

Recent Publications on Asian Elephants

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If you need additional information on any of the articles, please feel free to contact me. You can also let me know about new (2015) publications on Asian elephants.

M. Alamgir, S.A. Mukul & S.M. Turtona
Modelling spatial distribution of critically endangered Asian elephant and Hoolock gibbon in Bangladesh forest ecosystems under a changing climate

Applied Geography 60 (2015) 10-19

Abstract. The Asian elephant (*Elephas maximus*) and Hoolock gibbon (*Hoolock hoolock*) are two globally endangered wildlife species limited to only tropical Asian forests. In Bangladesh both species are critically endangered and distributed mainly in the northeast and southeast hilly regions bordering neighboring India and Myanmar. Using existing distribution data, land-use/land cover, elevation and bio-climatic variables, we modeled the likely distribution of Asian elephant and Hoolock gibbon in Bangladesh for 2050 and 2070. We used the IPCC's Representative Concentration Pathways (RCPs) e RCP6.0 and RCP8.5 and Maximum Entropy algorithm for our modelling. Our study indicated that the Asian elephant will be more resilient to climate change compared with the Hoolock gibbon. Habitat loss for the Asian elephant is also expected to remain constant (i.e. 38%) throughout the period, whilst Hoolock gibbon habitat will be more sensitive to climatic variations, with the species predicted to be extirpated from the country by 2070. Being highly exposed to climate change with ever increasing land use pressures, we believe our study in Bangladesh can be used to enhance our understanding of future vulnerabilities of wildlife in a rapidly changing climate. A trans-boundary conservation program with greater attention to the species that are less resilient to climate

change is also essential. © 2015 Reprinted with permission from Elsevier.

M. Benadusi

Elephants never forget: Capturing nature at the border of Ruhuna National Park (Yala), Sri Lanka

Capitalism Nature Socialism 26 (2014) 77-96

Abstract. Yala National Park, in south-eastern Sri Lanka, is a complex of adjoining natural reserves covering a large forested area partly open to tourists. The park is surrounded by a wide swath of shrub jungle that serves as a buffer zone separating the protected lands from the nearest rural villages. There have long been disputes over access to natural resources in this region, but they became more heated after 2009 when the state finally emerged victorious from a long civil war with Tamil separatist rebels, established in the north-eastern territories. With the conflict resolved, the government was able to repackage the country as a new Asian destination for international tourism. © 2014 The Center for Political Ecology.

L. Bennett, S. Dunham, L. Yon, S. Chapman, M. Kenaghan, L. Purdie & R. Tarlinton

Longitudinal study of Asian elephants, *Elephas maximus*, indicates intermittent shedding of elephant endotheliotropic herpesvirus 1 during pregnancy

Veterinary Record Open 2 (2015) e000088

Abstract. Introduction: EEHV-1 is a viral infection of elephants that has been associated with a fatal haemorrhagic syndrome in Asian elephants. Previous studies have suggested that pregnant animals may shed more virus than non-pregnant animals. Methods: This study examined whether pregnancy affected the frequency or magnitude of shedding of elephant

endotheliotropic herpesvirus 1 (EEHV1) using Taq man real-time PCR on trunk washes from four female elephants from a UK collection over three time periods between 2011 and 2014. These periods included pregnancies in two animals (period 1 and period 3). Behavioural observations made by keepers were also assessed. Results: During period 1 there was a high degree of social hierarchical instability which led to a hierarchy change, and was associated with aggressive behaviour. Also during period 1 EEHV-1 shedding was of a higher magnitude and frequency than in the latter two time periods. Conclusions: These results suggest that there is no clear relationship between shedding and pregnancy, and that behavioural stressors may be related to an increase in EEHV-1 shedding.

K. Chelliah & R. Sukumar

Interplay of male traits, male mating strategies and female mate choice in the Asian elephant, *Elephas maximus*

Behaviour 152 (2015) 1113-1144

Abstract. Elaborate male traits with no apparent adaptive value may have evolved through female mate discrimination. Tusks are an elaborate male-only trait in the Asian elephant that could potentially influence female mate choice. We examined the effect of male body size, tusk possession and musth status on female mate choice in an Asian elephant population. Large/musth males received positive responses from oestrous females towards courtship significantly more often than did small/non-musth males. Young, tusked non-musth males attempted courtship significantly more often than their tuskless peers, and received more positive responses (though statistically insignificant) than did tuskless males. A positive response did not necessarily translate into mating because of mate-guarding by a dominant male. Female elephants appear to choose mates based primarily on traits such as musth that signal direct fertility benefits through increased sperm received than for traits such as tusks that may signal only indirect fitness benefits. © 2015 Koninklijke Brill NV, Leiden.

S. Dasgupta & A.K. Ghosh

Elephant–railway conflict in a biodiversity hotspot: Determinants and perceptions of the

conflict in northern West Bengal, India

Human Dimensions of Wildlife 20 (2015) 81-94

Abstract. We quantified elephant–train casualties along the 163 km (101 mi) Siliguri–Alipurduar railway line in northern West Bengal, India and assessed stakeholder perceptions about this conflict. We found that casualties have increased post-conversion of this railway line from meter to broad gauge, and are highest during monsoons and winters. Higher casualty risk was associated with closer distances to nearest curve and higher forest cover. Elephants frequently visit near this railway line, and 83% of households living in close proximity to this line sighted elephants during 2012. Most train operators (87%) said that elephant–train collisions had increased, and cited speed, low visibility, and lack of warning systems as main reasons. Among household respondents, reasons for accidents included an increase in both train numbers and speed. Our suggestions for mitigating the conflict include installation of sensor-systems that can warn train drivers about approaching animals, and shifting trains to the alternate existing railway line. © 2015 Taylor & Francis Group, LLC.

P. Davidar, C. Rosset, P.C. Mammen, J.P. Puyravaud, R. Srivastava & B. Wright

Mortality records (1979–2011) shed light on threats to Asian elephants *Elephas maximus* Linnaeus, 1758 (Mammalia: Proboscidea: Elephantidae) in Nilgiris, southern India

Journal of Threatened Taxa 7 (2015) 7436-7442

Abstract. We compiled records of 291 elephant deaths over a 33-year period (1979–2011) from the Mudumalai Tiger Reserve and the reserved forests of Nilgiri North and South divisions of southern India from the databases of the Tamil Nadu Forest Department, the Wildlife Protection Society of India and the Nilgiri Wildlife and Environment Association. We tested the null hypothesis that the causes of elephant deaths would not differ with time, by gender and with level of protection. We classified records by gender and age: adults (≥ 15 years), sub adults (5–15 years), juveniles (>1 – <5) and calves (≤ 1). We organised records over 3-decade periods. The database consisted of 209 adults (≥ 15 years), 27 sub adults (5–15 years), 33 juveniles (>1 – <5) and 22 calves (≤ 1). MTR had the maximum records

(148) followed by NND (138) and NSD (4). The median age of death was 20 years for adult males and 30 years for adult females. Mean survival time for adult males was 22.45 years, and 31.84 for females. Poaching was responsible for the majority of deaths (40%), particularly of male elephants (82%), and unknown causes (31%) for the majority of female deaths (66%). Human-caused deaths, which included poaching and some accidents, averaged 72% between 1979 and 2000 and decreased to 22% during 2001–2011. Deaths due to unknown causes and diseases increased from 28% in 1979–1989 to 69% in 2001–2011. Relative to estimated population size, deaths attributed to poaching was higher in NND (47%) than in MTR (34%). The causes of death differed by region. In conclusion, the elephant population in the Nilgiris is at risk and needs stringent protection; the mortality database should be systematised; forensic capabilities upgraded, and detection of carcasses improved. © 2015 The Authors.

M.N. Elliza, M.N. Shukor, N. Othman & B.M. Md-Zain

Haplotype distribution among endangered Asian elephants (*Elephas maximus*) in Peninsular Malaysia

Malaysian Applied Biology 44 (2015) 129–135

Abstract. Asian elephants are classified as an endangered species on the IUCN red list, warranting more research and conservation efforts to protect them. A study of the distribution of haplotypes among Asian elephants in Peninsular Malaysia was performed using a partial DNA sequencing of a D-loop region. In this study, 10 haplotypes (Hap01–Hap10) were detected in Peninsular Malaysian populations with a high haplotype diversity (H) of 83%. Hap01 was shared by Kelantan (n = 1), Johor (n = 2), Pahang (n = 2), and Perak (n = 2). The other shared haplotype was Hap06, which was evident in the Pahang (n = 1) and Johor (n = 1) samples. DnaSP analysis demonstrated that low genetic diversity (π) was observed in Peninsular Malaysian elephants (0.55%). Conversely, the gene flow was high ($Nm = 9.65$ migrants per generation). In a test of population subdivision, all pairwise comparisons for Peninsular Malaysia were low (0.00 to 0.13) except for Kelantan–

Pahang (0.57). Our results demonstrated that the genetic diversity was low within the different populations of Peninsular Malaysia. The level of genetic differentiation was also low, but the gene flow was high regardless of the geographic distance of the Asian elephant populations in Peninsular Malaysia.

M. English, G. Gillespie, B. Goossens, S. Ismail, M. Ancrenaz & W. Linklater

Recursion to food plants by free-ranging Bornean elephant

PeerJ 3 (2015) e1030

Abstract. Plant recovery rates after herbivory are thought to be a key factor driving recursion by herbivores to sites and plants to optimise resource-use but have not been investigated as an explanation for recursion in large herbivores. We investigated the relationship between plant recovery and recursion by elephants (*Elephas maximus borneensis*) in the Lower Kinabatangan Wildlife Sanctuary, Sabah. We identified 182 recently eaten food plants, from 30 species, along 14 × 50 m transects and measured their recovery growth each month over nine months or until they were re-browsed by elephants. The monthly growth in leaf and branch or shoot length for each plant was used to calculate the time required (months) for each species to recover to its pre-eaten length. Elephant returned to all but two transects with 10 eaten plants, a further 26 plants died leaving 146 plants that could be re-eaten. Recursion occurred to 58% of all plants and 12 of the 30 species. Seventy-seven percent of the re-eaten plants were grasses. Recovery times to all plants varied from two to twenty months depending on the species. Recursion to all grasses coincided with plant recovery whereas recursion to most browsed plants occurred four to twelve months before they had recovered to their previous length. The small sample size of many browsed plants that received recursion and uneven plant species distribution across transects limits our ability to generalise for most browsed species but a prominent pattern in plant-scale recursion did emerge. Plant recovery time was a good predictor of time to recursion but varied as a function of growth form (grass, ginger, palm, liana and woody) and differences between sites. Time to plant recursion coincided with

plant recovery time for the elephant's preferred food, grasses, and perhaps also gingers, but not the other browsed species. Elephants are bulk feeders so it is likely that they time their returns to bulk feed on these grass species when quantities have recovered sufficiently to meet their intake requirements. The implications for habitat and elephant management are discussed. © 2015 The Authors.

A.F. Humphreys, J. Tan, R.S. Peng, S.M. Benton, X. Qin, K.C. Worley, R.L. Mikulski, D.-C. Chow, T.G. Palzkill & P.D. Ling

Generation and characterization of antibodies against Asian elephant (*Elephas maximus*) IgG, IgM, and IgA

PLoS ONE 10 (2015) e0116318

Abstract. Asian elephant (*Elephas maximus*) immunity is poorly characterized and understood. This gap in knowledge is particularly concerning as Asian elephants are an endangered species threatened by a newly discovered herpesvirus known as elephant endotheliotropic herpesvirus (EEHV), which is the leading cause of death for captive Asian elephants born after 1980 in North America. While reliable diagnostic assays have been developed to detect EEHV DNA, serological assays to evaluate elephant anti-EEHV antibody responses are lacking and will be needed for surveillance and epidemiological studies and also for evaluating potential treatments or vaccines against lethal EEHV infection. Previous studies have shown that Asian elephants produce IgG in serum, but they failed to detect IgM and IgA, further hampering development of informative serological assays for this species. To begin to address this issue, we determined the constant region genomic sequence of Asian elephant IgM and obtained some limited protein sequence information for putative serum IgA. The information was used to generate or identify specific commercial antisera reactive against IgM and IgA isotypes. In addition, we generated a monoclonal antibody against Asian elephant IgG. These three reagents were used to demonstrate that all three immunoglobulin isotypes are found in Asian elephant serum and milk and to detect antibody responses following tetanus toxoid booster vaccination or antibodies against

a putative EEHV structural protein. The results indicate that these new reagents will be useful for developing sensitive and specific assays to detect and characterize elephant antibody responses for any pathogen or vaccine, including EEHV. © 2015 The Authors.

B. Jasmine, D. Ghose & S.K. Das

An attitude assessment of human-elephant conflict in a critical wildlife corridor within the Terai Arc Landscape, India

Journal of Threatened Taxa 7 (2015) 6843-6852

Abstract. This study entails an attitude assessment of the local people living at Mankanthpur Village, one of the bottlenecks in the Bailparao-Kotabagh corridor, Terai West Forest Division, on the issue of elephant conservation, human-(wildlife) elephant conflict, and the measures to mitigate it. Data was collected through a questionnaire survey and several group discussions among the villagers. The frequency of crop raids and group size of elephants were calculated. Sixty-two crop raids took place during the study period (February– April 2010), and a mean sighting of 1.08 elephants per day was recorded. Data from the survey reflects that about 3.53 ha of crop land was damaged by the elephants during the survey period. The people residing on the fringes of the park and in the villages along the Bailparao-Kotabagh Corridor were surveyed about the conflict impact. Survey results indicate that the most effective management measures used were a combination of loud noise and scaring away elephants using fire. Local peoples' views regarding the current status of elephant raids and conservation were also documented. Peoples' reaction to compensation schemes was studied; 89% of the respondents feel an effective approach to compensation is a way to reduce sufferings due to conflict with wildlife. Attempts to reduce the conflict by forming local elephant control teams and enclosing the affected village with a tall cemented wall are under trial. The underlying assumption in this study is that if damage severely affects the livelihood of local communities, getting their active support, which is essential for conservation, will be difficult. © 2015 The Authors.

D. Jathanna, K.U. Karanth, N.S. Kumar, V.R. Goswami, D. Vasudev & K.K. Karanth

Reliable monitoring of elephant populations in the forests of India: Analytical and practical considerations

Biological Conservation 187 (2015) 212-220

Abstract. Reliable estimation of elephant population abundance and density assumes great importance in the context of massive threats from illegal hunting and habitat loss. However, available estimates of elephant populations, particularly in Asia, are often unreliable and misleading. We evaluate sources of bias and imprecision in commonly used estimation approaches, and demonstrate that if correctly applied, line transect sampling based on visual detections of elephant clusters can address these issues. We compare our own early transect surveys on foot that relied on purposive line placement, to subsequent surveys in 2011, which employed rigorous survey designs. Estimated elephant density $D(95\%CI(D))$ in our study sites in India, ranged between 0.25(0.12–0.53) and 3.29(1.74–6.21) elephants/km² in the earlier surveys and between 0.32(0.14–0.75) and 2.24(1.41–3.56) elephants/km² in the 2011 survey. Although coefficients of variation of estimated detection probability (p) and cluster size ($E(S)$) were higher at low sample sizes, they dropped to <15% with $n > 40$ detections. Variance of encounter rate (n/l) was the largest contributor to the variance of density estimates. We recommend that rigorous line transect surveys must ensure: random transect placement with systematic and sufficient spatial replication to ensure adequate spatial coverage; coverage of sufficiently large areas in a short duration to ensure population closure; and investment of adequate effort to ensure reasonable number of detections. Field and analytical protocols presented here can enable reliable estimation of density and abundance of other wildlife species that can be visually detected in forests. They can lead to improved animal monitoring programs that are central to rigorously evaluating the effectiveness of widely employed, expensive conservation interventions meant to counter massive anthropogenic threats facing elephants and other large, diurnal species. © 2015 Reprinted with permission from Elsevier.

D. Jathanna, K.U. Karanth, N.S. Kumar, K.K. Karanth & V.R. Goswami

Patterns and determinants of habitat occupancy by the Asian elephant in the Western Ghats of Karnataka, India

PLoS ONE 10 (2015) e0133233

Abstract. Understanding species distribution patterns has direct ramifications for the conservation of endangered species, such as the Asian elephant *Elephas maximus*. However, reliable assessment of elephant distribution is handicapped by factors such as the large spatial scales of field studies, survey expertise required, the paucity of analytical approaches that explicitly account for confounding observation processes such as imperfect and variable detectability, unequal sampling probability and spatial dependence among animal detections. We addressed these problems by carrying out ‘detection—non-detection’ surveys of elephant signs across a c. 38,000-km² landscape in the Western Ghats of Karnataka, India. We analyzed the resulting sign encounter data using a recently developed modeling approach that explicitly addresses variable detectability across space and spatially dependent non-closure of occupancy, across sampling replicates. We estimated overall occupancy, a parameter useful to monitoring elephant populations, and examined key ecological and anthropogenic drivers of elephant presence. Our results showed elephants occupied 13,483 km² (SE = 847 km²) corresponding to 64% of the available 21,167 km² of elephant habitat in the study landscape, a useful baseline to monitor future changes. Replicate-level detection probability ranged between 0.56 and 0.88, and ignoring it would have underestimated elephant distribution by 2116 km² or 16%. We found that anthropogenic factors predominated over natural habitat attributes in determining elephant occupancy, underscoring the conservation need to regulate them. Human disturbances affected elephant habitat occupancy as well as site-level detectability. Rainfall is not an important limiting factor in this relatively humid bioclimate. Finally, we discuss cost-effective monitoring of Asian elephant populations and the specific spatial scales at which different population parameters can be estimated. We emphasize the need to model the observation and sampling processes that often

obscure the ecological process of interest, in this case relationship between elephants to their habitat. © 2015 The Authors.

Ritesh Joshi

Impact of Gujjar Rehabilitation Programme on the group size of Asian elephants (*Elephas maximus*) in Rajaji National Park, North-West India

Biodiversitas 16 (2015) 188-195

Abstract. A comparative study has been done to assess the impact of the Gujjar Rehabilitation Programme on the group's size of Asian elephants (*Elephas maximus*) in Rajaji National Park, north-west India. Field surveys were carried out before the Gujjar's rehabilitation during 1999-2001 and after the Gujjar's rehabilitation during 2006-2008 in Chilla and Haridwar forest ranges of the park. A total of 833 groups of elephants were sighted, varying from 2-5 (mean value \pm SD=28.5 \pm 24.7) to 21-25 animals (mean value \pm SD=8.2 \pm 4.6). The number of groups sighted in Haridwar forest after the Gujjars' rehabilitation were significantly low in summer and winter as compared before the Gujjars' rehabilitation. However, the number of groups sighted in Chilla forest before and after the Gujjars' rehabilitation in both the seasons was found to be same. Results indicated that elephant's group's size and movement was shrinking/reducing in Haridwar forest, however, in Chilla forest it was found to be slightly expanding/increasing. The impact of Gujjar Rehabilitation Programme has not brought any drastic change in restoring the larger population of elephants and in increasing their group's size, however, this has increased the frequent movement and activities of elephants within their home range. Restoration of large fragmented forest stretches/corridors for elephant's migration and habitat management are of paramount importance in providing elephants a wider way to move across entire landscape in large herds. As increase in human population in the nearby areas and developmental activities, with increase in vehicle traffic pressure on national highways and railway track existing across the park were found to be creating negative impacts on the overall movement of large groups of the elephants. © 2015 Nusantara Bioscience.

C.P. Kilgallon, R.S. Larsen, A. Wong & C. Yellowley

Analysis of a collagen II degradation protein C2C and a collagen II formation protein CP II in serum of Asian elephants (*Elephas maximus*)

Journal of Zoo and Wildlife Medicine 46 (2015) 146-149

Abstract. Osteoarthritis is a major cause of chronic lameness in Asian elephants (*Elephas maximus*) in captivity worldwide. Radiology and other imaging technologies are of limited use in the early diagnosis of this condition in elephants. Collagen II is a major component of articular cartilage. The degradation and formation of collagen II can be monitored by the measurement of specific biomarkers in biologic fluids such as serum. It is possible that these biomarkers could also prove useful in identifying disease in elephants. In this study two commercially available immunoassays which measure a marker of collagen II degradation (C2C) and a marker of collagen II formation (CPII) were evaluated in Asian elephants. The ability of the assays to detect and measure C2C and CPII in the serum of Asian elephants was confirmed. Median serum concentration of C2C was 148 ng/L in nonlame elephants (n = 33) and 91.2 ng/L in lame elephants (n = 7). The difference was statistically significant (P 1/4 0.0002). Median serum concentration of CPII was 519.3 ng/L in nonlame elephants and 318.7 ng/L in lame elephants. The difference was also statistically significant (P = 0.039). Whereas CPII concentrations in lame elephants mirrored findings from human and animal osteoarthritis studies, C2C concentrations did not. Further studies which evaluate these and other similar biomarkers are necessary to elucidate their usefulness in the diagnosis of osteoarthritis in proboscidae. © 2015 American Association of Zoo Veterinarians.

C.L. Lynsdale, D.J. Franco dos Santos, A.D. Hayward, K.U. Mar, W. Htut, H. Htoo Aung, A. Thura Soe & V. Lummaa

A standardised faecal collection protocol for intestinal helminth egg counts in Asian elephants, *Elephas maximus*

International Journal for Parasitology: Parasites and Wildlife 4 (2015) 307-315

Abstract. The quantitative assessment of parasite infection is necessary to measure, manage and reduce infection risk in both wild and captive animal populations. Traditional faecal flotation methods which aim to quantify parasite burden, such as the McMaster egg counting technique, are widely used in veterinary medicine, agricultural management and wildlife parasitology. Although many modifications to the McMaster method exist, few account for systematic variation in parasite egg output which may lead to inaccurate estimations of infection intensity through faecal egg counts (FEC). To adapt the McMaster method for use in sampling Asian elephants (*Elephas maximus*), we tested a number of possible sources of error regarding faecal sampling, focussing on helminth eggs and using a population of over 120 semi-captive elephants distributed across northern Myanmar. These included time of day of defecation, effects of storage in 10% formalin and 10% formol saline and variation in egg distribution between and within faecal boluses. We found no significant difference in the distribution of helminth eggs within faecal matter or for different defecation times, however, storage in formol saline and formalin significantly decreased egg recovery. This is the first study to analyse several collection and storage aspects of a widely-used traditional parasitology method for helminth parasites of *E. maximus* using known host individuals. We suggest that for the modified McMaster technique, a minimum of one fresh sample per elephant collected from any freshly produced bolus in the total faecal matter and at any point within a 7.5 h time period (7.30 am-2.55 pm) will consistently represent parasite load. This study defines a protocol which may be used to test pre-analytic factors and effectively determine infection load in species which produce large quantities of vegetative faeces, such as non-ruminant megaherbivores. © 2015 The Authors.

M.D. Madhusudan, N. Sharma, R. Raghunath, N. Baskaran, C.M. Bipin, S. Gubbi, A.J.T. Johnsingh, J. Kulkarni, H.N. Kumara, Prachi Mehta, R. Pillay & R. Sukumar

Distribution, relative abundance, and conservation status of Asian elephants in Karnataka, southern India

Biological Conservation 187 (2015) 34-40

Abstract. Karnataka state in southern India supports a globally significant—and the country's largest—population of the Asian elephant *Elephas maximus*. A reliable map of Asian elephant distribution and measures of spatial variation in their abundance, both vital needs for conservation and management action, are unavailable not only in Karnataka, but across its global range. Here, we use various data gathered between 2000 and 2015 to map the distribution of elephants in Karnataka at the scale of the smallest forest management unit, the 'beat', while also presenting data on elephant dung density for a subset of 'elephant beats.' Elephants occurred in 972 out of 2855 forest beats of Karnataka. Sixty percent of these 972 beats—and 55% of the forest habitat—lay outside notified protected areas (PAs), and included lands designated for agricultural production and human dwelling. While median elephant dung density inside protected areas was nearly thrice as much as outside, elephants routinely occurred in or used habitats outside PAs where human density, land fraction under cultivation, and the interface between human-dominated areas and forests were greater. Based on our data, it is clear that India's framework for elephant conservation—which legally protects the species wherever it occurs, but protects only some of its habitats—while being appropriate in furthering their conservation within PAs, seriously falters in situations where elephants reside in and/or seasonally use areas outside PAs. Attempts to further elephant conservation in production and dwelling areas have extracted high costs in human, elephant, material and monetary terms in Karnataka. In such settings, conservation planning exercises are necessary to determine where the needs of elephants—or humans—must take priority over the other, and to achieve that in a manner that is based not only on reliable scientific data but also on a process of public reasoning. © 2015 Reprinted with permission from Elsevier.

S.K. Mikota, K. Gairhe, K. Giri, K. Hamilton, M. Miller, S. Paudel, K. Lyashchenko, R.S. Larsen, J.B. Payeur, W.R. Waters, R. Greenwald, G. Dumonceaux, B. Vincent & G.E. Kaufman

Tuberculosis surveillance of elephants (*Elephas maximus*) in Nepal at the captive-wild interface

European Journal of Wildlife Research 61 (2015) 221-229

Abstract. A comprehensive elephant tuberculosis (TB) survey using culture and four serological screening tests was conducted in Nepal in response to concern raised by wildlife officials that TB could threaten wild populations of elephants, rhinos, and other susceptible species. Captive elephants come into close contact with wild animals during conservation and tourism activities inside Nepal's national parks. Private and government-owned male and female captive Asian elephants (*Elephas maximus*) were included in the study. The mean reported age was 38 years (range 5–60 years). A total of 289 samples from 120 elephants were collected for mycobacterial culture. Culture samples were processed at the National Tuberculosis Centre (NTC) in Nepal and the National Veterinary Services Laboratories (NVSL) in Ames, IA. Acid-fast organisms were observed in 11 and 21 samples processed at NTC and NVSL, respectively, and nontuberculous mycobacteria (NTMs) were isolated from six elephants. There were no isolations of *Mycobacterium tuberculosis* or *Mycobacterium bovis*. Blood samples were also collected from 115 of the elephants for serological testing using the Chembio ElephantTB STAT-PAK®, the Chembio MultiAntigen Print Immunoassay test, a multi-antigen ELISA, and an immunoblot assay. Culture and serological results were variable and required careful interpretation to develop criteria to assess TB risk. Elephants were assigned to one of four disease risk groups (high, moderate, low, and undetermined), and management recommendations for each group were made to government authorities. Serological results were prioritized in developing recommendations because of culture limitations and inconclusive culture results. This strategy was based on evidence for the early predictive value of serological tests and the urgent need expressed by wildlife authorities in Nepal to

protect their captive elephants, mitigate TB at the captive-wild interface, and safeguard tourism. © 2015 With kind permission from Springer Science+Business Media.

D. Miller, B. Jackson, H.S. Riddle, C. Stremme, D. Schmitt & T. Miller

Elephant (*Elephas maximus*) health and management in Asia: Variations in veterinary perspectives

Veterinary Medicine International 2015 (2015) e614690

Abstract. There is a need to identify strategic investments in Asian elephant (*Elephas maximus*) health that will yield maximal benefits for overall elephant health and conservation. As an exploratory first step, a survey was administered to veterinarians from Asian elephant range countries at a workshop and via email to help prioritize health-related concerns that will mostly benefit elephants. Responses were received from 45 veterinarians from eight countries that had a range of experience with captive and wild elephants. The occurrence of medical conditions and responses to treatment varied among responses. However, injuries, parasitism, and gastrointestinal disease were reported as the most common syndromes responsible for elephant morbidity, whereas injury and infectious disease not due to parasitism were the most commonly reported sources of elephant mortality. Substandard nutrition, water quality and quantity deficiencies, and inadequate or absent shelter were among the factors listed as barriers to optimal elephant health. While this survey's results do not support definitive conclusions, they can be used to identify where and how subsequent investigations should be directed. Rigorous assessment of the relative costs and benefits of available options is required to ensure that investments in individual and population health yield the maximal benefits for elephants. © 2015 The Authors.

F.M. Molenaar, S.A. La Rocca, M. Khatri, J. Lopez, F. Steinbach & A. Dastjerdi

Exposure of Asian elephants and other exotic ungulates to Schmallenberg virus

PLoS ONE 10 (2015) e0135532

Abstract. Schmallenberg virus (SBV) is an

emerging Orthobunyavirus, first described in 2011 in cattle in Germany and subsequently spread throughout Europe, affecting mainly ruminant livestock through the induction of foetal malformations. To gain a better understanding of the spectrum of susceptible species and to assess the value of current SBV serological assays, screening of serum samples from exotic artiodactyls and perissodactyls collected at the Living Collections from the Zoological Society of London (Whipsnade and London Zoos) and Chester Zoo was carried out. There was compelling evidence of SBV infection in both zoological collections. The competitive ELISA has proved to be applicable for the detection of SBV in exotic Bovidae, Cervidae, Suidae, Giraffidae and most notably in endangered Asian elephants (*Elephas maximus*), but unreliable for the screening of Camelidae, for which the plaque reduction neutralisation test was considered the assay of choice. © 2015 The Authors.

H.S. Mumby, K.U. Mar, C. Thitaram, A. Courtiol, P. Towiboon, Z. Min-Oo, Y. Htut-Aung, J.L. Brown & V. Lummaa

Stress and body condition are associated with climate and demography in Asian elephants

Conservation Physiology 3 (2015) cov030

Abstract. Establishing links between ecological variation, physiological markers of stress and demography is crucial for understanding how and why changes in environmental conditions affect population dynamics, and may also play a key role for conservation efforts of endangered species. However, detailed longitudinal studies of long-lived species are rarely available. We test how two markers of stress and body condition vary through the year and are associated with climatic conditions and large-scale mortality and fertility variation in the world's largest semi-captive population of Asian elephants employed in the timber industry in Myanmar. Glucocorticoid metabolites (used as a proxy for stress levels in 75 elephants) and body weight (used as a proxy for condition in 116 elephants) were monitored monthly across a typical monsoon cycle and compared with birth and death patterns of the entire elephant population over half a century (n = 2350). Our results show seasonal variation in both markers of stress and

condition. In addition, this variation is correlated with population-level demographic variables. Weight is inversely correlated with population mortality rates 1 month later, and glucocorticoid metabolites are negatively associated with birth rates. Weight shows a highly positive correlation with rainfall 1 month earlier. Determining the factors associated with demography may be key to species conservation by providing information about the correlates of mortality and fertility patterns. The unsustainability of the studied captive population has meant that wild elephants have been captured and tamed for work. By elucidating the correlates of demography in captive elephants, our results offer management solutions that could reduce the pressure on the wild elephant population in Myanmar. © 2015 The Authors.

N.K. Nath, S.K. Dutta, J.P. Das & B.P. Lahkar
A quantification of damage and assessment of economic loss due to crop raiding by Asian elephant *Elephas maximus* (Mammalia: Proboscidea: Elephantidae): A case study of Manas National Park, Assam, India

Journal of Threatened Taxa 7 (2015) 6853-6863

Abstract. A study was carried out in Manas National Park, Assam in northeastern India between 2007 and 2009 to understand the magnitude of human-elephant conflict through a quantification of damage and assessment of economic loss. A cluster of six villages adjacent to the Park was selected for this study. Five major agricultural crops were grown during the study period of which three were raided by elephants: winter paddy, autumn paddy and pulses. Paddy was the principle crop central to the farmers' subsistence. Winter paddy was the most cultivated crop and autumn paddy was the least cultivated. The incidence rate of crop raiding was highest for autumn paddy and lowest for pulses. Overall economic loss due to crop raiding was negligible, however at the individual farmer level, it was quite high. The study revealed that human-elephant conflict is not so severe, indicating ample opportunity for human-elephant coexistence in the region. Crop fields adjacent to the Park were particularly vulnerable to crop raiding which necessitates creation of a buffer zone. The frequency of raiding and the extent

of damage was found to be significantly less in crop fields which were guarded by farmers. This was due to traditional crop guarding practices being followed in the region, the strengthening of which could effectively reduce annual crop loss and thus human-elephant conflict could be minimized to a large extent. © 2015 The Authors.

K.A. Phair, M. Sutherland-Smith, G.W. Pye, A.P. Pessier & T.L. Clippinger

Esophageal dissection and hematoma associated with obstruction in an Indian elephant (*Elephas maximus indicus*)

Journal of Zoo and Wildlife Medicine 45 (2014) 423-427

Abstract. A 42-year-old female Indian elephant (*Elephas maximus indicus*) developed a sudden onset of excessive salivation and dysphagia. Esophageal obstruction was suspected; possibly related to palm frond ingestion. Esophageal endoscopy revealed a mat of plant material in the distal esophagus. An initial attempt at relieving the obstruction was unsuccessful, but subsequent use of custom-made instruments along with insufflation and hydropulsion enabled partial removal of the material. Postimmobilization care included aggressive intravenous and rectal fluids, anti-inflammatory and antibiotic administration, and fasting. Despite treatment, the dysphagia persisted and the elephant was euthanized due to lack of improvement and grave prognosis. Postmortem examination revealed remaining plant material in the esophagus, complicated by an esophageal dissection, mural hematoma, and secondary bacterial infection. Iatrogenic trauma may have contributed to the extent of esophageal injury. Although treatment was ultimately unsuccessful, the supportive care employed could potentially aid recovery in cases of less severe esophageal trauma. © 2014 American Association of Zoo Veterinarians.

C.M. Proctor & J.L. Brown

A preliminary analysis of the influence of handling method on adrenal activity in zoo African and Asian elephants

J. of Zoo and Aquarium Research 3 (2015) 1-5

Abstract. As a first step towards investigating the effect of management choice – free contact (FC) or protected contact (PC) – on zoo elephant

well-being, this study evaluated serum cortisol concentrations in weekly samples collected over a 2-year period from 112 female elephants (58 African, 54 Asian) managed in either FC (n=58) or PC (n=54) management systems at 48 facilities. Results showed there were no differences in overall or baseline mean concentrations of serum cortisol between the two management systems. A GLM analysis exploring the response of individual baseline cortisol concentration to management (FC vs PC), facility, species, and the interaction of management and facility revealed that the only parameter with significant explanatory power was the facility where the elephants were housed. Thus, it may be more important to evaluate specific facility effects on adrenal activity, such as enclosure conditions, enrichment opportunities, or social interactions, rather than handling technique. Although many zoos are moving to a PC management approach, particularly within the American Zoo and Aquarium Association, from a welfare standpoint there is probably not a one-size-fits-all management strategy that is ideal. Rather, it may be necessary to consider individual elephant coping styles and social needs on a case by case basis before deciding whether FC or PC is most appropriate for management, especially when considering how to address welfare concerns. © 2015 The Authors.

A.L. Roca, Y. Ishida, A.L. Brandt, N.R. Benjamin, K. Zhao, & N.J. Georgiadis

Elephant natural history: A genomic perspective

Annual Review of Animal Biosciences 3 (2015) 139-167

We review DNA-based studies of elephants and recently extinct proboscideans. The evidence indicates that little or no nuclear gene flow occurs between African savanna elephants (*Loxodonta africana*) and African forest elephants (*Loxodonta cyclotis*), establishing that they comprise separate species. In all elephant species, males disperse, whereas females remain with their natal social group, leading to discordance in the phylogeography of nuclear and mitochondrial DNA patterns. Improvements in ancient DNA methods have permitted sequences to be generated from an increasing number of pro-

boscidean fossils and have definitively established that the Asian elephant (*Elephas maximus*) is the closest living relative of the extinct woolly mammoth (*Mammuthus primigenius*). DNA-based methods have been developed to determine the geographic provenance of confiscated ivory in an effort to aid the conservation of elephants. © 2015 Reproduced with permission from Annual Reviews.

R.K. Runting, E. Meijaard, N.K. Abram, J.A. Wells, D.L.A. Gaveau, M. Ancrenaz, H.P. Possingham, S.A. Wich, F. Ardiansyah, M.T. Gumal, L.N. Ambu & K.A. Wilson

Alternative futures for Borneo show the value of integrating economic and conservation targets across borders

Nature Communications 6 (2015) e6819

Abstract. Balancing economic development with international commitments to protect biodiversity is a global challenge. Achieving this balance requires an understanding of the possible consequences of alternative future scenarios for a range of stakeholders. We employ an integrated economic and environmental planning approach to evaluate four alternative futures for the mega-diverse island of Borneo. We show what could be achieved if the three national jurisdictions of Borneo coordinate efforts to achieve their public policy targets and allow a partial reallocation of planned land uses. We reveal the potential for Borneo to simultaneously retain 50% of its land as forests, protect adequate habitat for the Bornean orangutan (*Pongo pygmaeus*) and Bornean elephant (*Elephas maximus borneensis*), and achieve an opportunity cost saving of over US\$43 billion. Such coordination would depend on enhanced information sharing and reforms to land-use planning, which could be supported by the increasingly international nature of economies and conservation efforts. © 2015 Macmillan Publishers Limited.

A.F. Saripan & A. Reungsang

Simultaneous saccharification and fermentation of cellulose for bio-hydrogen production by anaerobic mixed cultures in elephant dung

International Journal of Hydrogen Energy 39 (2014) 9028-9035

Abstract. The objective of this study was to

optimize the culture conditions for simultaneous saccharification and fermentation (SSF) of cellulose for bio-hydrogen production by anaerobic mixed cultures in elephant dung under thermophilic temperature. Carboxymethyl cellulose (CMC) was used as the model substrate. The investigated parameters included initial pH, temperature and substrate concentration. The experimental results showed that maximum hydrogen yield (HY) and hydrogen production rate (HPR) of 7.22 ± 0.62 mmol H₂/g CMC_{added} and 73.4 ± 3.8 mL H₂/L h, respectively, were achieved at an initial pH of 7.0, temperature of 55°C and CMC concentration of 0.25 g/L. The optimum conditions were then used to produce hydrogen from the cellulose fraction of sugarcane bagasse (SCB) at a concentration of 0.40 g/L (equivalent to 0.25 g/L cellulose) in which an HY of 7.10 ± 3.22 mmol H₂/g cellulose_{added}. The pre-dominant hydrogen producers analyzed by polymerase chain reaction-denaturing gel gradient electrophoresis (PCR-DGGE) were *Thermoanaerobacterium thermosaccharolyticum* and *Clostridium* sp. The lower HY obtained when the cellulose fraction of SCB was used as the substrate might be due to the presence of lignin in the SCB as well as the presence of *Lactobacillus parabuchneri* and *Lactobacillus rhamnosus* in the hydrogen fermentation broth. © 2014 Hydrogen Energy Publications, reprinted with permission from Elsevier.

N. Sekar, C.-L. Lee & R. Sukumar

In the elephant's seed shadow: The prospects of domestic bovids as replacement dispersers of three tropical Asian trees

Ecology 96 (2015) 2093-2105

Abstract. As populations of the world's largest animal species decline, it is unclear how ecosystems will react to their local extirpation. Due to the unique ecological characteristics of megaherbivores such as elephants, seed dispersal is one ecosystem process that may be affected as populations of large animals are decimated. In typically disturbed South Asian ecosystems, domestic bovids (cattle, *Bos primigenius*, and buffalo, *Bubalus bubalis*) may often be the species most available to replace Asian elephants (*Elephas maximus*) as endozoochorous dispersers of large-fruited mammal-dispersed species.

We use feeding trials, germination trials, and movement data from the tropical moist forests of Buxa Tiger Reserve (India) to examine whether domestic bovids are viable replacements for elephants in the dispersal of three large-fruited species: *Dillenia indica*, *Artocarpus chaplasha*, and *Careya arborea*. We find that (1) once consumed, seeds are between 2.5 (*C. arborea*) and 26.5 (*D. indica*) times more likely to pass undigested into elephant dung than domestic bovid dung; and (2) seeds from elephant dung germinated as well as or better than seeds taken from bovid dung for all plant species, with *D. indica* seeds from elephant dung 1.5 times more likely to germinate. Furthermore, since wild elephants have less constrained movements than even free-roaming domestic bovids, we calculate that maximum dispersal by elephants is between 9.5 and 11.2 times farther than that of domestic bovids, with about 20% of elephant-dispersed seeds being moved farther than the maximum distance seeds are moved by bovids. Our findings suggest that, while bovids are able to disperse substantial numbers of seeds over moderate distances for two of the three study species, domestic bovids will be unable to routinely emulate the reliable, long-distance dispersal of seeds executed by elephants in this tropical moist forest. Thus while domestic bovids can attenuate the effects of losing elephants as dispersers, they may not be able to prevent the decline of various mammal-dispersed fruiting species in the face of overhunting, habitat fragmentation, and climate change.

R. Venu, T. Thoiba Singh, R. Veeraharin, D. Rajesh & C. Srilatha

First report of *Cobboldia elephantis* (Cobbold, 1866) larvae in a free ranging wild elephant from Andhra Pradesh, India

Journal of Parasitic Diseases 39 (2015) 168-170

Abstract. Larvae of *Cobboldia elephantis* have been reported from the stomach of a free ranging wild elephant (*Elephas maximus*) while conducting post mortem examination at Palamner forest range, Chittoor district of Andhra Pradesh state, India. This is the first report of *C. elephantis* in free ranging wild elephant in Andhra Pradesh state, India. © 2013 Indian

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P.G. Vimalraj & M. G. Jayathangaraj
Endoparasitic infections in free-ranging Asiatic elephants of Mudumalai and Anamalai Wildlife Sanctuary

Journal of Parasitic Diseases 39 (2015) 474-476

Abstract. Free-ranging Asiatic elephants dung samples from various forest divisions of Mudumalai Wildlife Sanctuary (MWLS) and Anamalai Wildlife Sanctuary (AWLS) were examined for identification of endoparasitic infection. The dung samples revealed 100% endoparasitic infection, with a high prevalence of Strongyles (64%) in MWLS and Anoplocephala sp. (46%) in AWLS. Similarly, from the same samples egg per gram of feces was done to ascertain the individual parasitic load. The present research paper communicates the high parasitic prevalence of free-ranging Asian elephants in dry seasons of (February–June 2010) MWLS and AWLS. © 2013 Indian Society of Parasitology, with kind permission from Springer Science+Business Media.

L. Vogelnest, F. Hulst, P. Thompson, K.P. Lyashchenko & K.A. Vinette Herrin

Diagnosis and management of tuberculosis (*Mycobacterium tuberculosis*) in an Asian elephant (*Elephas maximus*) with a newborn calf

J. of Zoo and Wildlife Medicine 46 (2015) 77-85

Abstract. In 2006, five Asian elephants (*Elephas maximus*) were imported to Taronga Zoo, Australia, from Thailand. Pre-import and initial postarrival tuberculosis screening was performed by trunk wash (TW) culture and was negative for *Mycobacterium tuberculosis*. In April 2009, the ElephantTB STAT-PAK® (SP) assay was used to test the elephants. A 15.5-yr-old pregnant cow was reactive. TW frequency for this cow was increased from annually to quarterly. TW cultures remained negative on all other elephants. In February 2010, the Dual Path Platform® (DPP) VetTB assay was used for the first time, and the SP-reactive cow also reacted on the DPP. A SP was run concurrently and was reactive. All other elephants were nonreactive on both assays. Treatment was not initiated due to

concern about the effect of antituberculous drugs on the fetus. Quarterly TW cultures continued. The cow gave birth on 2 November 2010. A routine TW on 24 November 2010 was culture positive for *M. tuberculosis*. Although previous shedding could not be ruled out, reactivation of latent infection or exacerbation of subclinical disease due to parturition was suspected. Treatment with isoniazid, pyrazinamide, rifampicin, and ethambutol commenced. A 12-mo treatment course was completed within a 15-mo period. The isolate was susceptible to these drugs and genotyped as a Beijing strain. Stored serum samples from 2004 and 2006 were tested retrospectively and were reactive on SP and DPP. TW, SP, and DPP screening frequency increased to monthly for the positive cow on commencement of treatment in January 2011. Monthly serum biochemistry indicated drug-induced hepatitis. Therapeutic drug monitoring was conducted to ensure therapeutic levels were achieved. The infant calf was reactive on DPP, but TW culture negative, and was not treated. Serial DPP results for the cow and calf during and after treatment indicated that the antibody levels were declining, suggesting a favorable response to therapy in the dam, and that the origin of the antibodies in the calf were maternal, rather than a response to infection. © 2015 American Association of Zoo Veterinarians.

L. Zhang , L. Dong, L. Lin, L. Feng, F. Yan, L. Wang , X. Guo & A. Luo

Asian elephants in China: Estimating population size and evaluating habitat suitability

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Abstract. We monitored the last remaining Asian elephant populations in China over the past decade. Using DNA tools and repeat genotyping, we estimated the population sizes from 654 dung samples collected from various areas. Combined with morphological individual identifications from over 6,300 elephant photographs taken in the wild, we estimated that the total Asian elephant population size in China is between 221 and 245. Population genetic structure and diversity were examined using a 556-bp fragment of mitochondrial DNA, and 24 unique haplotypes were detected from DNA analysis of 178 individuals. A phylogenetic analysis revealed

two highly divergent clades of Asian elephants, α and β , present in Chinese populations. Four populations (Mengla, Shangyong, Mengyang, and Pu'Er) carried mtDNA from the α clade, and only one population (Nangunhe) carried mtDNA belonging to the β clade. Moreover, high genetic divergence was observed between the Nangunhe population and the other four populations; however, genetic diversity among the five populations was low, possibly due to limited gene flow because of habitat fragmentation. The expansion of rubber plantations, crop cultivation, and villages along rivers and roads had caused extensive degradation of natural forest in these areas. This had resulted in the loss and fragmentation of elephant habitats and had formed artificial barriers that inhibited elephant migration. Using Geographic Information System, Global Positioning System, and Remote Sensing technology, we found that the area occupied by rubber plantations, tea farms, and urban settlements had dramatically increased over the past 40 years, resulting in the loss and fragmentation of elephant habitats and forming artificial barriers that inhibit elephant migration. The restoration of ecological corridors to facilitate gene exchange among isolated elephant populations and the establishment of cross-boundary protected areas between China and Laos to secure their natural habitats are critical for the survival of Asian elephants in this region. © 2015 The Authors.



Herd in Yala National Park (Sri Lanka)