and red ruffed lemurs (*Varecia rubra*) housed in a mixed walkthrough exhibit

Emily Auton

Nottingham Trent University and Colchester Zoo

Emilyauton.2@gmail.com

The aim of this dissertation was to investigate if varying visitor numbers had any effect on the behaviour of two species of lemurs, ring-tailed lemurs (n=11) and red-ruffed lemurs (n=3) housed in a mixed exhibit, where the public have the opportunity to walk through the enclosure. Behaviour was recorded alongside the number of visitors within the enclosure at each sampling time. Research was carried out at Colchester Zoo, UK, during August, September and October 2012.

The results indicate that ring-tailed lemurs and red ruffed lemurs did change their behaviour when visitors were present within the enclosure. When visitors were present the lemurs displayed significantly more alert and locomotive behaviour and spent significantly less time out of sight or "hiding". There was a significant reduction in avoidance or retreating behaviour when a small audience was present. No stereotypical behaviour was found during this study. These results suggest that, contrary to most literature on the effects of zoo visitors on the behaviour of captive primates, the lemurs were not stressed at the presence of visitors but instead chose to spend more time in overt places when the visitors were present than when they were absent. It could also be interpreted that the visitors were a form of environmental enrichment for the lemurs as they provided a constant source of novelty. It could however also be argued that the lemurs were more alert when the visitors were there as they were stressed about strangers being in their territory/enclosure. This however does not seem to be supported due to no significant increase in other stress related behaviour such as aggression, and no reduction in feeding, and social behaviours.

This study was only conducted in one enclosure and at one institution; therefore the findings from this study cannot be applied to all enclosures or different establishments, without further supporting research using the same methods at other institutions.

Housing effects upon the behaviour of Blair Drummond's African elephants (*Loxodonta africana*)

Kelsie Braidwood

Blair Drummond Safari Park

kelsieiona@gmail.com

In October 2013 the three African elephants at Blair Drummond were given access to their brand new 'Elephant habitat'. The new building has been designed to improve the welfare of the somewhat dysfunctional elephants. It has sand flooring, puzzle feeder walls, hanger feeders on timers amongst other things. The elephants also have the choice of being indoors or outside at all times, except whilst cleaning is underway. Over a period of four months over 400 hours of observational data were collected to establish activity profiles of the elephants in their new building. Data were collected using scan samples at 10 minute intervals from the viewing platform of their enclosure. In addition to this, overnight data was gathered using CCTV footage to establish the housing's effects on the behavioural patterns of the elephants overnight. Furthermore, the effects of visitor number upon behaviour were examined. It was hypothesised that the new building would decrease stereotypic behaviours from the levels found in previous studies in their old building. However, as no previous study has found a complete eradication of such complex stereotypic behaviours, it was hypothesised the elephants would still display stereotypic behaviour in their repertoire.

The data, although still being analysed, have shown a decrease in stereotypic behaviours, which have been almost eradicated from their behaviour. There also appears to be no correlation between stereotypic behaviours and visitor numbers. The three elephants each had very different reactions to the new building highlighting the need for others to consider the individual life histories and personalities when designing improved housing elsewhere in the UK.

A case study comparing the human directed behaviour of two species of Asian hornbill: rhinoceros (*Buceros rhinoceros*) and rufous (*B. hydrocorax*)

Rachael Brown and Carlos de Luna

Writtle College

brown.rachael.jane@gmail.com

Studies of human animal relationships (HAR) in species other than primates and big cats are lacking. To improve understanding of the human-related requirements of zoo housed species more studies should be conducted into the human-directed behaviour of non-mammalian animals. This study aimed to assess the human-directed behaviour of two species of hornbill, *Buceros rhinoceros* (the rhinoceros hornbill), and *B. hydrocorax* (the rufous hornbill) at Colchester Zoo. Behaviours were recorded by check sheet and statistically analysed. Correlations conducted found very weak to weak correlations between guest-directed behaviours and guest numbers for *B. rhinoceros* ($R^2=0.06$, 0.25, 0.09 and 0.01) and medium to strong correlations for *B. hydrocorax* ($R^2=0.46$, 0.51, 0.74 and 0.45). Comparisons between guest-directed behaviours (GWR and GWA) for each individual bird found no significant difference between the occurrences of the behaviours. Comparisons between keeper directed behaviours (KWR and KWA) for each individual bird also found no significant difference between the occurrences of the behaviours. Whilst no significance was found, the study still shows that behaviour of the hornbills is affected by the presence of guests, and some behaviour (such as aggression) could be leading to negative welfare. With some minor to major enclosure changes, this may be reduced. Another study could be conducted post changes (e.g. moving the nest box) to assess whether there is a reduction in guest -directed behaviours. Other studies could also be conducted including a similar one to this with an improved experimental design, or a measurement of intensity of aggression. With regards to keeper directed behaviours, little can be done to reduce attention paid to them, however, minor improvements to practice may be able to reduce aggression and therefore stress of the hornbills.

No influence of scatterfeeder enrichment on stereotypic behaviour in captive hyenas and on inactivity in captive raccoons.

Evelien De Groot¹, Lienert Buys², Annelies De Parade², Adinda Sannen^{1,2}, Ella Roelant² and Jeroen M.G. Stevens^{1,3}

¹Royal Zoological Society of Antwerp, ²KAHO Sint Lieven University College, ³Antwerp University
Evelien.De.Groot@kmda.org

In captivity, many carnivores that are active foragers and that occupy large territories in the wild, are prone to stereotypic behaviour. We tested whether a scatterfeeder can be used to stimulate active foraging and to reduce stereotypic pacing behaviour in two captive male spotted hyenas (*Crocuta crocuta*). In addition, a scatterfeeder was used to stimulate activity in three captive male raccoons (*Procyon lotor*). Both studies were conducted at Planckendael Wild Animal Park (Belgium).

For the hyenas, we collected observational data using the scan sampling technique for four 1 hour sessions per day in the following conditions: 1) five days without enrichment (baseline condition) 2) 15 days in which the following three conditions (each repeated five times) were randomized: a) dog biscuits scattered on fixed time in the morning; b) dog biscuits scattered on fixed time in the afternoon; c) no enrichment provided; 3) five days with no enrichment provided (return to baseline). For the raccoon study, the scan sampling technique was also used for four 1 hour sessions per day in the following conditions: 1) ten days without enrichment (baseline condition) 2) ten days in which the following conditions were randomized: a) five days in which dog biscuits scattered on a fixed time in the afternoon; b) five days with no enrichment.

Preliminary results indicate that, across the whole day, pacing and foraging levels remained constant for the two hyenas. However, pacing was reduced in sessions where biscuits were scattered, and foraging increased, but only in the dominant male. Aggression rates also increased in the scatterfeeder conditions, probably because of the limited area where the dog biscuits were spread out. These data suggest that a scatterfeeder can improve the welfare of captive hyenas, but that we have to take dominance relationships into consideration to improve the design. The level of activity did not improve in the raccoons and only one male responded to the feeder, but to a limited extent. It might be the case that the raccoons need more time to adapt to the scatterfeeder. This learning period has to be implemented in future designs.

Social networking in captive military macaws (*Ara militaris*): comparison between an all-male group and a mixed-sex group

Evelien De Groot¹, Lize De Borgher², Els Peeters² and Jeroen MG Stevens^{1,3}

¹Royal Zoological Society of Antwerp, ²KAHO Sint Lieven University College, ³Antwerp University

Evelien.De.Groot@kmda.org

Social behaviour varies among the different psittacine species but solitary behaviour is the exception. Most species show a complex social organization. However, little is known about psittacine social behaviour and how it is distributed among the members of the flock. The most important affiliative behaviours consists of allopreening and the maintenance of close proximity. Both behaviours are associated with the formation and maintaining of pair bonds, but they can also occur among same sex flock members, which indicates the existence of a social bond. Observations on wild psittacine species are scarce and in captivity most psittacines are kept in pairs for breeding purposes. The Royal Zoological Society of Antwerp (Belgium) houses two flocks of military macaws: a group of five adult males at Planckendael Wild Animal Park and a mixed-sex group of three females and three males at Antwerp Zoo. We looked at the activity budgets and social interactions (allopreening and close proximity) in both groups and used social network analyses (Agn software, version 2.1) to visualize the distribution of social behaviour. We used continuous focal animal sampling for a period of 15 days for each group, during December and January 2012-2013.

Results indicate that the activity budgets of both groups were more or less similar. They resemble to a great extent the activity budget of wild macaws during their midday rest. Allopreening did occur in both of our study groups, but occurred more frequently in the all-male group. Social network analyses show diversified social relationships in both groups. Allopreening was more directed to the closest social partner – same sex partners in the all-male group and opposite sex partners in the mixed-sex group. The allopreening interactions were even stronger between the male pairs of the Planckendael group than between the mixed-sex pairs of the Antwerp Zoo group. The males of the Antwerp Zoo group did not show allopreening behaviour. Proximity networks show the same result, but (to a lesser extent) the macaws also spend time in proximity with other group members, outside their bond. We can conclude that strong social interactions can also occur outside the pair bond, between same sex flock members. We suggest preliminarily that allopreening is more important for the establishment and maintenance of a bond, whereas being in close proximity would be more important for cohesion of the flock. In future research we will look more into the social behaviour during longer observation periods that also overlap with the breeding period.

Shall we groom? Preliminary study on the gestural communication between grooming partners in captive bonobos.

Evelien De Groot¹; Elke van Gils²; Jeroen MG Stevens^{1,3}

¹Royal Zoological Society of Antwerp, ²Utrecht University, ³Antwerp University

Evelien.De.Groot@kmda.org

Grooming is an important feature of the behavioural repertoire in primates. It has an hygienic function, but it is also a social glue that connects the members of a group. Much research has focused on the ultimate and proximate functions of grooming, but little is known about the gestural communication between the partners of a grooming dyad. How do grooming partners indicate to each other who is going to be the groomee or the groomer? How do they communicate this while changing parts in a grooming session? Do they also indicate where to groom or to be groomed? Research on gestural communication in primates can give us information on mental state attribution and to a further extent on the evolution of language in humans. In this preliminary study we looked at the gestural communication between captive bonobos (*Pan paniscus*) of Planckendael Wild Animal Park (Belgium). We filmed every grooming session between the seven adults for 10 days. We scored the identity of the subject that started the grooming session, the receiver, the gestures used to initiate a session and the response of the receiver to the gestures. In addition, we scored the body part being groomed or presented to the groomer. All footage was analyzed afterwards using the Observer (Noldus – XT 10.5) software. Results pointed out that “groom present” (presenting a body part to the groomer) was the most frequently used gesture to start a grooming session and to change parts in a session. Other gestures (putting hand on the groomer/groomee, touching the groomer/groomee, embracing the groomer/groomee) were less used. Also, the “direct scratch”, seen in wild chimpanzees (the groomee scratches a body part that he/she wants to see groomed by the groomer), did only occur to a very limited extent. In most cases, “groom present” was accepted by the groomer. The groomer groomed the body part presented by the groomee. Because of the limited sample size and observation period, our results are preliminary. Further research is needed to look more into the gestural communication.

Factors affecting territorial aggression in a captive cichlid, *Tropheus duboisi*

Emma Furstenheim¹ and Sue Dow²

¹ University of the West of England, ² Bristol Zoo Gardens

sdow@bristolzoo.org.uk

Territorial aggression can become a problem in captive conditions as there is limited space and no escape from aggressors, which can lead to serious welfare issues. The aim of this study was to determine which factors affect territoriality and aggression in the popular aquarium fish species *Tropheus duboisi*, the yellow banded cichlid.

T. duboisi, a territorial cichlid from Lake Tanganyika, was studied over a six week period at Bristol Zoo Gardens using scan sampling and all occurrence data capture techniques. Each week an element of the environment was changed, for example density, species and habitat. The two main focal animals were the two largest fish. Behaviour recording sessions were carried out twice each week and *ad hoc* observations were made on other days.

The number of attacks per week was significantly lowered ($\chi^2= 13.2$, d.f.=1, $p < 0.05$) when the two focal animals were housed with *Neolamprologus brichardi* as opposed to others of their own species suggesting that their aggression is more focused toward intra-specific intruders. This could be because they do not share the same diet. No significant difference was found ($\chi^2=0.08$, d.f.=1, $p > 0.05$) between the number of attacks performed in a complex compared with a bare habitat, possibly meaning that the habitats constructed were not different enough as the number of attacks in the complex environment were only slightly lower. The largest fish (Fish 1) held the largest territory which comprised the whole tank, performing regular patrols through it and attacking other individuals. Spread of Partition Index (SPI) for the attack area of Fish 1 was 0.49, showing that it attacks across many areas in the tank while Fish 2 attacks across fewer areas at 0.62. The smallest fish in the tank (Fish 5) was attacked the most frequently (35.6% of the time by Fish 1) possibly indicating that due to its small size the adults were not afraid of engaging with it. The effects of density were difficult to determine due to the limited sample size though fewer attacks did occur during the week with a lower density. Fish models and a mirror were presented and the number of attacks recorded although time constraints limited the testing to the largest (Fish 1). The fish attacked the mirror almost twice as many times as any other stimuli. The large adult model was attacked three times more than the small adult model.

Tropheus duboisi has shown that it is less aggressive to interspecific animals that do not share the same dietary needs so can be housed with other fish species. Further research is still required to accurately determine the effects of habitat and density on the territorial behaviour of this species. Experiments that determine which features of an intruder provoke the most aggressive reaction would also be useful as the results from this study are conflicting.

Play in mature bonobos: differences between the sexes and differences between zoos

Cosette Gils^{1,2}, Jeroen M.G. Stevens^{1,2}, Evelien de Groot² and Nicky Staes^{1,2}

¹Royal Zoological Society of Antwerp, ²University of Antwerp

Jeroen.stevens@kmda.org

Recent studies in play behaviour have found that female bonobos are more playful than males, and this has been linked to various aspects of bonobo society, including their egalitarian and female bonded society. Here we investigate play behaviour in a large sample of zoo housed bonobos, housed at 6 different European zoos, totalling 15 males and 27 females older than 6 years. We discriminate between 1) play including juveniles and 2) play including only mature individuals. Following Play behaviour was recorded by focal animal sampling (mean/animal =16.25 h) as well as 15 min group scan sampling.

When considering only play with mature partners or individual play, we did not find a significant difference between time spent playing between male and female bonobos in those two play contexts. Surprisingly we found that male bonobos spent significantly more time playing with infants, compared to female-infant play. Interestingly we found an effect of group on the amount of social play between adults, but no group effects on play including infants or on individual play. These results suggest that female bonobos do not play more than male bonobos, but that levels of playfulness can differ between groups and that care should be undertaken to generalise about the playful nature of bonobo society.

Differences in behaviour and enclosure use between pinioned and non-pinioned Greater Flamingos (*Phoenicopterus roseus*) in the non-breeding season at Bristol Zoo Gardens

Robert Harrison¹ and Sue Dow²

¹ University of the West of England, ² Bristol Zoo Gardens

sdow@bristolzoo.org.uk

Flamingos are a very charismatic species and are kept in over half of the world's zoos. Problems can arise with keeping large flying birds in an open enclosure and a flight control method may be used. The permanent method of flight control is pinioning, amputation of the wing tip. This renders the bird confined to captivity for the rest of its life as it cannot be released into the wild. This method may affect behaviours such as copulation in flamingos. This study looks at whether there are any other effects on behaviours in pinioned compared with non-pinioned, fully flighted, flamingos in an enclosure that is covered by netting.

The behaviours of greater flamingos (*Phoenicopterus roseus*) were observed over a two month period in the autumn at Bristol Zoo Gardens, UK. Scan samples were used to collect data twice per week for the activity budget and enclosure usage from the whole flock of 43 birds. Scans were made at 10 minute intervals for 1 hour sessions conducted at different times of day. In addition the behaviours of six pinioned and six non-pinioned flamingos were recorded using an all occurrence frequency count. Each group of six consisted of three males and three females.

No significant differences were found between the frequency of various behaviours between the pinioned and non-pinioned individuals. From the overall activity budget for the flock the results suggest that the flamingos prefer to spend a majority of their time performing wing related activities, mainly wing preening (35% of the time). The location of the flamingos was recorded according to the type of substrate in various parts of the enclosure. The flamingos spent 73% of their time around an area of soft sediment sand bank in the enclosure although this area represented only 15% on the enclosure. A modified Spread of Participation Index showed that the flamingos preferred some areas over others. (SPI = 0.65).

More research is needed to compare pinioned and non-pinioned birds during courtship and breeding to see if those behaviours are affected and whether enclosure use changes with season.

An Investigation into white rhino (*Ceratotherium simum*) preference of home-range in the Welgevonden Private Game Reserve, South Africa

Richard Heaton

Nottingham Trent University

Richard.Heaton2012@my.ntu.ac.uk

The Welgevonden Private Game reserve in the Waterburg biosphere, South Africa, has a population of 31 female and 29 male white rhino (*Ceratotherium simum*) ranging through all ages. White rhino are the only rhinoceros species listed as CITES Appendix II in the world since Zimbabwe (1995) and South Africa (2005) changed their white rhino status from Appendix I. This study was done to determine the white rhino's preference for home-range with size, terrain, habitat, grass species and gender as variables. White rhino have been extensively poached for their horn and now with populations increasing, knowledge of home-range to increase carrying capacity is crucial. Six 10km transect lines were used to acquire rhino sightings over a 6 week period between 21st June and 5th August 2012. During winter months (wet season) grass data were collected by reserve volunteers using 5m² quadrats within 100m² bird point count.

Results showed that rhino had preference to Old land and Plateau terrains with 213 and 103 sightings respectively. Rhinos preferred habitat was grasslands with 261 sightings which were over 50% of sightings for each gender. Chi-squared test showed grass species had no dependence on terrain which concludes rhino don't have a preference towards a particular grass species. Average home-range size showed larger home-range for females than males but gender did not show to be dependent for home-range size statistically. Gender was not significantly dependent on terrain and habitat. Dominant males had clearly separated territories while subordinate males and females would cross over each other's and dominant males home-ranges. Due to high precipitation the reserve has many water sources, this has led to dominant males not having water sources in their home-range, contrary to past authors observations. These results coincided with previous studies on the same topic so can be seen as relevant and reliable.

**Investigating pair bonding behaviour in a flock of captive
citron-crested cockatoos (*Cacatua sulphurea citrinocristata*)**

Isobel Johnson^{1,2}, Holly Farmer² and Kirsten Pullen^{2,3}

¹University of the West of England, ²Whitley Wildlife Conservation Trust (Paignton Zoo Environmental Park), ³BIAZA
holly.farmer@paigntonzoo.org.uk

In the wild, citron-crested cockatoos form monogamous pairs; however in captivity, birds are paired based on genetic appropriateness, coordinated by an EEP studbook. Intra-pair aggression, sometimes fatal, has previously been observed in captive pairs, which is suggested to be due to the lack of mate choice provided. At the request of the EEP coordinator, Paignton Zoo established a flock of five (2.3) genetically viable birds, with the aim of investigating behaviour over time and to determine the natural formation of pair bonds by providing the birds with a choice of partner. The flock were studied over four years, with behavioural data collected in three seasons. Instantaneous focal sampling of affiliative and agonistic interactions were conducted on each individual, in each season and the behaviours performed by both individuals and dyads were analysed. Results showed that two male-female pairs were possibly forming within the flock. Both breeding season and year (i.e. age and length of time spent together) appeared to have an effect on affiliative and agonistic interactions, although changes in group composition in 2013 may also have had an impact on behaviour. In response to EEP recommendations, the flock is to be separated but it is hoped that the study can restart with a new flock of juvenile cockatoos in the future.

Predator and prey relationship: a case study on the behavioural and physiological responses of housing prey next to its potential predator

Katja Kaikko, Susan L. Walker, Sonya P. Hill and Suzanne Turnock

Chester Zoo

k.kaikko@chesterzoo.org

It is important that zoos try to assess the impact of husbandry and housing on animal welfare, and improve where necessary. This study investigated the impact of moving a pair of Southern pudus (*Pudu puda*), from off-show enclosure, to a new on-show mixed-species exhibit situated next-door to jaguars (*Panthera onca*). The aim of the study was to provide physiological and behavioural evidence to support the management decision to move the pudus; however, if the results showed a negative impact then steps would be taken accordingly to address any welfare concerns.

The study consisted of six phases, each lasting for approximately two weeks. These became definable as follows: 1) baseline (pudus housed in off-show, single-species enclosure), 2) pudus moved to the on-show mixed species exhibit (housed with Azara's agoutis, *Dasyprocta azarae*), 3) pudus' first encounter with jaguars in adjacent enclosure, 4) no jaguars present in adjacent enclosure, 5) still no jaguars in adjacent enclosure and the pudus now housed without agoutis, and 6) pudus' second encounter with jaguars in adjacent enclosure. To monitor the potential impacts, physiological (adrenal faecal hormones) and behavioural measures (focusing on time budget and enclosure use) of the pudus were compared between and within the six phases. Behaviours and location in the enclosure were recorded using video cameras. The footage was then analysed using instantaneous, scan sampling at 2 minute intervals ($n \approx 135$ scans/day; $n \approx 378$ hours in total) to determine time budget and enclosure use for each individual. A spread of participation index was utilised to assess enclosure use for the six phases. Additionally, in phases 3 and 6 (jaguars present), we compared the pudus' use of enclosure based on resources and distance to the jaguar fence line when the jaguars were out of sight, with when they were visible to the pudus. Enzyme immunoassay was used to determine faecal glucocorticoid concentrations (GC) from pudus ($n=244$ samples). General Linear Mixed Models (GLMMs) were used to determine factors that may predict adrenal activity for each pudu. The model included the dependant variable GCs, the random factor of collection date and fixed factor of study phase and the presence or absence of jaguars. GLMMs were also used to determine differences for each individual's time budget across the six phases. The model included the dependant variable of behaviour, the random factor of observation date and fixed factor of study phase and the presence or absence of jaguars. Only one similar study has been done before, which looked at the effect of visual predator cues to prey behaviour. However, we were primarily interested in the welfare of the pudus and, as far as we know, there are currently no published studies done on physiological response in this type of situation. Thus, we hope to provide evidence that there is no prolonged negative behavioural or physiological response of housing pudus next to jaguars. Additionally, the results generated from this study will increase the body of scientific knowledge of housing prey next to their potential predator.

A comparison of social and reproductive behaviour in a captive group of Southern white rhinos (*Ceratotherium simum simum*) before and after the departure of a juvenile male at Colchester Zoo

Jade Lloyd
Writtle College
Jade_lloyd@hotmail.co.uk

Southern white rhinos are known to be poor breeders in captivity due to lack of behavioural and physiological understanding concerning their reproductive competence. Therefore, insight into their social behaviour can lead to an understanding of their reproductive behaviour. This study was conducted on a group of 5 Southern white rhinos located at Colchester Zoo. The juvenile male rhino that was born at the zoo in 2009 was due to leave in the summer of 2012. In wild conditions, a mother rhino would come into oestrus just prior to or following the departure of her young which would lead to a series of interactions between her and a bull male once she has entered a territory. This being the case, the social and reproductive behaviour of the whole group of rhinos was observed to investigate whether this same scenario occurred in this captive group, which could determine further breeding in the future. It was believed that hostility between the mother of the calf and the mature male of the group would decrease after the departure of the juvenile male.

The social and reproductive interactions were measured by an ethogram filled out every 5 minutes over a 3 hour period and video camera to capture any interactions missed by the ethogram. There was a significant difference between the social and reproductive behaviour of the mother with her companion female and the mature male before and after the juvenile's departure from the group ($z=3.50$, $p<0.04$). There was also a significant difference between the social and reproductive interactions between all 3 females before and after the juvenile male left ($z=0.35$, $p<0.04$). It was observed that the mother's reproductive behaviour increased slightly after the juvenile male left and her tolerance of the mature male increased. Her social bond with her companion female was seen to increase and her tolerance of the mature male increased since, less aggressive social interactions were recorded after the departure of the juvenile male. The mature male also started to build more of a territory once the juvenile had left. This study was significant in order to understand how captive rhinos react in a scenario, which in the wild, would provide optimum conditions for breeding.

The efficiency of deterrents for blackbacked jackal, *Canis mesomelas*, both in and ex situ

Kate Lucas

Writtle College

Jonathan.Amory@writtle.ac.uk

Predators around the world co-exist with humans in an environment where their natural habitat is being reduced by processes such as agriculture. Where livestock animals are present in a predator's territory, they could be perceived as an easy prey item, and therefore depredation is a likely result. The conflict between predators and livestock is of concern to farmers, conservationists, and animal welfare groups alike. The aim of the study was to find devices which may be able to deter black-backed jackals (*Canis mesomelas*), which are responsible for depredations on farms across Southern Africa, and to test the effectiveness of these. The present study firstly used camera traps, in a zoo in the UK, to investigate the effects of lights, a radio, and ultrasound and water spray devices on the latency of approach to a baited site, as well as the duration of time spent in the approach area and number of visits. The ultrasound and spray devices resulted in a decrease in time spent in the area, although this was not statistically significant. The lights and radio did not show any differences compared to the control condition. The second half of the study took the spray and ultrasound devices, and in addition, a barking device, to farmland in South Africa where the same variables were recorded. The result was complete avoidance of the area in three ultrasound conditions and one spray condition, i.e. there were no visits or approaches in the experimental conditions, despite consistent visits during the control. The barking condition did not show any avoidance behaviours compared to the control condition. This seemed to show that ultrasound and spray devices may be of some interest when considering ways to deter black-backed jackal from an area. More research is needed to confirm findings and to test the long-term and practical implications of such equipment in the field.

Hornbills perching high – enclosure use in captive individuals

Sophie Neller and Alison Fletcher

University of Chester

a.fletcher@chester.ac.uk

Hornbills are notoriously difficult to breed in captivity, possibly due to their naturally complex reproductive behaviour. There are numerous theories as to the cause of captive breeding failures, however it is likely that the captive environment plays some part, either through artificial pairings or enclosure design. The aim of this study was to investigate enclosure usage in 10 hornbill pairs, plus a solitary male, of five different species housed at Chester Zoo, in order to note any differences in enclosure usage and general behaviour between species, sexes and individuals of wild versus captive origin. Results indicate that all 11 birds had a perch of preference, which, for the majority was the highest perch available, enabling vigilance behaviour towards the visitor viewing area. These perches were also situated furthest from the viewing areas. There were no statistically significant behavioural differences in males versus females or wild-reared versus captive-reared individuals, although wild-reared individuals appeared to prefer natural foliage and clearly displayed visitor-avoidance behaviours. Research is needed on a larger number of captive pairs but it is suggested, in the meantime, that captive birds are provided with tall enclosures, high perches and plenty of cover to provide privacy from visitors, particularly in the case of wild-reared individuals.

Measuring faecal glucocorticoid metabolite levels in a variety of species to assess possible stress caused by late opening hours at ZSL-London

An Pas and Amanda Ferguson

ZSL London Zoo

amanda.ferguson@zsl.org

At London Zoo in 2011 a series of summer late night openings was initiated, called 'Zoo Lates'. For these events the animal exhibits remained open until 9pm (beyond the usual closing time of 6pm) every Friday for nine weeks. To assess if this increased exposure to the public causes increased stress and has an impact on animal welfare, faecal samples were collected from several species during the summer of 2011 and 2012. Species targeted included okapi (*Okapia johnstoni*), red-faced spider monkey (*Ateles paniscus*), western lowland gorilla (*Gorilla gorilla gorilla*), Sumatran tiger (*Panthera tigris sumatrae*), white-naped mangabey (*Cercocebus atys lunulatus*), pygmy hippo (*Hexaprotodon liberiensis*), southern tamandua (*Tamandua tetradactyla*) and black vulture (*Coragyps atratus*). Samples were collected daily and collection was started 10 days before 'Zoo Lates' began and 10-14 days after the event. Behavioral data were collected on 'Zoo Lates' evenings and control evenings throughout the run. Here we present the results of the faecal glucocorticoid metabolite (FGC) analysis for which a per species validated glucocorticoid enzyme immunoassay (EIA) technique was used (Watson *et al.*, 2013). We also discuss the complexity of analyzing these results when used to assess stress and welfare of the animals and the many confounding factors that have to be taken into account.

Watson R. , Munro C., Edwards K., Norton V., Brown J., and Walker S., 2013. Development of a versatile enzyme immunoassay for non-invasive assessment of glucocorticoid metabolites in a diversity of taxonomic species. *General and Comparative Endocrinology*, 186, pp. 16–24.

**The effects of pack size on the total aggressive time budgets of captive *Lycaon pictus*
(African hunting dog)**

Alyssa Ralph

The Grange School, Hartford

Alyssaralph94@gmail.com

Zoological Societies of the modern world have many aims, some of the most important being conservation and education. In order to do these, their exhibit animals must be kept at high standards of welfare, and encouraged to behave as naturally as possible. However, in the case of social mammals, such as African hunting dogs (*Lycaon pictus*), this may not occur for many reasons; possibly due to the social setting within the enclosure alongside other reasons. In the wild, the average pack size is approximately 15 individuals, but this number is often very difficult to replicate in captivity due to a lack of space or funding to provide a satisfactory level of welfare. There is also a clear cut hierarchy in the wild packs, which is much more liable to change with the presence of a keeper and the lack of a need to function smoothly as a group in order to obtain food and survive. Along with other variables, these contribute to the issues associated with inducing natural behaviours in captive *Lycaon pictus*.

This species has a negative reputation in the eyes of the general public, as they are seen as aggressive and vicious, and some experts believe that this reputation is part of the cause for poaching and little success with their conservation. This study looks at whether the size of a captive pack of *Lycaon pictus* has an effect on the percentage of aggressive behaviour displayed, known as the aggressive time budget. To do this, instantaneous scan sampling was used, in accordance with an ethogram derived from preliminary studies, to observe four packs of different sizes at different collections over the course of five days at each location. A mean aggressive time budget was calculated for each pack, and consequently run through the Kruskal-Wallis test with pairwise comparisons (complete with Bonferroni corrections). The data showed a significant correlation between increasing pack size and the mean aggressive time budget, showing that larger packs (of 5 or 6 individuals) show more aggressive behaviours than smaller packs (of 2 or 3 individuals). This information may be utilised to manipulate pack sizes in order to induce more desired behaviours, and perhaps help to improve the reputation of *Lycaon pictus* – which may aid conservation efforts in the long run.

Can dietary carotenoid supplementation improve colouration in Morelet's tree frogs?

Ruth E Shepherd^{1,2}, Andrea L Fidgett¹, Ben Baker¹

¹Chester Zoo, ² University of Glasgow

a.fidgett@chesterzoo.org

Amphibian species are declining at a rapid rate in the wild, with over a third threatened with extinction. Having reserve populations in captivity is crucial; however the nutritional needs of many species are unknown. Recent studies have highlighted the importance of carotenoids in amphibian diets. For example pure carotenoids added to the diet of tree frogs have been shown to influence mate choice, increase fecundity and survival in red-eyed tree frogs (*Agalychnis caldaria*) and improve colouration in black eyed tree frogs (*Agalychnis moreletti*). Many commercial dietary carotenoid supplements for animals are available e.g. to improve flesh colouration in salmon and feather colouration in canaries. However, few studies have tested their efficacy on colour change in amphibians.

This study investigates whether colour changes can be achieved in Morelet's tree frogs (*Agalychnis moreletti*) using keeper-friendly dietary carotenoid supplementation and if there is a difference in the mode of delivery (e.g. tree frogs fed on crickets dusted with a carotenoid supplement compared with crickets which are gut-loaded with the supplement). The critically endangered frogs used in the project are housed in the amphibian pods at Chester Zoo. The subjects were adult frogs with a known history of receiving dietary carotenoids. Whether frogs are able to utilize carotenoids because of previous exposure will be tested.

In the study *A.moreletti* were split into three groups; control, gut loading and dusting. Dusting and gut loading animals received carotenoid supplementation for two out of the three weekly feeds. Colouration was evaluated by measuring the proportion of red pixels (redness). This was done by taking weekly photographs of the hind leg region against a colour standard, which was analysed using imaging software. Snout to vent length and weight was also measured to monitor the effect of carotenoid supplementation on growth. Frogs in the study were fed the same prey item at the same frequency as *A.moreletti* not in the study and cleaning protocols were consistent with normal husbandry. The presentation will highlight findings so far.

This project will help demonstrate the effect of adding dietary carotenoids supplements to amphibian diets using keeper-friendly methods, which can be easily implemented in zoos. If a colour change is observed guidelines for keepers will be produced on how to feed carotenoid supplements to captive frogs, improving knowledge, husbandry and management of captive amphibians.

The effect of captivity on the vigilance of plains zebra (*Equus quagga*)

Megan Shersby

Aberystwyth University

mgshersby@hotmail.co.uk

Vigilance has been investigated in a variety of taxa, with the majority of studies focussing on the effect of group size upon vigilance or in specific locations. Wild plains zebras have higher levels of vigilance when approaching waterholes, and higher individual vigilance when in smaller herds and at night, regardless of other factors such as cover or season. In addition, wild zebras have been found to retain high levels of vigilance when translocated to a reserve free from large predators.

Wild zebras were found to spend a highly significantly ($P < 0.001$) greater amount of time vigilant than their captive conspecifics, whilst levels of vigilance varied between the captive locations. Two locations, Cotswold Wildlife Park and ZSL London Zoo were found to have significantly lower levels of vigilance. Factors affecting vigilance in captive zebras are suggested to be: presence of visitor attractions, proximity of visitors, multi-species exhibits and frequency of large noises (e.g. a nearby RAF base). Low levels of vigilance may be due to behavioural plasticity, social learning or adaption, which may affect reintroduction schemes for endangered species of zebras such as the Grévy's zebra.

Does the anticipation for food affect skin flushing in two species of captive vultures (*Cathartes aura* and *Necrosyrtes monachus*)?: a case study.

Katherine Smith

Writtle College

Jonathan.Amory@writtle.ac.uk

It has been shown that in captivity, vultures will skin flush quite regularly and in order to study this characteristic, captive vultures provide an opportunity to observe this trait in more detail under more controlled conditions. The explanation as to why skin flushing occurs in both wild and captive vultures is a very under researched topic and literature on this topic is sparse. The aim of this study is to provide fundamental research to help close the gap in knowledge, but also to determine whether two species of captive vultures, the hooded vulture (*Necrosyrtes monachus*) and the turkey vulture (*Cathartes aura*) can be influenced to exhibit skin flushing.

Using behavioural management these two species of vultures were conditioned to two different stimuli; one pink cup containing hidden food (FT) and a blue cup containing no food as the control (CT). Duration of skin flushing and mean flushing scores based on the level of intensity (0-4) were recorded to determine whether skin flushing occurred as a result of anticipating the hidden food and a two-way ANOVA was used to analyse duration and mean scores between treatments and species. Duration of skin flushing was significantly higher in the FT compared to CT (79.8 vs. 44.9 ± 0.26 , $P < 0.05$, FT vs. CT, respectively – means \pm SED) with a higher duration in the hooded vulture compared to the turkey vulture (49.6 vs. 75.0 ± 0.26 , $P < 0.05$, hooded vs. turkey, respectively – means \pm SED). Mean scores between treatments were not shown to be significant (2.88 vs. 2.62 ± 0.22 , $P = 0.230$, FT vs. CT \pm SED, respectively – means \pm SED) but was significant between species (2.755 vs. 2.750 ± 0.31 , $P = 0.230$, species vs. treatment, respectively – means \pm SED). The results concluded that anticipation for food does influence the duration of skin flushing with a significant difference between vulture species, however it does not significantly influence the level of intensity of skin flushing, in which there is scope for more detailed research to be undertaken regarding this topic.