Elephant Welfare and Tourism References (By date; most recent first)
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Schiffmann, C., L. Hellriegel, M. Clauss, S. Brother, K. Knibbs, C. Wenker, T. Hård and C. Galeffi (2023). "From left to right all through the night: Characteristics of lying rest in zoo elephants." Zoo Biol **42**(1): 17-25.

Despite increased research during the past years, many characteristics of resting behavior in elephants are still unknown. For example, there is only limited data suggesting elephants express longer lying bouts and increased total nightly lying durations on soft substrates as compared to hard surfaces. Additionally, it has not been investigated how frequently elephants change body sides between lying bouts. Here we present these characteristics based on observations of nighttime lying behavior in 10 zoo elephants (5 African Loxodonta africana and 5 Asian Elephas maximus elephants) living in five different European facilities. We found that elephants housed on soft substrates have significantly increased total lying durations per night and longer average lying bouts. Furthermore, at 70%-85% of all bouts, a consistently higher frequency of side change between lying bouts occurred on soft substrates, leading to an overall equal laterality in resting behavior. Deviations from this pattern became evident in elephants living on nonsand flooring or/and in nondominant individuals of nonfamily groups, respectively. Based on our findings, we consider elephants to normally have several lying bouts per night with frequent side changes, given an appropriate substrate and healthy social environment. We encourage elephant-keeping facilities to monitor these characteristics in their elephants' nighttime behavior to determine opportunities for further improvements and detect alterations putatively indicating social or health problems in individual elephants at an early stage.

Scherer, L., L. Bingaman Lackey, M. Clauss, K. Gries, D. Hagan, A. Lawrenz, D. W. H. Müller, M. Roller, C. Schiffmann and A. K. Oerke (2023). "The historical development of zoo elephant survivorship." Zoo Biol **42**(2): 328-338.

In the discussion about zoo elephant husbandry, the report of Clubb et al. (2008, Science 322: 1649) that zoo elephants had a "compromised survivorship" compared to certain non-zoo populations is a grave argument, and was possibly one of the triggers of a large variety of investigations into zoo elephant welfare, and changes in zoo elephant management. A side observation of that report was that whereas survivorship in African elephants (Loxodonta africana) improved since 1960, this was not the case in Asian elephants (Elephas maximus). We used historical data (based on the Species360 database) to revisit this aspect, including recent developments since 2008. Assessing the North American and European populations from 1910 until today, there were significant improvements of adult (≥10 years) survivorship in both species. For the period from 1960 until today, survivorship improvement was significant for African elephants and close to a significant improvement in Asian elephants; Asian elephants generally had a

higher survivorship than Africans. Juvenile (<10 years) survivorship did not change significantly since 1960 and was higher in African elephants, most likely due to the effect of elephant herpes virus on Asian elephants. Current zoo elephant survivorship is higher than some, and lower than some other non-zoo populations. We discuss that in our view, the shape of the survivorship curve, and its change over time, are more relevant than comparisons with specific populations. Zoo elephant survivorship should be monitored continuously, and the expectation of a continuous trend towards improvement should be met.

Harrington, L. A., A. Elwin and N. D'Cruze (2023). "Elephant 'selfies': Evaluating the effectiveness of Instagram's warning of the potential negative impacts of photo opportunities with wild animals." PLoS ONE **18**(4): e0283858.

Wildlife tourist attractions offering opportunities to observe, touch, and interact with wild animals, are visited by millions of people every year. Wildlife tourism has considerable economic value in many countries and can have positive impacts on wild animal populations (e.g. through habitat protection); it can also have negative impacts on population conservation and individual welfare (due to, e.g. habitat encroachment, disturbance, or disease). The recent phenomenon of 'wildlife selfies' shared on social media may seem harmless but can involve animals illegally or unsustainably captured from the wild, kept in poor conditions, or subject to cruel treatment. To address this issue, Instagram introduced a pop-up alert system that is triggered when users search for wild animal selfie hashtags (e.g. #elephantselfie), warning of the potential negative impacts of wildlife selfies on wild animals. Using elephant selfies as a case study, we found that Instagram's alert was triggered by only 2% of 244 elephant selfie-related hashtags tested. By comparing three pairs of similar hashtags (one of each pair that triggered the warning and one that did not), we were unable to detect a consistent difference in the type of post using each of the hashtags, the popularity of posts, or the sentiment of viewer comments. The warning is not shown when posting an image, or if a post is viewed directly by a follower, only if the post is encountered via a hashtag search. Currently, what is portrayed on social media appears to be inconsistent with apparent recent shifts in social acceptibilty regarding tourism, particularly as concerns direct contact between tourists and elephants. Instagram's wildlife selfie initiative was commendable but given its apparent lack of effect, we urge Instagram and other social platforms to do more to prevent harmful content from being posted on their platforms and to promote fair, ethical and sustainable interactions between wild animals and people.

Williams, E., N. Clark, J. Rendle-Worthington and L. Yon (2022). "Behaviour and Welfare Impacts of Releasing Elephants from Overnight Tethers: A Zimbabwean Case Study." Animals (Basel) **12**(15).

Within the southern African elephant tourism industry, chaining or tethering elephants is still a relatively routine practice, despite the known negative impacts. Cited reasons for chaining include fear of aggressive interactions between elephants when handlers are absent, or a general increase in

expression of aggressive behaviours (both to other elephants and to their human handlers). In Zimbabwe, concerns expressed include the danger of elephants escaping and entering human-inhabited areas. Four male semi-captive elephants at a Zimbabwe tourist facility were taken off overnight (~12 h) tethers and were placed in small pens ('bomas'), approximate sizes from 110 m(2) to 310 m(2)), as part of a strategy to improve elephant welfare. Behavioural data were collected from overnight videos from December 2019 to March 2020, between 18:00 to 06:00, using focal, instantaneous sampling (5-min interval). Data were collected for three nights at three time periods: (i) Tethered; (ii) approximately four weeks post-release; (iii) approximately eight weeks post-release. Behavioural change over these time points was analysed using general linear models with quasibinomial error structures. Behavioural changes indicative of improved welfare were observed following these management changes, and no significant increases in aggression were observed either between elephants, or towards their human handlers. Proportion of time engaging in lying rest was higher in the first month after release from tethering (mean ± SD, 50 ± 14%) than when elephants were tethered (20 ± 18%) (p < 0.05). Additionally, although not statistically significant, stereotypies were reduced when elephants were no longer tethered (4 ± 6% observations tethered compared to 2 ± 2% off tethers), and positive social behaviour also increased (1 ± 1% on tethers, 2 ± 2% off tethers), with the greatest improvements seen in the pair-housed elephants. To improve elephant welfare in southern African tourism facilities we strongly advocate that less restrictive management practices which enable greater choice and freedom of movement overnight are implemented.

Taylor, N. (2022). "Should we be keeping elephants in captivity?" Vet Rec **191**(3): 129.

Tangyuenyong, S., P. Kongdang, N. Sirikaew and S. Ongchai (2022). "First study on the effect of transforming growth factor beta 1 and insulin-like growth factor 1 on the chondrogenesis of elephant articular chondrocytes in a scaffold-based 3D culture model." Vet World **15**(7): 1869-1879.

BACKGROUND AND AIM: Osteoarthritis (OA) is recognized as a degenerative joint disease that leads to chronic pain and low quality of life in animals. Captive elephants, the largest land mammals with a long lifespan, are more prone to develop OA due to restricted spaces and insufficient physical activity. This study aimed to investigate the effect of transforming growth factor-β1 (TGF-β1) and insulin-like growth factor 1 (IGF-1) on elephant chondrogenesis in a scaffold culture of articular chondrocytes. MATERIALS AND METHODS: Elephant chondrocytes-seeded gelatin scaffolds were cultured in chondrogenic media with or without 10 ng/mL of TGF-β1 or IGF-1 alone or 5-10 ng/mL of their combination for up to 21 days. The mRNA expression of cartilage-specific anabolic genes, ACAN and COL2A1, was analyzed using a real-time reverse transcription-polymerase chain reaction. The amounts of sulfated glycosaminoglycans (sGAGs) in conditioned media and contents in cultured scaffolds were determined through

dimethylmethylene blue assay. Cell morphology, accumulation of proteoglycans, and details of the cultured scaffolds were determined using hematoxylin-eosin staining, safranin O staining, and scanning electron microscopy (SEM), respectively. RESULTS: TGF-β1 alone significantly upregulated ACAN gene expression but not COL2A1, while IGF-1 alone did not enhance both ACAN and COL2A1 genes. The combination significantly upregulated both mRNA expression levels of ACAN and COL2A1 gene at day 14. The sGAGs accumulation and contents in the treatment groups, except IGF-1 tended to be higher than the controls, concomitantly with the production of the extracellular matrix, showed the formation of a cartilage-like tissue through histological and SEM analyses. CONCLUSION: Together, our results suggest that the single treatment of TGF-β1 has a selective effect on ACAN gene, while the combined growth factors seem to be an advantage on elephant chondrogenesis. This three-dimensional culture model is probably helpful for developing cartilage regeneration in vitro and is further applied in tissue engineering for OA treatment in vivo.

Szydlowski, M. (2022). "Elephants in Nepal: Correlating disease, tourism, and welfare." Journal of Applied Animal Welfare Science.

Asian elephants and humans have long shared their lives, but recent changes in human perspectives on animal use have created ripples through the small country of Nepal. Captive elephants are caught in the crossfire between local communities, elephant owners, mahouts, and NGOs in debates over their treatment, health, welfare and use in tourism. In addition, zoonotic disease, natural disasters and political strife affect the lives of captive elephants and mahouts. For example, during the COVID-19 pandemic, elephants, caregivers and owners found themselves facing income loss, decreased welfare from housing and husbandry issues, and food shortages. Many owners sold elephants, fired mahouts, and "quit" the tourism industry. Others sought help from outside organizations, community members, and governmental agencies to retain ownership of what they viewed as valuable commodities. NGOs and grassroots organizations assisted in the hopes of keeping elephants in Nepal, thus preventing them from long, treacherous walks across the border and into situations where they might face further welfare decreases. This article combines elephant stable visits and interviews with mahouts, owners, NGO, and government staff between January 2019 and December 2021. It highlights the ongoing health and welfare challenges faced by elephants and mahouts in Nepal.

Supanta, J., J. L. Brown, P. Bansiddhi, C. Thitaram, V. Punyapornwithaya and J. Khonmee (2022). "Effect of the COVID-19 pandemic and international travel ban on elephant tourist camp management in northern Thailand." Front Vet Sci **9**: 1038855.

The COVID-19 pandemic has had a significant impact on the tourism industry, especially in Thailand. Starting in April 2020, the Thai government banned international travel and all elephant tourist camps closed. A wide variety of management changes were implemented because of the lack of

income from tourists. This study surveyed 30 camps that cared for >400 elephants in northern Thailand to obtain information on camp, elephant, and mahout management during the COVID-19 pandemic from April 2020 to 2022 compared to the year before. The survey consisted of questionnaires that interviewed elephant camp owners, managers, veterinarians, and mahouts, and captured information on changes in camp operations, including numbers of tourists, elephants and mahouts, elephant and mahout activities, and veterinary care. Results revealed significant changes in camp structure, elephant work activities and general care. Staff layoffs led to a decrease in the ratio of mahouts to elephants from 1:1 to 1:2. Elephant activities, distance walked, and amounts of food were reduced when compared to pre-COVID-19, while chain hours were increased due to reduced activity. Overall, the COVID-19 crisis altered elephant management significantly, potentially affecting animal welfare resulting from changes in nutrition, health, exercise, and numbers of mahouts. We hope to use these data to develop better management plans and guidelines for elephant camps in Thailand so they can cope with the current and potential imminent pandemics that result in decreased tourism income. A follow-up study will measure health and welfare markers in relation to COVID-19 induced changes to determine if any camps adapted management to still meet elephant health and welfare needs, and could serve as models for responding to future pandemics.

Mills, G. (2022). "Should elephants be kept in zoos?" Vet Rec **190**(10): 396-397.
Georgina Mills reflects on a recent report from Born Free which calls for an end to keeping elephants in captivity.

Jacobs, B., H. Rally, C. Doyle, L. O'Brien, M. Tennison and L. Marino (2022). "Putative neural consequences of captivity for elephants and cetaceans." Rev Neurosci **33**(4): 439-465.
The present review assesses the potential neural impact of impoverished, captive environments on large-brained mammals, with a focus on elephants and cetaceans. These species share several characteristics, including being large, wide-ranging, long-lived, cognitively sophisticated, highly social, and large-brained mammals. Although the impact of the captive environment on physical and behavioral health has been well-documented, relatively little attention has been paid to the brain itself. Here, we explore the potential neural consequences of living in captive environments, with a focus on three levels: (1) The effects of environmental impoverishment/enrichment on the brain, emphasizing the negative neural consequences of the captive/impoverished environment; (2) the neural consequences of stress on the brain, with an emphasis on corticolimbic structures; and (3) the neural underpinnings of stereotypies, often observed in captive animals, underscoring dysregulation of the basal ganglia and associated circuitry. To this end, we provide a substantive hypothesis about the negative impact of captivity on the brains of large mammals (e.g., cetaceans and elephants) and how these neural consequences are related to documented evidence for compromised physical and psychological well-being.

Hayward, P. T., S. Liu, A. P. Thigpen and L. A. Hart (2022). "Animal Tourism: Thai Caregivers' Perspectives on Their Relationships with Elephants and Tigers." Animals (Basel) **12**(6).

This study explored the perspectives of elephant mahouts (n = 55) and tiger caregivers (n = 18) working in 4 private or 2 government facilities in Thailand to learn their experiences and viewpoints pertaining to use of animals in tourism. Interviews were conducted in Thailand at facilities in four cities. Mahouts working in private tourism facilities used one-to-one management and were significantly younger and more poorly compensated than those working at government-funded zoos, where some had shifted to group management. Tiger caregivers in tourism had direct contact with young tigers, with group management; these caregivers also were significantly younger than in government zoos, and with fewer benefits. Mahouts and tiger caregivers differed in how they viewed their relationships with their animals. Most mahouts considered their elephants as family members; a slight majority of these questioned the ethics of use of elephants in tourism. Tiger caregivers classified tigers as family or friend equally often; one-third of tiger caregivers declined answering on their approval of using tigers in tourism. What to do with aging tigers is a problem; this may explain some tiger caregivers' reticence to answer questions about using young tigers in tourism. While solving some problems, animal tourism creates several challenges.

Garai, M. E., T. Roos, T. Eggeling, A. Ganswindt, Y. Pretorius and M. Henley (2022). "Developing welfare parameters for African elephants (Loxodonta africana) in fenced reserves in South Africa." PLoS ONE **17**(3): e0264931.

South Africa has many fenced reserves harbouring small to medium sized populations of African elephant (Loxodonta africana), most of which have been translocated. Elephants on fenced reserves may be exposed to various management interventions and practices (translocation, hunting, darting, high tourism impact, contraception programs, disruption due to infrastructure maintenance, etc.). These factors may impact the welfare of elephants. Poor elephant welfare may have serious consequences such as increased inter- and intra-species aggression that could result in fatalities. This is the first study to attempt to define behavioural and physiological welfare parameters for free-ranging elephants on small to medium sized reserves. The eight study sites incorporated reserves with different social structure combinations, elephant life-histories, reserve sizes, habitat, management, and tourism intensity. Data collection consisted of behavioural observations (10-minute videos) as well as faecal samples. By incorporating both behavioural and physiological (faecal glucocorticoid metabolite (fGCM) concentration) parameters, we aimed to investigate whether the two parameters showed similar trends. Five behavioural categories were identified (Arousal, Assessing, Ambivalent, Ambivalent/ Body care, and Frustrated behaviour), with various detailed behaviours demonstrated by the elephants that may indicate the influence of anthropogenic disturbance and possibly impact on animal welfare. The study showed significant differences between the selected detailed behaviours, behavioural categories and fGCM

concentrations of elephants across the eight reserves. History seemed to be a decisive factor, as reserves with predominantly ex-captive elephants showed higher frequencies of certain behaviours as well as higher fGCM concentrations. Age, sex, reserve size and season were also found to contribute to our defined welfare indices and fGCM concentrations. This indicates that behavioural parameters, indicative of certain behavioural states, are valuable indicators of welfare, as supported by the physiological response of the elephants. The results also highlight the importance of taking multiple specified behaviours from a category into consideration when evaluating the welfare of elephants, to account for individual variation.

Weston, M. E., K. E. Mills and M. von Keyserlingk (2021). " Your happiness or mine: Influence of affective states and level of " Animal Welfae **30**: 279-293.

Many captive Asian elephants (Elephas maximus) in Thailand participate in the tourism industry at attractions known as 'elephant camps.' There has been significant criticism of low welfare venues, where the elephants may experience injuries, poor nutrition, unnatural social environments and aversive handling. Despite increasing concern for animal welfare, the general public often have diffi- culty identifying the welfare issues affecting captive animals. The aim of this study was to investigate participants' willingness to support an elephant attraction and their perceived emotional value from the experience, based on the affective state of the captive elephant and their level of contact with it. Participants (n = 590) from the United States were randomly assigned to one of four vignettes (using a 2 × 2 experimental design) that described an elephant attraction, varying the affective state of the elephant (feels excellent, feels terrible) and the level of contact they could have with the elephant (low, high). A mixed methods approach was used, where partici- pants provided answers to Likert-type questions, followed by an open-ended response. Participants showed greater willingness to support the elephant attraction and greater perceived emotional value from the experience when the elephant felt excellent, as opposed to when the elephant felt terrible. There were no significant differences between low and high contact for the measures included in this study. Qualitative responses varied greatly, with participants making many assumptions about the elephant and the attraction, revealing potential misconceptions that they had regarding the welfare of captive elephants. This research may be used to encourage a shift in tourism preferences to venues that reflect positive elephant welfare.

Lo, Y. C. and P. Janta (2021). "Balancing Commercialization and Sustainability in Community-Based Tourism Practices - A Qualitative Study of Factors Affecting Elephant Habitat Communities in Northern Thailand." Front Psychol **12**: 685426.

Community-Based Tourism (CBT) offers local residents opportunities to manage local tourism resources while sustaining their lifestyle at the same time. The research objective of the study was to explore the process and experience of communities in Northern Thailand which are known as elephant habitats, how these communities strive for stimulating the local economy without jeopardizing the way of life. The study was qualitative in nature.

Qualitative data collection methods such as field observations and in-depth interviews were employed. The qualitative data were further analyzed with thematic analysis. In practicing CBT, the findings identified positive factors (Establishment of Elephant Camps), negative factors (Waste from Tourism Activity and Effects of Global Crisis on Employment and Local Income), and suggestions (Waste and Environment Management). The study found that the communities took pride in their cultural as well as natural resources and they are willing to commercialize these resources to a certain degree, i.e. founding elephant themed facilities, as has evidently been indicated. Consequently, as many issues factor into the practice of CBT, the study concluded that community participation and government support should have played a crucial role in maintaining new balance of overall local lifestyle sustainability and commercialization during and after the pandemic.

Lasky, M., J. Campbell, J. A. Osborne, E. L. Ivory, J. Lasky and C. J. Kendall (2021). "Increasing browse and social complexity can improve zoo elephant welfare." Zoo Biol **40**(1): 9-19.

While recent work has assessed how environmental and managerial changes influence elephant welfare across multiple zoos, few studies have addressed the effects of management changes within a single institution. In this paper, we examine how management changes related to social structure and diet affect the behavior of a group of zoo elephants over a 23-month period while also considering underlying factors, such as time of day, hormonal cycle, and individual differences. We recorded individual behaviors using 2-min scan samples during 60-min sessions. We analyzed behavioral changes across several study variables using generalized linear mixed models. We found that increasing browse can improve opportunities for foraging throughout the day but may not be sufficient to reduce repetitive behaviors. We observed that increasing group size and integration of bulls with cows can lead to increased social interaction in African elephants. Our results highlight the importance of using multiple management alterations to address elephant welfare, and considering environmental factors, when making management decisions.

Kongsawasdi, S., J. L. Brown, K. Boonprasert, P. Pongsopawijit, K. Wantanajittikul, S. Khammesri, T. Tajarernmuang, N. Thonglorm, R. Kanta-In and C. Thitaram (2021). "Impact of weight carriage on joint kinematics in asian elephants used for riding." Animals **11**(8).

Background: Elephants in Thailand have changed their roles from working in the logging industry to tourism over the past two decades. In 2020, there were approximately 2700 captive elephants participating in activities such as riding and trekking. During work hours, riding elephants carry one or two people in a saddle on the back with a mahout on the neck several hours a day and over varying terrain. A concern is that this form of riding can cause serious injuries to the musculoskeletal system, although to date there have been no empirical studies to determine the influence of weight carriage on kinematics in elephants. Methods: Eight Asian elephants from a camp in Chiang Mai Province, Thailand, aged between 21 and 41 years with a mean body mass of 3265 ± 140.2 kg, were evaluated under two conditions:

walking at a normal speed without a saddle and with a 15% body mass load (saddle and two persons plus additional weights). Gait kinematics, including the maximal angles of fore-and hindlimb joints, were determined using a novel three-dimensional inertial measurement system with wireless sensors. Results: There were no statistical differences between movement angles and a range of motion of the fore-and hindlimbs, when an additional 15% of body mass was added. Conclusion: There is no evidence that carrying a 15% body mass load causes significant changes in elephant gait patterns. Thus, carrying two people in a saddle may have minimal effects on musculoskeletal function. More studies are needed to further test longer durations of riding on different types of terrain to develop appropriate working guidelines for captive elephants. Nevertheless, elephants appear capable of carrying significant amounts of weight on the back without showing signs of physical distress.

Jacobs, B., H. Rally, C. Doyle, L. O'Brien, M. Tennison and L. Marino (2021). "Putative neural consequences of captivity for elephants and cetaceans." Reviews in the Neurosciences.

The present review assesses the potential neural impact of impoverished, captive environments on large-brained mammals, with a focus on elephants and cetaceans. These species share several characteristics, including being large, wide-ranging, long-lived, cognitively sophisticated, highly social, and large-brained mammals. Although the impact of the captive environment on physical and behavioral health has been well-documented, relatively little attention has been paid to the brain itself. Here, we explore the potential neural consequences of living in captive environments, with a focus on three levels: (1) The effects of environmental impoverishment/enrichment on the brain, emphasizing the negative neural consequences of the captive/impoverished environment; (2) the neural consequences of stress on the brain, with an emphasis on corticolimbic structures; and (3) the neural underpinnings of stereotypies, often observed in captive animals, underscoring dysregulation of the basal ganglia and associated circuitry. To this end, we provide a substantive hypothesis about the negative impact of captivity on the brains of large mammals (e.g., cetaceans and elephants) and how these neural consequences are related to documented evidence for compromised physical and psychological well-being.

Glaeser, S. S., D. Shepherdson, K. Lewis, N. Prado, J. L. Brown, B. Lee and N. Wielebnowski (2021). "Supporting Zoo Asian Elephant (Elephas maximus) Welfare and Herd Dynamics with a More Complex and Expanded Habitat." Animals (Basel) **11**(9).

Ensuring good health and welfare is an increasingly important consideration for conservation of endangered species, whether free-ranging or managed to varying degrees under human care. The welfare-based design of a new habitat for Asian elephants at the Oregon Zoo focused on meeting the elephants' physical, physiological, psychological, and social needs 24 h a day and across life stages. The habitat was designed to encourage activity,

promote species-typical behaviors, support changing social dynamics, offer increased opportunities for choice, and provide biologically meaningful challenges. In this 4-year study, we monitored elephant health and welfare indicators throughout the transition and acclimation from the previous habitat to the new habitat. Several welfare indicators obtained through longitudinal hormone analyses, behavior assessments, and GPS measurement of walking distance and space use provided evidence that these goals were achieved. The elephants were more active and walked farther on a daily basis in the new habitat, with an average walking distance of over 15 km per day. A switch from primarily caretaker-delivered food to seeking food on their own indicates that the disbursement of food with less temporal and spatial predictability increased foraging opportunities, which better satisfies appetitive motivations important for psychological well-being. All individuals showed adaptive and normal adrenal responses to change and challenge, with the highest fecal glucocorticoid metabolite (FGM) concentrations and variability during the construction phase, and a return to previous baseline concentrations in the new habitat, suggesting they acclimated well to the new environment. The elephants expressed a diverse range of species-typical behaviors and demonstrated social dynamics of a healthy herd in both habitats with transitions of individuals through life stages. They exhibited more autonomy in choosing whom to associate with socially and also by choosing different aspects of their environment with regular indoor/outdoor access and extensive resource use in the new habitat. Findings indicate that the complexity and flexibility of the new habitat and habitat management has been effective in improving overall welfare by providing meaningful challenges and the opportunity to express appetitive behaviors, by offering choice in environmental conditions, and by providing the space and resource distribution to support evolving herd dynamics and increased social equity for individuals.

Fuktong, S., P. Yuttasaen, V. Punyapornwithaya, J. L. Brown, C. Thitaram, N. Luevitoonvechakij and P. Bansiddhi (2021). "A survey of stereotypic behaviors in tourist camp elephants in Chiang Mai, Thailand." Applied Animal Behaviour Science **243**: 5.

Stereotypies are abnormal behaviors found in a wide range of animals that have been used as indicators of poor welfare. Elephants used in tourism have been reported to perform stereotypic behavior, but the occurrence has not been systematically assessed. The aims of this study were to ascertain the percentage of stereotypic behaviors exhibited by tourist camp elephants and relationship with demographic variables. This study surveyed 283 elephants from 20 elephant camps in Chiang Mai, Thailand. Amounts and types of stereotypic behavior were determined from 15-min direct observations. Additionally, demographic data and occurrence of stereotypic behavior (yes/no) were obtained from mahouts of 181 elephants using a questionnaire. Direct behavioral observations revealed that 57% (N = 161: 44 males and 117 females) of the elephants performed stereotypic behavior, while in mahout interviews, 58% were scored 'yes'. There were no differences in the least-squares mean score of stereotypic behaviors between

males and females (p = 0.32), whereas there were differences among age groups (p < 0.05), with the highest in elephants 4-10 years of age, followed by 11-30 years of age, 31-50 years of age, > 50 years of age. Calves 0-3 years of age displayed the lowest rate of stereotypic behavior, when most were still with their mothers. The most common type of stereotypic behavior was swaying. Our results indicate that scores of stereotypic behaviors in elephants used in tourism differed among age categories. The next step will be to determine how management factors affect stereotypic behavior of elephants in this population and steps to mitigate it.

Freeman, P. T., E. L. Anderson, K. B. Allen and C. E. O'Connell-Rodwell (2021). "Age-based variation in calf independence, social behavior and play in a captive population of African elephant calves." Zoo Biol **40**(5): 376-385.

African elephant calves are highly social and their behavioral development depends heavily on interactions with other elephants. Evaluating early social behaviors offers important information that can inform management decisions and maximize individual- and population-level welfare. We use data collected from the population of elephants at the San Diego Zoo Safari Park in Escondido, CA to evaluate developmental trajectories of spatial independence and social behavior in nine elephant calves across a range of ages. As calves aged, the probability of being further from mothers also increased. Tactile interactions were common among calves, with all individuals either initiating or receiving physical touches from other elephants in a large proportion of focal scans. While the probability of initiating tactile interactions tended to decline with increases in calf age, the probability of receiving tactile interactions from other elephants remained invariant with regard to this variable. The social play was also common, occurring in a fifth of all focal scans. While there was evidence that social play tended to decline with increases in calf age, results suggest additional factors may be useful in characterizing patterns in play behavior at the individual level. Calves most frequently engaged in play with individuals of similar age but showed substantial variation in play partner choice. Results of this study suggest that maintaining groups of elephants in captivity with diverse age structure positively contribute to their healthy social development.

Flower, E. K., G. L. Burns and D. N. Jones (2021). "How Tourist Preference and Satisfaction Can Contribute to Improved Welfare Standards at Elephant Tourism Venues in Thailand." Animals (Basel) **11**(4).

Consumer satisfaction and preference can be integral in influencing and solidifying change in user-driven industries such as tourism. High satisfaction rates are imperative to the continual success of a venue as satisfaction determines the likelihood of repeat business and positive recommendations to friends, family and online review forums. Tourist preference for ecocentric tourism venues, over anthropocentric ones, appears to be increasing in elephant tourism venues (ETVs) in Thailand. To explore this, we visited twelve ETVs in Chiang Mai, Thailand, and compared the preferences and satisfaction of tourists who visited riding and non-riding venues toward the use of captive elephants in an entertainment setting. We found that tourists

visited riding and non-riding ETVs for similar reasons, primarily due to recommendations from friends and reviews, and because the venue had a good reputation. Tourist preference for higher welfare standards was observed at venues where participants directly observed poor treatment of the elephants. Tourist satisfaction may be impacted by higher elephant welfare standards; therefore, tourists have the ability to influence the elephant tourism industry by demanding better living conditions for elephants and only financially supporting ETVs with higher welfare standards.

Fernandez, E. J., B. Upchurch and N. C. Hawkes (2021). "Public Feeding Interactions as Enrichment for Three Zoo-Housed Elephants." Animals (Basel) **11**(6).

The past few decades have seen increased interest in studies examining the welfare of elephants and animal-visitor interactions. One understudied area for both pursuits is the impact of public feeding interactions. Our study examined the effects of public feedings on the general activity of three zoo-housed elephants. Prior to public feedings, we developed and assessed a 21-behavior ethogram split into six classes of behavior. Comparisons between the elephants demonstrated that only one of the elephants engaged in stereotypies with regularity (>30%), and that the stereotypies occurred in place of most foraging. During public feedings, we compared the general activity of each elephant independently and across both public feeding and nonpublic feeding days, as well as the general activity before, during, and after a public feeding. Public feedings increased social activity and decreased stereotypies when compared with nonpublic feeding days for two of the elephants. In addition, all three elephants showed increased foraging and decreased inactivity in the period after a public feeding session. These results demonstrate that public feedings can be a useful tool for enriching the welfare of zoo-housed elephants and are among the first sets of data to demonstrate positive welfare outcomes associated with public feedings.

Crawley, J. A. H., O. Liehrmann, D. J. Franco Dos Santos, J. Brown, U. K. Nyein, H. H. Aung, W. Htut, Z. M. Oo, M. W. Seltmann, J. L. Webb, M. Lahdenperä and V. Lummaa (2021). "Influence of handler relationships and experience on health parameters, glucocorticoid responses and behaviour of semi-captive Asian elephants." Conserv Physiol **9**(1): coaa116.

Declining wild populations combined with accumulating captive populations of e.g. livestock, pets, draught and zoo animals have resulted in some threatened species with substantial proportions of their populations in captivity. The interactions animals have with humans in captivity depend on handler familiarity and relationship quality and can affect animal health, growth and reproduction with consequences for the success of conservation programmes. However, assessments of how specific human-animal relationships affect a range of physiological and behavioural outcomes are rare. Here, we studied semi-captive Asian elephants with detailed records of elephant-handler (mahout) relationships and veterinary management, allowing assessment of multiple welfare indicators in relation to specific mahout-elephant relationship lengths and mahout experience. These

included measures of physiological stress (faecal glucocorticoid metabolite [FGM], heterophil:lymphocyte ratio [H:L]), muscle damage (creatine kinase [CK]), immunological health (total white blood cell count [TWBC]) and behaviour (response to mahout verbal commands). We found no evidence that FGM or H:L related to aspects of the mahout-elephant relationship. Longer overall mahout experience (i.e. years of being a mahout) was linked to increased muscle damage and inflammation, but the lengths of specific mahout-elephant relationships were inversely associated with muscle damage in working-age elephants. Elephants responded more to familiar mahouts in behavioural tasks and faster to mahouts they had known for longer. In summary, our results found little evidence that the mahout-elephant relationship affects physiological stress in this population based on FGM and H:L, but mahout experience and relationships were linked to other physiological responses (CK, TWBC), and elephants require behavioural adjustment periods following mahout changes.

Williams, E., S. Bremner-Harrison, C. Hall and A. Carter (2020). "Understanding Temporal Social Dynamics in Zoo Animal Management: An Elephant Case Study." Animals (Basel) **10**(5).

Zoo animal management procedures which lead to changes to social groups can cause disruption in social hierarchies and the temporary breakdown of social relationships. Animals have different roles in social networks. Understanding individual positions in social networks is important for effective management and ensuring positive welfare for all animals. Using elephants as a case study, the aim of this research was to investigate temporal social dynamics in zoo animals. Behavioural data were collected between January 2016 and February 2017 from 10 African and 22 Asian elephants housed at seven zoos and safari parks in the UK and Ireland. Social interactions were defined as positive physical, positive non-physical, negative physical or negative non-physical. Social network analysis explored social relationships including the fluidity of networks over time and dyadic reciprocity. Social interaction networks were found to be fluid but did not follow a seasonal pattern. Positive interaction networks tended to include the entire social group whereas negative interactions were restricted to specific individuals. Unbalanced ties were observed within dyads, suggesting potential inequalities in relationships. This could impact on individual experiences and welfare. This research highlights subtle temporal dynamics in zoo elephants with the potential for species-level differences. Similar temporal dynamics may also be present in other socially housed zoo species. This research thus provides evidence for the importance of understanding the social networks of zoo animals over longer periods of time. Understanding social networks enables pro-active and evidence-based management approaches. Further research should seek to identify the minimum sampling efforts for social networks in a range of species, to enable the implementation of regular monitoring of social networks and thus improve the welfare of social species under human care.

Webb, J. L., J. A. H. Crawley, M. W. Seltmann, O. Liehrmann, N. Hemmings, U. K.

Nyein, H. H. Aung, W. Htut, V. Lummaa and M. Lahdenperä (2020). "Evaluating the Reliability of Non-Specialist Observers in the Behavioural Assessment of Semi-Captive Asian Elephant Welfare." Animals (Basel) **10**(1).

Recognising stress is an important component in maintaining the welfare of captive animal populations, and behavioural observation provides a rapid and non-invasive method to do this. Despite substantial testing in zoo elephants, there has been relatively little interest in the application of behavioural assessments to the much larger working populations of Asian elephants across Southeast Asia, which are managed by workers possessing a broad range of behavioural knowledge. Here, we developed a new ethogram of potential stress- and work-related behaviour for a semi-captive population of Asian elephants. We then used this to collect observations from video footage of over 100 elephants and evaluated the reliability of behavioural welfare assessments carried out by non-specialist observers. From observations carried out by different raters with no prior experience of elephant research or management, we tested the reliability of observations between-observers, to assess the general inter-observer agreement, and within-observers, to assess the consistency in behaviour identification. The majority of ethogram behaviours were highly reliable both between- and within-observers, suggesting that overall, behaviour was highly objective and could represent easily recognisable markers for behavioural assessments. Finally, we analysed the repeatability of individual elephant behaviour across behavioural contexts, demonstrating the importance of incorporating a personality element in welfare assessments. Our findings highlight the potential of non-expert observers to contribute to the reliable monitoring of Asian elephant welfare across large captive working populations, which may help to both improve elephant wellbeing and safeguard human workers.

Szott, I. D., Y. Pretorius, A. Ganswindt and N. F. Koyama (2020). "Normalized difference vegetation index, temperature and age affect faecal thyroid hormone concentrations in free-ranging African elephants." Conserv Physiol **8**(1): coaa010.

Conservation biologists can use hormone measurements to assess animals' welfare, reproductive state, susceptibility to stressors, as well as energy expenditure. Quantifying hormone concentrations from faecal samples is particularly advantageous as samples can be collected without disturbing animals' behaviour. In order for an endocrine marker to be useful for wildlife managers, we need to understand how extrinsic and intrinsic factors affect hormone concentrations in free-ranging animal populations. Thyroid hormones are linked to basal metabolic rate and energy expenditure. Previous research demonstrated that triiodothyronine (T3) can be measured successfully in faecal matter of African elephants, Loxodonta africana. However, to our knowledge, research into factors affecting changes in elephant T3 levels has only been carried out in captive elephants so far. Thus, we present the first study of faecal T3 metabolite (mT3) concentrations of a large population of free-ranging African elephants. Over 15 months, we collected faecal samples from identified (n = 43 samples) and unidentified (n = 145 samples) individuals in Madikwe Game Reserve, South Africa. We investigated whether vegetative productivity [normalized difference

vegetation index (NDVI)] in interaction with mean monthly temperature, age and sex affected mT3 concentrations. We found a significant negative interaction effect of NDVI and temperature. Increasing NDVI was related to higher concentrations of mT3, but increasing temperature was related to a decrease in mT3 concentrations in individually identified and unidentified elephants. In unidentified individuals, juvenile elephants had significantly higher mT3 concentrations compared to adult elephants. Faecal T3 can successfully be quantified in samples from free-ranging elephant populations and thus provides insight into energy expenditure in large herbivores.

Suter, I. (2020). "Rewilding or reviewing:Conservation and the elephant-based tourism industry
Commentary on Baker & Winkler on Elephant Rewilding." Animal Sentience **304**: 1-4.

Baker & Winkler (2020) provide a detailed examination of elephants in captivity, from an historical perspective to modern-day concerns. Concerns include the poor level of mahout skills and subsequent captive elephant welfare issues in the Thai elephant tourism industry. Rewilding is proposed as a method of rehabilitation and a way to include mahouts in the conservation process. This commentary argues that the tourism industry is making positive changes and mahout skills can be utilised successfully without the arduous task of rewilding. Animal rights groups and the transfer of misinformation surrounding captive elephant welfare are also examined, as these typically fail to acknowledge the socio-economic and geopolitical complexities of elephant conservation in the least developed and developing nations.

Seltmann, M. W., S. Ukonaho, S. Reichert, D. Dos Santos, U. K. Nyein, W. Htut and V. Lummaa (2020). "Faecal Glucocorticoid Metabolites and H/L Ratio are Related Markers of Stress in Semi-Captive Asian Timber Elephants." Animals (Basel) **10**(1).

Animals are kept in captivity for various reasons, but species with a slower pace of life may adapt to captive environments less easily, leading to welfare concerns and the need to assess stress reliably in order to develop effective interventions. Our aim was to assess welfare of semi-captive timber elephants from Myanmar by investigating the relationship between two physiological markers of stress commonly used as proxies for welfare, faecal glucocorticoid metabolite concentrations (FGM) and heterophil/lymphocyte ratios (H/L), and link these measures to changes in body condition (determined by body weight). We further assessed how robustly these two markers of stress performed in animals of different age or sex, or in different ecological contexts. We measured FGM concentrations and H/L ratios between 2016 and 2018 from 316 samples of 75 females and 49 males ranging in age from 4 to 68. We found a positive and consistent link between FGMs and H/L ratios in Asian elephants, irrespective of their sex, age, or ecological context. Our results will help to inform managers of (semi-) captive elephants about using heterophil/lymphocyte ratio data from blood smears on site as a potentially cheaper and faster alternative to determining stress than measuring faecal glucocorticoid metabolite concentrations in the

laboratory.

Schiffmann, C., T. Hård, M. Hjelm and M. Clauss (2020). "Soft and persistent—The influence of sand-flooring and calves on the resting behavior of a zoo-kept African elephant (Loxodonta africana) group." Zoo Biology **39**(1): 56-62.

Caring for all aspects of zoo elephants' well-being is considered a major challenge. Providing an appropriate flooring substrate to facilitate lying rest presents a meaningful part of a holistic management concept. Investigating the impact of a new sand flooring on the nocturnal resting behavior of a breeding group of seven African elephants living at one zoo revealed more total lying rest, longer bouts of lying rest and a reduced side preference in the adult females. With an average total daily lying rest of about 1.5–2.0 hrs, the investigated zoo elephants expressed longer lying rest compared to recently reported data from free-ranging individuals in Botswana. In addition, the presence of nursing calves in the observed elephant group seemed to impact the resting pattern of all group members, with around 60% of all lying bouts being discontinued after interruption by the youngsters. With respect to observed nursing during leaning rest, we encourage the installation of appropriate horizontal structures in breeding facilities to support leaning rest behavior of their female elephants. In doing so, zoos may improve rest quality of nursing females, and, in general, the welfare aspect of sleep for their elephants. © 2019 Wiley Periodicals, Inc.

Plangsangmas, T., J. L. Brown, C. Thitaram, A. Silva-Fletcher, K. L. Edwards, V. Punyapornwithaya, P. Towiboon and C. Somgird (2020). "Circadian Rhythm of Salivary Immunoglobulin A and Associations with Cortisol as A Stress Biomarker in Captive Asian Elephants (Elephas maximus)." Animals (Basel) **10**(1).

Salivary immunoglobulin A (sIgA) has been proposed as a potential indicator of welfare for various species, including Asian elephants, and may be related to adrenal cortisol responses. This study aimed to distinguish circadian rhythm effects on sIgA in male and female Asian elephants and compare patterns to those of salivary cortisol, information that could potentially have welfare implications. Subjects were captive elephants at an elephant camp in Chiang Mai province, Thailand (n = 5 males, 5 females). Salivette(®) kits were used to collect saliva from each elephant every 4 h from 06:00 to 22:00 h for 3 consecutive days (n = 15 samples/elephant). Enzyme immunoassays were used to quantify concentrations of IgA and cortisol in unextracted saliva. Circadian rhythm patterns were determined using a generalized least-squares method. Both sIgA and cortisol followed a circadian rhythm, although the patterns differed. sIgA displayed a daily quartic trend, whereas cortisol concentrations demonstrated a decreasing linear trend in concentrations throughout the day. There was no clear relationship between patterns of sIgA and salivary cortisol, implying that mechanisms of control and secretion differ. Results demonstrate for the first time that circadian rhythms affect sIgA, and concentrations follow a daily quartic pattern in Asian elephants, so standardizing time of collection is necessary.

Lasky, M., J. Campbell, J. A. Osborne, E. L. Ivory, J. Lasky and C. J. Kendall (2020).

"Increasing browse and social complexity can improve zoo elephant welfare." Zoo Biology.

While recent work has assessed how environmental and managerial changes influence elephant welfare across multiple zoos, few studies have addressed the effects of management changes within a single institution. In this paper, we examine how management changes related to social structure and diet affect the behavior of a group of zoo elephants over a 23-month period while also considering underlying factors, such as time of day, hormonal cycle, and individual differences. We recorded individual behaviors using 2-min scan samples during 60-min sessions. We analyzed behavioral changes across several study variables using generalized linear mixed models. We found that increasing browse can improve opportunities for foraging throughout the day but may not be sufficient to reduce repetitive behaviors. We observed that increasing group size and integration of bulls with cows can lead to increased social interaction in African elephants. Our results highlight the importance of using multiple management alterations to address elephant welfare, and considering environmental factors, when making management decisions.

Kosaruk, W., J. L. Brown, T. Plangsangmas, P. Towiboon, V. Punyapornwithaya, A. Silva-Fletcher, C. Thitaram, J. Khonmee, K. L. Edwards and C. Somgird (2020). "Effect of Tourist Activities on Fecal and Salivary Glucocorticoids and Immunoglobulin A in Female Captive Asian Elephants in Thailand." Animals : an open access journal from MDPI **10**(10).

Asian elephants have been an important part of wildlife ecotourism in Thailand for over two decades. Elephants in tourist camps are exposed to a variety of management styles and daily activities that can potentially affect health and welfare. This study investigated relationships between a novel welfare biomarker, immunoglobulin A (IgA), and daily camp activities, and compared results to glucocorticoid (GC) measures. Often no-riding camps are portrayed as providing better welfare than camps that offer riding. Therefore, we predicted that elephants at no-riding camps would have lower GC and higher IgA concentrations, and a low GC/IgA ratio. Forty-four female elephants from six elephant camps were divided into three groups based on riding activities: saddle-riding, bareback-riding, and no-riding. Fecal and salivary samples were collected monthly for 1 year along with evaluations of body condition, foot health, and wounding. Camp environment and management varied among camps, although the major difference was in riding activities. Concentrations of GCs and IgA varied among the working groups, but not always consistently between sample matrices. Overall fecal glucocorticoid metabolite concentrations were lowest in the saddle-riding group. Only in one bareback-riding camp did the elephants exhibit a potentially positive welfare response with a low GC/IgA ratio over time. Other results varied between the two biomarkers, with considerable variability across camps, suggesting there is more to good welfare than whether elephants participate in riding or not. Several other human-induced stressors, like chaining, ankus use, and limited social opportunities are likely to be impacting well-being and should be considered to ensure management practices meet physical and psychological welfare needs.

Grotto, C. E., T. Wolf, E. Berkeley, S. Lee and A. Ganswindt (2020). "Physiological measure of animal welfare in relation to semi-captive African Elephant (Loxodonta africana) interaction programs." African Zoology **55**(3): 245-249.

Elephant interaction programs, specifically ones that provide elephant back riding, have come under public scrutiny, and little information exists to show whether these activities affect animal welfare. This study examined the impact of human interactions and ride-based activities on physiological stress-related indicators in African elephants. Fifteen trained semi-captive elephants, as well as free-ranging elephants roaming under the same ecological conditions, were monitored. Faecal samples were collected over a nine-month period from both groups and these were analysed using an enzyme immunoassay detecting faecal glucocorticoid metabolites (fGCMs) with a 5 beta-alpha-ol-11-one structure. Elephants that participated in elephant-back-safari (EBS) activities showed significant decreases in fGCM concentrations when EBS were discontinued. Similarly, fGCM concentrations of the trained semi-captive individuals that did not participate in EBS showed decreased steroid concentrations over the same time. Overall, fGCM concentrations of the trained semi-captive herd and the free-ranging herd did not differ significantly. The collected data will help to better understand the physiological and behavioural requirements of semi-captive elephants with frequent exposure to humans. The findings will also help to optimise management strategies for wild elephant populations and elephants living in controlled environments on reserves exposed to wildlife tourism.

Greene, W. and D. Brenner (2020). "SURVEY OF GERIATRIC ELEPHANT MEDICAL CARE, NUTRITION, HUSBANDRY, AND WELFARE." Journal of Zoo and Wildlife Medicine **51**(3): 545-560.

Improvements in husbandry, veterinary care, and nutrition have led to increased longevity of animals in human care, including elephants. The goal of this study was to collect and synthesize information pertaining to geriatric elephant medicine, management, husbandry, and nutrition. An electronic survey was created and distributed to American Association of Zoo Veterinarians members through an online link. A total of 61 responses were received from veterinarians, nutritionists, and elephant managers with data encompassing 314 elephants, of which 142 were geriatric (over 40 years old) and 51 were on their final set of molars. Following the initial survey, willing respondents were contacted for follow-up interviews. Osteoarthritis, foot disease, and colic were the most commonly reported diseases, and flunixin meglumine and phenylbutazone were the analgesics most often used. Respondents described diseases treated, husbandry changes specific for older animals, welfare assessments and quality of life monitoring, nutritional modifications for dental attrition, a variety of integrative medicine modalities, and unique cases. It is the hope that the information identified in this study can be used to improve treatment, management practices, and overall welfare for geriatric elephants.

Finch, K., F. Sach, M. Fitzpatrick, N. Masters and L. J. Rowden (2020). "Longitudinal

Improvements in Zoo-Housed Elephant Welfare: A Case Study at ZSL Whipsnade Zoo." Animals (Basel) **10**(11).

Over the last two decades, criticisms were raised regarding the welfare experienced by elephants in European and North American zoos. Concerns regarding the welfare of zoo-housed elephants in the UK and Europe were consolidated in the publication of several key reports, and media interest peaked. Throughout this study we aim to outline the behavioural measures of welfare observed in the current group of Asian elephants (Elephas maximus) at Zoological Society of London (ZSL) Whipsnade Zoo, using key welfare indicators for this species and comparing them to previous published work. Following the instigation of a species-specific research programme, empirical behavioural data were available to quantify any developments in care and welfare. The collection of behavioural information revealed that individuals in our study group engage in low levels of stereotypic behaviour, have formed and maintain strong associations with one another and display a high proportion of engagement in lying rest. We outline that by applying simple, low-cost methods of behavioural data collection and analysis, it is possible to collect evidence that allows us to evaluate individual level welfare. This facilitates the adoption of an evidence-based approach to zoo management as well as demonstrating compliance with updated legislation for this species.

Fazio, J. M., T. Barthel, E. W. Freeman, K. Garlick-Ott, A. Scholle and J. L. Brown (2020). "Utilizing Camera Traps, Closed Circuit Cameras and Behavior Observation Software to Monitor Activity Budgets, Habitat Use, and Social Interactions of Zoo-Housed Asian Elephants (Elephus maximus)." Animals (Basel) **10**(11).

Accredited zoos and aquariums value superior animal husbandry and strive to ensure that the physical, psychological, and social needs of animals are met. In North America, the Association of Zoos and Aquariums (AZA) relies on species-specific standards to ensure facilities provide the best care for collection animals. The AZA also makes explicit recommendations for long-term monitoring of welfare. Data collected through behavioral observations can be used to modify management as animals respond over time to social, environmental, or physical changes. In long-lived, social species like elephants, it is particularly important to document herd dynamics, calf development, geriatric health, and social bonds throughout their lifetimes. The Smithsonian's National Zoological Park housed one male and six female Asian elephants in dynamic social groupings. Behavioral observations were conducted on all elephants for two years using two methods involving ZooMonitor, closed circuit cameras, and camera traps. The goal was to compare how these two methods function to provide individual activity budgets, habitat use, and social interactions. Methodologies such as these, alone or in combination, have the potential to produce valuable data about potential changes in welfare over time in a zoological setting and can be performed either by staff or volunteers with high reliability.

Evison, E., A. McKenzie and L. Holmes (2020). "Social and environmental impacts on sleep in captive Asian elephants (Elephas maximus)." Zoo Biol.

Modern zoos strive to improve standards of animal management, husbandry

and welfare of their animals as part of a continual evaluation process. Elephants (Elephantidae) have received particular attention in recent years due to the challenge of providing environments which promote natural behavior and opportunities for social interaction. A number of measures have been proposed to measure wellbeing, with sleep quality increasingly being used. Sleep is a vital aspect of life for cell replenishment as well as optimal development of young. Sleep deprivation can lead to immunosuppression and illness; therefore animal managers have a responsibility to ensure they reduce the potential for disturbance through noise, light, or other environmental factors. The social environment also plays an essential role in wellbeing, particularly for species that live in multi-generational family units. In this study the nocturnal behavior of a multi-generational captive herd was observed to determine impacts of husbandry changes on sleep duration and bout length (measured as recumbent rest). As expected, average total duration of sleep was higher in younger elephants and rates were comparable to those reported in other studies of Asian elephants. Overnight access to an outdoor paddock in warmer weather increased overall average bout length of sleep in the herd. Average total duration of sleep also increased for the herd following the movement of an unrelated adult female who had previously shown weak bonds with other herd members. This indicates that social compatibility is a vital component of elephant welfare, impacting not only behavioral interactions but sleep quality and duration.

Ertl, N., P. Wendler, E. Sós, M. Flügger, F. Schneeweis, C. Schiffmann, J. M. Hatt and M. Clauss (2020). "Theory of medical scoring systems and a practical method to evaluate Asian elephant (Elephas maximus) foot health in European zoos." Animal Welfare **29**(2): 163-176.

Several established models in human and veterinary medicine exist to evaluate an individual health or disease status. Many of these seem unsuitable for further epidemiological research aimed at discovering underlying influential factors. As a case example for score development and choice, the present study analyses different approaches to scoring the foot health of Asian elephants (Elephas maximus) living in European facilities. Sum scores with varying degree of detail, and without or with a weighting method, were compared using descriptive statistics, ie kurtosis, skewness, Shannon entropy, total redundancy, their maximum and their actual ranges. With increasing score complexity, a higher level of differentiation was reached. In parallel, the distribution of score frequencies in the population shifted systematically: with the least complex scoring model the pattern indicated a severely unhealthy population with an opposite skew to a hypothetically healthy population, whereas the most complex scoring model indicated a mildly affected population with a skew corresponding to that expected for a healthy population. We propose the latter, in the form of the Particularised Severity Score (ParSev), which accounts for every nail and pad individually and weights the sub-scores by squaring, as the most relevant score for further investigations, either in assessing changes within an elephant population over time, or correlating foot health in epidemiological studies to potentially influencing factors. Our results emphasise the relevance

of choosing appropriate scoring models for welfare-associated evaluations, due to implications for the applicability as well as the perceived welfare status of the test population. © 2020 Universities Federation for Animal Welfare

Derham, T. and F. Mathews (2020). "Elephants as refugees." People and Nature **2**: 103-110.

1. Habitat loss and climate change are displacing animals at alarming rates. In re- sponse, authors in the humanities and the sciences have described animals rhe- torically as 'refugees'. Such a description implies a strong call to action.
2. However, the term 'refugee' may serve as more than mere rhetoric, indicating in a more literal way the response most proper to some persecuted, traumatized and displaced animals, and prioritizing those animals.
3. We test the claim that animals can be refugees using widely accepted criteria in the Refugee Convention. If refugees are those who, due to a well-founded fear of persecution for reasons of their group identity, are unwilling or unable to avail themselves of the protection of their country, then some animals may be refu- gees. Recent behavioural research on African elephants Loxodonta africana dem- onstrates that many elephants meet the criteria, even without recourse to the claim that they are persons.
4. We outline the essential requirements of an animal refugee policy. We find that current biodiversity conservation policy is likely inadequate to provide for animal refugees, although important lessons can be taken from the collective experience of conservation scientists and managers.
5. An obligation to animal refugees poses new challenges, both theoretical and prac- tical, for ecological restoration, conservation and human–animal relations.

Carlin, E., G. Teren and A. Ganswindt (2020). "Non-Invasive Assessment of Body Condition and Stress-Related Fecal Glucocorticoid Metabolite Concentrations in African Elephants (Loxodonta africana) Roaming in Fynbos Vegetation." Animals (Basel) **10**(5).

Fynbos is a unique endemic vegetation type belonging to the Cape Floral Kingdom in the Western Cape Province of South Africa, representing the smallest of the six floral kingdoms in the world. Nowadays, only a few game reserves in this region support populations of African elephants (Loxodonta africana), and thus, little information exists regarding the suitability of the nutritionally poor Fynbos vegetation for these megaherbivores. Using already established non-invasive methods, the monitoring of individual body conditions and fecal glucocorticoid metabolite (fGCM) concentrations, as a measure of physiological stress, was performed to examine a herd of 13 elephants in a Western Cape Province Private Game Reserve, during two monitoring periods (April and June 2018), following a severe drought. The results indicate that overall median body condition scores (April and June: 3.0, range 2.0-3.0) and fGCM concentrations (April: 0.46 µg/g dry weight (DW), range 0.35-0.66 µg/g DW; June: 0.61 µg/g DW, range 0.22-1.06 µg/g DW) were comparable to those of other elephant populations previously

studied utilizing the same techniques. These findings indicate that the individuals obtain sufficient nutrients from the surrounding Fynbos vegetation during the months monitored. However, a frequent assessment of body conditions and stress-associated fGCM concentrations in these animals would assist conservation management authorities and animal welfare practitioners in determining ways to manage this species in environments with comparably poorer nutritional vegetation.

Brown, J. L., P. Bansiddhi, J. Khonmee and A. C. Thitaram (2020). "Commonalities in Management and Husbandry Factors Important for Health and Welfare of Captive Elephants in North America and Thailand." Animals (Basel) **10**(4).

Abstract: This review paper is a synthesis of results from multiple studies that we have conducted over the past several years using similar methodologies to identify factors related to welfare of captive populations of elephants in North American zoos and Thailand tourist camps. Using multiple conservation physiology tools, we found that, despite vastly disparate management systems, there are commonalities in how environmental and husbandry factors affect physical and physiological outcomes. Elephants appear to have better welfare, based on fecal glucocorticoid metabolite (FGM) analyses, when housed under conditions that provide a more enriched, stimulating, and less restrictive environment. We also found it is essential to balance diet and exercise for good body condition and metabolic function. In Thailand, use of tools to control elephants, such as the ankus (i.e., guide, hook) and chains, did not equate to poor welfare per se, nor did riding; however, improper uses were associated with higher wound scores and FGM concentrations. Foot health was good overall in both regions, with cracks being the most common problem, and better foot scores were found in elephants kept on softer substrates. Based on these findings, science-based guidelines are being developed in Thailand, while in North America, changes are being incorporated into elephant standards and husbandry resource guides. Management across venues can be improved by encouraging elephant exploration and exercise, establishing socially compatibility groups, ensuring proper use of tools, and providing balanced diets. We contend there is no "one-size-fits-all" management strategy to guarantee good welfare for elephants, but there are essential needs that must be met regardless of where or how they are managed. Future studies are needed to find ways to better socialize elephants; determine how temperament affects coping styles and resilience; study the importance of good handler-elephant relationships; identify more ways for elephants to engage with the environment; and assess the effect of life history on subsequent physiological and psychological well-being.

Bansiddhi, P., J. L. Brown and C. Thitaram (2020). "Welfare Assessment and Activities of Captive Elephants in Thailand." Animals (Basel) **10**(6).

Thailand is the epicenter of elephant tourism and visiting an elephant camp is a popular activity according to the Tourist Authority of Thailand. However, the welfare of these elephants has been questioned by animal activist groups, international tour operators, and the public. Conclusions that the

vast majority of captive elephants are abused often are based on anecdotal evidence and not solid science. So, it is difficult to tease apart emotion, opinion, and fact with regard to what practices are good or bad for elephant welfare. The aim of this paper was to: 1) describe the unique status of captive elephants in Thailand and associated regulations, 2) summarize current issues and challenges facing elephant tourism, 3) review studies conducted on welfare of tourist elephants in Thailand, and 4) offer recommendations for how elephants can be properly cared for under captive conditions in tourist camps. We conclude there are many ways to manage these elephants, and that not all tourist activities are bad for welfare. However, it is essential they be managed in a way that meets physical, physiological and psychological needs, and that management decisions are based on objective data.

Yon, L., E. Williams, N. D. Harvey and L. Asher (2019). "Development of a behavioural welfare assessment tool for routine use with captive elephants." PLoS ONE **14**(2): e0210783.

There has been much concern in recent years about the welfare of elephants in zoos across North America and Europe. While some previous studies have assessed captive elephant welfare at a particular point in time, there has been little work to develop methods which could be used for regular, routine welfare assessment. Such assessment is important in order to track changes in welfare over time. A welfare assessment tool should be rapid, reliable, and simple to complete, without requiring specialist training and facilities; welfare assessments based on behavioural observations are well suited to this purpose. This report describes the development of a new elephant behavioural welfare assessment tool designed for routine use by elephant keepers. Tool development involved: (i) identification of behavioural indicators of welfare from the literature and from focus groups with relevant stakeholders; (ii) development of a prototype tool; (iii) testing of the tool at five UK zoological institutions, involving 29 elephants (representing 46% of the total UK captive elephant population of 63 animals); (iv) assessment of feasibility and reliability of aspects of the prototype tool; (v) assessment of the validity of each element of the tool to reflect the relevant behaviour by comparing detailed behavioural observations with data from the prototype tool; (vi) assessment of known-groups criterion validity by comparing prototype tool scores in individuals with demographics associated with better or worse welfare; (vii) development of a finalised tool which incorporated all elements of the tool which met the criteria set for validity and reliability. Elements of the tool requiring further consideration are discussed, as are considerations for appropriate application and interpretation of scores. This novel behavioural welfare assessment tool can be used by elephant-holding facilities for routine behavioural welfare monitoring, which can inform adjustments to individual welfare plans for each elephant in their collection, to help facilities further assess and improve captive elephant welfare. This study provides an example of how an evidence-based behavioural welfare assessment tool for use by animal caretakers can be developed within the constraints of zoo-based research, which could be applied to a range of

captive species.

Williams, E., A. Carter, C. Hall and S. Bremner-Harrison (2019). "Social Interactions in Zoo-Housed Elephants: Factors Affecting Social Relationships." Animals (Basel) **9**(10).

Elephants have complex social systems that are predominantly driven by ecological factors in situ. Within zoos, elephants are held in relatively static social groups and the factors observed driving social relationships in the wild are largely absent. Little research has investigated the effect of social group factors in zoos on elephant social interactions. The aim of this research was to establish whether there is a relationship between social group factors and social behaviour, in order to identify factors that make elephant herds more or less likely to be compatible. Results will facilitate recommendations for optimum social groupings for zoo elephants. Behavioural data quantifying social interactions were collected between January 2016 and February 2017 at seven UK and Irish zoos and safari parks from 10 African and 22 Asian elephants. Social interactions were split into four categories: positive physical, positive non-physical, negative physical and negative non-physical. Social interactions were related to age (positive physical higher and negative non-physical lower in calves than adults), personality (elephants with higher sociability scores engaged in more positive interactions and less negative interactions), presence of calves in the herd (herds with calves had more positive non-physical), relatedness to other elephants in the herd (positive non-physical were higher when relatives were in the group and negative non-physical were higher between unrelated elephants) and species (Asian elephants engaged in more positive non-physical than African elephants). A greater understanding of factors that may contribute to the success of zoo-elephant social groups is important for individual and herd welfare as it will enable evidence-based decisions which have minimal impact on social structures to be executed. This knowledge will enable proactive management approaches to be undertaken and will thus be paramount in ensuring optimal welfare for elephant herds moving forwards.

Veasey, J. S. (2019). "Assessing the Psychological Priorities for Optimising Captive Asian Elephant (Elephas maximus) Welfare." Animals (Basel) **10**(1).

The welfare status of elephants under human care has been a contentious issue for two decades or more in numerous western countries. Much effort has gone into assessing the welfare of captive elephants at individual and population levels with little consensus having been achieved in relation to both the welfare requirements of captive elephants, or their absolute welfare status. A methodology capable of identifying the psychological priorities of elephants would greatly assist in both managing and assessing captive elephant welfare. Here, a Delphi-based Animal Welfare Priority Identification System(©) (APWIS(©)) is trialled to evaluate the reliability of the methodology and to determine the welfare significance of individual behaviours and cognitive processes for Asian elephants (Elaphus maximus). APWIS(©) examines the motivational characteristics, evolutionary significance and established welfare impacts of individual behaviours and

cognitive processes of each species being assessed. The assessment carried out here indicates appetitive behaviours essential for survival in the wild, together species-specific social and cognitive opportunities are likely to be important to the welfare of Asian elephant in captivity. The output of this assessment, for the first time, provides comprehensive species-specific psychological/welfare priorities for Asian elephants that should be used to inform husbandry guidelines, habitat design and management strategies and can also provide a valuable reference tool for Asian elephant welfare assessment. The effective application of these insights could lead to substantive improvements in captive Asian elephant welfare.

Taylor, M., C. E. Hurst, M. J. Stinson and B. S. R. Grimwood (2019). "Becoming care-full: contextualizing moral development among captive elephant volunteer tourists to Thailand." Journal of Ecotourism.

Tourism literature on animal ethics and animal welfare has given scarce consideration to how tourists become enrolled into caring, responsible practices towards animals. The objective of this paper is to contextualize a process of moral development–and specifically the emergence of an ethic of care–through the narratives and experiences of captive elephant volunteer tourists in Thailand. Guided by tenets of ecofeminism and a narrative methodology, our study forefronts how relational experiences prompted compassion and empathy as storied by 12 women volunteers. These volunteer tourists described how they shaped their own moral and ethical patterns through practices of witnessing abuse, questioning moral responsibilities, connecting with elephants, and advocating for improved conditions of captive individuals. As storied by the volunteers, processes of witnessing–questioning–connecting–advocating were deeply transformational, and inspired what we interpret as the development of an ethic of care. The research advances understandings of how intentional, relational engagements that prioritize animal wellbeing have the potential to facilitate among tourists processes of becoming care-full. © 2019, © 2019 Informa UK Limited, trading as Taylor & Francis Group.

Scott, N. L. and C. A. LaDue (2019). "The behavioral effects of exhibit size versus complexity in African elephants: A potential solution for smaller spaces." Zoo Biol **38**(5): 448-457.

Population-level analyses suggest that habitat complexity, but not necessarily space availability, has important welfare outcomes for elephants in human care. At the Dallas Zoo, the opening of a new exhibit complex allowed us to measure the behavior of two female African elephants across three treatments to evaluate the independent effects of complexity and space. Preoccupancy observations were conducted in the elephants' older exhibit, which consisted of a smaller, more simple yard (630 m(2)). Subsequent postoccupancy observations measured behavior in two different spaces in the new exhibit: a larger, complex yard (15,000 m(2)), and a smaller, but complex yard (1,520 m(2)). The elephants' overall activity levels were greater in complex habitats, regardless of their size. Similar effects of habitat complexity oversize were observed with greater rates of

foraging and lower rates of being stationary. Furthermore, elephants were out of view of visitors significantly more in the small, simple yard compared to either of the more complex habitats. However, exhibit size affected the incidence of stereotypic behavior (with lower rates of stereotypy in the larger exhibit compared to the smaller yards) and investigatory behavior (elephants investigated their environments more with increasing size and complexity). Behavioral diversity also increased with exhibit size and complexity. These results indicate that space availability alone is not sufficient to enhance the behavioral welfare of zoo elephants. Therefore, facilities with limited space can still encourage species-appropriate behaviors and improved welfare for the elephants in their care by converting a small, simple area into a more complex habitat.

Norkaew, T., J. L. Brown, C. Thitaram, P. Bansiddhi, C. Somgird, V. Punyapornwithaya, K. Punturee, P. Vongchan, N. Somboon and J. Khonmee (2019). "Associations among tourist camp management, high and low tourist seasons, and welfare factors in female Asian elephants in Thailand." PLoS ONE **14**(6): e0218579.

This study investigated how camp management and tourist activities affect body condition, adrenocortical function, lipid profiles and metabolic status in female tourist elephants. We compared twice monthly serum insulin, glucose, fructosamine, total cholesterol (TC), triglyceride (TG), low density lipoprotein (LDL), high density lipoprotein (HDL), and fecal glucocorticoid metabolite (FGM) concentrations to body condition scores (BCS) at five camps with different management styles (e.g., tourist activities, work type, diet) between the High (November-February) and Low (March-October) tourist seasons. There were significant camp effects on health parameters, with BCS, TC, HDL, insulin and glucose being among the highest, and G:I being the lowest (less heathy) in elephants at an observation camp compared to those at camps where elephants received exercise by providing rides to tourists. Differences between High and Low tourist season months also were found for all measures, except TG and FGM concentrations. Both work time and walking distance were negatively correlated to glucose, fructosamine and insulin, while walking distance was negatively related to FGM concentrations. By contrast, positive associations were found between tourist number and BCS, TG, and insulin, perhaps related to tourists feeding elephants. Quantity of supplementary diet items (e.g., bananas, sugar cane, pumpkin) were positively correlated with FGM concentrations, glucose, fructosamine, and insulin. This study provides evidence that body condition, adrenal activity, metabolic markers, and lipid profiles in captive elephants may be affected by visitor numbers, work activities, and the amount of supplementary foods offered by tourists. Some activities appear to have negative (e.g., feeding), while others (e.g., exercise) may have positive effects on health and welfare. We conclude that camps adopting a more hands-off approach to tourism need to ensure elephants remain healthy by providing environments that encourage activity and rely on more natural diets or foraging.

Norkaew, T., J. L. Brown, P. Bansiddhi, C. Somgird, C. Thitaram, V. Punyapornwithaya, K. Punturee, P. Vongchan, N. Somboon and J. Khonmee (2019).

"Influence of season, tourist activities and camp management on body condition, testicular and adrenal steroids, lipid profiles, and metabolic status in captive Asian elephant bulls in Thailand." PLoS ONE **14**(3): e0210537.

We previously found relationships between body condition and physiological function affecting health and welfare of female tourist camp elephants in Thailand, and used that approach to conduct a similar study of bull elephants in the same camps (n = 13). A body condition score (BCS) was done every other month, and fecal glucocorticoid metabolite (FGM) concentrations were measured twice monthly for 1 year. Effects of season, camp management and tourist activity on lipid profiles [total cholesterol (TC), low density lipoproteins (LDL), high density lipoproteins (HDL), triglycerides (TG)] and metabolic factors [insulin, glucose, fructosamine, glucose to insulin ratio (G:I)] were determined and correlated to measures of body condition, testosterone and FGM. Positive correlations were found between BCS and TG, between FGM and TG, HDL and glucose, and between testosterone and HDL, whereas BCS and testosterone were negatively associated with the G:I. There was a significant positive relationship between FGM and testosterone. Elevated FGM concentrations were associated with altered lipid and metabolic profiles and were higher in winter compared to summer and rainy seasons. Insulin and glucose levels were higher, while the G:I was lowest in the winter season. Strong positive associations were found between TC and HDL, LDL and HDL and glucose, and glucose and insulin. By contrast, negative relationships were found between the G:I and HDL and glucose, and between insulin and G:I. Differences also were found between High and Low tourist season months for FGM, insulin, and G:I. Last, there was notable variation among the camps in measured parameters, which together with tourist season effects suggests camp management may affect physiological function and welfare; some negatively like feeding high calorie treats, others positively, like exercise. Last, compared to females, bull elephants appear to be in better physical health based on normal BCSs, lower insulin levels and higher G:I ratios.

Kumar, V., M. Pradheeps, A. Kokkiligadda, R. Niyogi and G. Umapathy (2019). "Non-Invasive Assessment of Physiological Stress in Captive Asian Elephants." Animals (Basel) **9**(8).

Asian elephant (Elephas maximus) populations, both in the wild and in captivity, have been continually declining over the decades. The present study examined the physiological stress response of captive Asian elephants in relation to body condition score and different working conditions. A total of 870 dung samples of 37 captive elephants (24 males and 13 females) from four facilities were collected to examine fecal glucocorticoid metabolite concentrations (fGCM). The elephants in forest camps with exposure to natural habitats had a higher body condition score than those in more confined spaces. Wild born elephants and females (except in one case) had higher concentrations of fGCM than captive born elephants and males, respectively. Elephants engaged in the Dussehra festival had elevated fGCM concentrations than their counterparts at Mysore zoo. We recommend a few management practices for the long-term survival of rapidly declining captive

elephant populations.

Edwards, K. L., M. A. Miller, K. Carlstead and J. L. Brown (2019). "Relationships between housing and management factors and clinical health events in elephants in North American zoos." PLoS ONE **14**(6): e0217774.

Elephants experience a number of health issues that can contribute to their well-being and survival. In managed populations, housing conditions and management practices can influence individual health, so potential risk factors associated with morbidity or mortality should be identified to ensure the best possible standards of care. The goal of this study was to determine if the number of clinical events experienced could be a useful welfare indicator in zoo elephants, and to determine factors associated with key pathologies. We used an epidemiological approach to investigate how intrinsic (species, sex, age) and extrinsic (housing, management) factors were associated with both the total number of clinical events, and each of the four most prevalent pathology types (gastrointestinal issues, skin lesions, lameness, foot lesions), over a 12-month period. The study included 220 (127 African; 93 Asian) elephants housed at 61 facilities across North America. More than 1100 clinical events were identified. Species and sex differences were apparent in the types of pathology encountered, and unsurprisingly, the number of clinical events was positively correlated with age. Factors relating to housing (percent time with indoor/outdoor choice, space experience inside, number of unique environments an elephant was housed in, percent time on soft substrate) and management (enrichment diversity, spread of feeding opportunities) were also related to the number of clinical events. However, relationships were often counter to our initial hypotheses, highlighting caution in assuming cause and effect from correlational analyses such as these. Other welfare indicators such as serum and fecal glucocorticoids and serum prolactin were also associated with health status, being higher or more variable in individuals with a greater number of events. This approach provides insight into housing and management factors related to the health of these species in zoos, and in some cases, may reflect management changes that have already been made to mitigate existing or anticipated health concerns.

Edwards, K. L., P. Bansiddhi, S. Paris, M. Galloway and J. L. Brown (2019). "The development of an immunoassay to measure immunoglobulin A in Asian elephant feces, saliva, urine and serum as a potential biomarker of well-being." Conserv Physiol **7**(1): coy077.

Additional measures of well-being would be beneficial to the management of a variety of species in human care, including elephants. Immunoglobulin A (IgA) is an immune protein associated with pathogen defense, which has been demonstrated to decrease during times of stress, and increase in response to positive stimuli. This paper describes the development and validation of an enzyme immunoassay (EIA) for the quantification of Asian elephant (Elephas maximus) IgA in feces, saliva, urine, and serum. Samples were collected weekly from four females for 6 months to assess IgA and glucocorticoid (GC) concentrations, establish relationships between these two

biomarkers, and determine variability in IgA within and between individuals, and across sample types. IgA was quantified in all four sample types, although urinary concentrations were low and sometimes undetectable in individual samples. Concentrations were highly variable within and between individuals, with fecal, salivary and serum IgA, and fecal, salivary and urinary GCs all differing significantly across individuals. Contrary to previous findings, IgA and GC were generally not correlated. Serum IgA was less variable within individuals, with the exception of one female that experienced a brief illness during the study. However, marked inter-individual differences were still apparent. When data from all individuals were combined, fecal IgA was significantly predicted by salivary and urinary IgA; however, this relationship did not hold when individuals were analyzed separately. Analysis of a fifth female that exhibited a more severe systemic illness demonstrated clear increases in fecal IgA and GC, suggesting these may also be useful health biomarkers. Further investigation is needed to determine what sample type is most reflective of biological state in elephants, and how IgA concentrations are associated with health and positive and negative welfare states. Based on observed variability, a longitudinal approach likely will be necessary to use IgA as a measure of well-being.

de Mori, B., E. Stagni, L. Ferrante, G. Vogt, K. A. Ramsay and S. Normando (2019). "Scientific and Ethical Issues in Exporting Welfare Findings to Different Animal Subpopulations: The Case of Semi-Captive Elephants Involved in Animal-Visitor Interactions (AVI) in South Africa." Animals (Basel) **9**(10).

Elephants are charismatic, cognitively highly-developed animals, whose management conditions can vary along a "wild-captive continuum." Several protocols have been proposed for the assessment of zoo elephants' welfare. It is important to investigate the possible limitations, if any, of extending findings from zoo elephants to conspecifics in a different dynamic in said "wild-captive continuum." In this paper, findings regarding two issues will be discussed: those regarding the external validity and those regarding the acceptability of management procedures as applied to semi-captive (i.e., able to roam freely for part of the day) elephants involved in visitor-interaction programs in South Africa. In a questionnaire-based survey, half of the responding experts stated that at least some of the welfare issues they ranked as the five most important in captive elephants' management had a different relevance for semi-captive individuals, resulting in 23.6% of the issues being rated differently. Moreover, there was no agreement among the experts on the ethical acceptability of any of the investigated procedures used in the management of semi-captive elephants involved in visitor-interaction programs. Caution is thus needed when exporting findings from one subpopulation of animals to another kept in different conditions and more scientific and ethical research is needed on the topic.

Brown, J. L., K. Carlstead, J. D. Bray, D. Dickey, C. Farin and K. Ange-van Heugten (2019). "Individual and environmental risk factors associated with fecal glucocorticoid metabolite concentrations in zoo-housed Asian and African elephants." PLoS ONE **14**(9): e0217326.

A recent large-scale welfare study in North America involving 106 Asian (Elephas maximus) and 131 African (Loxodonta africana) elephants at 64 accredited facilities identified links (i.e., risk factors) between zoo environmental factors and a number of welfare outcomes (stereotypic behavior, ovarian acyclicity, hyperprolactinemia, walking and recumbence, body condition, health status, serum cortisol). For this population of elephants, we used the same epidemiological methods to examine associations between those risk factors and two additional welfare outcomes, mean concentration and individual variability (CV) of fecal glucocorticoid metabolite concentrations (FGM) as indicators of stress. Results indicate that African elephants are more responsive to social stressors than Asians, and that poor joint health is a stress-related welfare problem for Asian, but not African elephants in the North American population. For both species, higher FGM concentrations were associated with zoos located at more northern latitudes, whereas lower FGM concentrations were associated with having free access to indoor/outdoor spaces, and spending more time in managed interactions with staff. Also important for captive management, elephants having diverse enrichment options and belonging to compatible social groups exhibited reduced intra-individual variability in FGM concentrations. Our findings show that aspects of the zoo environment can be potential sources of stress for captive elephants, and that there are management activities that may facilitate coping with zoo conditions. Given species differences in factors that affected FGM, targeted, species-specific management approaches likely are needed to ensure good welfare for all elephants.

Brown, J. L. (2019). "Update on Comparative Biology of Elephants: Factors Affecting Reproduction, Health and Welfare." Adv Exp Med Biol **1200**: 243-273.

Asian (Elephas maximus) and African (Loxodonta africana) elephants serve as important keystone, umbrella and flagship species. Despite that, population numbers are declining, due mainly to poaching and habitat destruction. Understanding reproductive mechanisms is vital to effective management, particularly insurance populations in captivity, and to that end, long-term biological databases are key to understanding how intrinsic and extrinsic factors affect reproductive function at individual and population levels. Through decades of hormonal and ultrasonographic monitoring, many unique aspects of zoo elephant reproduction have been identified, including differences in luteal steroidogenic activity, follicular maturation, pituitary gonadotropin secretion, fetal development and reproductive tract anatomy. Reproductive problems also hamper captive propagation efforts, particularly those related to abnormal or lack of ovarian cyclicity. Recent large-scale, multi-institutional studies and use of epidemiological approaches have identified factors important for good welfare and reproduction, which include enrichment, feeding diversity, good elephant-keeper relations, social compatibility, exercise, and not being obese. There are notable differences in reproductive mechanisms between Asian and African elephants, as well as the factors that influence reproduction and welfare, suggesting species-targeted management approaches are needed to maximize fitness. In the first edition, we discussed reproductive function in male and female

elephants. Since then, a number of significant advances have been made primarily in female elephants, which will be the focus of this updated review.

Bansiddhi, P., K. Nganvongpanit, J. L. Brown, V. Punyapornwithaya, P. Pongsopawijit and C. Thitaram (2019). "Management factors affecting physical health and welfare of tourist camp elephants in Thailand." PeerJ **7**: e6756.

Background: Variation in management across elephant camps likely has differential effects on the well-being of elephants. Methods: This study calculated body condition, foot health and skin wound scores (WSs) for 122 elephants from 15 elephant camps in Chiang Mai province, and examined relationships to management factors using a multi-variable modeling approach. Results: The majority of elephants had high body condition scores (BCS) indicative of being overweight or obese, mild foot problems, but few visible wounds. Females had higher BCSs than males, as did elephants provided a water source at night. Increasing age was associated with higher foot and WSs. Higher WSs were observed in about a quarter of the cases where mahouts carried a hook. Wounds related to saddle riding were rare. Elephants that rested on sand floors at night had a decreased risk of high WSs compared to elephants that rested on compact dirt floors. Discussion: Findings emphasize the need for elephant camps to adjust management activities that negatively affect body condition (e.g., feeding too many sweet treats), foot health (e.g., hard substrates) and wounding (e.g., misuse of equipment) to improve health and welfare of this population.

Bansiddhi, P., J. L. Brown, C. Thitaram, V. Punyapornwithaya and K. Nganvongpanit (2019). "Elephant Tourism in Thailand: A Review of Animal Welfare Practices and Needs." Journal of Applied Animal Welfare Science.

Elephant tourism in Thailand has developed into an important socio-economic factor after a logging ban initiated in 1989 resulted in thousands of out-of-work elephants. However, the welfare of captive elephants has been a topic of intense debate among tourists, scientists and stakeholders because of the range of working conditions and management practices to which they are exposed. The aim of this paper is to summarize the current state of knowledge on captive elephant welfare, with an emphasis on tourist elephants in Thailand, and highlight information gaps and recommendations for future directions. Tourist-oriented elephant camps could improve the welfare of elephants through better management practices that take into account physiological and psychological needs of individual animals, including meeting social and nutritional requirements, providing good health care, and maintaining adequate facilities. Our goal is to develop science-based guidelines that government agencies can use to develop an enforceable set of practical regulations to ensure good management of tourist elephants in Thailand. © 2019, © 2019 Informa UK Limited, trading as Taylor & Francis Group.

Bansiddhi, P., J. L. Brown, J. Khonmee, T. Norkaew, K. Nganvongpanit, V. Punyapornwithaya, T. Angkawanish, C. Somgird and C. Thitaram (2019). "Management factors affecting adrenal glucocorticoid activity of tourist camp

elephants in Thailand and implications for elephant welfare." PLoS ONE **14**(10): e0221537.

Elephant camps are among the most popular destinations in Thailand for tourists from many countries. A wide range of management strategies are used by these camps, which can have varied impacts on health and welfare of elephants. The objectives of this study were to examine relationships between FGM (fecal glucocorticoid metabolite) concentrations and camp management factors (work routine, walking, restraint, rest area, foraging), and to other welfare indicators (stereotypic behaviors, body condition, foot health, and skin wounds). Data were obtained on 84 elephants (18 males and 66 females) from 15 elephant camps over a 1-year period. Elephants were examined every 3 months and assigned a body condition score, foot score, and wound score. Fecal samples were collected twice monthly for FGM analysis. Contrary to some beliefs, elephants in the observation only program where mahouts did not carry an ankus for protection had higher FGM concentrations compared to those at camps that offered riding with a saddle and shows. Elephants that were tethered in the forest at night had lower FGM concentrations compared to elephants that were kept in open areas inside the camps. There was an inverse relationship between FGM concentrations and occurrence of stereotypy, which was not anticipated. Thus, assessing adrenal activity via monitoring of FGM concentrations can provide important information on factors affecting the well-being of elephants. Results suggest that more naturalistic housing conditions and providing opportunities to exercise may be good for elephants under human care in Thailand, and that a no riding, no hook policy does not necessarily guarantee good welfare.

Williams, E., C. L. Chadwick, L. Yon and L. Asher (2018). "A review of current indicators of welfare in captive elephants (Loxodonta africana and Elephas maximus)." Animal Welfare **27**(3): 235-249.

Concerns over elephant welfare in UK zoos have implications for their future in captivity. To monitor improvements made to elephant welfare in UK zoos, non-invasive, valid and reliable indicators of welfare are needed. Using a rapid review strategy and critical appraisal tool, we aimed to appraise evidence from peer-reviewed literature on potential welfare indicators for captive elephants. Scopus, Web of Knowledge and Ovid were searched in January 2014 using terms relevant to captive elephants and welfare assessment. Inclusion and exclusion criteria were applied and remaining articles were critically appraised against a specially designed welfare indicator appraisal tool. Thirty-seven unique indicators of welfare were extracted from 30 peer-reviewed papers which met the inclusion criteria. Behavioural measures of welfare (n = 21) were more common than either physical (n = 11) or physiological (n = 5) measures. Stereotypies were the most frequently used behavioural measure, glucocorticoids were the most frequently used physiological measure and body condition scores were the most frequently used physical measure. There was most support for the following indicators of improved welfare state: reduced stereotypies, reduced glucocorticoids and improved body condition scores. Additional measures which require further validation but had strong associations with the most

supported measures, and thus have potential use in welfare assessment, were: increased lying rest and positive social interactions. Further validation of the described measures is needed, but this information forms a crucial part of the knowledge required to efficiently monitor and improve the welfare of elephants in captivity. © 2018 Universities Federation for Animal Welfare.

Safina, C. (2018). "Where Are Zoos Going-or Are They Gone?" J Appl Anim Welf Sci **21**(sup1): 4-11.

To some, zoos are prisons exploiting animals. In reality zoos range from bad to better. I make this distinction: A bad zoo makes animals work for it; a good zoo works for animals. Good zoos do effective conservation work and continually strive to improve exhibits, relevance to conservation, and inspiring public engagement for wildlife. Many zoos have improved enormously; the better ones being crucial in saving species that would have otherwise gone extinct. Nonetheless, for some people the mere word "zoo" carries impressions of old zoos, bad zoos, circuses, and theme-park shows that many find distasteful. Good zoos know they must innovate forward. As society grows increasingly estranged from nature and continues driving broad declines of wildlife, wild lands, and natural systems, the goal of zoos and every organization concerned with animal welfare should not be to separate humans from other animals, but to entangle all humans in nonhuman lives. Zoos of the next decades must become the first stage in bringing young people into life-long, engaged caring about animals. They could carry on that mission in their communities, in schools, in wild lands, as well as inside their gates. Without a strong public constituency, wild animals will not withstand continued human proliferation. Zoos and aquariums must innovate toward being a crucial force abetting the continued existence of wildness on Earth. Zoos of the future must become uplifting places of respect, rescue, enhancement, conservation, and public engagement.

Norkaew, T., J. L. Brown, P. Bansiddhi, C. Somgird, C. Thitaram, V. Punyapornwithaya, K. Punturee, P. Vongchan, N. Somboon and J. Khonmee (2018). "Body condition and adrenal glucocorticoid activity affects metabolic marker and lipid profiles in captive female elephants in Thailand." PLoS ONE **13**(10): e0204965.

Studies in western zoo elephants have found relationships between body condition and physiological function, and identified mitigating management strategies to optimize health and welfare. A similar methodological approach was used in this study, which evaluated a body condition score (BCS; 1 = thinnest, 5 = fattest) every other month and fecal glucocorticoid metabolite (FGM) concentrations twice monthly in 33 tourist camp elephants in Thailand for a 1-year period to assess seasonal variations, and determine how lipid profiles [total cholesterol (TC), low density lipoproteins (LDL), high density lipoproteins (HDL), triglycerides (TG)] and metabolic parameters [insulin, glucose, fructosamine, glucose to insulin ratio (G:I)] related to measures of body condition and adrenal function. The most prevalent BCS was 3-3.5 (60.6%), with 27.3% at BCS = 4 (overweight) and 12.1% at BCS = 4.5-5 (very overweight); no elephants had a BCS <2. BCSs were higher in rainy and winter seasons compared to summer, with FGM, TG, HDL, LDL, and

insulin also higher in the rainy and/or winter seasons ($p<0.05$). By contrast, TC and glucose were lowest in the rainy season. FGM measures were negatively associated with two environmental factors: temperature and rainfall, but not humidity. Positive correlations were found between BCS and TC, LDL, and HDL, and between FGM and TC, HDL, glucose, and insulin ($p<0.05$), whereas BCS and FGM were both negatively associated with the G:I ($p<0.05$). However, there was no relationship between BCS and FGM among the camp elephants. Using BCS and FGM measures as outcome variables in separate regression models, this study found high BCS and elevated FGM concentrations were associated with altered lipid profiles and metabolic status in elephants. Furthermore, more work hours/day was associated with better body condition and health measures. Thus, being overweight and exposed to factors that increase adrenal activity could adversely affect health status, requiring alterations in management for some individuals, whereas exercise appears to have a protective effect.

Miller, L. J., J. F. Luebke and J. Matiasek (2018). "Viewing African and Asian elephants at accredited zoological institutions: Conservation intent and perceptions of animal welfare." Zoo Biol.

African and Asian elephants are popular within zoos, however there is currently limited information on how viewing them impacts zoo visitors. The goal of the current study was to examine the relationship between viewing elephants in zoos accredited by the Association of Zoos and Aquariums and zoo visitors' reported conservation intent and perceptions of animal welfare. Visitors were systematically selected to fill out questionnaires following elephant observation at nine facilities throughout North America. Questions included information on conservation predispositions, exhibit experience, exhibit perceptions, animal welfare perceptions, emotional experience, learning outcomes, conservation intent, and demographics. Results suggest that observing elephants engaged in a variety of species-typical behaviors and having an up-close experience was significantly correlated to visitors having a positive emotional response. The positive emotional response, combined with visitor conservation predisposition had a significant positive relationship with reported interest in getting involved in conservation. Perceptions of animal welfare were significantly related to a positive emotional experience driven by seeing animals engaged in a variety of active species-typical behaviors as well as exhibit perceptions and whether or not visitors thought it was important to have elephants in zoos. Exhibit perception was primarily correlated with exhibit size. The results provide factors that could help to increase visitor interest in conservation as well as the potential impact of viewing elephants in an accredited zoo. Facilities can use this information to help ensure their visitors have similar type experiences in order to inspire visitors' interest in conservation as well as positive perceptions of animal welfare.

Harvey, N. D., C. Daly, N. Clark, E. Ransford, S. Wallace and L. Yon (2018). "Social Interactions in Two Groups of Zoo-Housed Adult Female Asian Elephants (Elephas maximus) that Differ in Relatedness." Animals (Basel) **8**(8).

Opportunities for positive social interaction are important in captive animals, and social interactions can be used as a welfare indicator. Wild elephants live in related multigenerational herds; however, in captivity they are often managed in less related groups, which could impact the quality of their social interactions, and thus their welfare. Here, we used a limited social network analysis to investigate the social interactions in two groups of four female captive Asian elephants, one of which contained individuals that were all related to one another, whilst the other was a mix of related and unrelated individuals. Data on pairwise social interactions was collected from eight days of video footage using an all-occurrence sampling technique. More affiliative, and fewer agonistic interactions were observed in the related elephant group. Additionally, non-contact displacement was observed at a higher frequency in the related elephant group, which we theorise represents an established functioning hierarchy, avoiding the need for overt aggression over resources. Although kinship is not likely to be the only factor affecting captive elephant social behaviour, these findings support the recommendation that for optimal welfare, elephants should be managed in multigenerational family herds. Evaluations of social interactions such as those conducted here would have wider applicability for aiding the management of any captive social species to identify when groups might be incompatible.

Bansiddhi, P., J. L. Brown, C. Thitaram, V. Punyapornwithaya, C. Somgird, K. L. Edwards and K. Nganvongpanit (2018). "Changing trends in elephant camp management in northern Thailand and implications for welfare." PeerJ **6**: e5996.

Background: Elephant camps are among the most attractive destinations in Thailand for tourists from many countries. A wide range of management strategies are used by these camps, which can have varied impacts on health and welfare of elephants. Methods: This study surveyed 33 camps with 627 elephants in northern Thailand to quantify the types of management practices and work activities experienced by captive elephants. The survey consisted of an interview with camp owners, and direct observations of camp operations. Results: Data revealed considerable variation in elephant demographics, work activities, elephant care (i.e., housing, restraint, nutrition, health care, and breeding), and mahout management among the camps. In general, older camps (those in existence for >16 years) were involved in more intensive activities, like riding with saddles and shows. By contrast, newer camps provided more one-on-one activities for tourists and elephants, and emphasized more intimate, relaxing experiences (e.g., feeding, bathing, walking) than entertainment. A demographic shift also was observed, with elephants 20 years of age and younger having a sex ratio closer to 1:1 compared to elephants in older age categories (1:4.1-1:9.8). Discussion: Shifts in elephant management to less intensive activities were observed, which could have positive implications for elephant welfare. The shifting sex ratio suggests successful captive breeding is resulting in the birth of more males, which could present new welfare challenges in the future, because bulls can be more difficult to manage and socialize, and are more likely to be kept isolated during musth. Ultimately, the goal is to understand how camp activities affect welfare, and to develop science-based guidelines

and standards to aid in the management of both male and female elephants used in tourism.

Tanya, L. (2017). Botswana's Elephant-Back Safari Industry – Stress-Response in Working African Elephants and Analysis of their Post-Release Movements, University of Massachusetts Amherst. **Masters**.

MacKenzie, C. A., J. Salerno, J. Hartter, C. A. Chapman, R. Reyna, D. M. Tumusiime and M. Drake (2017). "Changing perceptions of protected area benefits and problems around Kibale National Park, Uganda." J Environ Manage **200**: 217-228.

Local residents' changing perceptions of benefits and problems from living next to a protected area in western Uganda are assessed by comparing household survey data from 2006, 2009, and 2012. Findings are contextualized and supported by long-term data sources for tourism, protected area-based employment, tourism revenue sharing, resource access agreements, and problem animal abundance. We found decreasing perceived benefit and increasing perceived problems associated with the protected area over time, with both trends dominated by increased human-wildlife conflict due to recovering elephant numbers. Proportions of households claiming benefit from specific conservation strategies were increasing, but not enough to offset crop raiding. Ecosystem services mitigated perceptions of problems. As human and animal populations rise, wildlife authorities in Sub-Saharan Africa will be challenged to balance perceptions and adapt policies to ensure the continued existence of protected areas. Understanding the dynamic nature of local people's perceptions provides a tool to adapt protected area management plans, prioritize conservation resources, and engage local communities to support protected areas.

Kongsawasdi, S., S. Mahasawangkul, P. Pongsopawijit, K. Boonprasert, B. Chuatrakoon, N. Thonglorm, R. Kanta-In, T. Tajarernmuang and K. Nganvongpanit (2017). "Biomechanical parameters of Asian Elephant (Elephas maximus) walking gait." Kafkas Universitesi Veteriner Fakultesi Dergisi **23**(3): 357-362.

Quadruped animals have a unique mechanism of movement that minimizes energy use and allows muscles to work effectively. Elephants are the biggest quadruped animals on earth and how they stabilize their body and use energy are of interest. This study aimed to analyze the characteristics of kinematic gait in Asian elephants trained to work with a mahout for tourism activities in Thailand. Twenty-one healthy adult Asian elephants were recorded by 2 digital cameras while walking at normal speed (average 1.1 m s-1.) along a 15-meter, solid-soil path. The temporospatial parameters evaluated for each limb consisted of stride length (cm), stride time (sec), swing time (sec), stance time (sec) and stance time percentage, using 2D motion analysis software. The result revealed that the average stride length was varied between 192-199 cm with no significant difference between fore and hindlimbs on either side but the stride length on the right side was significantly longer than that on the left in both forelimbs (right 197.5 cm; left 192.6 cm, $P<0.05$) and hindlimbs (right 198.9 cm; left 193.2 cm, $P<0.01$). The mean gait cycle time (stride time) was varied between 2.26

and 2.34 seconds for each limb and mean stance time was varied between 1.67-1.80 seconds, with both parameters were longer on the forelimbs than hindlimbs significantly (P<0.01). Hence, swing time for the forelimb was shorter than that for the hindlimb (P<0.001). The calculated stance time percentage for each limb was 72.64-76.09%. Data from this study confirmed that elephants walk with a lateral sequence and footfall pattern, and distribute the center of mass proportionally between all four limbs. Gait analysis is a valuable tool for identifying and understanding the pathogenesis of gait abnormality.

Greco, B. J., C. L. Meehan, J. L. Heinsius and J. A. Mench (2017). "Why pace? The influence of social, housing, management, life history, and demographic characteristics on locomotor stereotypy in zoo elephants." Applied Animal Behaviour Science **194**: 104-111.

Stereotypic behaviors (SB) are common in zoo-housed elephants, and these behaviors can be performed at high rates. Elephants perform different SB forms (e.g., weaving, pacing), but no published studies have evaluated the factors contributing to the development or performance of these different forms. Instead, as with most SB studies across species, elephant studies have relied on analyses that aggregate all SB forms, which limits the development and testing of form-specific hypotheses or abatement practices. Our objectives were to characterize the SB forms of North American zoo elephants and use multivariable epidemiological models to test form-specific hypotheses. We videotaped 77 elephants (African: N = 5 males, 31 females; Asian N = 8 males, 33 females) at 39 zoos who performed SBs and used a novel classification scheme and 5-min instantaneous samples to characterize their SB forms. Locomotor and whole-body SBs were the most common, but most elephants who performed locomotor SBs also performed whole-body SBs. Thus, we characterized each elephant according to whether it included locomotion in its SB repertoire [Locomotor Presence (LP)] or only whole-body movements. We used binomial regression models fitted with generalized estimating equations to test hypotheses about which of 26 social, housing, management, life history, and demographic variables were most associated with LP. The odds of LP increased by 26% for every 10% increase in time housed separately (odds ratio = 1.026, p = 0.04), 96.2% for every additional social group with which an elephant had contact (odds ratio = 1.962, p = 0.01), and 46% for every 10% increase in time housed indoors (odds ratio = 1.046, p = 0.01). Age was non-significantly confounded with all three variables. We hypothesize that the social variables in our models increase LP risk because they are associated with uncontrollable social group changes, anticipation of potentially rewarding social experiences, or the frustration of social behaviors. The housing variable included in our model likely increases LP risk because indoor spaces are less complex, resulting in the channeling of walking or social avoidance behaviors into more simplistic movements. Overall, our results suggest that elephant managers may best be able to prevent locomotor SB by enhancing their elephants' social environment and the spatial complexity of their enclosures. Future research should focus on determining whether addressing the risk factors for LP results in less

frequent performance and identifying other temporally proximate eliciting factors. © 2017 Elsevier B.V.

Whitham, J. C. and L. J. Miller (2016). "Using technology to monitor and improve zoo animal welfare." Animal Welfare **25**(4): 395-409.

While the international zoological community is committed to enhancing the welfare of individual animals, researchers have yet to take full advantage of the tools available for non-invasively tracking behavioural and physiological indicators of welfare. We review technology currently being applied in studies of zoo, farm and laboratory animals to regularly monitor welfare status, as well as to evaluate responses to particular stimuli and situations. In terms of behavioural measures, we focus on automated assessments that offer insight into how animals - even those that are nocturnal or elusive - behave when humans are not present. Specifically, we provide an overview of how animal-attached technology (accelerometers, global positioning systems, radio frequency identification systems) can be implemented to generate activity budgets, examine use of space, conduct gait assessments, determine rates of movement and study social dynamics. We also emphasise the value of bioacoustics, as the rate and acoustic structure of certain vocalisations may vary across contexts and reflect an animal's internal state. While it can be challenging to identify non-invasive methods for investigating physiological welfare indicators, we discuss approaches (thermography, tracking measures of heart rate) that may be especially useful for monitoring affective states and psychophysiological functioning. Finally, we make a concerted effort to highlight tools that allow welfare scientists to consider measures of positive welfare. Ultimately, zoos can ensure that each animal has the opportunity to thrive by employing technology to create baseline behavioural and physiological profiles, conduct ongoing monitoring schemes and assess responses to specific conditions, events and stimuli. © 2016 Universities Federation for Animal Welfare The Old School, Brewhouse Hill, Wheathampstead, Hertfordshire AL4 8AN, UK.

Varadharajan, V., T. Krishnamoorthy and B. Nagarajan (2016). "Prevalence of stereotypies and its possible causes among captive Asian elephants (Elephas maximus) in Tamil Nadu, India." Applied Animal Behaviour Science **174**: 137-146.

Animals in captivity are often confined in small barren enclosures, preventing adequate exercise, and socialization with conspecifics. Captivity is also known for depriving young individuals' association with maternal relatives by weaning away from their mothers' earlier than what their peers experience in free-living populations. Such husbandry practices often lead to various welfare problems among captive animals. In India, Asian elephants are managed in captivity under various systems, for various purposes. To understand the effect of husbandry practices on the welfare of elephants, this study first time from a range country examined the prevalence of stereotypies and its possible causes among 144 captive Asian elephants managed under three captive systems-Private, Hindu Temple and Forest Department-in southern India. Occurrence of stereotypies and its possible influences by factors like age, sex, housing type and its size, duration of

chaining and access to conspecific socialization were obtained by direct observations on each elephant and from registers maintained at each facility. Among the systems, the number of elephants with stereotypies was the highest in temple system (49%) followed by private (25%) and the lowest in the forest department (7%). None of the elephants that born in or brought from the wild and managed only at the timber camps was stereotyped. But those transferred from the timber camps to the temple, private and zoo and from the zoo to the timber camps showed stereotypies. Consistent with the prevalence of stereotypies among the three systems, number of elephants managed only at the indoor enclosure and duration of chaining were the highest in temple followed by private and the least in forest department system. The proportion of elephants displaying stereotypies and the proportion of time spent on stereotypies decreased significantly with age, indicating a greater vulnerability of young individuals to stereotypies. Further, logistic regression on prevalence of stereotypies with demographic and welfare parameters revealed that stereotypies decreased significantly with age and free access to conspecific association until juvenile stage, indicating again the juveniles without conspecific association are more susceptible to develop stereotypies. Multiple regression on extent of stereotypies and various daily routines revealed that the extent increased significantly with daily rituals, resting, and marginally with feeding implying that prolonged daily rituals and resting promote its extent. It is argued that deprivation of association with maternal relatives and isolation from conspecifics result in the appearance of stereotypies among elephants in captivity, with younger individuals being more susceptible, perhaps the most active phase of their life being confined by chaining. © 2015 Elsevier B.V.

Scott, N. L., B. Hansen, C. A. LaDue, C. Lam, A. Lai and L. Chan (2016). "Using an active Radio Frequency Identification Real-Time Location System to remotely monitor animal movement in zoos." Animal Biotelemetry **4**(1).

Background: Radio and satellite telemetry collars have been used across taxa, including with elephants, in situ for decades to collect data used for various analyses. To quantify the movement patterns of African elephants, Loxodonta africana, in a zoo, we modified a Real-Time Location System using active Radio Frequency Identification tags originally developed for inventory and asset tracking in warehouses. This is the first phase of a multi-phase project that we have termed the Real-Time Observer of Animal Movement. It allows for the continuous data collection and data analytics of elephant movement and space use in a mixed-species African savanna habitat at the Dallas Zoo. This system could prove to be a useful remote welfare tool for a variety of animal species at multiple facilities. Results: We determined that a Real-Time Location System using Radio Frequency Identification tags could be used to continuously monitor elephant movement, social relationships, and exhibit use remotely over several acres in a zoo with a volume of data not otherwise possible to achieve. Real-time visual outputs include current location in the habitat, paths taken around the habitat, habitat preferences, social relationships between the elephants, and data tables with average rate of travel and distance traveled. Conclusions: The pilot system at the Dallas

Zoo is the first-ever use of active Radio Frequency Identification technology to observe zoo animal behavior patterns and monitor welfare. It has proven to be an effective tool for efficiently collecting data continuously and remotely throughout the day and night. It represents the first phase of a multifaceted project that will add capabilities and functionality for additional species and other zoos to form a network for sharing data to inform captive animal management strategies.

Prado-Oviedo, N. A., M. K. Bonaparte-Saller, E. J. Malloy, C. L. Meehan, J. A. Mench, K. Carlstead and J. L. Brown (2016). "Evaluation of demographics and social life events of Asian (Elephas maximus) and African elephants (Loxodonta Africana) in North American zoos." PLoS ONE **11**(7).

This study quantified social life events hypothesized to affect the welfare of zoo African and Asian elephants, focusing on animals that were part of a large multi-disciplinary, multi-institutional elephant welfare study in North America. Age was calculated based on recorded birth dates and an age-based account of life event data for each elephant was compiled. These event histories included facility transfers, births and deaths of offspring, and births and deaths of non-offspring herd mates. Each event was evaluated as a total number of events per elephant, lifetime rate of event exposure, and age at first event exposure. These were then compared across three categories: species (African vs. Asian); sex (male vs. female); and origin (imported vs. captive-born). Mean age distributions differed ($p<0.05$) between the categories: African elephants were 6 years younger than Asian elephants, males were 12 years younger than females, and captive-born elephants were 20 years younger than imported elephants. Overall, the number of transfers ranged from 0 to 10, with a 33% higher age-adjusted transfer rate for imported African than imported Asian elephants, and 37% lower rate for imported females than males ($p<0.05$). Other differences ($p<0.05$) included a 96% higher rate of offspring births for captive-born females than those imported from range countries, a 159% higher rate of birthing event exposures for captive-born males than for their imported counterparts, and Asian elephant females being 4 years younger than African females when they produced their first calf. In summarizing demographic and social life events of elephants in North American zoos, we found both qualitative and quantitative differences in the early lives of imported versus captive-born elephants that could have long-term welfare implications.

Powell, D. M. and C. Vitale (2016). "Behavioral changes in female Asian elephants when given access to an outdoor yard overnight." Zoo Biol **35**(4): 298-303.

A study was conducted at the Bronx Zoo to determine whether providing elephants with access to an outdoor corral at night had any significant effects on behavior, use of space, and use of a sand corral. Activity budgets for three female Asian elephants were compared when the subjects were housed indoors overnight and when they were given access to an outdoor yard overnight. Observations were recorded via infrared video cameras between the hours of 1900 and 0700 during the months of July-September. Two of the three elephants showed a significant preference for spending time

outdoors, whereas, the third elephant spent most of her time indoors. Standing and play behavior increased when the elephants had outdoor access while lying down and feeding behavior decreased. Swaying behavior decreased significantly when the elephants had access to the outdoor yard. The elephants made very little use of a sand-floor stall regardless of whether or not they had access to outdoors. The results of this study, suggest that having access to alternate areas overnight can promote well-being by reducing repetitive behavior and allowing animals to express their preferences for different locations. The relative importance of choice alone vs. the behavioral opportunities provided by choice options for zoo animals is discussed. Zoo Biol. 35:298-303, 2016. (c) 2016 Wiley Periodicals, Inc.

Panagiotopoulou, O., T. C. Pataky, M. Day, M. C. Hensman, S. Hensman, J. R. Hutchinson and C. J. Clemente (2016). "Foot pressure distributions during walking in African elephants (Loxodonta africana)." R Soc Open Sci **3**(10): 160203.

Elephants, the largest living land mammals, have evolved a specialized foot morphology to help reduce locomotor pressures while supporting their large body mass. Peak pressures that could cause tissue damage are mitigated passively by the anatomy of elephants' feet, yet this mechanism does not seem to work well for some captive animals. This study tests how foot pressures vary among African and Asian elephants from habitats where natural substrates predominate but where foot care protocols differ. Variations in pressure patterns might be related to differences in husbandry, including but not limited to trimming and the substrates that elephants typically stand and move on. Both species' samples exhibited the highest concentration of peak pressures on the lateral digits of their feet (which tend to develop more disease in elephants) and lower pressures around the heel. The trajectories of the foot's centre of pressure were also similar, confirming that when walking at similar speeds, both species load their feet laterally at impact and then shift their weight medially throughout the step until toe-off. Overall, we found evidence of variations in foot pressure patterns that might be attributable to husbandry and other causes, deserving further examination using broader, more comparable samples.

Morfeld, K. A., C. L. Meehan, J. N. Hogan and J. L. Brown (2016). "Assessment of body condition in African (Loxodonta africana) and Asian (Elephas maximus) elephants in North American zoos and management practices associated with high body condition scores." PLoS ONE **11**(7).

Obesity has a negative effect on health and welfare of many species, and has been speculated to be a problem for zoo elephants. To address this concern, we assessed the body condition of 240 elephants housed in North American zoos based on a set of standardized photographs using a 5-point Body Condition Score index (1 = thinnest; 5 = fattest). A multivariable regression analysis was then used to determine how demographic, management, housing, and social factors were associated with an elevated body condition score in 132 African (Loxodonta africana) and 108 Asian (Elephas maximus) elephants. The highest BCS of 5, suggestive of obesity, was observed in 34% of zoo elephants. In both species, the majority of elephants had elevated

BCS, with 74% in the BCS 4 (40%) and 5 (34%) categories. Only 22% of elephants had BCS 3, and less than 5% of the population was assigned the lowest BCS categories (BCS 1 and 2). The strongest multi-variable model demonstrated that staff-directed walking exercise of 14 hours or more per week and highly unpredictable feeding schedules were associated with decreased risk of BCS 4 or 5, while increased diversity in feeding methods and being female was associated with increased risk of BCS 4 or 5. Our data suggest that high body condition is prevalent among North American zoo elephants, and management strategies that help prevent and mitigate obesity may lead to improvements in welfare of zoo elephants.

Miller, L. J., M. J. Chase and C. E. Hacker (2016). "A Comparison of Walking Rates Between Wild and Zoo African Elephants." Journal of Applied Animal Welfare Science **19**(3): 271-279.

With increased scrutiny surrounding the welfare of elephants in zoological institutions, it is important to have empirical evidence on their current welfare status. If elephants are not receiving adequate exercise, it could lead to obesity, which can lead to many issues including acyclicity and potentially heart disease. The goal of the current study was to compare the walking rates of elephants in the wild versus elephants in zoos to determine if elephants are walking similar distances relative to their wild counterparts. Eleven wild elephants throughout different habitats and locations in Botswana were compared to 8 elephants at the San Diego Zoo Safari Park. Direct comparisons revealed no significant difference in average walking rates of zoo elephants when compared with wild elephants. These results suggest that elephants at the San Diego Zoo Safari Park walk similar rates to those of wild elephants and may be meeting their exercise needs. © 2016 Taylor & Francis.

Meehan, C. L., J. A. Mench, K. Carlstead and J. N. Hogan (2016). "Determining Connections between the Daily Lives of Zoo Elephants and Their Welfare: An Epidemiological Approach." PLoS ONE **11**(7): e0158124.

Concerns about animal welfare increasingly shape people's views about the acceptability of keeping animals for food production, biomedical research, and in zoos. The field of animal welfare science has developed over the past 50 years as a method of investigating these concerns via research that assesses how living in human-controlled environments influences the behavior, health and affective states of animals. Initially, animal welfare research focused on animals in agricultural settings, but the field has expanded to zoos because good animal welfare is essential to zoos' mission of promoting connections between animals and visitors and raising awareness of conservation issues. A particular challenge for zoos is ensuring good animal welfare for long-lived, highly social species like elephants. Our main goal in conducting an epidemiological study of African (Loxodonta africana) and Asian (Elephas maximus) elephant welfare in 68 accredited North American zoos was to understand the prevalence of welfare indicators in the population and determine the aspects of an elephant's zoo environment, social life and management that are most important to prevent

and reduce a variety of welfare problems. In this overview, we provide a summary of the findings of the nine papers in the collection titled: Epidemiological Investigations of North American Zoo Elephant Welfare with a focus on the life history, social, housing, and management factors found to be associated with particular aspects of elephant welfare, including the performance of abnormal behavior, foot and joint problems, recumbence, walking rates, and reproductive health issues. Social and management factors were found to be important for multiple indicators of welfare, while exhibit space was found to be less influential than expected. This body of work results from the largest prospective zoo-based animal welfare study conducted to date and sets in motion the process of using science-based welfare benchmarks to optimize care of zoo elephants.

Meehan, C. L., J. N. Hogan, M. K. Bonaparte-Saller and J. A. Mench (2016). "Housing and Social Environments of African (Loxodonta africana) and Asian (Elephas maximus) Elephants in North American Zoos." PLoS ONE **11**(7): e0146703.

We evaluated 255 African (Loxodonta africana) and Asian (Elephas maximus) elephants living in 68 North American zoos over one year to quantify housing and social variables. All parameters were quantified for the both the day and the night and comparisons were made across these time periods as well as by species and sex. To assess housing, we evaluated not only total exhibit size, but also individual animals' experiences based on the time they spent in the unique environments into which the exhibits were subdivided. Variables developed to assess housing included measurements of area as a function of time (Total Space Experience), environment type (Indoor, Outdoor, In/Out Choice) and time spent on hard and soft flooring. Over the year, Total Space Experience values ranged from 1,273 square feet to 169,692 square feet, with Day values significantly greater than Night values ($p<0.001$). Elephants spent an average of 55.1% of their time outdoors, 28.9% indoors, and 16% in areas with a choice between being in or out. Time spent on hard flooring substrate ranged from 0% to 66.7%, with Night values significantly greater than Day ($p<0.001$). Social factors included number of animals functionally housed together (Social Experience) and social group characteristics such as time spent with juveniles and in mixed-sex groups. Overall Social Experience scores ranged from 1 to 11.2 and were significantly greater during the Day than at Night ($p<0.001$). There were few significant social or housing differences between African (N = 138) and Asian (N = 117) species or between males (N = 54) and females (N = 201). The most notable exception was Total Space Experience, with African and male elephants having larger Total Space Experience than Asian and female elephants, respectively (P-value<0.05). The housing and social variables evaluated herein have been used in a series of subsequent epidemiological analyses relating to various elephant welfare outcomes.

Martin, R. A. and V. Melfi (2016). "A Comparison of Zoo Animal Behavior in the Presence of Familiar and Unfamiliar People." J Appl Anim Welf Sci **19**(3): 234-244.

As recorded in domestic nonhuman animals, regular interactions between

animals in zoos and keepers and the resulting relationship formed (human-animal relationship [HAR]) are likely to influence the animals' behaviors with associated welfare consequences. HAR formation requires that zoo animals distinguish between familiar and unfamiliar people. This ability was tested by comparing zoo animal behavioral responses to familiar (routine) keepers and unfamiliar keepers (participants in the "Keeper for the Day" program). Study subjects included 1 African elephant (Loxodonta Africana), 3 Rothschild's giraffes (Giraffa camelopardalis rothschildi), 2 Brazilian tapir (Tapirus terrestris), and 2 slender-tailed meerkats (Suricata suricatta). Different behavior was evident and observed as decreased avoidance behavior toward familiar keepers ($t7 = 6.00$, $p < .001$). This finding suggests the zoo animals have a lower level of fear toward familiar keepers. Keeper familiarity did not significantly affect any other behavioral measure. This finding suggests that in the current study, unfamiliar keeper presence did not appear to have detrimental effects. Furthermore, unfamiliar keeper-animal interactions could provide an increased number of positive human-animal interactions and potentially enhance animal welfare.

Holdgate, M. R., C. L. Meehan, J. N. Hogan, L. J. Miller, J. Soltis, J. Andrews and D. J. Shepherdson (2016). "Walking Behavior of Zoo Elephants: Associations between GPS-Measured Daily Walking Distances and Environmental Factors, Social Factors, and Welfare Indicators." PLoS ONE **11**(7): e0150331.

Research with humans and other animals suggests that walking benefits physical health. Perhaps because these links have been demonstrated in other species, it has been suggested that walking is important to elephant welfare, and that zoo elephant exhibits should be designed to allow for more walking. Our study is the first to address this suggestion empirically by measuring the mean daily walking distance of elephants in North American zoos, determining the factors that are associated with variations in walking distance, and testing for associations between walking and welfare indicators. We used anklets equipped with GPS data loggers to measure outdoor daily walking distance in 56 adult female African (n = 33) and Asian (n = 23) elephants housed in 30 North American zoos. We collected 259 days of data and determined associations between distance walked and social, housing, management, and demographic factors. Elephants walked an average of 5.3 km/day with no significant difference between species. In our multivariable model, more diverse feeding regimens were correlated with increased walking, and elephants who were fed on a temporally unpredictable feeding schedule walked 1.29 km/day more than elephants fed on a predictable schedule. Distance walked was also positively correlated with an increase in the number of social groupings and negatively correlated with age. We found a small but significant negative correlation between distance walked and nighttime Space Experience, but no other associations between walking distances and exhibit size were found. Finally, distance walked was not related to health or behavioral outcomes including foot health, joint health, body condition, and the performance of stereotypic behavior, suggesting that more research is necessary to determine explicitly how differences in walking may impact elephant welfare.

Holdgate, M. R., C. L. Meehan, J. N. Hogan, L. J. Miller, J. Rushen, A. M. de Passille, J. Soltis, J. Andrews and D. J. Shepherdson (2016). "Recumbence Behavior in Zoo Elephants: Determination of Patterns and Frequency of Recumbent Rest and Associated Environmental and Social Factors." PLoS ONE **11**(7): e0153301.

Resting behaviors are an essential component of animal welfare but have received little attention in zoological research. African savanna elephant (Loxodonta africana) and Asian elephant (Elephas maximus) rest includes recumbent postures, but no large-scale investigation of African and Asian zoo elephant recumbence has been previously conducted. We used anklets equipped with accelerometers to measure recumbence in 72 adult female African (n = 44) and Asian (n = 28) elephants housed in 40 North American zoos. We collected 344 days of data and determined associations between recumbence and social, housing, management, and demographic factors. African elephants were recumbent less (2.1 hours/day, S.D. = 1.1) than Asian elephants (3.2 hours/day, S.D. = 1.5; P < 0.001). Nearly one-third of elephants were non-recumbent on at least one night, suggesting this is a common behavior. Multi-variable regression models for each species showed that substrate, space, and social variables had the strongest associations with recumbence. In the African model, elephants who spent any amount of time housed on all-hard substrate were recumbent 0.6 hours less per day than those who were never on all-hard substrate, and elephants who experienced an additional acre of outdoor space at night increased their recumbence by 0.48 hours per day. In the Asian model, elephants who spent any amount of time housed on all-soft substrate were recumbent 1.1 hours more per day more than those who were never on all-soft substrate, and elephants who spent any amount of time housed alone were recumbent 0.77 hours more per day than elephants who were never housed alone. Our results draw attention to the significant interspecific difference in the amount of recumbent rest and in the factors affecting recumbence; however, in both species, the influence of flooring substrate is notably important to recumbent rest, and by extension, zoo elephant welfare.

Greco, B. J., C. L. Meehan, J. N. Hogan, K. A. Leighty, J. Mellen, G. J. Mason and J. A. Mench (2016). "The Days and Nights of Zoo Elephants: Using Epidemiology to Better Understand Stereotypic Behavior of African Elephants (Loxodonta africana) and Asian Elephants (Elephas maximus) in North American Zoos." PLoS ONE **11**(7): e0144276.

Stereotypic behavior is an important indicator of compromised welfare. Zoo elephants are documented to perform stereotypic behavior, but the factors that contribute to performance have not been systematically assessed. We collected behavioral data on 89 elephants (47 African [Loxodonta africana], 42 Asian [Elephas maximus]) at 39 North American zoos during the summer and winter. Elephants were videoed for a median of 12 daytime hours per season. A subset of 32 elephants (19 African, 13 Asian) was also observed live for a median of 10.5 nighttime hours. Percentages of visible behavior scans were calculated from five minute instantaneous samples. Stereotypic behavior was the second most commonly performed behavior (after feeding),

making up 15.5% of observations during the daytime and 24.8% at nighttime. Negative binomial regression models fitted with generalized estimating equations were used to determine which social, housing, management, life history, and demographic variables were associated with daytime and nighttime stereotypic behavior rates. Species was a significant risk factor in both models, with Asian elephants at greater risk (daytime: $p<0.001$, Risk Ratio = 4.087; nighttime: $p<0.001$, Risk Ratio = 8.015). For both species, spending time housed separately ($p<0.001$, Risk Ratio = 1.009), and having experienced inter-zoo transfers ($p<0.001$, Risk Ratio = 1.175), increased the risk of performing higher rates of stereotypy during the day, while spending more time with juvenile elephants ($p<0.001$, Risk Ratio = 0.985), and engaging with zoo staff reduced this risk ($p = 0.018$, Risk Ratio = 0.988). At night, spending more time in environments with both indoor and outdoor areas ($p = 0.013$, Risk Ratio = 0.987) and in larger social groups ($p = 0.039$, Risk Ratio = 0.752) corresponded with reduced risk of performing higher rates of stereotypy, while having experienced inter-zoo transfers ($p = 0.033$, Risk Ratio = 1.115) increased this risk. Overall, our results indicate that factors related to the social environment are most influential in predicting elephant stereotypic behavior rates.

Edwards, K. L., J. Trotter, M. Jones, J. L. Brown, H. W. Steinmetz and S. L. Walker (2016). "Investigating temporary acyclicity in a captive group of Asian elephants (Elephas maximus): Relationship between management, adrenal activity and social factors." General and Comparative Endocrinology **225**: 104-116.

Routine faecal steroid monitoring has been used to aid the management of five captive Asian elephant (. Elephas maximus) females at Chester Zoo, UK, since 2007. Progestagen analysis initially revealed synchronised oestrous cycles among all females. However, a 14- to 20-week period of temporary acyclicity subsequently occurred in three females, following several management changes (increased training, foot-care and intermittent matriarch removal for health reasons) and the initiation of pregnancy in another female. The aim of this study was to retrospectively investigate whether these management changes were related to increased adrenal activity and disruption of ovarian activity, or whether social factors may have been involved in the temporary cessation of cyclicity. Faecal samples collected every other day were analysed to investigate whether glucocorticoid metabolites were related to reproductive status (pregnant, cycling, acyclic) or management (training, foot-care, matriarch presence). Routine training and foot-care were not associated with adrenal activity; however, intensive foot-care to treat an abscess in one female was associated with increased glucocorticoid concentration. Matriarch presence influenced adrenal activity in three females, being lower when the matriarch was separated from the group at night compared to being always present. However, in the females that exhibited temporary acyclicity, there was no consistent relationship between glucocorticoids and cyclicity state. Although the results of this study do not fully explain this occurrence, the highly synchronised nature of oestrous cycles within this group, and the concurrent acyclicity in three females, raises the question of whether social factors could have been involved in the

temporary disruption of ovarian activity. © 2015 Elsevier Inc.

Cameron, E. Z. and S. J. Ryan (2016). "Welfare at Multiple Scales: Importance of Zoo Elephant Population Welfare in a World of Declining Wild Populations." PLoS ONE **11**(7): e0158701.

Brown, J. L., S. Paris, N. A. Prado-Oviedo, C. L. Meehan, J. N. Hogan, K. A. Morfeld and K. Carlstead (2016). "Reproductive health assessment of female elephants in north American zoos and association of husbandry practices with reproductive dysfunction in african elephants (loxodonta africana)." PLoS ONE **11**(7).

As part of a multi-institutional study of zoo elephant welfare, we evaluated female elephants managed by zoos accredited by the Association of Zoos and Aquariums and applied epidemiological methods to determine what factors in the zoo environment are associated with reproductive problems, including ovarian acyclicity and hyperprolactinemia. Bi-weekly blood samples were collected from 95 African (Loxodonta africana) and 75 Asian (Elephas maximus)(8-55 years of age) elephants over a 12-month period for analysis of serum progestogens and prolactin. Females were categorized as normal cycling (regular 13- to 17-week cycles), irregular cycling (cycles longer or shorter than normal) or acyclic (baseline progestogens, <0.1 ng/ml throughout), and having Low/Normal (<14 or 18 ng/ml) or High (14 or 18 ng/ml) prolactin for Asian and African elephants, respectively. Rates of normal cycling, acyclicity and irregular cycling were 73.2, 22.5 and 4.2% for Asian, and 48.4, 37.9 and 13.7% for African elephants, respectively, all of which differed between species ($P < 0.05$). For African elephants, univariate assessment found that social isolation decreased and higher enrichment diversity increased the chance a female would cycle normally. The strongest multi-variable models included Age (positive) and Enrichment Diversity (negative) as important factors of acyclicity among African elephants. The Asian elephant data set was not robust enough to support multi-variable analyses of cyclicity status. Additionally, only 3% of Asian elephants were found to be hyperprolactinemic as compared to 28% of Africans, so predictive analyses of prolactin status were conducted on African elephants only. The strongest multi-variable model included Age (positive), Enrichment Diversity (negative), Alternate Feeding Methods (negative) and Social Group Contact (positive) as predictors of hyperprolactinemia. In summary, the incidence of ovarian cycle problems and hyperprolactinemia predominantly affects African elephants, and increases in social stability and feeding and enrichment diversity may have positive influences on hormone status.

Wilson, M. L., B. M. Perdue, M. A. Bloomsmith and T. L. Maple (2015). "Rates of reinforcement and measures of compliance in free and protected contact elephant management systems." Zoo Biol **34**(5): 431-437.

Protected contact is an alternative to traditional captive elephant training

techniques that emerged as a result of concerns for animal welfare and personnel safety. The present study documented the behavior of elephants and their animal care professionals to determine rates of reinforcement and measures of compliance under two handling systems. Behavioral data were collected from animal care professionals and elephants during the elephants' baths in both free contact (FC) and protected contact (PC). Positive reinforcement, in the form of food, was delivered, on average, nearly eight times more frequently in the PC condition. Further, the mean rate at which the animal care professionals used the ankus in the FC condition as negative reinforcement was similar to the mean rate at which they provided positive reinforcement to the elephants in the FC condition. Latencies between verbal commands and the elephants' behaviors demonstrated an inconsistent pattern, but were generally longer in the PC condition. The mean percent of "refusals" by the elephants was higher for most behaviors across elephants in the PC condition. The findings suggest that animal care professionals did not heavily rely on positive reinforcement in the FC condition to elicit desired behaviors from the elephants, but this was the case in the PC condition. We propose that longer latencies and higher mean percent of refusals by the elephants may indicate that they were exercising choice or control over their environment, which has been associated with improved well-being. Additional studies of this kind are needed to enable other institutions to make informed decisions about elephant management and welfare.

Williams, E., S. Bremner-Harrison, N. Harvey, E. Evison and L. Yon (2015). "An investigation into resting behavior in Asian elephants in UK zoos." Zoo Biology **34**(5): 406-417.

Maintaining adequate welfare in captive elephants is challenging. Few studies have investigated overnight rest behavior in zoo elephants, yet time spent resting has been identified as a welfare indicator in some species. We investigated resting behavior in Asian elephants (Elephas maximus) in UK zoos, with the aim of identifying patterns or preferences in lying rest. Details of standing (SR) and lying (LR) rest behavior were identified by observing video footage of inside enclosures collected for 14 elephants (2 male, 12 female) housed at three UK zoos (Zoo A: 18 nights; Zoo B: 27 nights; Zoo C: 46 nights) from 16:00 to 08:30 (approximately). Elephants engaged in a mean of 58-337min rest per night. Time of night affected mean duration of LR bouts ($P<0.001$); longest bouts were observed between 22:01 and 06:00. Elephants showed a substrate preference when lying to rest; LR was not observed on concrete or tiled flooring. Where sand was available (to 11/14 elephants), all elephants engaged in LR on sand flooring. Only two elephants engaged in LR on rubber flooring (available to 7/14 elephants). Mean duration of rest bouts was greater when a conspecific was within two body lengths than when conspecifics were not ($P<0.01$). Our study indicated that elephants show substrate preferences when choosing an area for rest and engage in more rest when conspecifics are in close proximity. The results of this study could be used as a basis for future studies investigating the link between rest and welfare in captive elephants. Zoo Biol. 34:406-417, 2015. (c) 2015 Wiley Periodicals, Inc.

Ward, S. J. and V. Melfi (2015). "Keeper-animal interactions: Differences between the behaviour of zoo animals affect stockmanship." PLoS ONE **10**(10).

Stockmanship is a term used to describe the management of animals with a good stockperson someone who does this in a in a safe, effective, and low-stress manner for both the stock-keeper and animals involved. Although impacts of unfamiliar zoo visitors on animal behaviour have been extensively studied, the impact of stockmanship i.e familiar zoo keepers is a new area of research; which could reveal significant ramifications for zoo animal behaviour and welfare. It is likely that different relationships are formed dependant on the unique keeper-animal dyad (human-animal interaction, HAI). The aims of this study were to (1) investigate if unique keeper-animal dyads were formed in zoos, (2) determine whether keepers differed in their interactions towards animals regarding their attitude, animal knowledge and experience and (3) explore what factors affect keeper-animal dyads and ultimately influence animal behaviour and welfare. Eight black rhinoceros (Dicerosbicornis), eleven Chapman's zebra (Equus burchellii), and twelve Sulawesi crested black macaques (Macaca nigra) were studied in 6 zoos across the UK and USA. Subtle cues and commands directed by keepers towards animals were identified. The animals latency to respond and the respective behavioural response (cue-response) was recorded per keeper-animal dyad (n = 93). A questionnaire was constructed following a five-point Likert Scale design to record keeper demographic information and assess the job satisfaction of keepers, their attitude towards the animals and their perceived relationship with them. There was a significant difference in the animals' latency to appropriately respond after cues and commands from different keepers, indicating unique keeper-animal dyads were formed. Stockmanship style was also different between keepers; two main components contributed equally towards this: "attitude towards the animals" and "knowledge and experience of the animals". In this novel study, data demonstrated unique dyads were formed between keepers and zoo animals, which influenced animal behaviour.

Vicino, G. A. and E. S. Marcacci (2015). "Intensity of play behavior as a potential measure of welfare: A novel method for quantifying the integrated intensity of behavior in African elephants." Zoo Biology **34**(5): 492-496.

To the authors' knowledge there is currently no discrete index to measure the integrated intensity of a play bout in mammals, despite the potential for using intensity and duration of play bouts as a measure of physical activity and welfare. This study was developed to test an equation that quantified the intensity and duration of play bouts in a particularly gregarious mammal, African elephants (Loxodonta africana) housed at the San Diego Zoo Safari Park in Escondido, CA. To quantify these behaviors, we created a scale of intensity and a subsequent equation that produces an index value, giving

each unique bout a score. A compilation of these scores provides a range of intensity of play behavior that is a representative value for that particular herd at that point in time, and thus a database to which later bouts can be compared. It can be argued that play behavior is an indicator of positive welfare, and if quantifiable, it is our belief that it can be used as an additional measure of positive welfare in zoo housed animals. Here we present the methods and technique used to calculate a standardized Integrated Play Index (IPI) that has potential for use in other socially living species that are known to exhibit play behavior. Zoo Biol. 34:492-496, 2015. (c) 2015 Wiley Periodicals, Inc.

Rose, P. E. and D. P. Croft (2015). "The potential of Social Network Analysis as a tool for the management of zoo animals." Animal Welfare **24**(2): 123-138.

Social Network Analysis (SNA) enables the fine scale of animal sociality and population structure to be quantified. SNA is widely applied to questions relating to behavioural ecology but has seen little use in the application to zoo animal management, despite its clear potential. Investment in social bonds between individuals positively affects health status, welfare state, long-term fitness and lifetime reproductive output. Such positive affective states can be maintained consistently within captive situations if more information is known about the social preferences of the individuals that are kept. Disruption to social bonds may lead to impoverished welfare and stress to individuals which have seen their social support compromised. The patterning of social relationships between individuals also influences how space is utilised and how animals interact with resources provided for them. With more detailed knowledge of the social structure of a group or population, social groupings (for example, for captive breeding) can be specifically designed to minimise social stress. Likewise, enhancing the chances of successful reproduction can be achieved if we understand the role that each individual within a network plays and how these roles may impact on the behaviour of others. This paper discusses key aspects of SNA applicable to zoo-based researchers wishing to investigate the social lives of zoo animals. We present a review of how SNA can be used to assess social behaviour and highlight directions for future research. Our aim is to stimulate new research to ultimately improve our understanding of reproductive success, decision-making, group leadership, animal health and enclosure use. We conclude that what can be learned about the dynamics of social zoo-housed species using SNA can directly impact on husbandry decisions and help underpin excellent standards of animal welfare.

Ranaweerage, E., A. D. G. Ranjeewa and K. Sugimoto (2015). "Tourism-induced disturbance of wildlife in protected areas: A case study of free ranging elephants in Sri Lanka." Global Ecology and Conservation **4**: 625-631.

Tourism-induced disturbance is a growing concern in wildlife conservation worldwide. This case study in a key protected area in Sri Lanka, examined the behavioral changes of Asian elephants in the context of elephant watching tourism activities. Observations of different age-sex-group classes of elephants were conducted focusing on the feeding activity of elephants in

the presence vs. absence of tourists. Frequency and duration of alert, fear, stress and aggressive behaviors of elephants were significantly high in the presence of tourists and these behaviors occurred at a cost of feeding time. Tourist behavior, vehicle noise, close distances and time of the tours were closely associated with the behavioral changes of elephants. It is important to monitor tourism effects on endangered species such as Asian elephants and to take proper measures including controlled tourist behavior and vehicle activity in protected areas in order to reduce disturbance of wildlife behavior.

Magda, S., O. Spohn, T. Angkawanish, D. A. Smith and D. L. Pearl (2015). "Risk factors for saddle-related skin lesions on elephants used in the tourism industry in Thailand." Bmc Veterinary Research **11**.

Background: Lesions related to working conditions and improper saddle design are a concern for a variety of working animals including elephants. The objectives of the present study were to determine the prevalence of cutaneous lesions in anatomic regions (i.e., neck, girth, back, tail) in contact with saddle-related equipment among elephants in Thailand working in the tourism industry, and to identify potential risk factors associated with these lesions. Data for this cross-sectional study were collected between May 2007 and July 2007 on 194 elephants from 18 tourism camps across Thailand. Results: There was a high prevalence (64.4 %; 95 % CI 57.3 - 71.2) of active lesions, most often located on the back region. Using multilevel multivariable logistic regression modelling containing a random intercept for camp we identified the following risk factors: increasing elephant age, the use of rice sacks as padding material in contact with the skin, and the provision of a break for the elephants. Working hours had a quadratic relationship with the log odds of an active lesion where the probability of an active lesion initially increased with the number of working hours per day and then declined possibly reflecting a "healthy worker" bias where only animals without lesions continue to be able to work these longer hours. Conclusions: While we recognize that the cross-sectional nature of the study posed some inferential limitations, our results offer several potential intervention points for the prevention of these lesions. Specifically, we recommend the following until longitudinal studies can be conducted: increased monitoring of older elephants and the back region of all elephants, working less than 6 hours per day, and the avoidance of rice sacks as padding material in contact with skin.

Hasenjager, M. J. and R. A. Bergl (2015). "Environmental conditions associated with repetitive behavior in a group of African elephants." Zoo Biol **34**(3): 201-210.

Repetitive movement patterns are commonly observed in zoo elephants. The extent to which these behaviors constitute a welfare concern varies, as their expression ranges from stereotypies to potentially beneficial anticipatory behaviors. Nevertheless, their occurrence in zoo animals is often viewed negatively. To better identify conditions that prompt their performance, observations were conducted on six African elephants (Loxodonta africana) at the North Carolina Zoo. Individuals spent most of their time engaged in feeding, locomotion, resting, and repetitive behavior. Both generalized

estimating equation and zero-inflated negative binomial models were used to identify factors associated with increased rates of repetitive behavior. Time of day in conjunction with location on- or off-exhibit best explained patterns of repetitive behavior. Repetitive behaviors occurred at a lower rate in the morning when on-exhibit, as compared to afternoons on-exhibit or at any time of day off-exhibit. Increased repetitive behavior rates observed on-exhibit in the afternoon prior to the evening transfer and feeding were possibly anticipatory responses towards those events. In contrast, consistently elevated frequencies of repetitive behavior off-exhibit at all times of day could be related to differences in exhibit complexity between off-exhibit and on-exhibit areas, as well as a lack of additional foraging opportunities. Our study contributes valuable information on captive elephant behavior and represents a good example of how behavioral research can be employed to improve management of zoo animals.

Hacker, C. E., K. M. Horback and L. J. Miller (2015). "GPS technology as a proxy tool for determining relationships in social animals: An example with African elephants." Applied Animal Behaviour Science **163**: 175-182.

The potential application of GPS technology in determining relationships among social animals was addressed in this study of eight African elephants residing at the San Diego Zoo Safari Park in Escondido, CA, USA between 2009 and 2011. GPS coordinates were collected over nine 24 h periods from eight different elephants. The average distances between individuals were then calculated for the morning, afternoon and evening time periods as well as for the entire 24 h. Behavioral data were collected to calculate rates of both positive and negative interactions between elephants as well as David's scores to measure sociality. Lastly, input from the management staff regarding the elephants' social relations was utilized to determine pairs who may display high levels of social proximity as well as the construction of a dominance structure. Significant correlations were found between the social relations determined by animal management staff and the GPS morning data (r=0.431, P=0.022), the social relations determined by animal management staff and the GPS daily data (r=0.401, P=0.034), the corrected David's scores and the GPS daily data (r=0.471, P=0.012), the early time period (r=0.614, P=0.001), the morning time period (r=0.441, P=0.020) and the afternoon time period (r=0.474, P=0.012) and the rate of positive social interactions and the GPS evening data (r=0.386, P=0.042). These results suggest that GPS technology can be used as a proxy tool in determining social relationships. GPS devices can aid in animal behavior research by eliminating the need for an observer and thereby relieving time and staff restraints. Planning the daily management of animals around their known social groups can potentially increase overall animal welfare and safety for caretakers. For example, keeping the animals in their known social groups could decrease stress and the potential for aggressive behavior during training, transport, shifting of individuals or groups between exhibits, and general husbandry. (C) 2014 Elsevier B.V. All rights reserved.

Gurusamy, V., A. Tribe, S. Toukhsati and C. J. C. Phillips (2015). "Public Attitudes

in India and Australia toward Elephants in Zoos." Anthrozoos **28**(1): 87-100.

We surveyed the attitudes of people toward captive elephants in Australia, where importation into zoos has been controversial recently, compared with India, where elephants are indigenous. Both Australian (AR, n = 101) and Indian (IR, n = 101) respondents rated conservation as the most important reason for the role of zoos and sanctuaries. Australian respondents were more concerned about the husbandry conditions for keeping wild animals in zoos and sanctuaries than Indian respondents ($p = 0.02$). This concern for captive animals increased with the higher educational level of the respondents. Female Australian respondents were more concerned about the practice of keeping elephants in captivity than Australian men. More Australian respondents were prepared to pay extra to visit a zoo with elephants (AR 42.6%, IA 7.9%, $p < 0.001$). Indian respondents believed more than their Australian counterparts that it was important for any zoo to display elephants, and wanted to interact with elephants by feeding, touching, and riding on them. While Australian respondents' perceptions of captive elephants acknowledged their scientific value, Indian respondents viewed elephants primarily of religious, cultural, and historical significance. We conclude that Australians and Indians have different requirements for keeping elephants in zoos, which should inform zoo directors about the best way to present them to the public.

Duffy, R. (2015). "Nature-based tourism and neoliberalism: concealing contradictions." Tourism Geographies **17**(4): 529-543.

Tourism, including nature-based tourism, simultaneously produces and conceals the contradictions of capitalism. This is because it relies on creating attractions, or new sources of accumulation from the very crises it produces. Nature-based tourism is promoted as a 'win-win' that can resolve the contradiction between continual economic growth and finite natural resources. This is made possible via a process of neoliberalising nature, which cuts the threads that bind ecosystems together, so that the constituent parts can be transformed into new commodities. To draw out these broad arguments, this paper firstly examines the claims around tourism as 'green economy' – which proponents claim can produce environmentally sustainable economic growth – a benefit also associated with nature-based tourism. I also show that this can be regarded as simply the latest version of an existing debate rather than offering a new interpretation. This is explored further via a comparative analysis of how tourism neoliberalises nature at the scales of the individual animal (elephant trekking in Thailand) and the landscape (by global networks of NGOs operating in Madagascar). In the case of neoliberalisation of nature at the individual animal scale, the notion of bodily fix is also important. It is not just the elephants that are primed for commodity capture, it is the emotional experience of close interactions with elephants which is commodified. Such changes reshape societal relations with nature, but in uneven and incomplete ways. This is underlined by a discussion of the case of the Durban Vision Initiative in Madagascar – which reveals how neoliberalisation was incomplete as a result of its encounter with local level materialities.

Wong, K. (2014). "Tusk to dust." Sci Am **310**(2): 18.

Sin, H. L. and C. Minca (2014). "Touring responsibility: The trouble with 'going local' in community-based tourism in Thailand." Geoforum **51**: 96-106.

This paper discusses the question of responsibility with reference to community-based tourism. Local communities are often presented by the tourist industry as an inherent value to recognize and protect. Tourists visiting distant places are thus frequently exhorted to 'go local' through having a 'real' experience with local people and communities; they are also invited to behave responsibly and to appreciate the value of responsible management. In this article, we reflect on the consequences of the 'contact zone' produced by these trends and, more in general, on the rapid changes that the label 'responsible tourism' is generating in the ways that many travelers approach the experience of local communities and their lifestyles. We do so, by analyzing an Elephant Camp in Thailand, where tourists spend periods being involved in life of the camp and the management of the elephants. The tourists at the Elephant camp indeed show how this approach to travel often becomes an imbroglio of detachment and involvement, of paternalistic protection and mutual exploitation, of generosity and hospitality, but also of corruption and self-interest. All in all, we present the Elephant Camp as a laboratory for reflecting on how questions of responsibility towards distant people and places, especially when actually enacted in place - which is what tourism does - often become a complicated affair, which is at the origin of new opportunities but also new tensions, of learning and but also misunderstandings, of neo-colonial practices but also of actual support to the local economy. © 2013 Elsevier Ltd.

Massei, G. and D. Cowan (2014). "Fertility control to mitigate human-wildlife conflicts: A review." Wildlife Research **41**(1): 1-21.

As human populations grow, conflicts with wildlife increase. Concurrently, concerns about the welfare, safety and environmental impacts of conventional lethal methods of wildlife management restrict the options available for conflict mitigation. In parallel, there is increasing interest in using fertility control to manage wildlife. The present review aimed at analysing trends in research on fertility control for wildlife, illustrating developments in fertility-control technologies and delivery methods of fertility-control agents, summarising the conclusions of empirical and theoretical studies of fertility control applied at the population level and offering criteria to guide decisions regarding the suitability of fertility control to mitigate human-wildlife conflicts. The review highlighted a growing interest in fertility control for wildlife, underpinned by increasing numbers of scientific studies. Most current practical applications of fertility control for wild mammals use injectable single-dose immunocontraceptive vaccines mainly aimed at sterilising females, although many of these vaccines are not yet commercially available. One oral avian contraceptive, nicarbazin, is commercially available in some countries. Potential new methods of remote contraceptive delivery include bacterial ghosts, virus-like particles and

genetically modified transmissible and non-transmissible organisms, although none of these have yet progressed to field testing. In parallel, new species-specific delivery systems have been developed. The results of population-level studies of fertility control indicated that this approach may increase survival and affect social and spatial behaviour of treated animals, although the effects are species- and context-specific. The present studies suggested that a substantial initial effort is generally required to reduce population growth if fertility control is the sole wildlife management method. However, several empirical and field studies have demonstrated that fertility control, particularly of isolated populations, can be successfully used to limit population growth and reduce human-wildlife conflicts. In parallel, there is growing recognition of the possible synergy between fertility control and disease vaccination to optimise the maintenance of herd immunity in the management of wildlife diseases. The review provides a decision tree that can be used to determine whether fertility control should be employed to resolve specific human-wildlife conflicts. These criteria encompass public consultation, considerations about animal welfare and feasibility, evaluation of population responses, costs and sustainability. © CSIRO 2014.

Horback, K. M., L. J. Miller, J. R. Andrews and S. A. Kuczaj, 2nd (2014). "Diurnal and nocturnal activity budgets of zoo elephants in an outdoor facility." Zoo Biol **33**(5): 403-410.

The present study examined the activity budgets of 15 African elephants (1 bull, 6 cows, 2 male juveniles, 2 female juveniles, and 4 male calves) living at the San Diego Zoo Safari Park during the summers of 2010 and 2011. Onsite behavioral data (n = 600 hr) were collected for approximately 12 weeks from 0400 to 0830 and 1100 to 2400 during the 2010 and 2011 summer season. Foraging was the most common behavior state during the day followed by resting, and walking. During the evening hours, the elephants spent majority of their time foraging, resting, and sleeping. The average rate of self-maintenance behavior events (dust, wallow, etc.) increased from 0600 to 0700, 1100 to 1500, and from 1700 to 1900. Positive social behavior events (touch other, play, etc.) remained high from 0500 to 2300, with peaks at 0600, 1300, 1500, and 1900. Negative social events occurred at low rates throughout the day and night, with peaks at 0600, 1900, and 2200. The majority of positive behavior events during the daylight and nighttime hours involved the mother-calf pairs. Furthermore, the calves and juveniles initiated approximately 60% of all social events during the daytime and 57% of all social interactions at night. The results of this study demonstrate the differences between diurnal and nocturnal activity budgets of a multi-age and sex elephant herd in a zoological facility, which highlights the importance of managing elephants to meet their 24 hr behavioral needs.

Tingvold, H. G., R. Fyumagwa, C. Bech, L. F. Baardsen, H. Rosenlund and E. Røskaft (2013). "Determining adrenocortical activity as a measure of stress in African elephants (Loxodonta africana) in relation to human activities in Serengeti ecosystem." African Journal of Ecology **51**(4): 580-589.

African elephants (Loxodonta africana) play a vital role in most African

ecosystems, with their opportunity to alter the entire ecosystem by their sheer numbers. Defining and measuring animal welfare has been much discussed. One potential way of determining an animal's welfare is to record the absence or presence of stress. Little research on elephant welfare has so far been performed in the Serengeti ecosystem. The aim of this study was to record the faecal glucocorticoid metabolite levels of African elephants in areas with high or with minimum human interference. A total of 117 faecal samples were collected from randomly located single elephants as well as family herds in the northern, central and western Serengeti National Park (SNP) as well as in Grumeti Game Reserve and Ikoma Open Area, northern Tanzania in 2010. Elephants had higher levels of faecal glucocorticoid metabolites in the areas outside, compared with areas inside SNP. No single males were observed outside SNP, and in general, higher abundance of elephants was observed inside SNP. This suggests that elephants may prefer to reside in the potential safer areas inside the national park, demonstrating the importance of protected areas to improve the welfare of elephants. © 2013 John Wiley & Sons Ltd.

Suter, I. C., M. Hockings and G. S. Baxter (2013). "Changes in Elephant Ownership and Employment in the Lao PDR: Implications for the Elephant-Based Logging and Tourism Industries." Human Dimensions of Wildlife **18**(4): 279-291.

Communities in the Lao People's Democratic Republic (PDR) have been utilizing captive Asian elephants (Elephas maximus) for centuries. The elephant handler (mahout) profession has remained fundamentally unchanged. Captive elephants, however, are no longer necessary in roles where they were once considered vital, particularly the logging industry. To gauge mahout demographics and assess problems associated with elephant industries, we surveyed 133 mahouts in the Lao PDR. We found that mahoutship is an aging industry with a vanishing family association. Contrasts between logging and tourism mahouts were apparent when observing family tradition, finances, and industry-related experiences. Logging mahouts rely on tourism to provide them with future employment; however, tourism cannot currently employ elephants on a scale similar to that of logging operations. The need for the traditional mahout and a large population of captive elephants may have reached its finality in Laos. © 2013 Copyright Taylor and Francis Group, LLC.

Evans, K., R. J. Moore and S. Harris (2013). "The Release of a Captive-Raised Female African Elephant (Loxodonta africana) in the Okavango Delta, Botswana." Animals (Basel) **3**(2): 370-385.

Wild female elephants live in close-knit matrilineal groups and housing captive elephants in artificial social groupings can cause significant welfare issues for individuals not accepted by other group members. We document the release of a captive-raised female elephant used in the safari industry because of welfare and management problems. She was fitted with a satellite collar, and spatial and behavioural data were collected over a 17-month period to quantify her interactions with the wild population. She was then monitored infrequently for a further five-and-a-half years. We observed few

signs of aggression towards her from the wild elephants with which she socialized. She used an area of comparable size to wild female elephants, and this continued to increase as she explored new areas. Although she did not fully integrate into a wild herd, she had three calves of her own, and formed a social unit with another female and her calf that were later released from the same captive herd. We recommend that release to the wild be considered as a management option for other captive female elephants.

Carlstead, K., J. A. Mench, C. Meehan and J. L. Brown (2013). "An Epidemiological Approach to Welfare Research in Zoos: The Elephant Welfare Project." Journal of Applied Animal Welfare Science **16**(4): 319-337.

Multi-institutional studies of welfare have proven to be valuable in zoos but are hampered by limited sample sizes and difficulty in evaluating more than just a few welfare indicators. To more clearly understand how interactions of husbandry factors influence the interrelationships among welfare outcomes, epidemiological approaches are needed as well as multifactorial assessments of welfare. Many questions have been raised about the housing and care of elephants in zoos and whether their environmental and social needs are being met in a manner that promotes good welfare. This article describes the background and rationale for a large-scale study of elephant welfare in North American zoos funded by the (U.S.) Institute of Museum and Library Services. The goals of this project are to document the prevalence of positive and negative welfare states in 291 elephants exhibited in 72 Association of Zoos and Aquariums zoos and then determine the environmental, management, and husbandry factors that impact elephant welfare. This research is the largest scale nonhuman animal welfare project ever undertaken by the zoo community, and the scope of environmental variables and welfare outcomes measured is unprecedented.

Miller, L. J., J. Andrews and M. Anderson (2012). "Validating methods to determine walking rates of elephants within a zoological institution." Animal Welfare **21**(4): 577-582.

Much controversy surrounds the welfare of elephants within zoological institutions. Among the many concerns are lack of exercise and the prevention of sedentary health and welfare issues due to smaller exhibits in comparison to the home-range sizes for elephants in Africa and Asia. While many scientists have used GPS to examine distances travelled by wild elephants, there is currently little information on distance travelled by elephants within zoological institutions. In the wild, it is necessary to chemically immobilise elephants using a dart gun in order to put on or take off collars which are used to acquire GPS data. Within a zoological institution, elephants can be trained to wear a collar with a GPS device but this training can be time consuming and also dangerous depending on the level of expertise of animal care staff. However, training an elephant within a zoological institution to wear an anklet outfitted with a GPS device can be much safer and less time consuming. The purpose of the current research was to validate methods for examining the walking rates of elephants in a

zoological facility. This included testing GPS units, examining walking rates of eight elephants at the San Diego Zoo Safari Park using collars and conducting trials on a subset of elephants wearing both a collar and anklet outfitted with GPS devices to determine reliability. The average distance travelled by eight African elephants (Loxodonta africana) within a 24-h period was 8.65 (± 0.64) km which corresponds to a rate of 0.360 (± 0.033) kph. Trials comparing anklets to collars were found to be highly reliable except on days when weather conditions were overcast or there was rainfall at the park. The methods used for the current study can be utilised in future studies to examine walking rates as a component of animal welfare for elephants or other large mammals within zoological institutions. © 2012 Universities Federation for Animal Welfare.

Menargues, A., V. Urios, R. Liminana and M. Mauri (2012). "Circadian rhythm of salivary cortisol in Asian elephants (Elephas maximus): a factor to consider during welfare assessment." J Appl Anim Welf Sci **15**(4): 383-390.

Elevated glucocorticoid levels during an extended time period might be a stress indicator in nonhuman animals. Therefore, knowledge of the circadian pattern of cortisol secretion is very important to correctly interpret data obtained for welfare assessment of animals in captivity through salivary cortisol. In order to define the circadian rhythm of salivary cortisol secretion in the Asian elephant (Elephas maximus), morning and evening saliva samples of 3 Asian elephants were collected and analyzed by radioimmunoassay. Significantly higher salivary cortisol concentrations were found in the morning than in the evening in all individuals. These results show that salivary cortisol of Asian elephants follows a diurnal pattern of secretion, which could be taken into account when using this methodology to assess welfare in captive Asian elephants.

MacKenzie, C. A. (2012). "Trenches like fences make good neighbours: Revenue sharing around Kibale National Park, Uganda." Journal for Nature Conservation **20**(2): 92-100.

Revenue sharing aims to balance the disadvantages people encounter living next to protected areas while fostering improved conservation behaviours. In Uganda, 20% of protected area entrance fees are shared with local governments to benefit communities adjacent to national parks. The process to distribute funds and implement projects was investigated by interviewing Uganda Wildlife Authority wardens, local government and village residents around Kibale National Park, Uganda. The perceived benefit of revenue sharing by officials and local communities was collected through interviews and a household survey, while the influence of the program on conservation objectives was assessed by measuring illegal resource extraction from the national park adjacent to study villages. It was found that the program is evolving into an effective mechanism for sharing benefits, but that better project management and increased accounting transparency could further improve the program. If the projects specifically dealt with the problem of crop raiding by park-protected animals, then villagers did benefit and lower levels of illegal activity were found inside the park. Generally household

perceived benefit was low, however reduced in-park illegal activity was recorded where the village chairperson perceived higher benefit from the program, implying that the village leadership may be influencing the conservation behaviours within the community. Compared with other incentive options such as loss compensation, direct payment, and collaborative management, revenue sharing appears to be an effective and practical choice, given the limited funding available to the wildlife authority to benefit local communities while trying to improve conservation behaviours. © 2011 Elsevier GmbH.

Grand, A. P., C. W. Kuhar, K. A. Leighty, T. L. Bettinger and M. L. Laudenslager (2012). "Using personality ratings and cortisol to characterize individual differences in African Elephants (Loxodonta africana)." Applied Animal Behaviour Science **142**(1-2): 69-75.

The development of indices to assist in the management of captive animals and assess their well-being is a key priority for those responsible for providing care to animals in captivity, including the zoological community. In particular, the design of indices for use with some of the more charismatic and socially complex animals, such as African elephants is a major focus. The use of personality ratings and/or cortisol measurements has become a common tool for managing farm animals and is gaining popularity within zoos. However, a combined behavioral and physiological approach has not been examined in captive African elephants (Loxodonta africana). We sought to characterize African elephants using serum and salivary cortisol measurements and our Elephant Behavior Index, a personality rating system modified from an index designed for nonhuman primates. Subjects were five adult female African elephants housed at Disney's Animal Kingdom ®. Each subject was rated on the Elephant Behavior Index, which consisted of 23 personality adjectives on a 5-point scale, by 16 raters familiar with the elephants. Saliva and blood samples were collected for cortisol analyses. Reliability across raters for the Elephant Behavior Index was established and correlations between the 23 ratings revealed four components of elephant personality: fearful, effective, sociable and aggressive. Salivary and serum cortisol were correlated and the afternoon decline in cortisol that has been documented in a variety of species was detected for both salivary and serum cortisol (morning salivary - M=0.038, SD=0.012; morning serum - M=2.147, SD=1.305; afternoon salivary - M=0.020, SD=0.008; afternoon serum - M=0.445, SD=0.251). We found positive correlations between morning cortisol levels and the fearful component and negative correlations between cortisol and effective, sociable and aggressive components. Our study demonstrated how personality ratings and cortisol can be utilized to assess individual characteristics of African elephants. Determining these unique characteristics will allow caregivers to tailor management protocols to the meet the needs of individual elephants. © 2012 Elsevier B.V.

Ganswindt, A., J. L. Brown, E. W. Freeman, A. J. Kouba, L. M. Penfold, R. M. Santymire, M. M. Vick, N. Wielebnowski, E. L. Willis and M. R. Milnes (2012). "International society for wildlife endocrinology: The future of endocrine measures

for reproductive science, animal welfare and conservation biology." Biology Letters **8**(5): 695-697.

Hormone analysis is a precise and widely accepted tool formonitoring reproductive function and responses to stressors. Although hormones are present and can be measured in various biological matrices, non-invasive methods have gained popularity over the past 30 years as a more practical approach for assessing ovarian, testicular and, more recently, adrenocortical activity in intractable wildlife species. Noninvasive hormone monitoring also has been key to understanding biological mechanisms related to observed behaviours of captive and free-ranging animals. Despite the increasing popularity of this research field, wildlife endocrinologists have not had a specific forum for sharing and discussing their latest findings, technical developments and common challenges. To provide such a communication platform, the International Society for Wildlife Endocrinology (ISWE) was established in 2010, followed by an international meeting held on 3-4 November 2011 at the Toronto Zoo, Canada. Over several sessions, keynote speakers and participants discussed recent developments of new and innovative methods for hormone monitoring, as well as the latest advances in basic endocrinology as applied to adrenal function, reproductive physiology, animal health, ecology and evolution. Here, we introduce ISWE to the scientific community and discuss how this new society will serve as a resource for wildlife endocrinologists worldwide. © 2011 The Royal Society.

Vanitha, V., K. Thiyagesan and N. Baskaran (2011). "Social life of captive Asian elephants (Elephas maximus) in Southern India: implications for elephant welfare." J Appl Anim Welf Sci **14**(1): 42-58.

Asian elephants in the wild live in complex social societies; in captivity, however, management often occurs in solitary conditions, especially at the temples and private places of India. To investigate the effect of social isolation, this study assessed the social group sizes and the presence of stereotypies among 140 captive Asian elephants managed in 3 captive systems (private, temple, and forest department) in Tamil Nadu, India, between 2003 and 2005. The majority of the facilities in the private (82%) and temple (95%) systems held a single elephant without opportunity for social interaction. The forest department managed the elephants in significantly larger groups than the private and temple systems. Among the 3 systems, the proportion of elephants with stereotypies was the highest in temple (49%) followed by private system (26%) and the forest department facility (6%); this correlates with the social isolation trend observed in the 3 systems and suggests a possible link between social isolation and abnormal elephant behavior separate from other environmental factors. The results of this study indicate it would be of greater benefit to elephant well being to keep the patchily distributed solitary temple and private elephants who are socially compatible and free from contagious diseases in small social groups at "common elephant houses" for socialization.

McMahon, C. R., N. Collier, J. K. Northfield and F. Glen (2011). "Taking the time to assess the effects of remote sensing and tracking devices on animals." Animal

Welfare **20**(4): 515-521.

The remote monitoring of animal behaviour using telemetry and bio-logging has become popular due to technological advances, falling costs of devices and the need to understand behaviour without causing disturbance to subjects. Over the past three decades thousands of animals have had their movements tracked by these devices; however, attaching devices to streamlined bodies raises concerns about energetic costs and effects on vital rates and the reliability of the data collected (eg survival probability). We encourage researchers to discuss concerns, quantify the possible effects that devices and attachment methods have on subjects and present this work for peer review. © 2011 Universities Federation for Animal Welfare.

Duffy, R. and L. Moore (2011). Neoliberalising Nature? Elephant-Back Tourism in Thailand and Botswana. Capitalism and Conservation, Wiley-Blackwell**:** 274-298.

Duffy, R. and L. Moore (2011). "Global regulations and local practices: The politics and governance of animal welfare in elephant tourism." Journal of Sustainable Tourism **19**(4-5): 589-604.

This paper examines challenges associated with global regulation of the tourism industry via an analysis of the use of elephants for trekking and safaris in Thailand and Botswana. It highlights inherent problems in applying universal principles in diverse locations; it unpicks the North-South power dynamics involved in drawing up global standards for elephant welfare in tourism. The development and expansion of elephant riding raise important ethical issues around questions of animal welfare, especially definitions of acceptable and appropriate standards for working animals. This paper uses a political economy approach to understandings of global governance to analyse who has the power to govern, at what scale and with what effects. It examines the role of animal welfare NGOs as key epistemic communities shaping the debate on elephant welfare. It discusses the highly variable practices of working with elephants in Botswana and in Thailand. It concludes that attempts at global regulation need to seriously engage with local level practices if global standards are to be workable and acceptable for tour operators, animal welfare NGOs, elephant camp owners and tourists alike. It raises leading global governance issues and discussions of the role of NGOs in governance, in general. © 2011 Taylor & Francis.

Chase, M. J. and C. R. Griffin (2011). "Elephants of south-east Angola in war and peace: Their decline, re-colonization and recent status." African Journal of Ecology **49**(3): 353-361.

Angola's intermittent 27-year civil war displaced over four million people and decimated wildlife populations. During the 1980s, African elephants (Loxodonta africana Blumenbach) in Angola drew international alarm with reports of 100,000 elephants killed. Luiana Partial Reserve (PR), a conservation area in south-east Angola, was the military operations centre for UNITA (National Union for the Total Independence of Angola), which used elephant ivory to pay for arms and meat. However, the full impact of the civil war on elephants is uncertain because there are no reliable estimates of

Angolan elephant populations. Following the end of the civil war in 2002, our three aerial surveys of Luiana PR indicated that elephant numbers are increasing rapidly, from 366 in January 2004 to 1827 in November 2005, and expanding their range in the Reserve. Concurrently, elephants tagged with satellite collars in northern Botswana and the Caprivi Strip, Namibia, moved into Luiana PR. To facilitate re-colonization and conservation of elephants and other wildlife in Luiana PR, we recommend: (i) realignment of the veterinary fence on the Botswana-Namibia border; (ii) development of effective land use management and anti-poaching programmes; (iii) clearing of landmines; (iv) designation of the Reserve a national park; and (v) development of ecotourism and community conservation programmes. © 2011 Blackwell Publishing Ltd.

Burn, R. W., F. M. Underwood and J. Blanc (2011). "Global trends and factors associated with the illegal killing of elephants: A hierarchical bayesian analysis of carcass encounter data." PLoS ONE **6**(9).

Elephant poaching and the ivory trade remain high on the agenda at meetings of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Well-informed debates require robust estimates of trends, the spatial distribution of poaching, and drivers of poaching. We present an analysis of trends and drivers of an indicator of elephant poaching of all elephant species. The site-based monitoring system known as Monitoring the Illegal Killing of Elephants (MIKE), set up by the 10 th Conference of the Parties of CITES in 1997, produces carcass encounter data reported mainly by anti-poaching patrols. Data analyzed were site by year totals of 6,337 carcasses from 66 sites in Africa and Asia from 2002-2009. Analysis of these observational data is a serious challenge to traditional statistical methods because of the opportunistic and non-random nature of patrols, and the heterogeneity across sites. Adopting a Bayesian hierarchical modeling approach, we used the proportion of carcasses that were illegally killed (PIKE) as a poaching index, to estimate the trend and the effects of site- and country-level factors associated with poaching. Important drivers of illegal killing that emerged at country level were poor governance and low levels of human development, and at site level, forest cover and area of the site in regions where human population density is low. After a drop from 2002, PIKE remained fairly constant from 2003 until 2006, after which it increased until 2008. The results for 2009 indicate a decline. Sites with PIKE ranging from the lowest to the highest were identified. The results of the analysis provide a sound information base for scientific evidence-based decision making in the CITES process. © 2011 Burn et al.

Vanitha, V. and N. Baskaran (2010). "Seasonal and roofing material influence on the thermoregulation by captive Asian elephants and its implications for captive elephant welfare." Gajah **33**: 35-40.

Soltis, J. and J. L. Brown (2010). "Special issue-the care and welfare of elephants in AZA institutions." Zoo Biology **29**(2): 85-86.

Mason, G. J. and J. S. Veasey (2010). "How should the psychological well-being of zoo elephants be objectively investigated?" Zoo Biology **29**(2): 237-255.

Animal welfare (sometimes termed "well-being") is about feelings - states such as "suffering" or "contentment" that we can infer but cannot measure directly. Welfare indices have been developed from two main sources: studies of suffering humans, and of research animals deliberately subjected to challenges known to affect emotional state. We briefly review the resulting indices here, and discuss how well they are understood for elephants, since objective welfare assessment should play a central role in evidence-based elephant management. We cover behavioral and cognitive responses (approach/avoidance; intention, redirected and displacement activities; vigilance/startle; warning signals; cognitive biases, apathy and depression-like changes; stereotypic behavior); physiological responses (sympathetic responses; corticosteroid output - often assayed noninvasively via urine, feces or even hair; other aspects of HPA function, e.g. adrenal hypertrophy); and the potential negative effects of prolonged stress on reproduction (e.g. reduced gametogenesis; low libido; elevated still-birth rates; poor maternal care) and health (e.g. poor wound-healing; enhanced disease rates; shortened lifespans). The best validated, most used welfare indices for elephants are corticosteroid outputs and stereotypic behavior. Indices suggested as valid, partially validated, and/or validated but not yet applied within zoos include: measures of preference/avoidance; displacement movements; vocal/postural signals of affective (emotional) state; startle/vigilance; apathy; salivary and urinary epinephrine; female acyclity; infant mortality rates; skin/foot infections; cardio-vascular disease; and premature adult death. Potentially useful indices that have not yet attracted any validation work in elephants include: operant responding and place preference tests; intention and vacuum movements; fear/ stress pheromone release; cognitive biases; heart rate, pupil dilation and blood pressure; corticosteroid assay from hair, especially tail-hairs (to access endocrine events up to a year ago); adrenal hypertrophy; male infertility; prolactinemia; and immunological changes.

Mason, G. J. and J. S. Veasey (2010). "What do population-level welfare indices suggest about the well-being of zoo elephants?" Zoo Biology **29**(2): 256-273.

To assess zoo elephants' welfare using objective population-level indices, we sought data from zoos and other protected populations (potential "benchmarks") on variables affected by poor well-being. Such data were available on fecundity, potential fertility, stillbirths, infant mortality, adult survivorship, and stereotypic behavior. Most of these can also be affected by factors unrelated to well-being; therefore, for each, we analyzed the potential role of these other factors. Population-level comparisons generally indicate poor reproduction, and poor infant and adult survivorship in zoos compared with benchmark populations (with some differences between zoo regions and over time). Stereotypic behavior also occurs in c. 60% of zoo elephants; as the population-level welfare index least open to alternative interpretations, this represents the strongest evidence that well-being is/has been widely compromised. Poor well-being is a parsimonious explanation for

the diverse range of population-level effects seen, but to test this hypothesis properly, data are now needed on, for example, potential confounds that can affect these indices (to partition out effects of factors unrelated to well-being), and causes of the observed temporal effects, and differences between species and zoo regions. Regardless of whether such additional data implicate poor well-being, our findings suggest that elephant management has generally been sub-optimal. We also discuss the selection and utilization of benchmark data, as a useful future approach for evaluating such issues. © 2010 Wiley-Liss, Inc.

Mason, G. J. (2010). "Species differences in responses to captivity: Stress, welfare and the comparative method." Trends in Ecology and Evolution **25**(12): 713-721.

Approximately 26 billion animals, spanning over 10 000 species, are kept on farms and in zoos, conservation breeding centers, research laboratories and households. Captive animals are often healthier, longer-lived and more fecund than free-living conspecifics, but for some species the opposite is true. Captivity is a very long way from the ideal 'common garden' often assumed by evolutionary and ecological researchers using data for captive animals. The use of comparative methods to investigate the fundamental biological causes of these species differences would help to improve husbandry and enclosure design, and might even reveal relationships between susceptibilities to poor captive welfare and susceptibilities to anthropogenic threat in the wild. Studies of these species differences could also inspire and facilitate 'evo-mecho' research into the functions of behavioral control mechanisms. © 2010 Elsevier Ltd.

Duffy, R. and L. Moore (2010). "Neoliberalising nature? Elephant-back tourism in Thailand and Botswana." Antipode **42**(3): 742-766.

This paper examines the case of elephant-back safaris in Thailand and Botswana; it argues that tourism has extended and deepened neoliberalism by targeting and opening up new frontiers in nature. In essence tourism redesigns and repackages nature for global consumption. Through a cross comparison of the same product (the use of captive/trained elephants) in two very different contexts (Thailand and Botswana) this paper analyses the variations in "actually existing neoliberalisms" (Brenner and Theodore 2002) and demonstrates that the effects are not unremittingly negative (Castree 2008b). It also draws out the ways that neoliberalism is challenged and reshaped by context specific processes and so it does not completely displace existing ways of approaching nature. Instead, existing approaches mix with neoliberalism to create new ways of valuing and conserving elephants. © 2010 The Authors Journal compilation © 2010 Editorial Board of Antipode.

Dale, R. H. I. (2010). "Birth statistics for African (Loxodonta africana) and Asian (Elephas maximus) elephants in human care: History and implications for elephant welfare." Zoo Biology **29**(2): 87-103.

African (Loxodonta africana) and Asian elephants (Elephas maximus) have lived in the care of humans for many years, yet there is no consensus concerning some basic parameters describing their newborn calves. This

study provides a broad empirical basis for generalizations about the birth heights, birth weights, birth times and gestation periods of elephant calves born in captivity. I obtained data concerning at least one of these four characteristics for 218 newborn calves from 74 institutions. Over the past 30 years, newborn Asian elephants have been taller and heavier than newborn African elephants. Neonatal African elephants exhibited sex differences in both weight and height, whereas neonatal Asian elephants have exhibited sex differences only in height. Primiparous dams ex situ are at least as old as their in situ counterparts, whereas ex situ sires appear to be younger than sires in range countries. Confirming earlier anecdotal evidence, both African [N=47] and Asian [N=91] dams gave birth most often at night. © 2009 Wiley-Liss, Inc.

Rees, P. A. (2009). "The sizes of elephant groups in zoos: Implications for elephant welfare." Journal of Applied Animal Welfare Science **12**(1): 44-60.

This study examined the distribution of 495 Asian elephants (Elephas maximus) and 336 African elephants (Loxodonta africana) in 194 zoos, most of which were located in Europe (49.1%) and North America (32.6%). Cows outnumbered bulls 4 to 1 (Loxodonta) and 3 to 1 (Elephas). Groups contained 7 or fewer: mean, 4.28 (σ = 5.73). One fifth of elephants lived alone or with one conspecific. Forty-six elephants (5.5%) had no conspecific. Many zoos ignore minimum group sizes of regional zoo association guidelines. The American Zoo and Aquarium Association recommends that breeding facilities keep herds of 6 to 12 elephants. The British and Irish Association of Zoos and Aquariums recommends keeping together at least 4 cows over 2 years old. Over 69% Asian and 80% African cow groups - including those under 2 years - consisted of fewer than 4 individuals. Recently, Europe and North America have made progress with some zoos no longer keeping elephants and with others investing in improved facilities and forming larger herds. The welfare of individual elephants should outweigh all other considerations; zoos should urgently seek to integrate small groups into larger herds.

Rees, P. A. (2009). "Activity budgets and the relationship between feeding and stereotypic behaviors in Asian elephants (Elephas maximus) in a Zoo 75." Zoo. Biol **28**(2): 79-97.

Activity budgets were studied in eight Asian elephants (Elephas maximus) at Chester Zoo (UK) for 35 days, between January and November 1999. Recordings were made between 10:00 and 16:00 hr (with most behavior frequencies calculated between 10:00 and 14:00 hr). The elephants exhibited variation in activity depending on their age, sex, the time of day and the time of year. Only the five adult cows exhibited stereotypic behavior, with frequencies ranging from 3.9 to 29.4% of all observations. These elephants exhibited individual, diurnal and seasonal variation in stereotypic behavior. This has implications for studies that use short sampling periods and may make comparisons of data collected at different times of the day or year invalid. The six adult elephants spent 27.4-41.4% of the time feeding (between 10:00 and 14:00 hr), 22.9-42.0% standing still, 6.1-19.2%

walking and 3.9-9.6% dusting. The hypothesis that the frequency of stereotypic behavior in adult cow elephants was negatively correlated with the frequency of feeding behavior was tested and was found to be true. Stereotypic behavior increased in frequency toward the end of the day-while waiting to return to the elephant house for food--and elephants spent more time stereotyping during the winter months than during the summer months. Elephants were inactive (i.e. exhibited behaviors other than locomotion) for between 70.1 and 93.9% of the time. Creating more opportunities for elephants to exhibit foraging behavior and the introduction of greater unpredictability into management regimes, especially feeding times, may reduce the frequency of stereotypic behavior and increase general activity levels

Melfi, V. A. (2009). "There are big gaps in our knowledge, and thus approach, to zoo animal welfare: a case for evidence-based zoo animal management." Zoo Biol **28**(6): 574-588.

There are gaps in knowledge that hinder our ability within zoos to provide good animal welfare. This does not mean that zoos cannot or do not provide good welfare, only that currently this goal is hindered. Three reasons for these gaps are identified as: (1) there is an emphasis on the identification and monitoring of indicators that represent poor welfare and it is assumed that an absence of poor welfare equates to good welfare. This assumption is overly simplistic and potentially erroneous; (2) our understanding of how housing and husbandry (H&H) affects animals is limited to a small set of variables determined mostly by our anthropogenic sensitivities. Thus, we place more value on captive environmental variables like space and companionship, ignoring other factors that may have a greater impact on welfare, like climate; (3) finally, whether intentional or not, our knowledge and efforts to improve zoo animal welfare are biased to very few taxa. Most attention has been focused on mammals, notably primates, large cats, bears, and elephants, to the exclusion of the other numerous species about which very little is known. Unfortunately, the extent to which these gaps limit our ability to provide zoo animals with good welfare is exacerbated by our over reliance on using myth and tradition to determine zoo animal management. I suggest that we can fill these gaps in our knowledge and improve our ability to provide zoo animals with good welfare through the adoption of an evidence-based zoo animal management framework. This approach uses evidence gathered from different sources as a basis for making any management decisions, as good quality evidence increases the likelihood that these decisions result in good zoo animal welfare.

Mason, G. J. and J. S. Veasey (2009). "How should the psychological well-being of zoo elephants be objectively investigated?
47." Zoo. Biol.

Animal welfare (sometimes termed "well-being") is about feelings - states such as "suffering" or "contentment" that we can infer but cannot measure directly. Welfare indices have been developed from two main sources: studies of suffering humans, and of research animals deliberately subjected

to challenges known to affect emotional state. We briefly review the resulting indices here, and discuss how well they are understood for elephants, since objective welfare assessment should play a central role in evidence-based elephant management. We cover behavioral and cognitive responses (approach/avoidance; intention, redirected and displacement activities; vigilance/startle; warning signals; cognitive biases, apathy and depression-like changes; stereotypic behavior); physiological responses (sympathetic responses; corticosteroid output - often assayed non-invasively via urine, feces or even hair; other aspects of HPA function, e.g. adrenal hypertrophy); and the potential negative effects of prolonged stress on reproduction (e.g. reduced gametogenesis; low libido; elevated still-birth rates; poor maternal care) and health (e.g. poor wound-healing; enhanced disease rates; shortened lifespans). The best validated, most used welfare indices for elephants are corticosteroid outputs and stereotypic behavior. Indices suggested as valid, partially validated, and/or validated but not yet applied within zoos include: measures of preference/avoidance; displacement movements; vocal/postural signals of affective (emotional) state; startle/vigilance; apathy; salivary and urinary epinephrine; female acyclity; infant mortality rates; skin/foot infections; cardio-vascular disease; and premature adult death. Potentially useful indices that have not yet attracted any validation work in elephants include: operant responding and place preference tests; intention and vacuum movements; fear/stress pheromone release; cognitive biases; heart rate, pupil dilation and blood pressure; corticosteroid assay from hair, especially tail-hairs (to access endocrine events up to a year ago); adrenal hypertrophy; male infertility; prolactinemia; and immunological changes. Zoo Biol 28:1-19, 2009. (c) 2009 Wiley-Liss, Inc

Leighty, K. A., J. Soltis and A. Savage (2009). "GPS assessment of the use of exhibit space and resources by African elephants (Loxodonta africana) 65." Zoo. Biol **28**: 1-11.

In public discussions of animal rights and welfare, we as members and proponents of zoological institutions often face significant challenges addressing the concerns of our detractors due to an unfortunate deficiency in systematically collected and published data on the animals in our collections. In the case of elephants, there has been a paucity of information describing their use of space within captive environments. Here, using collar-mounted GPS recording devices, we documented the use of exhibit space and resources by a herd of five adult female African elephants (Loxodonta africana) housed at Disney's Animal Kingdom((R)). We found that dominant animals within the herd used a greater percentage of the available space and subordinate females avoided narrow or enclosed regions of the enclosure that we termed "restricted flow areas." In their use of other resources, dominant females demonstrated increased occupation of the watering hole over subordinate females, but all females demonstrated relatively equivalent use of the mud wallow. Overall, our results provide preliminary evidence that position within the dominancy hierarchy impacts the percentage of space occupied in a captive setting and may contribute to resource accessibility.

These findings can be applied to future decisions on exhibit design and resource distribution for this species. Zoo Biol 28:1-11, 2009. (c) 2009 Wiley-Liss, Inc

Kontogeorgopoulos, N. (2009). "Wildlife tourism in semi-captive settings: A case study of elephant camps in northern Thailand." Current Issues in Tourism **12**(5-6): 429-449.

Due to improved transportation and communication technology, changing social attitudes towards nature and wildlife, and the physiological benefits of interaction with animals, tourism centred on wildlife in captive and semi-captive settings is becoming increasingly popular. One example of wildlife tourism in a semi-captive setting is the proliferation of 'elephant camps' in Thailand, where tourists interact in a variety of ways with domesticated elephants. Though work in elephant camps can be difficult for elephants, tourism provides the only viable legal option for elephant owners and handlers to earn income. This study examines the characteristics, preferences, and values of the visitors of three elephant camps in the vicinity of Chiang Mai in northern Thailand and argues that despite reflecting divergent worldviews on, and practical approaches to, animal rights, each type of camp makes significant contributions to the overall welfare of Thailand's domesticated elephants. © 2009 Taylor & Francis.

Katsikaros, J. (2009). "The Elephant Valley Project." Aust Vet J **87**(10): N16-17.

Holdo, R. M., R. D. Holt and J. M. Fryxell (2009). "Grazers, browsers, and fire influence the extent and spatial pattern of tree cover in the Serengeti." Ecological Applications **19**(1): 95-109.

Vertebrate herbivores and fire are known to be important drivers of vegetation dynamics in African savannas. It is of particular importance to understand how changes in herbivore population density, especially of elephants, and fire frequency will affect the amount of tree cover in savanna ecosystems, given the critical importance of tree cover for biodiversity, ecosystem function, and human welfare. We developed a spatially realistic simulation model of vegetation, fire, and dominant herbivore dynamics, tailored to the Serengeti ecosystem of east Africa. The model includes key processes such as tree-grass competition, fire, and resource-based density dependence and adaptive movement by herbivores. We used the model to project the ecosystem 100 years into the future from its present state under different fire, browsing (determined by elephant population density), and grazing (with and without wildebeest present) regimes. The model produced the following key results: (1) elephants and fire exert synergistic negative effects on woody cover; when grazers are excluded, the impact of fire and the strength of the elephant-fire interaction increase; (2) at present population densities of 0.15 elephants/km2, the total amount of woody cover is predicted to remain stable in the absence of fire, but the mature tree population is predicted to decline regardless of the fire regime; without grazers present to mitigate the effects of fire, the size structure of the tree population will become dominated by seedlings and mature trees; (3) spatial

heterogeneity in tree cover varies unimodally with elephant population density; fire increases heterogeneity in the presence of grazers and decreases it in their absence; (4) the marked rainfall gradient in the Serengeti directly affects the pattern of tree cover in the absence of fire; with fire, the woody cover is determined by the grazing patterns of the migratory wildebeest, which are partly rainfall driven. Our results show that, in open migratory ecosystems such as the Serengeti, grazers can modulate the impact of fire and the strength of the interaction between fire and browsers by altering fuel loads and responding to the distribution of grass across the landscape, and thus exert strong effects on spatial patterns of tree cover.

Dickson, P. and W. M. Adams (2009). "Science and uncertainty in South Africa's elephant culling debate." Environment and Planning C-Government and Policy **27**(1):
110-123.

We analyse the debate about the culling of elephants in South Africa's national parks. This pits the need to reduce elephant density and grazing pressure to prevent environmental damage against animal-welfare concerns about the killing of elephants. This complex debate is characterised by factual uncertainty and moral complexity. The procull storyline suggests that high elephant densities pose a risk to biodiversity. The anticull standpoint critiques this position as politically and economically motivated and lacking in adequate scientific support. Both procull and anticull positions draw on science as a source of authority, and on the precautionary principle as a framework for making decisions. They differ in their interpretation of the scientific evidence for serious impacts of high elephant densities, the relations between scientific, ethical, and economic arguments, and the way uncertainty and the idea of a precautionary approach are used. A decision to resume culling of elephants in South Africa was made in February 2008, but debate continues.

Woolley, L. A., J. J. Millspaugh, R. J. Woods, S. J. van Rensburg, R. L. Mackey, B. Page and R. Slotow (2008). "Population and individual elephant response to a catastrophic fire in Pilanesberg National Park." PLoS. One **3**(9): e3233.

In predator-free large herbivore populations, where density-dependent feedbacks occur at the limit where forage resources can no longer support the population, environmental catastrophes may play a significant role in population regulation. The potential role of fire as a stochastic mass-mortality event limiting these populations is poorly understood, so too the behavioural and physiological responses of the affected animals to this type of large disturbance event. During September 2005, a wildfire resulted in mortality of 29 (18% population mortality) and injury to 18, African elephants in Pilanesberg National Park, South Africa. We examined movement and herd association patterns of six GPS-collared breeding herds, and evaluated population physiological response through faecal glucocorticoid metabolite (stress) levels. We investigated population size, structure and projected growth rates using a simulation model. After an initial flight response post-fire, severely injured breeding herds reduced daily

displacement with increased daily variability, reduced home range size, spent more time in non-tourist areas and associated less with other herds. Uninjured, or less severely injured, breeding herds also shifted into non-tourist areas post-fire, but in contrast, increased displacement rate (both mean and variability), did not adjust home range size and formed larger herds post-fire. Adult cow stress hormone levels increased significantly post-fire, whereas juvenile and adult bull stress levels did not change significantly. Most mortality occurred to the juvenile age class causing a change in post-fire population age structure. Projected population growth rate remained unchanged at 6.5% p.a., and at current fecundity levels, the population would reach its previous level three to four years post-fire. The natural mortality patterns seen in elephant populations during stochastic events, such as droughts, follows that of the classic mortality pattern seen in predator-free large ungulate populations, i.e. mainly involving juveniles. Fire therefore functions in a similar manner to other environmental catastrophes and may be a natural mechanism contributing to population limitation. Welfare concerns of arson fires, burning during "hot-fire" conditions and the conservation implications of fire suppression (i.e. removal of a potential contributing factor to natural population regulation) should be integrated into fire management strategies for conservation areas

van Kooten, G. C. (2008). "Protecting the African elephant: A dynamic bioeconomic model of ivory trade." Biological Conservation **141**(8): 2012-2022.

A dynamic bioeconomic model of ivory trade is used to investigate the efficacy of conservation payments, tourism benefits, quota regimes and a trade ban on the protection of the African elephant (Laxadonta africana). The model consists of four ivory exporting regions and one demand region. Results indicate that a trade ban might not be successful in maintaining elephants, even if it increases the costs of marketing ivory and leads to a stigma effect that reduces demand. Indeed, trade in elephant products may offer some hope for the elephant, but only if there exist effective institutions that translate in situ protection into economic values.

Thitaram, C., N. Thongtip, C. Somgird, B. Colenbrander, D. C. J. Van Boxtel, F. Van Steenbeek and J. A. Lenstra (2008). "Evaluation and selection of microsatellite markers for an identification and parentage test of Asian elephants (Elephas maximus)." Conservation Genetics **9**(4): 921-925.

Numbers of the Asian elephants (Elephas maximus) population are declining due to poaching, human-elephant conflicts, capture of wild calves for tourism and export and habitat destruction, which also may cause inbreeding in fragmented populations. In order to contribute to a reversal of this trend, we have developed an identification and parentage test by evaluation and selection of markers from 43 microsatellite loci that have been previously described for Asian or African elephants. Testing these markers on a panel of 169 Asian elephants comprising the 23 mother-offspring, 13 father-offspring and 13 parents-offspring pairs yielded 26 polymorphic markers. However, only 14 of these were found to be suitable for an analysis of molecular

diversity, 12 of which will be implemented for an identification and parentage test to control the capture of wild calves in Thailand and neighboring countries. © 2007 Springer Science+Business Media B.V.

Ramanathan, A. and A. Mallapur (2008). "A visual health assessment of captive Asian elephants (Elephas maximus) housed in India." J. Zoo. Wildl. Med **39**(2): 148-154.

A visual health assessment and survey questionnaire was conducted on 81 Asian elephants (Elephas maximus) housed in 10 animal facilities throughout India between November 2004 and February 2005. The survey questionnaire consisted of 10 questions that evaluated the health of the elephants, and they were completed after visually assessing each individual elephant. The information collected was ranked on a scale that was used to statistically compare the health among the study subjects. This study documented that 43.21% of the captive elephants surveyed exhibited hyperkeratosis. A significant proportion of the elephants owned by tourist camps had poor skin condition when compared with elephants from zoos and at a forest camp. Similarly, captive-born individuals were found to have better skin condition than animals that were caught from the wild. Sixty (74.1%) of the captive elephants that were observed during this study had fissures in their footpads, 20% of which were severe. The prevalence of foot fissures was significantly higher in females. A greater proportion of elephants owned by tourist camps displayed vertical and horizontal toenail cracks in comparison with the forest camp and zoo elephants. It was noted that 76.9% of the wounded animals and 80% of those having abscesses were housed at temples and tourist camps. Also, approximately 8.5% of the captive elephant population observed during this study had eye-related problems, and they were all housed at temples and tourist camps. In conclusion, it was evident that elephants housed at temples or tourist camps exhibited poor skin condition with wounds and abscesses. These findings suggest that the overall condition of the elephants housed at tourist camps was poor compared with elephants housed at zoos and at the forest camp

Metcalfe, S. and T. Kepe (2008). ""Your elephant on our land": The struggle to manage wildlife mobility on Zambian communal land in the Kavango-Zambezi transfrontier conservation area." Journal of Environment and Development **17**(2): 99-117.

Landscape connectivity that allows for wildlife mobility requires governance across a tenurial mosaic of managerial units based on reconciliation of social, economic, and ecological objectives. The proposed Kavango-Zambezi (KAZA) Transfrontier Conservation Area (TFCA), which includes Angola, Botswana, Namibia, Zimbabwe, and Zambia, features a spectacular display of mega fauna and a number of tourist attractions such as the Victoria Falls. However, Zambian communal area landholders, who are affected by the TFCA, presently lack sufficient incentives to accommodate the wildlife costs, especially those related to elephants. This article, which is based on long-term observation and recent field research (2005-2007), explores the dynamics of establishing wildlife corridors on Zambian communal land,

through an improved communal-state-private sector partnership based on an experimental communal land reform process that addresses social and ecological issues. These issues are discussed using case studies of some chiefdoms on the Zambian side of the Kavango-Zambezi Transfrontier Conservation Area. The paper recommends Zambian policy reform that might address the social, economic, and ecological challenges, with particular reference to elephants, and move the prevailing situation where ordinary rural residents are disempowered relative to the state, traditional leaders, and the private sector. © Sage Publications, Inc. 2008.

Menargues, A., V. Urios and M. Mauri (2008). "Welfare assessment of captive Asian elephants (Elephas maximus) and Indian rhinoceros (Rhinoceros unicornis) using salivary cortisol measurement." Animal Welfare **17**(3): 305-312.

The measurement of salivary cortisol allows non-invasive assessment of welfare in captive animals. We utilised this technique to test the effect of zoo opening on six Asian elephants and two Indian rhinoceros at the Terra Natura Zoological Park, Alicante, Spain, during pre-opening, opening and post-opening periods. Salivary cortisol concentrations were found to be significantly higher during the opening period than during pre- and post-opening periods for both species. This method could prove a useful tool in monitoring the success of decisions taken to improve the welfare of captive animals.

Kislak, P. (2008). "Thoughts on AVMA policy on elephant guides and tethers." J Am Vet Med Assoc **233**(4): 550; author reply 550-551.

Hynes, J. G. (2008). "Discussion on treatment of captive elephants continues." J. Am. Vet. Med. Assoc **233**(9): 1396.

Harris, M., C. Sherwin and S. Harris (2008). The Welfare, Housing, and Husbandry of Elephants in UK Zoos. UK, University of Bristol**:** 127.

Doherty, T. (2008). "More on AVMA policy on elephant guides and tethers." J Am Vet Med Assoc **233**(7): 1061.

Clubb, R., M. Rowcliffe, P. Lee, K. U. Mar, C. Moss and G. J. Mason (2008). "Compromised survivorship in zoo elephants." Science **322**(5908): 1649.

Burke, T., B. Page, G. Van Dyk, J. Millspaugh and R. Slotow (2008). "Risk and ethical concerns of hunting male elephant: behavioural and physiological assays of the remaining elephants." PLoS ONE **3**(6): e2417.

BACKGROUND: Hunting of male African elephants may pose ethical and risk concerns, particularly given their status as a charismatic species of high touristic value, yet which are capable of both killing people and damaging infrastructure. METHODOLOGY/PRINCIPAL FINDINGS: We quantified the effect of hunts of male elephants on (1) risk of attack or damage (11 hunts), and (2) behavioural (movement dynamics) and physiological (stress hormone metabolite concentrations) responses (4 hunts) in Pilanesberg National Park.

For eleven hunts, there were no subsequent attacks on people or infrastructure, and elephants did not break out of the fenced reserve. For three focal hunts, there was an initial flight response by bulls present at the hunting site, but their movements stabilised the day after the hunt event. Animals not present at the hunt (both bulls and herds) did not show movement responses. Physiologically, hunting elephant bulls increased faecal stress hormone levels (corticosterone metabolites) in both those bulls that were present at the hunts (for up to four days post-hunt) and in the broader bull and breeding herd population (for up to one month post-hunt). CONCLUSIONS/SIGNIFICANCE: As all responses were relatively minor, hunting male elephants is ethically acceptable when considering effects on the remaining elephant population; however bulls should be hunted when alone. Hunting is feasible in relatively small enclosed reserves without major risk of attack, damage, or breakout. Physiological stress assays were more effective than behavioural responses in detecting effects of human intervention. Similar studies should evaluate intervention consequences, inform and improve best practice, and should be widely applied by management agencies.

Teixeira, C. P., C. Schetini de Azevedo, M. Mendl, C. F. Cipreste and R. J. Young (2007). "Revisiting translocation and reintroduction programmes: the importance of considering stress." Animal Behaviour **73**(1): 1-13.

It is widely known that the adverse effects of stress must be considered in animal conservation programmes. However, a full consideration of how and where stress occurs in animal conservation programmes has not been undertaken, especially in translocation and reintroduction programmes. The literature concerning these types of programmes shows high levels of mortality, despite researchers' consideration of the effects of stress. However, an analysis of the literature shows that many conservation biologists have only a superficial knowledge about stress. For example, most do not understand the importance of subclinical stress or the fact that the effect of successive stressors can be additive or accumulative. While most conservation biologists know that stress is bad for animal health, few have considered its adverse effects on cognitive abilities, which an animal needs to survive in the wild (e.g. memory). In this paper we conclude with suggestions for improving the efficiency of animal conservation programmes in terms of the number of animals surviving after reintroduction or translocation. The most important conclusion from this review of the literature is that there needs to be a greater interchange of information between animal welfare and animal conservation scientists.

Millspaugh, J. J., T. Burke, G. Van Dyk, R. Slotow, B. E. Washburn and R. J. Woods (2007). "Stress response of working African elephants to transportation and safari adventures." Journal of Wildlife Management **71**(4): 1257-1260.

African elephants (Loxodonta africana) are intensively managed in southern Africa and are routinely translocated between reserves. Domesticated elephants are used for elephant-back safaris and interactions with guests. Understanding how elephants respond to such activities is critical because of

welfare issues associated with both humans and elephants. We investigated the stress response (i.e., fecal glucocorticoid metabolite secretion [FGM]) of working elephants in Letsatsing Game Reserve, South Africa, over 1 year to evaluate their response to transportation and ecotourism activities. We used free-ranging elephants in adjacent Pilanesburg National Park as controls. Fecal glucocorticoid metabolites were greatest prior to and during translocation and declined over the year. Within 1-2 months of transportation, FGM levels in working elephants became indistinguishable from those in wild elephants. Fecal glucocorticoid metabolite levels were higher during human interaction days than days without interaction. The highest observed FGM levels were associated with transportation and episodic loud noises. Transportation is a stressful activity for elephants, and >3 months should be provided to translocated elephants to acclimate to their new surroundings. Although stress levels of elephants increased slightly when interacting with humans in the contexts we studied, evaluating interactions under a wider range or contexts is necessary to minimize danger to elephants and humans.

Maple, T. L. (2007). "Toward a science of welfare for animals in the zoo." J. Appl. Anim Welf. Sci **10**(1): 63-70.

Although the accredited institutions of the Association of Zoos and Aquariums have all committed to enhancing the welfare of nonhuman animals, acceptable standards and best practices are still under debate. Currently, experts from zoos and the field hold widely divergent opinions about exhibition and management standards for elephants. Standards and practices for managing nonhuman primates provide a model for other nonhuman creatures exhibited in zoos and aquariums. Examining the key issues for primates demonstrates the value of applying scientific data before promulgating standards. The field of applied behavior analysis provides a wealth of information to frame the debate. Animal behaviorists have contributed to an emerging science of animal welfare, which may provide a foundation for empirical zoo management, standards, and practices

Laws, N., A. Ganswindt, M. Heistermann, M. Harris, S. Harris and C. Sherwin (2007). "A case study: Fecal corticosteroid and behavior as indicators of welfare during relocation of an Asian elephant." Journal of Applied Animal Welfare Science **10**(4): 349-358.

This study was a preliminary investigation of an enzyme immunoassay for measuring fecal glucocorticoid metabolites in a male Asian elephant (Elephas maximus) by investigating changes in behavior and cortisol metabolite excretion associated with a putative stressful event. The study collected fecal samples for 10 days prior to, and 10 days after, 24-hr transport and relocation of the elephant to a new herd. The study measured cortisol metabolites using 2 enzyme immunoassays indicating a 389% and 340% increase in cortisol metabolite excretion following relocation. Maximal cortisol metabolite excretion occurred 2 days after relocation and remained elevated during establishment of the new herd. Stereotypic behavior increased approximately 400% after relocation. The relocation disturbed sleep

patterns, the elephant spent less time sleeping during the night, and the elephant slept standing up. These results provide preliminary evidence that noninvasive monitoring of fecal cortisol metabolites can be used to investigate adrenal activity in Asian elephants and may be a safe, practical, and accurate welfare indicator. Copyright © 2007, Lawrence Erlbaum Associates, Inc.

Boissy, A., G. Manteuffel, M. B. Jensen, R. O. Moe, B. Spruijt, L. J. Keeling, C. Winckler, B. Forkman, I. Dimitrov, J. Langbein, M. Bakken, I. Veissier and A. Aubert (2007). "Assessment of positive emotions in animals to improve their welfare." Physiology and Behavior **92**(3): 375-397.

It is now widely accepted that good welfare is not simply the absence of negative experiences, but rather is primarily the presence of positive experiences such as pleasure. However scientific investigation of positive emotions has long been neglected. This paper addresses two main issues: first, it reviews the current state of scientific knowledge that supports the existence of positive affective states in animals and, second, it suggests possible applications of this knowledge that may enhance quality of life under animal management conditions. In the first part of the paper, recent advances in psychology and neuroscience are reviewed to provide pragmatic frameworks based on cognitive processes (such as positive anticipation, contrast and controllability) for further investigations of positive emotions in animals. Thereafter, the neurobiological bases of positive emotions are highlighted in order to identify behavioral and physiological expressions of positive experiences in animals. Monitoring both the autonomic nervous system (via heart rate and its variability) and the immune system could offer relevant tools to better assess emotional states in animals, complementary to classical adrenocortical measures. In the second part of the paper, useful strategies for enhancing positive experiences (such as physical, social and cognitive enrichment or putative genetic selection) are outlined. Then this paper emphasizes practical applications for assessing and promoting positive emotions that may help in providing animals with a better quality of life. Play, affiliative behaviors and some vocalizations appear to be the most promising convenient indicators for assessing positive experiences in laboratory and farm animals under commercial conditions.

Tresz, H. (2006). "Behavioral management at the Phoenix Zoo: New strategies and perspectives." Journal of Applied Animal Welfare Science **9**(1): 65-70.

It all started with a seemingly simple decision to re-evaluate and document the Phoenix Zoo's behavioral management protocol. The purpose of this project was to present proactive standards for the care and psychological well-being of our living collection, while meeting or exceeding the guidelines of the Animal Welfare Act (U. S. Department of Agriculture Animal and Plant Health and Inspection Service, Animal Care, 1999). Preparing the protocol was a catalyst to re-evaluate the zoo's philosophy and application of behavioral management. It suggested a restructuring of collection management and the rethinking of future goals and practices. Gradually, the

process became more focused and organized. Behavioral enrichment, training, animal behavior issues, and exhibit architecture were embraced as essential components for providing quality of life. Staff from all levels worked side-by-side on assignments. Our way of thinking and working was changing.

Hutchins, M. (2006). "Variation in nature: Its implications for zoo elephant management." Zoo Biology **25**(3): 161-171.

Despite many advances in animal care and welfare over the past few decades, zoos have been criticized recently for the quality of their elephant management programs. More specifically, critics have argued that elephants live miserable lives in captivity and thus should not be kept in zoos. Poor health and reproductive success, they say, are the result of the combined impact of: a lack of exercise; exposure to cold temperatures and disease; and stress due to the use of "brutal" training techniques, chaining and inappropriate social environments. Everyone, including zoo professionals, seems to agree that improvements in zoo elephant management are necessary and appropriate. However, there is considerable disagreement on how to proceed and little information on which to base such decisions. One tactic that the critics have adopted in their efforts to promote change is their frequent reference to "nature" as a yardstick for gauging the adequacy of zoo animal management and care. An argument is made that direct zoo-wild comparisons are of questionable utility and may be invalid from a scientific perspective. Some critics talk about "nature" as if it represented a fixed set of rules by which captive managers must either abide by or risk diminishing the health and welfare of their charges. However, many aspects of elephant natural history vary greatly depending on prevailing environmental conditions and elephants may be much more flexible than many critics are giving them credit for. Thus, although zoo animal managers should look to nature for clues about how to best care for captive elephants, they should not feel constrained by them. This revelation is not intended as an excuse for poor elephant management or to support the status quo. On the contrary, a better approach is to develop realistic and biologically meaningful metrics that reflect the quality of elephant care and welfare and to use them to measure the success of evolving zoo elephant programs.

Hutchins, M. (2006). "Death at the Zoo: The Media, Science, and Reality." Zoo Biol **25**: 101-115.

Media characterizations of zoo and aquarium animal deaths were randomly monitored on the internet for a 20-month period (September 2003-May 2005). Based on 148 samples collected, it was possible to classify articles into one of four categories, which were operationally defined: 1) dispassionate observers; 2) accusers; 3) sympathizers; and 4) balancers. In addition, with the notable exception of seven cases, all of the articles examined focused on large, charismatic mammals, such as gorillas, dolphins, lions, and elephants. Although a majority of the articles examined (70.4%) were either dispassionate and objective or sympathetic, nearly a third (29.6%) were either accusatory or attempted to

balance the accusatory statements of animal rights activists with sympathetic statements from zoo professionals. Recommendations are offered for how zoos should deal with the increasing media and public interest in zoo animal deaths, including: 1) a greater commitment to studying the reasons for mortality in a wide variety of species; and 2) an increased investment in record keeping and analysis,
which should allow zoos to calculate average life spans in animal populations and to monitor and assess the risk of certain lethal diseases on a real-time basis. Comparisons are drawn between zoo veterinary practices and human medicine, which are both inexact sciences. Suggestions are made for how the public and key decision-makers can distinguish between media reports on zoo animal deaths that are legitimate cause for concern vs. those that are sensationalist and meant to generate controversy and sell papers. A greater focus on the science of zoo animal death is necessary for accredited zoos to maintain the public's confidence in their animal care practices.

Ganguly, S., S. Rao and S. Varma (2006). The crisis in captive elephant welfare and management in India: Report from an all-India survey. Proceedings International Elephant Conservation & Research Symposium.

Druce, H., K. Pretorius, D. Druce and R. Slotow (2006). "The effect of mature elephant bull introductions on resident bull's group size and musth periods: Phinda Private Game Reserve, South Africa." South African Journal of Wildlife Research **36**(2): 133-137.

African elephants have been reintroduced into small, enclosed reserves in South Africa,many populations being established with orphans <10 years old.This has resulted in abnormal behaviour in some elephant populations, which was corrected in Pilanesberg National Park by introducing older bulls and culling certain problem elephants.In July 2003, three older bulls (29-41 years old) were introduced into Phinda Private Game Reserve, KwaZulu-Natal, South Africa, in order to normalize the bull age structure and in an attempt to reduce the abnormally long musth period of one particular resident bull. These introduced bulls were monitored intensively after release, as was the resident bull population, both before and after introduction of the older bulls.The introduced bulls all came into musth within eleven months postrelease.The older bulls do not appear to have had any influence on the musth periods of the oldest resident bull (36 years old at introduction). Detailed behavioural studies of the effects of management actions on elephant populations, within small, enclosed reserves provide information and resources for future management decisions.This study demonstrates that old bulls can be successfully introduced to very small areas provided that electrification of the entire perimeter is secure. Further, the introduction has no detectable medium-term (one year) effect on the behaviour of a relatively dense population of resident elephants, and the welfare of the elephants was not greatly affected.

Rahman, S. A., L. Walker and W. Ricketts (2005). "Global perspectives on animal welfare: Asia, the Far East, and Oceania

536." Rev. Sci. Tech **24**(2): 597-612.

In Asia and the Far East, livestock undergo major suffering due to malnutrition, overloading, and ill-treatment. At slaughter animals are handled roughly and watch other animals being killed; stunning is not practised. Cruelty to other animals such as elephants, horses, donkeys, bears, dogs, and circus animals has largely been prevented through the efforts of animal welfare organisations. Governments have taken initiatives to establish Animal Welfare Boards and enact laws for the prevention of cruelty to animals, but their efforts are far too limited to be of any significance and financial constraints and lack of personnel inhibit the implementation of the laws that do exist. In New Zealand and Australia, legislation and strong consultation procedures at governmental and community level strive to regulate and improve the welfare of animals in all spheres, but in other Oceanic countries there is a need for both an update in, or establishment of, legislation covering animal welfare. Limited progress has been made due to the status of the Veterinary Services and a lack of resources. Although some public and educational awareness programmes are carried out, increasing exposure to international media and attitudes of visiting tourists suggest that further awareness work needs to be undertaken. To address the problems of animal welfare in developing countries, it would be inappropriate to adopt the international standards that are implemented in the developed countries. Each developing country should evolve its own standards based on its own individual priorities

Douglas-Hamilton, I., T. Krink and F. Vollrath (2005). "Movements and corridors of African elephants in relation to protected areas." Naturwissenschaften **92**(4): 158-163.

Understanding how mammals satisfy their need for space in fragmenting ecosystems is crucial for ecosystem conservation. Using state-of-the-art global positioning system (GPS) technology we tracked 11 focal African elephants (Loxodonta africana) in Kenya at 3-hourly fix intervals and collected between 34 and 406 days per individual. Our recordings gave a high spatio-temporal resolution compared to previous studies and allowed novel insights into range use. The actual ranges of the tracked elephants are smaller than usually represented. Moreover, the ranges in our sample were complex and not confined to officially designated protected areas, except where fenced. All the unfenced elephants in our sample had distinct 'home sectors' linked by 'travel' corridors. Within each home sector the elephants concentrated in favourite 'core zones'. Such core zones tended to lie in protected areas whereas corridors typically crossed unprotected range. Elephants moved significantly faster along corridors than elsewhere in their range, which suggests awareness of danger outside the protected area. We conclude that understanding the complex use of an animal's range is crucial for conservation planning aiming to balance animal interests with those of human beings that co-habit in their range. © Springer-Verlag 2005.

Bandara, R. and C. Tisdell (2005). "Changing abundance of elephants and willingness to pay for their conservation

614." J. Environ. Manage **76**(1): 47-59.

This paper explores the way in which the stated willingness to pay for the conservation of Asian elephants in Sri Lanka varies with hypothetical variations in their abundance. To do that, it relies on results from a sample of residents of Colombo. The willingness to pay function is found to be unusual. It increases at an increasing rate for hypothetical reductions in the elephant population compared to its current level (a level that makes the Asian elephant endangered) and also increases at a decreasing rate for increases in this population from its current level. Rational explanations are given for this relationship. The relationship is, however, at odds with relationships suggested in some of the literature for total economic value as a function of the abundance of a wildlife species. It is suggested that willingness to pay for conservation of a species rationally includes a strategic element and may not always measure the total economic value of a species. Nevertheless, willingness to pay is still policy relevant in such cases

Wilson, M. L., M. A. Bloomsmith and T. L. Maple (2004). "Stereotypic swaying and serum cortisol concentrations in three captive African elephants (Loxodonta africana)." Animal-Welfare **13**(1): 39-43.

The behaviour and serum cortisol concentrations of three captive female African elephants (Loxodonta africana) were studied to determine whether their stereotypic swaying was more prevalent before regularly scheduled events in the elephants' routine, and whether the elephants that exhibited more stereotyped swaying had lower mean serum cortisol concentrations. Behavioural data were collected during hour-long observations balanced across three periods, and during 15-min observations prior to the elephants being moved to different portions of their enclosure. Observational data were collected using instantaneous focal sampling of behaviours every 30 s. Serum cortisol measures were obtained through weekly blood withdrawal from the elephants' ears. Of the three elephants, two exhibited stereotyped swaying, which accounted for a mean of 0.4% of the scans during the hour-long observations and a mean of 18% of the scans prior to the elephants being moved between different parts of the enclosure. Swaying was highly variable among the individual elephants during both categories of observations. Additionally, both elephants swayed more prior to moving in the afternoon than prior to moving in the morning. Analyses of serum cortisol concentrations indicated that each elephant had a different mean cortisol level, which did not clearly correspond with the expression of swaying. The findings indicate that a rigidly scheduled management event may elicit stereotyped swaying in the studied elephants. Future research should document the behavioural and physiological effects of an altered management routine to improve captive elephant welfare.

Stiles, D. (2004). "The ivory trade and elephant conservation." Environmental Conservation **31**(4): 309-321.

In response to significant elephant population declines in the 1970s and 1980s because of poaching for ivory, the Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES) banned the

international trade in Asian and African elephant species by listing them on Appendix I in 1973 and 1989, respectively. Many southern African countries disagreed with the African elephant trade ban and have continued to argue against it since the mid-1980s. They maintain that their governments practice sound wildlife management policies and actions and, as a consequence, their national elephant populations have reached unsustainable size. They argue that they should not be penalized because other countries cannot manage their wildlife. Further, they say they need the proceeds from ivory and other by-product sales to finance conservation efforts. In 1997, the CITES Conference of Parties voted to allow Botswana, Namibia and Zimbabwe to auction off 50 tonnes of government ivory stockpiles to Japanese traders on a one-off experimental basis, which took place in 1999. Ivory trade opponents allege that this sale stimulated ivory demand, resulting in a surge of elephant poaching. Nevertheless, CITES voted again in 2002 to allow Botswana, Namibia and South Africa to auction off another 60 tonnes of ivory after May 2004. Trade opponents have launched an active campaign to prevent the sales, warning that they could provoke a renewed elephant holocaust. This paper reviews available quantitative evidence on ivory trade and elephant killing to evaluate the arguments of the ivory trade proponents and opponents. The evidence supports the view that the trade bans resulted generally in lower levels of ivory market scale and elephant poaching than prevailed prior to 1990. There is little evidence to support claims that the 1999 southern African ivory auctions stimulated ivory demand or elephant poaching. Levels of elephant poaching and illegal ivory trading in a country are more likely to be related to wildlife management practices, law enforcement and corruption than to choice of CITES appendix listings and consequent extent of trade restrictions. Elephant conservation and public welfare can be better served by legal ivory trade than by a trade ban, but until demand for ivory can be restrained and various monitoring and regulation measures are put into place it is premature for CITES to permit ivory sales.

Smith, T. (2004). Zoo research guidelines: Monitoring stress in zoo animals. London.

Rees, P. A. (2004). "Some preliminary evidence of the social facilitation of mounting behavior in a juvenile bull Asian elephant (Elephas maximus)." Journal of Applied Animal Welfare Science **7**(1): 49-58.

This study recorded sexual behavior within a captive herd of 8 Asian elephants for approximately 230 hr on 50 days over a period of 10 months. The study observed a single adult and a single juvenile bull mounting cows more than 160 times. When the juvenile bull was between 4 years, 2 months and 4 years, 8 months old, he exhibited mounting behavior only on days when adult mounting occurred. Adult mounting always occurred first. Beyond the age of 4 years, 8 months, the juvenile bull exhibited spontaneous mounting behavior in the absence of adult mounting. This suggests that mounting behavior may develop because of social facilitation. Determining the significance of the presence of sexually active adults in the normal

development of sexual behavior in juveniles will require further studies. Encouraging the establishment of larger captive herds containing adults and calves of both sexes - if their presence is important - would improve the welfare of elephants in zoos and increase their potential conservation value. Copyright © 2004, Lawrence Erlbaum Associates, Inc.

Manteuffel, G., B. Puppe and P. C. Schön (2004). "Vocalization of farm animals as a measure of welfare." Applied Animal Behaviour Science **88**(1-2): 163-182.

Emotionally relevant external events, hormone concentrations affecting mood and appetitive behaviour, thirst and hunger are able to stimulate a complex central nervous network that regulates endocrine feedback and behaviour in order to maintain or regain homeostasis. Particular states of mood or emotion may thus be accompanied by specific behaviours, vocalization being one of them. Hence, in farm animals vocalizations may supply us with hints on their well-being in an easy way, given that the meanings of the respective calls are well-established. Then, it is possible to judge acoustically uttered current needs and impaired welfare by non-invasive, continuous monitoring. Vocalizations may also modulate emotions of the receivers such that welfare may also be affected in conspecifics hearing distress utterances, e.g., in an abattoir. For these reasons, the analysis of farm animal vocalization has gained increasing interest in the last years and a variety of attempts to decode the meaning has been made. Concentrating on important farm animal species (pig, cattle, poultry) an overview of the present state-of-the-art in this discipline is given and present problems as well as possible future developments are discussed. Modern techniques of sound analysis have provided tools to discriminate, analyse and classify specific vocalizations. Taking advantage of this, future bioacoustical research for welfare assessment should focus on comprehensive studies of a broad spectrum of species specific distress vocalizations. Increasingly precise attributions of such utterances to environments, behavioural contexts and relevant physiological parameters will lead to a deeper understanding of their meaning and significance with respect to well-being of farm animals. The result will offer applicable acoustic tools for farming environments where non-invasive techniques for welfare judgements are urgently needed. © 2004 Elsevier B.V. All rights reserved.

Talukdar, B. N. (2003). Practices on welfare and prevention of cruelty: legal provisions related to elephant. Healthcare, Breeding and Management of Asian Elephants. D. Das. New Delhi, Project Elephant. Govt. of India**:** 180-190.

Sukumar, K. (2003). "Asian elephants in zoos – a response to Rees." Oryx **37**(1): 23-24.

The real role of zoos in the conservation of threatened animals is increasingly coming under public scrutiny, and this is perhaps natural in the case of intelligent, charismatic animals such as elephants. From Roman times up to the mid nineteenth century the elephant was a curiosity in Europe, and then with the establishment of zoos and the popularity of modern circuses there was a steady influx of animals from colonies in Africa and Asia. Elephants,

however, never bred well in captivity, either historically in Asia or in recent decades in western zoos. Kings and other rulers have over the centuries obtained their elephant stocks mainly through capture from the wild, in many instances depleting these populations to the point of local extinction (Sukumar, 1989). Even the stocks of timber camp elephants in British India and Burma during the twentieth century were built up mainly through capture as opposed to breeding (Williams, 1950; Stracey, 1963; Gale, 1974; Krishnamurthy & Wemmer, 1995). The longevity of elephants ensured that sizeable numbers were available at any point in time; there was breeding among the timber camp elephants but in most places this rarely compensated for the mortality rate.

Rees, P. A. (2003). "The welfare and conservation of Asian elephants – a reply to Sukumar." Oryx **37**(1): 25-25.

Since my summary of the global fate of Asian elephants in zoos (this issue) was written Clubb & Mason (2002) have published a review of the welfare of zoo elephants in Europe, commissioned by the Royal Society for the Prevention of Cruelty to Animals in the UK. In an attempt to collect data on behaviour, reproduction, group composition, welfare and other aspects of husbandry, they sent questionnaires to the directors of the 18 zoos in the UK that hold elephants. Professor Sukumar doubts my contention that zoo directors lack the commitment necessary to manage the zoo elephant population as viable breeding units. Why then did none of the zoos contacted by Clubb & Mason reply?

Mikota, S. K., H. Hammatt and M. Finnegan (2003). Occurrence and prevention of capture wounds in Sumatran elephants (*Elephas maximus sumatranus*). Proc Amer Assoc Zoo Vet.

The capturing of elephants in Indonesia began in 1986 as an attempted solution to human-elephant conflict. The intent was to train "problem" elephants for use in agriculture, logging and tourism. The initial captures were conducted under the guidance of Thai mahouts and Thai koonkie elephants (trained elephants used for capture). A number of the Indonesians that were originally trained in capture techniques still work for the government forestry department (KSDA). The younger pawangs (elephant handlers) that participate in captures have learned from their peers. There is no formal training program. The actual mortality rate associated with elephant captures in Sumatra is unknown as official reports are lacking. The age structure of the existing ~ 400 captive elephants is young (most under 25) which suggests that smaller, younger elephants are preferentially captured and / or that adult elephants do not survive the capture and training processes. Our personal experiences (Mikota and Hammatt) in Sumatra show that mortality in newly captured elephants is high.In 2001, with endorsement from the World Wide Fund for Nature-Indonesia (WWF), the Wildlife Conservation Society (WCS), Fauna and Flora International (FFI), and the International Elephant Foundation (IEF), we requested a two-year Moratorium on elephant captures during which time capture techniques would be improved and alternative conflict mediation

techniques evaluated.

A Moratorium against placing additional elephants into the Elephant Training Centers has been issued by the central government, however capture for translocation is still sanctioned. Unfortunately, the provincial governments have increasingly acted in their own interests since the government of Indonesia began a de-centralization process a few years ago. Riau Province is thought to have the largest remaining populations of wild Sumatran elephants.Fifty-seven, human-elephant conflicts occurred in Riau between 1997-2000. Although Riau is a hotbed of conflict, problems are occurring throughout Sumatra and we are aware of conflicts and captures in Bengkulu and North Sumatra. In October 2002, we were invited by KSDA (the provincial forestry department) to accompany their team into the field as they attempted to capture a large bull that had been raiding a palm oil plantation. This opportunity was invaluable as we were able to observe first hand the techniques being used and where improvements were needed. As a result of this and other experiences with newly captured elephants we observed: ·Equipment (Palmer) is old, poorly maintained, and used improperly. ·Essential supplies are lacking or homemade substitutes are used.

·The dose of xylazine is very high compared to wild elephant capture doses used in India and Malaysia. The same dose is often used regardless of the size of the elephant. ·The needles are too short to reach muscle; open-ended needles are used which can become plugged with tissue, thus preventing injection. ·Neither the correct charge nor the correct load is selected. We observed that many darts bounced making it difficult to ascertain the amount of drug injected or its depth of penetration. Selection of an inappropriate charge results in unnecessary trauma. ·The preparation and use of darts, needles, and syringes lacks basic hygiene. ·Dart wounds are not treated and antibiotics are not administered. ·There is no understanding of stress or capture myopathy. ·The capture team was not aware that sternal recumbency severely compromises respiration in elephants and that they can quickly die in this position. ·It is believed that elephant restraints must inflict pain to prevent wild elephants from escaping once captured. ·There is no veterinarian on the capture team. The current capture techniques result in leg wounds from unprotected chains, neck wounds from "kahs" (neck yokes made of wood and wire), and abscesses from inappropriately administered darts. Leg and neck wounds often become maggot infested. Infections from dart wounds are, however, the primary cause of capture-related mortality. These abscesses can drain for several months, even with treatment, and often progress to a necrotizing fasciitis, acute sepsis, and death. The Riau Province KSDA Team has been receptive to suggested changes to minimize wounds. Provision of heavier chains has alleviated the fear that elephants will escape. Covering the chains with fire hose or heavy plastic minimizes injuries to legs and use of the kah has been discontinued. A basic dart wound treatment protocol has been established. In June 2003, a comprehensive Elephant Immobilization and Translocation Workshop for Sumatra is planned to retrain all of Sumatra's field teams and to upgrade equipment. Sumatra's wild elephant population probably numbers fewer than

3000 and is under continued threat. With so few elephants left, the preservation of as many viable herds as possible takes on increased urgency. The Moratorium achieved in 2001 has set the groundwork for KSDA to choose translocation of wild elephants rather than capture and placement into already over-crowded and under-resourced Elephant Training Centers. We cannot guarantee that Sumatra will capture elephants only for translocation, and it is inevitable that many more elephants will end up in captivity. Regardless, all of the elephants that must suffer the interruption of their lives at the hand of man deserve, at the very least, humane treatment. Translocations are neither simple nor a complete panacea. Identifying suitable translocation areas and insuring that elephants remain there are significant challenges. WWF-Indonesia is continuing its efforts to secure the lowland forest of Tesso Nilo in Riau Province as a "safe haven" for at least some of Sumatra's wild elephants (see WWF AREAS Program – Riau, Sumatra: http://www.worldwildlife.org/species/attachments/riau_profile.pdf). The identification of interim release sites, together with improved capture techniques, offers the hope that fewer elephants will be removed from the wild. ACKNOWLEDGMENTS: Our work in Sumatra has been supported by the Guggenheim Foundation, a CEF grant from the American Zoo and Aquarium Association, the International Elephant Foundation, Oregon Zoo, Columbus Zoo, Disney, Peace River Refuge, the Elephant Managers Association, the Riddles Elephant and Wildlife Sanctuary, Tulsa Zoo, Toronto Zoo, Niabi Zoo, San Antonio Zoo, Denver Zoo (AAZK Chapter), Milwaukee Zoo (AAZK Chapter), the Audubon Nature Institute (Youth Volunteers), Buttonwood Park Zoo, Melbourne Zoo, and private donors. Special thanks to Harry Peachey, John Lehnhardt, Holly Reed, Kay Backues, Mike Keele, Steve Osofsky, and Heidi and Scott Riddle.

Meredith, M. (2003). Biography of an Endangered Species in Africa, PublicAffairs. Review from Publishers Weekly: In this solid introduction to the world of elephants, Meredith covers all the major topics including biology, social behavior, recent scientific discoveries, ancient elephantology, the devastating ivory trade, the truth about elephant graveyards and the insistent threat of extinction. Meredith demonstrates that human involvement in elephantine affairs has been disastrous to the pachyderm: the quest for ivory had caused the extinction of all Syrian herds by 500 B.C.; many ancient cultures took elephants to war; and Romans used the animals in their blood sports. Much of the book follows the history of the European exploitation of Africa's three treasures: gold, slaves and ivory. The quantities of murdered elephants and descriptions of killing methodologies are deeply affecting. Once Meredith's history reaches modern times, the shock of population counts is astounding in comparison with the numbers of elephants that roamed free in the past. Aristotle's treatise on the animals' anatomy, behavior, diet and reproduction was the beginning of a long line of nterest, but only recently has science uncovered the answers to mysteries such as how separate herds coordinate movement over many miles. Meredith's primer on elephantine

matters will help turn a reader's casual interest into a fascination.

Langman, V. A., M. Rowe, D. Forthman, N. Langman, J. Black and T. Walker (2003). "Quantifying shade using a standard environment." Zoo Biology **22**(3): 253-260.

The purpose of this study was to quantify the thermal microclimate provided by a shade structure in the African elephant enclosure at Zoo Atlanta. The hypothesis was that the interior of a weather instrument shelter (a Stevenson screen) would provide the maximum environmental shielding and the coolest possible ambient conditions without artificial heating or cooling. The ambient conditions inside the Stevenson screen were compared with the ambient conditions in the shaded and nonshaded sections of the exhibit to quantify the extremes possible under the environmental conditions. The Stevenson screen reduced the radiant heat load by 766 W m-2. The shade structure in the elephant enclosure reduced the radiant heat load by 278 W m-2, which was 37% of the total possible reduction represented by the interior of the Stevenson screen. The longwave radiant heat was 10% greater in the direct sun and 37% greater in the shaded area than the shortwave radiant heat. The shade structure reduced the shortwave radiant heat by 254 W m-2 or 43%, but only reduced the longwave radiant heat by 24 W m-2 or 3%. Shade structures alone may not provide adequate protection from radiant heat for captive species. A cool microclimate in an artificial enclosure should be designed to reduce all sources of radiant heat.

Coe, J. C. (2003). "Steering the ark toward Eden: Design for animal well-being." J Am Vet Med Assoc **223**(7): 977-980.

(2003). In safe hands: A response to the RSPCA report on the welfare of elephants in captivity. London**:** 1-8.

(2003). Healthcare, Breeding and Management of Asian Elephants. New Delhi, Project Elephant. Govt. of India.

Tipprasert, P. (2002). Elephants and ecotourism in Thailand. Giants on Our Hands: Proceedings of the International Workshop on the Domesticated Asian Elephant, Bangkok, Thailand, 5-10 February 2001. I. Baker and M. Kashio. Bangkok; Thailand, FAO Regional Office for Asia and the Pacific (RAPA)**:** 156-172.

The numbers of elephants used at particular locations in Thailand, the activities for which they are used and the conditions under which they are kept are presented in tabular form. The Thai Elephant New World Project, which aims to integrate elephant ecotourism and conservation is described. Recommendations for the regulation and support of the use of elephants in ecotourism are given.

Suprayogi, B., J. Sugardjito and R. P. H. Lilley (2002). Management of Sumatran elephants in Indonesia: problems and challenges. Giants on Our Hands: Proceedings of the International Workshop on the Domesticated Asian Elephant, Bangkok, Thailand, 5-10 February 2001. I. Baker and M. Kashio. Bangkok;

Thailand, FAO Regional Office for Asia and the Pacific (RAPA)**:** 183-194.

The status of domestic elephants in Indonesia is described. The development of elephant training centres and reasons for their failure to encourage the use of elephants for logging operations are discussed. Problems of stress and other health problems are described. The availability of resources (feed, water and veterinary support) are discussed. Recommendations for improvement are given.

Schmid, J. (2002). "Keeping circus elephants temporarily in paddocks - the effects on their behaviour." Animal Welfare **4**: 87-101.

Ratanakorn, P. (2002). The role of NGOs in the management of domesticated elephants in Thailand. Giants on Our Hands: Proceedings of the International Workshop on the Domesticated Asian Elephant, Bangkok, Thailand, 5-10 February 2001. I. Baker and M. Kashio. Bangkok; Thailand, FAO Regional Office for Asia and the Pacific (RAPA)**:** 227-229.

For copies write to: Forest Resources Officer, FAO Regional Office for Asia and the Pacific, Maliwan Mansion, Phra Atit Road, Bangkok 10200, Thailand; Email: masakazukashio@fao.org

Prabhkaran, L. (2002). "Humane treatment of elephants and the legal perspective." Journal of Indian Veterinary Association Kerala **7**(3): 49-51.

Milroy, A. J. W. (2002). A.J.W. Milroy's Management of Elephants in Captivity. Dehra Dun, New Delhi, India, Natraj Publishers.

Lohanan, R. (2002). The elephant situation in Thailand and a plea for co-operation. Giants on Our Hands: Proceedings of the International Workshop on the Domesticated Asian Elephant, Bangkok, Thailand, 5-10 February 2001. I. Baker and M. Kashio. Bangkok; Thailand, FAO Regional Office for Asia and the Pacific (RAPA)**:** 231-238.

For copies write to: Forest Resources Officer, FAO Regional Office for Asia and the Pacific, Maliwan Mansion, Phra Atit Road, Bangkok 10200, Thailand; Email: masakazukashio@fao.org

Lair, R. (2002). A regional overview of the need for registration of domesticated Asian elephants. Giants on Our Hands: Proceedings of the International Workshop on the Domesticated Asian Elephant, Bangkok, Thailand, 5-10 February 2001. I. Baker and M. Kashio. Bangkok; Thailand, FAO Regional Office for Asia and the Pacific (RAPA)**:** 8-13.

The need for registration of domesticated elephants, in order to improve welfare, prevent smuggling and assist in conservation, is discussed. The tools required (tags, forms, databases etc.) are described. The feasibility of registration programmes in 11 Asian countries are discussed.

Khawnual, P. and B. Clarke (2002). General care and reproductive management of pregnant and infant elephants at the Ayutthaya Elephant Camp. Giants on Our Hands: Proceedings of the International Workshop on the Domesticated Asian

Elephant, Bangkok, Thailand, 5-10 February 2001. I. Baker and M. Kashio. Bangkok; Thailand, FAO Regional Office for Asia and the Pacific (RAPA)**:** 249-256.

The management practices used at the Ayutthaya Elephant Camp (Thailand), where animals are kept for ecotourism purposes, are described. The aspects covered include feeding, provision of water, waste management and veterinary care (including health monitoring and disease control). Detailed descriptions are given of the procedures for management of pregnant females. The topics covered include mating, pregnancy diagnosis, parturition and postpartum management of the female and her offspring. These practices had resulted in 4 successful births in 2000.

Grandy, J. W. and A. T. Rutberg (2002). "An animal welfare view of wildlife contraception." Reprod Suppl **60**: 1-7.

Although there is some dissent, the animal protection community generally supports the concept of wildlife contraception. However, some contraceptive agents, delivery mechanisms and specific applications will be opposed by animal welfare advocates on environmental, humane or other ethical grounds, and some animal rights advocates may oppose wildlife contraception entirely. The Humane Society of the United States (HSUS) has supported and conducted wildlife contraception studies for more than 10 years. In general, we have invested in contraceptive agents (such as porcine zona pellucida) that we believe will prove environmentally, physiologically and behaviourally benign, and in delivery mechanisms that are narrowly targeted. As we consider contraception to be a major intervention into natural processes, we believe that wildlife contraception should be applied judiciously, locally and in a manner that is sensitive to the needs of animals, humans and ecosystem function.

Clubb, R. and G. Mason (2002). A review of the welfare of zoo elephants in Europe: A report commissioned by the RSPCA. Oxford,U.K.**:** 1-280.

Alexander, K. A., E. Pleydell, M. C. Williams, E. P. Lane, J. F. C. Nyange and A. L. Michel (2002). "*Mycobacterium tuberculosis*: An Emerging Disease of Free-Ranging Wildlife." Emerging Infectious Diseases **8**(6): 598-601.

Expansion of ecotourism-based industries, changes in land-use practices, and escalating competition for resources have increased contact between free-ranging wildlife and humans. Although human presence in wildlife areas may provide an important economic benefit through ecotourism, exposure to human pathogens

may represent a health risk for wildlife. This report is the first to document introduction of a primary human pathogen into free-ranging wildlife. We describe outbreaks of *Mycobacterium tuberculosis*, a human pathogen, in free-ranging banded mongooses *(Mungos mungo)* in Botswana and suricates *(Suricata suricatta)* in South Africa. Wildlife managers and scientists must address the potential threat that humans pose to the health of free-ranging wildlife.

(2002). Live hard, die young - how elephants suffer in zoos. Southwater, U.K.**:** 1-

11.

Wehnelt, S. (2001). The New Elephant Exhibit at Chester Zoo - High Husbandry and Welfare Standards. A Research Update on Elephants and Rhinos; Proceedings of the International Elephant and Rhino Research Symposium, Vienna, June 7-11, 2001, Schuling Verlag.

Schmid, J., M. Heistermann, U. Ganslosser and J. K. Hodges (2001). "Introduction of foreign female Asian elephants (Elephas maximus) into an existing group: behavioural reactions and changes in cortisol levels." Animal-Welfare **10**(4): 357-372.

The present study examined the extent to which the introduction of three female Asian elephants (aged 3, 11 and 27 years) into a group of 5 (1 male, 4 female) elephants at Munster zoo, Germany, affects the behaviour and urinary cortisol levels of the animals involved. At Munster, only the females were monitored , while the bull was mainly kept separate. Behavioural observations were carried out before transfer and during the six-month period following transfer. Urine samples were collected regularly from each elephant during the whole observation period. All the elephants showed behavioural changes to the process of introduction. The transferred animals increased their social behaviour after arrival in the foreign zoo. Two of them showed an increase in stereotypies and one a reduction in stereotypes. The elephants at Munster reacted with decreased frequencies of stereotypies and increased frequencies of social behaviour and manipulation/exploration behaviour. Six months after transfer, three of the four elephants at Munster and one of the three transferred elephants showed nearly the same behavioural activity pattern as before transfer. One female still showed elevated stereotypic behaviour. From the four elephants in which cortisol measurements could be reliably performed (two of the transferred elephants and two elephants at Munster), only one individual at Munster responded to the process of introduction with a short-term elevation in urinary cortisol levels. One elephant showed a negative correlation between locomotion and cortisol levels and one a positive correlation between stereotypies and cortisol levels. Taken together, the results suggest that transfer and introduction caused some stress responses in the elephants, but that stress was neither prolonged nor severe. Serious welfare problems may have been prevented through individual behavioural coping mechanisms and former experience with stressful situations.

Mellen, J. and M. S. MacPhee (2001). "Philosophy of environmental enrichment: past, present, and future." Zoo Biology **20**: 211-226.

The brief tenure of environmental enrichment has been influenced both directly and indirectly by the field of psychology, from the work of B.F. Skinner to that of Hal Markowitz. Research on enrichment supports the supposition that an enriched environment does indeed contribute to a captive animal's well-being. Critical elements of effective environmental enrichment are 1) assessing the animal's natural history, individual history, and exhibit constraints and 2) providing species-appropriate opportunities, i.e., the

animal should have some choices within its environment. This paper presents a historic perspective of environmental enrichment, proposes a broader, more holistic approach to the enrichment of animals in captive environments, and describes a framework or process that will ensure a consistent and self-sustaining enrichment program.

Kurt, F. and M. Garai (2001). Stereotypies in Captive Asian Elephants - A Symptom of Social Isolation. A Research Update on Elephants and Rhinos; Proceedings of the International Elephant and Rhino Research Symposium, Vienna, June 7-11, 2001, Schuling Verlag.

Gsandtner, H. and H. Schwammer (2001). Future Perspectives for Elephant-Keeping in Circuses. A Research Update on Elephants and Rhinos; Proceedings of the International Elephant and Rhino Research Symposium, Vienna, June 7-11, 2001, Schuling Verlag.

Groo, M. (2001). "The elephant listening project." AWI (Animal Welfare Institute?) quarterly **50**(1): 10.

Wemelsfelder, F., E. A. Hunter, M. T. Mendl and A. B. Lawrence (2000). "The spontaneous qualitative assessment of behavioural expressions in pigs: First explorations of a novel methodology for integrative animal welfare measurement." Applied Animal Behaviour Science **67**(3): 193-215.

Qualitative assessments of behaviour integrate and summarize the different aspects of an animal's dynamic style of interaction with the environment, using descriptors such as 'timid' or 'confident'. Although such qualitative terms are widely used in the study of animal temperament and personality, their use in relation to questions of animal welfare has yet to be formally explored. The terms used in integrative assessment (e.g., content, distressed) tend to have expressive, welfare-related connotations, and lie at the heart of the lay public's concern for animal suffering. For this reason they are frequently dismissed as 'anthropomorphic' and unscientific. However, in theory it is possible that these terminologies reflect observable aspects of behavioural organization. They may therefore be liable to scientific analysis, and be of use as integrative welfare measurements. A first step in investigating this hypothesis is to examine the inter-observer reliability of assessments of behavioural expression. This study investigated the extent to which 18 naive observers showed agreement when given the opportunity to qualitatively describe, independently and in their own words, the behavioural expressions of 20 individual growing pigs. Pigs were brought singly into a test pen and given the opportunity to interact with a human squatting in the centre of the test pen. Observers were instructed to first observe each pig and then to write down terms which adequately summed up the emergent qualities of that pig's behaviour. Data thus consisted of 18 sets of individually generated descriptive terms, attributed to 20 pigs. This procedure was repeated a month later with the same observers but using a new group of 20 pigs. To analyze the resulting 36 sets of descriptive terms, pigs in each set were given a score for each term. This score was either 0 (term not used for

that pig) or 1 (term used for that pig). These data were analyzed with Generalized Procrustes Analysis (GPA), a multivariate statistical technique which finds a consensus between observer assessment patterns (the 'pig consensus profile'), and provides a measure of observer agreement. Results show that for each group of 20 pigs, the 'pig consensus profile' differed significantly from an analysis of the same data in randomized form ($p < 0.001$), indicating that the consensus profiles were not artifacts of the GPA procedures. It can therefore be concluded that observers showed significant agreement in their spontaneous assessment of pig expressions, which suggests that these assessments were based on commonly perceived and systematically applied criteria. The extent to which these shared criteria reflect observable aspects of behaviour now requires further study. (C) 2000 Elsevier Science B.V.

Mikota, S. K. (2000). Sumatra's elephant training centers: a call for assistance. AAZV and IAAAM Joint Conference.

Lewis, M. H., J. P. Gluck, J. M. Petitto, L. L. Hensley and H. Ozer (2000). "Early social deprivation in nonhuman primates: long-term effects on survival and cell-mediated immunity." Biol Psychiatry **47**(2): 119-126.

BACKGROUND: Early differential social experience of non-human primates has resulted in long-term alterations in behavior and neurobiology. Although brief maternal separation has been associated with changes in immune status, the long-term effects on survival and immune function of prolonged early social deprivation are unknown. METHODS: Survival rates were examined in rhesus monkeys, half of which had been socially deprived during their first year of life. Repeated measures of immune status were tested in surviving monkeys (18-24 years old). Peripheral blood T, B, and natural killer lymphocytes, macrophages, and monocytes were measured by flow cytometry. Functional cellular immune activity measures included T-cell proliferative responses to mitogens (concanavalin and phytohemagglutinin), T-cell memory response to tetanus toxoid antigen, T-cell-dependent B-cell proliferative responses to mitogen (PWM) and natural killer cell cytotoxic activity. RESULTS: Despite identical environments following isolation, early social deprivation resulted in a significantly decreased survival rate, males being particularly vulnerable to early death. Early social deprivation was associated with a decrease in the ratio of helper to suppressor T cells, and a significant increase in natural killer cell number and in natural killer cell activity in the surviving monkeys. No differences in T- or B-lymphocyte proliferation following mitogen or tetanus toxoid antigen stimulation were observed. CONCLUSIONS: Prolonged early social deprivation of non-human primates profoundly affected mortality and resulted in lifelong effects on cell-mediated immune status.

Hart, L. and Sundar (2000). "Family traditions for mahouts of Asian elephants." Anthrozoos **13**(1): 34-42.

The mahout and elephant relationship is one of the oldest human-animal relationships, possibly beginning as far back as 5,000 years ago. Valued for

their assistance in war and work, elephants were trained and managed using methods described in ancient Indian texts. The lifelong job of mahouts historically had a long apprenticeship, and was passed from father to son. In 1973, when the government in Karnataka, India, assumed ownership of the maharajah's elephants, Hindu and Muslim mahouts with their elephants were relocated to national forests and became employees of the Forest Department. Members of honey-gathering tribes (called tribals) began to be offered government jobs as mahouts. To assess the current patterns of family traditions with elephants among mahouts living within Nagarahole National Park, India, sixteen mahouts and four young assistants were interviewed, representing Hindu, Muslim, and tribal families. In all three cultures, almost all had been introduced to elephants by a father or other male relative; the mahouts' sons expected to be mahouts. Mahouts' sons regularly assisted and played an essential role in the management of female elephants. No examples of injuries to children were mentioned by mahouts, yet some mahouts and villagers had been killed or seriously injured by elephants. Family tradition played a major role for Hindus, Muslims, and tribals in the decision to work with elephants. The semi-captivity of, and traditional, structured work activities with, Asian elephants may afford some possible improvements for their welfare and human-elephant conflicts

Payne, K., I. Douglas-Hamilton, C. Moss and J. Poole (1999). "Alarm raised over elephant ivory trade [1]." Nature **399**(6734): 297.

Friend, T. H. and M. L. Parke (1999). "The effect of penning versus picketing on stereotypic behavior of circus elephants." Applied Animal Behaviour Science **64**(3): 213-225.

The behaviour of 9 female Asian elephants (Elephas maximus) who performed 2 shows each day with a circus that travelled to a new location in the USA (40 to 250 km from the previous day's lot) daily or every 2 days was studied during the 1996 and 1998 seasons. When not performing or working, the elephants were picketed during 1996 in the traditional fashion. During the 1998 season, the same elephants were maintained exclusively in small (approximately 52 m2 per elephant) portable electric pens. Camera and time-lapse recorders were used to videotape the behaviour of each elephant, while picketed or penned, for three _24 h periods during the 1996 and 1998 seasons. The behaviour of each focal elephant was recorded at 5 min intervals. The amount of time the elephants spent stereotypic weaving was significantly decreased by keeping the elephants in pens when compared to picketing. The incidence of all stereotypic behaviour (weaving, head bobbing and trunk tossing) was also significantly decreased when the elephants were kept in pens. The total amount of time spent performing all stereotypic behaviours (weaving, head bobbing and trunk tossing) was negatively correlated with age when the elephants were picketed in 1996 and somewhat less correlated with age when penned in 1998. Time spent performing all stereotypic behaviour was not correlated with time spent eating or time spent lying when the elephants were picketed or penned. It is concluded that

portable electric pens are preferred over picketing because the elephants show reduced stereotypic behaviour, they appear to be calmer when out of the pens for work or performances, and they can be kept cleaner.

Chatkupt, T. T., A. E. Sollod and S. Sarobol (1999). "Elephants in Thailand: determinants of health and welfare in working populations
531." J. Appl. Anim Welf. Sci **2**(3): 187-203.

The Asian elephant (Elephas maximus) has played a prominent role in Thai history and society. However, in the face of modernization, elephant handlers have been struggling to justify their continued ownership. As a result, working elephants may still encounter situations in which their health and welfare are jeopardized. This study developed both a survey instrument and a visual assessment to describe and evaluate the health and living conditions of elephants encountered in a variety of work and living situations. These situations were found to be significantly associated with whether or not an elephant received proper husbandry or was in good body condition. These results may prove valuable in predicting the welfare of elephants according to work and living situations

Taylor, V. J. and T. B. Poole (1998). "Captive breeding and infant mortality in Asian elephants: a comparison between twenty Western zoos and three Eastern elephant centers." Zoo Biol **17**: 311-332.

A questionnaire was designed to assess the importance of reproductive behaviour and husbandry factors on breeding success in captive Asian elephants (Elephas maximus). This was circulated to zoos in Europe and North America in 1996. Data from 20 zoos were analysed. Data were also obtained from 3 elephant centres in Asia (Pinnawela Elephant Orphanage in Sri Lanka, Myanma Timber Enterprise in Myanmar and the Tamilnadu Forest Department in India). The aims were to compare Asian elephant breeding success, establish possible causes for any differences, and make recommendations for improving the welfare and breeding success of the animals. Breeding success in most of the zoos was notably lower and the percentages of stillbirths and infant mortality were relatively higher when compared with those of the centres in Asia. Female elephants in zoos appeared to reach sexual maturity and reproduce earlier than those in the Asian establishments. However, zoo elephants produced fewer young per female. The different facilities and husbandry methods used are described. Recommendations are made for both short- and long-term changes that could be used to modify existing practices to improve the welfare and breeding success of captive Asian elephants.

(1998). National Symposium on Elephant Management and Conservation, Jayantha Jayewardene and Charles Santiapillai, Organizers.

(1998). Elephants in need :action alert. Washington,D.C., Humane Society of the United States; DNAL Videocassette-no.-2744 (6 min).

Focuses on a case showing the cruelty to wild baby elephants as they are being held and waiting to be sold for profit

Schmid, J. and F. Kurt (1996). Stereotypes in captive Asian elephants (*Elephas maximus*). First International Symposium on Physiology and Ethology of Wild and Zoo Animals.

Friend, T. and D. Bushong (1996). Stereotypic behaviour in circus elephants and the effect of "anticipation" of feeding, watering and performing. Proceedings of the 30th International Congress of the International Society for Applied Ethology 14-17 August, 1996, Guelph, Ontario, Canada.

Arnold, C. (1996). Riddle's elephant breeding farm and wildlife sanctuary and Hendrix College- -people helping animals and people. Proceedings of the 30th International Congress of the International Society for Applied Ethology 14-17 August, 1996, Guelph, Ontario, Canada.

Williams, L. M. and T. Williams (1995). Please pass up the salt. Bloomington, Ind.USA, Sandridge.

Tells the story of Congo, an elephant who lives in the Red Apple Zoo and who enjoys eating salty snacks, such as pretzels and peanuts. Describes the effect of too much salt on Congo, and discusses what healthy snacks can be substituted for salty ones.

Krishnamurthy, V. and C. Wemmer (1995). "Veterinary Care of Asian Timber Elephants in India: Historical Accounts and Current Observations." 534-534.

Schmid, J. and K. Zeeb (1994). The establishment of the paddocks for keeping elephants in the circus. Deutsche Tierarztliche Wochenschrift
Die Einfuhrung des Paddocks in die circuselefantenhaltung. **101:** 50-52.

The guidelines for keeping, training and using animals in circuses and similar institutions, which are made in connection with the law for prevention of cruelty to animals, claim to keep elephants daily 1 hour unshackled in a group in a paddock. The effect of the paddock on social, play behaviour, and the stereotypic movements of circus elephants is discussed. Parameters for housing and managing captured elephants are based on observations of their normal behaviour in nature. A pilot study with 29 elephants in 4 circuses showed that the paddock enabled the elephants to carry out social and comfort behaviour more frequently than when shackled. The stereotypic movements were nearly absent by keeping the elephants in the paddock.

McNeely, J. A. (1992). Elephants as beasts of burden. Elephants. Majestic creatures of the wild. J. Shoshani. Emmaus, Pennsylvania, Rodale Press**:** 149-151.

Kiley-Worthington, M. (1990). "Are elephants in zoos and circuses distressed?" Applied Animal Behaviour Science **26**(3): 299.

Hovell, G. J. R. (1990). "Transport animals promoted." British Veterinary Journal **146**(5): 385-386.

Cockrill, W. R. (1989). World Association for Transport Animal Welfare and Studies. Inaugural Meeting. Wolfson College Oxford, 12 December 1989. Working animals international. World Association for Transport Animal Welfare and Studies. Inaugural Meeting. Wolfson College Oxford, 12 December 1989. Working animals international.

Moore, D. E. and C. E. Doyle (1986). "Elephant training and ride operations, part I: animal health, cost/benefit and philosophy." Elephant **2**(2): 19-31.

Results from a survey, conducted by the authors as employees of the Burnett Park Zoo, show that very few captive elephants in zoos (18 in the USA) are trained for ride operations. Trained elephants are easily accessable for treatments, are less "bored", and overall are healthier than non-trained elephants, which may be manifested in a longer life span. The benefits derived from a well planned elephant training and ride operation outweigh the costs incurred.

Siegel, R. K. (1984). "LSD-induced effects in elephants: comparisons with musth behavior." Bull. Psychonom. Soc **22**(1): 53-56.

Musth is a condition observed in male Asiatic elephants and is characterized by aggression and temporal gland secretion. A classic and controversial 1962 study attempted to induce a musth syndrome in an elephant via treatment with LSD. Two elephants in the present study survived dosages of LSD (.003 -.10 mg/kg) and exhibited changes in the frequency or duration of several behaviors as scored according to a quantitative observational system. LSD increased aggression and inappropriate behaviors such as ataxia. Results are discussed in terms of musth and drug-induced perceptual-motor dysfunction.

Meyer-Holzapfel, M. (1968). Abnormal behavior in zoo animals. Abnormal behavior in animals. Philadelphia, W.B. Saunders**:** 479-484.

West, L. J. and C. M. Pierce (1962). "Lysergic acid diethylamide: Its effects on a male Asiatic elephant." Science **138**: 1100-1103.

Summary:Researchers gave LSD to a zoo elephant in order to "induce a behavioral abberation that might resemble the phenomenon of going on musth." Elephant cause of death was asphixiation secondary to laryngeal spasm.

Nicholson, B. D. (1956). "The African elephant: How to shoot it humanely, when necessary." Afr. Wildl **10**(1): 25-36.

Lieberman, S. S. (1955). African elephants: Can we end the slaughter. Monroe, Conn. USA**:** 41-43.

Milroy, A. J. W. (1922). A short tretise on the management of elephants. Shillong, Government Printer.

Tennent, J. E. (1867). The wild elephant and the method of capturing and taming it

in Ceylon. London, Longmans, Green and Co.