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Asian Elephant Support
Linda Reifschneider

Working Together for Elephant Conservation
Sarah Conley, Sean Hensman, Deborah Olson

Posters:

Applied research to inform zoo husbandry: examples from an evidence-based approach to Asian elephant (Elephas maximus) management at ZSL Whipsnade Zoo
Fiona Sach

Best practice transdisciplinary mitigation approaches to human-elephant conflict: from over-population to individual animals
Audrey Delsink

Porcine zona pellucida vaccine immunocontraception of African elephant (Loxodonta africana) cows: A review of 22 years of research
Audrey Delsink

Symposium Participant Lists
Symposium sponsors

Linda Reifschneider on behalf of Asian Elephant Support
MONDAY  October 21\textsuperscript{th}, 2019

18:00 – 22:00  Icebreaker

TUESDAY  October 22\textsuperscript{nd}, 2019

SHUTTLES START AT 6:45 AM

7:00 – 8:30  Breakfast Buffet

8:30 – 9:00  Opening Ceremonies

9:00 – 10:00  Keynote Address - Ian Craig, Northern Rangelands Trust

10:00 – 10:30  Break

Field Conservation – Community Programs

10:30 – 10:50  Project Orange Elephant: An economic solution for human-elephant coexistence
  Ravi Corea
10:50 – 11:10  A holistic and sustainable conservation approach to a peaceful cohabitation of people
  and desert-adapted elephants in Namibia
  Rachel Harris and Christin Winter
11:10 – 11:30  Are elephants Gods or Devils? Understanding people's perceptions of elephants in
  Northern Odisha
  Medha Nayak
11:30 – 11:50  Assessing the effects of a cognition-based education program on attitudes of villagers
  towards Asian elephants (\textit{Elephas maximus}) in conflict-prone areas
  Radhika N. Makecha
11:50 – 12:10  African ecosystems on the edge: What can be the strategies for living together?
  Mário Pereira
12:10 – 12:30  A crowd-sourced approach to monitoring Asian elephants in a human dominated
  landscape
  Tarsh Thekaekara

12:30 – 13:30  Lunch

Elephant Endotheliotropic Herpesvirus and Research

13:30 – 13:50  Introduction to elephant endotheliotropic herpesvirus (EEHV) and global EEHV
  resources.
  Lauren Howard, Nadine Lamberski
13:50 – 14:10  Current knowledge of EEHV in African elephants (\textit{Loxodonta Africana})
  Erin Latimer
14:10 – 14:30  Building capacity for tackling elephant endotheliotropic herpesvirus at an African level
  Edgar Simulundu
Serological detection of EEHV infections by a Luciferase Immunoprecipitation System assay
Paul Ling

Recommended EEHV monitoring in Asian and African elephants
Erin Latimer

15:10 – 15:30 Break

Elephant Endotheliotropic Herpesvirus and Research (cont.)

Treatment of EEHV hemorrhagic disease
Lauren Howard

Fatal elephant endotheliotropic herpesvirus 3 infection in two captive African elephants (Loxodonta Africana)
Melissa Fayette

Preparing for EEHV: The survival of Indali Hi-Way
Rebecca Le Brocq

EEHV capacity-building in Asia
Erin Latimer

Efficacy of Asian elephant (Elephas maximus) fresh frozen plasma
Chatchote Thitaram

Acute phase proteins as indicators of the elephant immune response to infectious disease
Katie L. Edwards

18:00 – 22:00 Dinner

WEDNESDAY October 23th, 2019

SHUTTLES START AT 6:45 AM

7:00 – 8:30 Breakfast Buffet

Field Conservation – Population Management

Revisiting the population size of the largest sub-population of the Borneo elephant
Cheryl Cheah Phaik Imm

Debunking critical assumptions to improve forest elephant census and monitoring
Amelia Meier

Pathways back to Zambia: re-establishing elephant migration routes through transboundary conservation
Kerryn Carter

Vasectomy of free ranging African elephants (Loxodonta Africana) as a conservation management tool
Kari Morfeld

Field Conservation – Human Elephant Conflict Mitigation

Transdisciplinary mitigation approaches to South African human-elephant conflict
Audrey Delsink

10:10 - 10:30 Break
Field Conservation – Human Elephant Conflict Mitigation (cont.)
10:30 – 10:50 New methods utilized to deter African elephants (*Loxodonta Africana*) from crop raiding in the Kasigau Wildlife Corridor, Kenya
R. Lynn Von Hagen
10:50 – 11:10 Patterns of human-elephant conflict inferred from field observations of Asian elephants in Sri Lanka’s national parks
Chase LaDue
11:10 – 11:30 Trialing a new scent-based repellent to mitigate elephant crop-raiding around Murchison Falls National Park, Uganda
Maz Robertson
11:30 – 11:50 Living with elephants: Herds of the Karbi Foothills
Rituraj Phukan
11:50 – 12:10 A crime science approach to human-elephant conflict in Murchison Falls National Park
Joanna Hill
12:10 – 12:30 Management of a conflict elephant in Rajaji Tiger Reserve release vs. rehabilitation
Aditi Sharma

12:30 – 13:30 Lunch

Field Conservation – Nutrition
Elisabetta Carlin
13:50 – 14:10 Exploring how mineral provision acts as a driver for African elephant movement (*Loxodonta africana*), and considering how this could be used to reduce human-elephant conflict (HEC)
Fiona Sach
14:10 – 14:30 Glycemic response of semi-free ranging African elephants to seasonal and provisioned diets
Beaux Berkeley

Field Conservation – Elephant Protection
14:30 – 14:50 Elephant habitat connectivity: corridors, gates and underpasses. elephant conservation and conflict mitigation within the Mount Kenya, Laikipia and Samburu elephant ranges
Enoch Ochieng
14:50 – 15:10 Recovery of Murchison Falls programme
Mike Keigwin

15:10 – 15:30 Break

Field Conservation – Elephant Protection (cont.)
15:30 – 15:50 Specialized units – selection, training and effectiveness
Nikita Iyengar
15:50 – 16:10 Experiences from establishing anti-poaching canine units across Africa
Jay Crafter
16:10 – 16:30 Malicious poisoning of elephant within the Zimbabwean component of the Kavango Zambezi (KAZA) Transfrontier Conservation Area (TFCA)
Jessica Dawson

Field Conservation – Elephant Monitoring
16:30 – 16:50 An assessment of using remote camera traps for Asian elephant research
Chandima Fernando
16:50 – 17:10  Collaring elephants: how they can be utilized for HEC mitigation and research  
Jaco Mattheus

**Field Conservation – Citizen Science**
17:10 – 17:30  Voluntourism’s place in conservation  
Taryn Ingram-Gillon
17:30 – 17:50  Initiating a voluntourism program as a sustainable economic initiative to help mitigate human elephant conflicts  
Ravi Corea

18:00 – 22:00  Dinner

Thursday  October 24th, 2019

SHUTTLES START AT 6:45 AM

7:00 – 8:30  Breakfast Buffet

THREE CONCURRENT SESSIONS

**SESSION 1**

**Emerging Technologies**
8:30 - 8:50  How cancer in elephants can inform treatment approaches for humans and elephants  
Lisa M. Abegglen
8:50 – 9:10  Molecular characterization of TP53 gene diversity in three distinct elephant populations in Kenya and evaluation of its implications in cancer resistance.  
Samuel Oliech Omolo

**Reproduction**
9:10 – 9:30  Post-natal oogenesis in the elephant: A realistic possibility  
Twink Allen
9:30 – 9:50  Understanding prolactin regulation and determining the efficacy of cabergoline and domperidone to mitigate prolactin-associated ovarian cycle problems in zoo African elephants (*Loxodonta africana*)  
Tina L. Dow, Ph.D.
9:50 – 10:10  Variations in the circannual rhythm of musth variables in captive Asian elephants  
T. Rajeev

10:10 – 10:30  Break

**Reproduction (cont.)**
10:30 - 10:50  Sperm motility, kinematics, morphometry and morphology of free-ranging African elephants over two seasons  
Ilse Luther-Binoir
10:50 – 11:10  Hyperactivation as a sperm functional test in African elephant bulls  
Liana Maree
11:10 – 11:30  Diagnostic imaging in elephant medicine – from eye to kidney
Imke Lüders

**Behavior**
11:30 – 11:50  What does the elephant brain tell us about elephant behaviour?
Paul Manger
11:50 – 12:10  Acts big but squeaks like a mouse: Production of Asian elephant high-frequency vocalizations
Veronika C. Beeck
12:10 – 12:30  Vocal flexibility in elephants
Angela S. Stoeger

12:30 – 13:30  Lunch

**Behavior (cont.)**
13:30 – 13:50  Sex differences in the play of ex situ African elephant calves (*Loxodonta africana*)
Robert Dale

**Elephant Welfare**
13:50 – 14:10  Management factors affecting adrenal glucocorticoid activity of tourist camp elephants in Thailand and implication for elephant welfare
Pakkanut Bansiddhi
14:10 – 14:30  A study on musth management and enrichment utilization of rescued captive Asian elephants (*Elephas maximus*) at Elephant Conservation & Care Center, Uttar Pradesh, India
Baiju Raj
14:30 – 14:50  The elephant in the room: Integrating behaviour to assess captive elephant welfare
Lisa Yon
14:50 – 15:10  Captive elephant research: towards a brighter future for African elephants in captive environments
Clare Padfield

15:10 – 15:30  Break

**ON YOUR OWN TO ENJOY ZEBULA GOLF ESTATE AND SPA**

**SESSION 2**
9:00 am – 17:00 pm  Elephant Endotheliotropic Herpesvirus (EEHV) Workshop
By Invitation Only

**SESSION 3**
9:00 am – 17:00 pm  The Role of Captive Elephant Management in southern Africa: The way forward
By Invitation Only

18:00 – 22:00  Dinner
Friday  October 25th, 2019

SHUTTLES START AT 6:45 AM

7:00 – 8:30  Breakfast Buffet

Veterinary Management
8:30 - 8:50  Ecological epidemiology to optimize policy interventions for tuberculosis control in captive elephants
David Abraham
8:50 – 9:10  Mycobacterium tuberculosis complex infection in free-ranging African elephants – novel diagnostic approaches
Michele Miller
9:10 – 9:30  General anesthesia in captive Asian elephant (Elephas maximus) using combination of dexmedetomidine hydrochloride and etorphine hydrochloride in Thailand
Nithidol Buranapim
9:30 – 9:50  Immobilization and transport of free-ranging African elephants
Peter Buss
9:50 – 10:10 Establishment of a first specialized elephant hospital in India
Yaduraj Khadpekar

10:10 – 10:30 Break

Veterinary Management (cont.)
10:30 – 10:50 Treatment of lightning strike in an Asian elephant
Supaphen Sripiboon
10:50 – 11:10 An emerging threat for Sri Lankan elephants (Elephas maximus maximus) and management of jaw-bomb victims
VPMK Abeywardana

Captive Elephant Management
11:10 – 11:30 Animal Care & Welfare Index: A protocol combining ethical reasoning and scientific assessment for the welfare of captive elephants in South Africa
Greg Vogt
11:30 – 12:30 Developing standards for management and welfare of elephants in human care in Zimbabwe: ZECA (Panel discussion)
Jake Rendle-Worthington, Chris Foggin, Lisa Yon, Sean Hensman

12:30 – 13:30 Lunch

13:30 – 13:50 Asian Elephant Support
Linda Reifsneider

Closing Remarks/Closing Ceremonies
13:50 – 14:30 Working together for elephant conservation
Sarah Conley, Sean Hensman, Deborah Olson

15:00  Shuttles leave for Johannesburg Airport
Ian Craig grew up in a family that — unusual for African ranchers of the time — valued wildlife on their ranch in northern Kenya. In the 1980s, the Craig’s helped establish a black rhinoceros sanctuary on their property after poachers had brought rhino populations nearly to the point of extinction. That rhino sanctuary evolved into the Lewa Wildlife Conservancy, a 62,000-acre nature reserve that is home to some of Africa’s most endangered species, including the black rhino and the Grevy’s zebra. Recognizing that his family’s efforts would only succeed in the long term if local communities embraced wildlife protection, in 2004 Ian co-founded the Northern Rangelands Trust (NRT), which equips and empowers community conservancies to improve their own lands and livelihoods. NRT now includes 27 member conservancies covering nearly 12,000 square miles of important wildlife habitat.

The Northern Rangelands Trust (NRT) supports community conservancies across northern and coastal Kenya. Together, they are changing the game; supporting communities to govern their wild spaces, identify and lead development projects, build sustainable economies linked to conservation, spearhead peace efforts to mend years of conflict, and shape government regulations to support it all. As institutions, community conservancies not only give people a voice, but provide a platform for developing sustainable enterprise and livelihoods either directly or indirectly related to conservation. Northern Kenya is a very different landscape now to the one it was ten years ago. Community conservancies are changing the narrative - a region once infamous for conflict and poaching is now at the forefront of community-led development, enterprise and peace efforts, all inextricably linked to the protection of its incredible wildlife and landscapes. NRT member community conservancies work to conserve wildlife and sustainably manage the grassland, forest, river and marine ecosystems upon which livelihoods depend.

Credit: Northern Rangelands Trust, https://www.nrt-kenya.org/
The economy in Sri Lanka has long depended on agriculture as a major source of income. A third of the land area is under permanent cultivation, and marginal lands are increasingly brought into production. However, agriculture is the least dynamic sector of the economy. The number of small farmers employed in the sector is 80%. Most of them live in poverty and depend on government subsidies.

Subsistence farmers consist of 40 percent of the rural poor in Sri Lanka. Rural subsistence agriculture along with habitat loss is the biggest contributors to human-elephant conflict (HEC) in Sri Lanka. Contrary to expectations, subsistence agriculture keeps a majority of rural farmers socially marginalized by trapping them in an eternal debt cycle. Adding to the considerable suffering of these people is HEC. The animal most affected by rural subsistence agriculture is the Sri Lankan elephant (Elephas maximus maximus).

HEC continues to increase due to ineffective landscape-level planning and land use practices. As available habitat for elephants shrink due to agricultural encroachment, elephants are pushed into marginal habitats and come into increasing and intense conflict with people and are considered pests. Annually elephants cause >US$10 million worth of crop and property damage to rural farmers and every year ~250 elephants die and 80 people are killed as a result of HEC. Clearly agriculture-based livelihoods are incompatible with elephants and these farmers need livelihoods that minimizes conflicts with elephants. Project Orange Elephant (POE) is a holistic approach that addresses these issues.

The primary crop of subsistence agriculture is rice. It is highly labor and cost intensive to cultivate rice. On average a farmer spends $891 to cultivate 2 acres of rice bringing an income of $1007 with a net profit of $116 per season. Rice is the staple food yet subsistence farmers incur a huge cost to sustain their dependency on rice. If they had the economic means, it is cheaper for these farmers to buy rice than cultivate it. This is one of the primary goals of Project Orange Elephant (POE).

The POE Pilot was conducted in the village of Himbiliyakade in Wasgamuwa from August 2006 to July 2007. Sixty-three farmers received 640 grafted orange plants. The average monthly income of the farmers in 2006 was $18. By 2009 the income of farmers who were making an income from POE had increased by ~289% to $52.60 per month. Following on the success of the Pilot Phase, in 2010, 53 farmers were selected from the Randunnewewa Village. The mean monthly income of the farmers in 2010 was $36. In 2019 the monthly mean income of POE farmers had increased by ~480% to $173 providing significant economic benefits.

POE farmers report attacks from elephants had drastically declined. While elephants still come to their compounds they don’t linger or loiter long enough to cause damage. The orange trees act as a trophic deterrent. POE is effectively addressing three primary issues caused by rural subsistence agriculture: 1) Provide farmers with a sustainable livelihood, 2) Minimizes conflicts with elephants, to 3) Create an environment for coexistence where people and elephants can survive without the fear of harassment, injury and death.

A holistic and sustainable conservation approach to a peaceful cohabitation of people and desert-adapted elephants in Namibia.

Rachel Harris, Christian Winter
Elephant – Human Relations Aid (EHRA)

Namibia’s desert-dwelling elephant population is decreasing. A major cause is human-elephant conflict which can result in destroying one or more elephants as “problem animals”. Sometimes the wrong animal gets shot; then the “real culprit” also gets shot. This, combined with trophy hunting, high infant mortality rates (possibly due to human-induced stressors) plus natural deaths, might spell doom for this population.

Elephant-Human Relations Aid (EHRA) is a Namibian registered not-for-gain organization (#21/2003/630), which was founded in 2003. It was launched as a result of the escalation in competition for and conflicts over water and other natural resources between the desert-adapted elephants and human inhabitants of the communal lands in the northern Erongo and Kunene regions of Namibia’s Northwest desert.

Due to over-hunting in the 1970-80s, the surviving elephants moved out of the area for about 20 years. During their absence, people moving in, as well as youngsters growing up, resulted in not knowing about...
elephants or how to live peacefully with them. Since the elephants returned in the 1990s, conflicts have been escalating, causing several human casualties and an ecologically critical decline in desert elephant numbers.

Less than 200 desert-adapted elephants are surviving in Namibia today. The elephants spend most of their time in the ephemeral rivers. EHRA monitors the elephants inhabiting the Ugab River and Huab River, which are home to a total of 62 desert elephants. Since 2016, the Ugab river elephant population has decreased by 32% due to natural and human-caused reasons (overhunting, conflict results, and stress).

To minimize the pressure on the people living with the elephants and to ensure the elephants’ recovery and long-term survival, EHRA developed a community-backed holistic approach to managing and reducing conflicts. This includes:

1. Physical protection of waterpoint infrastructure, funded and constructed through our award-winning volunteer project;
2. Education and safety training, in the form of our PEACE Project to reduce fear and increase knowledge on elephants and how to live safely with them;
3. Minimization of financial pressure, through the replacement of diesel water pumps with solar pumps in conflict-affected areas;
4. Identification and monitoring of the desert-adapted elephants, through week-long elephant patrols every other week of the year; and
5. Community development, in the form of school renovation and gardening projects in conflict affected areas, funded through EHRA’s sustainable volunteering and tourism initiatives.

We found that areas that benefited from elephants through these projects are more tolerant toward elephants.

‘Are elephants Gods or Devils?’- Understanding people's perceptions of elephants in Northern Odisha
Medha Nayak, Research Scholar, School of Humanities and Social Sciences, National Institute of Science Education and Research, Bhubaneshwar - HBN

Humans and elephants have co-evolved in a manner that their social, historical and ecological relations are mutually entangled. However, the coexistence has not been as harmonious as one would like that to be. Researchers suggest that the socio-economic changes over the years have altered the bonds between the humans and elephants. There is an increase in confrontations between the two that makes it more difficult to protect wildlife, because in areas prone to human elephant conflict (HEC), the real and/or perceived costs of living with wildlife can be greater than conservation benefits, reducing residents’ incentives to conserve wildlife. Despite the interventions by the government to mitigate damages to lives and livelihood and to curb intolerance against elephant depredation by providing ex-gratia to aid the affected families, organizing awareness campaigns, training workshops, introducing defensive technologies, demarcating elephant corridors, and many others, the frequency and intensity of HEC refuse to wither away. With this at the backdrop, we tried to understand different stakeholders’ perceptions of elephants, their responses to the problems and future of human-elephant coexistence in northern Odisha that is affected by inter-state elephant migration year after year. For this purpose, we conducted Participatory Rural Appraisal and semi-structured interviews across a range of stakeholders. The forest department, one of the stakeholders, was accused by village people to be biased towards elephants but forest department claimed to balance between safety of both people and elephants. Men were found to worry about economic losses and women were observed to hold on to the revered image of elephants. Further exploring cultural and ecological components of changing human elephant relations, this paper lists out suggestions for potential participatory and community-based mitigation strategies.

Assessing the effects of a cognition-based education program on attitudes of villagers towards Asian elephants (*Elephas maximus*) in conflict-prone areas
Radhika N. Makecha, Ratna Ghosal, Sagarika Phalke, & Yoshie Nakai
Eastern Kentucky University

This project assessed whether incorporating animal cognition (knowledge on animal minds and behavior) into education programs would have a more pronounced effect on attitudes towards wildlife and
conservation than education programs without animal cognition. More specifically, due to the increase in human-elephant conflict (HEC) in India, this project focused on education centered on the conservation of Asian elephants (*Elephas maximus*). Asian elephants are on the decline, due to an increase in human populations as well as habitat degradation. A vital role in elephant conservation and towards mitigating HEC involves participation from the local community, including participation in conservation education programs. Therefore, it is important to assess the type of information that would make a conservation education program highly effective in changing attitudes. Given the public’s fascination with animal minds, as well as the elephant being a cognitively complex species, we investigated the impact that a conservation education program incorporating elephant cognition had on attitudes towards elephants/elephant conservation. High HEC villagers (males over the age of 18 and the primary decision makers in the family) in around Bannerghatta National Park (BNP) in India were surveyed on their attitudes towards elephants/elephant conservation after being given either an educational presentation incorporating elephant cognition, a regular educational presentation (no information on elephant cognition), or no educational presentation. Significant differences in attitudes towards elephants and attitudes towards elephant conservation were found between both types of education groups and the control group (no educational intervention). However, there were no significant differences in attitudes towards elephants/elephant conservation regarding the two types of education. Additionally, the comments our participants made during the presentations as well as during the survey were recorded ad hoc and analyzed. Overall, our findings suggest that with high HEC populations, long-term educational programs (as opposed to a one-time short educational presentation) and community-based involvement may be more effective in long-term attitude change. Additionally, the villagers that were surveyed had an informal and local contextual knowledge on elephant cognition through their exposure to strategies used by elephants to break down barrier fences/raid crops. Future studies using the same methodological approach should focus on urban populations with little to no exposure to HEC, as well as children, who are not yet influenced by other over-riding factors of HEC.

**African Ecosystems on the edge - What can be the strategies for living together**

Anastácio¹, Rita, Batista¹, Milene, Pereira¹, Mário J.

¹Departamento de Biologia & CESAM, Universidade de Aveiro, 3810-193 Aveiro, Portugal

²AFPR – BB, Aveiro, Portugal

In the middle of the decade (2010-2020), identified as the decade of Biodiversity by the UN, the EU published the document ‘LARGER THAN ELEPHANTS: Inputs for an EU strategic approach to wildlife conservation in Africa’. In that synthesis, problems are identified and solutions requested for one of Europe’s major concerns, the wildlife crisis in Africa. Territory encroachment and fragmentation, disruption of the wildlife migration network, human demography, unsustainable use of biological resources, and the disruption of ecosystem services are identified, among others, as major drivers for the diversity loss. The need to face and stop biodiversity loss, to safeguard food security by healthy ecosystems and support ‘innovative ways to manage natural capital in the framework of a green economy, are identified goals. At a local level, the need to develop agricultural and energy projects as part of the solutions to reduce pressures on the ecosystems is also emphasized.

With this presentation we want to highlight that the needs of people and wildlife species must be addressed in a concerted and informed way, looking at the needs of all species, including humans, and finding solutions to live and let live. To achieve this goal, important actions like assessing biodiversity and keystone species and protecting them based on knowledge of their patterns and needs are required. Education and commitment is mandatory, either by changing practices (giving access to diversified energy solutions; avoid water sources contamination and overexploitation; improve soils and their ability to retain water; avoid overgrazing by domestic and wild species; reduce wood harvesting), or improving practices (implementing projects for growing plants for reforestation, trees for construction, and medicinal plants, diversifying crops and productivity, innovating irrigation systems, improving services provided by pollinators, protecting crops and stocks from wildlife). Involving the local communities in the benefits that the preservation of all species can provide and in the decision-making that must be supported by advised knowledge is mandatory to achieve success in all referred actions. Most of all, having in mind the gender equality targets and the human wellbeing categories should be a top priority.
Intersections Map with interconnected topics that, at least, must be addressed. Liaisons that can improve or jeopardize UN SDG’s such has: Sustainable Development Goals 1 – No poverty; 2 – Zero hunger; 3 – Good Health and Well-being; 4 – Quality education; 5 – Gender equality; 6 – Clean Water and Sanitation; 7 – Affordable and Clean Energy; 8 – Decent Work and Economy Growth; 12 – Responsible Consumption and Production; 13 – Climate Action; 14 – Life Below Water; 15 – Life on Land.

In the context of up-scaling agriculture, knowing the biodiversity of the target area, the behavioural and spatial ecology of the species and an adequate territory ordination/management will be key factors for reducing wildlife-man conflict and threats to biodiversity. Plants, forestry, and animal diversity must be a target at the moment of planning land use and changing land cover. Plants can help to maintain other species that depend on them, such as insects and herbivores, including species that improve field crop yields (e.g. bees and beehives), reduce elephants-man conflict, and contribute to the financial independence of women. Education/environmental education is an important activity to change attitudes and to prepare future generations for preserving ecosystem services, improving socio-economic development and reducing human pressure on environmental resources.

A crowd-sourced approach to monitoring Asian elephants in a human dominated landscape

Tarsh Thekaekara
Postdoctoral Fellow at the National Centre for Biological Sciences, Adjunct Fellow at Dakshin Foundation and Trustee and Co-Founder at The Shola Trust

India harbours 60% of the world's Asian Elephant population, amidst a high human density of 400 people/km². Only about 25% of the elephant range falls within the protected area network, and the long-term survival hinges on their ability to share space with people. Yet there is a dearth of literature on the elephants alongside people, where even the range of elephants outside PAs is not known. The majority of methods and tools are designed for elephants living in more intact forests, with the focus outside PAs being largely limited to “Human-Elephant Conflict”.

In the Gudalur region of Tamilnadu (a plantation landscape in the Nilgiri Biosphere Reserve), over the last three years we have experimented and evolved tools and methods to better understand these elephants and their interactions with people. Based primarily on photographs and videos for the identification of individual elephants based on morphological features, and working with field staff from the forest department, this has culminated in an app “Jumbo Radar”, that allows staff to collect and store elephant photographs and some simple additional data. With this, we have been able to gain significant insights into the lives of elephants in the region:

- Starting with basic question of numbers, we found that there are around 150 elephants using the region, with about 70 present at any given time (traditional sampling methods yielded results that ranged from 30-180 elephants).
• In terms of demography it is skewed towards young males, with a male:female ratio 1:0.7 (while for surrounding forests it is 1:4).
• We have a better understanding of movement patterns and found some elephants are resident all through the year with home ranges as small as 30km$^2$.

Most importantly, based on their interaction with people, we find a marked difference among the different elephants, which we classify into four behavioural categories. First, “transient elephants” that are seen less than 5 times a year, and probably only move through the region. Second, are “shy elephants”, that are seen often, but never near human habitation. Third are the “fight or flight elephants”, mostly young males that come near habitation regularly, but either charge or retreat when they encounter people. And fourth are the “highly habituated” males, that do not respond significantly to people, even when provoked.

An almost unintended consequence of this work, arguably from the field staff shifting from chasing elephant to largely monitoring them, is that human fatalities have reduced from about 9 per year (2014-2016) to 5 per year (2017-July2019).

We are expanding into other regions, and we hope this tool (the Jumbo Radar app) will make it easier for field staff and other NGOs to engage in a much more robust monitoring of elephants outside protected areas.

Introduction to elephant endotheliotropic herpesvirus (EEHV) and global EEHV resources.
Lauren L. Howard, DVM, Dipl. ACZM, Nadine Lamberski, DVM, Dipl. ACZM, DECZM (ZHM)
San Diego Zoo Global, PO Box 120551, San Diego CA, 92112-0551, USA

Elephant endotheliotropic herpesvirus (EEHV) causes severe, often fatal hemorrhagic disease in young Asian (Elephas maximus) and African elephants (Loxodonta africana). Gross necropsy lesions in elephants that succumb to this disease show edema and hemorrhage in many abdominal organs, as well as extensive hemorrhage within the pericardium. This virus is a natural infection of elephants, and has evolved with elephants over millions of years. It is carried and shed asymptotically by most elephants tested over time, and at the same time causes acute illness and death in certain age groups. Ten years of research advances in North America have allowed us to diagnose disease earlier, provide more aggressive treatment options, and better understand the immunity profiles of at-risk elephants, and hope to lead to EEHV1 vaccine development in the next few years.

Fatalities from EEHV Hemorrhagic Disease, or EEHV HD, have been documented in Asian and African elephants (Loxodonta africana) under human care, and in 18 free ranging elephants in India. Asian elephants under human care in North America and Europe are the best understood population when evaluating diagnosis, treatment, impact and epidemiology of EEHV. In North America and in Europe, EEHV HD is the single largest cause of death in young Asian elephants. Across Asian elephant range countries, 142 cases of EEHV HD have been confirmed via PCR testing, with many more suspect cases unconfirmed due to lack of resources.

Little to nothing is known of the incidence and impact of EEHV HD on wild elephant populations in their range countries. In preparation for this conference, a survey of 31 wildlife health professionals was initiated to gauge awareness of and interest in EEHV in wild African elephants. The respondents were from North Africa (3%), West Africa (3%), East Africa (29%) and southern Africa (65%). Just over 90% of respondents were aware of EEHV in wild Asian elephants and nearly 60% were concerned about herpesvirus in African elephants. 17% (n=5) of respondents had diagnosed herpesvirus-related disease in an African elephant and 39% (n=12) of respondents have observed skin lesions that could be attributed to herpesvirus. Only one respondent observed post mortem lesions that could be attributed to EEHV but over 90% indicated they want to learn more about herpesvirus in wild and orphaned elephants.

The North American EEHV Advisory Group (NA EAG) is a group of more than 20 veterinarians, researchers, conservationists and other zoo professionals with the goal to reduce elephant deaths due to EEHV. The NA EAG maintains a website, www.eehvinfo.org which has current information for veterinarians, researchers, and elephant care specialists, and is updated regularly by subject matter experts. Sample EEHV treatment protocols and a large bibliography are just two of many resources available on this globally used website. The European EEHV Research Consortium leads research priorities and funding decisions for Europe and the UK and is planning a meeting in The Netherlands in May 2020. The Asian EEHV working group is led by EEHV Taskforce Thailand and by conservation leaders at Wildlife Reserves Singapore, and will be meeting in Assam, India in late November of this year. A Global EEHV Workshop
is scheduled for 2021 in Chiang Mai, Thailand, and all regional groups are encouraged to attend. Further details will be shared when they are available.

Current knowledge of EEHV in African elephants (*Loxodonta africana*)

Erin Latimer MS¹, Kali Holder DVM DACVP¹, Melissa Fayette DVM², Shannon Nodolf DVM³, Virginia R. Pearson⁴, Gary Hayward Ph¹

¹Wildlife Health Sciences, Smithsonian’s National Zoological Park, Washington DC 20008, USA; ²Indianapolis Zoo, Indianapolis, IN 46222 USA; ³Fresno Chaffee Zoo, Fresno CA 93728 USA; ⁴Fox Chase cancer Center, Philadelphia, PA 19111 USA; ⁵Johns Hopkins University, Baltimore MD 21286, USA

Elephant Endotheliotropic Herpesvirus (EEHV) is best known for causing an acute hemorrhagic disease (EEHV HD) in mostly young Asian elephants (*Elephas maximus*), but it has also been implicated in morbidity and mortality in older Asian elephants and in African elephants. There has been increased interest in EEHV in the African elephant community because of recent deaths and disease due to EEHV in African elephants in the US. This report will review what is known about EEHV in African elephants, including saliva, lung and skin nodules in otherwise healthy animals in human care and in the wild, two deaths in the 1990s due to EEHV2 (USA), the serious illness in a young calf due to EEHV3B (USA), illness (USA) and death (Thailand) due to EEHV6, the recent deaths of three African calves with EEHV3 and three EEHV3 viremias in calves that survived (USA). In addition, EEHV shedding in trunk secretions and detection of low levels of EEHV2, 3-4, and 6 in blood and necropsy samples will be described. Comparisons to EEHV in Asian elephants will be presented.

Building capacity for tackling elephant endotheliotropic herpesvirus at an African level

Edgar Simulundu, BVM PhD¹

¹University of Zambia, School of Veterinary Medicine, Lusaka, Zambia

There is mounting evidence that elephant endotheliotropic herpesvirus (EEHV) has negative health effects on African elephants. However, many elephant range African countries lack laboratory and professional capacity to mitigate the impact of EEHV. Here, actions that could help build capacity to tackle EEHV at an African level in collaboration with international partners are discussed.

Serological detection of EEHV infections by a Luciferase Immunoprecipitation System assay

Paul Ling¹, Angel Fuery¹, Jie Tan², RongSheng Peng², Gary Hayward²

¹Baylor College of Medicine, ²Johns Hopkins School of Medicine

Elephant Endotheliotropic Herpesvirus (EEHV) can cause lethal hemorrhagic disease in juvenile Asian elephants, both in captivity and in the wild. Most EEHV deaths are caused by two chimeric variants of EEHV1- EEHV1A and EEHV1B, while two other EEHVs endemic within Asian elephants (EEHV4 and EEHV5) cause death less frequently. It remains unknown whether lethal infections caused by EEHV are due to primary infection or reactivation of latent virus. Furthermore, knowledge of the anti-EEHV antibody levels in young calves is limited. To address these important issues a Luciferase Immunoprecipitation Systems (LIPS) assay for antibody profiling and diagnosis of EEHV1 infection was investigated using a panel of proteins conserved between EEHVs 1, 4 and 5 and proteins unique to EEHV1. The results show that elephants who died from EEHV1A hemorrhagic disease (HD) were sero-negative for EEHV1A and thus likely died from a primary infection with that virus type. We were also able to demonstrate that waning of EEHV1A specific antibodies occurs in the first two years of life, indicating the likely acquisition of these antibodies from placental transfer, where there may be a potential threshold protective level of antibody required to prevent HD. Identification of these “diagnostic” proteins together with the LIPS assay itself, are likely to be extremely useful tools for the study of EEHV and responses to candidate EEHV vaccines in the future.
Recommended EEHV monitoring in Asian and African elephants
Erin Latimer MS
Wildlife Health Sciences, Smithsonian’s National Zoological Park, Washington DC 20008, USA.

Elephant Endotheliotropic Herpesvirus (EEHV) is the leading cause of death in young Asian elephants in human care; as testing capacity has increased in the range countries, it is being seen in young Asian elephants in the wild as well. Although it has not been as much of an issue in African elephants in the past, there have been recent deaths and illness in young African elephants in Thailand and the US; more research and data are needed to elucidate the relationship of African elephants and EEHV. It has been shown that routine monitoring by molecular methods can detect EEHV DNA in blood (viremia) before clinical signs appear, allowing clinicians to begin early aggressive treatment. Current recommendations from the North American EEHV Advisory Group will be presented, including PCR testing, blood work, and behavioral changes to track.

Treatment of elephant endotheliotropic herpesvirus (EEHV) hemorrhagic disease.
Lauren L. Howard, DVM, Dipl. ACZM
San Diego Zoo Global, PO Box 120551, San Diego CA, 92112-0551, USA

Fatalities from EEHV Hemorrhagic Disease, or EEHV HD, have been documented in Asian and African elephants (Loxodonta africana) under human care, and in free ranging Asian elephants. Asian elephants under human care in North America and Europe are the best understood population when evaluating the impact and epidemiology of EEHV. Little to nothing is known of the incidence and impact of EEHV HD on wild elephant populations in their range countries.

Treatment recommendations for elephants with EEHV HD have been developed and shared internationally. Detailed treatment recommendations can be found on www.eehvinfo.org. Principles of treatment for EEHV HD remain the same across North America, Europe, and Asia, though subtle regional differences exist. Early detection of viremia is important to allow early initiation of antiviral and supportive treatment. Antivirals used in EEHV cases include famciclovir, acyclovir, and ganciclovir, though none have been confirmed in vitro to have efficacy against the virus. In addition to antivirals, systemic support via fluid therapy is very important. Rectal fluids are very effective at resuscitating a dehydrated or depressed elephant, and can be performed in even the most primitive conditions. Intravenous fluid therapy and intravenous plasma transfusions have also been used in elephants being treated for EEHV HD, with some success seen when treatment is started early. Other treatments, such as antibiotics, anti-inflammatories, vitamin C, stem cells, and antioxidants should be considered by the attending veterinarian. Elephants that are suffering from EEHV HD may not appear very ill, even as they are developing severe internal hemorrhage. Therefore, aggressive, early treatment, sometimes initiated before a diagnosis can be confirmed, is the veterinarian’s best chance in helping a calf survive this terrible disease.

Fatal elephant endotheliotropic herpesvirus 3 infection in two captive African elephants (Loxodonta africana)
Melissa A. Fayette, DVM, Emily Brenner, DVM, Michelle R. Bowman, DVM, Erin Latimer, MS, and Jeffry S. Proudfoot, DVM
Indianapolis Zoo, Indianapolis, IN 46222 USA; National Herpesvirus Laboratory, Smithsonian’s National Zoological Park, Washington DC 20008, USA

Acute hemorrhagic disease caused by elephant endotheliotropic herpesvirus (EEHV) has been well documented in both captive and wild young Asian elephants (Elephas maximus). Currently there is a paucity of information on this disease in African elephants (Loxodonta africana). Clinical disease has previously been described in five African elephants, including two fatal cases with EEHV-2 infection, one fatal case and one survivor with EEHV-6, and one survivor with EEHV-3b. This report describes two fatal cases of EEHV-3 infection in African elephants managed at the same facility that developed disease within a one week time period. The first case is a 6.5-yr-old female presented with depressed mentation, abdominal pain, and anorexia. The elephant developed hematuria, oliguric renal failure, and pulmonary edema within 72 hr. and died despite supportive treatment. The second case is a 7.5-yr-old
female presented with diarrhea and hematuria. Antiviral treatment and supportive care were initiated immediately; however, this elephant also expired within 72 hr. of the initial onset of illness. Gross necropsy findings in both cases included extensive petechiae and ecchymoses on the heart, liver, spleen, stomach, intestine, colon, bladder, and within the reproductive tract. Histopathology revealed disseminated vascular necrosis with edema, hemorrhage, and endothelial cell intranuclear inclusions typical of herpesvirus in multiple organs. Antemortem and postmortem whole blood samples analyzed by quantitative polymerase chain reaction (qPCR) showed a high viremia (ranging from 1 x 10^6 to 3.7 x 10^6 viral genome equivalents/ml) in both elephants. Phylogenetic analysis identified the strain as EEHV-3 and whole genome sequencing is pending.

LITERATURE CITED

Preparing for EEHV: The survival of Indali Hi-Way.
Rebecca Le Brocq
Chester Zoo, The North of England Zoological Society

Chester Zoo has a history of fatal EEHV cases having lost 7 calves to the virus in the past. In 2019, the team was able to save 2 year-old calf, Indali, after having further adapted the husbandry protocol and treatment since the previous calf loss in 2018. Chester Zoo works in protected contact and has developed a daily husbandry routine with the calves in order to be prepared for a possible EEHV infection at any time. Daily training in a specially designed calf access area allows the calf to willingly enter the area for treatment when needed so that unnecessary stress can be avoided. In the case of Indali, the introduction of screening through weekly blood swabs allowed the virus to be detected at very low levels before any of the symptoms arose. Early detection is thought to be one of the main factors contributing to the survival of the calf.

Treatment protocol was initiated immediately after the positive result and included regular sedation, administration of anti-viral drugs, rehydration and blood plasma transfusion. Most of the plasma was sourced from the resident bull elephant who is trained to present his ear through the fence line and allowed weekly blood donation. Indali’s blood viral level was monitored carefully and at signs of recovery, sedation was discontinued and she was reunited with the herd. Anti-viral drugs could still be administered via darting. All herd members give regular trunk swabs to test for EEHV ‘shedding’. A positive result from Indali was used as an indication she had entered the recovery phase and a decision was made to stop treatment. Looking forward, we will apply this protocol to future positive screenings with other calves and continue to support the development of a vaccine.

EEHV capacity-building in Asia and Africa
Erin Latimer MS1; Supaphen Sripiboon, DVM PhD2; Sonja Luz, DVM PhD3;
1Wildlife Health Sciences, Smithsonian’s National Zoological Park, Washington DC 20008, USA; 2Kasetsart University, Thailand; 3Wildlife Reserves Singapore, Singapore.

There has been a great need for Elephant Endotheliotropic Herpesvirus (EEHV) testing capacity internationally, with a resulting international effort to provide molecular diagnostics training, equipment, and reagents to laboratories in elephant range countries. Molecular diagnostics of EEHV will be described and laboratory basics (equipment, reagents, training) enumerated. Details will be given for EEHV laboratory
Asian elephant fresh plasma and fresh frozen plasma are being focused upon, and the benefit of its use is increasingly drawing interest, particular with the treatment of severe blood loss from trauma and the Elephant Endotheliotropic Herpesvirus hemorrhagic disease (EEHV-HD). There were few studies about Asian elephant fresh frozen plasma compared to those of the other mammals such as human and dog. The objective of this study thus is to compare the efficacy of Asian elephant (Elephas maximus) plasma between fresh and post storage at -20°C for 4 and 8 months. Concentrations of fibrinogen and clotting factor VIII were determined by Fibrinogen Clauss Assay and One-stage clotting assay, respectively. Immunoglobulin G (IgG) were quantified by Colorimetric assay. The results demonstrated that the average of fibrinogen concentrations were not significantly different between fresh (255.16±28.76 mg/dL) and post-storage samples at four (264.37±25.99 mg/dL) and eight months (248.63±26.37 mg/dL) (p=0.19). The average clotting factor VIII concentrations were significantly different between fresh (900.89±199.42 %) and post-storage samples at four (833.24±163.34 %) and eight months (750.30±170.72 %) (p=0.03). However, the average of IgG concentrations in fresh (5.05±0.47 mg/dL) and post-storage samples at four (5.79±0.65 mg/dL) and eight months (6.81±1.09 mg/dL) were significantly different (p<0.001). The efficacy of Asian elephant fresh frozen plasma, stored at -20 °C for 4 and 8 months was slightly different from the fresh one; however, the clotting parameters were still acceptable and could be used in clinical treatment.

Acute phase proteins as indicators of the elephant immune response to infectious disease
Katie L. Edwards, Erin M. Latimer, Sharon S. Glaeser, Jessica L. Siegal-Willot, and Janine L. Brown
1Center for Species Survival, Smithsonian Conservation Biology Institute, 1500 Remount Rd., Front Royal, VA 22630, USA; 2National Elephant Herpesvirus Laboratory, Smithsonian’s National Zoological Park and Conservation Biology Institute, Washington, DC 20008, USA; 3Oregon Zoo, 4001 SW Canyon Rd. Portland, OR 97221, USA; 4Department of Wildlife Health Sciences, Smithsonian’s National Zoological Park and Conservation Biology Institute, Washington, DC 20008, USA

African and Asian elephants both in nature and under human care are susceptible to infectious diseases including elephant endotheliotropic herpesvirus (EEHV) and tuberculosis (TB). Although many adult African and Asian elephants are believed to be asymptomatic carriers of EEHV, hemorrhagic disease has occurred in about 20% of Asian and occasional African calves under human care, resulting in >65% mortality within hours to days of disease onset. EEHV has also been reported in at least seven Asian elephant range countries. TB is a zoonotic disease that poses a risk of transmission between elephants, humans and other species. Prevalence is around 10% in North America, and could be higher in situ. Although both of these diseases have important implications for elephant health, they are difficult to manage, in part due to challenges with detecting active infection, and to the complexity of underlying immune responses during disease. A better understanding of the elephant immune response to infection and response to available treatments would be beneficial to managing both of these diseases.

Measuring biomarkers of immune function can be a useful approach to improve our understanding of disease processes, and can be beneficial to disease management. Acute phase proteins form part of the innate immune response; they can be fast acting and increase by several orders of magnitude within hours of immune activation. For this study we measured two APPs, serum amyloid A and haptoglobin, in serum collected longitudinally from elephants with EEHV viremia and TB to determine whether these biomarkers could indicate changes in immune activation with infection and stage of disease.

Overall, APPs were positively correlated with EEHV viremia, and differences in magnitude of response between individuals may be associated with the viral strain and severity of infection. Serum amyloid A often increased in serum prior to detectable viremia (as determined via qPCR), and so could be a useful early indicator of infection. The APP response during TB infection was less clear due to additional...
pathologies that occurred during the study period, and the subclinical nature of infection. However, increases in APPs were observed during the time that latent infection was suspected to convert to active disease, and with disease progression.

Earlier detection of these pathologies and a better understanding of where immune processes could be failing could help to improve survival (EEHV), reduce risk of transmission (TB), and understand disease susceptibility. APPs are sensitive indicators of immune function in elephants that could be powerful tools to improve our understanding and management of infectious disease.

Revisiting the population size of the largest sub-population of the Borneo elephant
Cheryl Cheah Phaik Imml and K. Yoganand2
1 WWF-Malaysia, 6th Floor, CPS Tower, Centre Point Complex, 1 Jalan Centre Point 88800, Kota Kinabalu, Sabah, Malaysia 2 WWF-Laos, House no. 39, Unit 05, Saylom Village, Chanthabouly, Vientiane, Laos

A fundamental requirement for conservation, particularly for a large-bodied, long-ranging species such as the elephant is the knowledge of its population status and the factors that cause variation in it across its range. The Central Sabah subpopulation, in addition to being the largest subpopulation of Borneo elephants, also has the greatest opportunity for long term conservation due to the size of contiguous habitat available, and the large extent of this habitat currently protected from adverse land use change and human occupation. We surveyed this subpopulation in 2015, with the aim of obtaining an up-to-date estimate of population size and because substantial ambiguity was noticed in the previous estimate.

The ca. 5,499 km² study area comprised several contiguous forest reserves in Central Sabah, some of which were allocated for forestry production and the remaining were set aside as protected areas. Dung-count survey methods were used to estimate population size. For estimating dung persistence time, we used the ‘retrospective’ method where fresh dung piles were searched for and marked monthly from November 2014 until August 2015. The dung piles were classified using the CITES MIKE Program’s “S” system. We used a mean defecation rate of 18.15 defecations per day from a study in Sumatra of wild-caught and tamed elephants which foraged naturally in the forest. For estimating dung pile density, we used line transects. The transect locations were selected based on stratified random sampling and were categorized into high and medium suitability stratum. 75 transects targeted to be 1 km long were surveyed for dung and were chosen randomly. A Bayesian analysis framework was used to estimate dung persistence time and dung pile density. Observations on 97 dung piles were analyzed to estimate dung persistence time where we obtained a posterior mean of 212 days (95% BCI: 133 – 319). The area-weighted overall elephant density for the study area was 0.07 per km² (95% BCI: 0.03 – 0.11) and the population size was 387 elephants (95% BCI: 169 – 621).

The previous estimated population size of 1,132 individuals for the Central range was thrice larger than that estimated in this study. It was given a great importance as it was the first range-wide estimate made using an established method and it subsequently formed the basis for the Sabah government policy on elephant conservation. However, a close review of the previous study revealed a flawed study design and methods, large errors and many ambiguities, which would explain the differences in population estimates. A comparison of land use in the Central range showed no drastic adverse changes between 2008 and 2015, instead there has been a substantial increase in forest areas allocated for protection. It is unlikely that habitat changes or other external factors caused a population to decline so quickly and therefore both estimates should not be compared to infer population trends. Our estimate for the Central subpopulation which uses more robust methods will be used for advocacy with the Sabah government to influence conservation and management policies for the species.

Debunking Critical Assumptions to Improve Forest Elephant Census and Monitoring
Amelia Meier
Duke University

Accurate population estimates are essential for conservation management and strategic planning. However, to obtain accurate estimates for cryptic species such as African forest elephants, indirect survey methods such as line transect surveys counting dung are necessary. Despite being the most commonly used method, line transects with Distance analysis have several assumptions that could lead to potentially large sources of error. Two of these potential sources of error include subjective identification of unique
defecation events, and converting the density of dung into the number of elephants. First, to address the issue of subjective delineation of defecation events, we determined which characteristics of dung piles and distance between piles best distinguish defecation events by contrasting the genotype identity of several proximal piles. From these results, we created recommendations for field teams to objectively identify unique defecation events. Second, to improve the precision and consistency in conversion of dung density to elephant density we created adaptive models of dung degradation that can incorporate field collected habitat information and/or remote sensed layers. This research improves survey methods and reduces the costly need for site-based dung degradation studies, hopefully clarifying the regional abundance of forest elephants and supporting adaptive management of their populations.

Pathways back to Zambia: re-establishing elephant migration routes through transboundary conservation
Kerryn Carter
Elephant Connection Research Project

At least half of the estimated number of elephants in Africa occurs within the Kavango Zambezi Transfrontier Conservation Area (KAZA TFCA) in southern Africa, making it the largest remaining meta-population in the world, yet there is limited information available about the capacity of elephants to safely move across the multiple land-use types that make up the KAZA TFCA landscape. It is believed that historically elephants moved throughout the KAZA TFCA but years of persecution from 1970s, due to an increased demand for ivory coinciding with liberation wars in the region, dramatically reduced population numbers and migratory movements. In addition, elephant migration routes have been slowly settled by subsistence farming communities over the past few decades, resulting in fragmentation of habitats and anthropogenic disturbances in historic movement corridors.

One of the main objectives of the KAZA TFCA is to re-establish wildlife connectivity throughout its protected landscape, and by securing functional wildlife movement corridors that can enable animals to undertake long-distance movements between KAZA countries, this can be achieved. Elephants may re-establish their historic migration routes to move into areas with lower densities of elephants, which are now becoming safe again for elephants through the efforts of KAZA partner countries. Free movement of elephants may alleviate problems associated with the over-population of elephants that is currently occurring in some of the KAZA areas.

In Zambia, through our satellite tracking of elephants we are documenting transboundary movements and potential movement corridors that can link Zambia’s protected areas with the wider KAZA TFCA landscape. This information is needed to guide future conservation planning in Zambia for securing legally protected wildlife corridors that restore landscape connectivity between protected areas and enable free movement of wildlife between member countries. A future collaboration among KAZA elephant researchers will combine elephant movement data for a KAZA-wide connectivity analysis that will highlight the most functional transboundary movement corridors for protection.

This year, subsistence farming communities in Zambia are reporting elephant presence in some transboundary areas where elephants have not been seen for up to 10 years, signaling a return of elephants into once dangerous areas. Are elephants re-establishing migration routes into Zambia and what has prompted these movements? What management actions are needed to facilitate this process and what are the future implications of success? Here, we discuss these questions and present preliminary elephant movement data from the Zambian component of KAZA TFCA that is helping us to build a picture of historic, current and possibly future elephant migration routes.
Vasectomy of free ranging African elephants (*Loxodonta Africana*) as a conservation management tool

Kari Morfeld, PhD,¹ Mark Stetter, DVM, Dipl ACZM,¹,² Dean Hendrickson, DVM, Dipl CVS,¹,² Doug Merker, MBA,¹,² Jeffery Zuba, DVM,¹,4 and Mark Penning, BVSc,¹,5

¹Elephant Population Management Program, 4132 Vista Lake Drive, Fort Collins, CO 80524 USA, ²College of Veterinary Medicine, Colorado State University, Fort Collins, CO 80523, ³Cramer Decker Industries, 819 F St West Sacramento, CA 95605 USA, ⁴San Diego Zoo Safari Park, 15500 San Pasqual Valley Road, Escondido, CA 92027 USA, ⁵Walt Disney Parks & Resorts, 1375 E Buena Vista Dr, Lake Buena Vista, FL 32830 USA

We welcome partners, including reserves and areas facing high elephant densities, to collaborate with us to implement elephant vasectomy as a population control tool across Africa. Now that the procedure has proven successful, we aim to implement long-term monitoring post-vasectomy for individuals and populations to include data collection on elephant density, behavior, physiology, and endocrinology of males and females. Ultimately, the goal is to complete a comprehensive assessment on elephant vasectomy to understand the effectiveness, costs, obstacles, and benefits as a practical conservation tool.

Vasectomy in African elephants, a one-off operation in which a section of the vas deferens is removed via laparoscopic techniques under field conditions, has been developed as a tool for elephant conservation and population management. The procedure does not require repeated treatments, eliminating the ongoing practical and financial considerations for repeated treatments as is required for alternate population control methods such as hormonal contraceptives. First used in 2004, the vasectomy procedure was lengthy (taking over 4 hr.), but since has become increasingly more efficient now taking less than an hour. Thus, up to three bulls can be vasectomized in a day and rarely results in complications. For the procedure, patients are anesthetized, intubated, placed into a modified standing position with a sling and crane/capture truck, ventilated as needed, clinically monitored and vasectomized using specialized laparoscopic equipment and protocols. To provide safe anesthesia for elephants undergoing prolonged field procedures, unique anesthetic protocols and equipment were developed.

Behavioral implications are critical to consider of any population control method, and thus a case study examined this aspect of elephant vasectomy. In 2008 at the Pongola Game Reserve South in northern KwaZulu-Natal, field vasectomies were carried out on seven male elephants (ages 17-25) to limit population growth. The physical and behavioral effects were monitored from 2011-2016, revealing that the behavior of the vasectomized males was not influenced by vasectomies. Musth was displayed as anticipated in the oldest males, a linear dominance hierarchy was maintained, and association patterns with female groups remained intact.

Transdisciplinary mitigation approaches to South African human-elephant conflict

¹Audrey Delsink,²JJ van Altena,³Hendrik J. Bertschinger,⁴Robert Slotow

¹School of Life Sciences, University of KwaZulu-Natal, South Africa, ²Global Supplies, Gauteng, South Africa, ³Department of Production Animal Studies, University of Pretoria, South Africa, ⁴School of Life Sciences, University of KwaZulu-Natal, South Africa

Human-wildlife conflict (HWC) is an escalating global and increasingly widespread wildlife conservation problem. Most HWC research focuses along the edge of or encroaching on protected areas, e.g. crop-raiding Asian and African elephants (*Elephas maximus* and *Loxodonta Africana*) and livestock predating lions (*Panthera leo*). In South Africa, ± a third of the country’s elephants are in fenced-in reserves comprising of multiple stakeholders and land uses directed by diverse reserve management objectives. Together with high local population numbers that exacerbate the “elephant density effect”, human-elephant conflict (HEC) often occurs within protected areas requiring a multifaceted approach. Fences are common in South Africa’s protected area landscape. African elephants are capable of traversing ± 100 km/day, and fence-breaching of both internal and external perimeter fences is common, earning repeat offenders a “problem elephant” title. Problem elephants can be legally hunted or destroyed. However, lethal control does not solve the root of this complex problem ranging from poorly maintained fences to high local population growth and cannot be mitigated through reliance on a single mitigation technique. We applied innovative technology including deployment of 6 satellite collars on elephants enabling pro-active monitoring and management, constructed bee-hive fences and tusk-braced 2 bull elephant’s tusks, as non-lethal short to medium-term mitigation strategies to curb fence-breaching in two reserves. Fertility control
through porcine zona pellucida (PZP) immunocontraception; a non-lethal, non-hormonal population management tool that reduces and stabilizes local population growth rates in the medium to long-term, was implemented. This reduces competition of enclosed resources, particularly amongst bulls who may seek out new ranges outside perimeter fences. Approximately ± 900 cows on 28 reserves across South Africa spanning 22 years of treatment is underway, including the 2 study sites. We demonstrate that together, these non-lethal techniques facilitate the management of and successfully mitigate or reduce HEC, particularly fence-breaching activities.

New methods utilized to deter African elephants (*Loxodonta africana*) from crop raiding in the Kasigau Wildlife Corridor, Kenya

Von Hagen, R.L., Kasaine, S., Githiru, M., Amakobe, B.A., Schulte, B.A.

Western Kentucky University, Auburn University, Wildlife Works

Human elephant conflict (HEC) continues to escalate as human settlements and agricultural developments further expand into African elephant habitats. Elephants commonly cross at night from areas of refuge into farming communities and consume or trample crops, exacerbating the threat to the livelihood of farmers and the conservation of elephants. While traditional methods are affordable and practical, they rarely prevent habituation by elephants. Scientists and local people have worked to develop more modern deterrent methods that use signal theory coupled with a negative association to prevent habituation, though these also have been met with limited success. This study evaluated the efficacy of several deterrent methods as well as a newly developed metal strip (Kasaine fence) in a large-scale paired control study utilizing farm plots present in the Sasenyi farming community in the Kasigau Wildlife Corridor near Tsavo East National Park. Four blocks of farmland comprised of 4 different deterrent methods and their matching controls were ranked for efficacy. The study found that the Kasaine fence was effective at deterring elephants, and even more so when used in combination with a second deterrent method. These new methods show promise towards alleviating the conflict between rural farmers and the elephants that live among them.

Patterns of human–elephant conflict inferred from field observations of Asian elephants in Sri Lanka’s National Parks

Chase A. LaDue, Rajnish P. Vandercone, Wendy K. Kiso, and Elizabeth W. Freeman

George Mason University, Fairfax, VA, USA Department of Biological Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka 3Ringling Bros. Center for Elephant Conservation, Polk City, FL, USA

Incidents of human–elephant conflict (HEC) are among the highest in Sri Lanka, where balancing human and Asian elephant (Elephas maximus) needs continues to be a challenge. HEC is seriously concerning for the conservation of this species on the island as human activity encroaches onto elephant habitat. Male elephants—especially those in musth—are commonly involved in HEC. To better characterize the environmental and social correlates of musth variation, we are studying Asian elephants in three protected areas in Sri Lanka: Kaudulla National Park, Minneriya National Park, and Wasgamuwa National Park. Our study provides the opportunity to describe the indirect behavioral and physiological consequences of HEC in our study population. In a country where most of the adult male elephants lack tusks, we rely on other physical features (e.g., ear shapes, other markings) to distinguish individuals from each other. We discovered that some of the most reliable and differentiating features were scar patterns, the majority of which we suspect are caused by bullet wounds. It is relatively common in the areas surrounding our study sites for farmers to deter elephants with firearms during crop-raiding incidents. Therefore, the number and pattern of scars on an elephant’s body may serve as a more permanent record of its crop-raiding history. Interestingly, our photographic evidence suggests that scars are found almost exclusively in male elephants, with older male elephants tending to have more than younger elephants. We also report on differences in these patterns between parks and in the location of scars on the body. Our findings support the notion that the most frequent crop-raisers are male elephants, and that even elephants who spend much of their time in protected areas (like national parks) also engage in HEC. Further analysis of our data will yield information about how male elephant behavior and physiology are influenced by relevant environmental and social factors.
Trialing a new scent-based repellent to mitigate elephant crop-raiding around Murchison Falls National Park, Uganda

Maz Robertson
WildAid

Crop raiding by African elephants (*Loxodonta africana*), like elsewhere in eastern and southern Africa, is a major challenge to communities bordering Murchison Falls Protected Area (MFPA). Communities of subsistence farmers inhabit land right up to the northern edge of the park, and elephants are now coming into daily conflict with humans, with crop raiding rife.

The “smelly elephant repellent” was invented locally by a group of students for an innovation competition, where they had been tasked with finding a solution to a local problem. The concoction comprises locally available and low-cost chili, garlic, ginger, neem leaves, eggs, and cow or elephant dung. The solution is cooked up and stored in barrels to ferment for a minimum of two to three weeks to produce a pungent-smelling liquid. The liquid repellent can be sprayed directly on crops, or hung around fields in perforated containers interspersed between on ropes between posts, making a rudimentary fence line.

The method can be deployed during the weeks approaching harvest, or at any time when crop damage from elephants is a hazard. The solid residue can be made into chili bricks and burnt, or used as an organic fertilizer. At current prices (August 2019), if all items are bought from the market (i.e. not contributed by farmers for free) the cost of ingredients and production totals USD20 for 20 litres of repellent solution; enough to protect one acre (0.4 hectares) of crops. The cost of this novel technique of protecting crops is significantly cheaper than using numerous beehives or electric fencing. It is also low maintenance, with one application per fence-line sufficient to protect crops for a whole season. Initial trials of the smelly repellent produced promising results and strong anecdotal evidence that it is effective. Trials to collect quantitative data for 30 trial farmers, to back up the qualitative evidence, are due to come to an end in October 2019. Final results are expected to show the positive impact of the repellent on safeguarding crops; of 30 trial farmers, only eight suffered no elephant damage to their crops in the season before application of the repellent, but following repellent use during the second season in 2018, 24 of our 30 trial farmers suffered no crop damage by elephants. Further work is currently being undertaken to establish sustainability mechanisms and models for the repellent, and partners are being sought to trial the repellent in other locations greatly affected by elephant crop-raiding.

Living with elephants: Herds of the Karbi Foothills

Rituraj Phukan, Secretary General
Green Guard Nature Organization

The Karbi foothills along the Nagaon- Karbi Anglong border are contiguous to the Kaziranga-Karbi Anglong Elephant Reserve. Around 200 to 300 elephants inhabit this area and these numbers are multiplied during the migrations from Kaziranga National Park. Elephants regularly intrude into human settlements in these areas in search of food or while passing through traditional *dondie*, making it one of the major HEC affected zones in Assam.

Indigenous communities living at the fringe forest areas bear the brunt of man-animal conflict, with loss of life, livestock and property. In the Karbi foothills, destruction of houses and crop fields by elephant herds is common throughout the year. Elephant depredation has caused intense distress and socio-cultural impacts and is a key factor for the impoverishment of some of these communities.

The proliferation of invasive species of vegetation have blanketed grasslands, the staple fodder for these pachyderms. Wild fruits are becoming increasing rare, likely to have been affected by changing climatic conditions. Bamboo, its tender leaves being an important fodder for elephants, are also affected, with entire groves covered by thorny invasive creepers.

Other factors attributed to climate change have also contributed to increased man-animal conflicts; changes in rainfall, water stress and heat stress and increased straying from protected areas, which also increases poaching vulnerabilities. Encroachment of forest areas has also contributed to the fragmentation and degradation of the Karbi hills wildlife habitat.

Historically, men and beast have eternally coexisted in these parts. Elephants were revered and villagers paid obeisance to the passing herds. Even now, pieces of bones from dead elephants are placed for worship in the courtyard of households to ward off evil spirits. There was a tradition of *ganeshhhog* or
hastibhog, which is the ritual offering of a part of the harvest as appeasement to passing herds. But increased intrusions and conflict has led to violent retaliation by villagers. Elephants have been targeted by poisoned arrows, intentionally electrocuted and killed from gunshot injuries. Some have been speared and others have had burning bitumen sacks thrown on to their backs.

Since 2004, Green Guard Nature Organization has been working with these communities to develop locally sustainable methods to mitigate conflict and facilitate human-elephant coexistence. Some of these tools are derived from similar initiatives in elephant range countries and modified for the landscape using locally procured low-cost materials.

The indigenously developed Early Warning System, a type of trip-wire alarm system has been effective in warning villagers of the incidence and direction of intrusion in the night. Hedge fence of citrus was tried, which would have provided significant income too, but didn’t succeed as planned. Chili repellent using two potent native chili species was also tried with mixed results. The Community Elephant Fodder Plantation programme has been motivating these communities to devote a few days for improvement of the wildlife habitat by removal of invasive vegetation and regeneration of fodder vegetation.

A crime science approach to poaching and human-elephant conflict in Uganda

Joanna Hill
Rutgers University, New Jersey, USA, International Elephant Foundation and Elephant Research Foundation M. Philip Kahl Postdoctoral Fellow

Once described by Winston Churchill as the ‘Pearl of Africa’, Murchison Falls National Park is home to some of the most diverse species of wildlife in Africa. After decades of war and poaching, wildlife populations are thriving as a result of the exceptional work of the Uganda Wildlife Authority and its partners. But now a new challenge is emerging, which is threatening to undermine conservation efforts; namely human-wildlife conflict. Elephants in particular are decimating crops that people living around Murchison rely upon for their livelihoods. Consequently, some communities are poaching elephants and other wildlife, with some of the deaths attributed to retribution killings. To that end, the Center for Conservation, Criminology and Ecology (C3E) at Rutgers University, along with IEF and its other partners, are taking a novel approach to address poaching and human-elephant conflict in Murchison by drawing upon techniques in criminology. ‘Crime science’ uses modern scientific techniques to understand criminal activities and then tries to redesign the environment to reduce crime. Drawing from specific examples, I will explain how this approach is being used to address conservation problems in Murchison, and how they might be applied to other protected areas.

Management of a conflict elephant in Rajaji Tiger Reserve release vs rehabilitation

Adita Sharma
Rajaji Tiger Reserve

A young elephant bull (15-20 years old) was reported to have killed two people in January, 2018 at border of Rajaji Tiger Reserve. Additionally, the frequent visit of the animal in human dominated area, damage of properties and subsequent human causalities was obviously responded with panic reaction by the local people which required immediate management response. Accordingly, the elephant was captured by the team from Rajaji Tiger Reserve and was transported to Rawasan Range, Rajaji Tiger Reserve on 20.01.2018. On 22.01.2018, the elephant was sedated by the Senior Veterinary Officer of Rajaji Tiger Reserve and radio-collaring was done before releasing it into wild. Its movement was monitored by a dedicated ground team and also through satellite uplink of GPS data. It was clear from the movement data that the elephant made constant effort to return to its original location, this behaviour being known as homing instinct, and it is more pronounced in the case of elephants as they are known to site-fidelity and have stronger memory for landscape features. In May, 2018, the elephant was reported to reach back to its initial capture site. As reported by the tracking team, the elephant was accosted by one adult tusker or it is possible that this young elephant followed a tusker that crossed the Ganges. In terms of home range, between the release in January 2018 and the month of May 2018 when it crossed, the elephant had maximum home range of 94 sq.km (MCP Method). Once crossed, the elephant moved towards northwest for some distance and promptly made linear movement towards Haridwar Range including the location
where it was initially captured. In the month of November 2018, it killed one more person. Human elephant conflict is a vexing problem and often poses risks to the life of the people and in many cases to the life of conflict animal itself. In such situation, few options are generally considered to help resolve the human-elephant conflicts. These are: (a) Driving the animal into the forest and active prevention/barrier, (b) capture and relocate in some other areas, (c) capture and keep in confinement for posterity or in zoo, (d) capture and train it for management purpose, (e) elimination of the problem animal and (f) enabling the communities to live with the elephant. Given that the elephant was reported to have killed the people and there was obvious human response to capture the elephant, the question of enabling the communities to live with the elephant was beyond consideration. Therefore, this time the decision was taken to capture the elephant and to rehabilitate it in the elephant camp of Rajaji Tiger Reserve instead of releasing it back to the wild to avoid further human casualties and to prevent retaliatory killing of the elephant by the people. Capturing and keeping it in confinement forever is not an option both administratively and financially but the trained captive elephants on the other hand are excellent resource for wildlife management and such individuals help conservation of key wildlife population. This was done keeping in view the safety of the individual elephant and long-term conservation of elephant and other wildlife species in the reserve.

Non-invasive assessment of body conditions and stress hormone levels in African elephant (Loxodonta africana) roaming in Fynbos vegetation

E. Carlin1*, G. Teren2, A. Ganswindt1,3

1Mammal of Natural and Agricultural Sciences, Eugène Marais Chair of Wildlife Management, Department of Zoology and Entomology, Faculty of Natural and Agricultural Sciences, University of Pretoria, Pretoria 0028, South Africa; 2Wildlife and Ecological Investments (WEI), Unit 20/21, Fountain Square, 136 Main Road, Somerset West, 7130, P.O. Box 3288, Somerset West 7129, South Africa; 3Endocrine Research Laboratory, Department of Anatomy and Physiology, Faculty of Veterinary Science, University of Pretoria, Onderstepoort, 0110, South Africa

The Western Cape Province of South Africa is characterised by Fynbos vegetation. This unique endemic vegetation type belongs to the Cape Floral Kingdom, the smallest of the six floral kingdoms in the world, and only a few provincial, national and private game reserves in this area, support populations of African elephants (Loxodonta africana). As a result, not much is known about the ability of elephants to survive in such a unique environment. External factors such as nutritional poor diets, are known to contribute to physiological stress in mammals and establishing links between these two factors, was the focus of this study.

Non-invasive monitoring of individual faecal glucocorticoid metabolite (fGCM) concentrations, as a measure of stress, was utilised to examine a herd of 13 elephants in a Western Cape Province Private Game Reserve, South Africa, during two monitoring periods (April and June 2018). In combination with fGCM monitoring, individual body condition scores (BCS) were assessed for each individual using a previously established method.

Results indicate that overall body condition scores (Apr and Jun overall median: 2.0 and 3.0, on the BCS index of Morfeld et al. 2014) and fGCM concentrations monitored during the same periods (Apr: 0.46 µg/g DW vs Jun: 0.61 µg/g DW; range Apr: 0.35 – 0.66 µg/g DW vs Jun: 0.22 – 1.06 µg/g DW), were within acceptable limits, and comparable with those reported for African elephants utilizing other vegetation types like Mopaneveld.

Our findings underline the ability of elephants to adapt to different vegetation types and, their ability to obtain adequate nutrition from Fynbos vegetation. The use of non-invasive methods to assess body condition and stress hormone levels in these animals, would assist wildlife and conservation management authorities and animal welfare practitioners, in determining ways to monitor and manage this species in environments with comparable poorer nutritional vegetation.
Exploring how mineral provision acts as a driver for African elephant movement (Loxodonta africana), and considering how this could be used to reduce Human-Elephant Conflict (HEC)

Sach, F.1,2, Buss, P.1, Dierenfeld, E.4,5, Henley, M.6,7, Langley-Evans, S.2, Swemmer, T.4, Watts, M.1, Yon, L.9
1 Inorganic Geochemistry, Centre for Environmental Geochemistry, British Geological Survey, UK fsach@bgs.ac.uk
2 School of Biosciences, University of Nottingham, UK 3 Veterinary Wildlife Services, South African National Parks (SANParks) 4 Ellen Dierenfeld LLC, Saint Louis, MO, USA 5 School of Animal, Rural & Environmental Sciences, Nottingham Trent University, UK 6 Applied Behavioural Ecology and Ecosystem Research Unit, School of Environmental Sciences, University of South Africa (UNISA) 7 Elephants Alive, P.O. Box 960, Hoedspruit 1380, South Africa 8 South African Environmental Observation Network (SAEON) 9 School of Veterinary Medicine and Science, Faculty of Medical & Health Sciences, The University of Nottingham, UK

African Elephant incursion into the Phalaborwa mine, South Africa has resulted in human-elephant conflict (HEC), elephant and human injury and income loss. It is proposed that free-living elephants are attracted to the region surrounding the mine due to the unique mineral provision resulting from the geochemistry of the soil (and plants) in the area. Soil was sampled from 93 sites surrounding the mining area and outside of the mining area (Associated Private Nature Reserves (APNR) and Kruger National Park (KNP)). Initial soil analysis data supports the hypothesis that the soil within the mining area is higher in minerals such as phosphorus than the soil outside of the mining area (APNR and KNP).

Due to an increasing human population and global intensification of agriculture, African elephants’ face increased contact and conflict with humans. Habitat reduction and fragmentation have forced elephants into increasingly smaller geographical areas, often restricted by fencing or encroaching anthropogenic activities. This causes increased pressures on these areas to meet the animals’ resource needs, presents nutritional challenges to elephants and forces elephants to adapt their movement patterns to meet their needs for specific minerals, potentially bringing them into conflict with humans.

During the first phase of this project, methods were validated by measuring mineral levels in biological samples (plasma, toenails, tail hair, urine and faeces) from UK zoo elephants alongside soil, food and water consumed. Advanced inductively coupled mass spectrometry (ICP-MS) was used to determine mineral concentrations in the samples and identify the optimum biomarkers for mineral status in elephants.

The second phase of this project (in progress) applies these validated methods to samples collected from elephants living around the mine to determine if soil and plant mineral levels from the local environmental geochemistry influenced the elephants’ movements. Assessment was also made of trace metals levels (arsenic, lead, titanium, uranium, vanadium, barium and cadmium) in elephant tissues (tail hair and blood) and their environment (soil, water and plants) around the mine to investigate if mining activities were a risk to wildlife health. The results from this study will aid in understanding drivers for specific elephant movement. This information could be used to reduce HEC around the mine and applied to other similar conflict situations internationally. This work combines environmental geochemistry, wildlife nutrition & health and human-wildlife conflict, and demonstrates how samples from captive animals can assist with research to benefit their free-living counterparts.

Glycemic response of semi-free ranging African elephants to seasonal and provisioned diets

Berkeley E.V.1,2, Ganswindt A.3,4, Hensman, S.2
1 Department of Biology and Earth Science, Otterbein University, 1 South Grove Street, Westerville, OH, 43081, USA
2 Rory Hensman Conservation and Research Unit, Bela Bela, Limpopo, South Africa 3 Endocrine Research Laboratory, Department of Anatomy and Physiology, Faculty of Veterinary Science, University of Pretoria, 0110 Onderstepoort, South Africa 4 Mammal Research Institute, Department of Zoology and Entomology, Faculty of Natural and Agricultural Sciences, University of Pretoria, 0002 Pretoria, South Africa

Introduction: This project is part of ongoing research on establishing new methods to monitor nutritional- and health-related markers in managed populations of elephants. Few studies have examined how elephants’ diets influence their physiology in the wild yet dietary mediated diseases and poor fertility are often observed in captive African elephants. The objective is to determine the variation in elephants’ glycemic response by feeding the elephants different diets and monitoring the resulting blood glucose concentrations.

Methods: Experiments were conducted from May 2017 to July 2018. Five elephants living under semi-free-ranging conditions on 500 hectares of South African veldt, were used. All elephants were trained for blood collection by venipuncture of the ear. The elephants were fed an estimated 10% of their body weight per day including free ranging in the veldt for 10 hours per day. The supplemental food varies seasonally and was
harvested daily. For each of the provisioned diet trials, a percentage of the elephants’ daily estimated energy intake was fed as pelleted grain-based wild game feed (12% EPOL Grazer Game feed, RCL Foods, Westville, South Africa), Brazilian grass (Brachiara spp.), or oats hay (Avena sativa, Maluti cultivar). The 10% glucose powder (500g) was mixed to paste consistency with water and layered on top of the hay. For each of the free-ranging trials, elephants were followed in the veldt as they selected food ad libitum. The caudal side of the ear was pricked to draw blood onto the surface. Blood glucose concentrations were measured immediately using a handheld glucose meter (AccuChek, Roche Products, Randburg, South Africa).

Results: Blood serum glucose values (n=175) ranged from 72-135 mg/dl. Results demonstrated a marked difference in glucose responses according to diet over the three-hour period. The lowest averaged zeroed serum glucose concentrations were when elephants ate native browse during the winter.

Conclusion: Glucose monitors are low-cost simple tools to monitor elephant blood glucose concentrations. Winter browse was associated with the lowest blood glucose level concentrations. These results suggest that we may be able to modify diets to better reflect what elephants eat in the wild.

Elephant habitat connectivity: corridors, gates and underpasses. elephant conservation and conflict mitigation within the Mount Kenya, Laikipia and Samburu Elephant Ranges

Enock Ochieng
Mount Kenya Trust

Mount Kenya Trust is a conservation organization that has worked with a number of partners to reduce human-elephant conflict while restoring historical migration routes for elephant. In my presentation I will provide a case study of the holistic and integrated approach Mount Kenya Trust has taken towards elephant conservation. Practical tried and tested fence construction, road ecology applications, the use of SMART and an innovative new system of one-way gates have been applied to achieve success.

The boundary of the Mount Kenya National Reserve has been increasingly fenced to provide protection to people from wildlife conflict, while this tool is effective, it also creates problems for elephant populations with migratory patterns based on seasonal, dietary and social requirements. In order to mitigate the effects of isolating populations of elephant that were linked to northern rangelands and protected areas, a number of interventions have been employed.

Recovery of Murchison Falls programme

Michael Keigwin MBE,
Uganda Conservation Foundation

By the 1960s Murchison Falls National Park, in Uganda, was recognized as one of Africa’s most famous National Parks. Then followed four decades of severe elephant poaching. The Lord’s Resistance Army was terrorizing the communities across the whole of northern Uganda including in the park. The park’s wildlife crashed in numbers, resulting in habitats changing, tourism struggling, and regional development being suppressed.

In 2012 the Uganda Wildlife Authority (UWA) and Uganda Conservation Foundation developed the Recovery of Murchison Falls strategy. Whilst attempting to counter extreme levels of poaching in the park, UWA had none of the foundations for protected area management to counter existing poaching, let alone doing it sustainably.

Ranger posts, built in the 1950s and 1960s were positioned to stop the then threat of agriculture encroaching into the park. Today’s threats were dominated by severe poaching inside the park where UWA had no permanent capabilities: no rangers based there, no transport, no communications and no equipment to support their operations. UWA only had one working vehicle in the 5000km² area, and no external support to resolve the on-going crisis. The recovery programme focused on establishing ranger posts and infrastructure in strategically important positions, establishing capabilities such as the marine ranger and veterinary response units, as well as installing digital radio platforms across the park. Over 500 rangers benefited from extensive anti-poaching training, supported by the British and US Military.

Where previously only 3% of the park was relatively well protected, the programme has regained management control of over 75% of the park, protecting and conserving wildlife and habitats on a daily basis.
Aerial survey results have shown dramatic rises in wildlife numbers in all areas. Tourism levels have exceeded all past records and inward investment into tourism is strong. With 20% of park entry fees shared with local communities, UWA’s Community Conservation department is now able to share and sponsor local projects to the tune of over $400,000 a year, up from $50,000 eight years ago. The Recovery programme, based on investing into the very basics of UWA’s capabilities, has been and continues to be a huge success for conservation of elephants, Rothschild giraffes, lions and other species, as well as regional development.

Specialized Units - selection, training and effectiveness
Nikita Iyengar
Conservation Lower Zambezi (CLZ)

Experience has shown that hand selected, higher calibre training and more specialized units such as Canine Units, Rapid Deployment Units, Intelligence Units, Marine Units, Aerial Units and Rhino Units, are significantly more effective in wildlife conservation. The selection and vetting process is critical to the success of these units. Specialized training is also crucial, with new techniques on self-defense enabling officers to learn skills to not only be efficient and covert but to also protect themselves. While poachers use more sophisticated methods, the ability to use more progressive technologies and equipment leads to more advanced ways in tackling the illegal wildlife trade. Although these units are still greatly monitored, their level of independence and decision-making is increased due to the integrity and calibre of the officers. Ultimately the use of resources and the success ratio per dollar spent is much higher than traditional (although still required) patrol teams. Since CLZ started investing in specialized units and focusing on locations around the protected area as opposed to inside it, there has been a notable increase in success rates and a decline of poaching levels in the core area.

Experiences from establishing anti-poaching canine units across Africa.
Jay Crafter
Invictus K9

Invictus K9 is a company that specializes in canine solutions for law-enforcement particularly relating to wildlife protection. Invictus K9 have established anti-poaching canine programs in six different African countries for a number of different private and government organizations and have experience working in a range of different environments each of which presents unique challenges ranging from cultural diversity to Trypsanosomiasis. Invictus K9 will be talking about various canine capabilities that can be employed for successful elephant conservation and protection and will highlight some of the challenges and considerations for establishing such programs and how those challenges can be mitigated.

Malicious poisoning of elephant within the Zimbabwean component of the Kavango Zambezi (KAZA) Transfrontier Conservation Area (TFCA)
Jessica Dawson
Victoria Falls Wildlife Trust

Over the last few years we have seen a rise in the use of toxins to maliciously poison elephant for their ivory. In the North West area of Zimbabwe (which is a part of the KAZA TFCA) cyanide is the predominant toxin found, but other toxins are being used and are readily available despite many being banned. Poisoning affects all wildlife species, and vultures are especially at risk with large numbers of mortalities at many poisoning sites. In Zimbabwe more than 135 elephant were poisoned in 2013 with cyanide in Hwange National Park, and earlier this year more than 535 vultures were killed at a poisoning site in Botswana. Poisoning has continued throughout Zimbabwe and has spread to neighboring countries and is likely to continue as poachers don’t have to risk using firearms to poach elephant when they can silently target them with toxins. This is a case study that shows current interventions. Rapid detection of toxins is important but other than cyanide, field tests for other toxins are not available. Containing the crime scene, collecting samples and evidence from the crime scene is all critical to successful management.
An assessment of using remote camera traps for Asian elephant research
Chandima Fernando, Ravi Corea
Sri Lanka Wildlife Conservation Society

There has been significant growth in the application of affordable advanced technologies for ecological research in the last two decades. A widely used technology is remote camera traps (CTs). Since their initial use in the early 1980s, camera traps have been used to study a variety of species especially carnivores. As a result, adequate data are available to evaluate the effectiveness of CTs when studying species such as carnivores. The application of CTs to elephant research is more recent and it’s growing. However, to date, no evaluation has been done to assess the effectiveness of using CTs to study elephants.

We are presenting results from three types of commonly used Passive Infrared (PIR) cameras: Xenon white flash, white LED flash and infrared LED flash gathered over 1217 trapping days studying elephants in Wasgamuwa in the Central Province of Sri Lanka from 2016 to 2019. Based on our assessment we recommend the types of elephant research that can be conducted using CTs and provide guidelines and directions for effective camera trapping while highlight some of their limitations.

Camera trapping is most suitable for elephant research at the local scale especially to: (1) monitor local movement patterns and occupancy, (2) study population parameters e.g., density, (3) monitor physical conditions of individuals, (4) study behaviours, and (5) develop solutions to mitigate human- elephant conflicts.

We have found both types of white flash cameras are the most suitable than the infrared cameras. Flash cameras are capable of taking clear pictures both during day and night and allow the identification of individual elephants. While researchers are hesitant to use white flash cameras for elephant research, our results show elephants were not alarmed by the white flash, were not camera shy and did not display camera-avoiding behaviours. However white LED flash cameras that could be used to take videos at night are avoided by elephants. Hence, such cameras are not suitable for elephant studies that require videos at night.

Cameras with fast trigger speeds (< 1 s) were not necessarily required as two white flash cameras with relatively slow trigger speeds (around 1.2 s) demonstrated low probability of missing targets. The ideal mounting height of the camera is 1.2 m off the ground with an ideal minimum and maximum detection distance of 7 and 15 m, respectively (to obtain full frame images of various size elephants, whether during the day and/or night).

Elephants did damage cameras even though they were housed in metal protective boxes. To counter these attacks, we designed a custom metal protective box with short spikes on the outer cover which has been very successful in safeguarding the cameras from elephant attacks.

Remote cameras have proved to be a very efficient method to study elephants in Sri Lanka, and we are currently using them to gather vital information about elephants for our conservation and human-elephant conflict mitigation efforts.

Collaring elephants: How they can be utilized for HEC mitigation and research
Jaco Mattheus
Global Supplies, Inc.

With increasing pressure on natural systems and the wildlife populations they support, studying the range use of wildlife, social behavior, and ecosystem utilization, as well as the human impact on these dynamics has become increasingly important. This research is a focal point in both in understanding these systems, and in informing advocacy for better protections.

Elephants, as a keystone species are also impacted by shrinking habitats. Their co-existence near human settlements has led to several Human-Elephant Conflict situations arising.

There are various technologies available to monitor elephants, their movement, and habitat utilization. We will provide an overview of how Vectronic Aerospace Elephant collars can assist researchers and managers in their respective studies and mitigation strategies.
Voluntourism’s place in conservation
Taryn Ingram-Gilson, BSc Hons. Zoology.
Director at Worldwide Experience

The last two decades have seen an increase in the ‘voluntourism’ segment of the travel industry. Typically booked as part of a ‘gap year’, summer break or career break, it appears that people are looking for more immersive travel experiences, and genuinely want to contribute toward making a positive difference. Voluntourism provides an opportunity for such travel, where generally no experience is required. Professional organisations offering these placements will provide a thorough orientation and training for volunteers, and ensure all duties are safe and supervised, forming part of a structured programme that fits into an integrated conservation plan.

A popular choice when choosing a voluntourism experience is a conservation-based option, with elephants ranking as one of the most popular animals to work with. Two elephant projects supported by several voluntourism organisations that are carrying our admirable work are: 1) the Elephant Human Relations Aid (EHRA) in Namibia, and 2) the Sri Lanka Wildlife Conservation Society (SLWCS). I will be focusing on the latter in describing how voluntourism can create tangible benefits to species like elephants, and the local communities they have contact with.

The SLWCS is one of the first organizations in the world to develop an integrated approach to Human Elephant Conflict (HEC) resolution, poverty alleviation and elephant conservation in Sri Lanka. While still continuing to address HEC issues, the programme has evolved into a multi-pronged project consisting of ecological research, capacity building, community development and sustainable development components. Volunteers here assist with activities such as elephant research, fence monitoring, socioeconomic surveys, alternative agriculture monitoring, biodiversity surveys, farming and GIS mapping. Volunteers’ efforts feed into various projects aimed at providing rural farmers with a humane method of deterring elephants from their crops, protecting carnivores, using specific technology to mitigate HEC, enhancing the health and welfare of Sri Lanka’s captive elephants, exploring the use of natural methods for reducing HEC with farmers, and protecting the marine environment, to highlight a few goals.

When voluntourism projects are operated professionally, a mutual exchange of knowledge, skills and benefits is achieved.

Initiating a voluntourism program as a sustainable economic initiative to help mitigate human elephant conflicts
Ravi Corea, Chandima Fernando, Chinthaka Weerasinghe
Sri Lanka Wildlife Conservation Society

The Sri Lanka Wildlife Conservation Society established the voluntourism program in 2002 to fulfill several objectives. The first objective was to create a citizen science program where individuals from any background could participate in wildlife research and conservation to obtain a life changing experience.

The second objective was to develop a sustainable revenue source for the Society’s operations and projects. During the Society’s formative years, it became quite evident that the Society will not be able to survive if it were to depend on donor funding alone. It became imperative to look at alternative sustainable funding sources to ensure financial security for the SLWCS. Establishing a voluntourism program seemed a sensible way to sustain the Society’s research and conservation projects by integrating a responsible ecotourism program designed around them.

The third objective was to make elephants and other wildlife valuable to the local communities alive rather than dead, by engaging, training and paying locals to be involved in their conservation together with scientists and volunteers and by developing a sustainable tourism program in the area. By engaging and working with locally recruited and trained field assistants the volunteers help to send a strong conservation message to the local communities to value and protect their environment and wildlife. Developing the voluntourism program and its expansion and growth over the past one and half decades has turned out to be one of the most successful sustainable development initiatives of the SLWCS.

When it was launched in 2002 the volunteer program hosted only two volunteers. Today there is an entirely new and unique economy that had evolved and is wholly sustained by the SLWCS’ voluntourism program. This new economic growth and development can be observed in the socioeconomic
development of local stakeholders who directly and indirectly benefit from the program. Even for the Wasgamuwa National Park the SLWCS voluntourism program provides the largest number of foreign visitors contributing tremendously to its annual revenue.

Since its small beginnings in 2002, in 2018 the program hosted 367 volunteers from 29 countries. The SLWCS voluntourism program had hosted volunteers from 59 countries since its inception in 2002.

The SLWCS volunteer program was listed in 2017 by Fodor’s Travel as one of the top 10 wildlife experiences in Sri Lanka and listed in the 100 best volunteer vacations to enrich your life written by Pam Grout and published by National Geographic. It was also listed in several editions of the Lonely Planet Guide for Sri Lanka and also listed by Wilderness Travel and the Society for Travelers Respecting Animal Welfare as one of the top ethical elephant experiences in the world.

For information about the volunteer program please visit our website www.slwcs.org or email us at: info@slwcs.org

How cancer in elephants can inform treatment approaches for humans and elephants
Lisa M. Abegglen, Wendy Kiso, Aidan Preston, Mor Goldfeder, Cristhian Toruno, Gabriela Furukawa, Bahar Shamloo, Tony Iovino, Lauren N. Donovan, Aaron Rogers, Rosann Robinson, Kathleen Noble, Marc Tollis, Elliott Ferris, Aleah Caulin, Samuel Omolo, Valerie Harris, Amy Boddy, Moses Otiende, Avi Schroeder, Dennis Schmitt, Christopher Gregg, Carlo C. Maley, and Joshua D. Schiffman
University of Utah/Huntsman Cancer Institute

Studies of comparative biology have the potential to not only increase our understanding of how different species cope with various threats to health, but also teach us how to manipulate our own cellular responses to achieve improved outcomes to those same threats. Our study of cancer across species revealed that elephants are less likely to die from cancer compared to humans. Due to their large size and long life-span, elephants would actually be predicted to develop high rates of cancer (a phenomenon known as Peto’s Paradox). However, analysis of cancer incidence across species revealed cancer incidence was not associated with size or lifespan of the animal, and the elephant stood out as an example of a very large animal with a long life-span and very little cancer. In our dataset, which includes 191 elephants, both African (Loxodonta africana) and Asian (Elephas maximus) only 4 cases of malignant cancer (2.1%) are reported. It is important to note that the majority of neoplasms seen in elephants are benign, whereas humans have a significantly higher malignant cancer rate of 39.3%. When the genome of the African elephant was analyzed to look for genetic clues to explain this cancer resistance, elephants were discovered to have many additional copies of the TP53 tumor suppressor gene. TP53, called the guardian of the genome, is a critical tumor suppressor gene mutated in over half of all human cancers. Loss of one functional allele of TP53 in germline DNA leads to a human cancer predisposition syndrome known as Li-Fraumeni Syndrome (LFS) with more than a 90% lifetime risk of developing cancer and multiple primary tumors. Functional studies comparing p53 (the protein encoded by TP53) response in elephant versus human cells revealed that this elephant TP53 amplification was associated with increased p53-mediated, DNA damage induced apoptosis in elephant cells compared to human cells. In addition to this potential mechanism of cancer resistance in elephants, we identified other genomic contributors to cancer resistance, including the FANCL gene. We are also studying if the human response to DNA damage can be altered to mimic the TP53 response that evolved in elephants. Our recent data suggests that EP53 can enhance and/or restore p53 function in a wide range of human cancers and trigger p53-mediated cell death. We expressed various EP53 proteins in a variety of human cancer cells and compared apoptosis of EP53-expressing cells to negative control protein expressing cells. We observed a significant increase in cell death of cancer cells expressing EP53 compared to negative control cells (p<0.0001 for all cell lines tested). Additional evidence suggests that elephant p53 increases cell death through a unique mechanism compared to human p53. Our results support further exploration of EP53-based cancer therapeutics. In addition, we are working to understand how rare malignant tumors develop in elephants, and we hope this work will inform therapeutic approaches to improve and extend the lives of elephants with cancer.
Molecular characterization of TP53 gene diversity in three distinct elephant populations in Kenya and evaluation of its implications in cancer resistance.

Samuel Oliech Omolo
Kenyatta University Kenya.

Cancer is a life-threatening critical disorder which increases the morbidity and mortality of any metazoan species. Although different therapeutic modalities are indicated for managing various types of cancer, eradication of cancer remains a significant challenge across healthcare professionals and scientists. Multicellular and large-sized organisms better mitigate the risk of cancer compared to small-sized and unicellular organisms a theory known as Peto’s Paradox. The African Elephant (Loxodonta Africana) remain cancer resistant, with an estimated cancer mortality of 4.81% (95% CI, 3.14%-6.49%). Understanding the complex mechanisms that govern predisposition and resistance to cancer is an area of active research interest. Hence, there has been a constant search for novel therapeutic strategies based on natural tumor-suppressing mechanisms that could alleviate cancer or eliminate the risk of cancer. This proposed research aims to explore the genetic diversity of TP53 gene in three distinct elephant populations in Kenya and to evaluate its implications in cancer resistance (which differs in phenotype, genotype, and geographic distribution) and changes in amino acid sequence that will lead to functional variation, taking into account the domains of bioinformatics, cladistics, and molecular biology. This study will examine 35-52 Individual elephants per herd in 3 distinct elephant populations across Kenya with a total population of 26,000 African elephants namely; Maasai Mara (Approx.3, 000), Tsavo East (Approx. 15, 000) and Samburu National Parks (Approx.8, 000). Drop down Biopsy darting technique will be used to collect elephant tissue samples through random stratified sampling. DNA extraction will be carried out using PureLink® Genomic DNA Mini Kit, Thermo scientific, PCR will be carried out using Rotor Gene Q Machine (Qiagen), DNA Sequencing will be carried out using (ABI Prism Genetic Analyzer®). Data Analysis will be performed using; genome assembly LoxAfr3 and reference gene ENSLAFG00000007483 for sequence analyses, BLAST, Multiple alignments using (ENSEML and NCBI Databases) and SNP Analysis using fast Structure software. The findings of the proposed research will be beneficial in understanding the dynamics of gene polymorphisms and geographic distribution of the TP53 genotypes in Elephants.

Post-natal oogenesis in the elephant: A realistic possibility
Fiona Stansfield and W.R. (Twink) Allen
"Heatherbank", Kirkcudbright, Dumfries and Galloway DG6 4HF, Scotland, Sharjah Equine Hospital, Al Atain Area, Sharjah, United Arab Emirates

Physiological highlights of the 22-month pregnancy in the elephant include a slow rate of embryogenesis and fetal development, the commencing secretion of prolactin by the implanting trophoblast around Day 45 and its stimulation of the development of multiple large accessory corpora lutea (CL) in the maternal ovariies with a resulting marked increase in peripheral plasma progestagen concentrations. The zonary placenta develops from trophoblast-covered upgrowths of lumenal epithelium-deprived endometrial stroma and it remains attached to the endometrium by a remarkably thin fibrous band through which all the maternal blood vessels pass to vascularise the placenta.

Commencing around 11 months of gestation in both male and female fetuses the gonads undergo considerable enlargement from multiplication of the progestagen-secreting interstitial cells and, in the female fetus, waves of enlargement and regression of ovarian follicles. As a consequence of this fetal folliculogenesis the newborn elephant calf has only 600,000 oocyte-containing primary follicles persisting in her ovaries, together with clumps of persisting 3-beta hydroxysteroid dehydrogenase-positive interstitial cells in which groups of cells which stain positively for the stem cell markers, Stella, Oct 4, Nanog and Lin28 reside.

Intriguingly, the ovarian follicle reserve doubles in number between 0.5 and 8 years of age, highlighting the real and very novel likelihood of postnatal oogenesis in the ovaries of prepubertal female elephant calves.
Understanding prolactin regulation and determining the efficacy of cabergoline and domperidone to mitigate prolactin-associated ovarian cycle problems in zoo African elephants (*Loxodonta africana*)

Dow T.L.1,2,4, Cross D.L.3, and Brown J.L.1

1 Smithsonian Conservation Biology Institute, Smithsonian National Zoological Park, Front Royal, Virginia, USA; 2 West Virginia University, Division of Animal and Nutritional Sciences, Morgantown, West Virginia, USA; 3 Equi-tox Inc., Central, South Carolina, USA; 4 University of Central Florida, College of Medicine, Orlando, Florida

Perturbations in serum prolactin secretion, both over and under production, are observed in zoo African elephants (*Loxodonta africana*) that exhibit abnormal ovarian cycles. Similar prolactin problems are associated with infertility in other species. Pituitary prolactin is held under constant inhibition by a hypothalamic-derived neurotransmitter, dopamine; thus, regulation via exogenous treatment with agonists or antagonists may be capable of reinitiating normal ovarian cycles. This study tested the efficacy of oral administration of cabergoline (agonist) and domperidone (antagonist) as possible treatments for hyperprolactinemia or chronic low prolactin, respectively.

Hyperprolactinemic (overall prolactin mean > 30 ng/mL), acyclic female elephants were administered oral cabergoline (2 mg, n = 4) or placebo (dextrose capsule, n = 4) twice weekly. Overall mean prolactin concentration decreased in treated females compared to controls (32.22 ± 14.75 ng/mL vs. 77.53 ± 0.96 ng/mL; P = 0.01). Interestingly, overall mean progestagen concentrations also increased slightly (P < 0.05) in treated females (0.15 ± 0.01 ng/mL) compared to controls (0.07 ± 0.01 ng/mL), but no re-initiation of normal cyclic patterns were observed. Chronic low prolactin (overall prolactin mean < 10 ng/mL), acyclic females were orally administered domperidone (2 g/day, n = 4) or vehicle (dextrose capsule, n = 4) for four weeks, followed by eight weeks of no treatment (four cycles) to simulate the prolactin pattern observed in normal cycling elephants. Overall mean prolactin concentrations increased (P = 0.005) during domperidone treatment (21.77 ± 3.69 ng/mL) compared to controls (5.77 ± 0.46 ng/mL), but progestagen concentrations were unaltered. In conclusion, prolactin regulation by dopamine was confirmed by expected responses to dopamine agonist and antagonist treatment. Although prolactin concentrations were successfully reduced by cabergoline, and domperidone initiated the expected cyclic prolactin pattern, neither treatment induced normal ovarian activity.

Variations in the circannual rhythm of musth variables in captive Asian elephants

Rajeev, T.1 and David Abraham2

1: Veterinary Surgeon, Multi-Speciality Veterinary Hospital, Kudappanakkunnu, Thiruvananthapuram, Department of Animal Husbandry, Government of Kerala, India; 2: Assistant Forest Veterinary Officer, Thrissur Division, Department of Forests and Wildlife, Government of Kerala, India.

Musth is a unique phenomenon in male Asian elephants associated with specific variations in physical, physiological and behavioural features. For the purpose of this study, we defined these variations as separate variables, which show significant differences when the elephants are in musth and classified them in three separate groups. In nine male captive Asian elephants of ages ranging from 25 to 65 years, we recorded the variables for physical, physiological and behavioural changes, at least once every month for three years. The variables for physical and behavioural changes were recorded in categorical scales while the physiological changes were recorded in continuous scale. Temporal gland discharge, urine dribbling, and engorgement of temporal gland and perineum were the variables for physical changes that were recorded. Estimated levels of serum testosterone, free testosterone and cortisol were the variables for physiological changes that were recorded. For the changes in behaviour, the variables measured were obedience and aggression to the mahouts and general public. Analysis of variables in the three groups reveal that when the elephants come into musth, physiological changes occur first, even before the behavioural and physical changes are apparent. Similarly, when the elephants come out of musth, the physiological changes wane off first, followed by the behavioural and physical changes. Individual variations in the nature and extent of changes were high and hence a generalization of the change patterns across different ages was difficult. Except for engorgement of temporal glands, all other physical changes were more apparent in older than in younger animals. The physiological changes in elephants of age 40 years and above showed regular circannual rhythms while the same in elephants of age 30 years and below
showed more irregular patterns. Serum testosterone levels showed significant differences during musth with the peak obtained value of 198 ng/ml in a musth elephant. Patterns of obedience and aggression towards the mahouts and general public were apparently similar in elephants of all ages except for the oldest elephant aged 65 years. This elephant was obedient and did not show any kind of aggression towards anyone even during peak musth. The youngest elephant aged 25 years, which never showed any sign of musth, died towards the end of the study period and revealed maturation arrest of both testes on post-mortem histopathology examination. Major limitation of the study was the missing data for physiological variables during peak musth since blood samples could not be collected during musth from aggressive animals. Our study suggests that standardization of variations in the three groups of variables for each elephant can greatly augment the traditional musth management practices in elephant range countries in Asia. A musth scorecard that describes the physical, physiological and behavioural changes during musth for individual male elephants can enhance the safety and welfare of not only the elephants but also the attending mahouts.

**Sperm motility, kinematics, morphometry and morphology of free-ranging African elephants (Loxodonta africana) over two seasons**

Ilse Luther¹², Liana Maree¹², Antoinette Kotze², Thomas Hildebrandt³, Frank Göritz³, Robert Hermes³, Gerhard van der Horst¹²⁴⁵

¹Department of Medical Bioscience, University of the Western Cape, Private Bag X17, Bellville, 7535, South Africa; ²National Zoological Garden, South African National Biodiversity Institute, PO Box 754, Pretoria, 0001, South Africa; ³Department of Genetics, University of the Free State, P.O. Box 339, Bloemfontein, 9300, South Africa; ⁴Department of Reproduction Management, Leibniz Institute for Zoo and Wildlife Research, Berlin, Germany

Assisted reproductive technology (ART) is considered part of conservation management action plans aimed at the long-term maintenance and successful breeding of endangered, captive, isolated or fragmented wildlife populations. The main objectives of ART in such populations are to maintain genetic diversity and to produce healthy offspring. Successful captive breeding and ART are dependent on the availability of high quality, fresh, chilled or frozen semen (Graham 2005; Fickel et al. 2007; Holt et al. 2007). This study aimed to address the lack of information on quantitative semen and sperm characteristics of free ranging African elephants. Nineteen ejaculates were collected from twelve free-ranging African elephant bulls by means of electroejaculation. Seven semen samples were collected in spring (season 1), at the end of the dry season, and twelve samples in autumn, at the end of the rainy season (season 2). While most elephant cows are in estrus in the rainy season and conceptions take place, it is not evident whether sperm quality also improves during this period. Assessment of semen samples included both conventional and objective techniques, such as computer-aided sperm analysis, brightfield microscopy and transmission electron microscopy. Both seasonal and individual differences in sperm quality of free-ranging African elephants were found using various statistical approaches including multivariate visualizations. Ejaculates collected during season 2 revealed higher percentages for total motility, rapid motility, kinematic parameters and acrosome coverage compared to season 1 (P < 0.05). Although similar percentages were recorded for normal sperm morphology over the two seasons, a higher percentage sperm tail defects were found in season 2 (P < 0.05). The baseline reference data and sperm parameter associations reported in this study can be used in future to predict sperm quality and potential to fertilize. It is clear that quantitative studies using CASA can detect subtle differences in sperm quality of African elephant ejaculates and should be the approach for future investigations.

**Hyperactivation as a sperm functional test in African elephant bulls**

Ilse Luther¹²³, Liana Maree¹²³, Antoinette Kotze², Gerhard van der Horst¹²

¹Department of Medical Bioscience, University of the Western Cape, Private Bag X17, Bellville, 7535, South Africa; ²National Zoological Garden, South African National Biodiversity Institute, PO Box 754, Pretoria, 0001, South Africa; ³GEOsperm, Wildlife Reproduction and Biotechnology, PO Box 3300, Brits, 0250, South Africa

Evaluation of an ejaculate should ultimately determine if it contains sufficient functional spermatozoa to effectively colonize the female reproductive tract and reach the site of fertilization. Sperm
functional testing, rather than just a standard semen analysis, is therefore recommended to assess the potential fertility of a male, especially in cases of suspected subfertility or when selecting semen for artificial reproductive technologies (ART) in wildlife populations. Hyperactivation is an important milestone spermatozoa need to achieve during capacitation. These two processes are both essential before spermatozoa are competent to fertilize the oocyte and are regulated by Ca^{2+}-signalling. Since sperm hyperactivation is characterized by high-amplitude beating of the flagellum and asymmetrical movement, such sperm swimming tracks can be detected and evaluated using computer-aided sperm analysis (CASA).

**Main Questions** - This study aimed to induce hyperactivation in African elephant spermatozoa by using media containing caffeine. In order to determine the percentage hyperactivation of each sperm population, cut-off values for various CASA parameters had to be determined, since these values are species specific.

**Experimental Design** - Ten semen samples were collected from six free-ranging, adult African elephant bulls during electro-ejaculation. Both neat semen and semen extended with egg yolk were exposed to Ham’sF10 and BO medium (containing 10 mM caffeine) using a flush technique. Semen and sperm functional analysis included assessment of semen volume, sperm concentration, CASA motility, eight kinematic parameters and percentage hyperactivation. Recorded CASA motility tracks and receiver operating characteristics (ROC) curves were used in a Boolean argument to derive potential cut-off values for discriminating hyperactivated spermatozoa.

**Main Results** - Semen samples had a mean volume of 64.6 ± 32.2 mL, a sperm concentration of 926.7 ± 665.7 x10^{6}/mL, 97.8 ± 2.8% total motility and 77.7 ± 8.3% progressive motility. Visual assessment of individual sperm swimming tracks revealed four types of motion patterns, namely straight-line, linear (intermediate), circular and starpin patterns in both Ham’s F10 and BO media. The latter two motion patterns were considered distinctive of hyperactivated sperm tracks and resulted in three kinematic parameters being selected as cut-off values. Mean percentage hyperactivation in Ham’sF10 exposed samples was 5.7 ± 6.5% (range: 0-23%), while in BO medium the mean percentage was significantly higher at 23.3 ± 10.9% (range: 4-54%).

**Conclusions** - Although semen form African elephants had high percentages of motility, there was considerable variation in the percentage hyperactivation among the ten bulls. However, caffeine stimulation resulted in most bulls displaying more than 20% hyperactivation, which is indicative of semen containing spermatozoa with fertilizing ability. Assessment of hyperactivation results in deeper insight into the functional capabilities of spermatozoa and should be considered as a diagnostic tool.

**Diagnostic imaging in elephant medicine –from eye to kidney**

*Lüders I^{1,2},

^{1}GEOlifes Animal Fertility and Reproductive Research, 22457 Hamburg, GERMANY; ^2Zoologischer Westfälischer Garten Münster GmbH, 48161 Münster, GERMANY;

Veterinary examination of elephants is not always an easy task, given the enormous size of our patients as well as their unique anatomy and physiology. Diagnostic imaging tools, such as ultrasound and endoscopy can help finding some clues for certain organ systems in elephants, such as the eyes, respiratory-, reproductive- and gastrointestinal tract. Here, I want to report on several medical cases in captive Asian and African elephants where the application of ultrasonography and flexible videoendoscopy helped in diagnosing during acute and chronic ophthalmologic, respiratory, renal or reproductive problems.

**Reproductive tract** - It is widely known that transrectal ultrasound is the tool of choice to assess reproductive health in both, male and female elephants. Additionally, vaginal endoscopy can be of value. Over the years, some interesting cases of female reproductive pathologies were collected, reaching from numerous forms of uterine content, enormous tumors to prolapsed uteri. Six Asian elephants were diagnosed with closed or open pyometra which resolved without further treatment (n=1), needed antibacterial treatment and resolved (n=2) or re-occurred (n=2), or remained as is (n=1). Diagnosis and treatment of these conditions are challenging in elephants due to their special anatomy. Vaginoscopy and ultrasound help to detect these abnormal developments.

**Urinary Tract** - Reports on renal disorders in Asian elephants rare to find in literature and any renal dysfunction may be difficult to detect. In 7 cases of renal disorders in Asian elephants, transracial ultrasound was of additional value for finding the diagnosis. The Asian elephants ranged from 22 to 52...
years and were monitored over a period of 2-5 years. Four cases were terminal and full necropsy could confirm initial ultrasonographic findings.

Transrectal assessment of the urogenital tract revealed cystitis (n=2), accumulated debris within the urinary bladder (n=3), dilated ureter (n=4), and for the kidneys: abnormal outlines (n=3), abnormal size (n=3), multiple smaller and larger cysts (n=5), prominent renal vasculature (n=5), and/or a diffuse hyperechogenicity of the parenchyma with shadowing (n=5).

Histopathology in all 4 cases showed chronic interstitial nephritis, with additional findings such as tubulonephritis and tubular mineralization; glomerulonephritis with cystic degeneration and fibrosis; pyelitis or tubulointerstitial nephrosis and global glomerulosclerosis. A combined approach including individual blood analysis data, urinanalysis and ultrasonography is key to evaluate kidney function and identify chronically ill patients.

**Ophthalmology** - Elephants appear to be prone to eye problems. Additional to common ophthalmic examinations, ultrasound can provide further information, especially in cases with corneal edema. In three Asian and one African elephant, we found a prolapsed, partially prolapsed or removed lenses, which were confirmed or diagnosed using transpalpebral ultrasound scanning. Additionally, eye chamber size and attachment of the retina could be assessed in cases were the eye background was not accessible by direct observation.

**Bronchoscopy/Gastroscopy** - During full anaesthesia or by using a mouth gag during standing sedation, endoscopy of the lungs (n=23) and stomach (n=2) were performed in Asian and African elephants. These methods allow for detection of abnormalities in the trachea and bronchi, and esophagus and stomach respectively. Stomach ulcer, lung infection and foreign bodies may be detected potentially using this way of direct visualization. In addition, samples may be received for TB testing.

**What does the elephant brain tell us about elephant behaviour?**

*Prof. Paul R. Manger*

*School of Anatomical Sciences, Faculty of Health Sciences, University of the Witwatersrand*  
*Johannesburg, South Africa*

Extant elephants are well-known to possess the largest brains of all terrestrial mammals. This large brain size has often been associated with the amorphous concepts that elephants are generally highly intelligent animals, with significant memory capacities, behavioural flexibility, and a rich emotional world – but what do studies of the brain tell us about elephants?

In this presentation I will provide a summary of our detailed studies of many portions of the brain of the African elephant, outlining what we have found that is typically mammalian, but focusing on what is actually different regarding the elephant brain compared to other mammals and how these differences, or specializations, can help us to understand elephant behaviour. Our studies of the elephant brain allow us to not only understand currently observed behaviours in greater depth, but provides clues as to potential avenues to follow in future behavioural studies of the elephants. The presentation will cover such varied topics as general intelligence, memory capacities, sleep, infrasonic vocalization, and the olfactory system. By understanding the elephant from a neural level through to behaviour, the potential for greater understanding of these animals and potentially novel aspects of behaviour that can be adapted for the purposes of conservation may come to light.

**Acts big but squeaks like a mouse: Production of Asian elephant high-frequency vocalizations**

*Veronika C. Beeck, Gunnar Heilmann, Angela S. Stoeger*  
*University of Vienna*

African and Asian elephants demonstrate great vocal flexibility by varying and combining sound sources and vocal tract pathways. Calls range from the commonly used low frequency “rumble” (fundamental frequency < 20 Hz), produced by flow-induced vocal fold vibration, to high-pitched „trumpets“, produced by a blast of air through the trunk during excitement. Call combinations, sound imitation and invention add variety to the elephants’ vocal repertoires which in their complexities are yet far from being completely understood. Recent studies confirm the biological relevance of acoustic information coding in low-frequency rumbles within their complex fission-fusion societies. Only Asian
elephants also produce high frequency vocalizations (termed squeaks or chirps) with a fundamental frequency around 1kHz. We set to study the yet unexplored underlying mechanism and social functions of these particular calls, using sound visualization (an acoustic camera) along with audio and behavioural recordings in captive Asian elephants. We model and discuss potential sound production mechanisms contrasting potential biomechanic vibratory and aerodynamic sources in oral and nasal pathways. We suggest that the variety of sound production mechanisms in elephants allows to overcome the size related limitations of laryngeal sound production to explore a frequency range spanning seven octaves. This flexibility offers a scope of potential acoustic information coding in order to coordinate complex social interactions in concordance with specific habitat sound propagation properties. Exploring and comparing vocal flexibility across elephant species helps to understand the evolutionary driving factors of acoustic communication.

Vocal flexibility in elephants

Angela S Stoeger1,2, Anton Baotic1, Veronika Beeck1, Sean Hensman2,3
1Mammal Communication Lab, Department of Cognitive Biology, University of Vienna; 2The Rory Hensman Conservation and Research Unit; 3Advances with Elephants

In the last decade clear evidence has accumulated that elephants are capable of vocal production learning. Examples of vocal imitation are documented in African savanna (Loxodonta africana) and Asian (Elephas maximus) elephants. However, these studies present vocal imitation produced by captive elephants living in socially abnormal conditions, but nothing is known about the function of vocal learning within the natural communication systems of either species. Because vocal learning is central to human speech, but is not found in any other primate we must seek a deeper understanding of vocal learning by investigating other mammals, and elephants represent an important but poorly understood example.

African and Asian elephants use vocalizations with fundamental frequencies in or near the infrasonic range (‘rumbles’) for short-distance and long-distance communication. The most remarkable species-specific difference in the vocal repertoire is the appearance of high-pitched vocalizations (chirps/squeaks and squeals) in Asian elephants, which are typically absent in the African species. The vocal repertoire of African and Asian elephants, with about 8–10 distinct call types is not particularly large, but exhibits an interesting vocal plasticity (grading between call types, call type combinations, and sophisticated, context-dependent within-call type flexibility affecting all parameters including formant frequencies).

In addition, previously undocumented vocalizations sometimes emerge mostly documented in captive elephants. These sounds appear to be vocally inventive because they are structurally unique and not socially relevant.

In this talk we are going to present first results on our current research project on elephant vocal learning and inventive abilities. We specifically suggest that vocal production learning in elephants facilitates vocal convergence leading to vocal dialects as a mechanism for creating and reinforcing social bonds among affiliated individuals of matrilineal family groups (which is investigated at the Addo Elephant National Park). In addition, we currently test spontaneous call convergence in elephants during bonding ceremonies to emphasize social bonds (with the elephants at Adventures With Elephants, facilitated by the Rory Hensman Conservation & Research Unit).

Sex differences in the play of ex situ African elephant calves (Loxodonta africana)

Robert H. I. Dale & Samantha J. Ruppert
Psychology Department, Butler University, Indianapolis, IN 46208 – USA

The purpose of this study was to determine whether the social interactions of African elephant calves ex situ would resemble those of African elephant calves in situ. We observed video-recordings of the social interactions of a pair of calves which had been conceived by artificial insemination, and were born and housed at the Indianapolis Zoo. The pair included a male calf (Ajani, b. 4 August 2000) and a female calf (Amali, b. 6 March 2000) of similar ages. We recorded 14 typical calf behaviors during the period between September 2000 and April 2003. There were about 60 sessions, with a total of more than 30 hours of observation. Ajani (the male calf) and Amali (the female calf) performed many of these
behaviors equally often. Among these sex-neutral behaviors were: trunk-over-back-from-the-side ($\chi^2 = 1.09$, n.s.), push/ram ($\chi^2 = 0.5$, n.s.), spar ($\chi^2 = 0.68$, n.s.), trunk entwine ($\chi^2 = 0.13$, n.s.), trunk-on-head ($\chi^2 = 0.07$, n.s.), and headshake ($\chi^2 = 3.6$, n.s.). On the other hand, at about one year of age, Ajani (but not Amali) started to engage in play behaviors that looked strikingly similar to the reproductive behaviors of adult male elephants: Mount ($\chi^2 = 16.13$, $p < 0.0001$), and trunk-over-back-from-behind ($\chi^2 = 10.97$, $p < 0.001$). Mounting usually followed right after the “trunk-over-back-from-behind” behavior. If Ajani started out in front of Amali, he would often shift his position to get behind her before putting his trunk on her back and mounting her. Ajani’s play-mounting persisted for several months, but declined considerably (for whatever reason) after he was two years old. It is true that male calves in situ exhibit these behaviors but, unlike Ajani, they would most likely have had the advantage of observing adult elephants mating. Ajani had never even seen another male elephant. Amali engaged in several affiliative behaviors that are also common among female African elephant calves in situ. She followed the male calf when he moved away from her ($\chi^2 = 26.26$, $p < 0.0001$) and exhibited two forms of “testing”: trunk-to-genitals ($\chi^2 = 17.29$, $p < 0.0001$) and trunk-to-mouth ($\chi^2 = 23.12$, $p < 0.0001$). Ajani performed these three behaviors very rarely. From these results, it appears that these two ex situ calves behaved in ways similar to the behaviors of in situ calves. Moreover, it appears that mounting may be a pre-programmed behavior, a modal action pattern, rather than a behavior that is acquired through social learning.

Management factors affecting adrenal glucocorticoid activity of tourist camp elephants in Thailand and implication for elephant welfare

Pakkunat Bansiddhi, Janine L. Brown, Jarawan Khonmee, Treeradab Norkaew, Korakot Ngavongpanit, Yeeerasak Punyapornwithaya, Chalamechat Songird, Chatchote Thitaram, Taweepoke Angkawanish

Smithsonian Conservation Biology Institute, USA; Chiang Mai University, Thailand; National Elephant Institute, Thailand

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 levels 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 levels 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.

A study on musth management and enrichment utilization of rescued captive Asian elephants (Elephas maximus) at Elephant Conservation & Care Centre, Uttar Pradesh, India.

Wildlife SOS

This study was conducted at Elephant Conservation & Care Centre (ECCC) situated in Uttar Pradesh, India. This centre was established in the year 2010 in collaboration with Uttar Pradesh Forest Department and Wildlife SOS. This is one of its unique kind which houses both male and female elephants mainly for treatment an life time care. These elephants are rescued from various unfavourable conditions like begging on the road, circus and temple. The study was carried out from 2010 till 2013 which includes two male elephants and four female elephants. The main objectives of this study were to understand how
to manage male elephants in musth without restraining them. Traditionally in India male elephant in musth are kept restrained until their musth period is over. They are provided with very minimal food and water to suppress the musth period to get them for work. The study was to provide enrichment to minimise the stereotypic behaviour imprinted in them. The musth elephant management was a challenging task for us to introduce as the mahouts with traditional methods usually disagree to this. The mahouts and non-mahouts working with elephants were exposed to many awareness programs and the chain free method was gradually introduced first time in the country. This also included incorporating both traditional knowledge as well as scientific techniques. This implementation was very successful as the studied elephants never injured themselves or injured any keepers during these years. Each elephant was individually observed from the time of arrival and all the six elephants showed drastic decrease in the stereotypic behaviour- (Bhola 76% to 8.4%, Maya 75% to 5.60%, Bijlee 67% to 7.50%, Rajesh 89% to 11%, Phoolkali 54% to 16% and Chanchal 26% to 15%) with the result of extensive implementation of enrichments. This technique of musth management can be a tool which will ensure the safety of both the mahout and the elephant. This can also be widely implemented throughout the country like India with a large number of captive elephants. Today the centre takes care of seven males and eighteen female elephants which have been rescued by Forest department and Wildlife SOS. This study is continued within the centre to reduce stereotypic behaviour for all the elephants housed here. This centre is also an emerging model centre in the country for awareness and training programs including mahouts, veterinary officers, biologist, forest department administrators and frontline officers.

The elephant in the room: Integrating behaviour to assess captive elephant welfare
Lisa Yon, Naomi Harvey, and Giuliana Miguel-Pacheco
School of Veterinary Medicine & Science, University of Nottingham, Sutton Bonington, Leicestershire, LE12 5RD, United Kingdom

Across the world, elephants live in captivity under a range of different conditions, and for a number of different reasons. Elephants are routinely a feature at zoological parks, and serve to attract public visitors. Across Asia and at some facilities in southern Africa, elephants are used to give rides or provide ‘encounter’ experiences (such as feeding or bathing the elephants) to visiting tourists. However, in recent years, concerns have been voiced over the welfare of captive elephants both in European and North American zoos, as well as those being used for tourist activities in Asia and southern Africa. While there is considerable contention over keeping elephants in captivity for any purpose, it is nevertheless clear that we have a moral and ethical obligation to seek to provide good welfare for those elephants that are under human care.

Welfare can be defined as the state of an individual as regards its attempts to cope with its environment (Broom, 1997). Welfare is a multifaceted construct that includes aspects of disease, injury and emotional state. Thus, evaluating welfare requires a suite of measurements combining measures of behaviour with other types of measures, such as physical health, longevity, body condition and reproductive activity. Different types of measurements are required depending on whether short-term (such as acute pain or fear) or long-term welfare challenges (such as frustration, lack of control or chronic pain) are of interest. Conducting regular quantitative assessments of welfare can enable assessment of the impact of changes in management and husbandry on the well-being of each individual animal.

A number of studies have sought to assess captive elephant welfare, using measures such as physical health, longevity, or reproductive activity. Though these are important measurements, they are not sufficient by themselves. Biometric measurements, such as heart rate or glucocorticoid levels can be valuable additions, but interpretation can be difficult. Behavioural measurement must be included alongside such assessments to enable interpretation. Behavioural data has the advantage of being relatively straightforward to collect and doesn’t require specialist facilities to analyse. However, it can be challenging and potentially quite time-consuming to collect data which accurately represents the behavioural repertoire of an individual, so it is important to use methods which are both valid and reliable.

Our own research group recently developed and validated a new Elephant Behavioural Welfare Assessment Tool which was developed for use by elephant keepers to routinely assess the welfare of their elephants. Whilst this tool was designed for monitoring the welfare of elephants in zoological parks, we believe this new tool could also be adapted for use in range countries at timber camps, reserves, tourist camps, and other captive settings in Asia and southern Africa.
Routine evaluation of welfare over time, using a standardised, validated and reliable tool to incorporate behaviour alongside monitoring of physical health and physiological assessments, will enable facilities to comprehensively monitor the welfare of their elephants, and to inform management strategies which will improve the well-being of elephants in human care.

**LITERATURE CITED**


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**Captive elephant research: towards a brighter future for African elephants in captive environments**

*Clare Padfield, Debbie Young*

*African Elephant Research Unit (AERU)*

In a shrinking world with less space for elephants, captive environments – funded by tourism – are becoming more common. At the same time, tourists are becoming more discerning in the standard of animal welfare they expect, and more aware of what good and bad welfare looks like. This presents an opportunity – and a need – for more research on captive elephants, particularly relating to their welfare.

Few people would argue that captivity in any form is ideal for elephants, but there is momentum behind the idea that captivity always means exploitation and cruelty. This notion is bad news for welfare, because it closes the door to improvement. By asking how life in captivity can be made as full and positive as possible for the animal, research can lead the pull away from chains and isolation and fear: towards ‘captive’ environments which allow elephants to have maximum choice (where they go, what they do, which social neighbors they bond with) and enable them to exhibit as much of their natural behaviour as possible, which, in turn, increases the strength of their conservation message.

Here, we present brief summaries of research conducted by AERU as examples of the potential of captive elephant studies here in South Africa. These include:

- The impacts of tourist interactions, enrichment programs and environmental/housing variables on elephant welfare, as measured by outcomes such as stereotypic behaviour, restful/restless night-time behaviour, social interactions and FGM levels
- Long-term studies of state behaviours, how these change over time (relating to the elephant’s age and social status as well as changes to their management), and how patterns can relate to welfare
- Observing natural behaviours that would be difficult or impossible to observe in free-roaming elephants, particularly behaviours that mostly occur at night, such as yawning!
- The potential for human-animal bonds between captive elephants and their handlers, and how this relates to social enrichment and improved management
- The deep and enduring emotional bonds that can form between orphaned elephants after the loss of their kin relationships, and the crucial welfare importance of respecting those bonds
- The process of rehabilitating elephants from much more restricted captive environments
- Trunk gestures, self-directed behaviours and other displacement behaviours as a potential measure for elephant anxiety or emotional discomfort, and the potential to develop this into a tool to assess captive welfare

Much of this research could already be applied globally to help improve captive welfare standards. There may be no end in sight to the expansion of humankind and the shrinking of spaces where elephants can thrive, but by asking questions now about what constitutes optimal captive welfare – how elephants express it, and how humans can create it – we can lay the groundwork for a brighter future for elephants.

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**Ecological epidemiology to optimize policy interventions for tuberculosis control in captive elephants**

*David Abraham¹ and Deepa P.M.²*

¹Assistant Forest Veterinary Officer, Government of Kerala, Office of the Divisional Forest Officer, Thrissur, Kerala, India; ²Assistant Professor, Department of Preventive Veterinary Medicine, College of Veterinary and Animal Sciences, Kerala Veterinary and Animal Sciences University, Wayanad, Kerala, India.

Ecological studies examine the factors influencing abundance and distribution of organisms in the environments in which they survive. In ecological studies, the basic units of observation are, in most cases,
groups and not individuals. In ecological epidemiology, pathogens and the diseases they cause are referred as factors influencing the distribution and abundance of the host species. Such studies thus help to identify the risk factors for disease emergence and occurrence in a population. Early identification of risk groups can provide increased surveillance to those individuals in a population at greater risk. Understanding the ecological epidemiology of tuberculosis in captive elephants will greatly help to perform a comparative evaluation of the two major types of infection risks for a captive elephant, viz., the risks of infection from diseased mahouts and that from other diseased elephants. Considering the large number of captive elephants and mahouts in southern India, this study will provide adequate sample size to examine and analyze each risk separately. All traceable in-contact-elephants and mahouts of elephants affected and not affected with tuberculosis were identified through an extensive field survey. Preliminary results suggest that the risk of infection from diseased mahouts tend to outweigh the risk from diseased elephants.

India continues to report high incidence of tuberculosis in humans. Data on prevalence and incidence of the disease among domestic and captive wild animals, especially captive Asian elephants, are often lacking. It is well-understood that all members of the Mycobacterium tuberculosis complex (MTBC) are highly host-specific and can maintain sustained host-to-host infection only in those principal hosts in which they are evolutionarily adapted. Mycobacterium tuberculosis, the major human adapted pathogen in MTBC, has no known reservoir host in any other species other than humans. In other words, eradication of spillover infections of M. tuberculosis in captive elephants cohabitating humans can be achieved only by prioritizing the prevention of spillover from diseased humans, rather than by adopting diagnosis and control measures alone in diseased elephants. Existing policies for tuberculosis control in elephants, both in elephant-range and non-range countries, however, appear to focus more on the latter. Control and prevention measures for the mahouts are only given secondary importance. Another major bottleneck in the existing policies for tuberculosis control in elephants, especially in the range countries in Asia, is perhaps the contentious issue of euthanasia of diseased elephants. Unlike in many non-range countries in Europe and North America, not only the existing religious, cultural and traditional beliefs of the native people in Asia, but also the lack of clear-cut policies on the matter, often tend to exclude euthanasia as a possible option for tuberculosis control in elephants in range countries.

Based on evidence-based results from the ecological epidemiology of tuberculosis among captive elephants in southern India, we propose to suggest changes in priorities and thereby optimize the policy interventions for tuberculosis control in elephants, especially the range countries.

Mycobacterium tuberculosis complex infection in free-ranging African elephants – novel diagnostic approaches
Michele A. Miller, DVM, MPH, PhD, Dipl ECZM (ZHM),1,4* Peter E. Buss, BVSc, MMEdVet, PhD,2 Wynand Goosen, PhD,1 Tanya Kerr, PhD,1 Candice de Waal, BSc(Hons),3 Eduard Roos, PhD,1 Anzáan Dippennaar, PhD,1 Louis van Schalkwyk, BVSc, PhD,1 Sue-Lee Robbe-Austerman, PhD,1 Konstantin P. Lyashchenko, PhD,1 Sven D.C. Parsons, BVSc, PhD,1 Rob Warren, PhD,1 and Paul van Helden, PhD1
1Department of Science and Technology/National Research Foundation Centre of Excellence for Biomedical TB Research, South African Medical Research Council Centre for Tuberculosis Research, Division of Molecular Biology and Human Genetics, Faculty of Medicine and Health Sciences, Stellenbosch University, Cape Town 8000, South Africa; 2Veterinary Wildlife Services, South African National Parks, Kruger National Park, Skukuza, 1350, South Africa; 3Department of Agriculture, Forestry and Fisheries, Skukuza State Veterinary Office, P.O. Box 12, Skukuza, KNP 1350, South Africa; 4National Veterinary Services Laboratories, Agricultural Research Service, United States Department of Agriculture, Ames, Iowa 50010, USA; 5Chembio Diagnostic Systems, Inc., 3661 Horseblock Road, Medford, New York 11763, USA

Asian and African elephants under managed care, and more recently, in range countries, have been reported with Mycobacterium tuberculosis (M. tb) infection (Abraham and Pillai, 2016; Mikota et al., 2015; Obanda et al., 2013). However, there is little information regarding the risk of infection for free-ranging populations. In national parks in India and Sri Lanka, several wild Asian elephant (Elephas maximus) bulls were found that died with severe disease associated with M. tb (Chandranaik et al., 2017; Perera et al., 2014; Zachariah et al., 2017). In contrast, on the African continent, there have only been a few reports of suspected or confirmed infection in African elephants (Loxodonta africana), primarily in animals with known human contact (Obanda et al., 2013; Rosen et al., 2017; Miller unpubl. data). Discovery of a dead free-ranging African
elephant bull in Kruger National Park from human tuberculosis has led to greater surveillance in the park (Miller et al., 2019). Findings to date suggest that infection with *M. tuberculosis* complex organisms, including both *M. tuberculosis* and *M. bovis*, may occur sporadically in the KNP elephant population, based on a confirmed case of *M. bovis* by culture and a seroprevalence of 6% (95% CI 2-12%) (Kerr et al., 2019). Therefore, new diagnostic approaches have been developed to improve detection and investigation. Adaptation of field endoscopy and trunk wash methods, combined with use of the human GeneXpert Ultra technology (Cepheid) and new culture media (TiKa) have increased the possibility of detecting infection both ante- and post-mortem. Blood-based tests that measure antigen-specific upregulation of cytokine genes also show promise as diagnostic assays. Use of whole-genome sequencing performed on isolates can provide epidemiological information, such as in the case of the Kruger elephant case in which the *M. tuberculosis* isolate was unique from other elephant isolates, but clustered in the LAM3/F11 family commonly found in human TB patients in South Africa (Nicol et al., 2005; Van der Spoel et al., 2016). These findings highlight the growing threat of human and livestock TB in wildlife globally, especially in countries with high TB burdens, and the potential consequences of ignoring principles of One Health in addressing the spill over of pathogens into wildlife.

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**LITERATURE CITED**

General anesthesia in captive Asian elephant (*Elephas maximus*) using combination of dexmedetomidine hydrochloride and etorphine hydrochloride in Thailand

Nithidol Buranapim1,2, Chatchote Thitaram1,2, Tweweeke Angkawanish1,2, Petthisak Sombutputorn3, Warangkhana Langkaphin3, Natcha Monchaivanakit3, Kankanee Kasemjai3, Kittikul Namwongprom3, Thitaya Janyamethakul4, Wanlaya Tipkantha5, Nikorn Thongtip6 and Supaphun Sripiboon6

1 Department of Companion Animal and Wildlife Clinic, Faculty of Veterinary Medicine, Chiang Mai University 50100, Thailand 2 Center of Excellence in Elephant and Wildlife Research, Chiang Mai University 50200, Thailand 3 Elephant hospital, Thai Elephant Conservation Center 52190, Thailand 4 Patara Elephant Farm, Chiang Mai 50230, Thailand 5 Bureau of conservation and Research, The Zoological Park Organization Under the Royal Patronage of H.M. The King, 10300, Thailand 6 Faculty of Veterinary Medicine, Kasetarts University 73140, Thailand

General anesthesia was performed in Asian elephants by using the combination 3.5 mg dexmedetomidine hydrochloride (1.35 – 1.37 µg/kg) and 5.0 mg etorphine hydrochloride (1.93 – 1.96 µg/kg) via intramuscular administration. The data was collected and analyzed during two times of general anesthesia procedures. Onset time of light sedation effect presented in 5 - 6 minutes after drug administration; the movement of the ears and tail reduced, vulva relaxation, eyelids were closed, relaxation of the trunk, ataxia, and animal presented lateral recumbency posture after 6 - 11 minutes of drug administration. A combination of atipamezole hydrochloride 35 mg and naltrexone 250 – 285 mg was given as a reversal agent, which was ten times the amount of dexmedetomidine hydrochloride and fifty times the amount of etorphine hydrochloride respectively. Recovery effect started from open eyelids, trunk movement, head lifting, adjusted to standing position 10 - 19 minutes, and completed full recovery 15 - 30 minutes after administration. This study showed effects of the combination of 1.35 – 1.37 µg/kg dexmedetomidine hydrochloride and 1.93 – 1.96 µg/kg etorphine hydrochloride in general anesthesia of domestic Asian elephants. The drug combination is effective to induce animal recumbency within 11 minutes.

Immobilization and transport of free-ranging African elephants

Peter Buss BVSc, MMedVet1, Michele Miller DVM, MPH, PhD2, Francisco Olea-Popelka DVM, MS, PhD3,4

1Veterinary Wildlife Services, South African National Parks, Kruger National Park, Skukuza 1350, South Africa; 2DST-NRF Centre of Excellence for Biomedical TB Research/MRC Centre for Molecular and Cellular/Biology, Division of Molecular Biology and Human Genetics, Faculty of Medicine and Health Sciences, Stellenbosch University, Tygerberg 7505, South Africa; 3College of Veterinary Medicine and Biomedical Sciences, Applied Veterinary Epidemiology (AVE) Research Group, Colorado State University, Fort Collins, CO 80523, USA; 4College of Veterinary Medicine and Biomedical Sciences, Dept. of Clinical Sciences & Mycobacteria Research Laboratories, Colorado State University, Fort Collins, CO 80523, USA

Etorphine is commonly used to immobilize elephants. However potential adverse cardiovascular effects include hypertension.1 This has been associated with development of pulmonary edema and death. Addition of azaperone to the immobilizing combination may provide synergistic effects and counteract cardiovascular effects of etorphine. However, high doses of azaperone may result in problems with large elephants recovering after immobilization.

Translocation of free-ranging African elephants may be limited by the need for specialized transport equipment, sufficient capture and veterinary staff, a helicopter, and potential complications associated with immobilization drugs and the environment (i.e., terrain, heat). This presentation will describe the requirements for immobilization and process for successfully capturing and moving free-ranging African elephants.

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LITERATURE CITED
Establishment of a first specialized elephant hospital in India
Yaduraj Khadpekar, Ilayaraja S., Arun A. Sha, Baijuraj M. V., Kartick Satyanarayan, Geeta Seshamani
Wildlife SOS

India has a centuries old history of managing elephants in captivity. The latest captive elephant census in the country estimated the captive elephant number to be around 2,400. Most of these elephants are in the custody of private owners. Other categories include elephants owned by the state forest departments, zoos and rehabilitation centres. In current times, unfortunately, many captive elephants in India face severe physical and psychological health issues. Such issues are most evident in the elephants used for begging, in circuses and even in some cases, temples; and result from poor management practices such as long hours of tethering or walking on unnatural hard surfaces, long working hours without proper rest, unbalanced nutrition and neglected veterinary management protocols.

Wildlife SOS (WSOS), a non-profit wildlife conservation and welfare organization in India, manages two elephant rescue and rehabilitation centres in the country. Captive elephants rescued by state forest departments are brought to one of these facilities for long-term veterinary treatment and care. In many cases, for lifetime care and rehabilitation. These facilities house and take care of elephants with physical disabilities, severe feet issues, joint problems, chronic wounds and abscesses, and psychological issues such as chronic stereotypic behaviours.

WSOS established a first of its kind Elephant Hospital in India in November 2018. The hospital is specially designed to cater to the veterinary needs of elephants. The team of WSOS used the experience gained from 8 years of working with rescued Asian elephants, in planning and designing this hospital. The hospital boasts of modern advanced veterinary facilities such as thermal imaging camera, wireless Digital x-ray unit, laser therapy unit, portable therapeutic and diagnostic ultrasound and a diagnostic laboratory. It also consists of facilities required for veterinary management of elephants such as a weighing scale, an Elephant Restraining Device, a hoist with padded slings to lift and move a sedated or injured elephant, as well as a hydrotherapy pool specially designed for the treatment of elephants with joint ailments such as arthritis. WSOS also created the first specialized Elephant Ambulance to transport elephants to the hospital. The ambulance is designed to transport elephants over long distances with maximum comfort for the elephants and safety and convenience for accompanying staff. The aim of the Elephant Hospital is to provide best possible veterinary management to the captive elephants in need and serve as a standard for the same in India. The hospital also has facilities for and aims to conduct training programs and workshops for elephant care professionals as well as veterinarians from India and abroad, in humane elephant management, positive conditioning and veterinary care. This presentation describes the Elephant Hospital, Elephant Ambulance and need of such facilities in India.

Treatment of lightning strike in an Asian elephant
Supaphen Sripiboon1*, Patcharida Dittawong2, Phawaran Meetipkit2, Nikorn Thongtip1, Pornchai Santhitisaree1, Weerapongse Tangjitjaroen3
1 Department of Large Animal and Wildlife Clinical Sciences, Faculty of Veterinary Medicine, Kasetsart University, Kamphaeng Saen Campus, Nakhon Pathom 73140, Thailand
2 Kasetsart University Veterinary Teaching Hospital, Faculty of Veterinary Medicine, Kasetsart University, Kamphaeng Saen Campus, Nakhon Pathom 73140, Thailand
3 Department of Companion Animals and Wildlife Clinics, Faculty of Veterinary Medicine, Chiang Mai University, Chiang Mai 50100, Thailand

An approximately 30 years old, female, captive Asian elephant (Elephas maximus) was observed to be struck by lightning. The elephant was suddenly fell down and unconscious for about 30 minutes. However, elephant surprisingly woke up and slowly stood up by herself. Muscle shivering of all four legs and body were observed. Moreover, obtundation, muscle weakness and hypersalivation were also detected; however, no superficial burn injury was noticed. Elephant was sent to admit at Kasetsart University Veterinary Teaching Hospital for further diagnosis and treatment. Physical examination revealed normal body temperature, normal pulse rate, normal gait and posture; however, the weakness of the trunk and dysphagia still presented. Blood profile analysis revealed high levels of CK (>2036 U/L) and AST (54 U/L), which indicated severe muscle damage. Blood gas analysis showed increased blood pH (7.56), low
levels of PCO$_2$ (26.4 mmHg) and low levels of PO$_2$ (83.1 mmHg). Further examination of the visual system showed positive menace and dazzle response, but negative pupillary light response on both eyes. The electrocardiogram showed prolong PQ wave, ST depress and elevated Q wave, which indicated myocardial damage.

Treatment for this elephant included mannitol for first three days and dexamethasone for first ten days. Other supportive treatment included fluid, analgesic, GI protectant, antibiotic and vitamins were also given. After twelve days of treatment, the overall condition of the elephant was improved, however trunk weakness and dysphagia still noticed. Therefore, acupuncture was applied in order to stimulate nervous function. The electric-acupuncture (EA) was conducted at 4 Hz for 40 minutes at these following acupoints; DaFungMen, Feiman, GV14, ST2, GB20, ST4, BL10, ST6, ST19, and GB21. Laser-acupuncture (LA) was also applied to the acupoints that needles and electric cables were difficult to access, which included LI10, LI11, LI4, HT7, PC6, SP10, GB39, ST36, BL15, BL17, BL20, BL21, and Baihui. The EA and LA were conducted every other day. In addition, aqua-acupuncture (AqA) which was an injection of 5 ml vitamin B complex into acupoints (BL15, BL17, BL20, and BL21) was applied once a week.

After one session of acupuncture, elephant was able to pick up her food and deliver into her mouth. After ten sessions of acupuncture, elephant was able to eat roughage and drink normally. The ECG was re-examined on Day18 and Day34, which revealed the reduction of PR interval and the decreased of ST elevation, indicated that cardiac function was started to recover. Blood profile was routinely checked and showed the continuously decreasing of CK levels, which returned to normal range on Day31. The elephant was discharged on Day39. Ten tablet of vitamin B complex was continue given daily for one month. No relapsed of clinical signs were reported.

An emerging threat for Sri Lankan elephants (Elephas maximus maximus) and management of “jaw-bomb” victims.

1V.P.M.K. Abeywardana, 1B.V.Perera, 1K.P.Samarakoon, 1S.Gamage, 2D.S.Kodikara

1Elephant Transit Home, Udawalawa, Department of Wildlife Conservation, Sri Lanka; 2New Vet Animal Clinic, Nugegoda, Sri Lanka

Being a subspecies of Asian elephant whose population has declined by at least 50% over the last three generations (Choudhury, A. et al. 2008), primarily threatened by habitat loss and the conflict, Sri Lankan elephant (Elephas maximus maximus) is listed as ‘endangered’ under the IUCN list.

“Jaw bomb” or locally called “Hakka-patas” is a homemade small explosive that is used by poachers and local villagers for small mammal killing with common intentions of hunting and pest removal as in wild pigs. It contains gun powder wrapped with small metal pellets or stone particles and kept hidden with edible items for targeted animals (Gunathilake, K.M.T.B. et al. 2005). While exploring and grazing elephants mistakenly encounter with these explosives and encouraged to unfortunate bite resulting in severe extensive trauma to bones and soft tissues of its oral cavity leading to chronic starvation, mass dehydration and ultimately painful prolonged death experience.

Recorded deaths over “Jaw bomb” incidents in 2018 is 64 (n=64) and total recorded deaths from 2010 to 2018 is 364 (Department of Wildlife Conservation (DWC) data), including higher rates of juvenile victims and therefore considered as one of the emerging threats that actively contributed to decline of Sri Lankan wild elephant population over the last decade.

As the authorized organization for veterinary care of wild elephants, island wide Health Units of DWC have managed the survival of three victims of jaw bombed elephants out of total of….. Elephants, specifically diagnosed and accessed by professionals for further treatments. Prognosis of victims is highly depended on factors as the extent of the damage, size of the animal and the time lap between the injury and rescue. According to clinical case studies most of the victims resulted in multiple complicated mandibular fractures associated with severe injuries to tongue, teeth and soft tissues, in which correction of traumatic injuries and provision and maintenance of required nutrition and hydration status are drawn in equally leveled essential treatment plans for success. Therefore, treatment and management of jaw bombed victims is considered as a significant veterinary challenge in Sri Lankan wild elephant conservation present.

LITERATURE CITED

Animal Care & Welfare Index: A protocol combining ethical reasoning and scientific assessment for the welfare of captive elephants in South Africa
Barbara de Mori\textsuperscript{1}, Gregory Vogt\textsuperscript{2}, Keith A. Ramsay\textsuperscript{3}, Simona Normando\textsuperscript{1}
\textsuperscript{1}Department of Comparative Biomedicine and Food Science - Padua University, Italy; \textsuperscript{2}Conservation Guardians, South Africa; \textsuperscript{3}Department of Agriculture Forestry and Fisheries, South Africa - former Scientific Manager, Animal Production.

Over 120 elephants, defined as ‘captive’ in the South African Elephant “Industry”, are involved in elephant experiences for tourists. The project presented here aims to objectively define captive elephants’ care and welfare requirements on the basis of validated scientific data. For this purpose, this contribution describes a protocol (Elephant Care & Welfare Index System) merging scientific assessment and ethical reasoning to evaluate care and welfare in captive African elephants.

The protocol for the “on-facility” assessment of elephant care and welfare is designed combining four methods:
1. an experts consensus approach based on a Delphi and an Ethical Delphi procedure;
2. a correlational approach: to highlight correlation between characteristics of the facilities and animals-based output related to welfare; including a genetic study of captive population assessing suitability of social groupings;
3. an experimental approach identifying behavioral correlates of positive and negative mental states in elephants, using detailed analysis of the behavior expressed during situations, whose emotional value has already been established using avoidance/motivation paradigms. Preference/motivation tests could be also scheduled to assess the elephants’ perception of items found to be worth investigating in other parts of the project. Possible pessimistic cognitive bias will also be assessed.
4. an Ethical evaluation process in order to establish and evaluate all the relevant stakeholders’ viewpoints in the South African elephant industry. This is of paramount importance in calibrating the “on farm” assessment protocol for practical use and to increase compliance.

The main aims of the Elephant Care &Welfare Index are:
• merging science and ethics for the development and validation of an Elephant Care &Welfare Index Protocol for “on facility” scientific assessment of the welfare conditions of captive elephants in South Africa;
• the involvement of all stakeholders of the elephant industry in an “ethical oriented” reasoning and decision-making process aimed at highlighting the relevant viewpoints and reaching a consensus on the welfare standards to be granted to elephants and their care.

It is thus important that all stakeholders involved in decisions concerning these elephants strive to understand broad principles of elephant management, including managing the entire population rather than per facilities, and the broad consequences of the choices at play. This is one of the main reasons for which the ethical evaluation process involving all stakeholders is part of the devising of the Elephant Care &Welfare Index, where the involvement of all stakeholders is likely to promote compliance with a process by people who feel they had contributed to write them.

An ethical evaluation process requires also to include all the relevant aspects of care and welfare in the assessment process, including positive emotional aspects and mental states, and to prioritize animal based outputs, which represent the animals’ point of view, over resources related inputs, when selecting indicators to evaluate how animals respond to the conditions we make them live in. For these reasons the protocol is based on different methods that are confronted each other to reach an overall understanding of the care and welfare needs of the animals involved.

Preliminary results are detailed.

Developing standards for management and welfare of elephants in human care in Zimbabwe: ZECA
Jake Rendle-Worthington
We Are All Mammals

There are several hundred elephants across Southern Africa in Human care. These animals live in situations that are supported either by tourism, private ownership or programs intended for release into wild type areas. Due to rising pressures from human populations in the region, changes of attitudes to conservation from governments, wild populations are under threat. Many of the elephants that have come
into human care in the region have done so due to culling programmes, drought operations and/or being found orphaned, although some have been captured for the purpose.

The tourism industry, which has successfully supported many of these animals, has come under increasing pressure due to animal welfare concerns, some with justification and some without. Despite numerous attempts over the last 2 decades, the industry has failed to create standards for management and welfare to prove the welfare status of these elephants and address such concerns. There has been a need for such standards and joined up thinking amongst those caring for elephants to provide a viable future for these animals. An initiative to address this need, which has been developed over two and a half years, is presented here.

Various stakeholders, important to the welfare and sustainable management of elephant in human care in Zimbabwe and neighbouring countries, have engaged with this initiative. These stakeholders have been identified as belonging to 3 different categories:

- **Elephant Owners/Operators/Caregivers** - those who have a day to day duty of care for these elephants and financial responsibility;
- **Veterinarians and Welfare Inspectors** - those to whom welfare concerns are first reported or can inspect facilities with impartiality;
- **Welfare Scientists and Behaviour Experts** - who can disseminate information, assess and train both those working with elephants and those inspecting their welfare status in recognizing good and bad welfare.

Representatives of each one of these groups speaks about their contribution, challenges and roles involved in working toward these standards, from their perspective. The driver of this initiative, Kim (Jake) Rendle-Worthington, explains the history of Elephant Tourism in Zimbabwe, the need for standards, how stakeholders have been engaged, an overview of the process and what the conservation value is. The Welfare Scientist Dr. Lisa Yon, University of Nottingham and BIAZA elephant welfare working group, presents on how the guideline have been constructed and what welfare improvements have been needed. VAWZ and Victoria Falls Wildlife Trust Wildlife Vet. Dr. Chris Foggin talks about how the standards can be implemented and cross over with conservation goals in the KAZA area, and Mike Davis, CEO of Shearwater, gives his perspective as a tourism operator. and the importance of a certification process for the future of these elephants and their handlers.

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**Asian Elephant Support: Our commitment to Asian elephant conservation in 2019**

*Linda Reifschneider*

**Asian Elephant Support**

Asian Elephant Support is a non-profit conservation organization based in the United States dedicated to raise funds specifically for the conservation of Asian Elephants. The goal of our organization is to help people help Asian elephants. This presentation will give attendees an idea of the type of projects we are currently funding as well as disseminating information and making it known that Asian Elephant Support is another possible avenue of funding for their Asian elephant conservation efforts.

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**Working together for elephant conservation**

*Sarah Conley, Sean Hensman*

*International Elephant Foundation, Adventures With Elephants*

Many opinions exist about how best to manage elephants as individuals and populations as well as resolving human-elephant conflict, protecting habitat and dealing with an ever-growing human footprint on planet Earth. Elephants are found on 6 of the 7 continents existing in the wild and in human care. Therefore, in-situ and ex-situ conservation efforts for elephants must go hand in hand. It does not make sense to exclude a segment of the overall population in our efforts to protect habitat, understand elephant needs, their biology and protect them from over-consumerism due to political agendas or personal beliefs. Time to enact change is short and all conservationists should work together for the mutual benefit of the long-term survival of elephants.
African elephants \((Loxodonta africana)\) display remarkable olfactory acuity in human scent-matching to sample performance

Katharina von Dürckheim
Stellenbosch University, Private Bag X1, 7602 Matieland, South Africa

This paper presents data on the success rate of African elephants in human scent matching to sample performance. Working with equipment and protocols similar to those used in the training of police canine units in Europe, scent samples were collected on cotton squares from twenty-six humans of differing ethnic groups, sexes and ages, and stored in glass jars. Three African elephants were trained to match human body scent to the corresponding sample. In total, four hundred and seventy trials, during which the elephant handlers were blind to the experiment details, were conducted. Each trial consisted of one scent that served as the starting (target) sample to which the elephant then systematically determined a potential match in any of the nine glass jars presented. Elephants matched target and sample at levels significantly higher than indicated by random chance, displayed no loss of working memory, and successfully discriminated target odours. They also discriminated between related human individuals spanning three generations and including sibling pairs. In addition to demonstrating scent matching capabilities, this experiment proved the elephants’ significant ability to perform well at operant conditioning tasks.

Applied research to inform zoo husbandry: examples from an evidence-based approach to Asian elephant \((Elephas maximus)\) management at ZSL Whipsnade Zoo

Lewis J. Rowden, Katherine Finch, Fiona Sach
Zoological Society of London, Regent's Park, London NW1 4RY, United Kingdom

In zoo research is vital to providing knowledge to inform optimum captive animal husbandry and welfare. Although research is increasingly recognised as an essential part of modern zoo practice; there remains a disconnect between the production of research findings and the practical application of this knowledge to ensure best practice. The initial phase of a research program focusing on the Asian elephant \((Elephas maximus)\) groups housed at ZSL Whipsnade Zoo provided an opportunity to establish a more comprehensive understanding of how these animals behave. During approximately seven months of data collection, observational research documented the effects of various husbandry modifications on the behaviour and welfare of the elephants. This poster presents case studies of relevant husbandry alterations and their evidence-based outcomes; including decreased anticipatory behaviours through adjustments to browse provision and increased occurrence of natural, species-appropriate behaviours through other management changes. In these examples, research has facilitated an improved understanding of typical Whipsnade Zoo elephant behaviour, as well as the effect of planned mitigations and changes to husbandry, relevant to a 24-hour time period and different enclosure areas. It is intended that these examples of evidence-based husbandry changes will encourage the application of this approach across all zoo taxa, with the aim of providing more holistic and welfare driven animal care.

Conservation of Desert-Dwelling Elephants in Namibia – Status and Challenges

Shiweda1, 2, M., Pitoi2, C., Anastácio3, R., Pereira1, M.J.
1Departamento de Biologia & CESAM, Universidade de Aveiro, 3810-193 Aveiro, Portugal; 2EHRA Elephant - Human Relations Aid, Swakopmund, Namibia; 3AFPR – BB, Aveiro, Portugal

Elephants remain one of the world’s species classified as vulnerable in the Red List of the International Union for Conservation of Nature IUCN. In spite of poaching being regarded as the main cause, some populations, such as desert-dwelling elephants in Namibia’s hyper-arid northwest region, are vulnerable to many factors other than poaching and the threat might be higher in comparison to other populations that belong to the same subspecies, \(Loxodonta africana africana\) (the African Savannah elephant). Situations such as infant mortality or loss of life because of human-elephant conflicts and below average rainfall causing decreased food supplies are vital factors contributing to this population’s low
growth rate. Desert-dwelling elephants are considered very special due to their adaptations that help them survive a difficult existence in the world’s oldest desert. Water and food shortages, extreme weather conditions and high resource competition with human inhabitants in the pro-Namib Desert are some of their daily challenges. As they strive to survive, conflict with the local farmers escalates as both try to make ends meet. This work was compiled by reviewing numerous research papers on the life challenges of desert-dwelling elephants. Sharing water with local people and veld (rangeland food resources) with a large number of livestock appeared the main drivers of conflict.

Odor mediated navigation and scent trail tracking in African elephants
Katharina von Dürckheim
Stellenbosch University, Private Bag XI, 7602 Matieland, South Africa

The ability of animals to track or follow scent trails is fundamental to their ethology: it enables animals to navigate their territory, avoid danger, find food and identify offspring or mates, requiring only faint olfactory molecules to do so. Elephants are primarily olfactory animals as evidenced by their well-developed olfactory system, large olfactory bulb, and impressively high number of olfactory receptor genes. While there has been growing interest in the olfactory and cognitive ability of African and Asian elephants, scent trail tracking has not ever been studied in a controlled environment. Here we show that African elephants can track human scent trails. We created a behavioural task whereby three elephants were trained to ground track human scent trails across various temperatures, humidity, wind and substrate gradients in order to localise a food reward. Elephants navigated the scent trails in an open environment using naturally fluctuating ground borne odor cues as elephant positions were recorded in real time. Results showed that i) elephants can accurately scent track a human odor tail and ii) elephants are able to discriminate between two types of scent trails – the original trail, and a distractor trail laid half an hour later by a different person. To generate odour-mediated orientation, we trained elephants using operant conditioning procedures and trail laying methodologies adapted from forensic protocols for military sniffer dogs (SWGDOG). This is the first study to demonstrate that elephants can successfully discriminate between and track human scent trails.

Porcine zona pellucida vaccine immunocontraception of African elephant (Loxodonta africana) cows: A review of 22 years of research
Hendrik J. Bertschinger¹, Audrey Delsink², J.J. van Altena³, Jay F. Kirkpatrick⁴
¹Department of Production Animal Studies, University of Pretoria, South Africa; ²School of Life Sciences, University of KwaZulu-Natal, South Africa; ³Global Supplies, Gauteng, South Africa; ⁴The Science and Conservation Center, Billings, United States

Background: The native porcine zona pellucida (pZP) vaccine has been successfully used for immunocontraception of wild horses, white-tailed deer and approximately 90 zoo species for more than 25 years.

Objectives: To provide proof of concept and test contraceptive efficacy of pZP in African elephants. Once completed, test the population and behavioural effects on cows in the Greater Makalali Private Game Reserve (GMPGR). Following the GMPGR, test efficacy, population effects, safety and reversibility in 25 reserves with populations ranging from 9 to 700 elephants.

Method: Histological sections were reacted with anti-pZP antibodies to provide proof of concept. From 1996 to 2000, 21 and 10 cows were treated with pZP vaccine in the Kruger National Park (KNP) and monitored for pregnancy. Population effects of pZP with Freund’s adjuvants (three vaccinations in Year 1 with one annual booster) were studied on 18 cows in the GMPGR. Another six game reserves with a total of 90 cows were added to the project. The project was then expanded to include another 18 reserves.

Results: Binding of anti-pZP antibodies to elephant zona proteins was demonstrated in vitro. The KNP provided efficacy results of 56% and 80%, respectively. The contraceptive efficacy in the GMPGR and additional six reserves was 100% following calving of pregnant cows. Safety and lack of impact on social behaviour were demonstrated. In larger populations, efficacy was > 95%.
**Conclusion:** Contraceptive efficacy and safety of pZP vaccine could be demonstrated in small to large populations. The methodology is now being implemented in approximately 800 cows on 26 reserves across South Africa.

**LITERATURE CITED**
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<tr>
<th>NAME – FIRST</th>
<th>NAME - LAST</th>
<th>EMAIL ADDRESS</th>
<th>AFFILIATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lisa</td>
<td>Abegglen</td>
<td><a href="mailto:lisa.abegglen@hci.utah.edu">lisa.abegglen@hci.utah.edu</a></td>
<td>Huntsman Cancer Institute</td>
</tr>
<tr>
<td>Malaka</td>
<td>Kasun</td>
<td><a href="mailto:mkasuns@gmail.com">mkasuns@gmail.com</a></td>
<td>Elephant Transit Home</td>
</tr>
<tr>
<td>David</td>
<td>Abraham</td>
<td><a href="mailto:dr_da@hotmail.com">dr_da@hotmail.com</a></td>
<td>Assistant Forest Veterinary Officer, Government of Kerala</td>
</tr>
<tr>
<td>Twink</td>
<td>Allen</td>
<td><a href="mailto:twinkallen100@gmail.com">twinkallen100@gmail.com</a></td>
<td>Sharjah Equine Hospital</td>
</tr>
<tr>
<td>Pakkanut</td>
<td>Bansiddhi</td>
<td><a href="mailto:pakkanut.vet@gmail.com">pakkanut.vet@gmail.com</a></td>
<td>Chiang Mai University</td>
</tr>
<tr>
<td>Veronika</td>
<td>Beeck</td>
<td><a href="mailto:veronika.beeck@univie.ac.at">veronika.beeck@univie.ac.at</a></td>
<td>University of Vienna</td>
</tr>
<tr>
<td>Elizabeth</td>
<td>Berkeley</td>
<td><a href="mailto:eberkeley@otterbein.edu">eberkeley@otterbein.edu</a></td>
<td>Otterbein University</td>
</tr>
<tr>
<td>Nithidol</td>
<td>Buranapim</td>
<td><a href="mailto:nithidol.buranapim@cmu.ac.th">nithidol.buranapim@cmu.ac.th</a></td>
<td>Chiang Mai University</td>
</tr>
<tr>
<td>Peter</td>
<td>Buss</td>
<td><a href="mailto:peter.buss@sanparks.org">peter.buss@sanparks.org</a></td>
<td>Veterinary Wildlife Services, South African National Parks</td>
</tr>
<tr>
<td>Elisabetta</td>
<td>Carlin</td>
<td><a href="mailto:elisabetta.carlin1985@gmail.com">elisabetta.carlin1985@gmail.com</a></td>
<td>University of Pretoria</td>
</tr>
<tr>
<td>Kerryn</td>
<td>Carter</td>
<td><a href="mailto:kerryn@elephantconnection.org">kerryn@elephantconnection.org</a></td>
<td>Elephant Connection</td>
</tr>
<tr>
<td>Sarah</td>
<td>Conley</td>
<td><a href="mailto:sconley@elephantconservation.org">sconley@elephantconservation.org</a></td>
<td>International Elephant Foundation</td>
</tr>
<tr>
<td>Ravi</td>
<td>Corea</td>
<td><a href="mailto:ravi@slwcs.org">ravi@slwcs.org</a></td>
<td>Sri Lanka Wildlife Conservation Society</td>
</tr>
<tr>
<td>Jay</td>
<td>Crafter</td>
<td><a href="mailto:mike@elephant.co.za">mike@elephant.co.za</a></td>
<td>Invictus K9</td>
</tr>
<tr>
<td>Ian</td>
<td>Craig</td>
<td><a href="mailto:ian.craig@nrt-kenya.org">ian.craig@nrt-kenya.org</a></td>
<td>Northern Rangelands Trust</td>
</tr>
<tr>
<td>Robert</td>
<td>Dale</td>
<td><a href="mailto:rdale@butler.edu">rdale@butler.edu</a></td>
<td>Butler University</td>
</tr>
<tr>
<td>Jessica</td>
<td>Dawson</td>
<td><a href="mailto:jessica@vicfallswildlifetrust.org">jessica@vicfallswildlifetrust.org</a></td>
<td>Victoria Falls Wildlife Trust</td>
</tr>
<tr>
<td>Audrey</td>
<td>Delsink</td>
<td><a href="mailto:adelsink@hsi.org">adelsink@hsi.org</a></td>
<td>University of KwaZulu-Natal</td>
</tr>
<tr>
<td>Tina</td>
<td>Dow</td>
<td><a href="mailto:tinaldow@gmail.com">tinaldow@gmail.com</a></td>
<td>University of Central Florida</td>
</tr>
<tr>
<td>Katie</td>
<td>Edwards</td>
<td><a href="mailto:katieedwards787@gmail.com">katieedwards787@gmail.com</a></td>
<td>Smithsonian Conservation Biology Institute</td>
</tr>
<tr>
<td>Melissa</td>
<td>Fayette</td>
<td><a href="mailto:mfayette@indyzoo.com">mfayette@indyzoo.com</a></td>
<td>Indianapolis Zoo</td>
</tr>
<tr>
<td>Chandima</td>
<td>Fernando</td>
<td><a href="mailto:chandimaf@slwcs.org">chandimaf@slwcs.org</a></td>
<td>Sri Lanka Wildlife Conservation Society</td>
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<tr>
<td>Chris</td>
<td>Foggin</td>
<td><a href="mailto:cfoggin@zol.co.zw">cfoggin@zol.co.zw</a></td>
<td>Victoria Falls Wildlife Trust</td>
</tr>
<tr>
<td>Rachel</td>
<td>Harris</td>
<td><a href="mailto:Rachel@desertelephant.org">Rachel@desertelephant.org</a></td>
<td>Human Elephant Relations Aid</td>
</tr>
<tr>
<td>Sean</td>
<td>Hensman</td>
<td><a href="mailto:info@efaf.co.za">info@efaf.co.za</a></td>
<td>Adventures With Elephants</td>
</tr>
<tr>
<td>Joanna</td>
<td>Hill</td>
<td><a href="mailto:joannahill@protonmail.com">joannahill@protonmail.com</a></td>
<td>Rutgers University</td>
</tr>
<tr>
<td>Lauren</td>
<td>Howard</td>
<td><a href="mailto:lhoward@sandiegozoo.org">lhoward@sandiegozoo.org</a></td>
<td>San Diego Zoo Global</td>
</tr>
<tr>
<td>Taryn</td>
<td>Ingram-Gillson</td>
<td><a href="mailto:taryn@worldwideexperience.com">taryn@worldwideexperience.com</a></td>
<td>Worldwide Experience</td>
</tr>
<tr>
<td>Nikita</td>
<td>Iyengar</td>
<td><a href="mailto:nikita@conservationlowerzambezi.org">nikita@conservationlowerzambezi.org</a></td>
<td>Conservation Lower Zambezi</td>
</tr>
<tr>
<td>Michael</td>
<td>Keigwin</td>
<td><a href="mailto:michael.keigwin@ugandacf.org">michael.keigwin@ugandacf.org</a></td>
<td>Uganda Conservation Foundation</td>
</tr>
<tr>
<td>Yadjuraj</td>
<td>Khadpekar</td>
<td><a href="mailto:yaduraj@wildlifesos.org">yaduraj@wildlifesos.org</a></td>
<td>Wildlife SOS</td>
</tr>
<tr>
<td>Chase</td>
<td>LaDue</td>
<td><a href="mailto:cladue@gmu.edu">cladue@gmu.edu</a></td>
<td>George Mason University</td>
</tr>
<tr>
<td>Nadine</td>
<td>Lamberski</td>
<td><a href="mailto:nlamberski@sandiegozoo.org">nlamberski@sandiegozoo.org</a></td>
<td>San Diego Zoo Global</td>
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<tr>
<td>Erin</td>
<td>Latimer</td>
<td><a href="mailto:latimere@si.edu">latimere@si.edu</a></td>
<td>Smithsonian National Zoo</td>
</tr>
<tr>
<td>Rebecca</td>
<td>Le Brocq</td>
<td><a href="mailto:r.lebrocq@chesterzoo.org">r.lebrocq@chesterzoo.org</a></td>
<td>Chester Zoo</td>
</tr>
<tr>
<td>Paul</td>
<td>Ling</td>
<td><a href="mailto:pling@bcm.edu">pling@bcm.edu</a></td>
<td>Baylor College of Medicine</td>
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<td>Imke Lüders</td>
<td><a href="mailto:imke.lueders@gmail.com">imke.lueders@gmail.com</a></td>
<td>GEOlifes</td>
<td></td>
</tr>
<tr>
<td>Ilse Luther-Binoir</td>
<td><a href="mailto:ilseluther@gmail.com">ilseluther@gmail.com</a></td>
<td>University of the Western Cape</td>
<td></td>
</tr>
<tr>
<td>Radhika Makecha</td>
<td><a href="mailto:radhika.makecha@eku.edu">radhika.makecha@eku.edu</a></td>
<td>Eastern Kentucky University</td>
<td></td>
</tr>
<tr>
<td>Paul Manger</td>
<td><a href="mailto:Paul.Manger@wits.ac.za">Paul.Manger@wits.ac.za</a></td>
<td>University of Witwatersrand</td>
<td></td>
</tr>
<tr>
<td>Liana Maree</td>
<td><a href="mailto:lmaree@uwc.ac.za">lmaree@uwc.ac.za</a></td>
<td>University of Western Cape</td>
<td></td>
</tr>
<tr>
<td>Jaco Matheus</td>
<td><a href="mailto:jaco@globalsupplies.co.za">jaco@globalsupplies.co.za</a></td>
<td>Global Supplies</td>
<td></td>
</tr>
<tr>
<td>Amelia Meier</td>
<td><a href="mailto:ameliacmeier@gmail.com">ameliacmeier@gmail.com</a></td>
<td>Duke University</td>
<td></td>
</tr>
<tr>
<td>Michelle Miller</td>
<td><a href="mailto:miler@sun.ac.za">miler@sun.ac.za</a></td>
<td>Stellenbosch University</td>
<td></td>
</tr>
<tr>
<td>Kari Morfeld</td>
<td><a href="mailto:karimorfeld@yahoo.com">karimorfeld@yahoo.com</a></td>
<td>Elephant Population Management Program</td>
<td></td>
</tr>
<tr>
<td>Medha Nayak</td>
<td><a href="mailto:medha.nayak@niser.ac.in">medha.nayak@niser.ac.in</a></td>
<td>National Institute of Science Education and Research</td>
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</tr>
<tr>
<td>Enock Ochieng</td>
<td><a href="mailto:eochieng@mountkenyatrust.org">eochieng@mountkenyatrust.org</a></td>
<td>Mount Kenya Trust</td>
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<tr>
<td>Samuel Omolo</td>
<td><a href="mailto:mozomolo@gmail.com">mozomolo@gmail.com</a></td>
<td>Kenyatta University</td>
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</tr>
<tr>
<td>Clare Padfield</td>
<td><a href="mailto:research@aeru.co.za">research@aeru.co.za</a></td>
<td>African Elephant Research Unit</td>
<td></td>
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<tr>
<td>Mário Jorge V. Pereira</td>
<td><a href="mailto:mverde@ua.pt">mverde@ua.pt</a></td>
<td>Departamento de Biologia</td>
<td></td>
</tr>
<tr>
<td>Cheryl Cheah</td>
<td><a href="mailto:ccheah@wwf.org.my">ccheah@wwf.org.my</a></td>
<td>WWF-Malaysia</td>
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<tr>
<td>Rituraj Phukan</td>
<td><a href="mailto:rrajphukan@gmail.com">rrajphukan@gmail.com</a></td>
<td>Secretary General, Green Guard Nature Organization</td>
<td></td>
</tr>
<tr>
<td>Baiju Raj</td>
<td><a href="mailto:baiju@wildlifesos.org">baiju@wildlifesos.org</a></td>
<td>Wildlife SOS</td>
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<tr>
<td>T. Rajeev</td>
<td><a href="mailto:rajeev_pranavam@yahoo.co.in">rajeev_pranavam@yahoo.co.in</a></td>
<td>Kerala Animal Husbandry Department</td>
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<tr>
<td>Linda Reifschneider</td>
<td><a href="mailto:lwreifschneider@sbcglobal.net">lwreifschneider@sbcglobal.net</a></td>
<td>Asian Elephant Support</td>
<td></td>
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<tr>
<td>Jake Rendle-Worthington</td>
<td><a href="mailto:jake@weareallmammals.org">jake@weareallmammals.org</a></td>
<td>We Are All Mammals</td>
<td></td>
</tr>
<tr>
<td>Marion Robertson</td>
<td><a href="mailto:robertson@wildaid.org">robertson@wildaid.org</a></td>
<td>WildAid</td>
<td></td>
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<tr>
<td>Fiona Sach</td>
<td><a href="mailto:fsach@bgs.ac.uk">fsach@bgs.ac.uk</a></td>
<td>British Geological Survey and University of Nottingham</td>
<td></td>
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<tr>
<td>Aditi Sharma</td>
<td><a href="mailto:aditis2013@gmail.com">aditis2013@gmail.com</a></td>
<td>Rajaji Tiger Reserve, Uttarakhand Government</td>
<td></td>
</tr>
<tr>
<td>Edgar Simulundu</td>
<td><a href="mailto:edgar.simulundu@unza.zm">edgar.simulundu@unza.zm</a></td>
<td>The University of Zambia</td>
<td></td>
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<td>Supaphen Sripiboon</td>
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<td>Kasetsart University</td>
<td></td>
</tr>
<tr>
<td>Angela Stoeger</td>
<td><a href="mailto:angela.stoeger-horwath@univie.ac.at">angela.stoeger-horwath@univie.ac.at</a></td>
<td>University of Vienna</td>
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<td>Tarsh Thekaekara</td>
<td><a href="mailto:tarsh@thesholahtrust.org">tarsh@thesholahtrust.org</a></td>
<td>The Shola Trust</td>
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<td>Chiang Mai University</td>
<td></td>
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<tr>
<td>Greg Vogt</td>
<td><a href="mailto:greg@conservationguardians.co.za">greg@conservationguardians.co.za</a></td>
<td>Conservation Guardians</td>
<td></td>
</tr>
<tr>
<td>Lynn Von Hagen</td>
<td><a href="mailto:lvonhagen@comcast.net">lvonhagen@comcast.net</a></td>
<td>Auburn University</td>
<td></td>
</tr>
<tr>
<td>Christina Winter</td>
<td><a href="mailto:christin@desertelephant.org">christin@desertelephant.org</a></td>
<td>Human Elephant Relations Aid</td>
<td></td>
</tr>
<tr>
<td>Lisa Yon</td>
<td><a href="mailto:Lisa.Yon@nottingham.ac.uk">Lisa.Yon@nottingham.ac.uk</a></td>
<td>University of Nottingham</td>
<td></td>
</tr>
</tbody>
</table>
Finding a future for elephants in a changing world

The story of north Kenya’s community conservancies
The birth of community conservation 1990
Why communities?
Space & Politics
New Sector in Conservation
Can we really conserve at scale without communities?
Historic challenges

Ethnic conflict
Illegal Firearms
Rampant Poaching
The community conservancy model

- Managed by a locally-elected Board and management team

Key Pillars:
- Good governance
- Peace
- Security
- Sustainable rangelands/ marine/ forest management
- Building community-led enterprise and financial services
- Wildlife conservation
Growth 1990
Growth 2004
Growth 2012
Growth 2019
39 conservancies
18 ethnic groups
4.2 million hectares

70 peace ambassadors
5 rapid response teams
768 conservancy rangers

1,228 employees
1,296 women in the northern rangelands savings & credit cooperative

6,840 through one clinic in one year
3,462 girls have been educated
97% decrease in elephant poaching
Anti-poaching in community conservancies;

Each conservancy has its own **ranger team**
**They work alongside one of five mobile, rapid-response teams** – principal of community policing

Ranger activities are shaped by a central control room (JOCC) and informed using elephant movement data.
First Line Conservancy rangers; peace & security for people and elephants.

768 community conservancy rangers across the landscape

Locally employed from the conservancies in which they operate

Trained in partnership with Kenya Wildlife Service on wildlife monitoring and anti-poaching operations
Mobile security

5 mobile, rapid response teams working on anti-poaching and stock theft

Levels of training

Levels of communication

Aircraft, tracker dogs

Multi-ethnic, representing the diverse communities they cover on patrol- soft policing
74% drop in the number of lives lost in security incidents in 2018

23% drop in the number of cattle theft cases 2017-2018
Technology for conservation

**GPS Collars** – helping shape effective conservation plans
Technology for conservation

Joint Operations and Communications Centre – a hub for intelligence and data sharing
97% reduction in elephant poaching in 6 years
**Sustainability**

Tourism; a powerful incentive

**USD 860,000** paid to conservancies in conservation fees in 2018;

A **31%** increase in tourism in 2018
Over 180 people in permanent employment in tourism

Massive growth potential

**Safari tourism creates employment & powerful conservation incentives**
Lessons learned
Strength in Partnership
Govt, NGO’s, Pvt sector,
Zoo’s
Continuity Highs with the
lows
Training
Investment in social welfare
• Healthcare
• Education
• Clean Water
Mainstream conservation
into National Development
A common sense scale able exportable replicable model
Project Orange Elephant: An Economic Solution to Mitigate Human-Elephant Conflicts: A case study from Wasgamuwa, Sri Lanka

Ravi Corea, Chandima Fernando, Chinthaka Weerasinghe, Chathuranga Dharmarathne & Akila Weerakoon
Sri Lanka Wildlife Conservation Society (SLWCS)
www.slwcs.org
Impacts of HEC:

• Rural poverty
• Social marginalization
• Food security
• Increased human mortality
• Nutrition and hygiene imbalances
• Creating obstacles to education

• Segregating families
• Gender issues
• Declining quality of life
**HEC biggest socio-economic, environmental & wildlife issue**

- **Last 10 years** – 2530 elephant deaths and 770 human deaths
- **Last 10 years average of deaths per year** – **Elephants** - 253  **Humans** – 77
Elephant & Human Deaths from 2013 to 2018 – All Island

- Elephant deaths = 1503
- Human deaths = 482
- Average of deaths per year – Elephants - ~250  Humans - ~80
Root causes?

- Conflict over subsistence agriculture is one of the leading causes of conflict

Land use change

Competition for land between human and elephants

Habitat loss
Subsistence Agriculture

- Agriculture is the least dynamic sector of the national economy.
- Forty percent of rural farmers are subsistence farmers.
- Most live in poverty and depend on government subsidies.
Economic Impacts

• The extent of crop and property damage caused to farmers by elephants is Rs.1,121.42 million (~US$10 million) per annum (Bandara & Tisdell, 2004),

The animal most affected by rural subsistence agriculture is the Sri Lankan elephant (Elephas maximus maximus). HEC creates an uncertain future for the Sri Lankan elephant.
The solution to mitigate HEC to a certain extent has to be based on agriculture.

One of the main contributing factors for HEC is agriculture.

*To identify a crop that was not attractive to elephants but had a good market demand.*
Since 2006 SLWCS has been systematically evaluating cultivating oranges to resolve HEC.

**AIM...**

To develop an alternative sustainable primary income for farmers who suffer frequently from crop raiding elephants.
Feeding Trials with elephants

Percentage frequency of food type selection within the first ten minutes

- Carrot
- Bittergourd
- Cucumber
- Pumpkin
- Minor Orange
- Jumbola
- Orange
- Banana
- Orange Leaf

Time (Seconds)
## The Economics

### Income from rice cultivation

<table>
<thead>
<tr>
<th>Activity</th>
<th>Cost in US$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land preparation</td>
<td>131.00</td>
</tr>
<tr>
<td>Seed cost</td>
<td>29.00</td>
</tr>
<tr>
<td>Seed planting</td>
<td>26.50</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>221.50</td>
</tr>
<tr>
<td>Agrochemicals: Weedicide, Pesticide, Insecticide, etc.)</td>
<td>32.50</td>
</tr>
<tr>
<td>Harvesting</td>
<td>134.50</td>
</tr>
<tr>
<td>Transport</td>
<td>16.50</td>
</tr>
<tr>
<td>Other expenses (flashlight batteries, bulbs, kerosene oil, tea, sugar, etc.)</td>
<td>55.00</td>
</tr>
<tr>
<td><strong>Total Expenditure</strong></td>
<td><strong>646.50</strong></td>
</tr>
</tbody>
</table>

- Average Yield per season: 4,400 Kg
- Government approved price per 1 kg of paddy: 0.16

**Net profit**: $57.50

### Income from orange cultivation

<table>
<thead>
<tr>
<th>Activity</th>
<th>Cost US$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land preparation step</td>
<td>5.50</td>
</tr>
<tr>
<td>Plant cost</td>
<td>0.00</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>0.00</td>
</tr>
<tr>
<td>Harvesting</td>
<td>0.00</td>
</tr>
<tr>
<td>Transport</td>
<td>0.00</td>
</tr>
<tr>
<td>Other expenses</td>
<td>11.00</td>
</tr>
<tr>
<td><strong>Total Expenditure</strong></td>
<td><strong>16.50</strong></td>
</tr>
</tbody>
</table>

- Trees: 10
- Fruits per tree: 300
- Averaged market price: 0.15
- Harvest: 300 x 10 = 3,000
- Estimates value of crop: 0.15 x 3,000

**Income**: 450

### Orange Details

<table>
<thead>
<tr>
<th>Activity</th>
<th>Value US$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trees</td>
<td>10</td>
</tr>
<tr>
<td>Fruits per tree</td>
<td>300</td>
</tr>
<tr>
<td>Averaged market price</td>
<td>0.15</td>
</tr>
<tr>
<td>Harvest</td>
<td>300 x 10 = 3,000</td>
</tr>
<tr>
<td>Income</td>
<td>450</td>
</tr>
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### Graph

- Expenditure
- Income

- Bars for rice and orange cultivation.
• In 2006 average monthly income of first POE Pilot project farmers was $18
• By 2009 average monthly income had increased by ~289% to $52.60 per month
• In 2010 average month income of POE Pilot farmers in Randunnewewa was $36
• In 2019 month mean income had increased by ~480% to $173
Elephant & Human Deaths from 2013 to 2018 – Wasgamuwa

- Elephant deaths = 17
- Human deaths = 07
- Average of deaths per year – Elephants - ~1.8  Humans - ~1.16
Elephant & Human Deaths for All Island & Wasgamuwa from 2013 to 2018

<table>
<thead>
<tr>
<th>Year</th>
<th>Elephant Deaths</th>
<th>Human Deaths</th>
<th>Averaged Property Damaged</th>
<th>Elephant Deaths</th>
<th>Human Deaths</th>
<th>Property Damaged</th>
<th>Annual % Contribution to HEC from Wasgamuwa</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>1</td>
<td>3</td>
<td>18</td>
<td>213</td>
<td>82</td>
<td>1096</td>
<td>0.46% 3.65% 1.64%</td>
</tr>
<tr>
<td>2014</td>
<td>6</td>
<td>4</td>
<td>18</td>
<td>231</td>
<td>67</td>
<td>1279</td>
<td>2.59% 3.65% 1.40%</td>
</tr>
<tr>
<td>2015</td>
<td>0</td>
<td>0</td>
<td>18</td>
<td>205</td>
<td>63</td>
<td>1120</td>
<td>0 0 1.60%</td>
</tr>
<tr>
<td>2016</td>
<td>2</td>
<td>0</td>
<td>18</td>
<td>279</td>
<td>88</td>
<td>1470</td>
<td>0.71% 0 1.22%</td>
</tr>
<tr>
<td>2017</td>
<td>5</td>
<td>3</td>
<td>18</td>
<td>256</td>
<td>87</td>
<td>835</td>
<td>1.95% 3.44% 2.15%</td>
</tr>
<tr>
<td>2018</td>
<td>4</td>
<td>0</td>
<td>18</td>
<td>319</td>
<td>95</td>
<td>n/a</td>
<td>1.25% 0 0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>17</td>
<td>7</td>
<td>108</td>
<td>1503</td>
<td>482</td>
<td>5800</td>
<td>1.13% 1.45% 1.86%</td>
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</table>
• Only three main elements to the project.
• No complex technology involved.
• Uses existing “skills” of farmers to do something totally new, possible and beneficial.
• Can be sustained by community resources.
• Sustainable, renewable and cost effective.
• Currently 314 subsistence farmers from 17 villages are in the program.
• Planted ~14,000 orange trees.

What’s next???
Flow Chart to Sustainability

- Scale up and expand project
- Cultivate 50,000 orange trees
- Establish value added and derivative production facility
- Develop POE Business Model
  - A sustainable holistic industry to replace subsistence agriculture & create coexistence

Timeline:
- Present
- 2021
- 2022
- 2025
- 2030
Conclusion

• Critically important to identify specific issues at local level

• Find the appropriate, unique solutions – need to think outside of the box

• Adapt solutions that can be implemented at a local scale

• Link direct benefits to the community

• IMPLEMENT what you promise – be willing to pay for the local community for their tolerance for wildlife
ACKNOWLEDGEMENTS

A sincere and grateful Thank you from SLWCS and the communities we work with to all who have contributed to Project Orange Elephant.

A warm and grateful Thank you to organizational partners Asian Elephant Support and the International Elephant Foundation for sponsoring us to attend the 2019 International Elephant Conservation & Research Symposium in South Africa.
A holistic conservation approach to a peaceful cohabitation of people and elephants in Namibia.
A holistic conservation approach to a peaceful cohabitation of people and elephants in Namibia.
Non-profit organization
Non-profit organization in semi-arid northwest of Namibia
Born out of the need to help people and elephants co-exist.
Born out of the need to help people and elephants co-exist.

Financed through:

VOLUNTEER project
1970

- Struggle for independence.
- Elephants fled into safer regions.
- People were moved by the government into tribal homelands.

1990
- People grew up without elephants and lost knowledge about them.
- **Elephants returned!**
- Conflicts over water escalated.
Aggression and competition over natural resources

- Fear
- Intolerance
- Deaths
- Petition to remove all elephants
Aggression and competition over natural resources
Project area:
The ephemeral river systems of Namibia
Where EHRA works:

4 main conservancies

New project area: Okongwe, Omajete, Otjiperongo regions
Population number of Ugab River and Huab River resident elephants: 60
Stress factors:
• Droughts
• Human pressure (conflicts, tourism)
• Overgrazing
• Hunting
IMMEDIATE CONFLICT RELIEF
Over 220 protection walls!
IMMEDIATE CONFLICT RELIEF

Physical Protection
Development support
IMMEDIATE CONFLICT RELIEF

- Physical Protection
- Development support
- Financial relief

SOLUTIONS

Replacement of diesel water pumps with solar pumps
Conflict relief fund

RESULTS
Complete ID manuals.

Exact counts and population breakdown in the Ugab/ Huab.

Anticipate seasonal movement.
<table>
<thead>
<tr>
<th>TODAY</th>
<th>SOLUTIONS</th>
<th>RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMMEDIATE CONFLICT RELIEF</td>
<td>RESEARCH + MONITORING</td>
<td>ID and Monitoring</td>
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<tr>
<td></td>
<td></td>
<td>Sharing info</td>
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[Interactive Map Image]
To ID elephants that people no longer can live with.
IMMEDIATE CONFLICT RELIEF

RESEARCH + MONITORING

ID and Monitoring
Sharing info
Problem elephants

To ID elephants that people no longer can live with.

Elephants that have learnt to break houses to access food.
### TODAY

**IMMEDIATE CONFLICT RELIEF**

- **RESEARCH + MONITORING**
  - ID and Monitoring
  - Sharing info
  - Problem elephants

### SOLUTIONS

- To ID elephants that people no longer can live with.
- Elephants that have learnt to break houses to access food.
- Complete footprint study.
IMMEDIATE CONFLICT RELIEF

TODAY

RESEARCH + MONITORING

- ID and Monitoring
- Sharing info
- Problem elephants
- Calf mortality/disease monitoring

SOLUTIONS

RESULTS
PEOPLE AND ELEPHANTS AMICABLY CO-EXISTING
School learners and teachers

Safety around elephants

PEACE Project
School learners and teachers

- Safety around elephants
- Understanding elephants
- Appreciate elephants

**SOLUTIONS**

**EDUCATION + LOCAL LEADERSHIP**

**PEACE Project**
IMMEDIATE CONFLICT RELIEF

RESEARCH + MONITORING

EDUCATION + LOCAL LEADERSHIP

PEACE Project

TODAY

SOLUTIONS

RESULTS

✓ Reduce fear
✓ Defend your home

Community residents
Share knowledge!  

Community residents
Respect elephants

Local tour guides
Handle elephant emergencies
<table>
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<td>RESEARCH + MONITORING</td>
<td>EDUCATION + LOCAL LEADERSHIP</td>
</tr>
</tbody>
</table>

- PEACE Project
- Elephant Guard Program

Combat conflicts!
Combat conflicts!
Local conservation leaders!
Has anything changed?
Change in attitude.
"It was amazing to be so close to the animals that people have described as dangerous. I felt very nervous but still amazed as I watched them. Then, after some time, I felt at peace as if I am one with them."

Otjiperongo Teacher
Thank you!

Rachel@desertelephant.org  |  Christin@desertelephant.org

www.ehranamibia.org
A STORY TO SHARE

THE JUMBO JUGGLE
A conservation quandary
Medha Nayak Illustrations: Udaya Sanakar T

I am Ravi from Hatimunda village in Odisha. Like many others in the village, my life too changed due to the famed 'jumbo' episodes. State government aid for house and crop loss was delayed, in any case, it was insufficient to recover all losses. My father, a poor farmer and seasonal labour had a tough time in making ends meet. During those days, one of my uncles worked in the nearby town of Balasore. On my mother's request, he brought me along. I started working in a hotel there—washing dishes and waiting tables. I had no option but to work as efficiently as possible; after all, I had to supplement my father's meagre earnings. Befriending some co-workers of my age helped me acclimatise to the new world in which I was left to venture alone. Even the change of place and life couldn't take away those huge, dark shapes with long tusks that had made a permanent space in my mind.

Makar Sankranti, one of the harvest festivals in Odisha, was close when I requested my master for a few days of vacation. Surprisingly, he nodded in affirmation. The joy of home-coming was accentuated by the familiar sights and smell of the Sal (Shorea robusta) dominated mixed forests on either side of the road. As I de-boarded the bus, I desperately scanned for known objects which were once dear to me. Near the bus stop a forest department board, coloured in red and green, suddenly caught my attention. I went down memory lane recalling the life-altering event from a couple of years ago.

On that fateful day we school kids were discharged early from school. I considered all possibilities for this sudden closure and suspected a cyclone warning as the reason or an outbreak of fire. We headed to the playground, only to halt our steps on seeing about thirty elephants on the football field. They were gargantuan and dark brown in colour. Until that day it was only 'E' for 'elephant' that I had rote-learnt in school. I pinched myself to be sure if it was real and galloped home for life. Breathing with convulsive gasps, I staggered to my parents "E...E...E...Elephants."

I was aware that we lived about ten kilometers from Kuldiha Wildlife Sanctuary, an elephant sanctuary, but in those seven years of my stay there I had never seen even one elephant. Everyone in the village gathered
THE ASIAN ELEPHANTS

• In South and South-east Asia.

• Listed as Endangered on the IUCN Red list.

• Appears on Appendix 1 of CITES (Convention on International Trade of Endangered Species of Wild Fauna and Flora).

• Protected under Schedule-I species on WPA, 1972 of India.

• 2017 Elephant Census: 27,312 elephants in India.

• Highest population in Karnataka (6,049) and Odisha has 1976.
HUMAN ELEPHANT RELATIONS

• **Mutually entangled** social, historical, and ecological relations (Locke, 2016; Keil, 2016).

• **Complex and contrasting interactions** (Sukumar, 2016; Locke, 2016).

• **Humans consider Asian elephants as** (Locke, 2016): emblems of prestige, cohabitants, vehicles of labour, objects of entertainment, God.....

• Elephants appear extensively in **art, architecture and history** of Odisha (Swain, 2008).

---

* Piers Locke and Jane Buckingham (eds.). Conflict, negotiation and coexistence - Rethinking human-elephant relations in south Asia. New Delhi, India: Oxford University Press.
TROUBLE IN PARADISE
• Highlighted relationship - conflict and struggle.

• Cultural-ecological explanations for increasing HEC (Thekaekara, et.al. 2016, Sukumar 1986, Sar et. al. 2006).

• Loss on both sides of Humans and elephants (Lenin & Sukumar, 2011).

• Humans bear the “visible” costs and “hidden” costs of HEC (Ogra, 2008).

• The major sufferers are people belonging to the low-income groups.

• For mitigation the government spends hefty amounts.

STUDY AREA
OBJECTIVES

• To measure the severity and understand reasons of elephant issue in Balasore.

• To explore stakeholders responses to elephant issues

• To assess the effectiveness of deterrents.

• To understand what contributes to conservation and coexistence attitude towards elephants.

• To suggest ways to mitigate HEC.

IN PROGRESS....
## METHODS

<table>
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<tr>
<th>Stakeholders/ Respondents</th>
<th>Themes of discussion</th>
<th>Methods of data collection</th>
<th>Method of data analysis</th>
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<tbody>
<tr>
<td>Local community-</td>
<td>• Perceptions about</td>
<td>Qualitative data was</td>
<td>Thematic content</td>
</tr>
<tr>
<td>Around 100 adults and</td>
<td>elephants</td>
<td>obtained using:</td>
<td>analysis</td>
</tr>
<tr>
<td>about 60 children (7-15</td>
<td>• Reasons for their</td>
<td>• Semi-structured</td>
<td></td>
</tr>
<tr>
<td>years)</td>
<td>coming</td>
<td>interview by taking aid of</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Reasons for</td>
<td>an interview guide and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>conflict</td>
<td>Focus group discussions.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Experiences and</td>
<td>• Non-participant</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Responses to HEC</td>
<td>observation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Effectiveness of</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>deterrents</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Challenges</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Conservation ethos</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Expectations</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Staffs of forest</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>department-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Twelve male and six</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>female staffs.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
During the period 2010-18, elephants caused Crop loss on 2632.7 acres, 675 house damage, six humans died and ex-gratia of Rs. 2,81,60,320 has been paid so far.
## GENERAL PERCEPTION

<table>
<thead>
<tr>
<th>STAKEHOLDERS</th>
<th>PERCEPTIONS ABOUT ELEPHANTS</th>
<th>REASONS FOR THEIR COMING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>Wild-animals and Gods</td>
<td>Lack of food and water, Maoist/Naxalite activity in forest</td>
</tr>
<tr>
<td>Women</td>
<td>Gods</td>
<td>Lack of food and water</td>
</tr>
<tr>
<td>Forest staff</td>
<td>Wildlife, victim and few said God</td>
<td>Habitat loss and degradation, mining, stone quarries, climate change, change in lifestyle, increasing population of elephants and humans, human-induced development infrastructure.</td>
</tr>
</tbody>
</table>

![Image of elephant figures]
# EXPOSURE, EXPERIENCE & EXPECTATIONS

<table>
<thead>
<tr>
<th>STAKEHOLDERS</th>
<th>DURING AND POST ELEPHANT ISSUE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Men</strong></td>
<td><strong>Make shelter</strong> for family on trees. <strong>Pray</strong> to elephant Gods. <strong>Chase elephants away</strong> with fire torch. <strong>Unsatisfied</strong> with forest dept efforts. <strong>Participate</strong> with them in drives. Prepare to file claims for compassionate payment against damages caused. <strong>Worry</strong> about economic losses. <strong>Problems</strong> in repayment of loans. Sleepless nights and increased workload. Go out to <strong>see elephants</strong> with friends and family. Hue and cry is about <strong>loss of crop</strong> and vulnerability of attack on humans. <strong>Expectation</strong> is to prevent elephant from migrating and timely payment of ex-gratia.</td>
</tr>
<tr>
<td><strong>Women</strong></td>
<td>Blow conch shells when <strong>to welcome</strong> elephant God. Rely on forest dept efforts, men folk and prayers to elephant God. <strong>Sleepless</strong> nights hampers daily wage labourers who go to nearby towns. Access to forest for their <strong>daily utilities</strong> is hindered. <strong>Expectation</strong> is better guarding and cooperation from forest department.</td>
</tr>
<tr>
<td><strong>Forest staff</strong></td>
<td><strong>Manage</strong> elephants, enraged communities, curious spectators and selfie enthusiasts. <strong>Work closely</strong> with civil administration, electricity dept, and police. Massive <strong>paper work</strong>. Keep people calm until they receive ex-gratia. <strong>Learning</strong> experience. <strong>Expectation</strong> is cooperation from community members to not disturb elephants when in forest and avoid making fraudulent ex-gratia claims.</td>
</tr>
</tbody>
</table>
## EFFECTIVENESS OF DETERRENTS

List of deterrents used and its effectiveness as mentioned by respondents

<table>
<thead>
<tr>
<th>Deterrents used</th>
<th>FIRE</th>
<th>USING SIREN &amp; BEATING DRUMS</th>
<th>BURSTING FIRE-CRACKER</th>
<th>BURNING OLD AUTO MOBILE TYRES</th>
<th>CHILLI SMOKE</th>
<th>CHILLI POWDER FENCE</th>
<th>TEAR GAS</th>
<th>ELEPHANT PROOF TRENCH</th>
<th>SOLAR-ELECTRIC FENCE</th>
<th>HORSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local community</td>
<td>E</td>
<td>NE</td>
<td>SE</td>
<td>SE</td>
<td>RU</td>
<td>RU</td>
<td>NE</td>
<td>SE</td>
<td>E (but debated)</td>
<td>NE</td>
</tr>
<tr>
<td>Forest staff</td>
<td>E</td>
<td>SE (but agitates elephants)</td>
<td>SE</td>
<td>SE</td>
<td>RU</td>
<td>RU</td>
<td>NE</td>
<td>E</td>
<td>E</td>
<td>SE</td>
</tr>
</tbody>
</table>
a 4T proposal keeping in mind Scale, Scope and Speed

- Farmers’ and elephants’ safety in order to prevent the threats to elephant conservation.

- Less inputs, more output - ease out efforts and expenses yet be effective.

- Fast delivery – for ineffective and slow delivery of results in the sense of driving out elephants is a point of contestation.

- 4Ts:

  Technology – Training – Teamwork – Tourism
Any eulogy after extinction of a species is foolish, isn’t it?
Therefore, time is now to shoulder collective responsibility to resolve such complex challenge.
THANK YOU

“It’s surely our responsibility to do everything within our power to create a planet that provides a home not just for us, but for all life on Earth”
- David Attenborough

“For in nature we first emerged and to which we still belong.”
- Ruskin Bond

Acknowledgement: NISER, Balasore Wildlife Division, International Elephant Foundation
Assessing the Effects of a Cognition-Based Education Program on Attitudes of Villagers Towards Asian Elephants (*Elephas maximus*)
Radhika N. Makecha
Project Co-Authors

Dr. Ratna Ghosal, Ahmedabad University, India
Sagarika Phalke, A Rocha, India
Dr. Yoshie Nakai, Eastern Kentucky University
Does knowledge on elephant cognition result in more positive attitudes towards elephants and elephant conservation?
Why Study This?

Human-Elephant Conflict (HEC)

Indian villager pays respect to an elephant hit by a train
Why Study This?

• Mitigation measures are important
  - Education
Why Study This?

- Animal Cognition & Education??
Think Tank National Zoo, Washington, D. C.
Bielick & Karns (1998)

- Visitors reported: “a feeling of being more connected to the animal world.”
- Also reported having a more positive image of animals
Visitors spent more time at the research window when given a description and explanation of the research being conducted.
Living Seas: Epcot
Harley, Fellner, & Stamper (2010)

- Positive feedback from visitors who viewed a cognitive research session with dolphins
- Also spent more time watching dolphins when a session was going on
Visitors reported an increased appreciation for dolphins.
Have we looked at cognition-based education in elephants?

ex situ

San Diego Safari Park
(Hacker & Miller (2016))

Zoo Atlanta
Swanagan (2000)
Have we looked at cognition-based education in elephants?

*in situ*

Save the Elephants
Kwamboka (2013)

Think Elephants International
No *systematic* studies investigating the role that knowledge on animal cognition, and more specifically elephant cognition, plays on attitudes towards wildlife and wildlife conservation
Bannerghatta National Park
Bannerghatta National Park
**Participants:** Adult male villagers who have a self-sustaining source of income (agricultural) and the right to make family decisions regardless of their marital status (e.g. single, married). *Must also be in a high-conflict area.*

<table>
<thead>
<tr>
<th>Type of Education Program</th>
<th>Number of Participants</th>
<th>Presentation Length</th>
<th>Survey Administered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elephant Conservation-Education Program (no cognition)</td>
<td>43</td>
<td>10 minutes</td>
<td>Yes</td>
</tr>
<tr>
<td>Elephant Conservation-Education Program (cognition)</td>
<td>45</td>
<td>10 minutes</td>
<td>Yes</td>
</tr>
<tr>
<td>Control</td>
<td>45</td>
<td>NA</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Development of Scales

Attitudes Towards Elephants (AE) Scale

Attitudes Towards Elephant Conservation (AEC) Scale

- Based off the ABC model (affect, behavior, and cognition) which has been empirically supported by Rosenberg & Hovland (1960).

- Piloted at Eastern Kentucky University as well as validated by subject matter experts.

Attitudes towards Elephants (AE) Scale (9 items)

Respondent instruction: Please answer each of the following questions using Yes, Maybe yes, Maybe no, or No.

A. Affect
   1. Do you enjoy seeing elephants around?
      Yes  Maybe Yes  Maybe No  No
   2. Do you respect elephants?
      Yes  Maybe Yes  Maybe No  No
   3. Are you afraid of elephants?
      Yes  Maybe Yes  Maybe No  No

Attitudes toward Elephant Conservation (AEC) Scale (9 items)

Respondent instruction: Suppose you live in the area where you may encounter wild elephants. Please answer each of the following questions using Yes, Maybe yes, Maybe no, or No.

A. Affect
   1. Do you feel upset when deadly actions such as poisoning and electrocution are taken against elephants in crop-raiding?
      Yes  Maybe Yes  Maybe No  No
   2. Would you like to save the elephants so that the future generations can live with elephants?
      Yes  Maybe Yes  Maybe No  No
   3. Do you like the idea of people and elephants living together?
      Yes  Maybe Yes  Maybe No  No
Non-Cognition Educational Program
Cognition Educational Program
What Did We Find?

Quantitative Data

• Significant differences between both of the educational groups and the control group (Wilks’ lambda = 0.75, $F_{(4, 258)} = 10.22$, $p = 0.000$, partial $n^2 = 0.14$) were found on the AE and AEC scales.

• No significant difference found between the educational groups (cognition vs. non-cognition) on the AE and AEC scales.
What Did We Find?
Qualitative Data (Comments)

<table>
<thead>
<tr>
<th></th>
<th>Cognition</th>
<th>Control</th>
<th>Non-Cognition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total N</td>
<td>45</td>
<td>45</td>
<td>43</td>
</tr>
<tr>
<td># provided comments</td>
<td>44</td>
<td>43</td>
<td>41</td>
</tr>
<tr>
<td>% provided comments</td>
<td>97.78</td>
<td>95.56</td>
<td>95.35</td>
</tr>
<tr>
<td>Cognition</td>
<td>3</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Dangerous</td>
<td>16</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Gender difference</td>
<td>5</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Solitary vs. Group</td>
<td>2</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Kill</td>
<td>1</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>Do not kill</td>
<td>5</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>
Do you feel upset when deadly actions such as poisoning and electrocution are taken against elephants in crop-raiding (AEC Scale)?

“If they give permission, then we can shoot (control group).”

“Electrocution – 6 years ago mother and calf – felt very bad when he saw the calf (non-cognition group).”

“Consider them as God (cognition group).”
Why the lack of significant differences between the educational groups?

- Informal and local contextual knowledge on elephant cognition through their exposure to strategies used by elephants to break down barrier fences/raid crops.

- With high HEC populations, short-term education programs may be less effective than long-term education programs.
Future Directions

• Urban populations (little to no exposure to HEC)

• Children (who have not had a life-time of exposure to HEC)

• Long-term educational projects

• Community-based participation
Acknowledgements

Comprehensive Reference List Available Upon Request
A crowd-sourced approach to understanding Asian Elephants in Human-dominated Landscape

Tarsh Thekaekara, Arun Kumar, Ramesh Madan, Vishnu Varadhan, Prakash G, Manikandan R and Tamilnadu Forest Department, Gudalur Division.

All media by someone at The Shola Trust (CC-BY-NC-ND), unless otherwise mentioned
The Context
Hard Lines and Boundaries
Elephant Distribution
Human Diversity and Culture
Paniyas
Kattu Nayakans
Bettakurumbas
Chettys

Top three photos from www.wayanadanchetty.org
Malayalis
Sri Lankan Repatriates

Above images from (a) flickr, CC (b) Janeer Nelakotta
‘Elites’

Above images from flickr-CC
Culture and Conflict
Are some communities more tolerant to wildlife than others?
Gudalur Elephant Monitoring Project
(Since December 2015)

• Objectives
  • How many elephant use the Gudalur region?
  • What can we know about demography?
  • Are they permanently resident or only moving through?
  • Are there differences in personality or behavioural types?
Finding Elephants
Elephant Warning
+919711981981

1:22 PM
Ele devala Tarsh testing

1:23 PM
Ele Thorapally Tarsh testing Thorapally

20/10/2016 7:32 AM
Ele kupaithoti OVT8 was there all day yesterday, went down into silver cloud at around 630 pm.

02/11/2016 3:35 PM
Ele garbagedump OVT8 feeding at garbage dump now, 330 pm.

08/11/2016 6:09 PM
Ele garbagedump ovt8 is feeding at garbagedump now (6.10 pm)

MD-ELEWRN

Incident Reported, Thank you.

7:34 AM

Elephant movement reported at kupaithoti(-garbagedump/kuppa thotti) by Tarsh Thekaekara. OVT8 was there all day yesterday, went down into silver cloud at around 630 pm.. Please be careful.

4:51 PM

Elephant movement reported at garbagedump(குப்பாதுக்கி /குப்பாது) by Manikandan TST. new makna. Please be careful.

02/11/2016 3:35 PM
Incident Reported, Thank you.

3:36 PM

Elephant movement reported at garbagedump(குப்பாதுக்கி /குப்பாது) by Tarsh Thekaekara. Ovt8 feeding at garbage dump now, 330 pm.. Please be careful.
Identifying Individuals
Name: OV1/ Bommi Amma
Range: O'Valley
Description:
Middle aged female. Quite big in size, with round body. Back quite flat. Squarish ears, with uneven V shaped bottom, veins visible in both ears, with de-pigmentation at edges. Right ear has roll like top fold of about 3 inches all along the ear, with two small V cuts. Left ear is starting to fold, with rear part of ear folded backwards. No hair on tail. Has a small calf, born around June 2016. Matriarch of the O'Valley herd.
Date: October 2016.
The Elephants – 120 Individuals (+22 calves), named/identified, and 65 fully ‘profiled’
Understanding the Elephants

- **2016**: 415 CEMEWS reports, 165 sightings, 54 camera trap videos, 260 hours of observation
- **2017**: 155 sightings, 250 hours of observation (15% by FD staff)
- **2018**: 180 sightings, 290 hours of observation (35% by FD staff)
Demography

Age Distribution
Among the Gudalur Elephants

<table>
<thead>
<tr>
<th>Females/Herds</th>
<th>Old</th>
<th>Middle Aged</th>
<th>Young Adult</th>
<th>Sub-adult</th>
<th>Juvenile</th>
<th>calf</th>
<th>Old</th>
<th>Middle Aged</th>
<th>Young Adult</th>
<th>Sub-adult</th>
<th>Juvenile</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Individuals</td>
<td>19</td>
<td>14</td>
<td>3</td>
<td>2</td>
<td></td>
<td>19</td>
<td></td>
<td>3</td>
<td>9</td>
<td></td>
<td>22</td>
</tr>
</tbody>
</table>

Males

| | Old | Middle Aged | Young Adult | Sub-adult | Juvenile |
| | 3 | | | | |
| | 7 | | | | |
| | 9 | | | | |

Graph showing the age distribution of elephants in Gudalur.
# Home Range

## Method

<table>
<thead>
<tr>
<th>Method</th>
<th>Average locations per month [number (±SD)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Observation</td>
<td>3.46 (±5.59) [[1.5(±1.3) without Easa 1988]]</td>
</tr>
<tr>
<td>VHF Collars</td>
<td>7.48 (±4.01)</td>
</tr>
<tr>
<td>GPS Collars</td>
<td>11.43 (±6.60)</td>
</tr>
</tbody>
</table>

## Forest Type

<table>
<thead>
<tr>
<th>Forest Type</th>
<th>Females [km² (±SD)]</th>
<th>Males [km² (±SD)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry (scrub, deciduous, grassland, thorn, fragmented)</td>
<td>236 (±202)</td>
<td>240 (±105)</td>
</tr>
<tr>
<td>Wet (primary/secondary rainforest, fragmented plantations)</td>
<td>270 (±242)</td>
<td>191 (±216)</td>
</tr>
</tbody>
</table>
**Individual Elephant Profiles**

**Name:** KK1/Rani Kaapikad  
**Range:** Cherambadi/Bittherkadu  
**Description:** Middle aged female. Clear triangular cut in right ear called 'kiliya kaadhu' by staff. Ears are rectangular, with uneven V shape at the bottom. About 2 inch fold on top, and veins are visible. Top of back is smooth, with small lump towards the end. Found mostly around the Kapikad area. Her son is Messi, who is approx 3-5 yr old male. Matrarch of the KK Herd - KK1, KK2, CK3, CT6, Messi and Kutty KK.

**Date:** October 2016.

---

**Name:** Ganesan Naadodi  
**Range:** Cherambadi/Bittherkadu  
**Description:** Old (50+ yrs), large, fat Mahinda. Largest of the elephants in the region, and very well known. Squarish ears, with large top-fold, and tears in both ears, right more than left. Long tail, with full hair. Relatively peaceful, and does not get agitated even with lots of people around, but has damaged a few vehicles.

**Date:** October 2016.
Behavioural Categories

Sightings and Minimum Convex Polygons for Elephants seen most often in 2016
Gudalur Forest Division

Legend
- Gudalur Division
- Range Boundaries
- Contiguous Forest
- Natural Cover
- Elephant Ranges (MCP)
- Roads
- Highways
- Small Towns/Villages
- Big Towns
- Sightings with Photos
- CEMEWS Sightings

Gudalur Division
Range Boundaries
Contiguous Forest
Natural Cover
Elephant Ranges (MCP)
Roads
Highways
Small Towns/Villages
Big Towns
Sightings with Photos
CEMEWS Sightings
# Individuality – Quantifying Elephant Observation

<table>
<thead>
<tr>
<th>Score</th>
<th>Human presence</th>
<th>Landuse modification</th>
<th>Elephant Reaction</th>
<th>Elephant Behaviour</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Only us (1-3 people) with no field staff or public</td>
<td>Natural vegetation, more than 250m from human habitation</td>
<td>Unaware of people (few people, more than 250m away)</td>
<td>Most of the time spent resting/sleeping</td>
</tr>
<tr>
<td>2</td>
<td>Us and a few forest department staff (less than 10 people)</td>
<td>Plantation, more than 250m from habitation</td>
<td>Scared of people and moved away/were trying to move away</td>
<td>Most of the time spent feeding/moving, not visibly influenced by people</td>
</tr>
<tr>
<td>3</td>
<td>Us, forest department staff and members of the public (more than 10 people)</td>
<td>Forest patch (less than 5ha) less than 250m from human habitation</td>
<td>Didn’t react significantly to people</td>
<td>Most of the time spent moving and being actively chased by people</td>
</tr>
<tr>
<td>4</td>
<td>People actively chasing the elephants.</td>
<td>Semi-urban (main roads, alongside houses, villages etc.)</td>
<td>Showed signs of aggression towards people</td>
<td>-</td>
</tr>
</tbody>
</table>
Classifying Behavioural Types

Quantitative Categorisation of Elephant Behaviour

- **Seen Often?**
  - No → Type 1: Transient elephants
  - Yes → **Near human habitation?**
    - No → Type 2: Seen often, but away from habitation
    - Yes → **Comfortable around people?**
      - No → Type 3: “Fight or Flight” response
      - Yes → Type 4: Highly habituated
1 - Transient Elephants
1 - Transient Elephants
2 – Regular visitors, but away from houses
2 – Regular visitors, but away from houses
3 – Regular visitors near houses, but shy (Flight or Fight)
3 – Regular visitors near houses, but shy (Flight or Fight)
3 – Regular visitors near houses, but shy (Flight or Fight)
3 – Regular visitors near houses, but shy (Flight or Fight)
4. Highly habituated (no ‘fight or flight’ physiological response)
4. Highly habituated (no ‘fight or flight’ physiological response)
4. Highly habituated (no ‘fight or flight’ physiological response)
“Behavioural Types”

<table>
<thead>
<tr>
<th>Type 1 –Transient elephants (40%)</th>
<th>Type 2 – Seen often, but away from habituation (40%)</th>
<th>Type 3 – “Fight or Flight” (60%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BK (2)</td>
<td>OVMK (7)</td>
<td>CMK2</td>
</tr>
<tr>
<td>CMK1</td>
<td>OVMK1</td>
<td>CT1</td>
</tr>
<tr>
<td>CT2</td>
<td>OVMK2</td>
<td>CT4</td>
</tr>
<tr>
<td>CT7</td>
<td>OVT1</td>
<td>CT8</td>
</tr>
<tr>
<td>CT9</td>
<td>OVT4</td>
<td>CT12</td>
</tr>
<tr>
<td>CT10</td>
<td>OVT5</td>
<td>OVT3</td>
</tr>
<tr>
<td>CT11</td>
<td>OVT7</td>
<td>GDKH (10)</td>
</tr>
<tr>
<td>CT13</td>
<td>PMK1</td>
<td>KMH (11)</td>
</tr>
<tr>
<td>CT15</td>
<td>PT1</td>
<td>OVT (12)</td>
</tr>
<tr>
<td>CT16</td>
<td>PT2</td>
<td>OVT6</td>
</tr>
<tr>
<td>CT17</td>
<td>PT3</td>
<td>PMK (16)</td>
</tr>
<tr>
<td>CT18</td>
<td>PT4</td>
<td>CT19</td>
</tr>
<tr>
<td>CT19</td>
<td>PT5</td>
<td>MGMK (5)</td>
</tr>
<tr>
<td>MGMK (5)</td>
<td>PT6</td>
<td>MGM1</td>
</tr>
<tr>
<td>MGM1</td>
<td>PT7</td>
<td>MGM2</td>
</tr>
<tr>
<td>MGM2</td>
<td>PT8</td>
<td>MGM3</td>
</tr>
<tr>
<td>MGM3</td>
<td>PT9</td>
<td>MTRH (12)</td>
</tr>
<tr>
<td>MTRH (12)</td>
<td>PT10</td>
<td>PT10</td>
</tr>
<tr>
<td>OVM (2)</td>
<td>PT11</td>
<td>CBT1</td>
</tr>
<tr>
<td>OVT4</td>
<td>PT12</td>
<td>CMK1</td>
</tr>
</tbody>
</table>

Type 4: Highly Habited (80%)

<table>
<thead>
<tr>
<th>MGM1</th>
<th>MGM2</th>
<th>MGM3</th>
<th>MTRH (12)</th>
<th>OVM (2)</th>
<th>OVT4</th>
</tr>
</thead>
</table>
The Elephants – Changing Personality?
Ganesan in 2013 vs Ganesan in Kolapalli
Other regions – the famous Munnar Padayappa!
Madukarai Maharaj, Rowdy Ranga and Kalloor Komban
Next Steps – App for Monitoring
Wider Elephant Database - Mudumalai
Conclusions

- Baseline information – landuse, distribution of elephant and people – a vital first step to understanding HEC
- Diversity in the people and human culture is a key factor that hinders or allows coexistence
- Diversity in elephant behaviour important – in Gudalur 80% of the time is spent chasing 5 highly habituated elephants.
- Tools can be useful, but people more so!
Introduction to EEHV & Global EEHV Resources

Lauren L. Howard
Nadine Lamberski
San Diego Zoo Global
Today’s talk

• Introduction to EEHV
• EEHV Advisory Group
• Impact on Asian elephant populations in Europe, N America & Asia
• Survey of EEHV awareness in select African countries
What is EEHV?
Elephant Endotheliotropic Herpes Virus.
EEHV is a natural infection of Asian and African elephants.
EEHV is a natural infection of Asian and African elephants.

EEHV is carried and shed by **all** Asian and African elephants.
EEHV is a natural infection of Asian and African elephants.

EEHV is carried and shed by all Asian and African elephants.

EEHV can also cause fatal hemorrhagic disease. (EEHV HD)
EEHV is a natural infection of Asian and African elephants.

EEHV can also cause fatal hemorrhagic disease. (EEHV HD)

EEHV HD can cause death as early as 24-48 hours after we know an elephant is sick.

EEHV is carried and shed by all Asian and African elephants.
EEHV is a natural infection of Asian and African elephants.

EEHV is carried and shed by all Asian and African elephants.

EEHV can also cause fatal hemorrhagic disease. (EEHV HD)

EEHV HD can cause death as early as 24-48 hours after we know an elephant is sick.

Preparation and quick action are important for successful treatment of EEHV HD.
What is EEHV HD?

EEHV
- Ubiquitous virus
- Virus is found incidentally in trunk secretions, saliva, likely other places
- May be associated with low-level viremia
- Clinically insignificant

EEHV HD
- Hemorrhagic disease
- Associated with high viremia
- Associated with abnormal CBC
- Associated with clinical signs of illness
- Life-threatening
Who is impacted by EEHV HD?

Asian elephants <10 years old

African elephants ≤15 years old
What else about EEHV?

Asians: 3 EEHV viruses.

Africans: 4 EEHV viruses
What else about EEHV?

Asians: 3 EEHV viruses.

Africans: 4 EEHV viruses
EEHV: The Basics

Hemorrhagic Disease (EEHV HD)

Viremia ⇒ Systemic disease
EEHV: The Basics

Hemorrhagic Disease (EEHV HD)

Viremia ➔ Systemic disease ➔ Endothelial Damage ➔ Internal Hemorrhage ➔ Cardiovascular shock ➔ Death
North American EEHV Advisory Group

- Disseminating knowledge
- Providing technical assistance
- Facilitating Research

www.eehvinfo.org
African elephant-focused EEHV Meeting
February 24-26, 2020
4th Asian EEHV Working Group Meeting

Nov. 28-30, 2020
Assam, India

Dr. Sonja Luz
Sonja.luz@wrs.com.sg
European EEHV Research Meeting

• May 18 – May 19, 2020
• Hosted by Rotterdam Zoo, The Netherlands
• Immediately preceding EAZWV Annual Conference at Emmen

Contact Dr. Willem Schaftenaar: w.schaftenaar@diergaardeblijdorp.nl
North American Elephants and EEHV

<table>
<thead>
<tr>
<th></th>
<th>Asian Elephants</th>
<th>African Elephants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elephants born or imported since 1980, with known follow-up</td>
<td>129</td>
<td>258</td>
</tr>
<tr>
<td>Elephants still alive</td>
<td>87</td>
<td>158</td>
</tr>
<tr>
<td>Elephants that have died</td>
<td>42</td>
<td>100</td>
</tr>
<tr>
<td>EEHV HD deaths</td>
<td>27</td>
<td>5</td>
</tr>
<tr>
<td>% of elephant deaths that are from EEHV</td>
<td>27/42 = 64%</td>
<td>5/100 = 5%</td>
</tr>
</tbody>
</table>
## North American Elephants and EEHV

<table>
<thead>
<tr>
<th></th>
<th>Asian Elephants</th>
<th>African Elephants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elephants born or imported since 1980, with known follow-up</td>
<td>129</td>
<td>258</td>
</tr>
<tr>
<td>EEHV HD Survivors</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>EEHV HD Deaths</td>
<td>27</td>
<td>5</td>
</tr>
<tr>
<td>Fatality Rate of EEHV HD Cases</td>
<td>64%</td>
<td>50%</td>
</tr>
<tr>
<td>% of all elephants in population that have been impacted by EEHV</td>
<td>42/129 = 32%</td>
<td>10/258 = 4%</td>
</tr>
</tbody>
</table>
Total at-Risk population for EEHV-HD:
22 Asian elephants between 1-9 years of age by end of 2019
Total at-Risk population for EEHV-HD:

22 Asian elephants between 1-9 years of age by end of 2019

9 of these elephants have already survived one episode of EEHV HD.
Asian Elephants in Europe

- European Studbook
- Asian births 1985-2017
- 109 elephants followed for 8 years
- 25 EEHV fatalities
- 84 lived past 8 years of age
22 European Sires
• 59% (13) sired an EEHV calf

58 European Dams
• 32% (19) bore an EEHV calf

27 European Institutions
• 52% (14) have had an EEHV Fatality
In Asia, 142 EEHV HD Cases Reported 2003-2019

- **Nepal:** 12 cases, 5 survivors
- **Myanmar:** 4 cases
- **Vietnam:** 0 cases
- **Laos:** 1 case
- **Cambodia:** 1 case
- **India:** 32 cases, 18 wild
- **Thailand:** 81 cases, 25 survivors
- **Sri Lanka:** 1 sample
- **Indonesia:** 7 cases
- **Malaysia:** 4 cases, 1 survivor
In Asia, 142 EEHV HD Cases Reported 2003-2019

India: 32 cases
18 wild

Nepal: 12 cases
5 survivors

Myanmar: 4 cases

Thailand: 81 cases
25 survivors

Vietnam: 0 cases

Sri Lanka: 1 + sample

Laos: 1 case

Indonesia: 7 cases

Cambodia: 1 case

Malaysia: 4 cases
1 survivor
Reteti Elephant Sanctuary / Namunyak Wildlife Conservancy
Reason for Rescue

- Well
- Separated or Abandoned by Dam
- HWC or Poaching
- Misc.
# Reteti Elephant Rescues and Dispositions

<table>
<thead>
<tr>
<th>Year</th>
<th>Total</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>61</td>
<td>9</td>
<td>27</td>
<td>15</td>
<td>10</td>
</tr>
</tbody>
</table>

- **Total to Date**: 61
- **2016**: Total = 9
- **2017**: Total = 27
- **2018**: Total = 15
- **2019**: Total = 10
EEHV Survey Results of Wildlife Health Professionals Working in Africa
Responders:
WDA Africa and Middle East Section and Wildlife Vetnet Listservs

N=31 (Aug-Sep 2019)
In which region of Africa do you primarily do your wildlife health work?

- North Africa: 1 respondent (N=1)
- West Africa: 1 respondent (N=1)
- East Africa: 9 respondents (N=9)
- Southern Africa: 20 respondents (N=20)
Are you aware that herpesviruses can cause morbidity and mortality in wild Asian elephants?

Responses

- Yes: 28
- No: 3
Are you concerned about herpesvirus in African elephants?

- Yes, N=18
- No, N=13
Have you diagnosed herpesvirus-related disease in an African elephant?

- Yes: 30.00% (N=5)
- No: 93.00% (N=17)
- Not sure: 23.00% (N=4)
- Not applicable: 23.00% (N=4)
Have you observed skin lesions in an African elephant that you thought could be attributed to herpesvirus?

- **Yes**: 12 responses
- **No**: 12 responses
- **Not sure**: 4 responses
- **Not applicable**: 3 responses
Have you observed post mortem lesions such as internal fluid and hemorrhage and/or visceral hemorrhage and edema in an African elephant that could be attributed to herpesvirus?

- Yes: 22 responses
- No: 1 response
- Not sure: 3 responses
- Not applicable: 5 responses
Do you think it is important to learn more about the impact of herpesvirus on wild and orphaned African elephants?

- Yes: N=28
- No: N=2
- Not sure: N=1
- Not applicable: N=1
Current Knowledge of EEHV in African Elephants

Erin Latimer MS, Kali Holder DVM DACVP, Melissa Fayette DVM, Shannon Nodolf DVM, Virginia R Pearson, Gary Hayward PhD (plus lots of others)

EEHV Workshop in Africa, Oct 22, 2019
References


References


EEHV in African elephants

- EEHV found in free ranging elephants and in human care
- V Pearson did extensive sampling and testing in Kenya, Botswana, S Africa, Gabon
- EEHV2, 3A, 3B, 6, 7A, 7B found in L. africana. All but EEHV2 found in L. cyclotis (Gabon)
- Multiple EEHVs from lung and skin nodules
- Many gammaherpesviruses found in African elephants as well
<table>
<thead>
<tr>
<th>Strains</th>
<th>Host Type</th>
<th>Lethal Acute HD</th>
<th>Mild Viremia</th>
<th>TWS shedding</th>
<th>Saliva</th>
<th>Lung Nodules</th>
<th>Skin Nodules</th>
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</thead>
<tbody>
<tr>
<td>EEHV1A</td>
<td>EM</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>EEHV1B</td>
<td>EM</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>EEHV2</td>
<td>LA</td>
<td>Y</td>
<td></td>
<td>Y</td>
<td>Y</td>
<td></td>
<td>Y</td>
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<tr>
<td>EEHV3A</td>
<td>LA</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td></td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>EEHV3B</td>
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<td>Y</td>
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<td>EM</td>
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<td>Y</td>
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<td>Y</td>
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<td>EM</td>
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<td>Y</td>
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<td>Y</td>
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<td>EEHV7A</td>
<td>LA</td>
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<td>EEHV7B</td>
<td>LA</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Y</td>
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</tbody>
</table>

Updated table from ILAR Journal 56.3 (2016): 283-296
# Ubiquitous gammaherpes

<table>
<thead>
<tr>
<th>Virus Type</th>
<th>Host</th>
<th>Saliva Swabs</th>
<th>Skin Nodules</th>
<th>Blood</th>
</tr>
</thead>
<tbody>
<tr>
<td>EGHV 1A</td>
<td>EM</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EGHV 1B</td>
<td>LA</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>EGHV 2</td>
<td>Both</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>EGHV 3A</td>
<td>EM</td>
<td></td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>EGHV 3B</td>
<td>LA</td>
<td></td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>EGHV 4A</td>
<td>EM</td>
<td></td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>EGHV 4B</td>
<td>LA</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EGHV 5A</td>
<td>EM</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EGHV 5B</td>
<td>LA</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
</tbody>
</table>

*Some have also been detected in conjunctival and genital swabs*

---

**Table 3: EGHV Host Species and Tissue Sources**

ILAR Journal 56.3 (2016): 283-296

Pearson, JEMA, 2012
EEHV HD and viremias-pre 2019

• EEHV2: 2 fatalities (11 months, 13 years old)

• EEHV3B: HD, survived (5 years old)

• EEHV6: 1 fatality (10 years old), 1 mild viremia (15 months old)
EEHV6 death in Thailand

- 10 yo male zoo elephant
- Anorexia, depression, weakness
- Not treated, EEHV wasn’t suspected
- Died after a few days
- No other sick herd members

- ELEPHANT ENDOTHELIOTROPIC HERPES VIRUS TYPE 6 INFECTION IN A CAPTIVE AFRICAN ELEPHANT (Loxodonta africana) IN THAILAND
- Piyaporn Kongmakee, DVM1,5, Suttipong Suttiyaporn, DVM2, Wirongrong Changpetch, DVM2, Wichit Kongkham, DVM2, Chalisa Mongkolphan, BSc3, Kanittha Tonchiansai3, Preeda Lertwatcharasarakul, BSc, PhD4, Supaphen Sripiboon, DVM, MSc4, Boripat Siriaroonrat, DVM, PhD1, Wijit Banlunara, DVM, PhD5
African EEHV in 2019--US

> In US in 2019: 3 deaths in Afr calves with EEHV3 involved. 
> Two of the three also had bacterial co-infections 
> EEHV levels were high—3 - 11 x 10^6 vge/ml. We usually don’t see Asian survivors over 1-2 x 10^6 vge/ml

> Three more calves and one adult with viremias that seemed to be controlled; they did have clinical signs 
> why this sudden spike in EEHV in our African elephant population? Put out call for retrospective samples—some rec’d
Miss Bets, Fresno Chaffee Zoo
• 11 yo African elephant

• Index case for EEHV6 when at Riddles

• Died 2/9/19 after short illness
  Kali will present vet/path info

Followed by 12 yo herdmate with viremia
Miss Bets,
EEHV qPCR

- High levels of EEHV3B in antemortem WB
  11 x 10^6/ml

- High levels of EEHV3B in liver and lung

- 200,000 vge/ml in serum
ELEPHANT ENDOTHELIOTROPIC HERPESVIRUS ASSOCIATED WITH CLOSTRIDIUM PERFRINGENS INFECTION IN TWO ASIAN ELEPHANT (ELEPHAS MAXIMUS) CALVES


Abstract: Elephant endotheliotropic herpesvirus (EEHV) is an infection associated with fatal hemorrhagic disease in young Asian elephants (Elephas maximus). This brief communication describes the postmortem evaluation of two Asian elephant calves diagnosed with EEHV4 and EEHV1A in conjunction with Clostridium perfringens infection. Case 1 was a 7-mo-old, male captive-born Asian elephant that developed diarrhea and died 2 days after clinical presentation. Examination of the heart, lungs, liver, and spleen revealed predominantly basophilic intranuclear inclusion bodies in the endothelial cells of the blood vessels. Case 2 was a 3-mo-old, female wild-born Asian elephant that showed signs of lethargy, anorexia, and convulsions and died 6 hr after clinical presentation. No intranuclear inclusion bodies were observed. The heart, lung, liver, and spleen of both calves tested positive for EEHV by polymerase chain reaction. Phylogenetic analysis identified EEHV4 and EEHV1A in Case 1 and 2, respectively. Additionally, liver, spleen, and hemorrhagic intestinal tissue samples tested positive for C. perfringens a, b, and e toxins. This is the first reported case to describe coinfection of EEHV and C. perfringens in Asian elephant calves.

Key words: Asian elephant, Clostridium perfringens type B, elephant endotheliotropic herpesvirus, EEHV, Elephas maximus.
Lesions in non-fulminant African elephants

- Nodules
  - Usually in adults with no other signs
  - Skin and lungs
  - Lymphofollicular in lung
  - Proliferative in skin
  - EEHV detectable by PCR
Clinical findings in clinically ill calves

- Nonspecific
  - Lethargy
  - Abdominal pain/colic
  - Shaking/ataxia
  - Aggressive behavior
  - Leukopenia
  - anorexia

- Similar to EEHV in Asian elephants
  - Bleeding
  - Cyanosis of tongue

- Associated with secondary bacterial infections
  - Clostridial enteritis
  - Salmonellosis
Necropsy findings in clinically ill calves

- GI (secondary clostridial infection)
  - Colonic edema
  - Gastric ulcers
  - Colonic ulcers
  - Proctitis
  - Necrotizing enteritis (salmonellosis)

- Cardiovascular
  - Epicardial and myocardial hemorrhage
  - Perivascular edema and hemorrhage (brain, histo)
  - Hepatic centrilobular congestion
Histological findings in clinically ill calves

• Systemic/shock
  • Hemorrhage (multiple organs esp lung, brain, heart)
  • Edema (brain, lung, kidney)
  • Congestion (liver, kidney, myocardium)

• Viral
  • Intranuclear inclusions in cardiomyocytes (EEHV6) or endothelial cells (EEHV2)
  • Hemorrhagic endocarditis (EEHV6)
Indy Zoo

**Nyah**
- 6 yo African elephant
- Died 3/19/19
- 3/17/19 WB 2 x 10^6 vge/ml EEHV3-4
- 3/18/19 WB 3 x 10^6 vge/ml EEHV3-4
- EEHV3A

**Kalina**
- 8 yo African elephant
- Died 3/26/19
- 3/23/19 WB 1 x 10^6 vge/ml EEHV3-4
- 3/24/19 WB 3.7 x 10^6 vge/ml “
- 3/25/19 WB 1.6 x 10^6 vge/ml “
- Rest of herd neg for 2, 3-4, 6
Complete genome sequence of EEHV3 (Nyah)

- 204,633bp
- Gained 2 genes E20C, E26A; lost one E6B, compared to closest relative EEHV4 (Baylor)
- E26A: SAM methyl-transferase gene w/homology to a pulmonary strain of Tuberculosis?
- Essential—along with determination of EEHV2 and 6 genome sequences—for leveraging Asian elephant serology assays to Africans
### Asian vs African EEHV

**Asian elephants**
- EEHV1A, 1B
- EEHV4
- EEHV5
- Calves 1-6 years, deaths mostly due to EEHV1A, more rarely 1B, 4, 5
- TW shedding and viremia **rare**
- so far not seen in lung or skin nodules

**African elephants**
- EEHV2  
- EEHV3  
- EEHV6  
- EEHV7  
- Clinical disease WAS rare in elephants in human care
- Skews older than **Asians—up to 13 yo**
- Low level TW shedding and viremia **common**
- Often found in lung and skin nodules

*More on the differences in TW shedding and viremias in the Monitoring talk*
What next?

• We have learned a lot in the last year about EEHV in African elephants in human care, but much more to learn.
• Is EEHV HD found in wild African elephants and to what extent?
Building capacity for tackling EEHV at an African level

Edgar Simulundu
University of Zambia
School of Veterinary Medicine

21-25 October, 2019
INTRODUCTION: UNZA-VET
INTRODUCTION: UNZA-VET
Capacity building I: Training of human resource
Capacity building II: Equipment and Reagents
Arrival of Laboratory Equipment
qPCR and cPCR capacity
Sample storage capacity
Sequencing capacity
Capacity building III: Research capacity development

- Research is of essence in understanding EEHV in African elephants.
- Collaboration within the region and internationally is critical
- Research requires funding
- Continuous training of new and emerging researchers at postgraduate level (MSc, PhD, Postdocs, academics etc)
Capacity building IV: Communication and Networking

Formation of the African EEHV Working group:

- Dissemination of trustworthy information on EEHV
- Education and awareness of EEHV, particularly in Africa
- Research agenda and collaboration
- Facilitate sample transfer to EEHV diagnostic center(s)
- SOPs for monitoring, diagnosis and management of EEHV
African proverb: Chichewa language

Ukatamanga weka utamangisa, tikatamanga awili, tifikapatali" –

When you run alone, you run fast. When you run together, you reach far.
Thank you

Victoria Falls in Zambia
Serological detection of EEHV infections by a Luciferase Immunoprecipitation System assay

Angela Fuery PhD**, Taylor Pursell**, DVM, Jie Tan, RongSheng Peng, Peter D. Burbelo, Gary Hayward PhD, and Paul D. Ling, PhD

**Contributed equally to this work**
EEHV Serology assay

Question:
Is clinical illness (and/or lethality) caused by EEHV due to primary infection or reactivation?

Successful generation of a specific and sensitive EEHV serology assay will:
1. Enable us to answer primary/reactivation question
2. Assess potential vulnerability of young elephants to EEHV infection
3. Evaluate EEHV vaccines

Key point:
EEHV serology assay needs to be able to distinguish between infections caused by the different EEHV types (1A, 1B, 4 and 5)

Challenges:
1. The different EEHV types share common genes with homology (potential cross-reactivity)
2. Sensitivity and dynamic range of traditional serology assays could be limiting
3. Herpesviruses are generally ubiquitous; causing subclinical and clinical disease followed by long-term chronic/persistent infection—how do you find seronegatives when almost everyone in the population has been infected?
Schematic of the general steps involved in LIPS

A
- Transfect
- Gene of Interest
- pH7.9
- 
- Luciferase (Ruc)

B
- Elephant serum
- Incubate
- Add antibody to gB-Ruc extract
- Antibody-gB-Ruc complex
- Add Protein A
- Wash and remove free gB-Ruc
- Measure Light units
### Elephant cohorts tested

Table 1: Summary of EEHV chronically infected elephants evaluated in these studies

<table>
<thead>
<tr>
<th>Elephant</th>
<th>Location</th>
<th>Sex, Age</th>
<th>Origin (Born)</th>
<th>EEHV1A</th>
<th>EEHV1B</th>
<th>EEHV4/5</th>
</tr>
</thead>
<tbody>
<tr>
<td>HZI-1 (Thai)</td>
<td>Houston</td>
<td>M, 52</td>
<td>Wild</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>HZI-2 (Methai)</td>
<td>Houston</td>
<td>F, 49</td>
<td>Wild</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>HZI-3 (Shanti)</td>
<td>Houston</td>
<td>F, 27</td>
<td>Captive</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>HZI-4 (Tess)</td>
<td>Houston</td>
<td>F, 37</td>
<td>Wild</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>HZI-5 (Tucker)</td>
<td>Houston</td>
<td>M, 11</td>
<td>Captive</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>HZI-6 (Baylor)</td>
<td>Houston</td>
<td>M, 7</td>
<td>Captive</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>HZI-7 (Tupelo)</td>
<td>Houston</td>
<td>F, 7</td>
<td>Captive</td>
<td>+</td>
<td>+</td>
<td>+</td>
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<tr>
<td>HZI-8 (Duncan)</td>
<td>Houston</td>
<td>M, 4</td>
<td>Captive</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

Table 2: Summary of eight EEHV-associated lethal HD cases evaluated in these studies

<table>
<thead>
<tr>
<th>Elephant</th>
<th>Location</th>
<th>Sex, Age</th>
<th>Origin (Born)</th>
<th>EEHV species</th>
<th>Strain</th>
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</thead>
<tbody>
<tr>
<td>+HZI-9 (Beau Thai)</td>
<td>Houston</td>
<td>M, 4</td>
<td>Captive</td>
<td>1A</td>
<td>NAP06</td>
</tr>
<tr>
<td>+HZI-10 (Kiba)</td>
<td>Houston</td>
<td>M, 9</td>
<td>Captive</td>
<td>1B</td>
<td>NAP14</td>
</tr>
<tr>
<td>+HZI-11 (Kimba)</td>
<td>Houston</td>
<td>F, 13</td>
<td>Captive</td>
<td>1A</td>
<td>NAP23</td>
</tr>
<tr>
<td>+HZI-12 (Singgah)</td>
<td>Houston</td>
<td>M, 6</td>
<td>Captive</td>
<td>1A</td>
<td>NAP17</td>
</tr>
<tr>
<td>+OKC-4 (Malee)</td>
<td>Oklahoma City</td>
<td>F, 4</td>
<td>Captive</td>
<td>1A</td>
<td>NAP73</td>
</tr>
<tr>
<td>+ABQ-2 (Daizy)</td>
<td>Albuquerque</td>
<td>F, 5</td>
<td>Captive</td>
<td>1A</td>
<td>NAP72</td>
</tr>
<tr>
<td>+FE-2</td>
<td>Feld</td>
<td>M, 2.5</td>
<td>Captive</td>
<td>1A</td>
<td>NAP75</td>
</tr>
<tr>
<td>+FE-3</td>
<td>Feld</td>
<td>M, 4</td>
<td>Captive</td>
<td>1A</td>
<td>NAP80</td>
</tr>
</tbody>
</table>
### Elephant cohorts tested

**Table 4: Summary of elephants from different herds evaluated in these studies**

<table>
<thead>
<tr>
<th>Elephant</th>
<th>Location</th>
<th>Sex, Age</th>
<th>Origin</th>
<th>ORFQ Clade</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABQ-1 (Alice)</td>
<td>Albuquerque</td>
<td>F, 45</td>
<td>Wild</td>
<td>D</td>
</tr>
<tr>
<td>ABQ-2 (Sampson)</td>
<td>Albuquerque</td>
<td>M, 21</td>
<td>Captive</td>
<td>D</td>
</tr>
<tr>
<td>OKC-1 (Asha)</td>
<td>Oklahoma City</td>
<td>F, 24</td>
<td>Captive</td>
<td>C</td>
</tr>
<tr>
<td>OKC-2 (Bamboo)</td>
<td>Oklahoma City</td>
<td>F, 53</td>
<td>Wild</td>
<td>C</td>
</tr>
<tr>
<td>OKC-3 (Chandra)</td>
<td>Oklahoma City</td>
<td>F, 23</td>
<td>Captive</td>
<td>C</td>
</tr>
<tr>
<td>FE-1</td>
<td>Feld</td>
<td>F, 22</td>
<td>Captive</td>
<td>C</td>
</tr>
</tbody>
</table>
Antibodies to general conserved EEHV proteins

Log_{10} Luminometer Units

EEHV+ EEHV HD I

U39 (EEHV1A) **

U14 (EEHV1A) **

U28 (EEHV1A) **

U39 (EEHV4)

U39 (EEHV5)

U14

U28

gB (U39)
Anti-EEHV antibodies in HD cases

A

B

U39 (EEHV1A)

\[ p < 0.05 \]

U14 (EEHV1A)

\[ p < 0.05 \]
Finding a Biomarker for EEHV1

EEHV1A genome (Kimba)

Other/Novel ORF  ベータデルタ ORF
セティガマデルタ ORF  アルファデルタ ORF
アルファセティガマデルタ ORF  ベータクラスター細胞遺伝子
チロサイド家族

ORF Q
ORF Q varies among EEHV1A strains
All lethal EEHV cases are seronegative for EEHV1A
All but one of the lethal EEHV HD cases was seronegative for EEHV1B.
Clinical EEHV cases (nonlethal) were seronegative for the EEHV type that caused illness
Decline of maternal anti-EEHV1 antibody titers in juvenile elephants

![Graphs showing the decline of maternal antibody titers over time for ORF-Q and ORF-Q variants (HZI-6 and HZI-7).]
Decline of maternal anti-EEHV1 antibody titers in juvenile elephants
Summary

1. All EEHV HD cases were seronegative for the EEHV type associated with HD (1A or in one case 1B)—strong evidence for primary infection

2. Three cases of EEHV-associated illness also seronegative for EEHV type associated with illness

3. LIPS assay is sensitive and specific; able to distinguish between infections caused by EEHV1 from other EEHV types

4. Able to distinguish between infections caused by 1A versus 1B

Implications

1. Immunoprofiling using EEHV-LIPS can assess potential vulnerability of elephants for EEHV infection/illness, particularly EEHV1 species

2. Sensitive assay for evaluating future vaccines

3. If EEHV HD is a result of primary infection, is the goal of vaccination to provide enough immunity to naïve animals to control “runaway” infection?

Future

1. Seek other EEHV proteins/biomarkers to distinguish infections with EEHVs 4 and 5

2. “Automate” the LIPS assay to high throughput format; screen elephants at all zoos?

3. Leverage expertise to develop LIPS specific for African elephants?
Acknowledgements

Ling Lab
- Angela Fuery, PhD
- Jie Tan
- Rongsheng Peng
- Taylor Pursell, DVM

Houston zoo
- Veterinary team
- Elephant keepers

Funding

Houston Zoo

INTERNATIONAL ELEPHANT FOUNDATION.ORG
Questions?
Recommended EEHV Monitoring in Asian and African Elephants

IEF RESEARCH SYMPOSIUM, OCT 21, 2019
ZEBULA, SOUTH AFRICA
Resources to get you started

EEHVinfo.org downloads

- Monitoring of Asian elephants (to be updated soon)
- Monitoring of African elephants
- EEHV Monitoring and Testing Recommendations - Europe
- Facility-specific documents from Houston Zoo, Oklahoma City Zoo, ZSL Whipsnade Zoo, BIAZA
- Standards of Care for Elephant Calves for EEHV-Preparedness
- Videos on TW collection from Houston Zoo/Baylor
- EEHV Asia Brochure (on website and from Lauren this week)
- Clinical Findings Document
- EEHV Treatments Document
Diagnosis

- **Live animals:**
  - cPCR or qPCR on EDTA WB
  - Can detect virus in blood up to a month BEFORE clinical signs

- **Post Mortem:**
  - Gross lesions (take photos)
  - Formalin fixed tissues: histopathology
  - PCR of tissues: preserve frozen or in DNA preservative for cPCR or qPCR

**Prevalence:**

Trunk Wash (TW) shedding; cPCR or qPCR. Not good for diagnosis of an active case

Swabs not as sensitive as TW
Detection of pathogenic elephant endotheliotropic herpesvirus in routine trunk washes from healthy adult Asian elephants (*Elephas maximus*) by use of a real-time quantitative polymerase chain reaction assay

Jeffrey J. Stanton, DVM; Jian-Chao Zong, PhD; Erin Latimer, BS; Jie Tan, BS; Alan Herron, DVM; Gary S. Hayward, PhD; Paul D. Ling, PhD. AJVR, Vol 71, No. 8, August 2010


Generation and validation of new quantitative real time PCR assays to detect elephant endotheliotropic herpesviruses 1A, 1B, and 4. Taylor Pursell, Jie Tan, RongSheng Peng, Paul D. Ling, J Vir Meth 237 (2016), 138-142.
Test for appropriate EEHVs (EEHV1, 4, 5 in E maximus; EEHV2, 3, 6 in L africana) weekly or twice weekly by qPCR or cPCR

Up to 15 yo
IN AN IDEAL WORLD --
HANDS ON ACCESS TO ELEPHANTS;
PLENTY OF STAFF,
FUNDING FOR REAGENTS,
ACCESS TO TESTING CAPACITY

Look at your elephants every day for behavioral changes

Take HR, RR, fecal bolus temp, indirect blood pressure to establish individual norms

Weekly CBCs

Monthly serum chemistries

Bank EDTA WB/serum from herd for future studies
IN AN IDEAL WORLD --
HANDS ON ACCESS TO ELEPHANTS,
PLENTY OF STAFF,
FUNDING FOR REAGENTS,
ACCESS TO TESTING CAPACITY

If you get a positive EEHV result:

Increase to testing daily

Monitor and treat:
CBC and platelets
Increasing viremia
Clinical signs
Early EEHV Viremia is often associated with:
   Low overall WBC
   Monocytopenia
   Thrombocytopenia

Treat if blood values are off, clinical signs are present, viremia levels increasing
Platelets <100,000 = poor prognosis
IN AN IDEAL WORLD --
HANDS ON ACCESS TO ELEPHANTS,
PLENTY OF STAFF,
FUNDING FOR REAGENTS,
ACCESS TO TESTING CAPACITY

If you get a positive EEHV result:

Don’t wait for clinical signs to start treating! Rapid aggressive treatment has been shown to increase survival (R. Isaza)

Testing serum for EEHV levels and TEG values may give clues to prognosis

Test other calves in herd daily

Decrease testing as viral levels wane
IN THE REAL WORLD -- SPORADIC ACCESS TO ELEPHANTS;
LIMITED: STAFF, FUNDING FOR REAGENTS, ACCESS TO TESTING CAPACITY

Elephant Endotheliotropic Herpesvirus (EEHV) in Asia
Recommendations from the 1st Asian EEHV Strategy Meeting

Compiled by Sonja Luz and Lauren Howard
On behalf of the Asian EEHV Working Group
Calves not trained for blood draws:


IN THE REAL WORLD -- SPORADIC ACCESS TO ELEPHANTS; LIMITED STAFF, FUNDING FOR REAGENTS, ACCESS TO TESTING CAPACITY

No access to PCR testing:

IN THE REAL WORLD --
SPORADIC ACCESS TO ELEPHANTS;
LIMITED STAFF, FUNDING FOR REAGENTS,
ACCESS TO TESTING CAPACITY

No access to PCR testing:

Work with the EEHV Advisory Groups (N. America, Asia Working Group, Thailand Task Force) to get protocols/training/reagents
• AZA Asian Elephant SAFE program

Generating funds to combat EEHV in range countries (Sumatra, Myanmar, Nepal, Vietnam) that are in need of:

Drugs and medications  
Lab enhancements for tracking and treating  
Training
Thursday workshop:

gather data on what resources exist and where are the resource gaps

brainstorm ideas

form communication group—Facebook, WhatsApp?

develop collaborations

IN THE REAL WORLD --
SPORADIC ACCESS TO ELEPHANTS;
LIMITED STAFF,
FUNDING FOR REAGENTS,
ACCESS TO TESTING CAPACITY
Treatment of EEHV
Hemorrhagic Disease

Lauren L. Howard, DVM, Dipl. ACZM
Associate Director, Veterinary Services
San Diego Zoo Safari Park
Elephant Endotheliotropic Herpesvirus (EEHV)

Not if, but when

All elephants shed EEHV. It is already in your herd.
EEHV Epidemiology

We suspect EEHV hemorrhagic disease in elephants is due to uncontrolled primary infections that lead to systemic infection in calves with inadequate immune protection.
What does EEHV do?

ENDOTHELIAL CELL DAMAGE

\[\downarrow\]

VASCULAR LEAKAGE

\[\downarrow\]

HEMORRHAGE

\[\downarrow\]

SHOCK
What does EEHV do?

1. PREVENT INJURY WITH EARLY ANTIVIRAL TREATMENT

- ENDOTHELIAL CELL DAMAGE
  - VASCULAR LEAKAGE
  - HEMORRHAGE
  - SHOCK
What does EEHV do?

1. PREVENT INJURY WITH EARLY ANTIVIRAL TREATMENT

ENDOTHELIAL CELL DAMAGE → VASCULAR LEAKAGE → HEMORRHAGE → SHOCK

2. TREAT RESULTING INJURY WITH FLUIDS AND PLASMA
What do WE see with EEHV?
What do WE see with EEHV?

Virus is in blood up to **10 days BEFORE** any clinical signs of illness are observed.
What do WE see with EEHV?
Oral cavity: Bright red ulcerations

Systemic Inflammation: Elevated body temperature
Oral cavity: Bright red Ulcerations
Systemic Inflammation: Elevated body temperature
Bloodshot eyes: Scleral injection
Oral cavity:
- Bright red ulcerations

Lameness and stiffness
- Hemorrhage into joints?

Bloodshot eyes:
- Scleral injection

Systemic inflammation:
- Elevated body temperature

Colic, decreased appetite

Altered sleep patterns
Oral cavity: Bright red ulcerations

Edema: Swelling of head, Swelling of temporal gland

Lameness and Stiffness

Hemorrhage into Joints?

Bloodshot eyes: Scleral injection

Systemic inflammation: Elevated body temperature

Tongue: Cyanosis (blue discoloration)

Colic, Decreased appetite
Oral cavity:
Bright red Ulcerations

Edema:
Swelling of head
Swelling of temporal gland

Systemic Inflammation:
Elevated body temperature

Bloodshot eyes:
Scleral injection

Lameness and Stiffness
Hemorrhage into Joints?

Altered sleep patterns

Colic,
Decreased appetite

Oral cavity:
Bright red Ulcerations

Tongue:
Cyanosis (blue discoloration)
Diagnosing EEHV
Clinically Ill Animals or Dead Animals

- **Live animals:**
  - Identify virus in blood
  - Submit whole blood (EDTA) for PCR testing
- **Post Mortem:**
  - Gross lesions (take photos)
  - Formalin fixed tissues: histopathology
  - PCR of tissues: preserve frozen or in DNA preservative
  - PCR of post mortem blood sample: preserve frozen or in DNA preservative
When to treat for EEHV HD?
Vigilance

- EEHV in the blood may lead to EEHV HD illness
- EEHV can be detected via PCR in the blood **up to 2 weeks before illness**.
- Early changes in the CBC can indicate impending illness.
In North America, we recommend **weekly** blood testing in at-risk elephants for EEHV qPCR and a CBC.
EEHV Vigilance

• Evaluate CBC's regularly (weekly if possible)
• Establish INDIVIDUAL reference ranges for each elephant
• Early EEHV Viremia is often associated with:
  – Low overall WBC
  – Monocytopenia
  – Thrombocytopenia

Platelets <100,000 = poor prognostic indicator
EEHV Vigilance

Clinical appearance of elephant

CBC results

EEHV qPCR results
EEHV Vigilance

Start Treatment if:
• EEHV qPCR level is above comfort zone
  – Asian elephants: 5,000 vge/ml
• EEHV qPCR level climbs quickly
• Elephant is clinically ill
  – Treat first and await qPCR results
Early, Aggressive Treatment

Rectal Fluid Therapy

• NEVER UNDERESTIMATE THE ABSORPTIVE CAPACITY OF THE ELEPHANT'S RECTUM
• Excellent method to rehydrate a sick elephant
• Can be given BID to QID
• Low chance of adverse effects if done correctly
Early, Aggressive Treatment

Rectal fluids given by keeper staff.
Early, Aggressive Treatment

Rectal fluids given in a jungle
Early, Aggressive Treatment

- Antiviral Therapy
- Famciclovir 15 mg/kg TID
  - PO or rectal
- Aciclovir
  - PO or IV
- Ganciclovir
  - IV
Early, Aggressive Treatment

- Antiviral Therapy
- Famciclovir 15 mg/kg TID
  - PO or rectal
- Aciclovir
  - PO or IV
- Ganciclovir
  - IV

Antiviral therapy alone will not cure moderate to severe cases of EEHV HD.
Early, Aggressive Treatment

- CBC remains abnormal
- qPCR remains elevated
- Signs of illness

IV Plasma Transfusions
Additional Treatments

• Antibiotics
• Anti-inflammatories at low doses
• Opioids (Butorphanol)
• Lyophilized Elephant Platelets
• Stem Cell Therapy
• Amino caproic Acid
Summary Treating EEHV HD

- Rectal fluid therapy: FIRST STEP
- Antiviral therapy:
  - Acyclovir
  - Famciclovir
- Intravenous Therapy:
  - Elephant plasma
  - Electrolyte fluids
- Antibiotics, nutritional support, etc.

Visit [www.eehvinfo.org](http://www.eehvinfo.org) for updated treatment information
EEHV Vigilance and Treatment

EEHV1b at the Houston Zoo

CLINICAL INFECTION OF TWO CAPTIVE ASIAN ELEPHANTS (ELEPHAS MAXIMUS) WITH ELEPHANT ENDOTHELIOPTROPIC HERPESVIRUS 1B


Abstract: The ability of prior infection from one elephant endotheliotropic herpesvirus (EEHV) type to protect against clinical or fatal infection from others remains an important question. This report describes viremia and subsequent shedding of EEHV in two juvenile 4-5-year-old Asian elephants within 3 wk or 2 mo following significant infections caused by the same EEHV type. High levels of EEHV1b shedding were detected in the first elephant prior to emergence of infection and viremia in the second animal. The EEHV1b virus associated with both infections was identical to the strain causing infection in two herd mates previously. High EEHV viremia correlated with leukocytosis and thromboцитopenia, which was followed by leukopenia and thrombocytopenia when clinical signs started to resolve. The observations from these cases should be beneficial for helping other institutions monitor and treat elephants infected with EEHV1b, the most common EEHV associated with lethal hemorrhagic disease.

Key words: Asian elephant, EEHV1b, Elaphus maximus, Fumiciclovir, qPCR.

JZWM 47(1): 319-324, 2016

EEHV4 at the Houston Zoo

CLINICAL INFECTION OF CAPTIVE ASIAN ELEPHANTS (ELEPHAS MAXIMUS) WITH ELEPHANT ENDOTHELIOPTROPIC HERPESVIRUS 4


Abstract: Elephant endothelialtropic herpesvirus (EEHV) can cause fatal hemorrhagic disease in captive Asian elephants. A number of EEHV types and subtypes exist, where most deaths have been caused by EEHV1a and EEHV1b. EEHV1b has been attributed to two deaths, but both diagnoses were made postmortem. EEHV1 disease has not yet been observed and treated clinically. In this report, two cases of EEHV4 infection in juvenile elephants at the Houston Zoo are described, where both cases were resolved following aggressive treatment and administration of famciclovir. A qualitative real-time polymerase chain reaction detected EEHV4 viremia that correlated with clinical signs. High levels of EEHV4 shedding from travails were observed in the first animal, but no detectable infection in the second elephant with EEHV4.

Key words: Asian elephant, EEHV4, Elaphus maximus, Fumiciclovir, qPCR.

“Duncan”: EEHV5

“Tupelo”: EEHV1b & EEHV4

“Baylor”: EEHV1b & EEHV4
Range Country Treatments

This calf survived EEHV HD in Thailand, treated with fluids and acyclovir IV.

The veterinarian treating this animal used the information from our 2015 Singapore workshop and the Houston Zoo EEHV Protocol as a guide.
END EXTINCTION

END EXTINCTION

END EXTINCTION

END EXTINCTION
Acute Hemorrhagic Disease due to EEHV-3 Infection in Five Captive African elephants (Loxodonta africana)

Melissa A. Fayette, DVM

Co-Authors: Emily Brenner, DVM, Michelle R. Bowman, DVM, Erin Latimer, MS, Jeffry S. Proudfoot DVM, Michael M. Garner, DVM, Dipl ACVP
Case #1: Day 1

- **Presenting clinical signs**
  - Acute lethargy
  - Anorexia
  - Abdominal discomfort
  - Loose stool

- **Initial blood work**
  - Elevated Hematocrit (50%)

- **Treatment**
  - Flunixin meglumine (1.1 mg/kg IM)
  - Butorphanol (0.02 mg/kg IM)

**NYAH**

6.5 year old female
Case #1: Day 2

- Clinical signs
  - Continued lethargy and anorexia
  - Hematuria
  - Diarrhea
  - Vomiting
  - Tremors
  - Scleral hyperemia
  - Skin ulcerations

- Blood work
  - Elevated Hematocrit (63%)
  - Band neutrophilia (4%)
  - Thrombocytopenia
  - Azotemia
  - ↑AST and ↑GGT
  - Hyperbilirubinemia
  - Hyperkalemia

- Treatment
  - IV and rectal fluids
  - Excede (6.6 mg/kg SQ)
  - Banamine (1.1 mg/kg IM)
Case #1: Day 3

- **Clinical signs**
  - Severe depression
  - Dyspnea
  - Marked abdominal distension
  - Subcutaneous edema in the head and forelimbs

- **Blood work**
  - Elevated hematocrit (58%)
  - Band neutrophilia (2%)
  - Monocytosis
  - Thrombocytopenia
  - Worsening Azotemia
  - ↑AST, ↑GGT, ↑CK
  - Hyperbilirubinemia
  - Hypoproteinemia

- **Treatment**
  - Furosemide (1 mg/kg IV)
  - Ceftiofur sodium (2.2 mg/kg IV)

- **Outcome**
  - Death in <72 hrs. from the onset of clinical signs
Case #1: Necropsy Findings

- Skin ulcerations
- Vulva
- Heart
- Lungs
- Liver
- Intestine
- Stomach
Case #1: Necropsy Findings

Spleen

Kidney

Messentery

Bladder
Histopathology

- Disseminated vascular necrosis with edema, hemorrhage, and endothelial cell intranuclear inclusions within the liver, kidney, spleen, and ovary
- Severe renal tubular necrosis
- Mild rhabdomyolysis

Photo Courtesy of Michael Garner, DVM, Dipl ACZM
EEHV Testing

• **Quantitative PCR** (performed postmortem on banked whole blood samples)
  - Day 1: 2,000,000 vge/ml (EEHV-3/4)
  - Day 2: 3,000,000 vge/ml (EEHV-3/4)

• **Whole genome sequencing**
  - Performed on frozen lung tissue
  - Strain identified as EEHV-3a
Case #2: Day 1

- **Presenting clinical signs**
  - Loose stool
  - Hematuria

- **Initial blood work**
  - Band neutrophilia (1%)
  - Monocytopenia
  - Thrombocytopenia

- **Treatment**
  - Famiclovir (12 mg/kg PO q 8 hr)
  - Butorphanol (0.02 mg/kg IM q 8 hr)
  - Ceftiofur sodium (2.2 mg/kg IM q 24 hr)
  - Rectal fluids (q 6 hr)

Kalina
7.5 year old female
Case #2: Day 2

- Clinical signs
  - Lethargy
  - Anorexia
  - Stiff gait
  - Abdominal pain
  - Frank hemorrhage in urine

- Blood work
  - Band neutrophilia (2%)
  - Monocytosis (69%)
  - Thrombocytopenia
  - Hypoalbuminemia
  - ↑AST and ↑GGT
  - Hyponatremia

- Treatment
  - Famciclovir (12 mg/kg PO q 8 hr)
  - Butorphanol (0.02 mg/kg IM q 8 hr)
  - Ceftiofur sodium (2.2 mg/kg IM)
  - Rectal fluids (q 6 hr)
Case #2: Day 3

• Clinical signs
  o Depression
  o Edema along ventrum and in hind limbs
  o Tremoring of the trunk
  o Diarrhea

• Blood work
  o Band neutrophilia (1%)
  o Thrombocytopenia (18,496/μL)
  o ↑AST and CK
  o Azotemia
  o Hyponatremia
  o Hypoproteinemia
  o Hyperglycemia

• Treatment
  o Dexamethasone SP (0.25 mg/kg IV)
  o IV fluids (crystalloids + Hetastarch)
  o 2L of plasma collected from dam
  o Famciclovir (12 mg/kg PO q 8 hr)
  o Butorphanol (0.02 mg/kg IM q 8 hr)
  o Ceftiofur sodium (2.2 mg/kg IV)
  o Rectal fluids (q 6 hr)
Case #2: Day 4

• **Clinical signs**
  o Rectal hemorrhage
  o Tachypnea
  o Tachycardia

• **Blood work**
  o Band neutrophilia (4%)
  o Thrombocytopenia
  o ↑AST and CK
  o Worsening Azotemia
  o Hyponatremia
  o Hypoproteinemia
  o Hyperglycemia

• **Outcome**
  o Death in <72 hrs. from the onset of clinical signs
EEHV Testing

- **Quantitative PCR** performed on whole blood
  - Day 1: 1,000,000 vge/ml (EEHV-3/4)
  - Day 2: 3,700,000 vge/ml (EEHV-3/4)
  - Day 3: 1,600,000 vge/ml (EEHV-3/4)
  - Day 4 (antemortem): 920,000 vge/ml (EEHV-3/4)
  - Day 4 (postmortem): 2,300,000 vge/ml (EEHV-3/4)
## Indianapolis Zoo EEHV Surveillance Program

<table>
<thead>
<tr>
<th>Section</th>
<th>ROUTINE MONITORING</th>
<th>CLINICAL SUSPECT</th>
<th>CONFIRMED CASE</th>
<th>MANAGEMENT OTHER CALVES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Purple top (whole blood)</strong></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Purple top (whole blood)</strong></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td><strong>Red top / tiger-top (serum)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Calves: Weekly: In-house Chemistry panel, SAA/haptoglobin (UM) and serum banking  Quarterly: CP (Idexx)  Adults: Quarterly: CP (Idexx), SAA (UM)  Serum banking</td>
<td>ASAP: In-house CP, SAA/haptoglobin (UM) Pre-meds once: 50-100mls for serum banking</td>
<td>Twice daily: In-house CP (priority: BUN/Creatinine) Weekly: SAA/haptoglobin-(UM) Save rest for serum banking</td>
<td>Daily: In-house CP</td>
</tr>
<tr>
<td><strong>Green top (plasma)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>N/A</td>
<td>ASAP: Blood gases /electrolytes</td>
<td>Twice daily: Blood gases / electrolytes</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Urine</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Calves: Monthly: In-house UA  Adults: Quarterly</td>
<td>ASAP: In-house UA Save rest for research*</td>
<td>Daily: In-house UA Once: Research</td>
<td>Daily: In-house UA</td>
</tr>
<tr>
<td><strong>Trunk Wash</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Weekly (banked)</td>
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</tr>
<tr>
<td><strong>Royal blue top</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Quarterly sample for NS</td>
<td>N/A</td>
<td>Weekly: Mineral panel (MSU)</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Case #3

- **Presenting clinical signs**
  - Loose stool
  - Lethargy

- **Initial blood work**
  - Mild anemia
  - Monocytopenia
  - Thrombocytopenia
  - ↑ Acute phase proteins (SAA, haptoglobin)

- **EEHV qPCR**
  - Day 1: 5000 vge/ml (EEHV-3/4)
  - Day 2: 17,250 vge/ml (EEHV-3/4)
  - Day 3: 115,000 vge/ml (EEHV-3/4)
  - Day 4: 265,000 vge/ml (EEHV-3/4)

Kedar
13 year old
Case #3: Treatment Summary

- **Transfusions**
  - Plasma (~2 L) on Days 2 and 3
  - Whole blood (2-3.5 L) one or two times/day on Days 4-7 (Total of 6 transfusions)

- **Antibiotics**
  - Ceftiofur sodium (2.2 mg/kg IM q 24 hr) Days 2-9

- **Anti-inflammatory**
  - Flunixin meglumine (0.3 mg/kg IM q 24 hr) Days 2-7
  - Meloxicam (0.03 mg/kg PO q 24 hr) Days 8-10

- **Gastroprotectant**
  - Omeprazole (1 mg/kg PO q 24 hr) Days 4-11

- **Anti-viral**
  - Famciclovir (15 mg/kg PO or rectally q 8 hr) Days 2-25

- **Fluids**
  - Rectally q 6 hrs. Days 2-10
  - IV crystalloids on Day 3 with plasma transfusion
  - Hetastarch (2L with each whole blood transfusion)

- **Other**
  - Vitamin C (6 mg/kg IV) on Day 3
  - Stem cells (100 x 10^6 in 10 ml) IV on Day 7
Blood Collection From Donor Elephant
Case #3: Outcome

- **Day 4**: Viral load peaked at 265,000 vge/ml (EEHV-3/4).
- **Day 6**: Most severe changes in blood work seen.
- **Day 7**: Clinical improvement was noted and platelet number started to increase.
- **Day 10**: Elephant was considered to be back to normal behaviorally.
- **Day 12**: All blood parameters within the normal range.
- **Day 12**: Viral load decreased to <1000 vge/ml (EEHV-3/4).
- **Day 16**: EEHV-3/4 qPCR was negative.
- **Day 17 to Present**: Intermittent low level viremia (<1000 vge/ml) of EEHV-2, 3/4, and 6
- **Day 25**: All treatment discontinued. Daily monitoring of blood work still performed.
- **Day 36**: Resumed routine blood work monitoring (2 times per week).
Case #4

- **Presenting Clinical Signs**
  - None
  - Lethargy and loose stool on Day 5

- **Initial blood work**
  - All normal on Days 1 and 2
  - Day 3:
    - Severe thrombocytopenia
    - Band neutrophilia (7%)
    - Mild anemia
    - ↑ SAA

- **EEHV qPCR**
  - Day 1: 21,000 vge/ml (EEHV-3/4)
  - Day 2: 115,000 vge/ml (EEHV-3/4)
  - Day 3: 115,000 vge/ml (EEHV-3/4)
Case #4: Treatment Summary

- **Transfusions**
  - Plasma (1.5-2.6L) on Days 3, 6, and 7
  - Whole blood (1.8L) twice daily on Days 4-6

- **Antibiotics**
  - Ceftiofur sodium (2.2 mg/kg IM q 24 hr) Days 3-10
  - Marbofloxacin (2 mg/kg PO q 24 hr) Days 6-17

- **Anti-inflammatory**
  - Flunixin meglumine (0.3 mg/kg IM q 24 hr) Days 3-6

- **Gastroprotectant**
  - Omeprazole (1 mg/kg q 24 hr) Days 3-10

- **Anti-viral**
  - Famciclovir (15 mg/kg PO q 8 hr) Days 3-25

- **Fluids**
  - Rectally (q 6 hr) Days 3-10
  - Hetastarch (2L with whole blood)
Outcome

- **Day 5**: Viral load peaked at 1,100,000 vge/ml (EEHV-3/4)
- **Day 6**: Most severe changes in blood work seen
- **Day 8**: Elephant clinically normal and blood work starting to improve
- **Day 14**: All blood parameters returned to normal
- **Day 20**: Viral load <1,000 vge/ml
- **Day 23**: EEHV-3/4 q PCR negative
- **Day 25**: Treatment was discontinued
- **Day 37**: Resumed routine monitoring of blood work (2 times per week)
Viral Testing (Whole Blood)

EEHV-3/4 qPCR Results

- Kedar
- Zahara
Viral Testing (Trunk Wash)

EEHV qPCR

- Kedar
- Zahara
- Ivory
- Kubwa
- Sophi
- Tombi

*Viremia first detected*
Case #5: “Ivory”

- **37 year old female**

- **Presenting clinical signs**
  - Moving slower than normal

- **Blood work**
  - 40% reduction in platelets initially
  - Marked elevation in SAA
  - EEHV-3/4 q PCR: 3,200 vge/ml

- **Treatment**
  - Famciclovir (15 mg/kg PO q 8 hr) x 11 days
  - Naxcel (2.2 mg/kg IM q 24 hr) x 5 days
  - Omeprazole (1 mg/kg PO q 24 hr) x 4 days
  - Flunixin meglumine (1.1 mg/kg IM) x 4 days
  - Rectal fluids (q 6 hr)

- **Outcome**
  - Viral load peaked at 12,600 vge/ml on Day 3
  - Platelets decreased by 63% on Day 3, returned to normal by Day 5
  - Viral load undetectable by Day 10
  - SAA gradually returned to baseline by Day 13
• **Surveillance is the key!**
• Clinical signs may be absent or subtle
• Establish normal reference ranges for blood parameters for each individual elephant
• Be prepared to provide early and aggressive treatment
• Training of staff and elephants is essential
QUESTIONS???
Indali Hi Way Case Study

The Preparation, Treatment and Recovery of an EEHV case at Chester Zoo

Rebecca Le Brocq
EEHV and Chester Zoo

- Chester Zoo is home to a multigenerational breeding herd of Asian Elephants
- Chester has previously lost calves to EEHV
- All calves have been around 2 years old
- Methods and protocols for managing the virus have been adapted after each episode
- In March 2019, 2yo Indali Hi Way became the first elephant to undergo EEHV treatment and survive
• **Temperatures:**
  – Daily record keeping shows the normal range for each individual

• **Mouth Presentation:**
  – Check for physical symptoms including discolouration and lesions

• **Behavioural monitoring:**
  – Detection of subtle changes in alertness, appetite, movement and willingness to participate
Preparation: Calf Access Training

• A specially designed, positive area for calves that allows more flexible and safe access for keepers

• Aim to normalise the treatment procedure, minimising stress

• Rectal access for rehydration and drug administration

• Injection training

• Ear presentation for blood sampling
Preparation: EEHV Screening

• EEHV can be detected in the blood weeks before physical symptoms arise

• Blood swabs were taken from the ear 3 times a week and sent immediately to lab on-site

• Samples tested for EEHV 1, 3 and 4 using PRC methods

• A positive result that can be repeated initiates a pre-planned treatment protocol
Preparation EEHV Screening

- Trunk swabs are taken weekly from adults and calves
- A positive result indicates ‘shedding’
- When a herd member is shedding, the virus is active and more present therefore calves maybe more at risk of infection
Preparation: Plasma Collection

- Platelets in plasma ‘patch up’ damage to blood vessels caused by EEHV
- Blood donated weekly from resident bull, Aung Bo
- Plasma had previously been cross matched with Indali
- Plasma is stored on site until needed
Treatment

• Indali was brought into the calf access as in the usual routine, kept close to mother at all times

• Under standing sedation, treatment included:
  – Anti-viral medication
  – Immune boosting proteins
  – Blood plasma transfusion
  – Rectal fluid therapy
  – Regular full blood sampling to monitor her condition
Treatment

• After continued invasive veterinary treatment, Indali became unwilling to enter the calf access

• Treatment continued with general anaesthetic on alternate days

• Interferon was administered daily

• This is the first case at Chester in which Interferon was used in treatment
Recovery

• After 3 days of treatment, Indali’s blood viral load dropped but remained extremely high throughout.

• Recovery of the white blood cell count and ratio indicated that the body had begun to fight the infection.

• A positive trunk swab also indicated that the body was dealing with the virus appropriately.
Recovery

• When the risk of dying from anaesthetic became greater than the risk from the infection, intensive intravenous treatment was stopped

• Indali was remixed with the herd as soon as possible

• Indali became suspicious of keepers and was unwilling to enter training pen

• Interferon continued to be administered through darting

• Indali continued to shed the virus for 54 days
How is Indali Today?

- Indali’s relationship with keepers has recovered, she is happy to enter the calf access and participate in the treatment routine.
- Calf access modifications are ongoing to make a more comfortable space for a calf to remain during treatment.
- Screening for the virus is continues for all calves.
- Funding for the research and development of and EEHV vaccine is ongoing.
EEHV Capacity building in Asia

IEF Elephant Research Symposium, Oct 22, 2019
Zebula, S Africa
...Smithsonian Institution, an establishment for the increase and diffusion of knowledge.

**Understanding and Sustaining a Biodiverse Planet**

We will use our resources across scientific museums and centers to significantly advance our knowledge and understanding of life on Earth, respond to the growing threat of environmental change, and sustain human well-being.

**Our Mission:** At the Smithsonian's National Zoo and Conservation Biology Institute, we save species. We provide engaging experiences with animals and create and share knowledge to save wildlife and habitats.
Funding sources

- Smithsonian Under Sec Of Science
- Dennis Kelly & Steven Monfort, National Zoo Directors
- EEHV Consortium
- US State Dept
- Wildlife Reserves Singapore
- International Elephant Foundation
- Asian Elephant Support
- Kasetsart University
- Game Rangers International
- IFAW
- Zoological Parks Of Thailand
Considerations

• Existing infrastructure—lab space, equipment
• Existing capacity nearby
• Trained personnel
• Research record
• Funding
• Sustainability
• Number of elephants in country
• Access to elephants—physical and administrative
• Value of data collected
India

Two trips, 1st in 2008

SI funded equipment, reagents, & training
India

**Then**
2 small rooms
Basic equipment for cPCR
EEHV focused

**Now**
5 rooms
- cPCR and qPCR
- biochem, hematology
- Other wildlife diseases
- Has done testing for Myanmar and Sumatra
- 2 papers published, 3 in review
Follow-up training from India

5 people from Myanmar Timber Enterprise in Myanmar, May 2013

2 people from Veterinary Faculty, University Syiah Kuala, Banda Aceh, Indonesia and PT Sarwa Duta Medical Laboratory for Animal Health, Bogor, Indonesia, Nov 2012

Regional Asian Elephants and Tiger Veterinary Workshop, Kerala Veterinary and Animal Sciences University, February 1st-4th, 2016
Very well-equipped lab (cPCR only)
Collaboration between SWD, EcoHealth Alliance, and DGFC
Our training trip in 2017 funded by US State Dept
12 participants from 5 countries
Workshop summary

• **Train-the-trainers format**

• Lecture and lab
• Run through of DNA preps
  — blood and TWs
• qPCR set-up
  — blood/standard curves and TWs
• cPCR set-up
  — 1st rounds and 2nd rounds
• PCR gels and analysis
• Provided reagents to bring home
Thailand follow-up June 2018

Run by Supaphen Sripiboon
Similar format to Nov workshop

**24 participants**, including:
- Veterinary Research and Development Center (Department of Livestock Development)
- National Institute of Elephant Research and Health Service
- Zoological Park of Thailand
- Department of National Park, Wildlife and Plant Conservation
- National Elephant Institute
- University
Sumatra follow-up -March 2018

Run by Chia-Da Hsu
Similar format to Thai workshop
**4 participants** at Syiah Kuala University
Lab is currently functional but they have manpower issues
cPCR and qPCR
Next Steps

**Myanmar**
Grant proposal submitted for equipment and training for a lab at Myanma Timber Enterprise, run by Zaw Min Oo

Training will be provided by one of our new trainers

**Sri Lanka**
Working with Vijitha Perera on funding for lab at University of Peradeniya

He was trained at Nov Thai workshop

Looking at prevalence, diagnostics

**Nepal**
Working with Amir Sadaula at National Trust for Nature Conservation to provide qPCR equipment. Well-equipped lab (USAID); looking for funding for qPCR

He was trained at the Thai workshop in Nov

**Vietnam**
Will be working with Phan Van Thinh in near future on building capacity
AZA Asian Elephant SAFE Team

• **Current Team**
  • Program Leader– Adam Felts, Columbus Zoo
  • Co Leaders– Nick Newby, White Oak, Martha Fischer, Saint Louis Zoo

• **Support Team**
  • FCC Liaison – Kevin Drees, Oklahoma Zoo
  • SAFE Coordinator – Kayla Ripple, AZA

• **Steering Committee**
  • Christina Gorsuch – Cincinnati Zoo
  • Rachel Emory – Oklahoma Zoo
  • Bob Lee – Oregon Zoo
  • Jordon Piha – Tulsa Zoo
  • Danielle Ross – Columbus Zoo
  • Brittany Fredrick – Denver Zoo
## Asian Elephant SAFE Program Partners

### Strategic Partners

- Heidi Riddle  
  Riddle's Elephant and Wildlife Sanctuary
- Deborah Olson  
  International Elephant Foundation
- Cory Brown  
  United States Fish and Wildlife Services
- Wahdi Azim  
  Aceh Center for Wildlife Studies
- Charlie Gray  
  Africa Lion Safari
- Lauren Howard  
  EEHV Advisory Group
- Erin Latimer  
  EEHV Advisory Group
- Michael Kreger  
  Columbus Zoo
- Grant Spickemier  
  Oregon Zoo
- Dr. Arun Zachariah  
  Wildlife Disease Research Laboratory
- Peter Donlon  
  SPECIES 360
3 Asian Elephant SAFE Objectives

1. Build an Asian Elephant Educational Awareness Campaign
2. EEHV Support in Range Countries
3. Develop a layered registry for Elephants in human care in Asia

- 3 year action plan available upon request: adam.felts@columbuszoo.org
EEHV Support in Range Countries

- Collaboration with the International Elephant Foundation and the EEHV Advisory Group
- **Generating funds** to combat EEHV in range countries (Sumatra, Myanmar, Nepal, Vietnam) that are in need of:
  - Drugs and medications
  - Lab enhancements for **tracking** and **treating**
  - Local capacity building
EEHV Support in Range Countries

- **Supporting science of the treatment and management of EEHV in Asian elephant range states:** SAFE will engage elephant care professionals to encourage/support fundraisers amongst AZA institutions directed towards supporting the needs of range states in the treatment and management of EEHV.

[INTERNATIONAL ELEPHANT FOUNDATION.ORG](http://www.eehv.org)
Efficacy of Asian elephant (Elephas maximus) fresh frozen plasma

Chatchote Thitaram
Araya Pakamma, Kontawan Arintasai, Pakkanut Bansiddhi, Siripat Khammesri, Chonticha Sirikul, Janine L. Brown, Preeyanat Vongchan
Introduction

Elephant health problems:

- **Elephant endotheliotropic herpesvirus (EEHV)**
- Coagulation disorders
- Severe blood loss
  
  can cause sudden death

  in elephant
Introduction

**Fresh plasma transfusion**
- Decrease risk of
  - Immunosuppression
  - Hypovolemic shock: Blood loss

**Fresh Frozen Plasma (FFP)**
- Coagulation factors
  - Fibrinogen
  - FVIII
- Albumin
- Immunoglobulin: IgG
Objective

To compare the efficacy of Asian elephant (Elephas maximus) fresh plasma after freezing

Hypothesis

Efficacy of Asian elephant fresh frozen plasma such as clotting factors and immunoglobulin G are not different between before and after freezing
Materials and methods

Timeline

Biochemistry test
- Immunoglobulin G

Biochemistry test
- Immunoglobulin G

Biochemistry test
- Immunoglobulin G
Materials and methods

Sample group

20 Healthy elephants
10-60 years
Maesa & Maetaeng Elephant Camp

10 Males

10 Females
Materials and methods

Blood collection: 30 ml
Collecting site: ear vain
Needle 18 G 1"

Clotted blood
16 ml

CPDA-1 Whole blood
16 ml
(WB 14 ml + CPDA-1 2 ml)

2500 rpm
10 min, 4°C

IGG: Biochemistry test

Fibrinogen, Factor VIII

Stored at -20°C

M4      M8   M12
M0      M4   M8   M12
M0      M4   M8   M12

Stored at -20°C
Materials and methods

Fibrinogen & Factor VIII

: Month 0, 4, 8, 12 thaw at 37 °C

Clotting assay
Automated Blood Coagulation Analyzer
CS-2500

Clotting time compared with standard curve → mg/dL(Fibrinogen)
%
(Factor VIII)
Materials and methods

**Immunoglobulin G**

: Month 0, 4, 8, 12 thaw at 37 °C

Colorimetric assay: Immunoglobulin (g/dL)
Automated blood chemistry analyzer
bx-3010
Materials and methods

Statistic analysis

Repeated measures ANOVA

- Compare means of the fibrinogen, factor VIII and immunoglobulin G concentrations in
  - male and female
  - fresh plasma (before) and fresh-frozen plasma (after freeze)
- mean ± standard error of mean (SEM)
- \( \alpha = 0.05 \)
- R-studio version 3.5.1
Results: sex bias

Fibrinogen

Non-significantly different (p=0.48, n=20)

Factor VIII

Non-significantly different (p=0.56, n=20)
**Results: sex bias**

Immunoglobulin G

Non-significantly different
(p=0.48, n=20)
**Results:** fibrinogen

Non-significantly different ($p=0.19$)
Results: factor VIII

Decreased significantly (p=0.03)
Results: Immunoglobulin G

Increase significantly (p<0.001)
Discussion

Fibrinogen levels in plasma before and after storage are not significantly different as same as the previous study in human. (Alesci et al., 2009)

Factor VIII levels in post-stored plasma was decreased significantly in this study as same as the previous study in dog. (Wardrop and Brooks, 2001)
Discussion

Fibrinogen

This study use the suitable assay for fibrinogen measurement.

The result from different method for fibrinogen measurement might be different from this study.

Factor VIII

The average concentration in post-storage plasma was decreased significantly.

The reason might be in preparing process.

Immunoglobulin G

Determined from serum instead of plasma because of the laboratory limitation.

IgG concentration after storage increase. The possible reason is protein aggregation after thawing the sample.
Discussion

According to the previous studies, thawing the sample at 37°C does not affect the result. (Isaacs et al., 2004)

The small volume sample could be frozen faster than the practical blood collection volume and the plasma composition lost less in this period, so the fibrinogen or other parameters might be different in level.

The FFP storage duration follow the previous study of Wardrop and Brooks in 2001 which the results were similar.
Conclusion

The efficacy of Asian elephant fresh frozen plasma, stored at -20 °C for 12 months was slightly different from the fresh one, but the clotting parameters were still acceptable and could be used in clinical treatment.
Further study

For the further study about the storage of FFP in Asian elephant

- Other coagulation factors
- Storage temperature
- Duration
- Volume
- Chemical substance
Acknowledgement

- Staff and mahout of Maesa elephant camp
  Maetaeng elephant camp
- Center of elephant and wildlife research, Faculty of Veterinary Medicine, Chiang Mai University
- Faculty of Associated Medical Science, Chiang Mai University
- Mharaj hospital, Faculty of Medicine, Chiang Mai University
Acute Phase Proteins as Indicators of the Elephant Immune Response to Infectious Disease

Katie L. Edwards, Erin M. Latimer, Jessica L. Siegal-Willott, Sharon S. Glaeser, Janine L. Brown
Why Measure Biomarkers of Disease

Infectious disease:
• Morbidity/mortality
• Population health
• Transmission
  • Conspecifics
  • Zoonotic

Biomarker: a biological molecule found in blood, other body fluids, or tissues that is a sign of a normal or abnormal process, or of a condition or disease.
Elephant Endotheliotropic Herpesvirus

- Infectious disease of African and Asian elephants
- Herpes virus co-evolved with elephants
- Multiple subtypes can be detected/identified by PCR
- Can result in acute hemorrhagic disease (HD)
- More than 100 confirmed cases of EEHV HD
- High mortality rate when HD occurs
- Reported in animals under human care and in the wild
- Immune processes between different strains and between fatal vs. non-fatal cases unknown
Mycobacterium tuberculosis

- Infectious disease of African and Asian elephants
- Zoonotic
- Around 10% elephants in North America
- In situ prevalence difficult to assess
- Human tests to detect latent infection unreliable
- Trunk wash culture and serology currently used
- Immune processes underlying susceptibility to infection, transition from latent to active disease and treatment unknown
Objectives

To determine whether biomarkers of immune function can be useful indicators of infectious disease, underlying host: pathogen immune processes, treatment efficacy and prognosis.

Do immune biomarkers differ between different types of EEHV, or with increasing severity?

Do immune biomarkers indicate altered immune function during the transition between *M. tb* infection/disease states?
Acute Phase Proteins

• APPs provide a generalized early defense against tissue injury

• Innate immune response
  • Fast-acting
  • Non-specific

• Indicators of inflammation, infection, neoplasia, stress, and trauma

• Major: fast response, increase 10- to 1000-fold

• Moderate/minor: increase more slowly, increase 2- to 10-fold

INJURY

Pro-inflammatory cytokines (e.g. TNF-α, IL-6)

Liver

Acute phase proteins (e.g. SAA, HP)
Serum Analyses

**EEHV**

\[ N_{\text{ind}} = 14 \ (1 \text{ African, } 13 \text{ Asian}) \]
\[ N_{\text{cases}} = 32 \ (22 \text{ qPCR}) \]
\[ N_{\text{fatal}} = 5 \]

**TB**

\[ N_{\text{ind}} = 4 \text{ Asian} \]
\[ \text{Duration} = 3 - 5 \ 1/2 \text{ years} \]

RX Daytona clinical chemistry analyzer
Serum Amyloid A – Eiken
Haptoglobin – Tridelta
APPs in Elephants

**L.a**

- Serum Amyloid A (mg/l): RI: 0.100 – 6.914mg/l
- Haptoglobin (mg/ml): RI: 0.213 – 2.349mg/ml

**E.m**

- Serum Amyloid A (mg/l): RI: 0.100 – 37.617mg/l
- Haptoglobin (mg/ml): RI: 0.242 – 3.999mg/ml
APPs During EEHV Viremia

Age 4 ½
EEHV1

Whole blood viral load by qPCR (vge/ml)

Age 11
EEHV5

Whole blood viral load by qPCR (vge/ml)
APPs During EEHV Viremia

Age 4 ½ EEHV1

Age 11 EEHV5
APPs During EEHV Viremia

- Serum amyloid A (mg/l)
- Haptoglobin (mg/dl)

P = 0.005

N_{ind} = 14
N_{cases} = 32
APPs During EEHV Viremia

\[ N_{\text{ind}} = 14 \]
\[ N_{\text{cases}} = 22 \]
APPs During *M. tuberculosis* Infection
APPs During *M. tuberculosis* Infection
Conclusions

• Acute phase proteins are useful early indicators of infection in elephants

• They are non-specific biomarkers of inflammation, and should be used alongside other diagnostic tests

• Need to further understand whether increased SAA prior to detection of EEHV viremia may indicate co-morbidity or early response to viral presence

• APPs may indicate changes in TB activation, but are complicated by co-morbidities
Acknowledgements

- Oregon Zoo
- Institutions that supplied samples
- Carly Dickson
- Erin Latimer
Revisiting the population size of the largest sub-population of the Borneo elephant

Cheryl Cheah (WWF-Malaysia)
K. Yoganand (WWF- Greater Mekong)
Introduction


- **Totally protected species** under the Sabah Wildlife Conservation Enactment (WCE) 1997

- **Major Threats:** *Conversion and fragmentation of forests, Human-Elephant Conflict (HEC) and Poaching*

- The Central Sabah subpopulation, in addition to being the largest subpopulation of Borneo elephants, also has the greatest opportunity for long term conservation due to the size of contiguous habitat available.

- Central Sabah elephant range hosts a fairly large and un-fragmented population of elephants.

- **Study aim:**
  a) to obtain an up-to-date estimate of population size, eight years had passed since the previous estimate was made in 2007-08 (Alfred *et al.*, 2010)
  b) because substantial ambiguity was noticed in the previous estimate.
Elephant range in Sabah & Study site

1,132 elephants
(Alfred et al., 2010)
Methodology: Dung count methods

\[ \hat{D}_a = \frac{\hat{D}_s}{\hat{p} \times \hat{t}} \]

- Dung count survey methods were used to estimate population size.
- 3 components to a dung density based population survey
  a) Estimating dung pile density
  b) Estimating dung decay (persistence time)
  c) Estimating defecation (dung production) rates
Methodology: Estimating defecation rates

We used a mean defecation rate of 18.15 defecations per day from a study in Sumatra of wild-caught and tamed elephants which foraged naturally in the forest. (Tyson et al., 2002; Hedges et al., 2005).
Methodology: Estimating dung decay

We used the ‘retrospective’ method of estimating dung decay rate (Laing et al., 2003; Hedges & Lawson, 2006; Hedges, 2012), which involved monitoring dung decay preceding transect surveys for density estimation.

Fresh dung piles (moist, slimy, shiny and with flies often present - less than two days old dung) were searched for and marked monthly from November 2014 until August 2015.
Methodology: Estimating dung decay

- The dung piles were classified using the CITES MIKE Program’s “S” system.
- The dung piles corresponding to the classes ‘S1’ and ‘S2’ were included in the decay rate estimation and those in the ‘S3’ and ‘S4’ stages were considered decayed.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>All boli are intact (see notes below).</td>
</tr>
<tr>
<td>S2</td>
<td>One or more boli (but not all) are intact.</td>
</tr>
<tr>
<td>S3</td>
<td>No boli are intact, but coherent fragments remain (fibres are held together by fecal material, see notes below)</td>
</tr>
<tr>
<td>S4</td>
<td>No boli are intact; only traces (e.g., plant fibres) remain; no coherent fragments are present (but fibres may be held together by mud, see notes below).</td>
</tr>
<tr>
<td>S5 (gone)</td>
<td>No fecal material (including plant fibres) is present.</td>
</tr>
</tbody>
</table>
Methodology: Estimating dung pile density

• 75 line transects targeted to be 1 km long were surveyed for dung and were chosen randomly.

• Transect surveys were conducted from June to December 2015.

• For each dung pile detected along the transects, the perpendicular distance of the centre of the dung pile from the transect line was measured.
Methodology: Estimating dung pile density

- Transect locations were based on stratified random sampling
- Survey period: June – Dec 2015
- High suitability stratum: Size: 3,655 km², No. of transects: 57 transects
- Medium suitability stratum: Size: 1,844 km², No. of transects: 18 transects
Methodology: Data analysis

- Bayesian analysis was used to estimate dung decay and dung pile density.

- Models were run using the package JAGS v.4.3.0 (Plummer, 2017) in R environment v.3.2.5 (R Development Core Team, 2016). The R script and JAGS code for the model are available from Këry & Royle (2016).

- Densities were estimated for each stratum separately and the overall density for the study area was calculated as a weighted-mean of densities of each stratum weighted by their proportional extent.
Results

Estimating dung decay (persistence time)

- Observations on 97 dung piles were analysed where a posterior mean of 212 days (95% BCI: 133 - 319) was obtained.
- The posterior mean of probability of detection of dung in transect surveys, ‘p’, was 0.31 (95% BCI: 0.25 – 0.36)
Results

Estimating dung pile density and elephant population size

- The area-weighted overall elephant density for the study area was 0.07 per km$^2$ (95% BCI: 0.03 – 0.11)
- Population size (abundance) = Density X Size of study area
- The area-weighted population size was 387 elephants (95% BCI: 169 – 621) for the Central forest elephant subpopulation.
Discussion

• The previous estimated population size of 1,132 individuals was thrice larger.

• A comparison of land use showed no drastic adverse changes between 2008 and 2015, instead there has been a substantial increase in forest areas allocated for protection.

• It is unlikely that habitat changes or other external factors caused a population to decline so quickly and therefore both estimates should not be compared to infer population trends.

• A close review of the previous study revealed a flawed study design and methods, large errors and many ambiguities.
## Discussion

<table>
<thead>
<tr>
<th>Methodological issues</th>
<th>Alfred et al. (2010)</th>
<th>This study</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Location of transects</strong></td>
<td>Non-random layout of survey transects – close to roads, trails, rivers</td>
<td>Stratified random sampling layout–has strong theoretical basis and widely used for density estimation (Williams et al., 2002).</td>
</tr>
<tr>
<td><strong>Estimation of defecation rate</strong></td>
<td>Captive elephants fed natural fodder over a limited period of day (a defecation rate of 8.68 defecations/day).</td>
<td>Used a published estimate obtained from monitoring tamed elephants foraging entirely naturally in forest habitat (a rate of 18.15 defecations/day; Tyson et al., 2002; Hedges et al., 2005).</td>
</tr>
<tr>
<td><strong>Estimation of dung decay rate</strong></td>
<td>Dung piles were relocated which may affect decay rates resulting in a biased estimate.</td>
<td>In situ monitoring of dung piles conducted.</td>
</tr>
<tr>
<td></td>
<td>‘Prospective’ method (Laing et al., 2003) – does not estimate the decay rate of dung piles that are present at the time of transect surveys. Rather it estimates the decay rates after the dung density surveys are conducted</td>
<td>‘Retrospective’ method (Laing et al., 2003) – estimates the decay rates preceding the transect surveys and thereby producing the pattern of decay stages seen in dung counted during the transect survey.</td>
</tr>
<tr>
<td><strong>Size of study area for estimation of population size</strong></td>
<td>953.45 km$^2$ of suitable habitat in Central Sabah was used in the estimation. Ambiguous - as the calculated area is very different from the area mapped as suitable habitat in Alfred et al. (2010).</td>
<td>5,498.8 km$^2$ was used in the estimation.</td>
</tr>
</tbody>
</table>
Discussion

- GPS-collar based tracking of over 10 adult female led groups (WWF-Malaysia, unpublished data) suggested that many collared groups moved over 70 – 80% extent of the Central Sabah elephant range.

- This population can be considered large enough to be viable over the long term.

- Sub-population may be impacted by indiscriminate killing by poisoning/shooting in retaliation for crop damage, indiscriminate snaring and poaching.

- Our estimates will be used for advocacy with the Sabah government to influence conservation and management policies for the species.

- These policies include translocation of problematic elephants, culling aggressive elephants, immuno-contraception on wild populations and export of captive elephants.
Conclusion

• Reliable data and inference are crucial to guide conservation policies and actions for the species, instead of ad-hoc management.

• With this new population estimates in place, it is hoped that the current management practices for the species will be amended and implemented on the ground accordingly in order to safeguard their survival over the long-term.

Recommendations for future population surveys

i) We recommend having a longer period of monitoring (>18 months) for dung decay rate estimation.

ii) More sampling effort for transect surveys (≥100 transects) to estimate the dung pile density as this will yield more robust estimates and smaller credible intervals.
Thank you!
Debunking Critical Assumptions to Improve Forest Elephant Census and Monitoring

Amelia Meier
Duke University
African Elephants
Forest Elephant

- Eat fruit, leaves, bark, grass in some cases
- Eat over 300 species of plants
- Reach maturity 20-25
- First offspring at ~23 years
- Average group size 3-4 indiv.
Recent Drastic Declines

Approximately 100,000 forest elephants remaining.
(Maisels et. al 2013)

(Minkébé National Park (Gabon))

(Poulsen et. al 2017)
Counting Elephants
Line Transect Surveys

\[
\text{# of Elephants} = \frac{\text{Density of Dung Piles} \times \text{Decay Rate}}{\text{Defecation Rate}}
\]
### Line Transect Surveys

(Poulsen et al. 2017)

<table>
<thead>
<tr>
<th></th>
<th>Dung decay (days)</th>
<th>Estimated density (individuals km⁻²)</th>
<th>Estimated abundance (individuals)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Lower CI</td>
<td>Upper CI</td>
</tr>
<tr>
<td>Mankwe NP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(927 km²)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>19.0</td>
<td>5.80</td>
<td>9.00</td>
</tr>
<tr>
<td></td>
<td>18.5</td>
<td>3.50</td>
<td>4.80</td>
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<tr>
<td></td>
<td>16.0</td>
<td>1.20</td>
<td>3.70</td>
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<tr>
<td></td>
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<tr>
<td>2004</td>
<td></td>
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<td></td>
<td>19.0</td>
<td>5.80</td>
<td>9.00</td>
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<td>18.5</td>
<td>3.50</td>
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<td></td>
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</tr>
</tbody>
</table>
**Line Transect Surveys**

(Poulsen et al. 2017)
Line Transect Surveys

20% less elephants!

(Poulsen et. al 2017)
Factors Affecting Degradation
Factors Affecting Degradation
- Precipitation
- Sunshine
Factors Affecting Degradation

- Precipitation
- Sunshine
- Habitat Type
- Canopy Cover
- Substrate
Factors Affecting Degradation
- Precipitation
- Sunshine
- Habitat Type
- Canopy Cover
- Substrate
- Animal Disturbance
Factors Affecting Degradation
- Precipitation
- Sunshine
- Habitat Type
- Canopy Cover
- Substrate
- Animal Disturbance

Dung Characteristics
- Initial Dung Stage
- Number of Boli
- Size of Boli
- Composition
Methods

1) Observed 188 dung piles degrade
2) Collected field data
3) Downloaded remote sensed layers
Methods

1) Observed 188 dung piles degrade
2) Collected field data
3) Downloaded remote sensed layers
4) Determined relevant variables
   • Counting-Process Weibull Survival Model
     • Field Model
     • Remote Sensed Model
     • Combined Model
     • AIC selection
5) Validated with data withheld from model selection
Results – Important Variables

1) Field Data Model

- Animal Disturbance
- Substrate
- Habitat Type
- Canopy Cover
- Number Boli
- Number of Seeds in the Dung
Results – Important Variables

1) Field Data Model
   • Animal Disturbance
   • Substrate
   • Habitat Type
   • Canopy Cover
   • Number Boli
   • Number of Seeds in the Dung
Results – Important Variables

2) Remote Sensed Model

- Slope
- Temperature
- NDVI (vegetation complexity)
- Precipitation
- Canopy Cover (broad scale)
- Humidity
Results – Important Variables

2) Remote Sensed Model

• Slope
• Temperature
• NDVI (vegetation complexity)
• Precipitation
• Canopy Cover (broad scale)
• Humidity
Results – Important Variables

1) Field Data Model
- Substrate
- Habitat Type
- Canopy Cover
- Number of Seeds in the Dung

2) Remote Sensed Model
- Precipitation
- Canopy Cover (broad scale)
- Humidity

3) Combined Model
- Substrate
- Habitat Type
- Canopy Cover (field)
- Number of Seeds in the Dung
- Precipitation
- Humidity
- Tree Canopy Cover
Results – Important Variables

1) Field Data Model
   • Substrate
   • Habitat Type
   • Canopy Cover
   • Number of Seeds in the Dung

2) Remote Sensed Model
   • Precipitation
   • Canopy Cover (broad scale)
   • Humidity

3) Combined Model
   • Substrate
   • Habitat Type
   • Canopy Cover (field)
   • Number of Seeds in the Dung
   • Precipitation
   • Humidity
   • Tree Canopy Cover
Results – Predictive Ability
Differences in environmental variables can cause large downstream variation in population estimations.
Differences in environmental variables can cause large downstream variation in population estimations.
Implications

- All three elephant species
- Studies that use dung counts
- Multi-site/ national surveys
- Repeating surveys over time
  - Reduces observer bias
Thank you!
Questions?
Pathways back to Zambia:
re-establishing elephant migration routes through transboundary conservation

Dr Kerryn D. Carter
John Carter
Elephant Connection Research Project
Kavango Zambezi TFCA, Zambia
info@elephantconnection.org
Definitions

Transboundary Conservation – the process of cooperation to achieve conservation goals across one or more international boundaries

Wildlife Corridor - a usually linear landscape that connects patches of natural habitat and functions to facilitate movement

Transfrontier Conservation Area – an ecologically connected area that sustains ecological processes and crosses one or more international boundaries, and which includes both protected areas and multiple resource use areas
The Kavango Zambezi Transfrontier Conservation Area
Maps courtesy of KAZA TFCA www.kavangozambezi.org
## Elephant population

<table>
<thead>
<tr>
<th>Country</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angola</td>
<td>3,396</td>
</tr>
<tr>
<td>Botswana</td>
<td>131,626</td>
</tr>
<tr>
<td>Namibia</td>
<td>22,754</td>
</tr>
<tr>
<td>Zambia</td>
<td>21,967</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>82,630</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>262,373</strong></td>
</tr>
</tbody>
</table>

*Population estimates from IUCN African Elephant Status Report 2016. Overall Africa estimate 415,428*
KAZA TFCA Wildlife Dispersal Areas
Objective 1: Facilitate the development of an integrated land use planning process to secure long-term ecosystem integrity and **connectivity of KAZA’s elephant population**

Objective 2: Maintain and manage KAZA’s elephants as **one contiguous population**

Objective 3: Promote and support **co-existence of humans and elephants** for ecological, social and economic benefits

Objective 4: Reduce the **illegal killing** and trade in elephants and elephant products

Objective 5: Establish a high-level decision-making process on which to build the planning framework for conserving KAZA’s elephants
Objective 1: Facilitate the development of an integrated land use planning process to secure long-term ecosystem integrity and connectivity of KAZA’s elephant population

- Undertake a Strategic Environmental Assessment for KAZA on key transboundary wildlife corridors to strengthen and secure governments’ recognition to the importance of maintaining key KAZA corridors. This should be linked to large landscape planning in contrast to more traditional land use planning.
- Harmonize legislation and policy to secure (formal, legal recognition) WDAs, elephant movement corridors and landscape-level land uses.
- Secure WDAs and elephant corridors within and between these dispersal areas for the long term.

Objective 2: Maintain and manage KAZA’s elephants as one contiguous population

- Collect local movement data using long term collared elephant data and ground surveys at different scales and in different places.
- Improve understanding of how elephants occupy and use habitats and resources across the KAZA landscape.

Objective 3: Promote and support co-existence of humans and elephants for ecological, social and economic benefits

- Build capacity of community-based coexistence management i.e. mitigation through local level land use planning and use of local knowledge.
- Engage relevant stakeholders in co-existence and mitigation measures.
Transboundary collaboration

Zambia elephant study
Zambia elephant study
Zambia elephant study

- Human settlements
- Deforestation
- Game fences
- HEC
- Illegal activities
  - Logging
  - Charcoal production
  - Poaching
Methods for re-populating elephants

Forced translocations
- Quick result
- Expensive
- Long-term success?

Natural immigration
- Longer timeframe
- Investment in land use planning required
- Community engagement essential
- Law enforcement upscaling
- Long-term success?
Will elephants return to Zambia?

Kafue NP

Chobe NP
Identifying corridors for protection
Implications of Success

➢ HEC – conflict over both food & water resources
➢ Teaching communities how to live with elephants
➢ Relocating villages out of corridors
Pathways back to Zambia: re-establishing elephant migration routes through transboundary conservation

Partners & Donors
Pathways back to Zambia: re-establishing elephant migration routes through transboundary conservation
Vasectomy of Free Ranging African Elephants as a Conservation Management Tool

Kari Morfeld, PhD
Elephant Population Management Program & For Elephants, Inc.
Biodiversity, Ecosystem Health & Animal Welfare
Elephant Family Planning

WHY?
EPMP Goals

Provide a tool which can:

• Aid in biodiversity and ecosystem health
• Reduce the need for culling
• Help wildlife managers and officials with elephant management
Elephant Population Control Options

- Do nothing
- Cull
- Vasectomy-EPMP
- Translocate
- Contraception
Elephant Population Control

- Reduce population growth rate
- Promote ecosystem health
- Maintain normal social behavior in focal and area elephants
Vasectomy
Vasectomy

- Proven effective in humans and animals
- Permanent contraception
- Only need to do dominant bulls
- One time – permanent
- Flexibility based upon reserve needs
Where have we worked?

- Welgevonden
- Makalali
- Songimvelo
- Swaziland
- Pongola
- Phinda
Elephant Immobilization
Elephant Surgery in the Bush
Patient Positioning & Prep
Anesthesia
Elephant laparoscope
Laparoscopic surgery
Laparoscopic view

Testes

Vas deferens

Vas deferens removed
Recover Quickly and Heal Well
Population Modeling

Focus on dominant bulls*

• 2% of entire population – vasectomy
• Yield a 60% decline in population growth

• Vasectomy of all mature bulls
• Yield a 100% decline in population growth at 2 years

*Bokhout et al. Pachyderm No 39. 2005
Time

- Surgery time = 45-60 minutes
- Total down time about 1.5 hours
- Perform procedure on 3 bulls per day
Costs

EPMP provides:

• All surgical & anesthetic equipment and supplies
• All travel costs for team
• An additional $10,000 USD donation for expenses to participating reserve

Reserve responsible for:

• Helicopter and crane truck costs
• Hire of wildlife veterinarian
• Local room & board for group during
Behavior Implications

Pongola Game Reserve
Vasectomy on 7 males (ages 17-25) in 2008
Post-vasectomy monitoring for physical and behavioral effects 2011-2016 (Zitzer & Boult, 2018)

- Musth
- Male dominance hierarchy
- Male Association Patterns
Next Step: Long-term success & effects
Thank You!

- EPMP Team & President Dr. Mark Stetter
  - Colleen & Ted Hubbard
  - Dr. Dee Hutchins
  - For Elephants, Inc.
- International Elephant Foundation

www.elephantpmp.org
www.4elephants.org
Best practice transdisciplinary mitigation approaches to human-elephant conflict: from over-population to individual animals

Audrey Delsink, JJ van Altena, Hendrik Bertschinger and Robert Slotow
Introduction

• With increasing human populations and local elephant densities, human-elephant conflict (HEC) is increasing.
• HEC consequences vary from mild to extreme, with direct/indirect impacts.
South African elephants

- In South Africa, all elephant populations are fenced-in.
- 1/3 populations = multiple stakeholders and land uses.
- Fences challenge
  - 1) management
  - 2) normal bull biology and behaviour
- Closed-in status necessitates management.
Why Immunocontraception for population control?

• Fenced-in populations = irruptive growth, needs management.
• Immunocontraception = non-hormonal, non-steroidal, remotely deliverable, highly efficacious, cost-effective, target specific pro-active method.
• 28 reserves with >900 females on treatment (includes private, provincial and national reserves) spanning 22 years (Delsink et al. 2013; Bertschinger & Delsink et al. 2018)
“Problem” elephants vs normal behaviour?

• Bull dispersal = increased opportunity to encounter fences = increased opportunity for conflict.

• Elephants with repeated perceived “negative tendencies” are referred to as “problem elephants”.

• Long-term, HEC is not resolved by lethal control.

• Complex problem → poorly maintained fences → high local elephant density → encroaching human activities/settlements → management interventions/zonations not biologically relevant to elephant or appropriate for managing the ecological or human-wildlife impact of elephant (Delsink et al. 2013b).

• Removal of older males drives fundamental changes in reproductive tactics (Taylor et al. 2019)
Understanding the root of the problem

• “HWC’s are in essence conflicts between stakeholders, and perhaps more accurately presented as ‘human-human conflicts’”. [https://www.hwcconference.org/Human-Wildlife-conflict](https://www.hwcconference.org/Human-Wildlife-conflict)

• Many approaches to HEC are evidence-based.

• However, a transdisciplinary expert panel approach is needed.

Resources held, managed and shared

Complex elephant biology & ethology


• 3 panels facilitated – risk-based approach to management of elephants.
How to implement a risk-based approach?

• Create a framework for risk assessment to identify:
  • Objectives and main issues of concern/risks
  • Evaluate the severity of the risk and the probability of occurrence of the risk.

• Provides a visual representation of the sense of risk and immediacy.

## Prioritizing risks and mitigation actions

<table>
<thead>
<tr>
<th>TOP THREE MAIN ISSUES OF CONCERN</th>
<th>MITIGATING ACTIONS</th>
<th>MITIGATION SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Short Term: 6 months to 1 year</td>
<td>Medium: 1-2 years</td>
</tr>
<tr>
<td>People’s behaviour</td>
<td>3.25 1.5 1 2.17 2.83 2.27 1.17 1 192 2.33 1</td>
<td>2.45 4.33</td>
</tr>
<tr>
<td>Geographical Hotspots of Risks</td>
<td>1.25 2.75 3.25 3.55 2.17 2.08 3.58 2.92 2.42 3.17 3.42</td>
<td>3.64 4.33</td>
</tr>
<tr>
<td>Sudden Encounters</td>
<td>2.67 2.25 2.92 3.5 125 158 2.92 3.08 2.92 4.5 3.08</td>
<td>3.5 3.92</td>
</tr>
</tbody>
</table>

**MITIGATION SCORE**

7.2 6.5 7.2 9.2 6.3 5.9 7.7 7.0 7.3 10.0 7.5 9.6 12.6 12.7

2 PZP Study Sites

- Reserve A = Breaches of internal fence by a specific dominant bull
- Reserve B = Breaches of internal perimeter/island property fences
Mitigating Actions

Collars for pro-active management (1)

- GPS Vertex plus satellite collar
- 6 collars (3 cows & 1 bull at Reserve A, 1 cow & 1 bull at Reserve B)
Collars for pro-active management (2)

**Figure 1:** Illustration of Vertex Plus Collar and UHF ID Tags supplied by Global Supplies to allow for early and swift management intervention if target animals approach or breach buffer areas and boundaries. (Modified from Vectronic Aerospace).
Traditional methods of chasing or keeping elephants away

- Elephants are highly adaptable and rapidly habituate to ‘empty threat’ deterrent methods – those which scare, but cause no physical harm.
Novel sensory mitigation strategies to curb fence-breaching or turn elephants (1)

- Bee-hive fence in hotspot area.
- Simpler elephant deterrents to turn elephants from fences etc e.g. chilli smoke briquettes and more advanced technology such as drones.

Figure 2: Bee-hive fence at Reserve A; position illustrated on map, together with UHF ID tags (Fence tags 1-3), dashed line is 2-strand electric fence to keep elephants out of northern area, red ellipticals are hot spot zones. Photos: A Delsink.
Novel sensory mitigation strategies to curb fence-breaching

• Tusk-bracing is a novel and innovative method.
• A more immediate and individual behavioural modification tool.
• Reaffirms negative association with electric fences.
• Dominant “problem” bull’s tusks tusk-braced at Reserve A and B.

**Figure 3:** a) how an elephant uses its tusks to snap electric fence b) fitting wires to top and underside of reserve A’s bull’s tusk during tusk-bracing procedure and c) reserve A’s bull after tusk-bracing.
Results: Tusk-bracing Reserve A

**Figure 4**: Bull A’s movements prior to and a month post collar deployment and tusk-bracing. Note only 2 breaches into the no-go area.
But...

• Unfortunately, Bull A broke his right tusk in a fight with another bull (tusk also broke) a month post tusk-bracing, rendering the wiring redundant.

#RiffRaff #elephant
Results: Tusk-bracing Reserve B

**Figure 5**: Bull B’s movements 5-months pre and 4-months tusk-bracing.
Conclusions

• Expert and stakeholder risk assessments are critical for success.
• “Problem behaviour” is not generic elephant behavioural ecology.
• Non-lethal techniques facilitate the management of and successfully mitigate or reduce HEC, from an individual to local population scale, particularly for fence-breaching activities.
• Key is
  – Stakeholder engagement, commitment and accountability
  – identification of the main issues of concern or risk
  – Realistic management of the resources relevant to biological needs of the elephant
Thank you IEF, presenters and attendees

Non-lethal mitigation and management actions according to the species biological needs are critical to human wildlife co-existence.
New methods utilized to deter African elephants (*Loxodonta africana*) from crop raiding in the Kasigau Wildlife Corridor, Kenya

R. L. Von Hagen
INVESTIGATORS

- Dr. Bruce Schulte, WKU
- Dr. Mwangi Githiru, WW
- Dr. Urbanus Mutwiwa, JCUAT
- Dr. Chris Lepczyk, AU
- Simon Kasaine, WW
- Bernard Amakobe, WW
Human Elephant Conflict (HEC)

- Agricultural Expansion
- Crop Raiding
- Negative Outcomes
- Elephant Conservation
Traditional Deterrent Methods

- Barriers
- Guarding
- Fear of Humans
Deterrent Methods-Behavioral Contexts

• Costs & Benefits
• Signal Theory + Negative Associations

Resistance to Habituation

Practical
Affordable
Modern Deterrent Methods

- Chili Pepper Fence
- Bee-Hive Fence
- Electric Fence
Selected Deterrents:
Acacia Fence
Chili Fences
Metal Strip Fence
Combine Chili + Metal Fence
HYPOTHESIS.

• The chili + metal fence would have the highest efficacy, followed by the chili or metal strip fences, and lastly the acacia fence.
- The Kasigau Wildlife Corridor near Tsavo National Parks, Kenya Rukinga Wildlife Sanctuary
- The country’s largest elephant population
Experimental Design
Paired Control

Metal Strip (Kasaine) Fence
Chili Pepper Fence
CHILI + METAL FENCE
ACACIA FENCE
RESULTS

- Elephants approached all treatments equally, but not all blocks (ANOVA)
- Data analyzed at 25 m or less w/ Fisher’s exact test
- 419 visits to farms
RESULTS

• 33 successful crop raids/16%
• The metal fence and chili + metal fence demonstrated a significant deterrence effect**
RESULTS-SURPRISES

- Chili fence performed poorly
- Elephants reacted to the metal control
- Eland presence was substantial
Affordable
Practical
Resistance to Habituation
Affordable
Practical
WHAT NEXT?

- Beehive fences
- Double Kasaine fence
- New fence combinations

COMMUNITY WORKSHOP PROGRAMS

- CLIMATE SMART AGRICULTURAL PRACTICES
- CONSERVATION EDUCATION
- ELEPHANT EDUCATION
- SUSTAINABLE LIVELIHOODS
- DETERRENT METHODS
ACKNOWLEDGEMENTS:

Earthwatch Institute

WKU Graduate School

WKU Sisterhood

Elephants and Bees Project

Save The Elephants

IACUC Permit # 16-02
Graduate Committee Members: Dr. M. Stokes & Dr. N. Rice
QUESTIONS?
Patterns of human–elephant conflict inferred from field observations of Asian elephants in Sri Lanka

Chase A. LaDue, Rajnish P. Vandercone, Wendy K. Kiso, and Elizabeth W. Freeman
Human–elephant conflict (HEC) remains a major threat to Asian elephant populations.

In 2018, HEC resulted in 319 elephant and 96 human deaths in Sri Lanka.
In Sri Lanka, rather **large elephant** concentrations are occupying relatively **little land area**.

**BACKGROUND:** HUMAN–ELEPHANT CONFLICT

Fernando et al., 2019
In Sri Lanka, humans inhabit **70%** of elephant habitat. HEC is **not equally distributed** throughout the island.

**BACKGROUND:** HUMAN–ELEPHANT CONFLICT

2015

Fernando et al., 2019
There is evidence that **male elephants** are disproportionately involved in HEC.

**BACKGROUND: HUMAN–ELEPHANT CONFLICT**

88% of crop-raiding incidents in southeastern Sri Lanka occurred by male elephants.

Ekanayaka et al., 2011
There is evidence that **male elephants** are disproportionately involved in HEC.

**Male Asian elephants exhibit behavioral plasticity** along environmental gradients. e.g., Kumar and Singh, 2010; Srinivasaiah et al., 2019

**Significant behavioral and physiological shifts** occur during **musth** may drive changes in male elephant ecology. e.g., Chelliah and Sukumar, 2015; Taylor et al., 2019
There is evidence that **male elephants** are disproportionately involved in HEC.

**PROJECT QUESTIONS**

- How does **musth** influence how male Asian elephants respond to other elephants and their environments?

  Can we use this information to better manage and conserve Asian elephants?
All study sites are located in the North Central Province of Sri Lanka, where high rates of HEC occur.

- **Wasgamuwa National Park** surrounded by large areas of agriculture
- **Kaudulla National Park**
- **Minneriya National Park** subject to high levels of ecotourism

courtesy of Google Earth and Fernando et al., 2019
STUDY SITES: WASGAMUWA NATIONAL PARK

- 39,300 ha
- dry zone climate
- primary, secondary, and riverine forests
- large, grassy patches
- sampled elephants Dec 2018–Apr 2019
STUDY SITES: WASGAMUWA NATIONAL PARK
FIELD METHODS: DATA COLLECTION

- sampled elephants from vehicle on park roads from 06:00 through 18:00
- recorded age, sex, and location of all elephants encountered
- conducted behavioral observations on male elephants ≥10 yrs
- collected opportunistic fecal samples from male elephants
FIELD METHODS: DATA COLLECTION

**001**
"Arnold"
Age Category 3
Wasgamuwa NP
18 Dec 2018
- left side bullet in middle of body
- right side bullet close to right arm pit
- depigmentation most of face, edges on ears, small collar
- ears left fold complete, right fold partial
- bullets scattered on rump

**005**
Age Category 4
Wasgamuwa NP
18 Dec 2018
- left side many bullets; weird patch over left eye
- right side many bullets; big lump on right front leg, bush
  sometimes visible
- ears mostly intact; dangling left bit
- bullets excessive all over body
- tail missing last 1/3

**010**
Age Category 0
Wasgamuwa NP
18 Dec 2018
- left side mostly smooth, with wound on upper left leg
- right side unscathed
- depigmentation none
- ears mostly intact, with small notch in left ear
- bullets few to none

**018**
"Kevin"
Age Category 2
Wasgamuwa NP
20 Dec 2018
- left and right sides few bullets
- depigmentation moderate amount on face
  (visible when wet)
- ears left folds forward, right folds backward
- bullets moderate to many
- other throat pouch, bump on top of head
FIELD METHODS: DATA COLLECTION

- Most male elephants in Sri Lanka lack visible tusks.
- Some individuals can be distinguished by scar patterns.

Unexpected question:
Are these scars indicative of human–elephant conflict?
METHODS: PHOTOGRAMMETRY

- Based on photographs taken ≤5 days of each other, **position of scars noted and counted by section** for each elephant.

- If photo of one side unavailable, estimation based on known side (sides did not differ, $W = 2146.5$, $P = 0.32$).
CONCLUSION: WHAT DOES THIS ALL MEAN?

If we assume that most of these scars are incurred during HEC incidents from gunfire:

- male elephants engage in HEC more than females,
- male elephants engage in HEC earlier and as they age,
- male elephants with higher body condition engage in HEC more, and
- males may adopt riskier crop-raiding strategies as they age.
These results support other findings that male elephants engage in the majority of HEC.

Male elephants may require special consideration for HEC mitigation to be effective.

- Influence of musth?
- Broader behavioral and/or physiological effects?
- Plastic responses?
- Similar patterns in other locations?
ACKNOWLEDGEMENTS
Thank you.

Chase LaDue  cladue@gmu.edu
Body condition scoring protocol based on Pokharel et al. (2017).

Scoring standards based on ribs, pelvis, and backbone.
Smelly elephant repellent

An effective and economically sustainable solution to human-elephant conflict?
Why are we excited about the smelly repellent?
Effective

- Trials with 30 farmers
- 83% effective at preventing crop raiding
- Positive feedback from new trial community in another area
Low maintenance
Cheap

- Under USD20 per acre if using fence line method
- Double the quantity/cost for spraying, which may need reapplication, but has other benefits
How could we turn this into **economically sustainable** mitigation tool to address human-elephant conflict?
Conducting design research with farmers

**VALUE**
The repellent is valued, desired, and therefore can be sold to farmers to protect their crops.

**PURCHASE = ACTIVE CHOICE**
Farmers need to have choices, and to have agency over their situations. By enabling people to make choices over how to protect their crops, we can give power to each individual farmer.

**THE RECIPE IS NOT ENOUGH**
A guide sharing the elephant recipe is not enough to cause widespread use of the method. There may be a perceived local unavailability of ingredients, concern about their cost, and doubt are barriers for DIY uptake.

**POTENTIAL LARGER MARKET**
Big commercial farms are also suffer from crop raiding, and are willing to pay for protection. These farms increase revenue potential for repellent makers.

**A VALID COMMODITY**
The perceived value of the repellent matches (and can be higher) than its actual cost to produce, making it a realistic business opportunity.

The cost of the repellent is assessed in comparison to the products farmers purchase regularly for their business such as pesticides, fertilizers and tool rentals.
Uncovering the perceived value of the elephant repellent

Establishing the possible pricing for the elephant repellent on the Ugandan market.
Testing prototypes and developing a model for an economically sustainable production and distribution method

1. 1 x 1
   Support individual entrepreneurs in every village.

2. The co-op shop
   Incentivizing the production of cash crops by guaranteeing product purchase for the creation of repellent.

3. The farm
   Own the entire chain of growth, production and distribution for elephant repellent sales across large landscapes hiring local labor.
October 2018
Data collection begins from 30 farms in north-western Uganda.

July 2019
Design research study to uncover behavioral insights for the creation of a sustainable business.

November 2019
New trial begins with Save the Elephants near Tsavo, Kenya.

End 2019
Data released from the 30 farm study in north-western Uganda.

Early 2020
Prototyping to uncover ideal sustainable business model.

2020 - 2021
Addition of new trial sites combined with the business model results.

Create and disseminate open source toolkit for model replication.

PHASE 1
Inception
Early 2013
Repellent created by students for an innovation competition.

PHASE 2
In depth research & data collection

PHASE 3
Refinement & data expansion

PHASE 4
Scaling & dissemination

We are here
1. To produce a human-wildlife conflict solution that is **not** donor dependent.
2. To create an open-source toolkit for implementation, that can be rolled out anywhere, by anyone.
Where you come in…

- Trial the repellent
- New methods of deployment
- How elephants behave when encountering repellent
- Camera trapping

robertson@wildaid.org
+256 788 406739
Thanks!
Living with Elephants:
Herds of the Karbi Foothills
MEMORIAL SERVICE OR SHRADHA FOR AN ELEPHANT
Paddyfields
Habitat Destruction

- Destruction for slash and burn cultivation.
- Illegal logging inside the forest.
- Poachers roam freely inside the forest.
- Bamboo collection from the Karbi foothills
This stone crusher unit has emerged as a new threat to the Karbi foothills elephant habitat.
INTERVENTIONS TO MITIGATE HUMAN-ELEPHANT CONFLICT

- ASSESSMENT OF DAMAGE
- INSTALLATION OF EARLY WARNING SYSTEM
- CROP BARRIER FENCING
- CHILLY-BASED REPELLENT
- AWARENESS & SENSITIZATION
- SOFT MITIGATION APPROACH TRAINING
- COMMUNITY CONSERVATION EFFORTS
- HABITAT IMPROVEMENT
CROP DAMAGE ASSESSMENT
Installation of Early Warning System
CROPS PROTECTED BY EARLY WARNING SYSTEM
Crop Barrier Fencing: Citrus Plantation
Chilly Based Repellant
Community Outreach
জীবন শ্রেষ্ঠ মানুষ, আমাদের হেত্যা সম্বিনি - এই পৃথিবীর তোমাদের দের আমারা জীবান্ত।
থকার নম আর্থিকার আছে।
GREEN GUARD
Abandoned calf rescued from the possessed!
THANK YOU

Join Green Guard Nature Organization on Facebook
A crime science approach to human-elephant conflict in Uganda

Joanna Hill
joanna.hill@protonmail.com  www.c3e.rutgers.edu
Crime science

Offenders

Targets

Human-elephant conflict

Place and time

Preventers
## Crime scripting

### Steps of elephant poaching

1. Organise group & weapons
2. Obtain intelligence on rangers
3. Enter protected area
4. Follow trails & signs of elephants
5. Shoot elephant
6. Butcher meat & call for carriers
7. Exit protected area
8. Call customers to sell meat/ivory

### Potential response

- Disrupt weapons makers
- Deploy rangers deeper into protected area
- Network of community informants
- Map elephant trails
- Gunshot detectors & GPS collars (heart rate)
- Cut phone network in the protected area
- Park boundary geofencing
- Local butchers with domestic alternatives
Conservation Crime Science
Preventing human-elephant conflict in Northwest Murchison
Murchison Community Conservancy

Murchison Falls National Park

Aswa river

Gulu-Arua highway

Pakwach

Bwana Tembo

Murchison Falls National Park

Image © 2019 DigitalGlobe
© 2018 Google
Aims and objectives

• Collect base-line data on the situational factors of crop raiding
  – Offenders (elephants)
  – Targets (farmers)
  – Preventers (communities, NGO’s, UWA)
  – Spatial/temporal factors (habitat mapsseasonal data)
Data collection

Ground observations of elephants (GPS-tagged photos and ID records)
Road accidents
Snare damage
Crop raiding
Building a network of elephant informants
### Crop raiding scripting

<table>
<thead>
<tr>
<th>Steps of crop raiding</th>
<th>Potential response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Walk towards park boundary</td>
<td>Provide salt licks, water points inside park</td>
</tr>
<tr>
<td>2. Enter community (night)</td>
<td>Geofencing, plant non-edible crops at boundary</td>
</tr>
<tr>
<td>3. Search for crops</td>
<td>Deploy barriers/repellants around crops</td>
</tr>
<tr>
<td>4. Enter crop field &amp; raid</td>
<td>Vuvuzelas, spotlights to scare elephants</td>
</tr>
<tr>
<td>5. Leave farm (morning)</td>
<td>Guide back to park to prevent further damage</td>
</tr>
<tr>
<td>6. Exit community</td>
<td>Monitor the boundary so they don’t return</td>
</tr>
<tr>
<td>7. Return to protected area</td>
<td>Compensation, help with repairs to damage</td>
</tr>
</tbody>
</table>
MANAGEMENT OF A CONFLICT ELEPHANT IN RAJAJI TIGER RESERVE
RELEASE VS REHABILITATION

ADITI SHARMA, SENIOR VETERINARY OFFICER,
RAJAJI TIGER RESERVE, INDIA
A COLLABORATIVE OPERATION

1. PRIMARY AGENCY: RAJAJI TIGER RESERVE, UTTARAKHAND STATE FOREST DEPARTMENT

2. TECHNICAL SUPPORT: WILDLIFE INSTITUTE OF INDIA

3. RADIO COLLAR DONATION: WORLD WIDE FUND
TYPE OF CONFLICT

- Frequent visit of the animal in human dominated area, and damage of properties
- Three human causalities one on 13.01.2018 (inside the forest), one on 16.01.2018 near BHEL at Haridwar and one on 14th November, 2018 near BHEL
DESCRIPTION OF THE CONFLICT AREA
ELEPHANT DAMAGING THE PROPERTY IN A COLONY IN HARIDWAR CITY

DESCRIPTION OF THE CONFLICT ELEPHANT

AGE: 15-20 YEARS
SEX: MALE
ESTIMATED BW: 2500 KG
CAPTURE, TRANSLOCATION, RADIO COLLAR & RELEASE OF THE ELEPHANT IN JANUARY, 2018
CHALLENGES IN CAPTURE

❖ DENSE FOREST AND HILLY TERRAIN
❖ IMPROPER ROAD NETWORK AND ACCESS FOR TRANSPORTATION VEHICLE
❖ NONAVAILABILITY OF DRUG OF CHOICE: ETORPHINE HCL
❖ NONAVAILABILITY OF DEDICATED ELEPHANT TRANSPORT VEHICLE
❖ PERMISSION REQUIRED FOR IMMOBILISATION FROM CHIEF WILDLIFE WARDEN
❖ ELEPHANT CAPTURE NOT VERY COMMON IN NORTH INDIA SO STAFF NOT PROPERLY TRAINED
❖ NON AVAILABILITY OF MALE KUMKI ELEPHANTS
❖ CROWD AND MEDIA MANAGEMENT
REASON FOR CAPTURE

❖ HUMAN CASUALTIES
❖ RISK OF RETALIATE KILLING OF ELEPHANT
❖ IMMENSE PRESSURE FROM PUBLIC & POLITICIANS
❖ NEGATIVE REPORTING & PANIC BY MEDIA
❖ CRISIS MANAGEMENT SITUATION
SERIES OF THE EVENTS

- Elephant was sighted on 28.12.2017 to 05.01.2018 in and around BHEL colony, Bilkeshwar colony, Judges colony, Roshnabad and Haridwar.
- Communication from the District Administration and Session Judge received.
- Two human casualties on 13.01.2018 and 16.01.2018 near BHEL at Haridwar.
- Immobilisation permission granted by Chief Wildlife Warden of the state on 18.01.18
- A capture team was formed under technical guidance of Senior Veterinary Officer.
- Elephant tracked and darted around 8:30 p.m. on 18.01.18 and operation continued till 6:00 a.m. on 19.01.18
- Elephant was transported 40 KM away to Rawasan range of Rajaji Tiger Reserve on 19.01.18
- Elephant was radio collared on 21.01.18
- Elephant was released on 21.01.18
IMMOBILISATION/CAPTURE TEAM

1. Administrative Head: Mr. Sanatan, Field Director, Rajaji Tiger Reserve
2. Technical Leader: Dr. Aditi Sharma, Senior Veterinary Officer, Rajaji Tiger Reserve
3. Dr. Prasun Dubey, SVO, DDL, Rishikesh
4. Mr. Akash Verma, DFO, Haridwar
5. Mr. Komal Singh, Wildlife Warden, Haridwar
6. 2 Forest guards
7. 2 captive/coonkie elephants of RTR: Radha & Rangili along with their mahouts
8. Tracking Dog, Marshal along with its caretaker/handler
TIME FRAME OF THE OPERATION

❖ TOTAL OPERATION TIME: 4 DAYS

1. TRACKING & CAPTURE TIME: 2 HOURS (18.01.18)
2. DRIVING TO NEAREST ROAD HEAD: 8 HOURS (18.01.18 & 19.01.18)
3. HEALTH CHECK: 0.5 HOURS (19.01.18)
4. STABILISATION TIME: 3.5 HOURS (19.01.18)
5. LOADING AND TRANSLOCATION: 2 HOURS (19.01.18)
6. REST AND STRESS RELEASE: 36 HOURS (19.01.18 & 20.01.18)
7. RADIOCOLLARING & RELEASE: 4 HOURS (21.01.18)
ELEPHANT DAMAGING PROPERTY
ELEPHANT MOVING IN THE CITY
DARTING
ELEPHANT BROUGHT TO THE ROAD HEAD AFTER CAPTURE
PUTTING THE HARNESS
ELEPHANT READY TO BE LOADED
LOADING FOR TRANSLOCATION
ELEPHANT BEING TRANSPORTED IN A TRUCK
UNLOADING AT RELEASE SITE
PREPARING THE RADIO COLLAR
Details of Radio Collar

- Receiver, Model R-1000 (Communication Inc.)
- VHF range: 3 km in open area
  1.5 km in forest area.
RESTRAINING THE IMMOBILISED ELEPHANT FOR PUTTING THE RADIO COLLAR
ALL SET TO PUT ON THE RADIO COLLAR
AFTER PUTTING ON THE RADIOCOLLAR
ADMINISTRATING THE REVERSAL DRUG (YOHIMBINE HCL INTRAVENOUS)
FREEING THE RESTRAINTS: READY TO BE RELEASED
READY TO RETURN TO WILDERNESS AGAIN
GOING BACK HOME: NO LOOKING BACK
MOVEMENT LOCATIONS AND HOME RANGE (100% MCP) OF THE ELEPHANT IN THE EASTERN RAJAJI DURING JANUARY – MAY 2018
MOVEMENT LOCATIONS AND ACTIVITY CENTRES (KERNEL METHOD) OF THE ELEPHANT IN THE EASTERN RAJAJI DURING JANUARY – MAY 2018
ELEPHANT CROSSED THE GANGES RIVER & REACHED BACK TO THE CAPTURE SITE ON THE WESTERN SIDE OF THE RTR BEING ESCORTED BY ANOTHER TUSKER IN MAY, 2018
MOVEMENT LOCATIONS AND ACTIVITY CENTRES (KERNEL METHOD) OF THE ELEPHANT IN THE WESTERN RAJAJI DURING MAY – NOVEMBER 2018
MOVEMENT FROM 21st OCTOBER TILL 14th NOVEMBER, 2018

KILLED ONE MORE PERSON ON 14TH NOVEMBER
SCENARIO AFTER THIRD KILLING

❖ GREAT PANIC AND ANGER AMONG THE PUBLIC
❖ LOTS OF CRITICISM BY MEDIA
❖ DEMAND FROM PUBLIC TO KILL THE ELEPHANT
❖ HIGH RISK OF RETALIATE KILLING OF THE ELEPHANT BY THE PUBLIC
❖ PARK MANAGEMENT UNDER IMMENSE PRESSURE
❖ MORAL DUTY OF SAVING BOTH HUMAN AS WELL AS ELEPHANT’S LIFE
DECISION TAKEN BY THE RESERVE MANAGEMENT

❖ RECAPTURE THE ELEPHANT AS SOON AS POSSIBLE & NOT TO RELEASE THIS TIME

❖ TRANSPORT HIM INTO A TRANSIT CAMP

❖ KEEP HIM IN COMPANY OF OTHER CAPTIVE ELEPHANTS TO PREVENT STRESS DUE TO LONELINESS

❖ MOVE HIM INTO A STOCKADE TRADITIONAL TO SOUTH INDIA & TRAIN HIM WITH HELP OF EXPERT TRAINERS

❖ MAY BE USED FOR PATROLLING PURPOSE BY FOREST DEPARTMENT ONCE TRAINED
RECAPTURE OF THE ELEPHANT ON 23RD NOVEMBER, 2018 &
TRANSPORTATION TO TRANSIT CAMP ON EASTERN SIDE OF RAJAJI TIGER RESERVE
RESPONSE RECEIVED

❖ APPRECIATION FROM PUBLIC BECAUSE THEY WERE NOW RELAXED

❖ SUPPORT FROM SCIENTIFIC COMMUNITY IN FAVOUR OF REHABILITATION AS IT WAS IN ACCORDANCE TO THE GUIDELINES OF PROJECT ELEPHANT IN INDIA.

❖ STRONG OPPOSITION AND CRITICISM FROM ANIMAL ACTIVISTS TO THE EXTENT OF LODGING COMPLAINTS IN THE MINISTRY THAT RESERVE MANAGEMENT & VETERINARIAN ARE TORTURING THE POOR ELEPHANT BY KEEPING HIM IN CAPTIVITY & NOT RELEASING HIM & THAT THE VET SHOULD BE PUNISHED & IMMEDIATELY TRANSFERRED.

❖ I HAD TO UNDERGO AN EXPLANATION CALL FROM THE GOVERNMENT DUE TO THE COMPLAINT IN WHICH I FORTUNATELY GOT A CLEAN CHIT

❖ AN ENQUIRY WAS DONE BY A PANEL OF EXPERTS TO COMMENT ON THE PROCESS AND THE DECISION OF THE MANAGEMENT AND ALSO ON THE HEALTH STATUS OF THE ELEPHANT WHICH AGAIN FORTUNATELY DID NOT SEE ANY FLAW IN THE PROCESS.
JOURNEY FROM BEING ROGUE TO BEING A GENTLEMAN

❖ CAPTURED AND SHIFTED TO TRANSIT CAMP ON 23RD NOVEMBER
❖ EXPERT MOHOUTS FROM ASSAM WERE CALLED IN NOVEMBER END.
❖ TRAINING OF THE ELEPHANT STARTED FROM 1ST DECEMBER
❖ ELEPHANT WAS SHIFTED INTO STOCKADE ON 3RD JANUARY AND TRAINING CONTINUED
❖ HE STARTED RESPONDING WITHIN 2.5 MONTHS AFTER CAPTURE & WAS BROUGHT OUT OF STOCKADE ON 12TH FEBRUARY FOR TRAINING IN OPEN
❖ MARCH ONWARDS HE WAS STARTED TO BE TAKEN OUT IN THE FOREST FOR TRAINING
❖ FINALLY ON 15TH MAY HE WAS WALKED THROUGH THE FOREST AND SHIFTED TO OUR ELEPHANT CAMP WITH OTHER ELEPHANTS WHERE HE STAYS HAPPILY NOW.
RAJA AT PRESENT
LEARNINGS AND RECOMMENDATIONS BASED ON THIS CAPTURE AND REHABILITATION OPERATION


❖ Prebuilt stockades in areas of high human elephant conflict.

❖ Capacity building of the Forest Officers and staff and Veterinarians for carrying out such operations.

❖ Procurement of radio collars for elephants.

❖ Establishment of proper Rescue and Rehabilitation Centres for housing such elephants post capture.

❖ Availability of drug of choice (Etorphine HCl) and antidote for elephant immobilisation.

❖ Capacity building of mahouts for training elephants.

❖ Quantitative assessment of human elephant conflict and allocation of budget for mitigation measures in accordance to that.
FOOD FOR THOUGHT

❖ WHO IS RESPONSIBLE FOR CONFLICT: ELEPHANTS? HUMANS?
❖ WHO HAS A SURPLUS POPULATION: ELEPHANTS? HUMANS?
❖ WHO IS ENCROACHING THE AREA OF THE OTHER: ELEPHANTS? HUMANS?
❖ WHOSE POPULATION NEEDS TO BE CONTROLLED: ELEPHANTS? HUMANS?
❖ WHO SHOULD BE PUNISHED FOR THE CONFLICT: ELEPHANTS? HUMANS?
COLLABORATIONS WOULD BE HIGHLY APPRECIATED

- DISEASE SURVEILLANCE PROGRAM FOR EEHV, T.B.
- STRENGTHENING OF INFRASTRUCTURE FOR TREATMENT & DIAGNOSTICS
- HORMONAL ASSAY FOR STRESS LEVEL
- INFRASTRUCTURE DEVELOPMENT FOR ELEPHANT RESCUE & TRANSPORTATION
- CAPACITY BUILDING OF VETS, TECHNICIANS AND MAHOUTS
- AVAILABILITY OF DRUGS REQUIRED FOR IMMobilisation EG. ETORPHINE, THIAFENTANYL, AZAPERONE, BAM ETC.
- ANY OTHER STUDY ON ASIAN ELEPHANTS
ACKNOWLEDGEMENTS

- UTTARAKHAND FOREST DEPARTMENT
- WILDLIFE INSTITUTE OF INDIA
- WWF
- INTERNATIONAL ELEPHANT FOUNDATION
THANKS

aditis2013@gmail.com
+919412088024
+918077986460
Non-invasive assessment of body conditions and stress hormone levels in African elephants (*Loxodonta africana*) roaming in Fynbos vegetation

Elisabetta Carlin

Eugene Marais Chair for Wildlife Management
University of Pretoria

23rd October 2019, Bela Bela, Limpopo Province, South Africa
Fynbos biome

- The Western Cape Province of SA hosts the Cape Floristic Region, an important hotspot of endemic biodiversity

- The most prominent biome is the Fynbos Biome (*Proteacea, Restionacea, Fabacea, Geraniacea, Asteracea*, etc….)
Fynbos biome and Elephants

- Soil → poor in nutrients
- Vegetation → poor in copper, calcium, zinc, phosphorous and magnesium
- Is it able to sustain large herbivores?
- Balanced intake of food (longevity, physiological processes and reproduction rates)
- Artificial supplementation
Fynbos biome

- **Mid-17th century**, permanent European settlements led to **anthropogenic pressure** with **local extinction of large herbivores**

- Last remaining populations **forced to utilize less accessible areas** (Outeniqua and Tsitsikamma mountain ranges, Knysna Forest, Addo Elephant Park)
Diet and digestion

- **Mixed feeders** (grasses, herbs, woody plants, nuts, fruits, bark, branches and roots)

- **Hindgut fermenters**: large caecum with microbial fermentation

- **Nutrients absorption** is not very efficient

- Consume of food per day: 450 kg, but only **44%** of it is absorbed
Research site

- Gondwana P.G.R. surrounded by Fynbos
- Assessing body conditions and stress hormone levels of 13 Elephants
- Monitoring period: April and June 2018 (early and late wet season)
Aims and Objectives of the Study

• To determine the individual **Body Condition Score** (BCS)

• To determine the individual **faecal glucocorticoid metabolite concentrations** (fGCM)

• To examine **variations** in individual BCS and fGCM concentrations during **early and late wet season**

• To examine the **correlation** of individual BCS and fGCM concentrations
Elephants ID Kit
Assessing Body Condition Scores (BCS)

Five scores categories: from 1 (emaciated) to 5 (obese)

R= ribs
PB= pelvic bone
VR= vertebral ridge of backbone
LD= lumbar depression alongside backbone

(Morfeld et al. 2014)
BCS Index

(Morfeld et al. 2014)
Assessing Body Condition Scores (BCS)

- 3 relevant pictures from each individual, for each site visit
- pictures assessed by two different assessors to address inter-observer variability

(Morfeld et al. 2014)
Assessing BCS – Big Rip

**Ribs**: Not visible
**Pelvic Bone**: Visible but not too prominent
**Backbone**: Visible as a ridge but not too prominent
Stress

A response to a stimulus that threatens the homeostasis of an individual (Selvye, 1936)

The stress response activates the hypothalamic-pituitary-adrenal axis (HPA axis)

Species-specific hormones (Glucocorticoids) released into the blood (Ganswindt et al. 2010)
Chronic Stress

- Development of pathologies
- Degradation of body condition
- Suppression of immune functions
- Atrophy of tissues
- Reproduction failures
- Behavioural and cognitional problems
Causes of high fGCM conc. in African elephant

- **Availability and quality of food**  
  (Bourbonnais et al. 2014)

- **Competition for females**  
  (Foley et al. 2001)

- **Disease or injury**  
  (Ganswindt et al. 2010)

- **Musth?** In adult free ranging elephant, it is not associated with significant levels of fGCM conc.  
  (Ganswindt et al. 2003)
Assessing stress hormone levels – Samples collection

- Non – Invasive method ➔ Faecal samples

T A K E  A S  M A N Y  A S  Y O U  L I K E
Faecal samples collection

- To be done within an hour
- Gloves
- Collect from the center of the faecal pile
- Plastic container
- Cooler box with ice.
- Frozen at -20 °C
fGCM conc. in African elephant Faeces

Endocrine Research Laboratory of the University of Pretoria (ERL)

- **Sample preparation** (pulverizing, weighing and extraction)
- **Hormone concentration measurements**
List of samples collected

<table>
<thead>
<tr>
<th>Elephant ID</th>
<th>BCS April 2018</th>
<th>BCS June 2018</th>
<th>Median fGCM (μg/g DW) April 2018</th>
<th>Median fGCM (μg/g DW) June 2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big Rip</td>
<td>2.5</td>
<td>2.5</td>
<td>0.46</td>
<td>0.52</td>
</tr>
<tr>
<td>Split</td>
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<td>-</td>
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<tr>
<td>Bonnie’s Juv.</td>
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<td>0.58</td>
<td>0.76</td>
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<tr>
<td>Thambile’s Juv.</td>
<td>3</td>
<td>3</td>
<td>0.36</td>
<td>-</td>
</tr>
</tbody>
</table>
Comparing Individual Median fGCM conc.
Comparing Individual Median fGCM conc.

Early wet season  Late wet season
Correlating individual elephant fGCM conc. and BCS

Early wet season

Late wet season
Conclusions

- The majority of the elephants had a BCS between 2.5 – 3.0 which seems acceptable. No need for supplementing their food at this stage (Morfeld et al. 2014).


- No correlation between seasonal BCS and fGCM conc.
Further studies on the vegetation type the Elephants feed on, would be useful to investigate their ability to survive in Fynbos vegetation.
Acknowledgments

Prof. Andre Ganswindt
(Mammal Research Institute, University of Pretoria)

Dr. Gabi Teren from Wildlife & Ecological Investments (WEI)

Endocrine Research Laboratory, University of Pretoria (ERL)

Mammal Research Institute, University of Pretoria (MRI)

Eugene Marais Chair for Wildlife Management, University of Pretoria
Thank you for your attention!
Determining the optimal biomarkers for assessing mineral status in elephants (*Loxodontia africana* and *Elephas maximus*) using zoo elephants & Application in the field to reduce Human-Elephant Conflict

Fiona Sach

Ellen Dierenfeld, Murray Lark, Simon Langley-Evans, Michael Watts and Lisa Yon
African savanna elephants (Loxodonta africana) as an example of a herbivore making movement choices based on nutritional needs.
Movement of 7 collared elephants around the Phalaborwa mine

Data collected 15.6.12 - 23.7.17
Security guard killed by elephant at mine in Phalaborwa, Limpopo
2019-06-08 12:54
Canny Maphanga

news24

Elephant tramples security guard to death at mine outside Kruger National Park as he keeps watch for roaming lions
Worker believed to have been killed by animal after leaving guard room to investigate noises during night
HOME RANGE

Neighbouring elephants

Mine elephants

Km²

0  200  400  600  800  1000  1200

KNP  Sabi sands cow  APNR cow  APNR bull  Cow  Bull

Km²

0  200  400  600  800  1000  1200
**AIM:** Investigate how environmental geochemistry affects elephant movement

**Key objectives**

- Establish baseline levels for key minerals and trace metals in African elephants

- Determine if mineral levels in soil, forage and water near the mine are higher than the KNP/APNR

- Determine if the elephants near the mine have higher essential mineral levels or potentially harmful metals, reflected biomarkers compared to elephants in the KNP/ APNR
Phase 1: Validation of mineral analysis

**INPUT** - Environmental Samples  soil, water

**INPUT** - Diet Samples  hay, browse, grass, pellet, fruit + veg, supplements

**OUTPUT** - Elephant Samples  plasma, faeces, tail hair, urine, toenails
DIET AND WATER COMPARED TO RECOMMENDATIONS

Zinc

Iron

Calcium

water  Keeper fed diet

Ullrey et al. 1997
Conclusions

- No single matrix is suitable to monitor mineral status in elephants in isolation

- Body homeostatic control for macro minerals

- UK zoo elephants not mineral deficient

- UK zoo elephants eating vastly over 1-1.5% BW DM/day
Phase 2: Application of validated methods

1. Collared elephants
2. Banked samples (SA Biobank)
Elephant samples

- Toenail
- Tail hair
- Faecals
- Blood plasma
- Soil
- Water
- Plants
Sample sites 2017/18
PHOSPHORUS SOIL

31P_mg_kg non mine  31P_mg_kg mine

Non mine n= 53, mine n= 44
Mine n=16, non-mine n=36
Non-mine $n = 57$, Mine $n = 36$, 
Zoo v. free living
Phalaborwa mine

REDUCE HUMAN ELEPHANT CONFLICT

BENEFIT FREE-LIVING AND CAPTIVE ELEPHANT HEALTH
Supporting Partners
Validating A New Method for Quantifying Glycemic Response In African Elephants

Beaux Berkeley, PhD
Rory Hensman Conservation Research Unit, Limpopo, South Africa
Otterbein University, Columbus, Ohio, USA
Issues with Elephants in Captivity

• Husbandry
• Difficult to house

• Expensive to house
• Changing attitudes
Health Issues in Captivity

• Obesity, lameness, arthritis (Morfeld, 2014)

• Subfertility (Brown, 2016)

• So how to help?
Background:
Influence of dietary glucose on circulating glucose in white rhinos

Six rhinos (3.3) at two zoos
Rhinos fasted overnight
At first meal of the day, 0800 hours, blood collected every 45 minutes for 3 hours
Handheld glucose meter
Each rhino fed each diet in randomized fashion
Influence of dietary glucose on circulating glucose in white rhinos

<table>
<thead>
<tr>
<th>Foodstuff</th>
<th>% DM</th>
<th>CP % DM</th>
<th>CF % DM</th>
<th>ADF % DM</th>
<th>NDF % DM</th>
<th>DE % MJ/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pellets</td>
<td>88.0</td>
<td>12.5</td>
<td>7.0</td>
<td>12.0</td>
<td>37.0</td>
<td>12.0</td>
</tr>
<tr>
<td>Grass hay</td>
<td>88.3</td>
<td>6.7</td>
<td>-</td>
<td>45.1</td>
<td>78.7</td>
<td>6.6</td>
</tr>
<tr>
<td>Lucerne hay</td>
<td>87.2</td>
<td>15.3</td>
<td>-</td>
<td>44.6</td>
<td>56.1</td>
<td>7.5</td>
</tr>
<tr>
<td>Glucose</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>15.5</td>
</tr>
</tbody>
</table>

5 foodstuffs tested:
- 10% glucose powder
- 5% glucose powder
- 10% horse pellets
- 10% lucerne hay
- 10% grass hay

• 10% glucose powder
• 5% glucose powder
• 10% horse pellets
• 10% lucerne hay
• 10% grass hay
Outcomes:

Different diets result in changes in the magnitude and duration of the glucose response (similar to what is seen in horses)

Lucerne may be beneficial to keep blood glucose low in white rhinos

Changes in Baseline Blood Glucose Values in White Rhinos Fed Varying Diets,

Study Objectives

• Validate handheld glucometer for use in elephants
• Compare glycemic response to captive diet foods with freely chosen foods
Adventures With Elephants

Bela Bela
Limpopo Province
South Africa
Elephant Interaction Area
The Elephants
Herd Profile

- 3.4, 1.5-19 years old
- Chova – head bull, GnRH treated
- Chishuru – young male, GnRH treated
- Nuanedi – young female
- Shan – mother of Zambezi
- Mussina – mother of Bela
- Zambezi (born at AWE)
- Bela (born at AWE)
The Elephant Handlers
Procedure/Results

• Elephants “fasted” (hay only) overnight
• Blood collected every 45 minutes for 3 hours
• Anesthetic cream applied (sometimes)
• Ear venipuncture w/lancet or 22g 1” needle
• Two week acclimation/training period
• Oranges then game pellets used as training aid
• 6 diets tested

• 10 minutes total sampling time to do all 5 elephants (<4 minutes at the end!)
• Matching serum samples validated by lab glucose assay (Arbor Assays; n=33)
Blood Glucose Sampling
Zeroed Serum Glucose Values

Change in Zeroed Blood Glucose Concentrations (ng/dl)

Minutes

Winter
Summer
Zeroed Serum Glucose Values

![Graph showing change in zeroed blood glucose concentrations over time for different feed types.](image-url)
Take home messages

• Training elephants for blood sampling is useful
• Feeding low glycemic response foods may improve elephant health on small reserves
• Brazilian grass is the best that we tested
Next Steps

• Identify seasonal variation in plant types and consumption (RHCRU)
• Feed analysis
• Carrying capacity
• Analyze cost efficacy of farmed feed
• When to supplement?

• Asian elephants
• Repeat with US Zoos
Acknowledgements

- Otterbein University
- Andre Ganswindt
- Stephanie Ganswindt
- Stephen J. Lee/US Army Research Office
- Sean Hensman
- AWE staff
- RHCRU

Thanks to the IEF for the opportunity to share this project with other elephant folks!
Mt Kenya Trust
Mission
To drive collaborative action for the sustainable management of Mt Kenya’s biodiversity & natural resources through partnership with government, communities & civil society
Elephants Insight
Problem – Continual elephant migration across a human modified landscape.
The Mount Kenya Elephant Population

2001 and 2016 elephant density survey on the mountain (15 years apart)

The survey estimates that there are 2,600 elephants on Mount Kenya today.

Stable population. The slight reduction is speculative depending on some poaching and/or migration since the opening of the Northern Elephant Corridor. However this is a positive result in an era where elephant numbers are dwindling so rapidly.
The Elephant Corridor
Africa’s first Elephant Underpass
The 2nd Mt Kenya Elephant Underpass
Elephant Underpass
Elephant Underpass

Maintaining over 40 kilometers of the corridor fence and adjoining fences is a full time job.
MOUNT KENYA FENCE BUILD PROGRESS AS OF 6 NOVEMBER 2018
Elephant One Way Gates
MKT Rangers: SMART Enabled Patrols
Law Enforcement Patrols: SMART

Example of patrol results from ranger teams. Source: MKT
SMART: Decision Making
SMART: Advantages

Free and open source
- Broad suite of tools covering patrolling, law enforcement monitoring, intelligence and many other areas
- Supports an adaptive management cycle – over short, medium and long term planning cycles
- Available on cloud, mobile and desktop
- Online/offline
- Supports centralized/hierarchical management and reporting across PA
- Available in 20+ languages
- Community supported: Ask questions of difficulty experience and get answers
- Adopted at 800+ sites
- Built on a long term multi-agency commitment to improve protected area conservation
- Fully customizable data model
- Reporting engine – allows all data to be analyzed and reported
- Mobile data collection - without coding or system integration
The problem:
• Licenses are issued to some people others take advantage of the many unmanned access points
• At any given time we do not know who is in the forest

Potential Solutions:
• Introduction of SMART to KWS and KFS teams. Pilot to be rolled out in Meru County.
• Greater Information Sharing through JOINT Patrols
• Potentially introducing EarthRanger Technology to the Mountain Team
We rely 100% on donations and the proceeds from our events. Income sources include Kenyan, international donors & private individuals and donations in kind.
To sign up for our newsletter and follow us on social media go to:
www.mountkenyatrust.org
Thank you!
The Recovery of Murchison Falls Programme

INTERNATIONAL ELEPHANT FOUNDATION.ORG

UGANDA CONSERVATION FOUNDATION
The ‘as-was’:
Murchison Falls: A New Dawn
THE ORIGINAL PROBLEM

- How to ensure UWA succeeds & realizes their potential?
- The ‘as was’. UWA’s capability was limited to 3% of the park, and even that was extremely limited.
- How to Recover Murchison Falls with almost no funds or donors interested in Uganda....
THE STRATEGY:

1. Investing in the foundations of protected area management – to regain control of the protected area.

The basics must be in place.

- Infrastructure – the right capabilities in the right places to counter park threats and issues.
- Communications
- Transport
- The UWA team – trained, motivated, well lead and appropriately equipped.
Ranger post coverage – past and current.
THE STRATEGY:

2. Investing in critical UWA capabilities.
   - Veterinary dept, lab, vet response unit cars, dart guns, gas, drugs and basic equipment.
   - Marine Ranger Unit: marine ranger stations, boats and engines, training and operations support.
   - Joint Operations Command Centre
   - Prison block
   - Partnerships with local institutions
Seven years on – the impact on wildlife & tourism
Investing in regional development

UWA is finally able to take charge of their own relationship with the communities, and their role in regional development.
Investing in future generations
Africa Ranger of the Year - 2018
The Importance of Tourism, and therefore ‘conservation success’ to Uganda

Murchison Falls and Queen Elizabeth National Park are Uganda’s premier savanna protected areas. In the 1960’s Murchison Falls was Africa’s most visited park and Uganda was a one of the most popular African safari destinations. By then gorilla tourism did not exist. After the collapse of the parks, and a lack of investment over five decades, things are beginning to change once more:

In 2017 Uganda’s tourism industry was recognised as contributing:

• Total contribution to GDP 6.6%. ($1.8BN), with a growth forecast rise of 14.5% expected in 2017.
• Employment in Uganda: 504,000 people, directly and indirectly, with a forecast rise of 12.8% in 2017 to 568,500, and 930,000pm by 2027.
• FDI – 2016 $0.3bn, at a rise of 6.8% growth in 2017, to $0.6bn by 2027.

All indicators are upward, and this is with only 3% of the parks being available for tourism.

CONSERVATION LOWER ZAMBEZI
Working Today to Protect Tomorrow
SPECIALISED UNITS
The Value of Specialised Units

Marine Units
Investigations and Intelligence Units

Canine Units
Special Response Units
Aerial Units
CHALLENGES
The Value of Specialised Units

- Cost
- Effective law enforcement efforts
- Traditional Boots on the Ground efforts cannot stop

To address the following:
- Increase intelligence led operations
- Fitness levels
- Age and health
- Education levels and advanced skills
- Poor understanding of advanced technologies
- Internal corruption and integrity of Officers
SOLUTION: SELECTION
The Value of Specialised Units

- Long and specialised selection process with qualified instructors
- Pre selection
  - Education levels
  - Mental and physical fitness levels
- Integrity and honesty tests
- Ability to multitask
- Ability to understand technology
- Polygraphs
SOLUTION: TRAINING
The Value of Specialised Units

- Selection of qualified instructors
- Additional specialised training
  - Close quarter combat
  - Law
  - Poisons
  - Crime scene investigation
  - Helicopter operations
- Ongoing in-service training
- Technical advisors and mentorship
- Emphasising collaboration with other Units
SOLUTION: EQUIPPING
The Value of Specialised Units

- Use of modern technology
- Good communication equipment
- Identifiable uniforms (branding)
- Higher standard of basic equipment
- Suitably armed (Handguns, pepper spray, etc.)
- Equipped for night operations
SOLUTION: MOTIVATING
The Value of Specialised Units

- Increased salary
- Success incentives
- Advanced equipment
- Specialised branding
- Mentorship
- Trust
MONITORING
The Value of Specialised Units

- Robust M&E system
  - Databases
  - Monitoring procedures
  - SMART technology
  - Earth Ranger (DAS)
  - Semantica
  - Trackers
  - Digital VHF Radio
### IMPACT / SUCCESSES

The Value of Specialised Units

#### Total Suspects Apprehended

<table>
<thead>
<tr>
<th>Year</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
</tr>
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</table>

#### Total Firearms Confiscated

<table>
<thead>
<tr>
<th>Year</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
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</table>

#### Total Ivory Confiscated

<table>
<thead>
<tr>
<th>Year</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
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</table>

#### Total Poached Elephants

<table>
<thead>
<tr>
<th>Year</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
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</table>
THANK YOU

Nikita Iyengar, PR and Fundraising Officer, CLZ
nikita@conservationlowerzambezi.org
www.conervationlowerzambezi.org
Establishing Anti-Poaching Canine Units
Success

Training

Management

Handlers

Dogs

Proprietary Information - Invictus K9
Selection

Teamwork

Fitness

Pressure

Problem Solving

Non-verbal communication

Empathy

Effort

Anticipation

Communication
Canines
Management

- Documentation - training/health
- Temperature checks
- Kennel/equipment inspections
- Health checks, weight, body condition and fecal scores
- Veterinary support
- Team leader/Supervisor
- Continuation Training
- Remote management
Training

• Establish high standards
• Intensity increased with confidence
• Training in the actual operational environment
• **Feedback** for instructors and students
• Expect excellence and challenge competence
• Practice what you preach
Malicious Poisoning of Elephant within the Zimbabwean component of the Kavango Zambezi (KAZA) Transfrontier Conservation Area (TFCA)

16th International Elephant Conservation & Research Symposium
Zebula Resort, South Africa
Dr. Chris Foggin & Jessica Dawson
Who We are & Where we operate

• Zimbabwe based Non-Profit Organization, registered charity in the US & UK
• Facilities established in Victoria Falls National Park, Zimbabwe
• Mission: To actively advance and promote environmental conservation and the sustainable use of indigenous resources in Southern Africa
• Focal Areas: All of Zimbabwe and throughout KAZA TFCA

KAZA TFCA: Source- [www.kavangozambezi.org](http://www.kavangozambezi.org)
Malicious Poisoning of Wildlife - Present Crisis


- In 2013, approximately 2400 vultures died from poisoning, mostly white-backed (This may represent 5 – 10% of the population, these losses cannot be sustained)

- In June 2019, 7 elephant poached on Botswana/Zimbabwe border, laced with Carbofuran (after being shot) lost 536 vultures (found on site), likely others perished further afield.
Preliminary Assessment- Is this Malicious Poisoning?

**Signs to look out for:**
- A number of animals dead close together
- Live sick animals, especially with convulsions
- Different species dead in one area, especially different classes (predators and herbivores, mammals, birds and fish)
- Dead animals close to water, or salt licks
- Poisoned baits present – unusual fruits or vegetables for the area, salt, powders etc
- Dead parasites (flies externally), worms and bots internally in stomach and GI tract

**But be aware:**
- Some plant poisons can do this e.g. Umkauzaan (Dichapetalum cymosum)
- Lightning strike
- Some diseases can cause sudden death, with a number of animals dead, especially Anthrax
**Rapid Field Test for Cyanide**

**Note**
- This is not a quantitative test and should be used as a guide only; therefore confirmation should be done at a toxicology Lab (Challenging in Africa)
- Cyanide can disappear quickly from a carcass

**Reagents**
- 0.5% Picric acid + 5% Sodium Bicarbonate (ie Sodium Picrate)
- put strips of filter (blotting) paper in this solution before use

**Test Method**
- put a few grams of stomach contents / “poison” into a bottle
- the material should be moist
- hang the sodium picrate paper above the material
- close the lid and warm the bottle (with a lighter)

**Result**
if the filter paper changes colour from yellow to brick-red, it indicates that cyanide is present in the sample
If it is Poisoning

• Provide assistance to any live animals or euthanize (neurological damage)- call veterinary authorities
  - Antidotes: Aldicarb / Carbofuran you can inject with Atropine – 0.2 mg/kg body weight, intramuscular (or intravenous),
  -Cyanide dose with “Hypo”, sodium thiosulphate – 0.5 g/kg body weight

• Secure the crime scene- Call legally mandated investigative body
  - Secure your own safety, and protect the crime scene (protect the evidence)
  - Different countries/land use have different investigative requirements
  - GPS coordinates, number of animals (look further afield)
  - Avoid contaminating the scene w/footprints, touching evidence, etc
If it is Poison - Sample Collection

• Small animals (eg birds, small mammals, fish)
  - collect whole animal, crop content from birds, in plastic bags,

• Open at least one carcass that cannot be removed, and collect these samples (use a Vet if possible, and keep frozen)
  - blood in a clean bottle (if possible)
  - blood smear (if possible)
  - stomach contents (1 kg)
  - liver (0.5 kg)
  - kidney (0.5 kg)

• Source of poison (keep frozen)
  - water, if from a pool (2 litres)
  - any suspect poison material (1 kg if possible)
Poison Sample Submissions

• Take Care! - Cyanide turns into a gas, don’t just put samples in enclosed vehicle. Seal properly for your own safety.

• For Crime Scene Samples to be used as evidence in court, make sure you include:
  - Unique evidence number – on tamper proof evidence bag
  - What it is (stomach contents?, liver, etc)
  - GPS coordinates, Date and Time
  - Contact person for case and contact details
  - Docket Number
  - Chain of Custody Form
    (filled out and signed over at lab/next custodian)
Cleaning up a Poisoning Incident

1. Carcasses should be burned or buried on site, if possible; this includes intestinal contents that may be scattered, can take away and burn in an incinerator.

2. Any unburned carcasses should be covered with Caustic Soda or Quicklime; even if they are buried. This includes contaminated soil.

3. If it is impossible to burn / bury the carcasses, you can (second best)...
   - cover them in diesel
   - put black plastic or branches over them
   - put guards on them until they are decomposed

4. Flood the rest of the area of a water contamination and use chemical decontamination.
Forensic Lab Activities

- Confirmation on type of toxin (can do at some labs in Africa, sometimes-depends on baseline toxins) – VFWT currently send to USA toxicology lab
- No quantitative value test available- CHALLENGE! How do you prove toxin values were high enough to cause mortality?
- Sometimes, other charges are a better option- work with investigations to get as many charges as possible.
- Possession of cyanide or other toxins- usually not a very heavy fine or penalty
- Look at other means to link crime scenes (ivory identification, fingerprints)
Main Challenges with Wildlife Poisoning Cases

- Access to toxins is very easy, not controlled - In gold mining over a ton of cyanide is used per mine per day in Zimbabwe, so what if we are missing a kg or two...that is how many dead elephant?
- Penalties for Poisoning cases are minor, possession is not a criminal offense, only selling it or contaminating the environment is illegal and unless ivory is located on site, not effective deterrent
- Do you open the carcass in a suspected case to collect samples, knowing there is a possibility of anthrax (endemic in Africa)
Main Challenges with Wildlife Poisoning Cases

- No lab in S.Africa has been able to provide us with a quantitative analysis on toxin levels
- Only field test available is for cyanide, but different toxins used in different areas of Africa
- Definitive Diagnosis of sudden death in elephant can be very problematic (e.g. rubbish dump, Umkauzaan (Dichapetalum cymosum), septicaemic disease)
- Propensity for removal of tusks immediately increasing risk of spreading diseases (e.g. anthrax) by opening carcass
Prevention & Management

• First Responder training for all 5 member countries in KAZA on differentiating between a wildlife crime scene and diseases (7 courses complete, 3 to go)
• Post-mortems in the field in Zimbabwe of suspected poisoning cases or mortality of unknown cause
• Collection of evidence in wildlife poisoning cases around Victoria Falls
• Provision of field test of cyanide in suspect poisoning cases, lab analysis in USA
• October 2019 WCSI training 13 stations (13 police/13 PWMA) (evidence collection, photography, mapping, chain of custody, fingerprint analysis, etc)
• Conservation Education Program +1000 children/annum & Eco Clubs
Plans for the Future

• Complete Geographic Origin of Elephant Project by Jan 2020
• Training of all ZPWMA senior investigators on WCSI by end of 2021
• Wider dissemination of Cyanide field test and training in all 5 KAZA countries on Wildlife Diseases and Poisonings by June 2020
• Training of KAZA partner countries, wildlife investigations on fingerprinting of ivory
• Improved cross-border collaboration on cases, criminal syndicates are moving transnationally with their wares, connect the evidence and the crime scenes
Questions?

www.vicfallswildlifetrust.org

cfoggin@zol.co.zw

jessica@vicfallswildlifetrust.org
An Assessment of Using Remote Camera Traps for Asian Elephant Research

CHANDIMA FERNANDO & RAVI COREA
SRI LANKA WILDLIFE CONSERVATION SOCIETY
What is a Camera Trap

- any camera triggered by an animal to take pictures is classified as a camera trap.
- A camera triggered remotely by a human is not a camera trap.
Evolution of camera traps

- Use for over a century - from the very beginning of wildlife photography
- Early cameras - large, cumbersome, mechanical trigger & recorded just a few pictures
- In 1990s – became commercial
- Modern digital cameras – came to prominence from 2005 onward
Evolution of camera traps

- Digital camera traps began to compete seriously with film camera traps from the mid-2000s.
Evolution of camera traps and their use

- Annual number of articles
The purposes camera traps been used for

The uses of camera traps – from 1990 to the present

- Rapid rise in the number of camera trap studies that focussed on monitoring animal abundance, species distributions
- 95% of studies focussed on mammals – in particular carnivores (65% of studies)
- The application of CTs to elephant research - more recent & growing
- However, to date, no evaluation has been done to assess the effectiveness of using CTs to study elephants
Use of Camera traps for elephant research - Wasgamuwa
Monitoring elephant health
– Snare damage
Population Studies
Population Studies

Hasthi – M051AD

Prominent dipig on - ears, trunk and neck
Distinct eyes

Right body - No preeminent lumps/scars/wounds

Right ear

PE – Forward – flat
SF – Forward – flat
Tiny ear hole
Population Studies
Population
Studies – monitoring births
Male behaviour
Movement Patterns
Results from three types of commonly used Passive Infrared (PIR) cameras

Compares three different Camera types

- Xenon white flash
- White LED flash
- Infrared LED flash

- Trapping effort - 1217 trapping days
White LED flash
Xenon white flash
Infrared LED flash
Infrared LED flash
Camera trapping - most suitable for elephant research at the local scale especially

1. monitor local movement patterns and occupancy
2. study population parameters e.g., density
3. monitor physical conditions of individuals
4. study behaviours
5. develop solutions to mitigate human-elephant conflicts
Most suitable camera type – to study elephants

- both types of white flash cameras are the most suitable than the infrared cameras
- elephants are not alarmed by the white flash
- white LED flash cameras that could be used to take videos at night are avoided by elephants –
- such cameras are not suitable for elephant studies that require videos at night
Other important camera settings - for elephants

- fast trigger speeds (< 1 s) are not necessarily required
- relatively slow trigger speeds (around 1.2 s) demonstrated low probability of missing targets
- The ideal mounting height of the camera- 1.2 m off the ground with an ideal minimum and maximum detection distance of 7 and 15 m
Camera - Protection

- Elephants did damage cameras even though they were housed in metal protective boxes.
- Designed a custom metal protective box with short spikes on the outer cover.
- Successful in safeguarding the cameras from elephant attacks.
ACKNOWLEDGEMENTS

A sincere and grateful Thank you from SLWCS to Dr. Anthony Giordano of the S.P.E.C.I.E.S. Foundation and Mr. Loi Nguyen for donating the remote cameras.

A warm and grateful Thank you to Asian Elephant Support and the International Elephant Foundation for sponsoring us to attend the 2019 International Elephant Conservation & Research Symposium in South Africa.
Collaring Elephants: How can they be utilized for HEC mitigation and research...?

Jaco Mattheus
Technical Advisor
BACKGROUND

• With increasing pressure on natural systems and the wildlife populations they support, studying the range use of wildlife, social behavior, and ecosystem utilization, as well as the human impact on these dynamics has become increasingly important. This research is a focal point in both in understanding these systems, and in informing advocacy for better protection.

• Elephants, as a keystone species are also impacted by shrinking habitats. Their co-existence near human settlements has led to several Human-Elephant Conflict situations arising.

• There are various technologies available to monitor elephants, their movement, and habitat utilization. We will provide an overview of how Vectronic Aerospace Elephant collars can assist researchers and managers in their respective studies and mitigation strategies.
History

• Global Supplies has been at the cutting edge of delivering top class products and services to the wildlife industry for the last 17 years. Drawing on a combined 42 years of personal and practical experience in the field, specifically also related to Elephant Management, we are ideally qualified from a technological & practical angle.

Our services include:
• **Elephant Immuno-contraception**,
• Reserve consultancy and management
• **Wildlife Capture & Translocation**
• Supply of various wildlife industry related products
• Pneudart Darting Equipment
• **Wildlife Tracking Solutions**
• **Remote Camera Traps**
• Fencing (as approved by South African National Parks and Nature Conservation authorities)
• Pharmaceuticals (Scheduled and non – scheduled)
• **Wildlife Insurance**
• DNA testing and certification
• Microchips and scanners
• Animal Identification Eartags
• Passive and mass capture equipment
• Helicopter services
• Anti-Poaching equipment and expertise.
HEC SCOPE

• Due to fragmentation of habitat, elephant ranges have become confined to smaller areas, with some historical migration corridors being totally abandoned due to degradation of forest cover, extension of human settlements, intensification of agricultural practice, unsustainable slash and burn practices, unplanned road construction, fencing etc.

• Overpopulation and the race for space!

• Conflict between humans and elephants has become an important issue for conservationists in the past two decades and Elephants don’t always make good neighbors (!!?)

• Ruaha example of increased incidents.
Anger rises over human-elephant conflict in Tanzania

Commentary by Adam C. Stein, Brennan PetersonWood, Hannah Shaw on 9 February 2017
Human-elephant conflict: Can we coexist in peace?
Human-elephant conflict: Can we coexist in peace?

By Amy McConaghy - July 23, 2019

Bitter human-elephant conflict undermines Botswana’s leading conservation efforts

By Shravan Kumar reddy Apparigani - September 23, 2019
HEC SCOPE

• Several mitigation strategies
  • Watchtowers
  • Chillibombs & Dung
  • Trip Wires
  • Beehive Fences
  • Non-preferred crops
  • Pyrotechnics
  • Drones etc.

BUT ...!

• Continued Research & Monitoring required
• Technological advancement of methodology & equipment
• Larger Protected Areas & Corridors
Elephant browsing at night
VERTEX PLUS-13(+2) IRIDIUM Elephant Collar

- Single housing design – no risk of cable breaks
- Double antenna design with splitter
- Iridium bi-directional communication
- UHF radio communication (optionally)
- VHF Beacon Transmitter
- „Activity“ sensor
- High flexible scheduling for GPS and VHF
- Virtual Fence
- External Sensor detection via UHF (optionally)
ACTIVITY SENSOR (3-axis Acceleration)

- **Basic 3-Axis Sensor Package:**
  - Storing average acceleration data every 5 minutes on 3 axis
  - Mainly used for mortality alerts & basic activity sensing

- **Advanced 3-Axis Sensor Package:**
  - Storing acceleration raw data on all three axis
  - Sampling rate 2 to 32 Hz (default 8 Hz)
  - Sensitivity range ±2 to ±8 G (default ±4 G)
  - Download of advanced acceleration data is only possible via cable connection after retrieving the collar!
EXTERNAL SENSORS

Detection of GPS collars for interaction studies:

- integrated UHF ID Tag Option
  - collar is transmitting its own ID

- integrated UHF External Sensor Reception Option
  - collar is receiving IDs from other GPS collars

External Proximity Receiver

- Stationary Receiver to detect ID Tags of GPS collars
PROXIMITY SENSOR

• VERTEX PLUS collar with External Sensor Reception Option

• Listening for IDs from GPS collars in user-defined intervals
• ID, time stamp, signal strength is stored in the collar memory
• Status message is sent with every transmission of GPS data
• Alternative GPS schedule (optional)
• Communication range up to 300 m
SEPARATION SENSOR

- VERTEX PLUS collar with External Sensor Reception Option
- Listening for ID tags (up to 8) every 10 min
- Status message is sent with every transmission of GPS data
- Alert message in case of mortality or separation + latest GPS fix
- Communication range ~130 m
VIRTUAL FENCING

• Initially very basic tool.
• Habitat Use
• Interaction
• Human Wildlife Conflict

Cons:
Fix rate specific...
Post breach / incursion incident.
VIRTUAL FENCING (version 2)

• Buffer Zone
• UHF Proximity Stations – Hotspots, Homesteads, Crop boundaries, water tanks etc
• Increased fix rate
• Pre-alert to initiate mitigation
VIRTUAL FENCING (version 2)
AUTOMATED UHF BASE STATION

- Crop/Kraal system
- Same principle as UHF Proximity with actuator
  - Lights
  - Alarm/Siren
  - Alert message
DAS/ VULCAN EARTH RANGER

• Originally developed by Vulcan/ Save the Elephants
• Ingesting multiple data streams (Personnel / Vehicles / Collars)
Thank you !!
GLOBAL SUPPLIES
www.globalsupplies.co.za
ONE-STOP Ranching Service

JJ van Altena DIRECTOR
Mobile: +27 (0)82 417 0853
Office: +27 (0)600 GLOBAL (456 225)
Fax: +27 (0)86 458 5436
E-mail: jj@globalsupplies.co.za

Jaco Mattheus TECHNICAL ADVICE
Mobile: +27 (0)82 468 6975
Fax: +27 (0)86 590 6957
E-mail: jaco@globalsupplies.co.za

VECTRONIC Aerospace

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Conservation Voluntourism
Overview

- About voluntourism
- Why do people volunteer?
- Funding & fundraising
- Transparency – programme fees
- Choosing a voluntourism programme
- Ethical standards
- Worldwide Experience
- Elephant conservation projects supported by Worldwide Experience
About voluntourism

Why do people sign up for volunteer travel?

- Gain experience and skills
- To make a difference
- For their résumé

- Seek a deeper, more meaningful experience
- Explore career paths

Join the ethical conservation revolution!
About voluntourism

Self-funded volunteer experiences

- Structured programme delivered by qualified guides and conservationists / researchers
- Volunteering cycles
- Days off
- Run by experts
- Health and safety
- Financial protection
- 24 hour support
- Vetted projects
- Fundraising & awareness
Fundraising

"Nurturing nature today, for tomorrow." Worldwide Experience are conservation specialists sending volunteers to responsible volunteering projects around the world where they can help make a real difference to wildlife, natural habitats and communities locally at our projects. Our project placements offer unique and life-changing experiences for everyone involved.

Campaign

2

Start Fundraising
Choosing a voluntourism programme

- It is very important for travellers to choose their placement carefully, according to ethical standards.
- “The tragic rise of gap year voluntourism” – The Guardian 2013
- “Voluntourism is one of the fastest growing trends in travel today. More than 1.6 million volunteer tourists are spending about $2 billion each year.” – NPR 2014
Ethical standards

- Responsible protocol for interactions with captive animals
- Complete transparency with programme fees
- Engage with elders in local communities and obtain their input and approval for activities in the community
- Commit to improving local learning facilities
- Programme staff are suitably qualified with valid first aid certifications and public driving licenses
- Support local business
- Strong and authentic commitment to the local community
- Increase skill set of local community
- Volunteer code of conduct
  - Interacting with each other and staff
  - Interacting with wild / captive animals
  - Interacting with children and community members
- Child protection policy and guidelines
- Goals of the programme are clear, focussed and obtainable
- Volunteering tasks do not take jobs or learning opportunities away from local people
- Minimise negative impacts
Worldwide Experience

- 2002 – Shamwari Game Reserve
- Part of the Mantis Collection
- Added other programmes to the portfolio (20 products today)
- 2012 – developed the Nakavango Conservation Programme at The Stanley and Livingstone Private Game Reserve
- 2015 – Operations moved to Mantis head office
- 2019 – WWE business moving to South Africa from the UK
- CCFA – Community Conservation Fund Africa
- Zambezi Queen – elephant conservation and community
Making a real impact
Reconnecting people with nature
Meaningful experiences
Integrated approach
Projects that are ethical, authentic, safe and supervised
Peace of mind
Collaborating to make a difference through the integration of education, conservation, sustainability and community.
Voluntourism:
Self-funded volunteers join projects with the primary goal of making a difference.
- Wildlife conservation
- Animal rehabilitation
- Game reserve research
- Marine conservation

Vets Go Wild!:
A wildlife veterinary module for vet students, counting toward their EMS criteria for the veterinary qualifications.
- Vets Go Wild! 16 day module
- Vets Go Wild Impact 12 day module

Accredited Courses:
For students who wish to achieve a certificate in:
- Game ranging (nature guiding)
- Wildlife management
- Foreign language
- Scuba diving.

Group Travel:
Bespoke itineraries for various groups.
- Eco School Challenge
- Family volunteering
- Eco Charity Challenge
- Eco Teambuilding Challenge
- Bespoke volunteering
Our conservation categories

- Wildlife conservation
- Animal rehabilitation
- Game reserve – research
- Marine conservation
- Vets Go Wild
EHRA (Elephant Human Relations Aid)
Namibia
Thank you!
Initiating a Voluntourism Program as a Sustainable Economic Initiative to help Mitigate Human Elephant Conflicts

Ravi Corea, Chandima Fernando, and Chinthaka Weerasinghe
Sri Lanka Wildlife Conservation Society (SLWCS)
www.slwcs.org
Voluntourism - Gaining a New Perspective on the World

“Aiding or alleviating the material poverty of some groups in society, the restoration of certain environments and research into aspects of society or environment.”

Stephen Wearing
Impacts of Voluntourism

*It is “making a difference” in the truest sense.*

- The most notable positive impact of volunteer tourism is its impact on the host community.
- Money is directed to areas that would not normally benefit from tourism.
- Volunteer tourism projects not only provides a direct source of income, but the time and effort to conserve and preserve societies and environments provides a financial support in which host communities financially benefit from it in the long-run.
- Enhanced cross-cultural understanding.
- Reduction in racial, cultural and social boundaries.
- Volunteers can utilize their skills that locals may not have.
- Contributes towards international development.
- Provides sustainability.
The Need for a Voluntourism Program

- Community-based conservation cannot be sustained by grant funding alone

- Grants critical to initiate projects

- Grants are not available for long term project maintenance

- Property damage

- Electric fence maintenance

- Deaths from elephant attacks
Established in 2002 to fulfill several objectives:

- To develop a sustainable revenue source for the Society’s operations and projects.
- To create a citizen science program where individuals from any background could participate in wildlife research and conservation to obtain a life changing experience.
- To make elephants and other wildlife valuable to the local communities alive rather than dead, by engaging, training and paying locals to be involved in their conservation.
- By engaging and working with locally recruited and trained field assistants the volunteers help to send a strong conservation message to the local communities to value and protect their environment and wildlife.
The Field Scouts Program

- An innovative program to train and employ local youth as field assistants
- Since its inception the program has provided employment to 30 local youth
From 2002 to 2019

- In 2002 we hosted only 2 volunteers
- In 2018 we hosted 367 volunteers
Benefits from the program

- Since its inception the program has provided employment to 57 locals
- Large network of vendors: transport, supplies, services, facilities, & labour
The SLWCS Voluntourism Program Supports:

**Research**
- Human-elephant conflict surveys
- Elephant identification catalogue
- Elephant health monitoring
- Elephant foraging studies
- Elephant behavior, ranging & habitat use
- Carnivore project
- Small cat study
- Bird ecological studies

**Community-based Conservation**
- Saving Elephants by Helping People
- Community Electric Fencing
- Project Orange Elephant
- EleFriendly Bus Service
- Elephant property damage & death assistance
- Carnivore attack livestock compensation
- Community development

**Biodiversity Conservation**
- Butterfly Sanctuary Project
- Reforestation project
- Bird conservation project
- Rescue & release
Cycle of Positive Feedback

- Grant Makers
- SLWCS
- Volunteers

Projects & Programs
ACKNOWLEDGEMENTS

A sincere and grateful Thank you from SLWCS and the communities we work with to all our volunteers and volunteer company partners.

A warm and grateful Thank you to Asian Elephant Support and the International Elephant Foundation for sponsoring us to attend the 2019 International Elephant Conservation & Research Symposium in South Africa.
HOW CANCER IN ELEPHANTS CAN INFORM TREATMENT APPROACHES FOR HUMANS AND ELEPHANTS

Lisa M. Abegglen, PhD
International Elephant Research and Conservation Symposium
24 October 2019
Patients always guide us.
Elephants rarely get cancer!
Elephants = 20x TP53
Elephant p53 (EP53) triggers more robust cell death
Accelerated Evolution in Distinctive Species Reveals Candidate Elements for Clinically Relevant Traits, Including Mutation and Cancer Resistance

Graphical Abstract

Highlights
- Accelerated evolution in terrestrial, aerial, marine, and subterranean mammals
- Accelerated regions (ARs) uncover diverse putative functional elements
- Elephant ARs reveal candidate mechanisms to decrease mutations and cancer risk
- Human AR homologs indicate concordance between clinical and species' phenotypes

Authors
Elliot Ferris, Lisa M. Abegglen, Joshua D. Schiffman, Christopher Gregg

Correspondence
chris.gregg@neuro.utah.edu

In Brief
Ferris et al. report an analysis of accelerated evolution in the elephant, little brown bat, big brown bat, orca, dolphin, naked mole rat, and thirteen-lined ground squirrel that reveals candidate functional genomic elements for shaping somatic mutation rate, cancer risk, digit development, immunity, glaucoma, pigmentation, and other clinical phenotypes.
Juno
Female
52 years old
Mammary Adenocarcinoma
Treatment: local bleomycin
Electrochemotherapy X 3
Histology images courtesy of Michael Garner
Cancer in Wild Elephants
PEEL = Hebrew word for elephant
A Cancer Therapeutic
55 Million Years in the Making
For Kiera and Schuyler...
Summary

• **Elephant TP53 and Cancer:** less cancer than predicted with extra TP53 to trigger death of damaged cells

• **Translational Science:** EP53-based medicine may benefit people and animals with cancer

• **Elephant Conservation:** better understanding of cancer in elephants can guide treatment decisions to save lives

Let’s work together for a future with MORE elephants and LESS cancer!!!
Schiffman Lab Members
- Joshua Schiffman***
- Gabriela Furukawa
- Aidan Preston
- Tony lovino
- Cristhian Toruno
- Kathleen Noble
- Bahar Shamloo
- Gareth Mitchell
- Niraja Bhacheck
- Aaron Rogers
- Schuyler O’Brien
- Emily Payne
- Journey Bly
- Liz Fedak
- Luke Maese

University of Utah Collaborators
- Chris Gregg and Elliot Ferris (Dept of Human Genetics)
- Jeffrey Yap (Dept of Radiology and Imaging Sciences)
- David Lum (Preclinical Research Resource)
- Lor Randall (Dept of Orthopaedics)
- Kevin Jones (Dept of Oncological Sciences)
- Fred Adler (Dept of Mathematics)

National and International Collaborators
- Avi Schroeder (Technion)
- Mor Goldfeder and Aleah Caulin (PEEL Therapeutics)
- Carlo Maley, Amy Boddy, Marc Tollis, Tara Harrison, Valerie Harris (Arizona Cancer Evolution Center)
- Dennis Schmitt & Wendy Kiso (Ringling Bros. CEC)
- Moses Oteinde and Samuel Omolo (Kenya Wild Life Service)
- Eric Peterson & Lauren LeCoque (Hogle Zoo)
- Kenneth Pienta (Johns Hopkins University)
- David Malkin (Sick Kids)
- David Lane (Agency for Science, Technology and Research)
- Michael Garner (Northwest ZooPath)
- Carol Prives (Columbia University)
- Laura Attardi (Stanford)
- Virginia Pearson (Fox Chase Cancer Center)
- Lauren Howard and Carmel Witte (San Diego Zoo)
- Point Defiance Zoo and Aquarium
- Wildlife Reserves Singapore
- El Paso Zoo
- Jooke Robbins (Center for Coastal Studies)

Former Lab Members
- Lauren Donovan
- Rosann Robinson
- Kiera Jorgensen
- Ashley Chan
- Kristy Lee
- Tanner Wright
- Kelvin Chang
- Erin Young
- Kristina Moore

Supervisors Name:
Susan Musembi, PhD - Department of Biochemistry and Biotechnology, Kenyatta University.
Moses Otiende, PhD - Forensic and Genetics Laboratory, Kenya Wildlife Service
Comparative Oncology

“Between animal and human medicine there is no dividing line – nor should there be. The object is different but the experience obtained constitutes the basis of all medicine.”

Rudolf Virchow (1821-1902)
Introduction

- **Elephants** are large mammals of the family **Elephantidae** and the order **Proboscidea**.

- Three species are currently recognised: the **African bush elephant** (*Loxodonta africana*), the **African forest elephant** (*L. cyclotis*), and the **Asian elephant** (*Elephas maximus*).

- Scattered throughout **sub-Saharan Africa**, **South Asia**, and **Southeast Asia**.
• The African elephant is—a terrestrial animal living up to 70 years,
• 100 times the size of Human beings.
• Thus high cancer rates expected?
• multicellular and large-sized organisms better mitigate the risk of cancer compared to small-sized and unicellular organisms. -Peto’s Paradox
• Elephants remain cancer resistant, with an estimated cancer mortality of 4.81% (95% CI, 3.14%-6.49%), (Abegglen et al, 2015).
Cancer incidence across wild and domestic Species
Elephant (*Loxodonta africana*) TP53 Gene

- p53 is involved in multiple cellular processes/pathways
  - Apoptosis
  - Cell cycle arrest
  - DNA repair
  - Negative regulation
  - Senescence

**p53** is known as the **genome guardian**.
Elephants = 20x TP53
Cancer Cont...

- Cancer is recognised as the second largest cause of all-cause mortality in the United States.
- TP53 Mutation leading to Li-Fraumini Syndrome (LFS) in humans
Problem Statement and Justification

- Elephants remain cancer resistant, with an estimated cancer mortality of 4.81% (95% CI, 3.14%-6.49%), (Abegglen et al, 2015).
- Eradication of cancer remains a significant challenge across healthcare professionals and scientists.
- Evidence on such modalities remains either inconclusive or questionable.
- No such studies have been conducted on African Elephants in Africa.
- No such studies have been conducted on tumour of African Elephants in Africa.
- ETP53 gene has been demonstrated to destroy various forms Cancer.
- Novel therapeutic modalities should try to address such polymorphisms at the genetic level.
- In-depth analysis of comparative genomics might hold the promise of overcoming cancer in the near future.
Gene: ENSLAFG00000007483

**Description:** Cellular tumor antigen p53

**Location:** SuperContig scaffold_47, 11,688,313-11,693,871 reverse strand.

This gene has 1 transcript.

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<td>382</td>
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</table>

In Archive Ensembl we provide displays at two levels:

- Transcript views which provide information specific to an individual transcript such as the cDNA and CDS annotation.
- Gene views which provide displays for data associated at the gene level such as orthologues, paralogues

This view is a gene level view. To access the transcript level displays select a Transcript ID in the table above and want using the menu at the left hand side of the page. To return to viewing gene level information click on the Go page.
Hypothesis

1. There is geographical variation in the TP53 gene isolated from distinct Elephant populations in Kenya.

2. There is single nucleotide polymorphisms in the TP53 gene in distinct Elephant populations in Kenya

3. There is single nucleotide polymorphism in the TP53 gene isolate of Cancer Tumour from Kenyan Elephant.

4. There is changes in amino acid sequence that will lead to functional variation in TP53 gene in silico.
Objectives

Main Objective

To characterize the genetic diversity of TP53 gene in three distinct elephant populations in Kenya and to evaluate its implications in tumorigenesis.

Specific Objectives;

1. To determine geographical variation in the TP53 gene isolated from three distinct Elephant populations in Kenya.

2. To identify single nucleotide polymorphisms in the TP53 gene in distinct Elephant populations in Kenya.

3. To identify single nucleotide polymorphism in the TP53 gene isolate of Cancer Tumour from Kenyan Elephant.

4. To detect changes in amino acid sequence that will lead to functional variation in TP53 gene in silico.
Elephant Population sampling

- This study examined 3 distinct elephant populations across Kenya.

- The Study sites were; Maasai Mara (Approx. 3,000), Tsavo East (Approx. 15,000) & Samburu National Parks (Approx. 8,000). (Total of 26,000)

- Sample collection was done using drop down skin biopsy darting technique (Dominic et al, 2016)

http://www.smiletoafricaadventure.com/tailor_made_safaris.html
Sample size determination.

- Elephants live in herds of 30 - 50 related individuals (Dorst, et al, 1970)

- African elephants will be randomly selected in a stratified manner in 3 distinct parks

- \( \frac{26,000}{50} = 520 \) herds

- Selecting (20-30%) of study population per distinct site will be representative.

- \( 520 \times \frac{0.2}{3} = 35 \)

- \( 520 \times \frac{0.3}{3} = 52 \)

- **35-52 Individual** African elephant herd will be eligible to be included in the study.
• Sample collected and transported to the lab
• Stored in 70% Ethanol

DNA Extraction
(PureLink® Genomic DNA Mini Kit, Thermo scientific.)

PCR
Using Applied Biosystems™ Veriti™ 96-Well Fast Thermal Cycle

DNA Sequencing
(ABI Prism Genetic Analyzer).

Data Analysis
- genome assembly LoxAfr3 will be used for sequence analyses
- BLAST & Multiple alignments using (ENSEML & NCBI Databases)
- Data Analysis, using the Geneious bioinformatics software
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<td></td>
</tr>
</tbody>
</table>

(Abegglen & Schiffman, 2018,)
DNA Sequence Alignment

[Image of a software interface for DNA sequence alignment]

- **Geneious**
- **Alignment Type**: Global alignment with free end gaps
- **Cost Matrix**: 65% similarity (5.0-4.0)
- **Gap Open Penalty**: [Input Field]
- **Gap Extension Penalty**: [Input Field] 3
- **Refinement Iterations**: [Input Field] 2
- **Options**:
  - Automatically determine direction (slower)
  - Build guide tree via alignment (faster)
  - Create an alignment without actually aligning the sequences

[Buttons: OK, Cancel]
Result

- Region specific analysis has been done with focus on Tsavo East.

- The GTG - GTT transversion corresponding to (Val - Val) amino acid was identified in the absence of other genetic alterations.

- This is a silent Mutation (GTG - GTT) found in Exon 3 of ETP53

- Analysis for the remaining Maasai Maraa and Samburu complex are ongoing
Exon 1 - WT

Exon 2 - WT (Clean)

Exon 3 - One SNP (GTG -> GTT) Silent (Val -> Val)
Discussion

- ETP53 gene is an evolutionarily conserved gene
- Mutation in TP53 gene leads to Li-Fraumini Syndrome (LFS) in humans
- ETP53 remains highly conserved in elephants and uses the 20 copies working in concert to prevent Cancer in Elephant
Conclusion

- This is the first time GTG GTT transversion corresponding to (Val Val) amino acid was identified in ETP53 gene.

- Further analysis is underway to elucidate more information per unique and distinct geographic site.

- Followup plan is underway on the 19 copies of rETP53 gene to understand genetic variation.

- These variation may be used as markers of identification to boost conservation efforts.
Ethical considerations

Appropriate permissions were obtained from the animal ethics committees, Kenya wildlife service before initiation of the study. The study will be non-invasive, the chances of risk are minimal across the study participants. Dissemination or unauthorised access to such data were to be subjected to legal litigations.
THANK YOU
Acknowledgment

- Kenyatta University-
- Kenya wildlife service
- My supervisors

- Susan Musembi, PhD - Kenyatta University.
- Moses Otiende ,PhD - Kenya Wildlife Service
- Lisa Abegglen - PhD- University of Utah
-
PLACENTATION AND ENDOCRINOLOGICAL FEATURES OF PREGNANCY IN THE ELEPHANT

Fiona Stansfield¹ and Twink Allen²

¹The Elephant Research and Conservation Unit, Kirkudbright, Scotland
and
²Sharjah Equine Hospital, Sharjah, UAE
ELEPHANT (*Loxodonta africana*)

22 month gestation
Zonary endotheliochorial placenta

Photo: Martyn Colbeck, gettyimages.com
BULL ELEPHANT
Musth
6 TONNE BALANCING ACT
CREMASTER MUSCLE AIDED VULVA
ELEPHANT OVARIES AND UTERUS
Elephant Oestrous Cycle

Redrawn from Lueders et al (2010)
UNICORNUATE CONCEPTUS DEVELOPMENT
PLACENTAL DEVELOPMENT

2 months

7 months

11 months

16 months
PARTURITION AND INVOLUTION
Implantation and Early Placentation
ACTIVATION OF LUTEINISED FOLLICLES TO FORM ACCESSORY CORPORA LUTEA
PLACENTAL GROWTH

4 months

7 months
Fetal testes

18.8 months

H & E

3βHSD
FETAL OVARIIES

16.7 months

H & E

3βHSD
PROGESTAGEN PROFILES IN PREGNANCY

ENDOCRINOLOGY OF ELEPHANT PREGNANCY
ELEPHANT LATE FETAL AND PRE-PUBERTAL SMALL FOLLICLE NUMBERS

Stansfield et al (2012)
NUMBER OF SMALL FOLLICLES IN ELEPHANT FETAL AND PRE-PUBERTAL OVARIIES

Stansfield et al (2012)
STEM CELL MARKERS IN PRE-PUBERTAL ELEPHANT OVARIES

STELLA (1 y.o calf)

NANOG (6 mth calf)

OCT 4 (4.5 y.o calf)

LIN28 (6 mth calf)
IS SHE UNDERGOING POST-NATAL OOGENESIS?
Understanding Prolactin Regulation and Determining the Efficacy of Cabergoline and Domperidone to Mitigate Prolactin-Associated Ovarian Cycle Problems in Zoo African Elephants (*Loxodonta africana*)

J Zoo Wil Med. 2020; 51(1)

Dow TL¹,², Cross DL³, and Brown JL¹

¹ Smithsonian Conservation Biology Institute, Smithsonian National Zoological Park, Front Royal, Virginia
² University of Central Florida, College of Medicine, Orlando, Florida
³ Equi-tox Inc., Central, South Carolina
Circulating Serum Prolactin Concentrations

<table>
<thead>
<tr>
<th>Group</th>
<th>Nonluteal Phase</th>
<th>Luteal Phase</th>
<th>Estrous Cycle</th>
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<tbody>
<tr>
<td>Normal Cycling</td>
<td>34.38 ± 1.77^a</td>
<td>10.51 ± 0.30^b</td>
<td>16.10 ± 0.40</td>
<td>16.11 ± 2.89^a</td>
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<tr>
<td>Irregular Cycling</td>
<td>32.75 ± 2.61^a</td>
<td>9.67 ± 0.42^b</td>
<td>15.03 ± 0.57</td>
<td>15.03 ± 4.17^a</td>
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<tr>
<td>Acyclic</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>33.03 ± 5.93^b</td>
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<tr>
<td>High Prolactin</td>
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<td>64.90 ± 13.31^a</td>
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<td>N/A</td>
<td>6.47 ± 1.73^*</td>
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</table>

Dow and Brown, 2012
Representative Profile of a Normally Cycling Elephant
Representative Profile of an Acyclic Hyperprolactinemic Elephant
Representative Profile of an Acyclic Low Prolactin Elephant
Prolactin

Ben-Jonathan et al., 2005
Possible Treatment of Hyperprolactinemia Acyclic Females

Acyclic, Hyperprolactinemic females (n = 8)

• Cabergoline (dopamine agonist)- Pfizer Pharmaceuticals
  – 2 mg twice weekly for 52 weeks (n=4); vehicle twice weekly for 52 weeks (n=4)
    • Dose established by Morfeld et al., 2014
    – Weekly serum samples for progestagen and prolactin analysis

• Expected Results
  – Normalize prolactin concentration
  – Restore gonadal function
  – Reduce adverse effects of chronic hyperprolactinemia
Overall Serum Prolactin Concentrations Cabergoline Treated and Controls
Overall Serum Progestagens Concentrations Cabergoline Treated and Controls

![Graph showing overall serum progestagens concentrations for Cabergoline treated and controls over weeks. The graph plots serum progestagens (ng/mL) against weeks from 1 to 51. The Cabergoline treated group shows fluctuating levels with some peaks, while the control group remains relatively stable.](image-url)
Representative Profile of a Cabergoline Treated Cow

![Graph showing the serum prolactin and progestagens levels over time for a cow treated with Cabergoline.](image-url)
Representative Profile of a Cabergoline Control Cow

![Graph showing serum prolactin and progestagens levels over time. The x-axis represents weeks, and the y-axis represents concentration in ng/mL. The graph displays two lines: blue for prolactin and red for progestagens. There are arrows indicating key weeks, such as week 57 and week 99.]
Mean Serum Prolactin and Progestagen Concentrations in Elephants with Hyperprolactinemia Before and During Oral Cabergoline Treatment

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Elephant 9</th>
<th>Elephant 10</th>
<th>Elephant 11</th>
<th>Elephant 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prolactin</td>
<td>49.35 ± 12.94</td>
<td>48.11 ± 35.13</td>
<td>61.36 ± 19.68</td>
<td>77.73 ± 6.00</td>
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<tr>
<td>Progestagen</td>
<td>0.10 ± 0.06</td>
<td>0.07 ± 0.04</td>
<td>0.09 ± 0.07</td>
<td>0.05 ± 0.00</td>
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<tr>
<td>During treatment</td>
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<tr>
<td>Prolactin</td>
<td>10.58 ± 18.11</td>
<td>73.92 ± 17.36</td>
<td>12.17 ± 15.03</td>
<td>32.30 ± 23.58</td>
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<tr>
<td>Progestagen</td>
<td>0.10 ± 0.04</td>
<td>0.13 ± 0.05</td>
<td>0.14 ± 0.06</td>
<td>0.16 ± 0.08</td>
</tr>
</tbody>
</table>

Table 1. Mean (± standard deviation [SD]) serum prolactin and progestagen concentrations (ng/ml) in elephants with hyperprolactinemia before and during oral cabergoline treatment.
Possible Treatment of Low Prolactin in Acyclic Females

Acyclic, Low Prolactin females (n = 8)

- Domperidone/Equidone (dopamine antagonist)- Equi-tox Inc. & MAF
  - 2 g per day for four weeks followed by 8 weeks no treatment for 52 weeks (n=4)
  - Vehicle for four weeks followed by 8 weeks no treatment for 52 weeks (n=4)
  - Weekly serum samples for progestagen and prolactin analysis

- Expected Results
  - Normalize prolactin concentration
  - Restore gonadal function
  - Reduce adverse effects of chronic hyperprolactinemia or low prolactin
Overall Serum Prolactin Concentrations Equidone Treated and Controls

![Graph showing overall serum prolactin concentrations for equidone treated and control groups. The x-axis represents weeks, ranging from 1 to 51, and the y-axis represents serum prolactin concentration in ng/mL, ranging from 0 to 80. There are two lines: one for control and one for Domperidone treated, with error bars indicating variability. There are arrows indicating specific weeks for treatment.](image-url)
Overall Serum Progestagens Concentrations: Equidone Treated and Controls

![Graph showing serum progestagens concentrations over weeks with control and treated groups.](image-url)
Representative Profile of a Domperidone Treated Cow
Representative Profile of a Domperidone Control Cow

![Graph showing Serum Prolactin and Progestagens levels over weeks. The x-axis represents weeks (1 to 127), and the y-axis represents levels in ng/mL. The graph compares Control and Domperidone treated groups.]

- Prolactin (blue line)
- Progestagens (red line)

Weeks 1, 15, 29, 43, 57, 71, 85, 99, 113, 127 are marked on the x-axis.

For Serum Prolactin and Progestagens, the y-axis ranges from 0 to 80 ng/mL, and from 0 to 1.0 ng/mL, respectively.
## Mean Serum Prolactin and Progestagen Concentrations in Elephants with Low Prolactin Before and During Oral Domperidone Treatment

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Elephant 1</th>
<th>Elephant 2</th>
<th>Elephant 3</th>
<th>Elephant 4</th>
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<tbody>
<tr>
<td>Before treatment</td>
<td></td>
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<td></td>
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<tr>
<td>Prolactin</td>
<td>6.24 ± 1.25</td>
<td>8.18 ± 1.77</td>
<td>7.94 ± 2.31</td>
<td>4.25 ± 2.68</td>
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<tr>
<td>Progestagen</td>
<td>0.05 ± 0.00</td>
<td>0.08 ± 0.05</td>
<td>0.05 ± 0.00</td>
<td>0.05 ± 0.00</td>
</tr>
<tr>
<td>During treatment</td>
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<tr>
<td>Progestagen</td>
<td>0.09 ± 0.05</td>
<td>0.13 ± 0.08</td>
<td>0.10 ± 0.04</td>
<td>0.10 ± 0.07</td>
</tr>
</tbody>
</table>

*Table 2.* Mean (± standard deviation [SD]) serum prolactin and progestagen concentrations (ng/ml) in elephants with prolactin deficiency before and during oral domperidone treatment.
Project Summary

- Significant perturbations in serum prolactin concentration is a common factor in all acyclic females.

- Response to dopamine agonist and antagonist suggests feedback mechanism similar in elephants.

- Dopamine antagonists and agonists are effective at normalizing serum prolactin concentrations.

- A single Cabergoline treated female experienced one normal cycle as indicated by progestagen pattern and concentration.

- Cabergoline given in cyclical regimen may have been more beneficial.

- No ultrasound data: no evidence of changes on ovary.
  - Elevated progestagens could have been from an adrenal not ovarian origin.
Hyperprolactinemia

- **Physiological**
  - Pregnancy and lactation

- **Pathological**
  - Tumors
  - Primary Hyperthyroidism

- **Pharmacological**
  - Anti-inflammatory medications
  - Analgesics
  - H₂ inhibitors (antacids)

Low Prolactin

- **Genetic**
  - Multiple Pituitary Hormone Deficiency
  - Albright Hereditary Osteodystrophy

- **Pathological**
  - Tumors
  - Severe Hypothyroidism
  - Growth Hormone Deficiency
  - Associated with Cushing’s Disease
  - Infection (tuberculosis, histoplasmosis)

- **Pharmacological**
  - Ergot alkaloids (5-HT agonist)
  - Pyridoxine (Vit. B6)
  - Diuretics
Conclusion

• Continue monitoring reproductive status
  – Ultrasound data to understand physiological changes on the ovary

• Prolactinomas
  – Necropsy

• Influence of pharmaceuticals as endocrine disruptors
  – Phenothiazine, butyrophenones, metaclopromide, reserpine, and cimetidine

• Basic husbandry and management
  – Diet and exercise, enrichment, housing, and clinical health
  – Edwards et al., 2019

• Cyclicity abnormalities continues to effect a large proportion of RAF
  – 51.6% RAF (Brown et al., 2016)

• The problem is very complex
Possible Contributing Factors to Acyclicity in Captive Female African Elephants (*Loxodonta africana*)

**Acyclicity**

- **Reproductive Tract Pathologies**
  - Brown et al., 1999b; Hildebrandt et al., 2000a; Hermes et al., 2004

- **Age**
  - Hermes et al., 2004

- **Pregnancy & Lactation**
  - McNeilly et al., 1983

- **Body Condition**
  - Ange et al., 2001; Clubb et al., 2009; Freeman et al., 2009a

- **Hyperprolactinemia**
  - Brown et al., 2004b

- **Housing**
  - Brown et al., 2016
  - Greco et al., 2016
  - Edwards et al., 2019

- **Endocrine Disruptors**
  - Natural, chemical, pharmaceutical

- **Climate** (temperature, precipitation)
  - Schulte et al., 2000

- **Diet**
  - Hatt and Clauss, 2006
  - Greco et al., 2016

- **Herd Dynamics/Behavior**
  - Freeman et al., 2009a and 2010; Proctor et al., 2010

- **Disease**
  - Edwards et al., 2019

- **Stress**
  - Clubb et al., 2009

- **Endocrine Disruptors**
  - Natural, chemical, pharmaceutical

- **???

References:
- Freeman et al., 2009a and 2010; Proctor et al., 2010
- Edwards et al., 2019
Thank You
Estrous Cycle in the Elephant

Brown et al., 2004
Table 2
Overall mean (±SEM) and average overall mean range concentrations of serum pituitary, ovarian, thyroid, and adrenal hormones in cycling and non-cycling Asian and African elephant females

| Hormone | Asian Cycling | Asian Non-cycling | African Cycling | African Non-cycling | All Elephants
|---------|---------------|-------------------|-----------------|---------------------|-----------------
| LH (ng/ml) | 0.82 ± 0.06 (0.65-1.02) | 0.63 ± 0.09 (0.39-0.95) | 0.67 ± 0.05 (0.34-0.98) | 0.73 ± 0.06 (0.34-1.19) | 0.71 ± 0.03 |
| FSH (ng/ml) | 4.32 ± 0.29* (1.92-3.40) | 2.91 ± 0.32* (1.51-3.51) | 4.41 ± 0.29* (0.56-6.41) | 2.16 ± 0.23* (0.83-3.49) | 3.33 ± 0.41 |
| Prolactin (ng/ml) | 4.85 ± 0.42* (2.30-6.73) | 4.36 ± 0.45* (2.50-6.25) | 7.81 ± 0.54* (4.32-8.84) | 15.19 ± 2.74* (3.33-60.41) | 12.19 ± 2.69 |
| TSH (ng/ml) | 0.75 ± 0.42 (0.61-1.08) | 0.97 ± 0.36 (0.41-1.47) | 0.66 ± 0.15 (0.42-1.27) | 0.56 ± 0.14 (0.37-0.86) | 0.69 ± 0.15 |
| Estradiol (pg/ml) | 14.74 ± 2.29* (13.89-15.54) | 44.88 ± 2.67* (18.11-45.33) | 24.86 ± 6.09* (14.31-42.34) | 36.04 ± 3.09* (21.24-62.71) | 24.22 ± 6.09 |
| Free T3 (pg/ml) | 1.93 ± 0.26 (1.06-2.98) | 1.39 ± 0.24 (0.73-2.86) | 1.61 ± 0.27 (0.70-3.49) | 1.41 ± 0.21 (0.41-3.68) | 1.56 ± 0.12 |
| Free T4 (ng/dl) | 1.01 ± 0.06 (0.74-1.44) | 0.87 ± 0.05 (0.63-0.97) | 0.91 ± 0.03 (0.72-1.10) | 0.93 ± 0.04 (0.72-1.46) | 0.94 ± 0.02 |
| Total T3 (ng/dl) | 128.95 ± 6.25 (91.37-158.35) | 126.72 ± 6.33 (110.65-153.95) | 124.03 ± 4.30 (99.54-148.07) | 123.27 ± 4.38 (89.49-177.48) | 123.97 ± 2.62 |
| Total T4 (μg/dl) | 20.76 ± 0.57 (18.62-14.54) | 11.12 ± 0.46 (9.53-12.52) | 10.06 ± 0.34 (7.58-12.25) | 10.76 ± 0.41 (8.45-16.56) | 10.73 ± 0.24 |
| Cortisol (μg/ml) | 23.32 ± 4.21 (20.42-7.34) | 20.04 ± 7.83 (17.79-55.53) | 20.57 ± 4.86 (17.79-55.53) | 27.53 ± 5.92 (24.05-110.91) | 24.15 ± 3.27 |

* Mean values with different superscripts are significantly different across all groups (P < 0.001).
A Combined data from both species for hormones where there was no significant difference (P < 0.001) between species or reproductive status groups.
B Excludes LH surge data.

Brown et al., 2004b
Comparative Endocrinology Between Cycling and Acyclic Females

<table>
<thead>
<tr>
<th>Hormone</th>
<th>Asian</th>
<th>African</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Cycling</td>
<td>Non-cycling</td>
</tr>
<tr>
<td>FSH (ng/ml)</td>
<td>4.32 ± 0.29&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.91 ± 0.32&lt;sup&gt;b&lt;/sup&gt;</td>
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<tr>
<td></td>
<td>(1.92–3.40)</td>
<td>(1.51–3.51)</td>
</tr>
<tr>
<td>Prolactin (ng/ml)</td>
<td>4.85 ± 0.42&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.36 ± 0.45&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
<td></td>
<td>(2.30–6.78)</td>
<td>(2.50–6.23)</td>
</tr>
<tr>
<td>Estradiol (pg/ml)</td>
<td>14.74 ± 2.28&lt;sup&gt;a&lt;/sup&gt;</td>
<td>44.88 ± 2.67&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Brown et al., 2004b
Variations in the Circannual Rhythm of Musth Variables in Captive Asian Elephants

Rajeev T. & David Abraham
Background

https://commons.wikimedia.org/wiki/File:ThrissurPooram-Kuda.jpg
Background ...

Introduction

• In Asian elephants, **musth** is a unique phenomenon associated with physiological, physical and behavioural variations.

• Traditional management practices in southern India consider **regular occurrence of musth** as an indication of **good health** in the captive bulls.

• In most healthy adult bulls, musth occurs every year. In some, it occurs more than once in a year and in very few, its biannual.

• **Circannual cycles** are biological processes that occur in living creatures over a period of approximately one year.
Introduction ...

• Over three years, nine bulls aged 25 to 65, were monitored

<table>
<thead>
<tr>
<th>Elephant</th>
<th>1-PS</th>
<th>2-NK</th>
<th>3-MS</th>
<th>4-ND</th>
<th>5-TK</th>
<th>6-SA</th>
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<td>32</td>
<td>47</td>
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<td>57</td>
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</table>

• For each bull, there sets of variables, which show significant changes when they come into musth, were recorded at least once a month
  • Physiological
  • Physical
  • Behavioural

• Archived opportunistic data of the nine bulls was used for the observational study
Objective

• Evaluate the recorded changes that happened in the three sets of variables in the nine bulls over the three years
• Examine for correlations, if any, in the three sets of variables, within as well as across the individuals
Materials and Methods

- Variables for **physiological changes**
  - *Serum testosterone (ng/ml) was estimated by electrochemiluminescence immunoassay (cobas*)*

- Continuous scores

<table>
<thead>
<tr>
<th>Year</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
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<td>0.20</td>
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</table>

| Monthly High | 11.10 | 23.80 | 5.56 | 11.10 | 21.80 | 5.60 | 0.10 | 0.50 | 0.30 | 1.91 | 0.10 | 3.40 |
Materials and Methods ...

• Variables for **physical changes**
  • Temporal gland engorgement (TGE)
  • Temporal gland discharge (TGD)
  • Perineal engorgement (PE)
  • Urine dribbling (UD)

• Categorical scores

<table>
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<tr>
<th></th>
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<th>UD</th>
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</table>
**Materials and Methods** ...

- Variables for **behavioural changes**
  - Mahouts
    - Obedience
    - Aggression
    - Attack
  - Public
    - Aggression

- Categorical scores

<table>
<thead>
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</table>
1-PS
25y

Physiological

Physical

Behavioural

2-NK
25y

Physiological

Physical

Behavioural
• 3-MS
• 26y

• 4-ND
• 30y
• 7-UK
• 47y

• 8-SC
• 57y
• 9-SS
• 65y
**Inference**

- Physiological changes seem to occur first, even before the physical and behavioural become apparent.

- Physiological changes also seem to wane off first, followed by the behavioural and physical changes.

- Between-individual correlation -- variations are high.

- Generalization of the change patterns across different ages is difficult.
**Inference ...**

- Except for TGE, all other physical changes were more apparent in older than in younger animals.
- Physiological changes in elephants 40 years and above appear to show regular circannual rhythm; in elephants of age 30 years and below its irregular.
- Peak value of serum testosterone level obtained was 198 ng/ml in a musth elephant.
- The oldest elephant aged 65 years, was obedient and did not show any kind of aggression towards anyone even during peak musth.
Inference ...

• **2-NK**, which never showed any sign of musth, died towards the end of the study

• Maturation arrest of both testes on histopathology, after post-mortem examination
A: Normal testes, B: Testes with maturation arrest. Seminiferous tubules (arrow) smaller in size and with fewer germinal epithelial cells. Spermatids remarkably absent, but Sertoli and Leidig cells prominent.
Discussion

• Major limitation of the study was the missing data for physiological variables during peak musth; since blood samples could not be collected during musth from aggressive animals.

• Our study suggests that standardized recordings of the three-set variables for each elephant can greatly help to approximately predict aggressive behaviour.

• A musth scorecard for individual male elephants that describe the physical, physiological and behavioural changes during musth can enhance the safety and welfare of not only the elephants, but also the attending mahouts.
Sperm motility, kinematics, morphometry and morphology of free-ranging African elephants (*Loxodonta africana*) over two seasons

Ilse Luther, Liana Maree, Antoinette Kotze, Thomas Hildebrandt, Frank Goeritz, Robert Hermes, Gerhard van der Horst
ONE EVERY 9-11 HOURS

ONE EVERY 15 MINUTES
The premature extinction of African species

<table>
<thead>
<tr>
<th>SPECIES</th>
<th>1900</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elephant</td>
<td>12 million</td>
<td>280 000</td>
</tr>
<tr>
<td>Rhino</td>
<td>1 million</td>
<td>21 000</td>
</tr>
<tr>
<td>Lion</td>
<td>200 000</td>
<td>20 000</td>
</tr>
<tr>
<td>Giraffe</td>
<td>1 million</td>
<td>100 000</td>
</tr>
<tr>
<td><strong>Human</strong></td>
<td><strong>2 billion</strong></td>
<td><strong>7 billion</strong></td>
</tr>
</tbody>
</table>
How do we contribute to conservation efforts?

- To maintain healthy wildlife populations an adequate genetic pool required
  
  - Many species face a steady decline in;
    - population numbers and habitat availability

Loss of genetic diversity = Inbreeding
Inbreeding = Low fertility + increased genetic defects

Low fertility = Infertility
Infertility = No progeny = Population extinct
• The rationale to conduct reproduction biology research;
  – to gain knowledge and understanding of basic reproductive function and activity;
  – that can lead to the development of appropriate reproductive technologies

• Development of reproductive biology as a science?
  – Improvement and standardization of processing and analytical techniques
  – Provides a threshold for achieving a more detailed understanding of the species specific male and female reproduction biology
Optimizing every opportunity!!
Aims and Objectives

• To assist in quantifying the semen quality of free-roaming African elephants with the use of CASA (computer assisted sperm analysis)

• To achieve a more objective evaluations

• And consequently adding this information to the current baseline data available
African Elephant
(Loxodonta africana)

19 Ejaculates
(12 individuals)

Motility and kinematic parameters:
- EY X 6
- EY_HAMS X 19 : NT_HAMS X 12
- EY_INRA X 12 : NT_INRA X 12
  Total samples: 61

Hyperactivation:
- EY_BO X 12 : NT_BO X 12
- EY_HAMS X 19 : NT_HAMS X 12 (control)
  Total samples: 55

Morphology: x 17 samples
- Vitality: x 8 samples
- Head Morphometrics: x 14 samples
- TEM: x 7 samples
  Total samples: 48

Genomics:
- CATSPER 1 genome sequencing for L. africana
  Total samples: 7
MATERIALS AND METHODS:
Field analysis
Semen evaluation of Motility:
Individual Motility = Functionality
*Functionality = Fertilization Potential of a spermatozoa*
Semen evaluation of:
Individual Motility = Functionality
Functionality = Fertilization Potential of a spermatozoa

* Rapid progressive motility (<120 um/sec)
* Slow progressive motility (<80 um/sec)
* Non-progressive motility (<40 um/sec)
* Immotile

- * Rapid progressive (type a): VCL 30% VAP 50%
- * Slow progressive (type b): VCL 2% VAP 1%
- * Non-progressive (type c): VCL 6% VAP 10%
- * Immotile (type d): VCL 30% VAP 67%

**Speed**
- Total: VCL 300, VAP 300
- Slow: VCL 250, VAP 250
- Medium: VCL 200, VAP 200
- Rapid: VCL 150, VAP 150
<table>
<thead>
<tr>
<th>Parameters</th>
<th>Population Average Season 1</th>
<th>Population Average Season 2</th>
<th>Overall Population Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total motility (%)</td>
<td>77 ± 25.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>97 ± 3.01&lt;sup&gt;b&lt;/sup&gt;</td>
<td>81 ± 29.7</td>
</tr>
<tr>
<td>Progressive motility (%)</td>
<td>58 ± 25.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>78 ± 7.5&lt;sup&gt;b&lt;/sup&gt;</td>
<td>62 ± 26.9</td>
</tr>
<tr>
<td>VCL (µm/sec)</td>
<td>193 ± 70.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>270 ± 20.4&lt;sup&gt;b&lt;/sup&gt;</td>
<td>241 ± 58.5</td>
</tr>
<tr>
<td>VSL (µm/sec)</td>
<td>133 ± 55.3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>196 ± 25.9&lt;sup&gt;b&lt;/sup&gt;</td>
<td>173 ± 181.6</td>
</tr>
<tr>
<td>VAP (µm/sec)</td>
<td>158 ± 63.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>226 ± 26.9&lt;sup&gt;b&lt;/sup&gt;</td>
<td>201 ± 54.5</td>
</tr>
<tr>
<td>LIN (%)</td>
<td>57 ± 22.6&lt;sup&gt;a&lt;/sup&gt;</td>
<td>73 ± 7.9&lt;sup&gt;b&lt;/sup&gt;</td>
<td>67 ± 16.4</td>
</tr>
<tr>
<td>STR (%)</td>
<td>84 ± 5.7</td>
<td>86 ± 5.5</td>
<td>86 ± 85.7</td>
</tr>
<tr>
<td>ALH (µm)</td>
<td>3.2 ± 0.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.9 ± 0.4&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4 ± 0.8</td>
</tr>
</tbody>
</table>

Data presented as mean ± standard deviation (±SD)

<sup>a, b</sup> values in rows labelled with different superscript letters indicate significantly difference between seasons (p<0.05)

VCL = Curvilinear velocity, VSL = Straight line velocity, VAP = Average path velocity, LIN = Linearity of tract, STR = Straightness of tract, ALH = Amplitude of lateral head displacement
### Acrosome and Viability Evaluation
#### African Elephant

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Population Average Season 1</th>
<th>Population Average Season 2</th>
<th>Overall Population Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Membrane integrity intact (LIVE) (%)</td>
<td>n/m</td>
<td>68 ± 11.9</td>
<td>68 ± 11.9</td>
</tr>
<tr>
<td>Acrosome intact (%)</td>
<td>n/m</td>
<td>77 ± 11.3</td>
<td>77 ± 11.3</td>
</tr>
</tbody>
</table>

Data presented as mean ± standard deviation (±SD)

\textsuperscript{a, b} values in rows labelled with different superscript letters indicate significantly difference between seasons (p<0.05)
Morphology Evaluation

African Elephant
### African Elephant

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Population Average Season 1</th>
<th>Population Average Season 2</th>
<th>Overall Population Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal morphology (%)</td>
<td>58 ± 21.8</td>
<td>54 ± 11.3</td>
<td>55 ± 14.2</td>
</tr>
<tr>
<td>Number of head defects (%)</td>
<td>24 ± 24.1(^a)</td>
<td>9 ± 6.8(^b)</td>
<td>15 ± 17.1</td>
</tr>
<tr>
<td>Number of midpiece defects (%)</td>
<td>12 ± 7.8</td>
<td>16 ± 10.7</td>
<td>14 ± 9.7</td>
</tr>
<tr>
<td>Number of tail defects (%)</td>
<td>9 ± 4.9(^a)</td>
<td>21 ± 11.3(^b)</td>
<td>16 ± 11</td>
</tr>
</tbody>
</table>

Data presented as mean ± standard deviation (±SD)

\(^a, b\) values in rows labelled with different superscript letters indicate significantly difference between seasons (p<0.05)
# African Elephant

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Population Average Season 1</th>
<th>Population Average Season 2</th>
<th>Overall Population Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head length (µm)</td>
<td>6.73 ± 0.45</td>
<td>6.85 ± 0.18</td>
<td>6.83 ± 0.26</td>
</tr>
<tr>
<td>Head width (µm)</td>
<td>3.23 ± 0.23</td>
<td>3.35 ± 0.15</td>
<td>3.32 ± 0.18</td>
</tr>
<tr>
<td>Head area (µm²)</td>
<td>18.84 ± 2.59</td>
<td>20.76 ± 1.39</td>
<td>20.17 ± 1.96</td>
</tr>
<tr>
<td>Acrosomal coverage (%)</td>
<td>38.11 ± 0.66&lt;sup&gt;a&lt;/sup&gt;</td>
<td>39.32 ± 0.77&lt;sup&gt;b&lt;/sup&gt;</td>
<td>38.95 ± 0.92</td>
</tr>
</tbody>
</table>

Data presented as mean ± standard deviation (±SD)

<sup>a, b</sup> values in rows labelled with different superscript letters indicate significantly difference between seasons (p<0.05)
Longitudinal section showing the acrosome (A), nucleus (N) and plasma membrane (PM) of a elephant spermatozoon.

Longitudinal section showing the capitulum (CAP), the proximal centriole (PC) and the outer dense fibres (ODF) of the midpiece and a cross section showing the principal piece (PP).
Cross section of the midpiece:
showing the outer dense fibres (ODF) of the midpiece (MP) surrounded by plasma membrane (PM). The difference in size was apparent in the outer dense fibres (ODF) 1, 5 and 6.

Cross section of the principal piece:
of flagellum showing the outer dense fibres 3 and 8 as inward extensions of the fibrous sheath (FS) surrounded by plasma membrane (PM).
MULTIVARIATE FACTOR ANALYSIS
African Elephant Data

VCL = Curvilinear velocity, VSL = Straight-line velocity, VAP = Average path velocity, LIN = Linearity of track, WOB = Wobble, ALH = Amplitude of lateral head displacement, Tot. Motile = Total motile, Prog. = Progressive, Non-prog. = non-progressive.
## African Elephant

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean ± SD</th>
<th>Mean ± SEM</th>
<th>Range</th>
<th>Mean ± SD</th>
<th>Mean ± SEM</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume (mL)</td>
<td>56 ± 38</td>
<td>11 ± 5</td>
<td>27 ± 5</td>
<td>40 ± 7</td>
<td>28 ± 4</td>
<td>93 ± 48</td>
</tr>
<tr>
<td>Concentration (× 10⁶/ml)</td>
<td>818 ± 750</td>
<td>74 ± 640</td>
<td>1158 ± 183</td>
<td>830 ± 220</td>
<td>1610 ± 4</td>
<td>2409 ± 521</td>
</tr>
<tr>
<td>Total # sperm per ejaculate (× 10⁹)</td>
<td>47.1 ± 9.7</td>
<td>17 ± 16</td>
<td>31 ± 2</td>
<td>50 ± 90</td>
<td>70 ± 6</td>
<td>50 (40-70)</td>
</tr>
<tr>
<td>Progressive motility (%)</td>
<td>62 ± 26.9</td>
<td>35 ± 10</td>
<td>90</td>
<td>50 ± 9.2</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Non-progressive motility (%)</td>
<td>19 ± 9.2</td>
<td>14 ± 4</td>
<td>90</td>
<td>50 ± 9.2</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>VCL (µm/sec)</td>
<td>241 ± 58.5</td>
<td>221 ± 36</td>
<td>130</td>
<td>63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VSL (µm/sec)</td>
<td>173 ± 181.6</td>
<td>84 ± 13</td>
<td>167</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VAP (µm/sec)</td>
<td>201 ± 54.5</td>
<td>112 ± 13</td>
<td>167</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIN (%)</td>
<td>67 ± 16.4</td>
<td>39 ± 8</td>
<td>63</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WOB (%)</td>
<td>83 ± 6.6</td>
<td>73 ± 5</td>
<td>80</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STR (%)</td>
<td>86 ± 85.7</td>
<td>73 ± 5</td>
<td>80</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALH (µm)</td>
<td>4 ± 0.8</td>
<td>10 ± 2</td>
<td>5.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BCF (Hz)</td>
<td>21 ± 3.1</td>
<td>30 ± 2</td>
<td>27.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Membrane integrity intact (LIVE, %)</td>
<td>68 ± 11.9</td>
<td>73 ± 11</td>
<td>47 ± 5</td>
<td>87 ± 2.7</td>
<td>83 (62-90)</td>
<td></td>
</tr>
<tr>
<td>Normal morphology (%)</td>
<td>55 ± 12.4</td>
<td>68 ± 4</td>
<td>84 ± 2</td>
<td>64 ± 70</td>
<td>78 ± 23</td>
<td></td>
</tr>
<tr>
<td>Number of head defects (%)</td>
<td>15 ± 17.1</td>
<td>13 ± 6.6</td>
<td>5 ± 1</td>
<td>46 ± 1</td>
<td>84 (79-90)</td>
<td></td>
</tr>
<tr>
<td>Number of midpiece defects (%)</td>
<td>14 ± 9.7</td>
<td>1 ± 0.3</td>
<td>9 ± 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of tail defects (%)</td>
<td>16 ± 1</td>
<td>8 ± 2</td>
<td>12 ± 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acrosome intact (%)</td>
<td>77 ± 13.3</td>
<td>80 ± 12</td>
<td>70 ± 10</td>
<td>51 ± 5</td>
<td>7.8 - 8</td>
<td></td>
</tr>
<tr>
<td>Head length (µm)</td>
<td>6.8 ± 0.3</td>
<td>7.8 ± 0.1</td>
<td>7 - 8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head width (µm)</td>
<td>3.3 ± 0.2</td>
<td>3.8 ± 0.4</td>
<td>4 ± 0.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head area (µm²)</td>
<td>20.2 ± 1.2</td>
<td>23.9 ± 0.4</td>
<td>4 ± 0.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head ellipticity</td>
<td>2.1 ± 0.1</td>
<td>1.2 ± 0.1</td>
<td>1.2 ± 0.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head elongation</td>
<td>0.4 ± 0.02</td>
<td>0.4 ± 0.02</td>
<td>0.4 ± 0.02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head perimeter</td>
<td>148 ± 0.6</td>
<td>19.6 ± 0.2</td>
<td>7.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head regularity</td>
<td>0.9 ± 0.02</td>
<td>4.5</td>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head toughness</td>
<td>1.2 ± 1.2</td>
<td>19.6 ± 0.2</td>
<td>7.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acrosomal coverage (%)</td>
<td>38.95 ± 0.1</td>
<td>38.95 ± 0.1</td>
<td>38.95 ± 0.1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* detached heads

EE = Electro-ejaculation, MS = Manual stimulation, AV = Artificial Vagina
CASA = Computer-aided sperm analysis, Manual = Phase contrast microscope, CASMA = Computer-aided sperm morphology analysis
VCL = Curvilinear velocity, VSL = Straight line velocity, VAP = Average path velocity, LIN = Linearity of tract, STR = Straightness of tract, WOB = Wobble, BCF = Beat cross frequency, ALH = Amplitude of lateral head displacement
Conclusion

• The use of appropriate data analysis methods
  – can further increase our understanding of the various sperm subpopulation within an ejaculate that can be related to fertilization potential of an bull

• The ability to detect the slightest changes in motion/morphometric can become critically important to identify or monitor any environmental/external stressors on sperm

• Since reproduction is correlated with naturally occurring variation in environmental factors,
  – we aim for a meaningful linkage between ecological and physiological considerations in our quest to understand the energetic of reproduction
The success of the semen and data collection within free-ranging populations; could be of tremendous significance for future conservation management strategies:

• **TO SUPPORT LEGISLATION, REGULATION AND BIODIVERSITY STRATEGIES;**

• **OR CRYOPRESERVED AND STORED IN LIQUID NITROGEN FOR LATER APPLICATION (GAMETE BIOBANKING);**

• **SEMEN COULD BE USED WITHIN FRESH SEMEN ARTIFICIAL INSEMINATION (AI) PROGRAMS;**
  – within captive, isolated or fragmented wildlife populations to ensure the genetic diversity is sustained.
Acknowledgements

- ZooParc de Beauval, France.
- University of the Western Cape.
- National Zoological Gardens of South-Africa.
- Research Team:
  Thomas Hildebrandt, Frank Goeritz, Robert Hermes, Jette Dierich and Imke Lueders,
  Institute for Zoo and Wildlife Research (IZW), Alfred-Kowalke street 17, D-10315, Berlin, Germany
  Romain Potier,
  ZooParc de Beauval, 4110 Saint Aignon, France
  Adrian Tordiffe and Paul Bartels
  National Zoological Gardens of South-Africa, 232 Boom street, Pretoria, 0110, South-Africa
  Barbera Baker and Willy Theison
  Pittsburg Zoo and PPG Aquarium, One Wild place, Pittsburg, PA 15206, North-America
  Douw Grobler and JJ van Altena
  Catchco Africa, 11844 Silverlakes, 0054, South-Africa
  Gerhard van der Horst and Liana Maree
  Department of Medical Biosciences, University of the Western Cape, Modderdam road, Belville, Cape Town, 7535, South-Africa
THANK YOU
Hyperactivation as a sperm functional test in African elephant bulls

Liana Maree (PhD)

in collaboration with
Ilse Luther, Antoinette Kotze, Gerhard van der Horst

16th International Elephant Conservation and Research Symposium
21-25 October 2019
Introduction

Can we predict fertility by assessing a semen sample?

Robert D. Martin - www.psychologytoday.com/us/blog/how-we-do-it
Semen/sperm requirements

According to WHO criteria* for human semen:

a) Semen volume (≥ 1.5ml)
b) Semen colour
c) Semen pH (7.2-8.0)
d) Total sperm motility (≥ 40%) & progressive motility (≥ 32%)
e) Sperm concentration (≥ 15x10⁶/ml)
f) Normal morphology (≥ 4%*)

* WHO laboratory manual for the examination and processing of human semen (2010)
Sperm functional tests

a) Vitality
b) Motility & kinematics
c) Hyperactivation
d) Acrosome reaction
e) Reactive oxygen species
f) Mitochondrial membrane potential
Semen/sperm requirements

Semen/sperm requirements

Importance of hyperactivation

- characterized by high-amplitude beating of the flagellum and asymmetrical movement
- assists spermatozoa to:
  - migrate through the viscoelastic environment of the female reproductive tract, to
  - detach from the oviductal epithelium and
  - enable penetration of the layers of the oocyte
Importance of hyperactivation

Aim of study

Can we induce & assess hyperactivation in African elephant spermatozoa?

- **Which medium and chemical to use?**
  - caffeine, pentoxifylline
  - thimerosal
  - procaine hydrochloride
  - progesterone

- **Which motility (kinematic) parameters to classify?**
  - determine cut-off values for CASA* parameters
  - values are species specific

* CASA = computer-aided sperm analysis
Materials & Methods

• 6 free-ranging African elephant bulls
• 10 semen samples collected through electro-ejaculation
Materials & Methods

- neat semen (NT) or extended with egg-yolk (EY)
- exposed to Ham’s F10 (Ham’s) or BO sperm wash (containing 10 mM caffeine)
  1. EY_Ham’s
  2. EY_BO
  3. NT_Ham’s
  4. NT_BO

Flush technique
**Materials & Methods**

- **CASA motility analysis – Sperm Class Analyzer®**
- tracking sperm to measure 8 kinematic parameters:

<table>
<thead>
<tr>
<th>Curvilinear velocity (VCL)</th>
<th>Straight-line velocity (VSL)</th>
<th>Average path velocity (VAP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linearity (LIN)</td>
<td>Straightness (STR)</td>
<td>Wobble (WOB)</td>
</tr>
<tr>
<td>Amplitude of lateral head displacement (ALH)</td>
<td>Beat cross frequency (BCF)</td>
<td></td>
</tr>
</tbody>
</table>

![Diagram showing sperm motility analysis](image)
## Results

<table>
<thead>
<tr>
<th>Sample</th>
<th>Volume (ml)</th>
<th>Concentration (x10^6/ml)</th>
<th>Sperm/Ejaculate (x10^9)</th>
<th>Total Motility (%)</th>
<th>Prog Motility (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LA1</td>
<td>98</td>
<td>74</td>
<td>7252</td>
<td>98</td>
<td>74</td>
</tr>
<tr>
<td>LA2</td>
<td>130</td>
<td>150</td>
<td>19500</td>
<td>99</td>
<td>94</td>
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<tr>
<td>LA5</td>
<td>57</td>
<td>2025</td>
<td>115425</td>
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<td>LA6</td>
<td>68</td>
<td>472</td>
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<td>LA10</td>
<td>38</td>
<td>750</td>
<td>28500</td>
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<tr>
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<td>109573</td>
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<td>76</td>
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<tr>
<td>AVERAGE</td>
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Results

HAM’S F10 FLUSH
Results
Results
Results

STRAIGHT-LINE

LINEAR

CIRCULAR

STARSPIIN

A

B

C

D
Results

STRAIGHT-LINE

CIRCULAR

LINEAR

STARSPIN
Results
% HA for *L. africana*

100 > VCL > 500
1 < VSL > 70.2
1 < STR > 26.5
1 < LIN > 45.2
## Results

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| Sum  | 29                 | 5                 | 20                 | 4                 |
Discussion

Which motility parameter to assess?

• Total motility: range 91-100%
• Progressive motility: range 67-94%
• Hyperactivation: ranged 8-53% in EY-BO and 4-58% in NT_BO
**Discussion**

<table>
<thead>
<tr>
<th></th>
<th>Volume (ml)</th>
<th>Concentration (x10⁶/ml)</th>
<th>Sperm/Ejacul. (x10⁹)</th>
<th>Total Motility (%)</th>
<th>Prog Motility (%)</th>
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</tbody>
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Discussion

Which motility parameter to assess?
- total motility: range 91-100%
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- hyperactivation: ranged 8-53% in EY-BO and 4-58% in NT_BO

Potential fertility?
- semen with $\geq$ 20% HA has good fertilizing ability
- 7/9 samples had > 20% HA, but large variation
- quality of $1^{st}$ vs $2^{nd}$ vs $3^{rd}$ sample
Discussion

Which motility parameter to assess?
- total motility: range 91-100%
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Potential fertility?
- semen with ≥ 20% HA has good fertilizing ability
- 7/9 samples had > 20% HA, but large variation
- quality of 1st vs 2nd vs 3rd sample

Hyperactivation as diagnostic tool
- fertile vs subfertile males
- dominant vs subordinate males
- environmental impact, e.g. season, nutrition
Acknowledgements

Ilse Luther-Binoir (PhD)  
GEOSperm

Antoinette Kotze (PhD)  
SANBI NZG

Gerhard van der Horst  
(PhD, PhD) – UWC
DIAGNOSTIC IMAGING IN ELEPHANT MEDICINE – FROM EYE TO KIDNEY

Dr. Imke Lüders
(DVM, PhD, DiplECZM)
Nearly 10 years ago....

IEF Conservation and Research Symposium February 2010
Kwalata, South Africa
Diagnostic Imaging

“...the use of electromagnetic radiation and certain other technologies to produce images of internal structures of the body for the purpose of accurate diagnosis.”

- Ultrasound
- Endoscopy
- X-ray
- CT/MRI
Ultrasound in Elephants
Transcutaneous vs. Transrectal Approach

- Late pregnancy fetus
- Liver
- Veines/ Lymphnodes
- Urogenital Tract, Early pregnancy
- Heart
- Eye
Transrectal ultrasound

**Ultrasound of the Female Urogenital Tract**

- **Uterine horns (cross section)**
- **Uterine body (cross section)**

**Ovary**
- Follicular phase
- Luteal phase
- Ovary: luteinizing follicle, late follicular phase
- Ovulatory follicle
Early Pregnancy

Reproductive Pathologies

Small leiomyoma, uterine wall
Cystic endometrial hyperplasia
Uterine horn cross section, leiomyoma, fluid
Uterine Pathologies
(Endometrial Hyperplasia, Leiomyoma, Uterine content)
Renal Ultrasound

Chronic kidney disease (CKD) to end-stage renal disease (ESRD)

- 8 adult Asian elephants (*Elephas maximus*): 1 male / 7 females
- Age: 21-53 years
- From 7 different facilities in Switzerland (3)/ Belgium (1)/France (2)/Germany (1)/UK (1) (one captive born, all other wild caught)
- 4 terminal cases with full histopathology
Symptoms (out of 8 elephants)

- Weight loss: n= 7
- Facial OR Ventral oedema: n= 7
- Pale mucous membranes: n= 5
- Polydipsia: n= 5

© Zoo Zurich
Symptoms (videos)

Muscle tremble/convulsions
n=8 elephants
Also: trunk weakness/paralysis, tremor (n=3)
Ultrasonography

Transrectal approach

Cysts

Irregular echotexture, shadowing

Echodense texture

dilated vessels

Furthermore: increased size, ureter dilatation, calcification/fibrosis
Sample prior to symptoms

Blood urea nitrogen

BUN (mmol/l)

Species360® Mean

Em1 Em2 Em3* Em4* EM5*
CKD ESRD
Sample prior to symptoms

Species360® Mean

Serum CREA Creatinin

Em1 Em2 Em3* Em4* EM5*
Serum Calcium (mmol/l)

Sample prior to symptoms

Species360® Mean

CKD

ESRD
URINALYSIS

Urine Creatinine (uCREA) remained on average < 0.1 mg/ml urine:

symptomatic elephants mean ± SD: 0.09 ± 0.04 mg/ml; n=7

unremarkable controls 0.26 ± 0.08 mg/ml; n= 5
PATHOLOGY
(n= 4 elephants)

➢ Glomerulosclerosis and/or Tubulonephritis/ nephrosis,
➢ one Pyelitis
➢ interstitial Fibrosis/ complete replacement with Connective tissue
➢ Mineralization/ Calcification
➢ Protein rich cysts / protein tubular casts
Eye ultrasound

Asian elephant female, 51 year old, cataract both eyes
Prolapsed lens

2016
Fibrotic lens in position

2018
Prolapsed lens anterior chamber
6 weeks after surgery
Endoscopy in Elephants

- Gastroscopy
- Bronchoscopy
- Vestibuloscropy
- Artificial insemination
Elephant Endoscopy
Bronchoscopy und Bronchial Lavage

Photo: © Whipsnade zoo
Bronchoscopy
Bronchial Lavage for TB testing in captive elephants

- 21 elephants
- Sumatra and Europe
- During standing sedation

Combined trunk wash, BAL, stomach fluid and serology!

<table>
<thead>
<tr>
<th>Elephant</th>
<th>Gender</th>
<th>Age</th>
<th>Specie(s)</th>
<th>Serology (STAT-PAK/DPP/Interferone)</th>
<th>Trunk Wash</th>
<th>Bronchial lavage</th>
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The blind men and the elephant

How our limited knowledge leads us to believe it to be the whole truth.
Thank you very much!

- Thanks to all partners, colleagues and collaborators!
What does the elephant brain tell us about elephant behavior?

Paul Manger, 
University of the Witwatersrand
Elephant Eyesight

- Visual acuity of 14 cycles per degree – about \( \frac{1}{4} \) as good as human eyesight.
- 2 areas of peak acuity, one for the trunk, one for the side.
- Unusual tapetum lucidum.
- Trunk-eye co-ordination and vigilance.
Brodest sense of smell for mammals?

- 2000 active olfactory receptor genes – most of any mammal.
- Large honeycombed glomerular layer
- No accessory olfactory bulb!
Elephant brain in numbers

- Total cells – 420.92 billion (420 920 000 000)
- Cerebellum – 234.36 billion cells, 205 billion neurons (humans have 69 billion neurons)
- Cerebral cortex – 60.32 billion cells, 5.1 billion neurons (humans have 16 billion neurons)
- About the same number of cortical neurons as a gorilla.
Elephant cerebral cortex

- 5 layers
- Moderate to low cell density
- 2.5 - 3 mm thick
- Normal range of neuronal morphologies
Golgi stained neocortical cells
The matriarch neuron

- Matriarch neuron similar in size and complexity to those seen in human frontal cortex.
One specialized hippocampal feature
Largest relative cerebellar size of all mammals
Cerebellar cortex

Basket cell, golgi stain

Purkinje, golgi stain

Stellate cell, calbindin
Cerebellar cortex

Lugaro neuron, golgi

Lugaro neuron, calretinin
Hypocretin neurons
Locus coeruleus neurons
How much sleep do Elephants have each day?
2 hours of sleep per day
What’s unusual about elephant sleep?

- Sleep only 2 hours per day
- Only lie down to sleep every 3 or 4 days – REM?
- Sleep onset and offset related to environment
- Can go for up to 48 hours without sleep
Reception of Infrasound – getting a 3D localization of sound source
Seismic reception

- Pacinian receptors in feet transmit incoming seismic wave.
- Large dorsal column nuclei
- Spinotectal tract
- Ventral posterior inferior nucleus
- Pulvinar nucleus
- Somatosensory cortex
- Associative cortex
Auditory reception

- Cochlea and 8th nerve to cochlear nuclei
- Enlarged lateral superior olivary nucleus – interaural intensity difference
- Inferior colliculus – map of auditory space
- Superior colliculus – register with seismic waves
- Transverse infrageniculate nucleus and auditory cortex – semantic of infrasound
- Pulvinar and Associative cortex – timing differential of wave arrivals
Transverse infrageniculate nucleus

- Specialized portion of the medial geniculate body.
- Likely involved in processing low frequency sounds.
- Has a bilaminar appearance.
- Only found in elephants.
Neural Production of Infrasound

- Anterior cingulate cortex
- Amygdala (emotion), midline thalamus (awareness), hypothalamus (motivation), ansa lenticularis (attention).
- Nucleus ellipticus (vocal pattern generator).
- Nucleus ambiguus (phonatory pre-motoneurons)
Nucleus ellipticus
How is infrasound produced?

- Huge frontal sinus
- Helmholtz resonance
Future work on brain and behavior to add value to conservation efforts:

* **Elephant cognition** – more brain work needed.
* **Reception of infrasound** – test the hypothesis of timing differential to determine whether elephants can make a 3D localization of sound source.
* **Production of infrasound** – anatomical dissections and functional endoscopy.
* **Use of infrasound** – when and where and what conditions affect the production of infrasound.
Plains zebra: the focus of conservation efforts of the African savannah?
Sex Differences in the Play of ex situ African Elephant Calves (Loxodonta africana)

We acknowledge and appreciate the guidance and assistance of the elephant keepers, the data collection by many Butler students and the support of both the Indianapolis Zoological Society and Butler University.
This study was conducted to determine whether the social interactions of African elephant calves ex situ would resemble those of African elephant calves in situ.

- We video-recorded the social interactions of two calves at the Indianapolis Zoo.
- The female calf (Amali) was five months older than the male calf (Ajani).
- Both calves had been conceived by artificial insemination (& different dams).
- Neither calf had seen an adult male elephant or another male elephant calf.
- Thus one cannot attribute the male calf’s behavior to modeling (social learning)
Comparing Behaviors \textit{in situ} and \textit{ex situ}

- Adult male (Age unknown)
  Moss et al. (2011)

- Ajani and Amali (Age \(\cong 2\) years)
  Ajani had never seen another male elephant
The Second Exhibit at the Indianapolis Zoo
Method

• We observed the calves during 90 sessions, for a total of 61 hours

• After discarding data for all intervals during which we could not see both calves (15.4 hours) or during which the keepers were managing the elephant group or either calf was interacting with a keeper (11.5 hours) - We obtained data for a period of 33.4 hours

• We recorded 21 typical calf behaviors during the period from September 2000 to April 2003

• In June 2002 the elephant group moved from a moderate-sized exhibit to a large exhibit

• For both calves, we used a zero-one coding system to record any of these behaviors that occurred during each 30s interval

• This conservative approach eliminated the effect of repetition of any behavior
Method (cont’d)

• We recorded four classes of behavior

• Social/Affiliative [Trunk-to-genitals, Trunk-to-mouth, Follow and “Lower” (sit, kneel, lay down)

• Aggressive play [Spar, Trunk-entwine, Push, Ram ]

• Reproductive play [Trunk-on-back-from-behind, Trunk-on-back-from-side, Mounting and “Side Climb” (Climbing on the other elephant from the side) – Both Mounting and Side Climb could be either Full (both feet on other’s torso) or Partial (One foot on other’s torso)

• Other [Tusk-to-ground, Foot-swing, Headshake, Trunk-on-other’s-head, Approach, Leave]
Method (cont’d)

• All data were coded by one observer (RD)
  [two coders (RD and SR) had coded a different set of behaviors using somewhat different criteria]

• The Test-Retest reliability (proportion of disagreements) for Coder RD was 0.89 for all of the behaviors other than Approach and Leave, and only 0.77 for Approach and Leave

• The difficulty with scoring Approach and Leave occurred because the “Approach” criterion was to move within two body lengths of the other calf and the ”Leave” criterion was to move more than two body lengths away from the other calf – and the calves spent a considerable portion of the time about two body lengths apart

• We experienced a similar difficulty previously, using a one-body-length criterion

• A one-sample Chi-square test was used for all statistical analyses of behavior frequencies
Sample of Aggressive and Reproductive Behaviors
Results - Social/Affiliative behaviors

**Follow**
- Amali (N = 133); Ajani (N = 41) (p <0.0001)

**Lower Body**
- Amali (N = 155); Ajani (N = 83) (p <0.0001)

**Trunk-to-genitals:**
- Amali (N = 96); Ajani (N = 14), (p <0.0001)

**Trunk-to-mouth:**
- Amali (N = 74); Ajani (N = 26), (p <0.0001)
Results: Aggressive Play

• **Spar:** Amali and Ajani sparred 124 times

• **Trunk entwine:** Amali and Ajani intertwined trunks 57 times

• **Ram:** Amali (N = 4); **Ajani** (N = 21) \((p < 0.01)\)

• **Push:** Amali (N = 29); **Ajani** (N = 78) \((p < 0.0001)\)

• **Head shake:** Amali (N = 32); **Ajani** (55) \((p < 0.02)\)
Results - Reproductive Play

• Trunk-on-back-from-behind:  
  \[ \text{Ajani (N = 102); Amali (N = 28) } \ p < 0.0001 \]

• Trunk-on-back-from-side:  
  \[ \text{Ajani (N = 64); Amali (N = 28), } \ p < 0.001 \]

• Trunk-over-back-from-behind/Mount:  
  \[ \text{Ajani (N = 59); Amali (N = 4); } \ p < 0.0001 \]

• Trunk-over-back-from-side/Side Climb:  
  \[ \text{Ajani (N = 25); Amali (N = 4) } \ p < 0.001 \]

• Mount (Full & Partial):  
  \[ \text{Amali (N = 12), Ajani (N = 90) } \ p < 0.0001 \]

• Side Climb (Full & Partial):  
  \[ \text{Amali (N = 4), Ajani (N = 25) } \ p < 0.001 \]
Reproductive Play cont’d

- Amali did not perform her first Full Mount until Ajani had Mounted 49 times
- Amali’s first Full Mount occurred after 18 months of observation (on 2-15-02)
- Most of Amali’s eight Full Mounts were clumsy and imprecise
- Of Amali’s eight Full Mounts, none occurred with a Trunk-over-the-back-from-behind
- From the start Ajani’s Full Mounts resembled adult male (*prototypical*) Mounts
Results - Other Behaviors

• **Tusk-to-Ground**: Amali (N = 27); Ajani (N = 41) *Not Significant* (p = 0.12)

• **Trunk-on-other’s head**: Amali (N = 69); Ajani (N = 58) *Not significant* (p = 0.38)

• **Foot swing**: Amali (N = 31); Ajani (N = 13) (p < 0.02)

• **Approach**: Amali (N = 150); Ajani (N = 90) (p < 0.0001)

• **Leave**: Ajani (N = 166); Amali N = (118); (p < 0.01)
Conclusions

• Ajani performed all of the Reproductive Play behaviors more than did Amali

• Amali did not perform a Full Mount until Ajani had done so 49 times. This was after about 18 months of observations

• They performed these behaviors despite never seeing another male elephant: suggesting that male mating behavior is exhibited without social learning – it is pre-programmed (Modal Action Patterns)

• Amali performed all of Social/Affiliative behaviors more than did Ajani

• Ajani performed all of the Aggressive Play behaviors more than did Amali
A study on musth management and enrichment utilization of rescued captive Asian elephants (*Elephas maximus*) at Elephant Conservation & Care Centre, Uttar Pradesh, India.

Baiju Raj. M.V.  
*Director- Conservation Projects*  
*Member - Crocodile Specialist Group, IUCN*  
*Authorized Inspector for Captive Elephants. AWBI- Govt. of India*  
*Special Officer (Vol) Wildlife Crime Control Bureau. Govt. of India*
Established & operates centres in collaboration with State Forest Departments

- 4 nos Sloth Bear Rescue Centres (Agra, Bangalore, Bhopal & Purulia)
- 2 nos Asiatic Black Bear Rescue Centre (Dachigam & Pahalgam – J & K)
- Leopard Rescue Centre (Maharashtra)
- Primate & Reptile Rescue Centre (Haryana)
- 2 nos Elephant Care Centres (U.P & Haryana)
- Wildlife Helpline Service in NCT Delhi and Agra
- Elephants and Sloth bears (Human animal interaction mitigation projects)- Chhattisgarh
- Conservation research projects in collaboration with National and International Institutions like WII, IISC, IVRI, San Diego Zoo Global etc
Objective

1. To minimise the stress level / stereotypic behaviour through implementation of various enrichments.

2. To introduce a chain free method for the musth management.
Methodology

Objective No. 1
Scatter feeding in the enclosure
Feeding enrichment using puzzle feeder (Barrel/Cans)
Green fodder feed enrichment with vegetation/browse on top of the shed inside.
Slight change in feeding set times for increasing temporal activities.
Increasing the number of feeding times/day.
Logs for the bulls elephants inside the enclosure and logs outside for cow elephants.
Tyres

Objective No: 2.
Designing of a large enclosure with adequate precaution for the musth elephants.
Intensive introduction of enrichments to reduce the stress level and deviate from charging, pacing, hurting himself.
A temporary cover around the enclosure is maintained to avoid distraction of people and vehicle movements.
Water is available throughout the day.
### Study Elephants

<table>
<thead>
<tr>
<th>Date of receipt</th>
<th>Name</th>
<th>Sex</th>
<th>Approx Age</th>
<th>Received/ Court Case</th>
<th>Health Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>25.03.2010</td>
<td>Champa</td>
<td>F</td>
<td>60</td>
<td>Surrendered from a Saint through Mathura Forest Department</td>
<td>Died on 09.09.2011</td>
</tr>
<tr>
<td>03.11.2010</td>
<td>Bhola</td>
<td>M</td>
<td>46</td>
<td>Ghaziabad Case No. 12/ 10-11 dated 02.11.2010</td>
<td>Under Treatment</td>
</tr>
<tr>
<td>13.05.2012</td>
<td>Phoolkali</td>
<td>F</td>
<td>55</td>
<td>SDO, Agra letter no 432/35-1 dated 29.05.2012, Court order dated 25.05.2012</td>
<td>Under Treatment</td>
</tr>
<tr>
<td>30.06.2012</td>
<td>Chanchal</td>
<td>F</td>
<td>18</td>
<td>Rescued in road accident, permission from Chief Wildlife Warden.</td>
<td>Under treatment</td>
</tr>
</tbody>
</table>
Bhola: Blind Bull: 45 Yrs: 2010
Begging Trade
Bijili: Cow: 30 Yrs: 2010 Circus
Maya: Cow: 35 Yrs: 2010 Circus
Rajesh: Bull: 30 Yrs: 2010 Circus
Phoolkali: Cow: 55 Yrs: 2012
Begging Trade
Chanchal: Cow: 15 Yrs: 2012
Begging Trade
The implementation of a good enrichment program can increase empathy and promote a closer bond between keeper and animal.

A good enrichment program can help to reduce “stereotypic behaviour”, which is developed due to boredom.
Enrichment
Enrichment
Social interaction

Bhola with other females
Long walks
Social interaction and groups
Results through enrichment

Phoolkali

Chanchal
Results through enrichment

**Bijlee**

- Frequency of Stereotypy
- 2010
- 2011
- 2012
- 2013

**Maya**

- Frequency of Stereotypy
- 2010
- 2011
- 2012
- 2013
Results through enrichment

**Bhola**

- Frequency of Stereotypy over years 2010 to 2013.

**Rajesh**

- Frequency of Stereotypy over years 2010 to 2013.
Condition during arrival
Musth management
(traditional method)

Initial days of musth
(2010)
Musth management (traditional method)

Initial days of musth 2010
Conditioned to wear bracelet
Musth Management with positive reinforcement
Musth Management with positive reinforcement
Musth Management with positive reinforcement
Natural behavior display
Exercise Long walks help address arthritis, joint pain etc.
Social interaction
Social interaction
Musth Management with positive reinforcement
Musth Management with positive reinforcement
Treatment with positive reinforcement
Long exercise walks after musth
Frequency of the stereotypic behaviour of each elephants were recorded (Bhola, Maya, Bijlee, Rajesh, Phoolkali, Chanchal) from the date of arrival until April 2013 during, (still continuing) different seasons with the implementation of enrichments. The graphs shown above shows a positive signs to the enrichment utilization.

Results

<table>
<thead>
<tr>
<th>Name of elephants</th>
<th>Sex</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bhola</td>
<td>M</td>
<td>76%</td>
<td>62%</td>
<td>32%</td>
<td>8.40%</td>
</tr>
<tr>
<td>Maya</td>
<td>F</td>
<td>75%</td>
<td>67%</td>
<td>23%</td>
<td>5.60%</td>
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<tr>
<td>Bijlee</td>
<td>F</td>
<td>67%</td>
<td>46%</td>
<td>33%</td>
<td>7.50%</td>
</tr>
<tr>
<td>Rajesh</td>
<td>M</td>
<td>89%</td>
<td>75%</td>
<td>43%</td>
<td>11%</td>
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<tr>
<td>Phoolkali</td>
<td>F</td>
<td></td>
<td>54%</td>
<td></td>
<td>16%</td>
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<tr>
<td>Chanchal</td>
<td>F</td>
<td></td>
<td>26%</td>
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<td>15%</td>
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</tbody>
</table>
• In India we usually see the traditional methods of dealing with musth bulls by restraining them till musth period is over.
• We implemented chain free method for the first time in India. The methods were successful for the three consecutive musth period in both Bhola and Rajesh.

1. Using bracelets and making them used to bracelets with a positive reinforcement. (This avoids darting in emergency)
2. Taking them for long walk for more exercise. (Space restriction)

However we need to look into the fact of taking the male elephants for a long walk implementing traditional methods (riding) with a scientific approach as every male elephant have a different personality.

Studies continued..
Long way to go

Long term goal of the center

- Awareness training
- Mahouts training
- Veterinary officers training
- Biologist
- Forest department officers training
- Volunteer programs
Awareness and training
Awareness and training
Volunteers walk with elephants
Thank you...

Acknowledgements:

Mrs. Nichole Sharp, Executive Director, Wildlife SOS, USA

W: wildlifesos.org | E: baiju@wildlifesos.org | M: 9917190666

You cannot research a species, unless you put in the effort to protect the species....

Dr. Dian
The elephant in the room: Integrating behaviour to assess captive elephant welfare

Lisa Yon, Naomi Harvey, and Giuliana Miguel-Pacheco
Commonly used measures of welfare in captive wildlife

- **Resource based**
- **Health/physical**
  - Body condition
  - Health/ill-health
  - Physical activity/movement
- **Physiological**
  - Glucocorticoids (cortisol/corticosterone)
  - Heart rate
Physical activity: Distance walked
Physical activity: Distance walked = good welfare??
Physiological measures: Glucocorticoids (cortisol)

Stress $\rightarrow$ activates HPA axis

Stimulates adrenal glands (cortisol)
Eating food → Increase cortisol
Reproductive activity → Increase cortisol
Physical activity/locomotion → Increase cortisol
Chronic stress → Decreased cortisol (sometimes)

- Cortisol can decrease with chronic stress
- Not a simple 1:1 relationship
- Need more information (behaviour) to interpret cortisol data

FGMs in translocated (blue) vs. control (red) elephants

Cortisol in chronically stressed (top) vs. control fish
Physiological measures: Heart Rate

• Also excitement or arousal, as well as stress
“…careful observations of behavior can provide us with … information about animals' requirements, preferences and dislikes, and internal states

Behavior… [provides]…information to human caretakers about the welfare of the animal”

- Joy Mench, 1998
Why Don’t More People Assess Behaviour?

• Time consuming
• There was no standardised (validated) method
• Data can be difficult to interpret
• May require expertise in the methodology
Novel Elephant Behavioural Welfare Assessment Tool

• Assess welfare of captive elephants using behavioural indicators
• For use by elephant keepers
• Rapid, reliable and valid method
• Monitor changes in welfare over time
Content of Behavioural Welfare Tool: A – Qualitative Behaviour Assessment (QBA)

• Demeanour
• Live observations on one day; four 1 minute observations (spread across the day)
• Rate using adjectives: content, wary, relaxed, playful, agitated, uncomfortable, tense, frustrated
• **Three days, live observation.** Four 5-minute observations/day (spread across each day)
• **Checklist of behaviours** seen each time
• **Answer questions at end of 3 days:**
  • Stereotypies, Wallowing, Feeding, Activity, Social and Environmental Interactions, Response to Unexpected Situations, Vocalisations
### Section B: Daytime Activity Cribsheet

| Elephant name: |  |
| Weather conditions: |  |
| Dates of observation: |  |

<table>
<thead>
<tr>
<th>Day</th>
<th>Time Block</th>
<th>Stereotyping</th>
<th>Wallowing</th>
<th>Feeding</th>
<th>Foraging</th>
<th>Environmental Interaction</th>
<th>Affusive Giving or receiving</th>
<th>Names of others</th>
<th>Affusive Agonistic Giving or receiving</th>
<th>Names of others</th>
<th>Affusive Conspecific Play</th>
<th>Names of others</th>
<th>Anticipating</th>
<th>Locomotion</th>
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<td>Date</td>
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Content of Behavioural Welfare Tool: C – Night time activity

• One night, video footage
• Checklist of behaviours seen every 30 minutes overnight
• Stereotypies, Lying down, Feeding/foraging, Interacting with the Environment, Comfort, Social behaviour. Any aggression. Note elephants they interact with
### Section C: Datasheet for Overnight Behaviour

<table>
<thead>
<tr>
<th>Time</th>
<th>Feeding</th>
<th>Lying down</th>
<th>Stereotypy</th>
<th>Comfort</th>
<th>Interaction with Environment</th>
<th>Social/Affiliative</th>
<th>Other (describe)</th>
<th>Out of view</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Alone</td>
<td>With others</td>
<td>Names of others</td>
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</table>
Example EBWAT Data:
→ Identify Impact of Management/Husbandry
→ Inform future decisions and policies
All respondents agreed that "Since I started to use the EBWAT Tool, it has become easier and faster to use the tool:

- “I am more confident with the tool and what to look for in elephant behaviour”
- “The more you use it, the easier it will get as you understand the behaviours better”
Survey of UK Elephant Keepers: Experience with EBWAT

Used the data from the EBWAT to help improve the welfare of their elephants:

• “... it forces you to observe your elephants more, it can make any problems clear and the improvements you will see throughout the EBWAT”

• “we improve enrichment or out of enclosure time based on behavioural issues seen [with the EBWAT]”

• [use the EBWAT] “particularly in regards to tracking stereotypy amounts i.e. comparing amount to last time used”
All respondents agreed "The use of a video recording is useful to assess elephant welfare"

- we regularly score the same clip individually and then compare results to establish each others reasoning for score
- You can watch it over again, either if you are not sure or to get somebody else’s opinion

- And one keeper stated: “I think its a great tool, thank you for making it :)

"
Include Behaviour in Assessments of Welfare

- Need suite of measures
- Behaviour gives context to other measures
- Not financially costly
- Worth the investment in time
- Assess Positive Welfare/Quality of Life (not just negative welfare)
Acknowledgements

• **Keepers and staff:** Twycross Zoo, Chester Zoo, Colchester Zoo, ZSL-Whipsnade Zoo, Knowsley Safari Park for trialling the EBWAT; all UK elephant-holding zoos for their support

• **Students and volunteers:** James Mursell, Esme Taylor-Roberts, Ellen Williams, Isabelle Lawn, Ana Martos, Carolyn Daly

• **Elephant Welfare Group, Behaviour Subgroup:** (Lucy Asher), Samantha Bremner- Harrison, Oliver Burman, Ellen Williams, Ros Clubb, Clare Ellis

• **Funding from:**
  • University of Nottingham
  • Defra
  • BIAZA
The End

Thank You for Your Attention
Abstract

In a shrinking world with less space for elephants, captive environments – funded by tourism – are becoming more common. At the same time, tourists are becoming more discerning in the standard of animal welfare they expect, and more aware of what good and bad welfare looks like. This presents an opportunity – and a need – for more research on captive elephants, particularly relating to their welfare.

Few people would argue that captivity in any form is ideal for elephants, but there is momentum behind the idea that captivity always means exploitation and cruelty. This notion is bad news for welfare, because it closes the door to improvement. By asking how life in captivity can be made as full and positive as possible for the animal, research can lead the pull away from chains and isolation and fear: towards ‘captive’ environments which allow elephants to have maximum choice (where they go, what they do, which social neighbours they bond with) and enable them to exhibit as much of their natural behaviour as possible, which, in turn, increases the strength of their conservation message.

Here, we present brief summaries of research conducted by AERU as examples of the potential of captive elephant studies here in South Africa. These include:

- The impacts of tourist interactions, enrichment programs and environmental/housing variables on elephant welfare, as measured by outcomes such as stereotypic behaviour, restful/restless night-time behaviour, social interactions and FGM levels
- Long-term studies of state behaviours, how these change over time (relating to the elephant’s age and social status as well as changes to their management), and how patterns can relate to welfare
- Observing natural behaviours that would be difficult or impossible to observe in free-roaming elephants, particularly behaviours that mostly occur at night, such as yawning!
- The potential for human-animal bonds between captive elephants and their handlers, and how this relates to social enrichment and improved management
- The deep and enduring emotional bonds that can form between orphaned elephants after the loss of their kin relationships, and the crucial welfare importance of respecting those bonds
- The process of rehabilitating elephants from much more restricted captive environments
- Trunk gestures, self-directed behaviours and other displacement behaviours as a potential measure for elephant anxiety or uncertainty, and the potential to develop this into a tool to assess captive welfare

Much of this research could already be applied globally to help improve captive welfare standards. There may be no end in sight to the expansion of humankind and the shrinking of spaces where elephants can thrive, but by asking questions now about what constitutes optimal captive welfare – how elephants express it, and how humans can create it – we can lay the groundwork for a brighter future for elephants.
About AERU

The African Elephant Research Unit (AERU) is dedicated to research on captive elephants in South Africa, particularly with regard to their welfare. AERU is based at Knysna Elephant Park (KEP) in the Western Cape, which was established in 1994 to give a home to orphaned, unwanted or ‘problem’ elephants. In 2009 AERU was established as the research/welfare wing of KEP, with the motto “Research guiding elephant management” – AERU’s modest purpose was to guide and shape KEP’s elephant husbandry and handling methods with evidence-based advice, to achieve continuous improvement in the welfare of the elephants at KEP. In the ten years since then, in addition to these local improvements, AERU has begun to reach beyond the boundaries of KEP and contribute to elephant behaviour and welfare research on a wider scale. AERU is now a registered non-profit trust in its own right.

Here we discuss the urgent need for captive elephant research and its potential, and look towards a future of co-operation and trust in which all captive elephants can enjoy the benefits of welfare research.

The captivity problem

‘Elephant tourism’ has been established in Asia for many years, but is relatively new in South Africa. The Kruger culls of the 1990s created young elephant orphans, some of whom became the pioneers of a new kind of visitor experience: interaction with habituated rescued elephants under free contact in a naturalistic environment, where the elephants have a degree of choice over their contact with people and how they spend their time.

Of course, keeping African elephants in captivity presents huge practical and ethical challenges. In a perfect world, there would be no human-habituated elephants because captivity and wildlife tourism would not be necessary. However, unlike other parts of the continent, in southern Africa there are more elephants than there is space for. In our 21st century reality, the economic value of a living animal is its safeguard; the universal appeal of elephants, through tourism, is their best protection against the human conquest of Earth. For orphaned or unwanted elephants whose place in the human-controlled ‘wild’ has been lost, captive elephant tourism may provide the means to care for an animal who would otherwise have died.

But as we know, captivity comes in a wide array of forms. It is right that travellers are becoming more aware of the ethical impacts of their spending choices, including the suffering endured by some captive wild animals that are exploited for maximum profit and whose welfare is only as relevant as how it has to appear to paying visitors. Unfortunately, this increased awareness among tourists sometimes comes with a belief that captive animals inevitably suffer, that welfare is always sacrificed for financial gain, and that husbandry is universally cruel. Such a tourist may therefore choose to avoid captive facilities entirely.

The problem with this assumption is that it punishes captive facilities indiscriminately, thus removing the incentive for elephant tourism operators to invest in higher standards. For welfare to be placed at the heart of captive elephant management, tourists must recognise and reward excellence. This creates an opportunity, and an urgent need, for researchers to understand captive elephant welfare in much more depth. It is of course vital that poor welfare can be recognised and corrected, but we feel it is just as important to develop our evidence-based understanding of what great welfare looks like, and explore what we might learn from habituated elephants whose behaviour is as relaxed and natural as can be.

We would like to present some examples of AERU’s past and ongoing research in pursuit of this vision, while recognising that the work is only just beginning!
Elephant management

A captive animal’s physical environment, and how it may spend the 24 hours of each day, are central to welfare as they essentially constitute that animal’s world. Outcome measures used by AERU include well-established stress indicators such as stereotypic behaviour and faecal/salivary glucocorticoid measures, and also behavioural measures which could indicate positive welfare: for example, affiliative social interactions, restful and relaxed night-time behaviour, and curious/exploratory behaviour towards humans.

- Padfield (2013) examined whether the type and frequency of tourist interactions experienced by an individual elephant affected their night-time stereotypic behaviour. There was a significant positive correlation, both on a short-term scale (one day’s tourist contact predicted that night’s stereotypies) and medium-term (across the study), but with strong individual differences. At this time, each elephant was enclosed in an individual indoor pen during the night with sensory and tactile access to neighbours.

- In 2014, based on advice from AERU on reducing stereotypic behaviour, Knysna Elephant Park redesigned the elephants’ night housing. The boundaries between the pens were removed to create one large indoor area, allowing free physical contact (or avoidance) between individuals (see fig. 1). The elephants also gained free night-time access to a 2.5-hectare outdoor enclosure, giving them the option to graze and allowing them to choose whether to be inside or out at any point. Grayson (2014) compared night-time behaviour before and after this change and found a significant drop in stereotypies, and also a significant reduction in social interactions due to the new opportunity for individuals to choose solitary behaviour. In two elephants, stereotypies stopped entirely following the management change.

Fig. 1. The KEP elephant boma, before (L) and after (R) the removal of individual pens in 2014. Photos by Sarah Grayson.

- AERU has trialled several forms of evening environmental enrichment in the indoor boma, both before and after the management change described above. One of the most successful has been auditory enrichment including classical music. Reilly (2015) tested 90-minute playlists of music and other sounds, on separate evenings. ‘Sounds of the bush’ actually increased stereotypic behaviour vs the no-sound control and white noise had no impact, but classical music – both slow and fast – significantly decreased it.

Later, Hurt (2018) played music of different moods (as classified by humans) and found significant differences in elephants’ behavioural responses. In particular, they spend more time standing quietly inside (where the speakers are) when music is playing, especially Calm or Sad music. The success of these student studies prompted a regular program of musical enrichment, and the elephants now enjoy carefully curated playlists every Thursday evening. Preliminary observations of these regular ‘karaoke nights’ suggest that the elephants lie down to sleep earlier on nights when the Calm playlist is used.
Night-time behaviour

When studying wild animal behaviour, it is of course ideal to observe subjects in a wild environment – but for some research areas this is practically impossible. The night-time behaviour of African elephants is an example. Captive research opens the possibility of observing subtle and intimate resting behaviours in relaxed elephants without the observer causing any disturbance.

At KEP, night-time observations are conducted from a raised platform overlooking the elephants’ indoor and outdoor areas. An infrared camera system also records video (without sound) throughout the night. These options made it possible to study yawning in African elephants, resulting in the first published account and recordings of this behaviour in collaboration with the University of California: Davis (Rossman et al. 2017a). Images and video clips of yawning can be viewed through this study’s DOI.

The next step for our yawning research is to show that elephants can ‘catch’ yawns when they see each other yawn or even when they see humans yawn, which is called contagious yawning and is related to empathy. Demonstrating that elephants feel empathy – even for members of another species – could have broad ethical impact, and could benefit elephants by allowing people to connect with them as fellow emotional beings.

Long-term observation

AERU is supported by volunteer assistants: visitors who stay between 3 and 12 weeks to contribute to research and spend time with the elephants. Because these volunteers are not required to have experience with elephants or behavioural fieldwork, the methods they are taught must be relatively simple to learn and use, so that these ‘citizen scientists’ can contribute reliable data.

These straightforward methods, used by an almost continuous chain of volunteers and AERU staff 4 days a week for about the last 8 years, have generated an unprecedented and still-growing longitudinal account of captive elephant behaviour: in particular, their state behaviours (how they spend their time, day and night) and preferred proximity to each of their herdmates. Acute events, such as introductions of new elephants, can be examined in the context of changes in each individual's established daily patterns; much more gradual changes in behaviour can also be observed, such as those linked with the maturing of juveniles and changes in social status. This dataset is a precious resource for comparison with newly-collected data or even for retrospective analysis.

Social networks in captive elephants

Many captive elephants worldwide are kept in small groups for obvious practical reasons. These groups may also be subject to sudden changes such as when an individual is moved for breeding. However, our research at KEP provides a striking example of sociality between unrelated elephants who are housed together in a larger, stable social group with space to decide their own proximity to each other.

Manning (2015) studied the social relationships within the KEP herd of seven elephants, using an association matrix based on proximity. She found strong and consistent preferred associations – friendships – between pairs of unrelated elephants, in a structure that resembles and mimics a natural herd of related females and their young. Moreover, comparison with volunteer-collected proximity data from previous years demonstrated that these friendships remained consistent even on a scale of years. This invites comparison with Gobush & Wasser’s (2009) observations of wild elephants forming bonds with unrelated conspecifics following the loss of their kin relationships. The welfare implications here are clear: it would be a grave mistake to assume that any captive elephant pair or group could be split up without breaking an emotional bond comparable to a kin relationship. The investment that captive elephants place in these friendships implies their importance: social bonds may have a powerfully positive effect on welfare.
Newman (2018) expanded on this work by studying the introduction of a group of three new elephant cows to the KEP herd of seven, and the formation of bonds between members of the two groups. A year after the introduction, several preferred pairings (and avoided pairings) had been established. Newman also demonstrated that pairs who chose to be in closer proximity also performed more affiliative behaviours towards each other, further supporting the conclusion that these unrelated elephants were forming friendships resembling kin relationships. By contrast, pairs who avoided each other performed more agonistic behaviours when they did come into contact: an important reminder that housing incompatible elephants together could be unintentionally detrimental to welfare, especially if the two cannot get away from each other.

**Human-animal bonds**

Some of the most rewarding projects at AERU have come about because of incidental observations that occurred during regular fieldwork. One such example is our study on the bonds between KEP’s elephants and their handlers, which was inspired by the ‘common knowledge’ on the park that many of the elephants have a favourite human guide (handler) to whom they respond better than others.

Rossman et al. (2007b) quantified this by studying the frequency with which individual elephants initiated contact with humans: guides, volunteers and tourists. All elephants were more likely to initiate interactions with guides than other types of human, and human-animal bonds did indeed exist between individual elephants and guides; elephants with favourite guides would preferentially interact with them.

Human-animal bonds could be a potentially welfare-enhancing (Hosey & Melfi, 2010) source of social enrichment for elephants in a captive environment where trust, not fear, is the foundation of the working relationship between elephants and their handlers or keepers in free or protected contact. Particularly for a low-ranking elephant who has relatively weak social bonds with conspecifics, trusted humans could be a source of reassurance, companionship, and even protection from more dominant elephants.

**Rehabilitation**

In May 2017, an ex-circus elephant bull named Clyde was returned to the wild in a private game reserve, together with a companion named Shaka. Clyde had come to KEP several years earlier after being ‘retired’ from his life as a performing animal and had initially been very suspicious of people. Although KEP handlers had made a lot of progress with gaining Clyde’s trust, it was clear that he did not thrive on human contact and, being an adult bull, was no longer accepted by the main herd. Once a suitable site was found where the two bulls could roam without coming into conflict with people, release was clearly the best option for his welfare.

AERU researchers observed Clyde and Shaka before and after their translocation. Watching these young bulls exploring their wild environment was a privilege, particularly seeing how Clyde rapidly discarded his captive-learned behaviours. They chose to maintain much closer proximity to each other in the unfamiliar environment, and spent much more time feeding on the many new flavours available (Clyde spent 82% of the daytime feeding in the first week, vs 54% the week prior to translocation). It was particularly heartening to return after a few months and see how readily the pair had been accepted by the much older resident bull.

Although this was only a small, opportunistic study (Padfield et al., 2017), such observations have the potential to inform and guide rehabilitation efforts and give hope that even very traumatised and mistrustful animals have the potential to regain their instincts and live a full and contented life.
Elephant displacement behaviour

Since researcher Lisa Olivier proposed the idea in AERU’s early days, we have been investigating the potential for elephant trunk gestures and other self-directed behaviours (SDBs) to be validated as a form of displacement behaviour – an expression of anxiety or uncertainty caused by tension, indecision, frustration or boredom, and first proposed by Maestripieri et al. (1992) to be useful as an animal welfare measure in primates by identifying situations that provoke anxiety. Unlike stereotypies, which captive animals may develop to cope with long-term stress, SDBs are normal and natural behaviours that wild elephants also perform.

Many SDBs serve an obvious function such as hygiene, but may be performed out of context or at a much higher rate in anxious situations. Behavioural functions for some others have been postulated (e.g. Elephant Voices, 2019), and some types of SDB already being used as stress indicators, e.g. Szott, Pretorius & Koyama (2019).

AERU students Jim (2015), Hauff (2016), Evans (2017) and Schwilp (2018) have each examined elephant SDBs from a particular angle, with each finding that elephant trunk gestures and other SDBs are related to their broader behaviour or activity in a way that is consistent with them being an expression of emotion as described above. However, there is not yet enough evidence to make welfare inferences from specific gestures.

Evans (2017) tested salivary cortisol for correlation with SDB rates at the corresponding time, but the results were inconclusive. We are still working towards being able to state with confidence what particular SDBs mean in elephants, but the potential is huge: a non-invasive and fine-scale method for ‘reading’ elephant anxiety in the scenario in which it occurs, allowing management to consider changing the scenario before it becomes detrimental to welfare.

Conclusions

In conclusion, we believe that captive elephants are best served by building a robust body of research into their welfare: not only recognising and countering poor welfare, but also asking with an open mind how life in captivity can be made as full and positive as possible for the animal. If an elephant cannot be returned to the wild, we envision enriched captive environments which give maximum choice to the elephant: where they go, what they do and when, which social neighbours they bond with, when to interact with humans and when to withdraw. We hope our research plays a part in creating a future where, if captivity has to exist, it does not imply suffering. Where more captive elephants can exhibit more of their natural behaviour, enjoy positive affective states, maintain enriching bonds with conspecifics and humans alike; and where tourists recognise and support such facilities as places of refuge for elephants.

Photo by Zoë Rossman zoerossman.com
Acknowledgements

The various studies described in this presentation are the work of diverse teams of people including researchers, students, AERU staff, scientists with whom we collaborate, and hundreds of volunteer field assistants. We have not been able to mention all their work here, but we thank them all for lending their skills and passion to improving the lives of elephants in human care.

We also gratefully thank everyone who has supported and believed in AERU; all the staff of Knysna Elephant Park, from the cleaners to senior management; and especially the guides, our colleagues and friends with whom we can walk among our elephants as family.

Thank you AERU team members past and present:

Abby Grobani • Christina Tholander • Cindi Rosslee • Elmi van Beelen-Savelberg • Hannah Needle • Jay Purdon • Jenn Claey • Jesse Wildeman • Jessica Smith • Kathy Schroeder • Laurie Schelle • Lisa Olivier • Lisa Weidner • Lizzie Dawson • Mpho Madiba • Nicki Milachowski • Nicky Webber • Nikki Perosino • Taryn Tainton • Zoë Rossman • ...and all our vols and students

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Schwilp, L. (2018). *Behavioural effects in captive African elephants following the discontinuation of tourist rides.* Unpublished undergraduate study, University of Veterinary Medicine, Hungary.

Ecological Epidemiology to Optimize Policy Interventions for Tuberculosis Control in Captive Elephants

David Abraham & Deepa P.M.
• **Ecologic studies (aka correlation studies)**
  – examine and identify factors influencing abundance and distribution of organisms in their environments
  – populations are the units of analyses
  – ecological fallacy
• **Ecological epidemiology**
  – similarities in population-based theories of ecology and epidemiology
  – variations in occurrence of pathogens/diseases in different populations
  – early identification of high-risk groups and risk factors for disease emergence

https://en.wikipedia.org/wiki/1854_Broad_Street_cholera_outbreak
• **Ecological epidemiology of tuberculosis in captive elephants in southern India**
  – by now, tested more than a thousand elephants
  – adequate sample sizes to test almost all types of risk factors
  – basic descriptive epidemiology; variations in prevalence
    • Sex
    • Age
    • Origin
    • Management
      – *the ecological fallacy* e.g.
    • Location
    • Musth
    • Genetic susceptibility (?)
Host–pathogen coevolution in human tuberculosis

Sebastien Gagneux*

Department of Medical Parasitology and Infection Biology, Swiss Tropical and Public Health Institute and University of Basel, Seestrasse 57, 4002 Basel, Switzerland

Tuberculosis (TB) is a disease of antiquity. Yet TB today still causes more adult deaths than any other single infectious disease. Recent studies show that contrary to the common view postulating an animal origin for TB, *Mycobacterium tuberculosis* complex (MTBC), the causative agent of TB, emerged as a human pathogen in Africa and colonized the world accompanying the Out-of-Africa migrations of modern humans. More recently, evolutionarily ‘modern’ lineages of MTBC
Ecological epidemiology of tuberculosis in captive elephants in southern India ...

- large number of mahouts also in southern India
- the major source of infection to a captive elephant?
  - diseased elephants vs. diseased mahouts
  - preliminary data do give indications
  - but more maths and statistics to confirm!
• **Science policy interface**

  – science (from Latin *scientia*, meaning knowledge) organizes knowledge in the form of testable explanations and predictions
    • *the subjective to objective approach*
  – policy (from Greek *politeia* meaning state) organizes decision making process to achieve rational outcomes
    • *the objective to subjective approach*
  – science-policy-interface bring scientists and policy makers to a common platform


  • *but priorities of both parties need not always be the same!*
Science policy interface of tuberculosis in elephants

- Aetiology
- Diagnosis
- Pathogenesis
- Epidemiology
- Treatment & control
- Prevention
Most prevalent spoligotype (EAI) was same as found in humans in southern India
• Science policy interface of tuberculosis in elephants
  
  – Aetiology
  – Diagnosis
  – Pathogenesis
  – Epidemiology
  – Treatment & control
  – Prevention
• Science policy interface of tuberculosis in elephants...
  – based on evidence-based results
  – we propose to suggest changes in priorities to move ahead

– Some serious One Health thoughts indeed!
  • attempting to stop the spillover of M. tuberculosis from humans would perhaps be the most effective way to prevent tuberculosis in captive elephants
  • adopting diagnosis and control measures in diseased elephants, though essential, appears to be of secondary importance
Mycobacterium tuberculosis
Complex Infection in Free-Ranging Elephants - Novel Diagnostic Approaches

M Miller, P Buss, W Goosen, T Kerr, C de Waal, E Roos, A Dippenaar, L van Schalkwyk, SL Robbe-Austerman, K Lyashchenko, S Parsons, R Warren, P van Helden

Stellenbosch University, South African National Parks, Skukuza State Veterinary Office, National Veterinary Services Laboratories, Chembio Diagnostic Systems Inc.
Acknowledgements

Stellenbosch University Animal TB Research Group
M. tuberculosis in Captive Elephants

- More than 60 cases of M. tb in captive elephants worldwide
  - Predominantly in Asian elephants

- 2 cases of M. tb in African elephants in National Zoological Gardens, Pretoria
**M. tuberculosis** in Wild Elephants?

- 1 case of MTBC-related death in African elephant in Kenya
  - Elephant was hand-reared orphan

- 2017 Emerging Infectious Diseases
  - 2 papers on *M. tb* in wild Asian elephants in national parks

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*Mycobacterium tuberculosis* in
Wild Asian Elephants, Southern India

Arun Zachariah, Jeganathan Pandiyam, G.K. Madhulatha, Sathish Mundayoor, Bathirachalam Chandramohan, P.K. Sajesh, Sam Santhosh, Susan K. Mikota

*Mycobacterium tuberculosis*
Infection in Free-Roaming
Wild Asian Elephant

Basavegowdanadoddi Marinaik Chandranai, Beechagondahalli Pappana Shivashankar, Kunigal Srinivasa Umashankar, Poojappa Nandini, Pappana Giridhar, Somenahalli Munivenkatappa Byregowda, Basavegowdanadoddi Marinaik Shrinivasa
M. tuberculosis in Wild Elephant

- October 2016 - Tshokwane, Kruger National Park
- Adult bull African elephant (est 45 yrs)
- Thin, but no external wounds
Post-Mortem Findings

- Lung: multifocal to confluent encapsulated cavities (1 to 15 cm diam) with caseonecrotic, yellow-green and granular contents

- Entire parenchyma of left caudal and middle lobes (± 80% of left lung) and right caudal lobe (40 to 50% of right lung) affected

- Portions of left lobe were consolidated with miliary focal granulomas

- Histopath: **ZN+ bacterial rods** in necrotic debris in granuloma centres
Laboratory Findings

<table>
<thead>
<tr>
<th>Sample</th>
<th>Culture &amp; PCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lung</td>
<td><em>M. tb</em> on direct PCR and culture</td>
</tr>
<tr>
<td>Thoracic LNs</td>
<td><em>M. tb</em> on direct PCR and culture</td>
</tr>
<tr>
<td>Abdominal LNs</td>
<td><em>M. tuberculosis</em></td>
</tr>
</tbody>
</table>

**PCR assay:**
Mycobacterial speciation assay performed according to Warren et al., 2006. Note: PCR results confirmed by culture.

**Chembio VetTB DPP assay:**
Serum from heart blood - antibodies present to ESAT6/CFP10 (strong positive; T2) and MPB70 (weak positive; T1).
Increased Surveillance in KNP Elephants

- Opportunistic necropsy - 1 incidental case of *M. bovis* infection
- Retrospective serological survey - 6% (95% CI 2-12%) seropositive on DPP
- Active surveillance - opportunistic immobilization of mostly bull elephants for sampling (endoscopic BAL, trunk wash, serological and cytokine assays)
GeneXpert results from *Mtb* and *M. bovis* spiked elephant BAL and TW samples
Genotyping

- Isolation of *M. tuberculosis* or *M. bovis* should be followed by other genotyping techniques to determine epidemiological relationship with other isolates
  - Spoligotyping
  - Whole genome sequencing
Whole Genome Sequence of *M. tb* Elephant Isolate

- *M. tuberculosis*
  - Euro-American strain (lineage 4.3.2)
  - LAM3 - equivalent of F11 according to IS6110 RFLP family
  - Pan drug sensitive

- 70 SNPs different from two F11 clinical isolates from Western Cape
- LAM3/F11 has been found in Limpopo and Mpumalunga
Elephant Cytokine Gene Expression Assays

- Confirmed target sequences for the following reference and cytokine genes: ACTB, GAPDH, B2M, YWHAZ, IFNg, TNFa, TGFb, IL4, IL10, IL12, CXCL9 and CXCL10
- Able to amplify multiple targets in qPCR and detect upregulation in mitogen-stimulated samples
- Goal is develop cytokine gene expression assay that can detect mycobacterial specific immune sensitization creating a blood-based diagnostic assay
- Based on successful test development in other species such as lions, deer, cattle

Development of a Gene Expression Assay for the Diagnosis of Mycobacterium bovis Infection in African Lions (Panthera leo)

T. T. Olivier¹, J. M. Vielen², J. Hofmeyr², G. A. Hauser³, W. J. Goosen¹, A. S.W. Toddiffe³, ⁴, P. Buss², A. G. Loxton¹, R. M. Warren¹, M. A. Miller¹, P. D. van Helden¹ and S. D. C. Parsons¹

Development and Evaluation of a Real-Time Reverse Transcription-PCR Assay for Quantification of Gamma Interferon mRNA To Diagnose Tuberculosis in Multiple Animal Species

Noel P. Harrington,⁵ ⁶ ⁷ ⁸ Om P. Surujballi,¹ W. Ray Watern,³ and John F. Prescott⁷
Tuberculosis in Wildlife Range Countries

- Of the 30 high TB burden countries listed by the World Health Organization, 22 are elephant range countries
  - India has highest human TB burden

- South Africa has high human TB burden
  - Approximately 454,000 active TB cases per year
  - 80% of population infected with TB; most are latent cases

Increased interfaces between humans and wildlife increase risk of zooanthropogenic disease
Conclusion

- TB is growing health and conservation threat for wildlife globally
  - Especially in countries with high human and livestock TB burdens

- Ignoring One Health principles and threats of multi-host diseases may lead to introduction of human and livestock pathogens into wildlife populations
General anesthesia in Asian elephants (*Elephas maximus*) using combination of Dexmedetomidine hydrochloride and Etorphine hydrochloride in Thailand

NITHIDOL BURANAPIM¹², CHATCHOTE THITARAM¹², TAWEEPOKE ANGKAWANISH³, SARAN CHANSITTHIWET³, PETTHISAK SOMBUTPUTORN³, WARANGKHANA LANGKAPHIN³, NATCHA MONCHAIVANAKIT³, KANKAWEE KASEMJAI³, KITTIKUL NAMWONGPROM³, THITTAYA JANYAMETHAKUL⁴, WANLAYA TIPKANTHA⁵, NIKORN THONGTIP⁶ AND SUPAPHEN SRIPTIBOON⁶

¹ Department of Companion Animal and Wildlife Clinic, Faculty of Veterinary Medicine, Chiang Mai University, Thailand
² Center of Excellence in Elephant and Wildlife Research, Chiang Mai University, Thailand
³ Elephant hospital, Thai Elephant Conservation Center, Thailand
⁴ Patara Elephant Farm, Chiang Mai, Thailand
⁵ Bureau of conservation and Research, The Zoological Park Organization Under the Royal Patronage of H.M. The King, Thailand
⁶ Faculty of Veterinary Medicine, Kamphaengsaen campus, Kasetsart University, Thailand
Clinical history and symptoms

- 25 - 52 years old
- The body weight range was 2,350 - 4,135 kg.
- Body condition score = 2-3/5
- Reason for general anesthesia
  - Aphagia and regurgitation signs (esophageal obstruction)
  - Oral, esophageal and physical examination (endoscopy, remove foreign body)
  - Workshop
Aphagia and regurgitation signs
Introductions

- **General Anesthesia** is an fundamental process for veterinary procedures in zoo and wild animals such as diagnostic procedures, sample collections, trunk laceration, dental check, surgery, laparoscopic vasectomy, and other treatments (Stegmann, Grobler, & Zuba, 2014).
Introductions

- **Etorphine** HCl (M99) is a semi-synthetic opioid possessing an analgesic ability approximately 1,000 – 3,000 times that of morphine (Bentley & Hardy, 1967).

- Side effects: severe **cardiopulmonary depression**.

- **Elephants immobilization** (West, Heard, & Caulkett, 2014).
Introductions

- Several **α2-adrenergic agonist** drugs are common to sedate elephant
- Xylazine HCl, Demetomidine HCl (Bouts et al., 2017).
- Medetomidine HCl (Sarma et al., 2002).
- Medetomidine HCl is a high potency, effects in the autonomic nervous system (Savola, Ruskoaho, Puurunen, Salonen, & KÄRki, 1986).
- Medetomidine HCl also induces respiratory rate reduction and bradycardia (Sarma, Pathak, & Sarma, 2002).
- **Dexmedetomidine HCl** is an α2-adrenoceptor agonist with sedative, anxiolytic, sympatholytic, and analgesic sparing effects, and minimal depression of respiratory function. It is potent and highly selective for α2-receptors with an α2:α1 ratio of 1620:1 (Weerink et al., 2017)
- Sedation by **dexmedetomidine** is similar to natural sleep and often causes bradycardia. (Kang et al., 2018)
Introductions

- 20 free range African elephants were anesthetized with 9.5 ± 0.5 mg etorphine HCl (IM) by a dart rifle. Lateral recumbency was achieved in 8.7 ± 2.4 minutes (Osofsky, 1997).


- Using of azaperone and etorphine HCl (IM) then maintained with halothane inhalation for oral examination (Stegmann, 1999).

- Using azaperone (IM) with etorphine HCl (IV) and supported by a crane to remove foreign body from esophageal obstruction (Thongtip et al, 2015).

Animals preparation

- Physical examination
- Blood collection: CBC, blood chemistry.
- Food and water were withdrawn for 12 - 36 hours, respectively (Fowler et al., 2000).
Anesthetic area preparation

- 36 m² flat terrain was prepared as an anesthesia area.
- Two stable pillars with 3 - 4 m. gap were installed for elephants physical restrain.
- A 5.0 x 2.8 meters rubber mattress with 10 c.m. thickness was placed to support elephant body weight during anesthesia.
### Table 1.
Anesthetic agents of elephant anesthesia: total amount, dose, drug supplement & maintain time.

<table>
<thead>
<tr>
<th>Anesthesia data</th>
<th>Asian Elephant</th>
<th>Medetomidine - Etorphine</th>
<th>Dexmedetomidine - Etorphine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elephant weight (kg)</td>
<td>2,350 - 2,700</td>
<td>2,550 - 4,135</td>
<td></td>
</tr>
<tr>
<td>Alpha 2 agonists (Med or Dex)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amount (mg)</td>
<td>5.5 - 6.0</td>
<td>3.5 - 6.5</td>
<td></td>
</tr>
<tr>
<td>Dose (mcg/kg)</td>
<td>2.22 - 2.34</td>
<td>1.35 - 1.57</td>
<td></td>
</tr>
<tr>
<td>Etorphine HCl</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amount (mg)</td>
<td>4.0 - 5.0</td>
<td>5.0 - 7.5</td>
<td></td>
</tr>
<tr>
<td>Dose (mcg/kg)</td>
<td>1.70 - 1.91</td>
<td>1.81 - 1.96</td>
<td></td>
</tr>
<tr>
<td>Etorphine HCl supplement</td>
<td>none or 28 min/ 1 mg (0.43)</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>Time supplement/ mg (mcg/kg)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st Time maintain/ mg (mcg/kg)</td>
<td>91 - 98 min/ 1 mg (0.40)</td>
<td>44 -64 min/ 0.7 - 1.0 mg (0.24 - 0.27)</td>
<td></td>
</tr>
<tr>
<td>2nd Time maintain/ mg (mcg/kg)</td>
<td>138 min/1 mg (0.40)</td>
<td>79 min / 1 mg (0.24)</td>
<td></td>
</tr>
<tr>
<td>3rd Time maintain/ mg (mcg/kg)</td>
<td>none</td>
<td>107 min / 1 mg (0.24)</td>
<td></td>
</tr>
<tr>
<td>4th Time maintain/ mg (mcg/kg)</td>
<td>none</td>
<td>118 min / 0.5 mg (0.12)</td>
<td></td>
</tr>
<tr>
<td>Guaifenesin (GG)</td>
<td>1,000 - 4,000</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>Volume (ml)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isofurane</td>
<td>1 - 4 %</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>Percentage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration (min.)</td>
<td>6 - 231</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>Endotracheal tube</td>
<td>35</td>
<td>35, 40</td>
<td></td>
</tr>
</tbody>
</table>
Elephants displayed sedated/anesthesia signs
Elephants displayed sedated/anesthesia signs
The elephant gradually fell down to a right lateral recumbency position after anesthetic drug administration. Tied ropes were pulled to guide the elephant to lay down in the right direction.
Procedures of elephant anesthesia: intubation

- Intubation with 35, 40 mm endotracheal tube was inserted in trachea when animal’s jaw-tone is relaxed.

- The endotracheal tube was then connected to a connecter and two demand valves linked to oxygen.

- For isoflurane vaporizer was used for maintain anesthetic stage if necessary. Fluid therapy was given intravenously in case supplemental drugs were required.
Endotracheal tube intubation
Procedures of elephant anesthesia: intubation

Oxygen was given through two demand valves connected with the endotracheal tube using Y-shape connector (arrow) accessing the respiratory circuit.
Oxygen was given through two demand valves connected with the endotracheal tube.
Table 2
The effects and vital signs during general anesthesia: Respiratory rate (RR), Pulse rate (PR), Peripheral oxygen saturation (SpO₂).

<table>
<thead>
<tr>
<th>Anesthesia data</th>
<th>Asian Elephant</th>
<th>Medetomidine - Etorphine</th>
<th>Dexmedetomidine - Etorphine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time of anesthesia sign</td>
<td>Initial effect (min.)</td>
<td>2 - 20</td>
<td>3 - 13</td>
</tr>
<tr>
<td>(Reduce ear &amp; tail movement, Tunk down, Genitalia protudesion, Leg stiffness, Eye closing, Snoring)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sit down &amp; Lateral recumbance (min.)</td>
<td></td>
<td>7 - 30</td>
<td>6 - 11</td>
</tr>
<tr>
<td>Vital sign during anesthesia</td>
<td>RR before anesthesia (bpm)</td>
<td>6 - 8</td>
<td>6 - 10</td>
</tr>
<tr>
<td></td>
<td>RR during anesthesia (bpm)</td>
<td>3 - 6</td>
<td>4 - 10</td>
</tr>
<tr>
<td></td>
<td>HR/PR during anesthesia (bpm)</td>
<td>15 - 49</td>
<td>26 - 49</td>
</tr>
<tr>
<td></td>
<td>SpO₂ during anesthesia (%)</td>
<td>48 - 100</td>
<td>62 - 100</td>
</tr>
<tr>
<td></td>
<td>Temp during anesthesia (°F)</td>
<td>96.4 - 99.0</td>
<td>96.6 - 101</td>
</tr>
</tbody>
</table>
Table 3 Reversal drugs, recovery signs and duration of anesthesia.

<table>
<thead>
<tr>
<th>Anesthesia data</th>
<th>Asian Elephant</th>
<th>Medetomidine - Etorphine</th>
<th>Dexmedetomidine - Etorphine</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Atipamezole HCl</strong></td>
<td><strong>Amount (mg)</strong></td>
<td>28 - 30</td>
<td>35 - 65</td>
</tr>
<tr>
<td></td>
<td><strong>Dose (times of med/dex)</strong></td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td><strong>Naltrexone</strong></td>
<td><strong>Amount (mg)</strong></td>
<td>250 - 330</td>
<td>250 - 500</td>
</tr>
<tr>
<td></td>
<td><strong>Dose (times of M99)</strong></td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td><strong>Time of recovery sign</strong></td>
<td><strong>Initial effect (min.)</strong></td>
<td>0.5 - 4</td>
<td>5 - 9</td>
</tr>
<tr>
<td></td>
<td>(Eye open, Tunk movement)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Head up &amp; Sternal recumbency (min.)</strong></td>
<td>2 - 7</td>
<td>7 - 18</td>
</tr>
<tr>
<td></td>
<td><strong>Standing (min.)</strong></td>
<td>3 - 25</td>
<td>10 - 19</td>
</tr>
<tr>
<td></td>
<td><strong>Full recovery (min.)</strong></td>
<td>10 - 142</td>
<td>15 - 45</td>
</tr>
<tr>
<td><strong>Time of down to antagonist (min.)</strong></td>
<td></td>
<td>26 - 281</td>
<td>58 - 122</td>
</tr>
<tr>
<td><strong>Time of Etorphine HCl to full recovery (min.)</strong></td>
<td></td>
<td>52 - 306</td>
<td>68 - 91</td>
</tr>
</tbody>
</table>
Elephant Recovery signs
Elephant Recovery signs
Discussions

- **Restrain method** and position of anesthetized animals during veterinary procedures were tremendously essential.

- In this study, elephants were put in custom-made rope, administered with etorphine hydrochloride in standing position, then adjusted the animal’s position to lateral recumbency with the support of rubber mattress and rubber tires.
Conclusions

- Lateral recumbency time: 6 – 30 mins.
- Lateral recumbency duration: 1 - 4 hours.
- Recovery standing time: 3 – 25 mins.
- The anesthesia is recommended for short duration (<60 min.) without any complication.
References


References


Thank you for your attention
General anesthesia in Asian elephants (*Elephas maximus*) using combination of Dexmedetomidine hydrochloride and Etorphine hydrochloride in Thailand

NITHIDOL BURANAPIM\(^1,2\), CHATC HOTE THITARAM\(^1,2\),
TAWEEPOKE ANGKAWANISH\(^3\), SARAN CHANSITTHIWET\(^3\), PETTHISAK SOMBUTFUTORN\(^3\),
WARANGKHANA LANGKAPHIN\(^3\), NATCHA MONCHAIVANAKIT\(^3\), KANKAWE KASEMJAI\(^3\), KITTIKUL NAMWONGPROM\(^3\),
THITTAYA JANYAMETHAKUL\(^4\), WANLAYA TIPKANTHA\(^5\), NIKORN THONGTIP\(^6\) AND SUPAPHEN SRIPISOON\(^6\)

1 Department of Companion Animal and Wildlife Clinic, Faculty of Veterinary Medicine, Chiang Mai University, Thailand
2 Center of Excellence in Elephant and Wildlife Research, Chiang Mai University, Thailand
3 Elephant hospital, Thai Elephant Conservation Center, Thailand
4 Patara Elephant Farm, Chiang Mai, Thailand
5 Bureau of conservation and Research, The Zoological Park Organization Under the Royal Patronage of H.M. The King, Thailand
6 Faculty of Veterinary Medicine, Kamphaengsaen campus, Kasetsart University, Thailand
Immobilization and Transport of Free-ranging African Elephants

Dr Peter Buss
BVSc, MMedVet (wildlife), PhD
Veterinary Senior Manager
Veterinary Wildlife Services
Kruger National Park
- Different techniques
  - Species and countries
  - Captive vs. wild
- Brief overview of SANParks technique
  - Initially developed in Zimbabwe, 1990’s
  - Adopted by SANParks
  - Modified by private sector
## Immobilizing agents

<table>
<thead>
<tr>
<th>Immobilizing drug mixture (opioid plus tranquilizer)</th>
<th>Crate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Administer with antidote</td>
</tr>
<tr>
<td>Etorphine or Thiafentanil</td>
<td>Azaperone</td>
</tr>
<tr>
<td>Adult bull</td>
<td>16 – 20 mg</td>
</tr>
<tr>
<td>Adult cow</td>
<td>12 – 16 mg</td>
</tr>
<tr>
<td>Sub-adult</td>
<td>6 - 12 mg</td>
</tr>
<tr>
<td>Juvenile</td>
<td>3 – 6 mg</td>
</tr>
<tr>
<td>Calf</td>
<td>1 – 3 mg</td>
</tr>
</tbody>
</table>

- **Availability of potent opioids**
  - Etorphine and Thiafentanil
    - Antidotes – naltrexone, diprenorphine, butorphanol
- **Tranquilizers**
  - Azaperone and Haloperidol
- **Hyaluronidase**
Use of helicopters

- Locating animals
  - Large area
  - Finding elephant
- Herding
  - Suitable recovery site
- Darting
  - Drug delivery
- Managing immobilization
  - Managing induction
- Communications
  - Ground support
Equipment and personnel

- Specialized equipment
  - Loading and transport
  - Trained and skilled operators

- Trained personnel
  - Manage immobilized elephants
    - Monitor
    - Ensure safety of elephants and people
Immobilized elephant

- Lateral recumbency
  - Facilitates respiration
  - $\leq 15$ min
  - Appropriate equipment
    - May require ropes and vehicle

- Obligate nasal respiration
  - Positioning of trunk
    - Ensure patency

Photo credit: Mike Kock
Recovery and crating

• How to crate an immobilized elephant?
  • Limiting factor
    • Translocation of adult cows and bulls
  • Large and heavy
    • ≤ 6000 kg
  • Immobilized
    • Maintain status
      • Extended period
    • Additional opioid drugs
      • Repeat bolus doses IV
      • Constant rate infusion
    • Monitor
Recovery and crating

- Suspend by limbs
  - Specialized equipment
    - 4x4 vehicle
    - Crane
  - Trained personnel
  - Monitoring of elephant
  - Careful positioning
Recovery and crating

- Loading on to transport trailer
  - Elephant secured onto conveyor belting
    - Chains with protective padding
  - Conveyor belting winched onto trailer
    - Rollers on tray
    - Tray tilts hydraulically
Recovery and crating

- Transport to recovery crate
Recovery and crating

- Recovery crate
  - Wider than transport crate
    - Elephant lateral recumbency
  - Very stable on ground
    - Allows for elephant movements during recovery
  - Recovery crate linked to transport crate
Immobilization reversal

- Remove chains
  - Securing elephant to conveyor belt
- Antagonize immobilization
  - Naltrexone IV
- Close doors
- Elephant recovers in own time
Immobilization reversal
Transportation

• Bulls
  • Crate limits movements
    • Stability of transport vehicle
    • Elephants lock forelimbs
  • Food and Water
    • Not provided
    • Don’t eat or drink
Transportation

• Bulls
  • Tranquillization
    • Azaperone
      • ≈ 2 hours
    • Haloperidol
      • ≈ 10 hours
  • Duration
    • ≤ 36 hours
Complications

- **Immobilization**
  - Respiratory depression
    - Limited compared to other species
    - Place in lateral recumbency
  - Hypertension
    - Include azaperone in dart
    - May result in hypotension
      - Ideal dose to be determined

- Bulls unable to stand in recovery crate
  - May need to release

- Bulls collapse in transport crate
  - May need to release

- Prolonged transport
  - Dehydration
  - Muscle damage and injury

- Broken tusks
  - During recovery in crate
• Southern African technique
  • Meets requirements
    • Repopulate areas
  • Available resources
  • Infrastructure
  • Drugs
• Limited morbidity / mortalities
  • Elephants recover within a few hours of transport
  • Mortalities ≤ 1 %
    • Usually capture associated

Aspects may be applicable in other countries
To the many pioneers, veterinarians, ecologists and sponsors that have developed and refined this technique in support of elephant conservation
Establishment of a first specialised Elephant Hospital in India

Yaduraj Khadpekar, Ilayaraja S., Arun A. Sha, Baijuraj M. V., Kartick Satyanarayan, Geeta Seshamani
CAPTIVE ELEPHANTS IN INDIA
CAPTIVE ELEPHANTS IN INDIA
CAPTIVE ELEPHANTS IN INDIA
CAPTIVE ELEPHANTS IN INDIA
CAPTIVE ELEPHANTS IN INDIA
ELEPHANT CONSERVATION AND CARE CENTRE
ELEPHANT CONSERVATION AND CARE CENTRE
ELEPHANT CONSERVATION AND CARE CENTRE
ELEPHANT HOSPITAL
FUTURE PLANS

- Providing best possible veterinary care to the elephants
- Getting international experts for surgeries and training
- Developing Elephant Hospital as a model to create such facilities elsewhere in the country
- Developing Elephant Hospital as a well-equipped training centre for veterinarians, elephant keepers and elephant managers in healthcare management, treatment and humane handling of elephants
THANK YOU!
Lightning strike in Asian elephants: an integrative treatment

Supaphen Sripiboon*, Patcharida Dittawong, Phawaran Meetipkit, Soontaree Phetdee, Pornchai Santhitisaree, Nikorn Thongtip, Weerapongse Ngitjaroen
LIGHTNING STRIKE IN
ASIAN ELEPHANT HISTORY and CLINICAL SIGN TREATMENT REGIME DISCUSSION
SIGNALMENT

- Name: BoonMee
- Species: Asian elephant (*Elephas maximus*)
- Sex: Female
- Age: ~ 30 years old
- Status: Captive
- BW: ~ 2500 kg
- Etc. No history of mating or offspring
  No previous major illness
HISTORY TAKING

- Eye witness of lightning strike over the front area (head and trunk)
- Unconscious for 30 mins
- Obtundation, pale mucous membrane, muscle weakness and shivering, hypersalivation
- Steroid (dexamethasone, 0.1 mg/kg)
- Supportive treatment: IV fluid, glucose, vitamin, GI protectant etc.
Clinical signs were improved, however turned to obtundation again on Day 5, elephant was referred to Elephant hospital on Day 6.
PHYSICAL EXAMINATION (Day 6)

• Mild obtundation
• Dysphagia
• Hypersalivation
• Muscle weakness (unable to use its trunk)
• BT = 98.2 F (normal 97-99)
• Pulse rate 26 bpm (normal 25-30)
# CLINICAL EXAMINATION

### Hematology

<table>
<thead>
<tr>
<th></th>
<th>BoonMee</th>
<th>Normal range</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCV</td>
<td>40</td>
<td>30-40</td>
</tr>
<tr>
<td>RBC</td>
<td>3.7</td>
<td>2.5-5.0</td>
</tr>
<tr>
<td>WBC</td>
<td>21.26↑</td>
<td>10-18</td>
</tr>
<tr>
<td>PIt</td>
<td>415</td>
<td>200-600</td>
</tr>
<tr>
<td>TP</td>
<td>9.4</td>
<td>6-12</td>
</tr>
</tbody>
</table>

### Blood chemistry

<table>
<thead>
<tr>
<th></th>
<th>BoonMee</th>
<th>Normal range</th>
</tr>
</thead>
<tbody>
<tr>
<td>BUN</td>
<td>3</td>
<td>5-20</td>
</tr>
<tr>
<td>Creatinine</td>
<td>2.0</td>
<td>1.0-2.0</td>
</tr>
<tr>
<td>ALT</td>
<td>12↑</td>
<td>1.5-3.0</td>
</tr>
<tr>
<td>AST</td>
<td>54↑</td>
<td>15-35</td>
</tr>
<tr>
<td>ALP</td>
<td>100</td>
<td>60-450</td>
</tr>
<tr>
<td>CK</td>
<td>&gt;2036↑</td>
<td>50-250</td>
</tr>
</tbody>
</table>

### Blood gas analysis

<table>
<thead>
<tr>
<th></th>
<th>BoonMee</th>
<th>Normal range</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.565↑</td>
<td>7.4±0.01</td>
</tr>
<tr>
<td>pCO₂</td>
<td>26.4↓</td>
<td>39.4±0.3</td>
</tr>
<tr>
<td>pO₂</td>
<td>83.1↓</td>
<td>103±2</td>
</tr>
<tr>
<td>SΟ₂%</td>
<td>98.2</td>
<td>98-100</td>
</tr>
<tr>
<td>Na⁺</td>
<td>138.2</td>
<td>120-140</td>
</tr>
<tr>
<td>K⁺</td>
<td>4.40</td>
<td>3.0-6.0</td>
</tr>
<tr>
<td>Cl⁻</td>
<td>103.2</td>
<td>100-115</td>
</tr>
</tbody>
</table>
• Positive menace reflex
• Positive dazzle reflex
• Positive intact visual perception
• Negative pupillary light response (mydriasis)**
• No evidence of strabismus and electric cataract
• Decreased in sensorimotor function of head region**
• Saliva dripping from oral cavity**
• Remained hearing perception
ECG: two standard chest lead

- Prolong PR interval
  → 1st degree AV block (probably)

- Elevate Q wave
  → interventricular septum problem

- Depression of ST segment
  → myocardial hypoxia
LIGHTNING STRIKE IN ASIAN ELEPHANT HISTORY and CLINICAL SIGNS TREATMENT REGIME DISCUSSION
TREATMENT REGIME

- Mannitol (0.5 g/kg iv sid x 3 days)
- Dexamethasone (0.1 mg/kg iv,im sid x 10 days)
- Tramadol (0.1 mg/kg iv/im sid-bid x 10 days)
- Ranitidine (0.5 mg/kg iv/im sid x 10 days)
- Long-acting Amoxycillin (5 mg/kg im q72 hr x 5 times)
- Daily oral medication: Vitamin B complex (Neurobian®), Mecobalbmin (Methycobal®), Lecithin, Coenzyme Q10,
After 12 days of treatment
1. Electro-acupuncture (EA): 5 pairs, 3-4 mA of 4 Hz for 40 mins
2. Laser-acupuncture (LA): 9 points, 4-6 Joules/cm²/point [Charlie Probe]
   : 8 points, 2 Joules/cm²/point [Laser Probe]
3. Aqua-acupuncture (AqA): 8 points, 5ml vitamin B complex

- EA and LA were performed every other day
- AqA was performed once a week
ACUPUNCTURE IN ELEPHANT

Electroacupuncture

Points:
- ST6
- ST19
- ST4
- ST2
- DFM
- GB20
- BL10
- GV14
- Feimen
- GB21
ACUPUNCTURE IN ELEPHANT

Laser puncture

Mphi Equine Orange MLS® Laser Machine
ACUPUNCTURE IN ELEPHANT
<table>
<thead>
<tr>
<th>Day</th>
<th>NOTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>Lightning strike: unconscious for 30 mins</td>
</tr>
<tr>
<td>D2-D5</td>
<td>Steroid + supportive</td>
</tr>
<tr>
<td>D6</td>
<td>Refer to KU wildlife hospital: can not grab food</td>
</tr>
</tbody>
</table>
| D7-D16| Mannitol, steroid, supportive: can grab food, but can ""not prehend into mouth"
| D17 (1<sup>st</sup> acu) | Acupuncture (EA, LA, AquA): can grab food and prehend into mouth, but can not chew and swallow properly |
| D 26 (5<sup>th</sup> acu) | Can grab food, prehend into mouth, can chew and swallow small roughage, (+_ PLR – still can’ not swallow long grass |
| D 37 (10<sup>th</sup> acu) | Returned to normal                                                  |
LIGHTNING STRIKE IN ASIAN ELEPHANT HISTORY and CLINICAL SIGN TREATMENT REGIME DISCUSSION
DISCUSSION - lightning strike

- Usually leads to sudden death from cardiac arrest
- Disturbances in skeletal muscles, sensorimotor functions, and cardiac function can be observed in survivors
DISCUSSION - acupuncture

- Traditional Chinese Veterinary Medicine (TCVM)
- Acupuncture = bring back normal flow of Qi (vital energy that circulate through meridian)
- Pain management, paralysis, lameness and specific nerve disorder
- Acupuncture used to treat trunk paralysis – returned to normal at 5 mt
- Combination of EA, LA, AqA could magnify the effect of acupuncture
- BoonMee returned to normal after 10 sessions of acupuncture or approximately 3 weeks after referral date
An improvement in neurologic deficits of the cranial nerve in this elephant after acupuncture treatment was observed without any complications. This suggested that this form of treatment is beneficial in elephants, especially for neurological disorders. However, care should be taken, and recommendations from experts are needed in order to develop a proper acupuncture protocol in elephants.
THANK YOU
An Emerging Threat for Sri Lankan Elephants (*Elephas maximus maximus*) and Management of “Jaw-Bomb” Victims.

V.P.M.K. Abeywardana (BVSc, MSc)
Elephant Transit Home, Department of Wildlife Conservation,
Sri Lanka.
ELEPHANTS IN SRI LANKA

- Endangered
- Population - 5879
- 10% of the global Asian elephant population. 2% of the land
- Occupying 60% of total land area of the country.
- 70% of the population - outside the protected areas.
- Major threat - habitat deduction and fragmentation.
ELEPHANT DISTRIBUTION IN SRI LANKA

- Some populations are getting extinct.
- There are few isolated populations in the wet zone.
- They lost around 16 percent of their range in the past 55 years.

RESULT

• Conflict
### Number of Elephant Deaths and causes in Sri Lanka 2010 - 2018

<table>
<thead>
<tr>
<th>Year</th>
<th>Gunshots</th>
<th>Unknown</th>
<th>Electrocuted</th>
<th>Poisoned</th>
<th>Hakkapatas</th>
<th>Accidents</th>
<th>Natural</th>
<th>Train Accident</th>
<th>Other causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>53</td>
<td>29</td>
<td>38</td>
<td>3</td>
<td>44</td>
<td>32</td>
<td>38</td>
<td>16</td>
<td>46</td>
</tr>
<tr>
<td>2017</td>
<td>50</td>
<td>50</td>
<td>24</td>
<td>7</td>
<td>54</td>
<td>25</td>
<td>22</td>
<td>7</td>
<td>17</td>
</tr>
<tr>
<td>2016</td>
<td>52</td>
<td>54</td>
<td>26</td>
<td>6</td>
<td>47</td>
<td>17</td>
<td>35</td>
<td>12</td>
<td>30</td>
</tr>
<tr>
<td>2015</td>
<td>44</td>
<td>39</td>
<td>17</td>
<td>5</td>
<td>51</td>
<td>6</td>
<td>11</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>2014</td>
<td>52</td>
<td>63</td>
<td>12</td>
<td>7</td>
<td>33</td>
<td>9</td>
<td>33</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>2013</td>
<td>35</td>
<td>54</td>
<td>27</td>
<td>6</td>
<td>32</td>
<td>6</td>
<td>25</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td>2012</td>
<td>45</td>
<td>77</td>
<td>22</td>
<td>7</td>
<td>35</td>
<td>14</td>
<td>11</td>
<td>9</td>
<td>29</td>
</tr>
<tr>
<td>2011</td>
<td>67</td>
<td>62</td>
<td>18</td>
<td>16</td>
<td>36</td>
<td>22</td>
<td>2</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>87</td>
<td>30</td>
<td>17</td>
<td>11</td>
<td>14</td>
<td>2</td>
<td>58</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: The above table and chart provide data on the number of elephant deaths in Sri Lanka from 2010 to 2018, categorized by cause. The chart uses colored bars to indicate the distribution of deaths across different causes.
WHAT IS “HAKKA PATAS” OR “JAW BOMB”?

• Home made small explosive
• For hunting and removal of pests. Targeting small mammals / wild pigs
• Accidently elephants get that explosives and end up with prolong starvation, dehydration and finally death.
• Difficult in control
HISTORY OF TREATMENT FOR JAW BOMB AND PROGNOSIS

• There is an age relationship of injured elephants. (2 to 7 years)

• Only 3 elephants were survived in the history

• Prognosis depends on
  ▪ time between the injury and rescue
  ▪ Size of the animal
  ▪ Extend of the damage
DAMAGE

• Mainly damage to teeth, tongue, soft tissues of the mouth, palate and mandible. In some cases – trunk

• Secondary – Bacteria infection and maggot infestation.

• Excess salivation - electrolyte imbalance

• Starvation and dehydration.
DAMAGE
HISTORY OF TREATMENT JAW BOMB VICTIMS

Only three young elephant survival cases were recorded from 2012.
CASE 1 (NEELA)

- Found in 2013
- Female
- 6 years old
- Soft tissue injuries.
- IV Antibiotics.
- Wound cleaning.
- Soft food.
- Wounds get healed after two weeks.
CASE 2 (LEELA)

- Found in 2016
- 4 years old
- Damage to tongue and soft tissues in the mouth
- Mandibular fracture- stable fracture
- IV antibiotics
- Vitamin and Mineral supplements
- Soft food in the initial stage
- Released in 2017.09.10
CASE 3 (MATTALA)

- Released Elephant from ETH- Udawalawa in 2017
- Male
- 6 years of age.
- Found on 31\textsuperscript{st} of July 2018
- Comminuted fracture in mandible.
- Intubated on 5\textsuperscript{th} Aug 2018.
- Keep the tube until 2\textsuperscript{nd} Sep 2018.
MANAGEMENT PROCEDURE

- Initial treatments in the field - rehydration and energy
- Mild sedation for transportation (0.1mg/kg – Xylazine)
- Wound cleaning
- Cefuroxime (10mg/kg – IV, bid) and Metronidazole (5 mg/kg – IV, bid)
- NaCl (0.9%) IV, Dextrose IV
OESOPHAGOSTOMY TUBE PLACEMENT

Pre medications
• 0.2mg/kg Xylazine
• NSAID – Ketoprofen 1mg/kg IM, Sid
• Tetanus toxoid
• Local anesthesia (12 ml of Lignocaine infiltrated to the site)

Selection of surgical site
Due to severe bleeding on the left cervical incision the incision was maid again on the right side.
SELECTION OF SURGICAL SITE
SURGICAL PROCEDURE

• 1 inch diameter clear flexible PVC tub was insert orally to the oesophagus for direct the incision.

• 2 inch long cross skin incisions were made just caudal to the ramus of mandible on the oesophagus.

• Blunt dissection was continued deeper between the sternomandibularis and Brachecephalicus up to oesophagus.

• Longitudinal incision was maid on the oesophagus.

• Remove the oral tube and insert a same kind of tube up to the stomach from the incision as the oesophageal tube.
POST SURGICAL CARE

• Antibiotics
• Pain killers
• Daily wound dressing
• Tube feeding – Three times per day
  (Pumpkin, Green leaves, Fruits, Serial)
• Vitamin and mineral supplement
RECOVERING

• Started getting soft food after 3 weeks
• Gradually change to roughages
• Keep under observation for two months.
• Stopped feeding gradually and released to the wild in December.
CONCLUSION

- It's an emerging threat for Sri Lankan Elephants.
- Survival rate is very low.
- Prognosis is depended on extent of the damage, size of the animal and the time lap between the injury and rescue.
- For survival – a strict management procedure is must.
  (Antibiotics/ Nutrition/ Nursery)
- Feeding using a Oesophagostomy tube is the most suitable practice in long term treatments.
- This is the first recorded oesophagostomy tube application in elephants
REFERENCES


• Phair, K. A. Et Al. (2014) ‘Esophageal Dissection And Hematoma Associated With Obstruction In An Indian Elephant ( Elephas Maximus Indicus ) Esophageal Dissection And Hematoma Associated With Obstruction In An Indian Elephant ( Elephas’.


ACKNOWLEDGMENT

• Veterinarians International

• All the staff in Elephant Transit Home – Udawalawa.
• Dr. Pramuditha Dewasurendra, Veterinary Surgeon DWC.
• Dr. Dinush De Silva, Veterinary Surgeon DWC.
THANK YOU.
Guidelines for the Welfare and Management of Elephants in Human Care: ECA
Supporting the care and conservation of Asian elephants in their range countries
2019 Projects

International Elephant Foundation
Conference 2019
Support & Attend EEHV Conferences

28-30th November, 2019

Fourth Asia Working Group Meeting
And International Seminar on Elephant Endotheliotropic Herpes Virus (EEHV)

October 21-25, 2019
Sent Sumatran Mahouts to African Wildlife Safari for training

Learning Experience with Charlie Gray’s team
Dr. Christopher Stremme at the ECC Laos
7 Mile Camp – Myanmar

Hospital with electricity and running water
Supported collaring efforts for conservation in Sumatra.

This year we funded 3. One was a replacement and we discovered that mom had a healthy calf.

And 2 other collarings were for wild elephants in Way Kambas National Park.
AES supported 2 veterinarians from Myanmar to attend a course in "Asian Elephant Health and Breeding Management" hosted by the Chiang Mai University in Thailand.
Jayantha Jaywardene School Awareness Program
For their future
Working Together for Elephant Conservation

Sarah Conley  
Conservation Coordinator  
International Elephant Foundation  
sconley@elephantconservation.org

Deborah Olson  
Executive Director  
International Elephant Foundation  
dolson@elephantconservation.org

Sean Hensman  
Adventures With Elephants
Many Approaches to Conservation
Ambassadors

Viewing elephants in person ➔ Conservation dollars/action
In-Situ Ambassadorship

Elephant Pride Day 2018, Kibale National Park
More Than Just Conservation Dollars

Providing stress-free biological samples

Behavioral observations and tests

Elephants can store heat in their bodies during the warmest part of the day and release it later at night when temperatures are cooler.

#EleFunFactFriday
Cooperation is Key to Survival
Thank you!
Introduction
Modern zoo practice depends upon an evidence-base to ensure optimum husbandry. Behaviour data forms a key part of this; however collection can be time consuming.
A species-specific research program was developed at ZSL to provide information on priority areas – social interactions, behavioural activity and enclosure use.

Methodology
- Internship to gather baseline data, Summer 2018 - Spring 2019.
- Combination of live observations and CCTV footage.
- Instantaneous focal sampling of state behaviours & social proximity.
- All-occurrence sampling of event behaviours and social interactions.
- Day: 30 minute observation sessions with 1 minute intervals.
- Night: 15 minute intervals across the whole night.

Case One: Browse Provision
Anticipatory behaviours expressed on typical and increased browse days.

Case Two: Social Relationships
Quantifying individual interactions within and between the two social groups.

Case Three: Resting Behaviour
Quantifying rest behaviours of all individuals.

Conclusions
Data from these observations have provided information for a wide range of management areas, covering individual and group level applications over diurnal and nocturnal periods.
Evidence-based management is vital to ensure optimum animal care, with these applications strengthening the engagement with animal teams and scientific zoo practice.
Introduction

Human-wildlife conflict (HWC) is an escalating global and increasingly widespread wildlife conservation problem. Most human-elephant conflict (HEC) research focuses along the edge of or encroaching on protected areas, e.g. crop-raiding, fence-breaching or damage-causing elephants (Loxodonta africana). Elephants with repeated perceived “negative tendencies” are referred to as “problem elephants”. In Africa, “problem elephants” may be legally hunted or destroyed. Long-term, HEC is not resolved by lethal control; it does not solve the root of this complex problem. This ranges from poorly maintained fences, high local elephant population growth, encroaching human activities/settlements or management interventions or zonations that are not biologically relevant to elephant, or appropriate for managing the ecological or human wildlife impact of elephant.

Objectives

To demonstrate that mitigation through reliance on a single mitigation technique is largely ineffective and that combinations of non-lethal techniques in the short to long-term are more effective at addressing HEC.

Methods

Short to medium-term mitigation strategies to curb fence-breaching

Resident movement studies are essential to determine known and contained zones of influence defined by elephant behaviour for pro-active management and is facilitated through satellite collar deployment. Five UHF satellite collars were deployed on elephants (4 cows and 1 bull at Reserve A in Limpopo to track resident movements of herds and the dominant bull (Bull A). The collars, 3 UHF ID tags and geo-fencing created early warning systems for management interventions prior to a fence breach (Figure 1).

Tusk-bracing, a more immediate and individual behavioural modification tool, was adopted at collar deployment of Bull A’s right tusk (left tusk very short) at Reserve A. This novel and innovative method involved embedding wire into the elephant’s tusk with contact under the lip so that when the elephant attempted to break electric wires with his tusk, the tusk wire acted as a conductor and the elephant received a shock (Figure 3).

Medium to long-term mitigation strategies to curb HEC

Fertility control through porcine zona pellucida (pZP) immunoncontraception is a non-hormonal population management tool that reduces and stabilizes local population growth rates in the medium to long-term. pZP immunoncontraception has been administered to ≥ 850 cows on 26 reserves across South Africa, including Reserve A since 2000.

Results

• Tusk-bracing is a conditioning technique to reaffirm the negative consequence of making contact with and trying to breach fences.

• Only 2 breaches occurred a month post-tusk-bracing. No breaches occurred along the bee-hive fence-line.

• Bull A’s breaches correlated with non-mushth periods, when he would try to return to his historical bull area north of the exclusion fence.

• Unfortunately, Bull A broke his right tusk in a fight with another bull (tusk also broke) a month post-tusk-bracing, rendering the wiring redundant.

• The collar data demonstrates that Bull A was often held accountable for fence damage/breaks when the cause was another species (giraffe) or unknown.

• Immunoncontraception reduces or stabilises local growth rates and competition of local resources, particularly amongst bulls who may seek out new ranges outside perimeter fences. Breaches into Reserve A were from non-resident bulls. Resident bulls more frequently breached into areas of historical range cut-off by an exclusion fence erected in 2016.

Conclusions

Many traditional mitigation and population control techniques are intended to encompass only localised effects on elephant within a target zone, assuming no effect into adjacent disturbed zones, or into contiguous neighbouring landholdings. Furthermore, “problem behaviours” e.g. crop-raiding/fence-breaching are primarily done by individual elephants, not elephants as a category and is not simply generic elephant behavioural ecology, but individuals, their species and specifically individual “problem” elephants is critical. Consequently, large-scale lethal interventions may result in ripple effects that have severe unintended consequences, targeting incorrect elephants, even outside the intended zone of impact. Together, non-lethal techniques facilitate the management of and successfully mitigate or reduce HEC, from an individual to local population scale, particularly for fence-breaching activities.

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Authors & Contact

Authors: Amarula Elephant Research Programme, School of Life Sciences, University of KwaZulu-Natal, Durban, RSA (Delsink & Slotow); Humane Society International/Africa, Cape Town, RSA (Delsink & van Altena); Global Supplies, Highlands North, Gauteng, RSA (van Altena); The University of Pretoria, Department of Production Animal Studies, Tshwane, RSA (Bertschinger). Contact: Audrey Delsink e-mail: adelsink@hsi.org. +27839900337

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Porcine zona pellucida vaccine immunocontraception of African elephant (Loxodonta africana) cows: A review of 22 years of research

Hendrik J. Bertschinger, Audrey Delsinki, JJ van Altena and Jay F. Kirkpatrick.

Methods

Proof of Concept

Histological ovarian sections were reacted with anti-pZP antibodies to provide proof of concept.

Kruger National Park efficacy trials

From 1996 - 2000, 21 and 10 cows were treated with pZP vaccine in the Kruger National Park (KNP) and monitored for pregnancy.

GMPGR Population effects

Population effects of pZP with Freud’s adjuvants (three vaccinations in Year 1 with one annual booster) were studied on 18 cows in the GMPGR commencing May 2000. This increased to 26 cows in 2018.

GMPGR Vaccinations

During 2000 - 2002, 100% of all cows of breeding age (cows aged 10 - 12 years) were vaccinated as per the treatment protocol. Thereafter prepubescent cows were left to mature, conceive and give birth to their first calves; only being vaccinated after the birth of their first calves. Vaccine was delivered with a drop-out dart, initially delivered from the ground, fixed into the semimembranosus or semitendinosus muscle mass and later from a helicopter delivered into the rum p muscles (FIGURE 2a, b & c).

GMPGR Population growth rates

The Contraceptive Rate of Increase (population rate of increase post contraception implementation) was calculated as the population’s growth with regards to births since 1999 (prior to treatment) to 2016, excluding mortalities, introductions and fatalities i.e. the Contraceptive Effect.

GMPGR Behavioural responses

The effects of sustained use and application of the pZP vaccine on elephant behavioural and spatial responses were examined by evaluating herding range, fusion - disintegration, associations, hierarchy and reproductive and sexual behaviours.

Population control method in multiple periods

Another six game reserves with a total of 90 cows were added to the project. The project was then expanded to include another 18 reserves. All vaccinations were administered from a helicopter.

Results

1) By 2016, the GMPGR population growth rate had dropped to between 1% - 3% from an annual average growth rate prior to implementation of 8.9% (FIGURE 3).

Conclusions & Implications

- Contraceptive efficacy and safety of pZP vaccine was demonstrated in small to large populations with no prolonged behavioural, social, or spatial changes or consequences over the 22-yr study period.
- Immunocontraception is a variable and remotely deliverable and lacks physiological side effects5-7.
- Although elephant cows may reproduce well into their 60s, there is a definite decrease in the number of ovarian follicles with age with some cows showing ovarian senescence between 55-65 years of age. Thus, a failure of reversal in old cows may be because of ovarian senescence rather than the effects of pZP immunocontraception5.
- pZP mimics natural episodic events such as drought where inter-calving intervals are lengthened14.
- The methodology is now being implemented in approximately 850 cows on 26 reserves (private, provincial and national) across South Africa15.
- Even if some moderate consequences exist, the alternatives are often worse (e.g. over-population, culling).

After 20 years of research, pZP immunocontraception must be considered as a realistic, alternative, reliable and humane method for elephant population control, particularly as part of a longer-term management strategy.

References


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<td>Lisa</td>
<td>Huntsman Cancer Institute, University of Utah</td>
<td>USA</td>
<td><a href="mailto:lisa.abegglen@hci.utah.edu">lisa.abegglen@hci.utah.edu</a></td>
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<td><a href="mailto:mkasuns@gmail.com">mkasuns@gmail.com</a></td>
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<tr>
<td>Abraham</td>
<td>David</td>
<td>Assistant Forest Veterinary Officer</td>
<td>India</td>
<td><a href="mailto:dr_da@hotmail.com">dr_da@hotmail.com</a></td>
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<td>Allen</td>
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<td>Anton</td>
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<td>Berkeley</td>
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<td>Otterbein University</td>
<td>USA</td>
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<td>Nithidol</td>
<td>Chiang Mai University</td>
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<td><a href="mailto:nithidol.buranapim@cmu.ac.th">nithidol.buranapim@cmu.ac.th</a></td>
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<tr>
<td>Buss</td>
<td>Peter</td>
<td>Kruger National Park</td>
<td>South Africa</td>
<td><a href="mailto:peter.buss@sanparks.org">peter.buss@sanparks.org</a></td>
</tr>
<tr>
<td>Carlin</td>
<td>Elisabetta</td>
<td>University of Pretoria</td>
<td>South Africa</td>
<td><a href="mailto:elisabettacarlin1985@gmail.com">elisabettacarlin1985@gmail.com</a></td>
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<tr>
<td>Carter</td>
<td>Kerryn</td>
<td>Elephant Connection</td>
<td>Zambia</td>
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<td>Conley</td>
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<td>International Elephant Foundation</td>
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<td>Ravi</td>
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<td>Invictus K9</td>
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<td>Craig</td>
<td>Ian</td>
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<td>Robert</td>
<td>Butler University</td>
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<td>Jessica</td>
<td>Victoria Falls Wildlife Trust</td>
<td>Zimbabwe</td>
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<td>Tina</td>
<td>University of Central Florida</td>
<td>USA</td>
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<tr>
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<td>Katie</td>
<td>Chester Zoo</td>
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<td>Rachel</td>
<td>Human Elephant Relations Aid</td>
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<td>Samuel</td>
<td>Kenyatta University</td>
<td>Kenya</td>
<td><a href="mailto:mzomolo@gmail.com">mzomolo@gmail.com</a></td>
</tr>
<tr>
<td>Padfield</td>
<td>Clare</td>
<td>African Elephant Research Unit</td>
<td>Research</td>
<td><a href="mailto:research@aeru.co.za">research@aeru.co.za</a></td>
</tr>
<tr>
<td>Pereira</td>
<td>Mário</td>
<td>Universidade de Aveiro</td>
<td>Portugal</td>
<td><a href="mailto:mverde@ua.pt">mverde@ua.pt</a></td>
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<td>India</td>
<td><a href="mailto:baiju@wildlifesos.org">baiju@wildlifesos.org</a></td>
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<tr>
<td>Rajeev</td>
<td>T.</td>
<td>Kerala Animal Husbandry Department</td>
<td>India</td>
<td><a href="mailto:dr_da@hotmail.com">dr_da@hotmail.com</a></td>
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<td>Linda</td>
<td>Asian Elephant Support</td>
<td>USA</td>
<td><a href="mailto:lwreifschneider@sbcglobal.net">lwreifschneider@sbcglobal.net</a></td>
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<td>Jake</td>
<td>We Are All Mammals</td>
<td>United Kingdom</td>
<td><a href="mailto:jake@weareallmammals.org">jake@weareallmammals.org</a></td>
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<tr>
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<td>Christin</td>
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<tr>
<td>Yon</td>
<td>Lisa</td>
<td>University of Nottingham</td>
<td>United Kingdom</td>
<td><a href="mailto:Lisa.Yon@nottingham.ac.uk">Lisa.Yon@nottingham.ac.uk</a></td>
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## Symposium Attendees

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