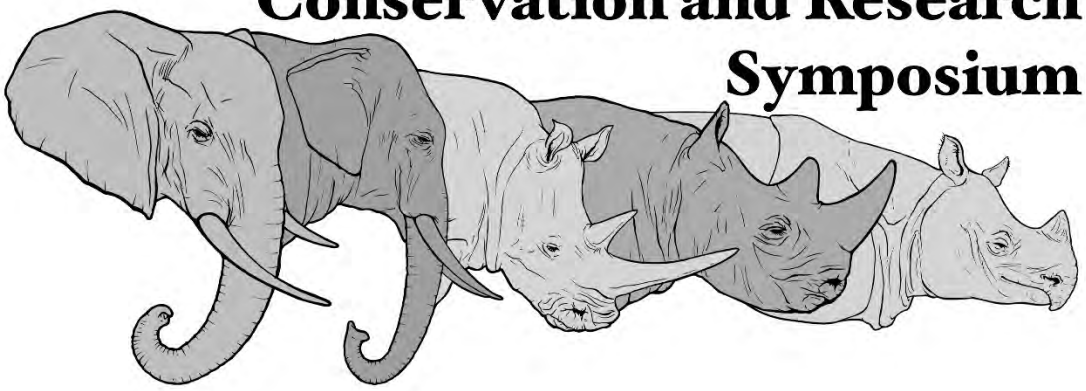
INTERNATIONAL ELEPHANT FOUNDATION.ORG

INTERNATIONAL RHINO FOUNDATION

15th International Elephant & Rhino Conservation and Research Symposium



November 14-18, 2016

SCIENTIFIC PROGRAM

Wildlife Reserves Singapore Group

JURONG BIRD PARK | NIGHT SAFARI | River Safari | Singapore Zoo | Wildlife Reserves Singapore Conservation Fund



ASIAN ELEPHANT SUPPORT

The printing of this program provided through the generous donation of Linda Reifschneider on behalf of Asian Elephant Support

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The International Elephant Foundation encourages meetings and workshops for the education, understanding and analysis of issues related to elephant conservation, research and management, and believes reports and proceedings of these meetings are most useful when broadly disseminated. The opinions and views expressed by the authors and participants of this workshop may not necessarily reflect the formal policies and opinions of the International Elephant Foundation.

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2016 INTERNATIONAL ELEPHANT AND RHINO CONSERVATION AND RESEARCH SYMPOSIUM SCIENTIFIC PROGRAM

MONDAY November 14th, 2016

17:30 **Shuttles leave the hotel to Singapore Zoo**

18:00 – 19:00 **Registration**
Flooded Forest at the River Safari

19:00 – 21:00 **Icebreaker**
Flooded Forest at the River Safari

21:30 **Shuttles leave Singapore Zoo to hotel**

TUESDAY November 15th, 2016

7:00 **Shuttles leave the hotel for the Singapore Zoo**

Opening Ceremonies

8:00 – 8:20 Welcome
8:20 – 9:00 The impact of captive elephants on conservation
Heidi Riddle
9:00 – 9:30 2016 state of the rhino
Susie Ellis
9:30 - 10:00 Human-elephant conflict: Challenges and the way ahead
Ajay Desai

10:00 – 10:30 **Break**

Habitat Management

10:30 – 10:45 Aspects of seed dispersal by Asian elephants (*Elephas maximus*) in and around Kaudulla National Park, Sri Lanka
M. S. Perera
10:45 – 11:00 Facing the habitat crisis: Securing, restoring and connecting refuges for elephants and Sumatran rhinos in South East Asia
Robert Risch
11:00 – 11:15 Identification of elephant (*Elephas maximus*) traditional paths and its implementation for population estimation, distribution and utilization of habitat in Kalakad-Mundanthurai Tiger Reserve, Southern India
Subbiah Sathish-Narayanan

11:15 – 11:30 A holistic approach for securing the Thirunelli Kudrakote elephant corridor, Wanard, Kerala, India
Kalyanasundaram Ramkumar

11:30 – 11:45 Landscape ecological analysis and characterization of elephant migration through GIS Application
Nilanjana Das Chatterjee

11:45 – 12:00 Finding possibilities of re-opening of elephant corridors in the North Western Province of Sri Lanka and recommendations for reducing HEC
Pubudu Weerarathna

12:00 – 13:30 **Lunch**

Veterinary Management Part 1

13:30 – 13:45 Emerging diseases of elephants in captivity and their management protocol
TS Rajeev

13:45 – 14:00 A clinical diary for captive elephants: experiences from Palakkad district in southern India
Joju Davis

14:00 – 14:15 Sedation of Asian elephant calves (*Elephas maximus*) using Xylazine hydrocholoride – applied approach
B. Vijitha Perera

14:15 – 14:30 Identification of *Protozoa gastrointestinal* to the wildlife (tiger, rhino and elephant) and domestic livestock (cattle, buffalo and goat) in Way Kambas National Park, Lampung, Indonesia
Dedi Candra

14:30 – 14:45 Investigation of an emerging infectious skin disease in Kenyan black rhinoceros
Kali Holder presented by Marc T. Valitutto, VMD

14:45 – 15:00 Health policy implications of tuberculosis in captive elephants and mahouts
David Abraham

15:00 – 15:30 **Break**

Veterinary Management Part 1 (cont.)

15:30 – 15:45 Bronchoscopy, bronchial lavage and gastric fluid sampling for Mycobacterium tuberculosis screening during standing sedation in Asian elephants
Imke Lueders

15:45 – 16:00 Newly-developed lung lavage system in elephants using a closed flushing and collection system for safe and sterile sample collection
Thomas Hildebrandt

16:00 – 16:15 Thirty years in elephant health care in north-east India
K. K. Sarma

Elephant Endotheliotropic Herpesvirus Research

16:15 – 16:30 Elephant Endotheliotropic Herpesvirus (EEVH): A global perspective and update on recommendations from the EEHV Advisory Group
Lauren L. Howard DVM, Dipl. ACZM

16:30 – 16:45 EEHV Hemorrhagic disease: Extraordinary levels of non-1a, 1B pattern genetic variation amongst individual EEHV/1 strains
Gary Hayward

16:45 – 17:00 Genetic characterization of EEHV and Gammaherpesvirus in lung or skin nodules and saliva from zoo and wild African elephants
Virginia Riddle Pearson

17:00 – 17:15 Identification of candidate proteins for an EEHV vaccine
Paul Ling

17:15 – 17:30 Elephant endotheliotropic herpes virus (EEHV) associated with Clostridium perfringens infection in two Asian elephant calves
Chatchote Thitaram

17:30 – 17:45 Development of freeze-dried platelet-derived hemostatic agents as a novel treatment for elephant endotheliotropic herpes virus hemorrhagic disease
Sabrina McGraw presented by Marc T. Valitutto, VMD

18:30 **Shuttles leave the Singapore zoo for the hotel**

Wednesday November 16th, 2016

7:00 **Shuttles leave the hotel for the Singapore Zoo**

Captive Management

8:00 - 8:15 The Aspinall Foundation black rhino breeding program to include reintroductions to Africa
Berry White

8:15 – 8:30 Benefits of long-term hormone monitoring programs for breeding and welfare management of elephants
Sharon Glaeser

8:30 – 8:45 Asian Captive Elephant Working Group: Studying and developing best practices to ensure the welfare of working elephants
Janine Brown

8:45 – 9:00 Captive elephant health care and wild elephant conservation activities in Myanmar
Zaw Min Oo

9:00 – 9:15 Employing mahouts and captive elephants for elephant conservation programs in Sumatra
Nazaruddin

9:15 – 9:30 Employing mahouts and captive elephants for elephant conservation programs in Sumatra (cont.)
Nazaruddin and Slamet Riyanto

9:30 – 9:45 Rehabilitation of greater one-horned rhinoceros calves in Assam, India
Rathan Barman

9:45 – 10:00 Rejuvenation camps for captive elephants: A novel and unique conservation strategy for the isolated captive elephants in the state of Tamil Nadu, India
S. Paulraj

10:00 – 10:30 **Break**

Captive Management (cont.)

10:30 – 10:45 Pregnancy and birth of the second Sumatran rhinoceros calf at the Sumatran Rhino Sanctuary, Way Kambas National Park, Indonesia
Zulfi Arsan

Behavior

10:45 – 11:00 Acoustic detection and monitoring as a conservation tool
Angela Stoeger

11:00 – 11:00 What elephant rumbles tell us about the sender?
Anton Baotic

11:15 – 11:30 White rhino olfactory communication and the potential for odor manipulation
Courtney Marneweck

11:30 – 11:45 Female social organization in Asian elephants in southern India
T.N.C. Vidya

11:45 – 12:00 Understanding the behavior of African elephants as they move in landscapes with different protection status and habitat types in the Mahale-Katavi-Lwafi ecosystem of Tanzania
Andimile Martin

12:00 – 13:30 **Lunch**

Behavior (cont.)

13:30 – 13:45 Sleeping behavior in a group of captive Asian elephants
Emma Evison

Nutrition

13:45 – 14:00 Resource use and food plant preference of the Bornean elephant in the Lower Kinabatangan Wildlife Sanctuary, Sabah
Megan English

14:00 – 14:15 Genetic basis of iron storage disease (ISD) in captive black rhinoceros
Donald Paglia

14:15 – 14:30 A case report treatment of iron storage disease in a black rhinoceros in western Europe
Linda van Sonsbeek

14:30 – 14:45 Validation of a rhino specific ferritin enzyme immunoassay for the black rhinoceros for assessing the impact of individual and environmental factors on serum ferritin concentrations
Jessye Wojtusik

14:45 – 15:00 Effects of drought on elephant survival in semi-arid savannas of Africa
Yussuf Adan Wato

15:00 – 15:30 **Break**

Reproduction

15:30 – 15:45 Endocrine monitoring of wild Asian elephants in modified landscapes
Sreedhar Vijayakrishnan

15:45 – 16:00 Endocrine changes and ovarian activity of captive African (*Loxodonta Africana*) and Asian (*Elephas maximus*) elephants during the postpartum lactating period
Kazuyoshi Taya

16:00 – 16:15 Analysis of Asian elephant (*Elephas maximus*) seminal plasma for the improved understanding of semen collection and preservation
Cameron Negus

16:15 – 16:30 Progress in sperm sorting and cryopreservation technologies for modifying populations sex ratio and preserving genetic diversity in the rhinoceros and elephant
Justine O'Brien

16:30 – 16:45 Post-partum ovulation in Asian and African elephants in Europe
Ann-Kathrin Oerke

16:45 – 17:00 New strategies in Sumatran and northern white rhinoceros conservation based on advanced assisted reproduction techniques combined with cellular technologies
Thomas Hildebrandt

17:00 – 17:15 Etorphine free anesthesia protocols optimized for frequent reproductive interventions ranging from semen collection, artificial insemination to Ovum-Pick-Up (OPU) in four rhino species
Frank Goeritz

17:15 – 17:30 First results of oocyte maturation and in-vitro fertilization (IVF) in Sumatran and northern white rhinoceroses
Cesare Galli

17:30 – 17:45 Ovarian down regulation by GnRF vaccination decreases reproductive tract tumour size in female white and greater one-horned rhinoceroses
Robert Hermes

18:30 **Shuttles leave the Singapore zoo for the hotel**

Thursday November 17th, 2016

7:00 **Shuttles leave the hotel for the Zoo**

Human-Elephant Conflict Mitigation Strategies Part 1

8:00 - 8:15 Human-elephant conflict reduction via deterrents, understanding ecological correlates, and climate smart agriculture practices
Bruce Schulte

8:15 – 8:30 Finding pathways to human-elephant coexistence: A risky business
Anna Songhurst

8:30 – 8:45 Socio-economic profile of human wildlife conflict affected farmers and their perception towards human wildlife conflict in Tamil Nadu, India
K. Senthilkumar

8:45 – 9:00 Hunger Games: Understanding human elephant relationships in a landscape matrix of the Western Ghats
Vinod Krishnan

9:00 – 9:15 Finding joint solutions for human-elephant conflict reduction in an emerging plantation landscape in Sabah Malaysian Borneo
Cheryl Cheah Phaik Imm

9:15 – 9:30 Spatial and temporal trends in human-elephant encounters in northeastern India
Aritra Kshettry

9:30 – 9:45 Sensitizing local communities in India in conservation of the declining greater one-horned rhino with training and education
B. A. Daniel

9:45 – 10:00 The use of audio playback to deter crop-raiding elephants
Evan Bittner

10:00 – 10:30 **Break**

Human-Elephant Conflict Mitigation Strategies Part 1 (cont.)

10:30 – 10:45 Is an elephant proof trench an effective mitigating measure against human-elephant conflict?
Ramakrishnan Balasundaram

Population Management and Protection

10:45 – 11:00 Prerequisites to prevent extinction of the genus Dicerorhinos
John Payne

11:00 – 11:15 Lessons learned from the decline of the Sumatran rhino in Sabah
Petra Kretzschmar

11:15 – 11:30 Saving the Sumatran rhino: Amalgamation in the Leuser ecosystem
Rudi Putra

11:30 – 11:45 Conserving Javan rhino through special interest ecotourism in Ujung Kulon National Park
Ofat Sofwatuddin

11:45 – 12:00 Current threats to Asian rhinos from illegal rhino horn trade
Bibhab Talukdar

12:00 – 13:30 **Lunch**

Population Management and Protection (cont.)

13:30 – 13:45 Population modeling of Asian elephants in a rain forest
Jyoti Das

13:45 – 14:00 Spatial distributions of Sumatran rhino calf at Way Kambas National Park based on its footprint and forest fire in one decade (2006 to 2015)
Arief Rubianto

14:15 – 14:30 The African Rhino Community Centre (ARCC): A collaborative strategy to protect rhino in the Eastern Cape of South Africa
Mike Slattery

14:30 – 14:45 Pointless: A quantitative assessment of supply and demand in rhino horn and a case against trade
Barbara Maas

14:45 – 15:00 Directing rhino meta-population management "best practice" during a poaching crisis
Gayle Pedersen

15:00 – 15:30 **Break**

Veterinary Management Part 2

15:30 – 15:45 Recurrent keratitus in captive elephants
Nili Avni-Magen

15:45 – 16:00 Periodontal disease in black rhinoceros.
Benn Bryant

16:00 – 16:15 Management of tusk fractures in captive elephants
Gerhard Steenkamp

16:15 – 16:30 Development of rhino ferritin specific assay for determining the association between serum ferritin concentrations and hemochromatosis in the Sumatran rhinoceros
Terri Roth

16:30 –16:45 Clinical Case: Gross Examination on left rear of Sumatran Rhinoceros (*Dicerorinos sumatrensis*) Harapan by using digital x-Ray
Made Fera presented by Bibhab Talukdar

16:45 – 17:00 Common Foot disorders in captive Asian elephants in Kerala
M.K. Narayanan

17:00 – 18:00 **Visit Singapore Zoo**

18:00 – 20:30 **Gala Dinner at the Forest Lodge of the Singapore Zoo**

20:30 – 22:00 **Night Safari at the Singapore Zoo**

22:30 **Shuttles leave the Singapore zoo for the hotel**

Friday November 18th, 2016

7:00 **Shuttles leave the hotel for the Singapore Zoo**

Genetics and Conservation

8:00 - 8:15 Speciation and hybridization in African elephants
Alfred Roca

8:15 – 8:3 A genetic and genomic analysis of the evolution and conservation status of the black rhinoceros and its implications for conservation
Michael Bruford

8:30 – 8:45 Genetic Advances and the conservation of African forest and savanna elephants
Yasuko Ishida

8:45 – 9:00 Conservation genetics of greater one-horned rhinoceros in India – from identifying individuals to determining conservation priorities
Udayan Borthakur

9:00 – 9:15 Developing effective markers for the censusing of Sumatran and Javan rhinos by local researchers
Alfred Roca

9:15 – 9:30 Expression of elephant p53 (EP53) increases cell death in human cancer cells
Lisa Abegglen

Human-Elephant Conflict Mitigation Strategies Part 2

9:30 – 9:45 An assessment of human elephant conflicts and mitigating measures taken to resolve the conflict in Dharamapuri Forest Division, Southern India
Arivazhagan Chelliah

9:45 – 10:00 The EleFriendly bus service initiative: A case study in implementing a conflict specific mitigation strategy to mitigate human elephant conflicts in Wasgamuwa, Sri Lanka
Ravi Corea

10:00 – 10:30 Break

Human-Elephant Conflict Mitigation Strategies Part 2 (cont)

10:30 – 10:45 Integrating teaching and folklore theatre to promote HECx in Tamil Nadu, India
R. Marimutha

10:45 – 11:00 Participatory management of human-elephant interactions in the Anamalai: Role of technological interventions
Ganesh Raghunathan

11:00 – 11:15 Cultivating alternative crops reduces crop losses due to elephants
Eva Gross

11:15 – 11:30 Behavior and social dynamics of crop-raiding elephants (*Elephas maximus*): Can beeline fencing mitigate human-elephant conflict in a highly crop-raided region of Sri Lanka?
Kylie Butler

Education and Conservation

11:30 – 11:45 Engaging legislators in wildlife conservation in Aceh, Indonesia
Wahdi Azmi

11:45 – 12:00 Knowledge on bio-diversity, elephants, elephant conservation among the school students
D. Edwin Raja Kumar

12:00 – 13:00 Lunch

Education and Conservation (cont.)

13:00 – 13:15 Education programs of Asian Elephant Support (AES)
Linda Reifschneider

13:15 – 13:30 Raising Awareness and Funds from the Field: Effective Strategies in the Age of Interconnectivity
Sarah Conley and Nikki Sharp

13:30 – 13:45 Making the Shortlist: Grant Writing Best Practices to Improve Funding Success
Deborah Olson and Sarah Conley

13:45 – 14:00 Closing Ceremonies

14:30 Shuttles leave the Singapore zoo for the hotel

Posters

Poliwire electric fencing systems as farm-based deterrents for elephant crop-raiding
Kerryn Carter

Effects of environmental pressures on patterns of gastrointestinal parasitism in black rhinoceros in Addo Elephant National Park, South Africa
Elizabeth Freeman

A comprehensive evaluation of foot disorders among captive elephants in Kerala
P. B. Giridas

Testosterone characteristics and musth onset of young male Asian elephants at African Lion Safari and Oregon Zoo
Sharon Glaeser

Effect of the GnRH vaccine Improvac® on testicular size and ultrasonographic appearance in African elephants (*Loxodonta Africana*)
Imke Lueders

World Rhino Day in Japan
Kaora Kiyasu

Improving elephant welfare through science and management
Cory Nordin

Translocation of problematic Tuskers: Lessons learnt from practical experience with an Asiatic tusker (*Elephas maximus*) in Hosur Forest Division, Tamil Nadu, India
S. Paulraj

The impacts of dehorning on the southern white rhinoceros
Samuel Penny

Stress physiology in free-ranging Asian elephant: Influence of ecological factors
S.S. Pokharel

ABSTRACTS

The Impact of Captive Elephants on Conservation

Heidi S. Riddle
Riddle's Elephant and Wildlife Sanctuary

Elephants have a long history of captivity in both Africa and Asia, and have adapted to many environments. Currently a significant portion of the world's Asian elephant population is in captivity, mainly managed in Asian countries. Captive elephants are those in direct human care and control. The words "domestic" and "domesticated" have been used to describe captive elephants; however, despite the close link for thousands of years, elephants have not been selectively bred by humans for certain traits as is the case with other animals defined as "domestic" such as dogs, cats, or cattle.

The majority of captive elephants managed worldwide come from wild elephant capture programs. Some elephant range countries have used capture as a conservation tool to address increasing conflicts with humans due to loss of habitat or to the re-settlement of local people in or near elephant habitat. For a few African countries, capture has been one component of management policy to control overpopulation through removal (via culling and capture) of wild elephants in areas with limited space, such as within fenced parks. While the large-scale capture of wild elephants for captivity has significantly declined worldwide in recent years, both legal and illegal captures and trade of live elephants continue.

Currently very few African elephant range countries manage captive elephants, yet all 13 Asian elephant range countries have a captive population; the numbers, uses, and need for captive elephants differ from country to country. While some uses of captive elephants have become obsolete (i.e. as war animals), other uses are increasing e.g. for tourism and for elephant-back patrols used in direct conservation interventions such as monitoring protected areas or mitigating human-elephant conflict (HEC).

This presentation will focus on the impacts of captive elephant populations on field research, wildlife legislation, and species conservation.

2016 State of the Rhino

Susie Ellis
International Rhino Foundation

Rhinos are among the most threatened species on Earth, facing a myriad of threats ranging from poaching for horn to habitat loss and fragmentation to small population effects. For almost 25 years, the International Rhino Foundation (IRF) has partnered with like-minded organizations to conserve rhinos through *in situ* conservation programs in Africa and Asia. These partnerships provide a critical lifeline for rhino conservation in range countries by providing financial support for field programs and generating funds to support critical research projects yielding information that can help to better manage wild populations. This presentation gives an update of the status of rhinos worldwide and provides examples of the important research synergies benefitting rhinos in terms of research.

Human-elephant conflict: Challenges and the way ahead

Ajay A Desai
Consultant to Wildlife Institute of India and WWF India

Human-elephant conflict (HEC) has been present ever since people started cultivating crops in elephant habitat. However, given the high human population density coupled with significant developmental needs of most Asian elephant ranges states, HEC poses a major challenge as scarce space is available for elephant conservation in all Asian elephant range states. Hundreds of people are killed by elephants each year and at the same time crop depredation and damage to houses by elephants adversely impacts the livelihoods and wellbeing of tens of thousands of families across Asia, often rendering them destitute. The resultant antagonism towards conservation has resulted in hundreds of elephants being killed in retaliation, undermining government authority in conserving and managing wildlife and their habitats, and generating adverse publicity. Data shows that conflict is increasing, indicating that we are not succeeding in our efforts to contain it. Our current failure in addressing HEC is due to poor strategies and implementation. We have not taken into account the difference between historical and current HEC situations and we have failed to take into consideration the behavioral ecology of elephants when planning for conservation and HEC mitigation. HEC mitigation has largely focused on symptomatic treatment while failing to address the causal factors. It most often focuses on short term remedies rather than on long term solutions. I discuss the causes for HEC both in terms of land use changes made by humans and elephant responses to such changes. Factors that exacerbate conflict are also discussed. The implications of these for conservation and conflict mitigation, both short term and long term, are discussed. Structured HEC mitigation strategies and methods starting with a) addressing causal factors b) reversing past changes which caused HEC c) containing existing HEC d) compensation when all else fails. Long term solutions to HEC are very challenging but they need to be addressed as failure to do so will undermine conservation. As managers, conservationists and scientists we need to change our perception of HEC and how we deal with it. We need to take into consideration long term implications of both our conservation and HEC mitigation strategies.

Aspects of Seed Dispersal by Asian Elephants (Elephas maximus), in and around the Kaudulla National Park, Sri Lanka

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Elephants are ecosystem engineers that modify their environment through actions such as herbivory and seed dispersal. Their broad dietary breadth, large gape size, and extensive home ranges accentuate their role as the ideal seed dispersal agents. Thus, an increase or decline in elephant populations may have consequential impacts on sustaining forest plant species diversity. While a significant number of studies have focused on seed dispersal by the African elephant, relatively few have examined seed dispersal by Asian elephants. These studies indicate a high degree of variability in seed dispersal between elephant populations, and hence a few studies may be insufficient to evaluate the seed dispersal potential of Asian elephants. Thus our understanding of seed dispersal potential of Asian elephants is at its infancy. Here, we explore the role of elephants as seed dispersers in and around Kaudulla National Park, Sri Lanka through the analysis of 66 elephant dung piles. We specifically focus on investigating the quantitative

aspects of seed dispersal by analyzing the diversity of dispersed plant species and also the qualitative aspects of dispersal by investigating the germination potential of dispersed seeds. Additionally, we examined the influence of gut passage on seed germination and latency of *Bauhinia racemosa*, a seed frequently encountered in dung piles. The seeds of ten species belonging to the plant families Solanacea, Fabaceae, Poaceae, Euphorbiaceae, Scrophulariaceae, Moraceae and Cucurbitaceae were dispersed. The germination potential of majority of the seeds dispersed was poor. In the case of Bauhinia, gut passage significantly reduced the time taken for germination but did not affect germination success. In comparison to other elephant populations, the elephant population at Kaudulla was not highly frugivorous and hence dispersed only the seeds of a few plant species. It is also clear that ingestion decreased dormancy in seeds of Bauhinia. Our study indicates that elephants effectively dispersed relatively few plant species

Facing the habitat crisis: Securing, restoring and habitats for elephants and Sumatran rhinos in South East Asia

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The increase of the human population in Asia, agricultural expansion, logging activities, forest fires and urbanization are causing one of the highest rates of deforestation in the tropics. As a consequence, wildlife habitat is being reduced and fragmented. Large mammals such as elephants (*Elephas maximus*), Sumatran rhinos (*Dicerorhinus sumatransis*) and tigers (*Panthera tigris*) are suffering primarily due to the restriction of their movements which often results in human-wildlife conflict. Elephants are especially influenced due to their natural habit of long-distance migration. Human-elephant conflict has many forms, from crop raiding to injury or death of people and killing of elephants. As a consequence, plantations are being fenced which results in elevated elephant densities in the remaining forest patches and which negatively impacts the remaining vegetation. The Rhino and Forest Fund (RFF) is a German-based NGO operating in Sabah, Malaysia and in Sumatra, Indonesia. Our aim is to restore habitat for wildlife and to establish wildlife corridors. Focus species are the two subspecies of the Sumatran rhinos (*D. s. harrissoni* and *D. s. sumatrensis*) as well as the Bornean (*E. m. borneensis*) and the Sumatran elephant (*E. m. sumatranus*). Together with local authorities, two forest restoration projects have been started in Sabah. As a result of our activities, electric fences restricting the movements of elephants and other wildlife have been removed, threatened forest land has been secured for conservation, and habitat connectivity has been improved. Further projects are planned in Indonesia. The target of the Rhino and Forest Fund is to establish a network of well-connected conservation areas of sufficient size and quality to overcome current habitat fragmentation. The corridors are being carefully designed to provide sufficient food for elephant and other wildlife so that the stimulus to move elsewhere is minimized. The wildlife corridors will also help to save and enhance the gene pool of currently isolated sub-populations of wildlife isolated inside the forest reserves. The RFF works together with all crucial stakeholders and considers the socio-economic setting as well as likely ecological and socio-economic developments. Anticipating already visible trends, the RFF has also started working on a model project for best practice restoration of oil palm plantations and soli rehabilitation. Due to heavy soil degradation on oil palm plantations, agriculture will not be economically viable in the future. This enhances the likelihood that huge areas in Southeast Asia will become available for forest restoration during the next decades.

Identification of elephant (*Elephas maximus*) traditional paths and its implementation for population estimation, distribution and utilization of habitat in Kalakad-Mundanthurai Tiger Reserve, Southern India.

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Kalakad-Mundanthurai Tiger Reserve

Spatial information at the landscape scale is enormously important for conservation planning, especially in the case of long-ranging vertebrates. The richness of biodiversity and high level endemism of Kalakad- Mundanthurai Tiger Reserve (KMTR) in the Western Ghats of southern India holds a viable population for the long-term conservation of the Asian elephant. Through the knowledge of indigenous communities and rapid and extensive field surveys, we have mapped traditional migration paths for elephant population monitoring. We have primarily focused on elephant habitat and have estimated the elephant population from dung decay and density. The elephants utilize eleven natural forest habitats, of which the southern tropical wet evergreen forest is most utilized. The reserve has 871.6 km of traditional elephant migration routes across the seven forest ranges. A comparison of dung piles indicates a significant difference ($p < .0000$) across the habitats and the numbers of elephant dung piles appears to be greatest during the wet season in the grasslands, second most prevalent during the wet season in the dry deciduous forest and third most prevalent during the dry season in the dry deciduous as well as evergreen forests, respectively. These methods have significantly contributed to our understanding of elephant habitat preference and helps to identify the reason for crop depredation in the foothills. We also provide awareness to people and we have joined hands with farmers to help them drive elephants from cultivated land back into the forest through traditional and scientific inputs. We build tolerance and understanding of the public and hope to build coexistence propensities into the management of wildlife habitat of India.

A holistic approach for securing the Thirunelli-Kudrakote elephant corridor, Wayanad, Kerala, India

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The endangered Asian elephant is running out of space and time throughout its range of distribution. The spread of human settlements, ensuing mindless development activities (mining, industry, railways, etc.) and unbridled abuse of our natural resources have increasingly degraded and fragmented elephant habitats across its range of distribution, and in a few cases restricting them into small pocketed herds in habitat islands. Elephants numbering about 29,000-30,000 in India mainly remain isolated in Protected Areas and other forests and their long-term survival is dependent on the interconnectivity of these habitats. The relatively narrow, linear landscape that connects two or more patches of viable elephant habitats or connecting two or more viable elephant populations are called “elephant corridors.” Many of these corridors are human dominated, degraded and lack legal protection. One such high priority corridor is the Thirunelli - Kudrakote corridor that maintains habitat contiguity between Nilgiri Biosphere Reserve and Brahmagiri Hills supporting more than 6000 elephants. The corridor had seven villages inside it, of which four (Thirulakunnu, Valiyaemmady, Kottapady and Puliyankolly) are strategically located at points that considerably reduce the effective width of the corridor. Wildlife Trust of India (WTI), with financial support from World Land Trust, Elephant Family and IUCN Netherlands and in collaboration with the Kerala Forest Department and local communities initiated a project in 2004 – 05 to secure the corridor.

The corridor was secured by purchasing land owned by the villagers and providing suitable alternate land and rehabilitation packages for the tribal and BPL (below poverty line) families. The process of land securement was through Prior Informed Consent of villagers, assessing long-term the socio-economic status and aspirations of the villagers and in consultation with all governmental authorities and permissions for rehabilitation. WTI has in the course of the last 10 years relocated 37 families from the four critical villages through this rehabilitation package that includes alternate land for settlement and agriculture, new houses, water, electricity and other basic amenities. About 25 acres of land was purchased, although they physically occupied 47.5 acres of land that is now free of human habitation and available for wildlife movement. The secured land has been handed over to Kerala Forest Department that has been granted as part of Protected Area under Wayanad Wildlife Sanctuary and Reserve Forest under Wayanad North Forest Division by Kerala state government in 2015. The corridor is being periodically monitored to assess its usage by elephants. Pre and post securement of the corridor shows considerable improvement in elephant dung encounter rate to pre and post relocation of two corridor villages (Thirulakunnu - Pre:8.7 dung piles/km and Post:15.9 dung piles/km; Valiyaemmady - Pre:5.0 dung piles/km and Post:25.3 dung piles/km) and similarly in remaining two villages (Puliyankolly - Pre:6.9 dung piles/km and Post:8.5 dung piles/km and Kottapady - Pre:15.9 dung piles/km and 12.9dung piles/km). The rehabilitated people have also been monitored for the past five years to assess the impact of relocation on their social and economic conditions. WTI has established linkages with agriculture/horticulture/social welfare departments to channelize the government schemes for villagers contributing to conservation. The assessment has shown remarkable improvement with good agricultural land with less exposure to human-wildlife conflict, clean drinking water from wells, and better access to other livelihood options, communications, healthcare, education and electricity. Average monthly income of rehabilitated villagers has increased to 248 % - 569% in the four rehabilitated villages post securement. This has created a win-win situation for both the animals and the rehabilitated villagers and is a successful model of collective approach that could be replicated for securing other corridors.

Landscape ecological analysis and characterization of elephant migration through GIS application

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Landscape pattern entails spatial heterogeneity in terms of spatial composition, spatial configuration and anisotropy. The main components of spatial heterogeneity are types and number of patches of different land use and land cover, their size, shape and the directional difference etc. in a particular landscape. Landscape pattern or diversity of landscape indicates the level of resource diversity and their distribution over space. This diversity can be analyzed through Landscape Ecological Analysis. Landscape ecological analysis may be used for characterization of a particular habitat too. The patch diversity and composition may determine the quality of habitat i.e. concentration, dominance or lack of natural resource. This may further be related to the spatial distribution and migration of species and their foraging character that depends on that resource base. Irregularity in patch shape may indicate the edge effect or fragmentation of habitat. Changes in the background metrics may be responsible for dispersal and migration of elephants. The present paper tries to explain landscape character and its relation to habitat selection by the elephant. The study covers an area of forested parts of Bankura District, West Bengal and Dalma Wildlife Sanctuary, Jharkhand, India. The area has been invaded by migratory Dalma elephants since the 1980s. The Panchet Forest Division covers an area of 336.04 km2 and is distributed among 7 C.D Blocks of Bankura District. The forest area is divided into 5 territorial ranges which are divided into a total of 21 forest beats which include 236 forest bearing mouzas. Dalma Wildlife Sanctuary on the other hand is

located 22 42’ 00”N to 23 01’00”N latitude and 86 E to 86 30 E longitude with an average elevation of about 400 meters, total area 195km2. Spatial arrangements of habitat patches over a surface are identified in GIS platform which is helpful in understanding habitat heterogeneity by using LISS-IV merged images of 2013 and LISS III image of 1980, 1990, 2000 and 2010. For measuring the habitat characteristic, metrics like patch type, richness and diversity, patch dynamics; path connectivity; patch isolation; fragmentation; corridors; permeability ; edge effect and edge contrast etc. are adopted and analyzed in landscape analysis software. Finally specific reasons are identified behind the preference of habitat selection by elephants in the Panchet Forest Division.

Finding possibilities of re-opening of elephant corridors in the North Western Province of Sri Lanka and recommendations for reducing HEC

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The North Western Province (NWP) of Sri Lanka comprises two districts, Puttalam (3,013 km2) and Kurunegala (4,813 km2), and it is estimated that nearly 20% of the nation’s elephant population (1189 elephants) is scattered in small pockets of habitat throughout the NWP as herds and individuals. Agriculture is the main livelihood in more than 50% of the NWP, and much of the elephant habitat is fragmented due to agricultural activities. The NWP is the area most affected by HEC in the country. In 2010-2015, 90 humans died due to HEC in the NWP, but there was a large difference in the number of deaths between the 2 districts, with Kurunagala having over 4 times as many as Puttalam in the last 3 years. The NWP has a number of large water tanks and forest areas as water catchment areas, and the elephants use these tanks to drink and bathe and to graze along the tank beds. Seasonal migrations occur throughout national parks, sanctuaries, and Protected Areas, but development and agriculture have cleared corridors, fragmented forest patches, and installed fencing to protect lands. We conducted a study to investigate the possibility of re-opening elephant corridors in the NWP, identify isolated elephant habitats, identify the communities highly affected by HEC, and record elephant-human interactions. The goal was to identify the cause of increasing HEC and potential solutions (medium and short-term) through community participation in collaboration with the Department of Wildlife Conservation (DWC). During the initial phase of this study, HEC data was collected through discussion with the DWC and review of records in government offices, and then highly effected villages were selected based on the DWC data for 2005 to 2012 and complaints received by regional government offices. Among the 11 vulnerable administrative areas, 9 were identified as critical HEC areas. We identified and mapped out 12 major existing elephant corridors, many miner corridors, 17 large scale elephant habitats, and 22 small isolated elephant habitats. We also mapped 8 state forest boundaries, 4 proposed reservation boundaries, 11 existing and abandoned electric fences, and 3 protected area boundary electric fences. Villagers and community based organizations are responsible for maintaining fences, but many have been neglected and are not functioning properly. Temporary measures are being taken to keep elephants out of human areas. Farmers keep watch and use torches, fire crackers, thunder flashes, loud noises, lighting fire, and kerosene lamps; but these measures are not sustainable long term. A long term solution is needed to re-create elephant corridors and protected areas with coordination among administrative authorities. Habitat fragmentation and lack of food are the most important issues to be addressed to mitigate the HEC problem. The government policy of development needs to be sustainable in order to protect the elephants and habitat as well as the other flora and fauna. Results of this study provide necessary data to support the re-opening of elephant corridors and reduce HEC in the NWP.

Emerging diseases of elephants in captivity and their management protocol

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The Kerala State, the southernmost in India, is bearing a lion share of the captive domesticated Asian elephants than other parts of the country as they are considered as the incarnation of lord Ganapathi in Hindu religion and are widely used for rituals by Muslims and Christians as well. The survival of elephants in domesticity without access to their natural food and societal culture might compromise the health condition of these animals. The elephants in captivity encounter specific diseases which have not been well studied and have not been frequently reported from any other parts of the world. The present paper discusses the occurrence of certain diseases especially seen in domesticated elephants and which have recently been noticed more frequently by the authors. Some of the emerging diseases of elephants discussed here include specific diseases like FMD, Osteoarthritis, Suppurative bronchopneumonia and the subcutaneous infections by Bunostomum Sp larvae of dogs and the nonspecific disease like sand enterocolopathy. However, the common diseases like EEHV, Rabies, Biveteleobilharziosis, Haemorhagic septicemia (HS) and toxemic septicemia shall also be considered as emerging in elephants due to the increasing number of cases reported and needs no explanation here as detailed scientific reports are available for reference. The latest outbreak of FMD (foot and Mouth Disease in captive male Asian elephants in the state was assessed in detail. The causative organism was identified as FMD virus Strain 'O', which was the same in the cattle and buffalo which had a severe parallel attack at the same time. The outbreak in elephants was identified in places where they had close association with domestic animals affected with FMD outbreak or sharing of handlers in common. The symptoms were so severe with hyperthermia of about 102 -104 degree f, vesicles in the foot region subcutaneously and oral cavity which later formed into ulcers. In three cases, peeling of the mucus membrane inside the trunk as well as the skin outside at the distal end was noticed. The method of treatment adopted was controlling the secondary infection, correcting the nutritional imbalances and making the animal stable and improving immunity to combat the virus. Another emerging condition is osteoarthritis, detected in old animals above fifty years of age mainly in the forelimb knee joint or at the tip of radius and ulna. The diagnosis was confirmed by radiological examination of the joints and bones at the distal part of the forelimb which showed osteoarthritis changes with mild degree of osteomyelitis. The approach of treatment was to use anti-inflammatory and antibiotics supported with chondrioitin Sulphate for three months which has given excellent results. Some elephants were reported to have a history of dermatitis or eczematous lesions on the skin especially over back and hind limbs. On the detailed microscopic examination of skin scrapings and hair follicles, the organism was initially identified as Bumostomum.Sp larvae seen in dogs. The diagnosis was correlated with stray dogs which may have contaminated the surroundings. Fenbendazole group of drugs was administered orally (5 mg / kg) repeated in a fortnight with antacids and with external anti-hypersensitivity topical agents. The lesions were completely cured in one month. Suppurative pneumonia which was wrongly diagnosed as tuberculosis was confirmed in the post mortem. The animal manifested with all respiratory symptoms, cachexia, exercise intolerance and finally death. Abscess in lungs without any nodule were found and the disease was diagnosed as Suppurative pneumonia

originating from some ulcerative wounds in the joints and skin which had not healed. Non-specific diseases encountered were primarily 'sand enterocolopathy' with the history of eating too much of clayed or semi solid hard sand from the ground and associated in appetence, faecolithiasis etc. On autopsy, it was noticed that the intestine had an absence of food materials and more degenerated caecal cul-de-sac was reported. All the symptoms were suggestive of the sand entero-colopathy condition which is common in horses. All the diagnosis, treatment and follow up of the above reported emerging diseases were on the basis of works reported by (Chakraborty and Chaudhury, 1996).Rao and Acharjyo (1984) , Maske et al. (1990) , and Murray et.al (2008) .The practical utility of this paper involves the screening of evidences on specific and nonspecific diseases affecting captive elephants. The paper is meant to sensitize the Veterinarians and managers of captive and wild elephants so that such type of threats are to be expected so as to save the pachyderms with better healthcare. The study will help in the framing of suitable management related measures. The limitation of such studies includes the unavailability of suitable and relevant information and dearth of studies and also meager facilities to undertake scientific works on elephants for further investigations.

A clinical diary for captive elephants: Experiences from Palakkad District in Southern India

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Historically, captive elephants have played major roles in the cultural and religious lives of the people in Kerala. In Palakkad district in central Kerala, there are century-old records of temples as well as private owners maintaining captive elephants for various purposes. The present number of captive elephants in Palakkad is 44 (43 males and one female), which had gone up to 66 several years back. Every year, during the festival season in Palakkad district, which stretches from September to May, more than 500 festivals that parade elephants take place. Of these, more than 150 festivals parade at least one elephant and at least two festivals parade more than 70 elephants. In addition to elephants within the district, elephants from other districts also participate in the festivals in Palakkad. The Captive Elephant Management Rules implemented by the Government of Kerala in 2003 primarily aims to ensure the welfare of captive elephants and ultimately the safety of public during the festivals. The set of rules stipulates that every elephant paraded in festivals should carry a fitness certificate issued by a licensed veterinarian, after assessing the condition of each animal. It is estimated that a minimum of a thousand instances of health check-up and issuing of fitness certificates are undertaken by the veterinarians in the district during each festival season. At present, there is no single document available to the veterinarians, which can provide information of all elephants in one place. To address this lacunae, we collected health and management related data and attempted to prepare a clinical diary for all captive elephants in Palakkad district. In addition to the right and left lateral, front and back photographs, close-up photographs of the body parts of all elephants were taken. The health-related information collected mainly included the results of laboratory examination of blood, urine and dung and a detailed history of occurrence of diseases in each elephant. The management related information, in addition to others, mainly included the time and duration of occurrence of musth as well as a detailed investigation of the temperament of each animal. Details of individual elephant owners and mahouts were also collected and provided along with the data of each elephant. Forty-four two-page Elephant Health Profiles, which included all information of each elephant, were prepared and included in the clinical diary. A concise note on the normal physiology and major disease conditions of elephants were also provided as appendix. A hundred copies of the clinical diary were printed and distributed among the veterinarians, elephant owners and government officials.

Preliminary response suggests that there this great demand as well as good utility for such a clinical diary on captive elephants. However, in order to ensure sustained utility, revised editions of the same need to printed, at least every three years.

Sedation of Asian elephant calves (*elephas maximus*) using Xylazine hydrochloride -applied approach

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Wild elephant conservation in Sri Lanka includes intense veterinary interventions that commonly require sedation, such as treatment of wounded individuals, handling of animals for health screening, specimen collections, translocation of problem animals, and radio-collaring etc. Xylazine hydrochloride (HCl) was used for 157 sedation (mild to deep) procedures of 91 orphaned elephant calves (4 mo - 6 yr old, 70 - 1,050 kg) undergoing rehabilitation at the Elephant Transit Home in Sri Lanka during Aug. 2010 - June 2016. For mild sedation, 20 mg xylazine was administered intramuscularly for the first 100 kg body weight, plus 10 mg for every additional 100 kg. For deep sedation, 40 mg xylazine was used for the first 100 kg body weight, plus 20 mg per extra 100 kg. Top up doses were given if needed. For reversal, yohimbine HClb was administered intravenously at 1 mg per 10 mg xylazine. Physiological variables were stable throughout sedation (range of pulse rate 30-45 beats/min, respiratory rate 4-12 breaths/min, rectal temperature 35.6-37.2 °C). Pulmonary function and acid-base balance were adequate (range of PaO2 89-123 mmHg, PaCO2 33-52 mmHg, pH 7.35-7.54, lactate 0.9-2.5 mmol/L). The induction and recovery times, and the level of sedation varied unpredictably between individuals, as well as within calves that were sedated repeatedly. This may be due to individual response variation, different doses, adequacy of intra muscular drug penetration, and the animal's temperament before and after drug administration. In conclusion, xylazine at the doses used in elephant calves produced mild to deep sedation with stable physiology and no major complications.

A Balanzine®100 mg/ml, Health-Tech Pharmaceutical Co. Ltd, Taipei, Taiwan. b Reverzine® 10mg/ml, Bomac Pty Limited, Hornsby, NSW 2077, Australia.

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Identification of *Protozoa Gastrointestinal* to the wildlife (tiger, rhino and elephant) and domestic livestock (cattle, buffalo and goat) in Way Kambas National Park, Lampung, Indonesia

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Gastrointestinal parasite interaction, especially protozoa, in the 37 villages adjacent to the buffer zone of Way Kambas National Park (WKNP) is a problem that should receive serious attention because some protozoa are zoonotic. The risk of transmission of parasites between wildlife populations (tigers, rhinos and elephants) and domestic livestock populations (cattle, buffalo, and goats) is great in this area. This study aimed to identify protozoa from faecal samples of wildlife and domestic livestock from around WKNP collected during the period February - July 2014 and October 2014 - February 2015. The sampling area included 36 locations (25 villages and 11 WKNP areas). Fecal samples were examined using the sedimentation and flotation methods for parasite identification and the analysis of potential zoonotic protozoa conducted through a literature study. Protozoa found in the buffalo, cows and goats are: Eimeria spp, Balantidium coli, Cycloposthium spp and Entamoeba coli. Protozoa founded in the Sumatran rhino and elephants are Balantidium coli and Cycloposthium spp. Protoza founded in the wildlife and domestic livestock are Balantidium coli and Cycloposthium spp. Possible parasite protozoa with a potential of zoonosis in this study are Eimeria spp, Balantidium coli, and Entamoeba coli.

Investigation of an emerging infectious skin disease in black rhinoceros (*Diceros bicornis*)

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Black rhinoceros (Diceros bicornis) are one of the most universally recognized and critically endangered of African wildlife species. They are the focus of regional conservation efforts, national pride, and a draw for economy-boosting ecotourism[1]. Threats to their survival are numerous –most notably from poaching and ecosystem destruction-and now an as yet undescribed emerging disease is being reported[2]. In recent years, a severe, ulcerative skin infection has been increasingly described in black rhinoceros, with a similar, previously unreported condition seen in the white rhinoceros (*Ceratotherium simum*) in Kenya[3]. The skin lesions are large, open sores, often on the legs and sides that progress to a grossly thickened and raised crusting of the skin. The lesions have spread to an increasing number of Rhinoceros, with unknown consequences to feeding behaviors, breeding, or susceptibility to secondary infections. Based on reports from the 1960s in South Africa and Kenya, filarial dermatitis in rhinoceros have been attributed to *Stephanofilaria dinniki*[4,5,6]. Biopsies from similar lesions in Zimbabwe taken from black rhinos in 1988 contained filarial nematode adults on histopathology, but the nematodes were never confirmed morphologically to be *S. dinniki*[6]. This organism has never been molecularly identified[7,8]. Indeed, though Stephanofilaria spp. are widespread parasites of hoofstock around the world, to the authors' knowledge no primers for this genus have been developed for molecular diagnostics purposes. The apparent expansion in host range to include white rhinos is extraordinarily concerning. Moreover, the vector(s) for this parasite have never been identified, leaving an open question regarding the effects of climate change. This investigation expands on the gross observations reported by Mutinda, et al. 2012 and details the histopathological and molecular evidence of a re-emergence of this rare pathogen in black rhinoceros

with extension to a previously unreported host species, the white rhino. Anthelminthic treatment protocol and subsequent resolution timeline for treated vs. untreated animals are also described.

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Health policy implications of tuberculosis in captive elephants and mahouts

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In the hands-on and open systems of captive elephant management in southern India, there are nearly a thousand captive Asian elephants and not less than 3,000 mahouts. Tuberculosis among the elephants and mahouts presents the risk of both inter and intra-species disease transmission. As part of a long-term research project, one time screening of more than 800 captive elephants and their mahouts was completed. Screening of elephants was done using serological tests and mycobacterial isolation on Lowenstein Jensen medium by culture of trunk wash from live animals and lung nodules from dead animals by a team of veterinarians. A team of medical physicians completed the tuberculosis screening of mahouts by clinical examination, chest X-ray evaluation, sputum culture and tuberculin skin testing. With the available results, we examined three different scenarios of tuberculosis transmission. First scenario is the risk of infection from a diseased mahout to an elephant. Second is the risk of infection from a diseased elephant to a mahout and third is the risk of infection from a diseased elephant to another elephant. Our preliminary results suggest evidence for inter-species tuberculosis transmission. Under the tropical climatic conditions in southern India, the risk of infection to a captive elephant from a diseased mahout seems to far outweigh the risks of infection to a mahout from a diseased elephant. Also, there seems to

be little evidence to suggest elephant-to-elephant transmission of human tuberculosis. Ethical as well as political consequences of the outcomes in each of the three scenarios are both complex and diverse. Detailed contact investigations of the traceable human and animal contacts of diseased mahouts and elephants are needed to ascertain the risk of disease transmission in the three specific scenarios. Mahouts and captive elephants in southern India are highly migrant and contact tracing and follow-up testing of the subjects is difficult. Hence, systematic and regular tuberculosis screening of mahouts and captive elephants will be a challenge. In the existing cultural and religious contexts in southern India, implementing the policy guidelines for prevention and control will be an even bigger challenge. In the long term, with the help of evidence based results, we intend to formulate specific policy guidelines to mitigate the risk of intra and inter-species tuberculosis infection among captive elephants and mahouts.

Bronchoscopy, bronchial lavage and gastric fluid sampling for Mycobacterium tuberculosis screening during standing sedation in Asian elephants

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In North America, approximately 5% of captive Asian elephants are diagnosed with tuberculosis (TB). These estimates are based on trunk washes or necropsy samples culturing M. tuberculosis (Mtb)[1]. For captive Asian elephants in range countries, TB seroprevalences of 20% were reported for Nepal[2] and Malaysia[3] and 12-25% for India[2]. The close contact of humans and elephants and the high prevalence of TB amongst the human population may foster two-way transmission of Mtb. The prevalence of TB disease among elephants in European Zoos is unclear. Over the past 24 months, four Asian and two African elephants were diagnosed with TB post mortem in European facilities. Culture positive cases have occurred in the recent past in zoos in Sweden, Germany, the Netherlands and Switzerland. Establishing a diagnosis of TB is challenging during an elephant's lifetime. Serological tests such as the elephant DPP® VetTB Assay (Chembio Diagnostic Systems Inc., USA) are used for screening, but a “reactive” result is not a definite diagnosis. The World Health Organization (WHO) has recommended against the use of serological tests for diagnosis of TB in humans (http://www.tbfacts.org/serological-test-tb). Culture remains the gold standard, usually performed from serial trunk washes in elephants. Sensitivity is considered low[4,5]. Although strongly recommended, not all elephants are readily trained for trunk washes. If humans are unable to produce sputum, broncho-alveolar (BAL) and gastric lavage (GL) samples are used for diagnostic testing[6]. Here, we describe a field-applicable technique to acquire these samples in elephants employing an elephant full-mouth speculum during standing sedation[7]. A total of 10 Asian elephants underwent this procedure: six animals (1,5) were of the Sumatran subspecies (*Elephas maximus sumatranus*), the other four (0,4) were mainland elephants (*E. m. indicus*). The elephants were fasted overnight and sedated in the morning with either an IV dose of 0.1 – 0.13 mg/kg xylazine plus 0.033 – 0.04 mg/kg ketamine (Sumatra) or an IM dose of 0.02mg/kg detomidin plus 0.02-0.03 mg/kg butorphanol (Europe). The mouth opener, consisting of two steel bite blades was positioned into the mouth cleft onto the gum prior to the molars and opened carefully. A portable, battery driven 3.3m flexible video endoscope (ESO Endoskopietechnik, Germany) was placed manually into the trachea or the esophagus and 30-50ml sterile saline was administered through a sterile catheter into the bronchi and immediately aspirated with a 30 ml syringe. For gastric sampling a sterile horse nasogastric tube was advanced into the

esophagus. In addition, trunk washes were performed for the six Sumatran elephants and two elephants kept in Europe. Samples were tested at the respective National Mycobacterium Reference Laboratory in Germany and Sumatra for mycobacteria using molecular techniques (PCR) and solid and liquid culture. All samples (trunk wash, BAL, GL) from the six Sumatran elephants tested negative. The samples from the four European elephants revealed atypical mycobacteria in two BALs. Sequencing revealed non-tuberculous mycobacteria of unknown species for both isolates. Test results, including culture, of the remaining elephants are still in process. In the future, we plan a larger study, involving one sampling per day for a series of days during which a set of tests will be conducted including: blood sampling for the DPP® VetTB Assay and full blood analysis, trunk wash, and BAL and GL for mycobacterial PCR and culture. Ideally, all elephant handlers should be tested for Mtb infection at the same time using Interferone-γ release assays. Examining a larger number of elephants using a standardized protocol will enable the design of an appropriate testing protocol.

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Newly-developed lung lavage system in elephants using a closed flushing and collection system for safe and sterile sample collection

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Tuberculosis in Proboscidea was put into the spotlight about two decades ago when a few circus elephants in North America were diagnosed as carrying Mycobacterium tuberculosis. The disease has been known

to infect elephants, among many other mammals, for thousands of years. Because of the close association between elephants and humans, and therefore the zoonotic risk, and because of their high susceptibility to Mycobacterium tuberculosis, periodic testing was enacted in many zoological institutions around the world. Presently, trunk wash, followed by bacterial culture is still considered to be the gold standard diagnostic method for tuberculosis in elephants, despite its well-known sensitivity limitations and the increasing use of molecular methods such as the polymerase chain reaction (PCR). Trunk wash, however, puts the operator at risk, it is insensitive, and is prone to contamination. We describe here a new technique that would increase the safety and sensitivity while reducing the risk of cross-contamination. The technique relies on performing standing sedation and nerve block to the trunk, followed by insertion of an extra-long videochip endoscope through the trunk and up to the larynx or the trachea. A newly developed TBH-catheter is then inserted through the endoscope further into the respiratory system where lavage is performed and, when needed, biopsy may be taken through the endoscope's working channel using a modified human heart biopsy forceps. The additional information provided by the visual inspection of the respiratory system mucosal integrity is helpful for the disease diagnostics. The entire collection is done in closed system. The technique is safe for the operator and elephant handlers, and has higher probability of harvesting the bacteria when they are shed. The protocol excludes the risk of environmental and trunk-related contamination.

Thirty years in elephant healthcare in north-east India

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Administering healthcare to a gigantic animal like an elephant weighing over eight thousand pounds spread over hundreds of kilometers of geo-politically hostile area like the north-east of India is itself a massive task; and pursued by this author for over three decades. The captive elephants of the region numbering over 2000 are largely engaged in logging (legal and illegal), ecotourism, wildlife park management and management of human-animal conflicts etc. The wild elephant population, numbering around six thousand, is primarily spread over four states, viz. Assam (5300), Arunachal Pradesh (800-1000), Meghalaya (200) and Nagaland (70). An attempt is being made in this paper to look retrospectively at the medical/surgical problems handled by this author in a span of over 30 years (1986-2016). **Wild elephants**: A total of 64 wild elephants were handled during the period. Majority of these (31) had gunshot wounds, followed by spear/arrow injuries (11), fractures (6), straying along with various injuries (17), electrocution (2), injuries during infighting (3), and trapped in rocks (1). Another 18 (not included in above 64) carcasses of adult elephants were investigated and found to be maliciously poisoned with an organophosphate insecticide (dimecron). **Captive elephants:** An average of 300-400 captive elephants are handled by this author in a year. A retrospective look into the disease pattern reveals that almost every elephant whose fecal examination was carried out had various helminth parasitic infections. *Fasciola gigantica* was found to be the most pathogenic parasite responsible for morbidity and mortality followed by strongyle and amphistomes. Parasitism also lead to geophagia, gastric and colonic impaction and even death if not treated timely and properly. Cobboldia elephants, the elephant bot fly larvae also was found to cause morbity and mortality in the foot hills region of Bhutan and Arunachal Pradesh. Filarial infection was also fairly common. Almost half of the adult elephants of the region are affected with various foot affections. Lack of foot hygiene, improper substrate maintenance (excess moisture or dryness) and absence of pedicure practices are responsible for this. Large numbers of farragall abscesses, fistulae, bursitis, tail gangrene, fracture of tusks, gunshot wounds and fractures were frequently met with in the working (logging) elephants. Bolting and aggressive behaviour in the frenzy of musth (127) has also been

another common problem associated with captive bulls that demands veterinary intervention. Escaping to the wild has been occasionally met with particularly in the females which are lured away by the wild bulls during mating season. Two confirmed cases of rabies, four cases of FMD, two cases of tetanus, one Black quarter caused by clostridium septicum, and two herpes virus cases were confirmed. Tuberculosis cases were few (2) compared to the size of the population and other captive elephant populations elsewhere. The majority of the captive females are actively reproducing and there has not been a single incidence of obstetrical problem. Calf scour and its complications like severe dehydration, intussusceptions has been observed, particularly in orphaned calves reared under human care. In conclusion, it can be stated that captive elephants can be maintained in healthy state with attention to the following:

1. Balanced nutrition
2. Cleanliness of stable in general and the floor in particular and avoiding overcrowding
3. Housing elephants for minimum period and allowing natural grazing and scope for expression of species-specific behaviour
4. Routine fecal examination (at least thrice a year) and appropriate deworming
5. Vaccination against prevailing infectious diseases
6. Training of elephants to receive foot care and administration of regular foot care together with substrate management
7. Management of musth bulls

Elephant endotheliotropic herpesvirus (EEHV): A global perspective and update on recommendations from the EEHV Advisory Group

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Elephant endotheliotropic herpesvirus (EEHV) causes severe, often fatal hemorrhagic disease in young Asian elephants (*Elephas maximus*). 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 has evolved with elephants over millions of years, and is carried and shed asymptomatically by most elephants tested over time. While much has been learned about the epidemiology of EEHV in elephants in the last 10 years, there are still many questions left to answer. 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. Early detection of viremia is important to allow early initiation of antiviral and supportive treatment. Monitoring for EEHV should be done on the individual level for at risk elephants, and on the population level, whenever possible, for elephant herds. Individual monitoring of young Asian elephants is aimed at discovering the virus in the blood before the elephant becomes sick, to allow for early treatment. The EEHV Advisory Group has Regional Steering Committees in North America, Europe, and Asia, and is available with further information on EEHV and advice on all aspects of management, testing, treatment, and monitoring. The EEHV Advisory Group website, www.eehvinfo.org 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 the website.

EEHV Hemorrhagic Disease: Extraordinary levels of non-1A, 1B pattern genetic variation amongst individual EEHV1 strains

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Many of the familiar envelope glycoproteins involved in herpesvirus cell-type specific receptor and immune response interactions are unique to different mammalian herpesvirus sub-families and hence are either absent or replaced within the EEHVs (proposed new Deltaherpesvirus sub-family). Instead, the EEHVs encode a novel set of Proboscivirus genus and species-specific spliced anchored N- and O-linked envelope glycoproteins known as ORF-O, P, Q and R, as well as multiple alternative paralogues of anchored immunoglobulin-family (CD148-like) proteins. In addition, they also encode three captured OX2-like genes and varying complements of an ancient tandemly-duplicated gene family containing 25 distantly related paralogous members of 7xTM (transmembrane) domain proteins, including a subset of orphan chemokine-receptors (vGPCRs). We have used standard Sanger PCR plus long-range PCR-Illumina techniques to selectively sequence about 15% of the genome (30-kb) encompassing many of these novel genes from between 30 and 60 strains of EEHV1 derived from both viremic hemorrhagic disease cases and asymptomatic TW shedding by Asian elephants worldwide. Surprisingly, when the results were used to generate "phylogenetic family trees" at each characterized gene locus, ORF-P and ORF-Q, as well as gH, gN, gO, vGPCR7, vGPCR8, vFUT9 and most of the 10-kb block of alternative paralogous vIgFam genes proved to fall into multiple highly diverged clustered subtypes. Many of these show little or no relationships to the previously described 1A versus 1B diaspora patterns that map within the linked chimeric (CD-I, CD-II, CD-III) parts of the central core segment. A listing of several of the most extraordinary examples of hypervariable EEHV1A genes includes: (1) The intact gH glycoprotein falls into five subtype clusters that differ by between 7-15% at the amino acid (aa) identity level and diverge from EEHV1B versions by 35%; (2) ORF-P and ORF-Q are both highly diverged and fall into four major subtypes each with 25-40% aa differences that all diverge by 60% from EEHV1Bs; (3) The vGPCR7 and vGPCR8 protein sets together fall into six distinct alternative paralogous gene types that are over 50% diverged, but in contrast to the first two examples are unrelated to 1A versus 1B patterns; (4) The three vOX2 genes display a wide range of variability but without obvious subtyping and again do not fit into the previous 1A versus 1B patterns; (5) As just a single representative example of the vIgFam genes, the E52.5(vIgFam2.3) gene itself splits into five clustered subtypes that differ from each other by 48% with one large group being highly fragmented and non-functional; and (6) Overall, there are as many as 18 different paralogous versions of the vIgFam proteins found across the entire EEHV1 strain population, but each individual strain carries just five or six of these genes mapping at different positions and in alternative arrangements (with about a third also being fragmented or containing frame shifts). Evidently, the extant EEHV1 virus population has ancient, highly diverged and very flexible genomes, with a complex but still actively ongoing evolutionary history and with far greater levels of scrambled recombined chimerism than previously recognized in any other DNA virus type.

Genetic characterization of EEHV and gammaherpesviruses in lung or skin nodules and saliva from zoo and wild African elephants

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In contrast to more than 100 confirmed cases of EEHV hemorrhagic disease in Asian elephants *(Elephas maximus*, EM) worldwide, there have been only four documented cases of EEHV disease in African elephants (*Loxodonta africana*, LA). These include: (1) the death of an 11-month old LA calf in a California zoo in 1996 (the prototype example of EEHV2); (2) a surviving case of viremia in a one-year old USA zoo LA calf in 2009 (the prototype example of EEHV6); (3) a surviving case of EEHV3B viremia in a USA LA calf in 2012 and (4) a lethal case in a young LA living in a Thailand zoo in 2013 (first known death associated with EEHV6). We recently published a study (Zong et al, 2015) of necropsy lung and spleen samples from five otherwise healthy adult LA elephants in which we detected 16 distinct examples of quiescent EEHV strains from amongst four highly diverged species of Probosciviruses (namely EEHV2, EEHV3, EEHV6 and EEHV7) that were especially highly abundant in lymphoid lung nodules similar to those first described by McCully et al, (1971). Healthy asymptomatic African zoo elephants in the USA were also reported to shed several types of EGHV from the Gammaherpesvirus sub-family in a pioneering study of primarily conjunctival swabs by Wellehan et al (2008). Over the past several years, we have undertaken to search for and genetically evaluate EEHVs and EGHVs in numerous clinical samples, including skin nodule biopsies and saliva from LA in the wild in Kenya, Botswana, Zimbabwe and South Africa (Pearson et al, 2012, 2013), in FFPE skin nodule biopsies (Jacobson et al, 1986) and in saliva swabs collected from asymptomatic adults at six USA facilities (Pearson et al, unpublished data). This research has all involved Sanger PCR sequencing of purified DNA products amplified directly from clinical DNA products using a series of specific primers designed for diagnostic detection of individual EEHV species or both generic and individual primers for each EGHV species. We have detected examples of EEHV2, EEHV3A, EEHV3B, EEHV7A, EEHV7B, and EGHV1B, EGHV2, EGHV3B, EGHV5B amongst ten biopsied skin nodules from juvenile and adult wild LA in Africa, as well as of EEHV2, EEHV3A, EEHV3B, EEHV6, and EGHV1B, EGHV2, EGHV3B, EGHV4, EGHV5B from saliva of 26 examined USA zoo LA salivas and also of EEHV2, EEHV3A, EEHV3B, EEHV7A, EEHV7B and EGHV1B, EGHV2B, EGHV3B from 38 examined wild LA salivas collected across Africa. Using PCR probes for the POL, HEL, U71/gM, OBP, vGPCR1 and UDG loci virtually all of the EEHV species identified can be resolved into multiple distinct strains, and many nodule and saliva samples contain several different species and strains simultaneously. On the other hand, in a couple of cases, the exact identical strain of one EEHV species was found in the matching calf's skin nodule, calf's saliva and mother's saliva samples. We conclude that quiescent infections by a total of at least eleven species and subtypes of EEHV or EGHV herpesviruses are endemic in asymptomatic African elephants.

Identification of candidate proteins for an EEHV vaccine

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Elephant Endotheliotropic Herpesvirus (EEHV) can cause acute hemorrhagic disease in juvenile Asian elephants. Two chimeric variants of EEHV, EEHV1A and 1B, have accounted for more than 90% of juvenile Asian elephant deaths. Hence, there is a distinct need to both understand and provide a solution to the vulnerability of Asian elephant calves to the lethal effects of this virus. Studies of related herpesviruses,

such as CMV, VZV, EBV and HHV-6, have all demonstrated the essential role of T cell responses for mediating protection against the potentially harmful effects of these viruses. Attempts to study any type of T cell response in Asian elephants have been hampered by a lack of reagents and established assays. We have successfully identified and generated several reagents that have been used in the establishment of two first generation assays for detecting Asian elephant specific T cell responses. We first used rabies as a model antigen for establishing an IFN-γ ELISpot assay and are now in the process of using the assay to screen proteins of EEHV1A for their ability to induce T cell responses. Our approach is to construct peptide libraries of these proteins, where each peptide resembles epitopes presented to T cells in vivo. Preliminary data have shown a significant response to one series of peptides from the EEHV1A major capsid protein (MCP) in multiple elephants. We continue to assess a number of other likely protein targets for the induction of dominant T cell responses found in naturally infected elephants. Such proteins are likely to be good candidates for inclusion into future EEHV vaccines.

Elephant endotheliotropic herpes virus (EEHV) associated with Clostridium perfringens infection in two Asian elephant calves

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EEHV is a viral infection associated with a fatal hemorrhagic disease in young Asian elephants. This report describes the post-mortem evaluation of two Asian elephant calves diagnosed with EEHV4 and 1A in conjunction with Clostridium perfringens infection. Case 1 was a 7-month-old, male captive-born Asian elephant that developed diarrhea and died within 2 days after presence of clinical signs. Examination of the heart, lungs, liver, and spleen revealed predominantly eosinophillic intranuclear inclusion bodies in the endothelial cells of the blood vessels. Case 2 was a 3-month-old, female wild-born Asian elephant that showed signs of lethargy, anorexia and convulsions, and died 6 hours later. The vital organs of both calves tested positive for elephant endotheliotropic herpes virus (EEHV) by PCR, and phylogenetic analysis identified EEHV4 and EEHV1A, respectively. Additionally, samples tested positive for C. perfringens alpha, beta and epsilon toxins. Based on histopathology and molecular laboratory results, both EEHV and C. perfringens type B infections were diagnosed in these two elephant calves. This is the first report to describe the co-infection of EEHV and C. perfringens in Asian elephants.

Development of freeze-dried platelet-derived hemostatic agents as a novel treatment for elephant endotheliotropic herpesvirus hemorrhagic disease

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Elephant endotheliotropic herpes virus (EEHV) is the leading cause of death of young captive Asian elephants (1-15 years old).[6] Clinical disease involves severe fulminant hemorrhagic disease (EEHV HD) and often rapid mortality[1]. In the 20 years since the index case was reported at the Smithsonian Institution's National Zoological Park, much has been learned about the disease, but effective treatment remains elusive.[1,4] Antiviral therapies have demonstrated limited efficacy but are often cost prohibitive.[4] To date, treatment primarily consists of supportive care. Acute thrombocytopenia is a poor prognostic indicator in many hemorrhagic diseases, including EEHV HD, but platelet products for use in replacement therapy have a short shelf life (5 days), and are therefore not feasible for elephant care facilities. As a practical alternative, novel technologies are available to produce freeze-dried platelet-derived hemostatic agents (FDPDHAs), which can be stored at ambient temperature for 24-36 months and be reconstituted within minutes.[2] Through a collaboration with Cellphire Inc., FDPDHAs have been produced from Asian elephant blood. These are undergoing quality analyses and production reviews to ensure safe and effective products. Eventually, these shelf-stable products will be made available for use in critically ill elephants through a collaborative network of elephant care facilities, and will be tested for applicability in related species (e.g. African elephants). Finally, FDPDHAs of this type have potential for topical use in wound healing, and a future use in ulcerative skin diseases and other conditions is being explored.

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The Aspinall Foundation black rhino breeding programme to include reintroductions to Africa

Berry White and Helen Rhodes
The Aspinall Foundation

Howletts and Port Lympne have been keeping Black Rhino since the early 70s. The founding trio, initially started at Howletts, were Baringo (a young bull from Dublin Zoo) and two wild caught females from Kenya, Rukwa and Naivasha. After a year at Howletts, they were moved to the sister park Port Lympne to their new spacious house and two paddocks. The first calf to be born at Lympne was the bull Basha (born to Naivasha in 1977). Since then Port Lympne has enjoyed the success of 33 mother-raised black rhino calves. Eight rhinos have been successfully returned to projects in Africa and have gone on to breed and raise their own calves in the wild. As the numbers have grown, the rhinos are lucky enough to now have 11 spacious paddocks with a 12th area of 90 acres of the African Experience which we have had since 2004. This area lends itself well to rhinos that are going to be reintroduced to Africa. The park's main focus is to breed endangered species with a view to expand the genetic pool, with the ultimate goal of returning animals back to the wild to assist breeding projects in the field. This has proven to be very successful in the case of the black rhino. Several black rhino calves have been born in Africa with the most recent being born to Grumeti and Zawadi, two young female black rhinos who were translocated to Mkumazi Rhino Sanctuary in Tanzania in June 2012. In 2003 a new black rhino facility was built at Howletts with an initial 1.2 rhinos from Port Lympne being moved over. After a ten-year period the rhinos had not bred therefore it was decided to shake things up a bit and a change the dynamic. One of the Howletts females (Salome) stayed put, whilst Howlett's female Rufiji moved to Lympne and female Damara from Lympne came to Howletts, also joined by Port Lympne's proven breeding bull Zambezi. Howlett's bull Vungu went on loan to Rotterdam where he is currently mixed with two females. The switch around proved to be fruitful and Howlett's first ever black rhino calf, a bull named Kasungu, was born to female Damara on the 1st October 2015. At the time of writing Salome is expecting her first calf in September 2016. Once we had confirmation of Salome's pregnancy via faecal samples, it was decided to send Zambezi back to the African Experience at Lympne to give the girls a little more space. Helen has worked exclusively with the black rhinos at Howletts for 11 years and Berry worked initially with both Black and Sumatran rhino between 1984 and 2003 and has worked with the black rhino since her return to Lympne in 2012. In her years away, Berry worked on translocation projects working for Pete Morkel in Africa returning zoo rhinos back to the wild and also the boma care of rhinos being translocated between African countries to start new populations. The Howletts and Port Lympne herd are managed as a collection. Berry and Helen will be talking about the husbandry and on-going breeding programme of the herd with a focus on the translocated rhinos, and their successes and future plans of the parks. Another huge part of the history of the rhinos at Port Lympne was the undertaking of the capture and attempt to breed Sumatran rhino at Port Lympne. Three Sumatra rhinos came to Port Lympne between 1985 and 86 – Torgamba, Sabur and Meranti. Sabur tragically died of dietary issues in her first year so a second female (Meranti) came to us in 1986. Torgamba and Meranti had several happy years together but never bred. Following Meranti's death (after an attempt to remove a large tumour from the uterus), rather than keeping him as a solitary animal it was decided the best thing for the species was to return Torgamba back to Sumatra to an in-situ breeding project– Way Kambus (the Sumatra Rhino Sanctuary) where he lived happily for several years until his death. Although he never sired any of his own calves, much was learned about the science and

the behavior of the Sumatran rhino. Torgamba definitely contributed to the program's success in his own way. He was not only much loved but a great ambassador for his species and enjoyed many years back in his own native land. John Aspinall (The founder of the Aspinall Foundation) was very supportive of the Way Kambus Project. Berry will include in the talk a historical look at the Sumatran Rhinos at Port Lympne.

Benefits of long-term hormone monitoring programs for reproductive and welfare management of elephants

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Long-term monitoring facilitates the assessment of changes and trends on an individual and population basis. Through longitudinal measures of hormones, we have characterized basic endocrine function in elephants in western zoos, and determined how factors in the captive environment (e.g., major life events, social structures, aging, climate) affect gonadal and adrenal function. We have then used that information to improve captive management through better timing of breeding (both natural and assisted), increased social opportunities, and improvements in exhibit design and husbandry. Findings from work on ex-situ elephants have also been used to design studies of elephants in situ, and serve as important baseline data for interpreting results. For example, analyses of hormone metabolites in fecal samples from free-ranging elephants in Africa have identified the effect of season, translocation, poaching and resource availability on reproductive physiology and/or stress. In Asia, hormone monitoring is now being used to evaluate ovarian cyclicity status, time breeding and diagnose pregnancy of working elephants, and examine the effects of season and resources on stress. Successful artificial insemination in Thailand was the result of predicting ovulation through hormone analyses. Hormone testing can provide important information for assessing and managing musth in bulls, a condition that creates both human safety and animal welfare concerns under certain circumstances. Today, data generated by endocrine labs in western zoos and range countries support research projects, and can provide a more in depth understanding of how hormones affect the physiology and behavior of animals. As a result, long-term hormone monitoring is increasingly being used to improve the welfare and reproduction of ex-situ and in-situ elephant populations, with the ultimate goal of ensuring sustainability of both.

Asian captive elephant working group: studying and developing best practices to ensure the welfare of working elephants

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Questions continually are raised about whether elephants can be maintained under captive conditions that ensure good welfare. This is true for western zoos, as well as facilities in range countries, although specific welfare concerns can differ. Recently, use of elephants in tourism has come under fire from animal rights groups that claim activities such as riding, shows and painting are inhumane. Mahouts are caught in the middle, needing an income to care for their elephants, but faced with increasing limitations on how

to best manage them. Tourists are told that traditional tools like chains and the ankus are cruel, but they still expect to have close encounters with elephants. For-profit "sanctuaries" take advantage of western perceptions of ethical animal treatment by banning riding and traditional tools, yet allow tourists to feed, bathe, and walk with elephants under free-range conditions, which can be dangerous to people and elephants alike. Furthermore, such claims of animal cruelty in relation to elephant tourism are not based on scientific fact or study, but rather on anecdote and emotion. Recognizing the need for practical guidelines and recommendations on how to effectively manage captive elephants, the Asian Captive Elephant Working Group was established in June 2015. Members include multinational elephant specialists, veterinarians, researchers and conservationists, who are developing best management practices and methods of camp assessment, and conducting research to identify factors important for elephant welfare. An epidemiological approach, modeled after a large, comprehensive elephant welfare study recently completed in the U.S., is being used to assess tourist camp management in northern Thailand to aid in these recommendations. Surveys of different sized camps utilizing elephants in a variety of ways are being conducted, along with physical examinations of individual elephants, to determine how well physical, psychological and social needs of elephants are being met. We intend to produce science-based welfare outcomes and objective criteria that travel agencies can use to identify camps that adhere to high welfare standards, with the ultimate goal being to produce widely-used/accepted elephant camp standards. Given dwindling wild Asian elephant populations, and the accepted impossibility of releasing large numbers of captive elephants back into the wild, it is increasingly important to work with and support responsible camps that are committed to the welfare of elephants and their mahouts.

Captive elephant health care and wild elephant conservation activities in Myanmar

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Presently in Myanmar, nearly 3000 captive elephants belong to the Myanma Timber Enterprise (MTE), nearly 2500 captive elephants are in the hands of private owners, and nearly 2000 wild elephants are in the forest. For captive elephant health care, MTE runs two mobile clinics in north and south Myanmar which are supported by The Asian Elephant Foundation. In addition, MTE and Asian Elephant Support initiated the development of an elephant hospital to provide intensive care for elephants. Over the past 10 years, the captive elephant population in MTE has gradually increased year by year. During 2014, MTE confirmed that some juvenile elephants died due to the herpes virus disease (EEHV). According to MTE records, most elephants have died due to unknown causes and old age. Some causes of death are parasitic infestation, clostridium, and other bacterial infectious diseases. Unknown infectious disease and parasitic infestation are threats to elephants therefore MTE has regular vaccination and deworming programs as prevention. For captive and wild elephant conservation, in 2015 MTE established Emergency Elephant Response Units (EERU) to address HEC and wild elephant conservation. MTE has eight wild elephant conservation response units all over the country. MTE is working in collaboration with International Elephant Foundation (IEF) developing patrolling units. The main threat for wild elephants in Myanmar is habitat loss and poaching. The wild elephant habitat is fragmented by dam construction, and roads. Illegal settlement is also one of the main problems.

Employing Mahouts and captive elephants for elephant conservation programs in Sumatra

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In Sumatra, the management of captive elephant populations and professional mahoutship is fairly recent and has only existed since the mid-1980s when the Indonesian government launched a program to capture wild elephants in Human Elephant Conflict (HEC) areas and brought them to newly established elephant training centers. Due to poor concepts about utilizing the captured elephants, a lack of sufficient resources for the care and management of these elephants, and a lack of sufficient training and education for the newly recruited mahouts, the management and care of these elephants was initially lacking. To address these issues and involve captive elephants and mahouts in elephant conservation strategies, over a decade ago some government conservation agencies along with NGOs, started to develop concepts and programs to establish elephant patrol units where mahouts are trained and employed, and captive elephants are used for wild elephant conservation activities. These activities include conducting patrols and law enforcement in and around protected areas, HEC mitigation and management by monitoring wild elephants and their movements, driving them away from cultivated areas and back into protected forests, or, in cases where single elephants have ventured deep into farmland or settlements, evacuate the animals and relocate them back into protected forest areas. Further activities for which mahouts and captive elephants are sometimes employed include translocation of wild elephants from encroached areas to suitable habitats, education awareness activities, and fitting GPS collars on wild elephants for monitoring their movements to evaluate home ranges, habitat utilization, and HEC management prevention. To conduct such activities in and around the 126,000 hectare Way Kambas National Park, between 2011 and 2014 the NP agency, supported by local and international conservation NGOs, has established 3 Elephant Response Units (ERU) in 2011, 2013, and 2014. The ERU Teams consist of mahouts, community members, forest police, and specially trained elephants. The teams are permanently based at newly constructed base camps located at well-known HEC hotspots in areas inside the NP but along the boundary. All ERU team members are specially trained for patrolling, field navigation (using maps, GPS, compass, etc.), HEC mitigation tools, legal information, record keeping, and monitoring. Furthermore, they are educated about welfare needs for captive elephant management, handling, and care practices. All ERU activities are conducted in close collaboration with the 18 local communities in the operation area of the ERUs. The ERU teams help and train groups from local communities to conduct regular crop guarding during the night at strategic locations outside the NP but directly on the border. The ERU teams help to build observation posts and train and back up the local people in conducting wild elephant drives. An ongoing information exchange scheme by mobile phone between the ERU teams and the local community groups is established to ensure timely exchange of information about wild elephant occurrence and movement in the NP border area. This scheme effectively anticipates potential HEC risks and incidents by coordinating actions between the ERU and local community teams. The Way Kambas ERU model of community-based approach was recognized as an essential component of the program to ensure a sustainable management of HEC, and overall demonstrates an ideal concept integrating wild and captive elephants in a synergetic elephant conservation strategy. Since its inception the ERU program has contributed to a very significant decline in HEC and habitat encroachment in the operation areas of the ERUs, and has become a very important and effective tool in the Way Kambas National Park Agencies Conservation Strategy.

Rehabilitation of greater one one-horned rhinoceros calves in Assam, India

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For the first time in the history of rhino conservation in India, ten rescued orphan greater one-horned rhinos (*Rhinoceros unicornis*) calves have been rehabilitated Assam, India and contributed to the rhino conservation in India. Of the ten rhinos rehabilitated, eight were in Manas National Park and two in Kaziranga National Park, both World Heritage Sites in India. The source of all the 1-5 months old rhino calves was Kaziranga National Park (NP), rescued under various circumstances. The calves were hand-reared at the Centre for Wildlife Rehabilitation and Conservation (CWRC) established to deal with wildlife emergencies and displacements in the state. As per the rhino rehabilitation protocol that was prepared in 2004 and constantly updated, the calves were milk-fed till 18 months of age, and then held in large stockades till they turned 3 years of age. Eleven of them were translocated to the release site Manas NP, about 500 km away from Kaziranga, and accommodated in a pre-release power-fenced boma of 600 acres. The acclimatized rhinos were then released after about two years, during which period no supplementary feeding was resorted provided. Only the vegetation inside the boma was managed, primarily by cutting and/or burning tall grasses in order to encourage sprouting of new grass. The calves were radio-monitored for two years and established their own home ranges. The rhino rehabilitation project and the subsequent India Rhino Vision 2020 project successfully brought rhinos back to Manas after a gap of about 25 years. Three of the released rhinos have so far given birth to five calves, with the inter-calving interval being just 2 years and 2 months, perhaps the shortest ever recorded inter-calving interval for the greater one-horned rhinoceros in the wild. Besides these soft-released rhinos, two hand-raised male rhinos were hard-released in 2015 in Kaziranga National Park itself. The successful establishment of these two orphan males in a densely rhino populated park like Kaziranga, has shown that orphan rhinos can also be hard-released as well.

Rejuvenation camps for captive elephants –A novel and unique conservation strategy for the isolated captive elephants in the state of Tamil Nadu, India

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India has a very long tradition of rearing elephants in captivity for various purposes. The Tamil Nadu state in India is one among the south Indian states that has an ancient tradition of rearing elephants in Hindu temples as a part of performing temple rituals. This type of activity is considered as an important conservation strategy through which the elephants are respected and thereby protected for hundreds of years. As poaching of tuskers is a major concern for saving this wild species from extinction during recent years, protective measures in the form of captive breeding has become imperative in saving this species from extinction. Tamil Nadu forest department has a several century old practice of establishing elephant camps for various forestry purposes and has a long history of successful captive breeding programs. This practice helps to protect the potential breeding population, especially tuskers for their long term survival which otherwise faced the threat of extinction in the wild. Unlike the camp elephants of the forest

department that are scientifically managed, the temple elephants are not scientifically managed so as to fulfill their physiological and psychological needs. As a result, these temple elephants are found to be abnormal both in their physiological and behavioral status. These isolated non-breeding populations of temple elephants that number more than fifty, received the attention of the Government for their scientific management. The government of Tamil Nadu, with their own funds, came forward to rejuvenate these elephants by rearing them together for about two months in camps in a forest environment. Several teams of experts are employed to attend these annual camps. This rejuvenation camp that started in the year 2003, has completed its eighth round in 2016. The paper explains the impact of these rejuvenation camps with reference to the overall health of the elephants for a prolonged healthy survival. Elephants being a mega herbivore, have access to around 200 species of flora in the wild. In the rejuvenation camp a well-balanced, nutritious palatable concentrate diet supplemented by vitamins, minerals, micro nutrients, 'ayurvedic' and 'siddha' (Indian medical systems) ingredients along with variety of green fodder is provided as per the prescription of expert veterinarians. Foot ailments were common in captive elephants as they were mostly maintained on hard substrates. The substrate at the camp site is close to natural elephant habitat substrate hence walking on it improved their health and foot condition. Various strategies in organizing the camp such as, selection of site, method of transport, protection in the camp site etc., and various scientific management inputs such as balanced food, medical aid, physical exercise etc., will be discussed.

Pregnancy and birth of second Sumatran rhinoceros calf in Sumatran Rhino Sanctuary, Way Kambas National Park, Indonesia

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Sumatran Rhino Sanctuary

The Sumatran rhinoceros (*Dicerorhinus sumatrensis)* is one of the most threatened mammals in the world and listed as Critically Endangered by IUCN. Within two decades the number has decreased from 200-400 in 1985 to only around 100 animals in the world (SRCS, 2013). Any mortality or natality significantly impacts this small population. Efforts to breed this species in captivity started over a century ago, while an intensively managed program started three decades ago. Today, only 5 captive bred Sumatran rhinoceros have been born. The Sumatran Rhino Sanctuary, an intensive breeding center for Sumatran rhinoceros within its natural habitat in Way Kambas National Park, Indonesia, hosts 3 males and 4 females. One of the females named Ratu, age 15, gave birth to a healthy female Sumatran rhinoceros calf on 12th of May 2016, sired by Andalas, born at the Cincinnati Zoo and Botanical Garden in 2001. On 22nd of January 2015, the staff detected by ultrasound examination that Ratu had good sized follicle (18x24mm). On same day, mating occurred twice, with a duration 10 and 25 minutes. Her follicle was detected as ovulated on a post-breeding ultrasound check on 24th of January 2016. Sixteen days after ovulation an embryonal vesicle was detected with 15 mm diameter on right uterus horn. On day 36 of pregnancy the vesicle enlarged to 62 mm with 16 mm of embryo length, heartbeat of the embryo could be observed at this age of pregnancy. An early stage foetus was observed on day 48 with 23 mm length, the vesicle diameter could not be measured due to limitation of ultrasound machine. On day 70 the foetus length increased to 32 mm. On day 112 an image of head of the calf was captured using ultrasound, showing the length of the head to be 52 mm, and the total foetus length estimated to be 150mm. Development of the foetus could not be monitored further, only vital signs of heartbeat and foetal movement. The foetal heartbeat was 120 bpm. On 466th day of pregnancy, Ratu was placed in a boma with CCTV installed in order to allow intensive monitoring of early birth signs. Signs were monitored on two parameters, physical and behavioral signs. A unique behavioral sign was observed before parturition, Ratu was putting her front

legs high up almost vertically on tree, more frequently when closer to parturition. On 03:00 am 12th of May 2016, on day 477, the first sign of parturition was observed. Ratu suddenly woke from her sleep and made vocalizations, and walked around briskly. At 04:05 am the amnionic sac broke and Ratu had more intensive contractions, both while laying down and in a standing position. At 04:48 am the amnionic sac was protruding and at 5:11 am both of the calf's hind legs were protruding. At that time, it was observed that the birth will be a posterior presentation. On 5:40 am the calf was born and started breathing 1 minute later. The calf started to walk 1 hour after birth and started to nurse 2 hours after birth. The calf has gained an average of 1 kilogram per day.

Acoustic detection and monitoring as a conservation tool

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The decline of habitat for elephants due to expanding human activity is a serious conservation problem. This has continuously escalated the human–elephant conflict in Africa and Asia. Elephants make extensive use of powerful infrasonic calls (rumbles) that travel considerable distances. In principle, this makes elephants well-suited for acoustic monitoring because it enables detecting elephants even if they are out of sight. In addition using acoustic signals to actively control or manipulate the spatial use of elephants is increasingly considered. But these applications require a detailed knowledge about elephant vocal behavior, the acoustic structure including all kind of natural variability, and the functional relevance of vocalizations, necessitating the collaboration of biologist and computer scientists. We will provide an integrated overview of our interdisciplinary project that established the scientific fundamentals for a potential future acoustic early warning and monitoring system. We present a method for the automated detection of elephant (*Loxodonta africana*) rumbles that is robust to the diverse noise sources present in situ. We evaluated the method on an extensive set of audio data recorded under natural field conditions in South Africa. Results show that the proposed method outperforms existing approaches and accurately detects elephant rumbles. From our project results we draw a number of conclusions that are discussed and summarized. We clearly identified the most critical challenges, restrictions, limitations and necessary improvements of the proposed detection methods and suggest that our findings have the potential to form the basis for a future automated early warning system for humans living in human-elephant conflict areas. We conclude that a long-term evaluation of the presented methods in situ using real-time prototypes is the most important next step to transfer the developed methods into practical implementation.

What elephant rumbles tell us about the sender?

Anton Baotic and Angela Stoeger
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Sound production mechanism in various mammal species is considered to be well explained by the so-called 'source-filter' theory, which states that a vocal signal is generated by vibrations of the vocal folds in the larynx (source) and modified acoustically by the vocal tract (filter) between the larynx and the mouth. Recent comparative data revealed that vocal tract resonance frequencies (formants) are cues to vocal tract length and body size in animals, and have a functional relevance in a variety of behavioural

contexts such as during their breeding activities, for territorial defense, dominance rank and mother-offspring interactions. The African elephant's (*Loxodonta africana*) nasal vocal tract is exceptionally elongated, compared to its oral vocal tract, and occupies a special position amongst mammal vocal production. Elephants are capable of producing a wide range of different vocalizations and are particularly famous for their commonly used "rumble" vocalization, a low-frequency and harmonically rich call type used in short-and long-distance communication. So far, however, acoustic research in the last 30 years strongly focused on females and next to nothing is known about male vocal behavior (besides the fact that they produce the so called 'musth rumble' when in musth), the structure and the information content of male vocalizations. Therefore we specifically incorporated social rumbles of adult males into the analysis applying the source and filter theory approach. Our recent findings demonstrate that the acoustic structure of male elephant social rumbles (in non-reproductive contexts) encode information about individuality, maturity (age/size) and sex (discriminating well from female calls) about the caller and seem to function as acoustic indicators to strength and body size for potential mating partners and competitors. In all analyses, formant frequencies were highly discriminative. Elephant rumbles are proposed to be used in long-distance communication context, but to what extend is the relevant social information about sex, maturity and individuality transmitted? We conducted re-recording experiments by using synthesized and manipulated rumbles to verify the extent of potential information transfer via long-distance communication and examine the persistence of this low-frequency vocalization in different habitats and environmental conditions. In this talk we will present first results and provide methodological insights into our perceptual field study.

White rhino olfactory communication and the potential for odor manipulation

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Olfactory communication via urine, dung and/or scent glands is a key way in which many mammals transmit information, demarcate boundaries, find mates, and ultimately increase their reproductive success. Therefore, understanding olfactory communication can help conservation efforts related to threatened mammal species. Using white rhinos, we created a framework to investigate mammalian olfactory signals. We identified the specific dung odor profiles representing the age, sex, male territorial status, and female oestrus state of white rhinos. We then validated our findings with a behavioural experiment conducted on wild free-ranging white rhinos using synthetically replicated odors. Our results were encouraging and provide insight into how to potentially use odor signals to manipulate rhino behaviour. For example, by manipulating odors across the landscape, we might be able to create artificial boundaries that may prevent individuals from moving into areas where they would be at risk from humans. In addition, we might be able to increase relocation success and reduce conflict between translocated individuals and residents by manipulating the odor landscape prior to release. Finally, it may be possible to provide olfactory cues to captive rhinos (e.g. novel territorial male odors) that could potentially increase breeding success. In light of the current rhino poaching crisis in South Africa, the results of our study provide an innovative tool that could help with the conservation and management of both wild and captive white rhino populations.

Female social organization in Asian elephants in southern India

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Jawaharlal Nehru Centre for Advanced Scientific Research

Social organization is important in information flow, access to resources, reproductive opportunities, and disease spread, making its study important in the understanding of endangered species such as elephants. We report on the first quantitative study of female social organization in Asian elephants in India. We aimed to characterize the female social structure of elephants in southern India and find out whether this social structure was similar to previous studies of Asian and African elephants. We carried out field work in Nagarahole and Bandipur National Parks and Tiger Reserves in southern India from March 2009 - July 2014 and collected data on associations between females. Females were individually identified using a combination of natural physical characteristics. "Groups" were identified as aggregations of female elephants along with their young that showed coordinated movement and were usually within 50-100 m of one another. Only sightings in which all the females were identified were used for analysis. Social structure was examined through network and cluster analyses. We found that female social structure in the study population was highly modular with clearly defined communities and little association across communities. We refer to these most inclusive communities as clans. Some clans showed more than one level of clustering, while others did not show hierarchical structure within clans. In keeping with the high modularity, the average association indices between individuals was low, and the distribution was highly skewed towards high association indices. Social organization was more fluid than that reported in the African Savannah elephant. This could be a result of smaller group sizes in the Asian elephant, which necessitates greater fluidity for interaction with members in the clan. The associations that extend beyond the small groups generally observed in the field indicate the need for varied and extended associations. When we compared our data, matched for sampling method, with a previous study in Sri Lanka, we found that the Sri Lankan population showed lower levels of cohesiveness, possibly because of the extensive historical disturbance in Sri Lanka.

Understanding the behavior of African elephants as they move in landscapes with different protection status and habitat types in the Mahale –Katavi –Lwafi ecosystem of Tanzania

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African elephants (*Loxodonta africana*) are wide ranging animals that move long distances, often traveling beyond the boundaries of a single protected area. Multiple factors such as habitat type, protected area status, and human disturbances can affect the behavior of elephants. The goal of the current project is to investigate the distribution and behavior of African elephants in the varying landscapes of Katavi National Park, Mahale National Park and Lwafi Game Reserve, Tanzania. The International Elephant Foundation and the Elephant Research Foundation M. Philip Kahl Postdoctoral Fellowship are supporting this project, permitting the establishment of an elephant monitoring program (the Katavi Elephant Research Project) within the Mahale-Katavi-Lwafi ecosystem of Tanzania. To monitor the extent of elephant occupancy and habitat use, walking transects are being conducted in a grid of randomly established points in areas identified as "suspected elephant movement areas." We have been recording all the elephants sighted, as well as their tracks, feces, partially eaten grasses, and some of the demographic aspects of the herd

such as number of individuals, sex, and estimated age. We are establishing a population ID database by identifying elephants using physical characteristics such as ear pattern of tears, folds and holes, tusk and tail morphology, and body scarring. We also record habitat type, such as bush land, bushed shrub, wooded grassland, and woodland. To date two sets of transects have been conducted and over 80 transects have been walked in the Katavi and Lwafi Reserves. A third set of transects is planned to take place in August, 2016. The number of individuals in each group were typically 5 to 12 and in a few cases ranged 50 to 80 elephants. We measured 67 boli along the transects, which had a mean diameter 45±25.9cm (SD=) each with5.7 ± 2.1 boli per pile. We sampled numerous tracks (n=90), which had a mean size of 38±3.5cm length and 28±2.8 width. We also identified vegetation partially eaten by elephants, including various grasses, foliage, and twigs from three tree species; *Acacia nilotica* (65%), *Antidesma vernosu* (20%)and *Hymenocardia acida* (15%) were the species elephants ate. Our preliminary analyses suggest that elephants move throughout Katavi National Park, the Katavi-Mahale corridor, and the Lwafi Game Reserve; thus, the elephant population in this area appears to be moving within and between three protected areas. Additionally we are recording the elephant's activity budget at Ikuu and Chada, the sections of Katavi where they spend most of their time. Ongoing analyses of transect data will address more detailed questions regarding the behavior of elephants in this ecosystem.

Sleeping behaviour in a group of captive Asian elephants

Emma Evison
Chester Zoo

This study of sleeping patterns on a captive group of Asian elephants has been conducted for a period of two years and is an ongoing study and is in the process of been written for publication. The group consists of a family unit as well as a bull elephant and two unrelated females (one was moved within the study period). UK zoos are currently under pressure to show improvements in elephant welfare and within a time frame of 10 years (DEFRA, 2015). The welfare state of an animal should include physiological and psychological health measurements as well as an assessment of social relationships in group living species. Physiological health can be easier to examine and has been the main focus for elephant welfare studies i.e. foot health, injurious behaviours and health problems (Carlstead et al, 2013 and Mason and Veasey, 2010). It has been found that sleep behaviour can be a valuable tool for assessing, non-invasively, stress and welfare for animals in groups and low amounts of sleep can be a sign of physiological and physical stress (Abou-Ismail, 2007). Rest is sometimes measured by standing rest (SR) or lying rest (LR); the latter is said to be the only way for the elephants to fully rest and they may only do this if they are comfortable in the environment as it can be viewed as a vulnerable state (Siegel, 2009 and Koyama et al, 2012). Few studies have investigated lying rest in elephants over a long time period. Lying rest can be seen as an indicator of welfare and therefore identifying patterns, preferences and factors in which impact on their sleeping behaviour over time could be vital for improving their welfare (Williams et al, 2015 and Abou-Ismail et al 2007). Continuous sampling methods were used to review camera footage (n= 290 nights) during a 12-hour period (1900 – 0700), two to three times every week. The behaviours recorded included; start time of sleep (classified as when the elephant was in a recumbent position), wake up time (was when the elephant was on all four feet in a standing position), individuals they slept in close proximity too (defined as the individuals within a distance of two elephant lengths of the sleeping animal) and if they were touching another elephant (any part of the elephant touching another). Part of this data demonstrated that moving an unrelated female out of the group greatly improved sleeping relations within the family after her departure and would be discussed as part of the presentation as well as the overall results.

Resource use and food plant preference of the Bornean elephant in the Lower Kinabatangan wildlife Sanctuary, Sabah

Megan English
Global Visions International Elephant Reintroduction Programme

Optimal foraging theory predicts site re-use (recursion) as a function of the quality of the site, extent of its last use, and time since its last use because these influence site resource status and recovery. We used GPS collars, behaviour and site sampling to investigate recursion of foraging sites for two elephant herds (*Elephas maximus borneensis*) in the Lower Kinabatangan Wildlife Sanctuary, Borneo, over a 12-month period. Recursion occurred to 48 out of 87 foraging sites and was most common within 48 hours or between 151–250 days, indicating two different types of recursion. Recursion was more likely to occur if the site had previously been occupied for longer. Moreover, the time spent at a site at recursion was the same as the time spent at the site on the first occasion. The number of days that had passed between the first visit and recursion was also positively correlated with how much time was spent at the site at recursion. Habitat type influenced the intensity of site-use, with more time spent at recursion within riverine/open grass areas along forest margins compared to other habitat types. Unlike other elephants that live in a forest environment, the Bornean elephant preferred sites containing species from the Poaceae (specifically *Phragmites karka* and *Dinochloa scabrida*) over other plant types including gingers, palms, lianas and woody trees. Recursion, therefore, is a common behaviour used by the elephants and its pattern suggests it may be a foraging strategy for revisiting areas of greater value. The qualities of recursion sites might usefully be incorporated into landscape management strategies for elephant conservation.

Genetic basis of iron storage disease (ISD) in captive black rhinoceroses (*Diceros icornis*)

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Many mammalian and avian species develop iron toxicity (iron storage disease, ISD) when misplaced from natural ecosystems of their evolutionary origins.[2] When properly studied, all African black (*Diceros bicornis*) and Sumatran rhinoceroses (*Dicerorhinus sumatrensis*) in captivity exhibit evidence of progressive ISD, whereas African white (*Ceratotherium simum*) and Asian Greater One-Horn (*Rhinoceros unicornis*) do not. Pathological effects of ISD are caused by iron-catalyzed reactive oxygen species (ROS) that induce significant morbidity and mortality, often without overt clinical signs or symptoms until irreversible organ dysfunction develops. Recent collapse of the U.S. Sumatran rhino captive breeding program can be directly attributed to ISD that could have been prevented by measures, such as periodic phlebotomies, that are established standards of practice for human ISD.[5] In the wild, iron homeostasis among ISD-susceptible species likely relies on selective consumption of native forage containing compounds with high avidity for dietary iron, allowing enteric passage without systemic absorption.[1] Since iron balance in most vertebrates is regulated through the hormone hepcidin,[3] we compared black and white rhinos by sequencing genes known to be involved in human hereditary hemochromatosis caused by hepcidin deficiencies. Most had identical sequences in black and white rhinos (hepcidin, ferroportin, HFE, hemojuvelin, BMP6), but a mutation in the hepcidin regulator, transferrin receptor 2

(TfR-2), was identified that had G28A amino acid substitution. It remains to be determined if this substitution alters TfR-2 function. We next focused on differences potentially affecting red blood cell (RBC) development and survival, since such defects also cause ISD in humans and mice. Using unbiased mRNA sequencing of liver and spleen mRNA, we identified two mutations in proteins important for RBC function. These mutations were unique to black rhinoceroses compared to white rhinos and all other mammalian species. One mutation was identified in the SLC28a2 gene, which codes for the concentrative transporter for adenosine.[4] Since adenosine salvage is essential for maintenance of BC adenine nucleotides,[6] this mutation may be relevant to the extremely low (2-5%) RBC reserves of adenosine triphosphate (ATP) that are uniquely characteristic of rhinoceroses compared to almost all other mammals. Another mutation was found in EPB4.1, an erythrocyte membrane protein. Functional consequences of these mutations remain to be determined, but they could enhance RBC vulnerability to environmental stresses mediated by ROS, initiating a cycle of low-grade hemolysis and inducing increased iron absorption. Iron-catalyzed ROS in turn could worsen RBC damage, as has been observed in β-thalassemia, thus causing a vicious cycle of RBC destruction and iron overload. Understanding the genetic basis of RBC vulnerability and predisposition to ISD in black rhinoceroses should contribute to more effective captive management of browser rhinos, tapirs and other ISD-susceptible species.

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Case report: treatment of iron storage disease in a black rhinoceros (*Diceros bicornis*)in western Europe

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In January 2015 Vungu, a 15 year-old black rhino male, housed at the Rotterdam Zoo since 2013, became less active, had less appetite and laid down for prolonged periods. Weekly blood samples were collected for hematology and clinical chemistry. As black rhinos are sensitive for iron storage disease, a monitoring program for this disease was initiated[1,2]. Monthly serum samples were sent to the Veterinary Faculty in Utrecht for measuring serum iron (Fe2+), iron saturation and total iron binding capacity. GGT levels were very high (up to 131U/L, ref: 6-54U/L3) and iron saturation was up to 99%. In most species a saturation of maximum 70% is acceptable. In horses GGT is a reliable indicator for liver damage. Attempts to visualize the liver by ultrasonographic examination failed. Because of the concerns for his physical condition and behavior, a long-term large volume phlebotomy treatment was initiated. At first the procedure was done under general anesthesia (a combination of Immobilon (2.25mg

etorphine/ml, Pharmacy Veterinary Faculty Utrecht) with Zalopine®(10mg medetomidine/ml, Orion Pharma Animal Health). After 1 phlebotomy under general anesthesia (volume 8,5L) and an intensive successful training program for conditioned blood collection, phlebotomy could be performed without sedation. After 13 months and a 22 phlebotomies (volume varied between 0,2-6,8L) serum GGT decreased to 66U/Land the iron saturation dropped to below 80%. His general condition improved dramatically, including his appetite and activity and even hairs on the tip of his ears have grown back.

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Validation of a rhino specific ferritin enzyme immunoassay for the black rhinoceros (*Diceros bicornis*) for assessing the impact of individual and environmental factors on serum ferritin concentrations.

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Hemochromatosis (iron overload disease) is a potentially fatal disease that sometimes affects the critically endangered black rhinoceros (*Diceros bicornis*). Therefore, it is important to develop methods for monitoring the progression of iron storage (hemosiderosis), diagnosing the disease state, evaluating treatment efficacy, and assessing environmental factors that may impact iron absorption in this species. Ferritin is an acute phase protein complex that binds iron for storage and is used to measure total iron stores. Traditionally, an enzyme immunoassay (EIA) developed for horses was used to measure rhino ferritin. However, ferritin is species-specific, and recent inconsistencies in the equine EIA results prompted our lab to create a rhino-specific assay originally developed and validated for Sumatran rhinoceros (*Dicerorhinus sumatrensis*) ferritin. Our goal was to validate this assay for the black rhino and to investigate the influence of several environmental and individual factors on ferritin concentrations. Ferritin was isolated from black rhino liver then subjected to gel electrophoresis, using equine and Sumatran rhino ferritin as positive controls to verify sample purity. Staining with potassium ferricyanide confirmed the isolated protein was positive for iron. Western blot analysis and a parallelism were used to validate cross-reactivity of the Sumatran rhino ferritin antibody with black rhino ferritin. Serum samples (n= 681) collected during 1990-2016 from 28 black rhinos ranging in age from <1 to 32 years and maintained at 11 U.S. institutions were analyzed using the rhino ferritin EIA. Data were analyzed by NOVA and correlation analysis with the following factors included: individual, subspecies, location, sex, age, age group, collection date (month, year, season), captive/wild status of individual at birth and of parents, and time in captivity. All data are reported as means± SEM. The mean serum ferritin concentration for all samples was 3090.5 ± 98.4 ng/ml (range: 84.6 to 19,296.1 ng/ml). Concentrations differed among individuals ($P < 0.05$) and were higher ($P < 0.05$) in males (3539.2± 108.6 ng/ml) than females (1094.7 ± 124.0). Ferritin was lower ($P<0.05$)in pre-pubertal (< 5 years old) individuals (1761.8 ± 152.7 ng/ml) than adults(6-25 years; 3392.7 ± 118.3) and seniors (26+ years; 3570.7 ± 347.3). Ferritin levels in adults and seniors were not different ($P> 0.05$), but the senior sample size was small limiting the possibility of

significance. Overall, ferritin concentrations were not directly correlated with age (R2= 0.25). Interestingly, ferritin differed between subspecies with concentrations higher in Southern black rhinos (3264.8 ± 112.1) than in the Eastern sub-species (2322.5 ± 184.4). Location of birth (captive vs. wild) for the individual, or its parents, did not influence ferritin levels (P> 0.05) and there was no correlation found between amount of time spent in captivity and serum ferritin (R2= 0.19). Ferritin concentration was not impacted by date, month or season of serum collection (P> 0.05). The rhino-specific ferritin EIA was validated for use in measuring black rhino serum ferritin concentrations. The resulting data indicate that ferritin concentrations are variable and influenced by individual, subspecies,
sex, and age group and therefore these factors must be considered when trying to diagnose hemochromatosis.
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Endocrine monitoring of wild Asian elephants in modified landscapes

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Biologically, stress has been defined as the response evoked in an individual when a threat or a particular stressor is perceived. Although a coping mechanism acting through secretion of glucocorticoid and related hormones, stress may have negative effects on individuals by suppressing their reproduction, altering feeding and movement patterns, as well as negatively affecting their immune responses. Our study attempted to monitor stress responses in Asian elephants in a plantation-dominated landscape and a forest-farm matrix from November 2013 to April 2014, and August 2015 to March 2016. 5 to 10 g of dung samples were collected from identified individuals on an opportunistic basis and wherever individual identification of samples was not possible, identification was ensured at least at a herd level. Samples were dried using a heater-blower setup, and were preserved in airtight containers with silica gel devoid of moisture. The hormones were later extracted from these samples using enzyme-linked immunosorbent assay (ELISA) techniques. We used hierarchical Linear Mixed Effect (LME) models to assess the factors influencing FGM concentrations in elephants under several circumstances. Through model averaging tasks, we assessed the best fitting model, which indicated that the glucocorticoid metabolite concentrations in elephants are affected by age-sex classes and occurrence of disturbance events. The data showed a stark increase in most age-sex categories post perturbations, or in other words, human disturbances had a fairly high negative influence on the physiology of elephants, characterized by elevated FGM concentration. In 2015-16, we collected 512 dung samples and preliminary results of the analysis comparing the two landscapes, shows that the mean FGM concentrations in elephants of Sathyamangalam (n=38) seem to be significantly higher ($p<0.00001$; $t=-4.958$) than that of the elephants in Valparai (n=474), irrespective of their age, sex, group composition, and habitat use. This could potentially be because of the higher frequency of interactions between elephants and humans in Sathyamangalam, where elephants come to croplands on a daily basis and indulge in crop damages as opposed to Valparai where elephants use human-use areas for movement, than for activities such as foraging. A similar result is obtained by comparing samples collected from anthropogenic habitats in Valparai (tea/coffee plantations, settlements, and roads and mud paths) and that in Sathyamangalam (banana fields and roads) where the mean FGM of the latter seem to be significantly higher than that in Valparai ($p<0.00001$; $t =-4.961$). FGM levels of males invariably were high across landscapes and this is in

corroboration with earlier studies on African elephants. The study emphasizes the general importance of understanding individual- and herd-level variation in behaviour and physiology within a population of a threatened mammalian species. More specifically, it highlights the need for long-term monitoring of the stress physiology of elephants in highly human-dominated landscapes and concomitant cross-landscape comparisons to better our understanding of their biology.

Endocrine changes and ovarian activity of captive African (*Loxodonta africana*) and Asian (*Elephas maximus*) elephants during the postpartum lactating period

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Ovarian function and related endocrine changes in the postpartum period were investigated in captive African and Asian elephants, with special reference to the suckling stimulus. Two captive African and an Asian elephant were used. They were kept outside during the daytime and indoors at night throughout the year. Blood samples were collected weekly from an ear vein without anesthesia. The serum concentrations of progesterone, inhibin, cortisol and prolactin were determined by specific radioimmunoassays. The estrous cycles and pregnancy in each animal were identified by the serum levels of progesterone. The week before the first rise of progesterone was determined as Week 0 of the estrous cycle, which meant ovulatory week in each estrous cycle and in pregnancy. During the estrous cycle, the period with basal level of progesterone was classified as the follicular phase, and the period with high progesterone level after ovulation was the luteal phase. An African elephant named “Ai” delivered two healthy calves, a male calf in 1998 and a female calf in 2002. The birth interval was four years. In her second lactating period, ovulation recovered 13 months after delivery, though the female calf was still suckling from its mother’s breast. The calf started eating foods at this time, indicating that the suckling stimulus by the calf decreased at this time. In the case of “Rica”, she conceived four times, however, in the first pregnancy in 2002 the calf was stillborn, in the second pregnancy in 2004 she had an abortion the 17th month of gestation. In the third pregnancy in2006 and the fourth pregnancy in 2009, a healthy female and male elephant were born. Each pregnancy was 656, 529, 670, and 644 days. The birth interval was 2, 2 and 3 years, and the estrous cycle was recovered 9, 10 and 36 weeks after delivery. In the case of Asian elephant, “Zuze”, she gave birth three times, in 2002 (stillbirth), 2004 (healthy female calf) and 2007 (healthy male calf). Both calves born in 2004 and 2007 were nursed by zoo keepers because of Zuze’s rejection to her calves. Zoo keepers milked “Zuze” manually for several months after the third and fourth parturition. The birth interval was 2 and 3 years, and the estrous cycle was recovered 14 and 33 weeks after the third and fourth parturition. These results clearly demonstrated that the suckling stimulus by calves is mainly responsible for suppression of ovarian function during the postpartum lactating period in elephants. In addition, these results also demonstrated that the milking by keepers was also effective to suppress ovarian function. In the postpartum elephants, circulating progesterone was lower but prolactin and cortisol were higher than cycling elephants, indicating that the adrenal function was stimulated by suckling stimulus during lactation.

Analysis of Asian elephant (Elephas maximus) seminal plasma for the improved understanding of semen collection and preservation

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Artificial insemination is becoming an increasing part of modern reproductive management of captive Asian elephants worldwide. However, a prerequisite for this method of artificial breeding is the ability to reliably collect and successfully preserve a high quality semen sample until the point of insemination. It is common for Asian elephants to produce an inconsistent quality of semen when collected via transrectal massage of the accessory glands, particularly in regards to sperm motility and viability. It is hypothesized that variation in semen quality between males and ejaculates could be explained by disparity in the protein component of seminal plasma, perhaps caused by differences in accessory glands secretions during transrectal massaging. Therefore the aim of this study was to improve our current knowledge on Asian elephant semen by characterizing the complete Asian elephant seminal plasma proteome using mass spectrometry. Nine ejaculates of varying semen quality, collected from three different males, were used for this study. The seminal plasma was isolated from the spermatozoa and pooled with equal quantities. The pooled sample was reduced, alkylated and digested then loaded onto a mass spectrometer for LC-MS/MS analysis. Collected spectra were searched against UniprotKB and customized database using MASCOT (version 2.4). After analysis, a total of 155 proteins were identified in Asian elephant seminal plasma with an array of molecular and biological functions. Ontology analysis of the seminal plasma proteome identified at least 10 different molecular functions (42.5% binding, 41.0% catalytic activity) and 22 different biological processes (15.7% metabolic processes, 15.3 % cellular processes). Although proteins from the transferrin, nucleobindin, heat shock protein, clusterin and carboxylesterase/lipase families were identified, the majority of the proteins have not been identified in most of the largely common domestic species' seminal plasma. This is the first reported study to identify the whole proteome of Asian elephant seminal plasma. The improved knowledge of the Asian elephant seminal plasma proteome is a fundamental step towards identification of those proteins which may be essential to reproductive processes in the species, as well as identifying candidate proteins to improve sperm function during application of assisted reproductive techniques, such collection and preservation of the semen. The research is supported by Taronga Conservation Society Australia, Perth Zoo and Melbourne Zoo. Authors would also like to acknowledge the help of the Bioanalytical Mass Spectrometry Facility at UNSW.

Progress in sperm sorting and cryopreservation technologies for modifying population sex ratio and preserving genetic diversity in the rhinoceros and elephant

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AZA TAG/SSP-endorsed sperm sorting and cryopreservation research has been conducted in zoological rhinos and elephants by our group over the past decade. Our long-term goal is to establish a cooperative cryobank of sex pre-selected sperm for use in artificial insemination toward managing socially cohesive and genetically diverse elephant and rhino populations in conjunction with natural breeding efforts. Optimized methodologies for sperm sex-sorting and cryopreservation have been established in all studied species (white rhino: *Ceratotherium simum*, black rhino: *Diceros bicornis*, Indian rhino: *Rhinoceros unicornis*, Asian elephant: *Elephas maximus*, African elephant: *Loxodonta africana*) but inconsistent ejaculate quality has been the greatest challenge to establishing banked insemination doses. Electroejaculation of anesthetized males remains the optimal semen collection method for rhinos. For elephants, semen continues to be collected using transrectal massage of standing males but the majority of males produce poor quality ejaculates, with a considerable proportion of sperm exhibiting characteristics of aged cells (poor motility and DNA integrity). To date, sexed sperm banking is underway in all of the aforementioned species except the African elephant, from which high quality ejaculates have been difficult to access. Post-thaw sexed sperm quality has been more extensively studied in rhino than elephant species, but overall in vitro longevity data (computer assisted sperm analysis, DNA integrity, membrane and acrosome integrity, mitochondrial activity) indicate that sex-sorted sperm need to be inseminated into the uterus within 6 h prior to ovulation. This short insemination time-frame relative to ovulation necessitates an extensive understanding of female reproductive physiology, especially knowledge of temporal relationships among luteinizing hormone (LH) surge initiation, LH surge peak and ovulation. Because growing evidence indicates ovulation induction methods are needed to address anovulatory cycles that are exhibited by many rhinos of all three species, research is also needed to establish endocrine markers of follicular/oocyte maturity in association with trans-rectal ovarian ultrasound monitoring. For female elephants which typically ovulate spontaneously, serum LH profiles using a thrice-daily collection schedule during the three day ovulation window (the determination of which is based on the timing of the prior anovulatory LH surge) may be acceptable for timing inseminations with sex-sorted sperm. Pachyderm female reproductive research and sex-sorted sperm banking efforts remain ongoing and insemination trials with sex-sorted sperm are planned to start in the Indian rhino and Asian elephant during 2017.
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Post-partum ovulation in Asian and African elephants in Europe

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Reproduction in elephants is comparatively slow with females giving birth only every 4 years. This interbirth interval includes the period until the next conception and the subsequent pregnancy. Whereas gestation is a constant measure of ~22 months, the period between birth and the next conception may be highly variable and therefore represents an important parameter for the reproductive life time success of a female elephant. Ideally, an elephant cow should conceive again during her post-partum estrus. However, unless animals are not constantly monitored for reproductive status or bulls have free access to the herd, the post-partum ovulation (ppOV) might be missed and the interbirth interval extended, reducing the reproductive lifetime success of the elephant female by additional cycles. In order to provide reliable information on the timing of ppOV and to assess possible species differences therein, long-term data from our endocrine service to non-invasively monitor reproduction in Asian and African elephants in European zoos were analyzed and results related to factors potentially affecting the period between birth and ppOV, i.e. birth of live or dead calf, sex of calf, duration of preceding pregnancy and age and parity of the mother. The data include a total of 70 post- partum periods, 52 from 31 Asian elephants and 18 from 13 African elephants. ppOV was determined hormonally by progestogen analysis in weekly urine samples using specific enzyme immunoassays. Overall, ovulation occurred on average 40 weeks post-partum in Asian elephants (range 7 – 107 weeks) and 49 weeks post-partum in African elephants (range 11 – 111 weeks), the difference being statistically non-significant. Births resulting in dead calves or calves that were hand-reared were followed by a significantly shorter period to ppOV in Asian elephants (14 weeks vs. 50 weeks after birth of a live calf), whereas the difference in African elephants was not significant (36 weeks vs. 55 weeks after birth of a live calf), possibly due to the lower number of pregnancies monitored in this species. The sex of the calf had no significant effect on the timing of the ppOV in births with surviving calves in either species. There was also no relation to duration of pregnancy (Asian elephants: 612-692 days¸ African elephants: 626-674 days) as well as age (Asian elephants: 7 – 43 years, African elephants: 12 - 23 years) and parity of the mother (Asian elephants 1 - 5 births, African elephants 1 - 3 births). Analysis of data in individual elephants with several ppOVs, however, suggest that animals with a higher rank have shorter post-partum periods to ovulation than those with a lower rank. The data presented here provide comprehensive baseline information on the timing of ppOV in captive elephants and factors influencing its variability. This may be of practical importance to improve the breeding management of this species in zoos, and thus aid to conservation efforts, as the knowledge generated may help to reduce the interbirth interval in proven breeders.

New strategies in Sumatran and northern white rhinoceros conservation based on advanced assisted reproduction techniques combined with cellular technologies

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The Sumatran rhinoceros (SR, *Dicerorhinus sumatrensis*) and the northern white rhinoceros (NWR, *Ceratotherium simum cottoni*) are the two megaherbivores which suffer from the most accelerated population decline on our planet over the last decade. The NWR rhino is reduced to a none self-sustaining group of three individuals which are kept under protected condition in Ol Pejeta Conservancy, Kenya. The SR, divided into two subspecies, is dwindled down to fewer than 100 individuals, largely scattered over the islands of Sumatra (under 90 SR) and Borneo (approx. 10 SR). The NWR is already declared as extinct in the wild and the SR has a high risk to follow the same destiny. The current approach of habitat protection will not save the NWR and most likely the SR either. For an effective conservation program, it is critical to increase their reproductive rate substantially. With the application of advanced assisted reproduction techniques such as in-vivo gamete collection and in-vitro embryo production, followed by embryo transfer into surrogate females, combined with emerging cellular technologies based on induced pluripotent stem cells (iPSCs), it might be possible to maintain the genetic variability necessary for self-sustaining populations and rewind the extinction process of these two rhinoceroses. The authors will present the various options embedded in a strategic road map developed at a multidisciplinary meeting under the name “Conservation by Cellular Technologies” and published online in Zoo Biology on May, 3rd 2016 (doi: 10.1002/zoo.21284).

Etorphine free anesthesia protocols optimized for frequent reproductive interventions ranging from semen collection, artificial insemination to Ovum-Pick-Up (OPU) in four rhino species

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In order to elucidate the problems of poor reproductive performance in captive rhinos the EEP and IZW have encouraged intensive and serial reproductive monitoring. A multi-disciplinary and multi-institutional research proposal was initiated. The use of restraint chutes and recent implementation of medical training offered new possibilities of safe handling and management of rhinoceros. However, serial ultrasonographical reproductive assessments, artificial inseminations, semen collections and OPU, as well

as bronchial lavages for reliable tuberculosis diagnostic require safe immobilization and anesthesia protocols in rhinos. In the past we mainly used etorphine in combination with detomedine and butorphanol (Walzer at al. 2002). Due to negative side effect known for etorphine (e.g. V/Q mismatch with the result of hypoxemia, we especially noticed in Sumatran rhinos) and because of safety and legal aspects (e.g. prohibition to import opioids into Asian countries) we developed a safe and effective etorphine free anesthesia protocol for different rhino species and optimized dosages regarding species-specific potency (e.g. Indian rhino > White rhino > Black rhino) and regarding procedure-specific level of anesthesia needed (e.g. transrectal ultrasound < artificial insemination < OPU). The author will describe the specific anesthesia protocol (I. premedication/standing sedation: injection via dart or by hand i.m. of combination of detomidine, butorphanol, midazolam and ketamine; II. drop dose/bolus: ketamine i.v.; III. maintenance: quad-drip i.v., CRI) and will demonstrate its use by means of elected procedures.

First results of oocyte maturation and In-Vitro-Fertilisation (IVF) in Sumatran and northern white rhinoceroses

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Over the last two years a total of seven ovum-pick-up (OPU) procedures were performed in two Sumatran rhinoceroses (SR*, Dicerorhinus sumatrensis*) housed at the field research station in Tabin, Sabah, Malaysia. Parallel, eight OPUs were performed in six southern white rhinoceroses (SWR, *Ceratotherium simum simum*) housed in different European zoos. In SR a total of 12 oocytes were harvested and three developed into metaphase 2 stage during incubation in a modified horse media. None of these three oocytes developed into an embryo after In-Vitro-Fertilisation by intracytoplasmatic sperm injection (ICSI). In SWR a total of 17 oocytes were harvested, three entered the metaphase 2 stage and ICSI was performed. Two of the 17 harvest SWR oocytes developed under similar In-Vitro conditions used in SR into an early embryo. Both stopped at 5-cell-stage. Based on these first results there is a clear indication that both maturation and fertilization protocols need to be improved for SR and SWR. New In-Vitro approaches will be discussed.

Ovarian down regulation by GnRF vaccination decreases reproductive tract tumor size in female white and greater one-horned rhinoceroses

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Reproductive tract tumors, specifically leiomyoma, are commonly found in female rhinoceroses. Similar to humans, tumor growth in rhinoceroses is thought to be sex hormone dependent. Tumors can form and expand from the onset of ovarian activity at puberty until the cessation of sex-steroid influences at senescence. Extensive tumor growth results in infertility. The aim of this study was to down regulate reproductive function of tumor diseased and infertile females to stop further tumor growth using a Gonadotropin releasing factor (GnRF) vaccine. Four infertile southern white (*Ceratotherium simum simum*) and three Greater one-horned rhinoceroses (*rhinoceros unicornis*) with active ovaries and 2.7 ± 0.9 and 14.0 ± 1.5 reproductive tract tumors respectively were vaccinated against GnRF (Improvac®, Zoetis, Germany) at 0, 4 and 16 weeks and re-boostered every 6 – 8 months thereafter. After GnRF vaccination the ovarian and luteal activity was suppressed in all treated females. Three months after vaccination the size of the ovaries, the number of follicles and the size of the largest follicle were significantly reduced ($P<0.03$). Reproductive tract tumors decreased significantly in diameter (Greater-one horned rhino: $P<0.0001$; white rhino: $P<0.01$), presumably as a result of reduced sex-steroid influence. The calculated tumor volumes were reduced by 50.8 ± 10.9 % in Greater one-horned and 48.6 ± 12.9 % in white rhinoceroses. In conclusion, GnRF vaccine effectively down regulated reproductive function and decreased the size of reproductive tract tumors in female rhinoceros. Our work is the first to use down regulation of reproductive function as a symptomatic treatment against benign reproductive tumor disease in a wildlife species. Nonetheless, full reversibility and rhinoceros fertility following GnRF vaccination warrants further evaluation.

Human-elephant conflict reduction via deterrents, understanding ecological correlates, and climate smart agriculture practices

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Human-Elephant Conflict (HEC) is an increasingly prevalent problem that exacerbates difficulties in the conservation of African (*Loxodonta africana*) and Asian (*Elephas maximus*) elephants. In addition to ethical justification, the importance of elephants as ecological engineers and charismatic megafauna for ecotourism stands against the option of population reduction as a viable means of HEC resolution. Crop raiding is the major form of HEC that directly impacts the livelihoods and welfare of humans who share habitat with elephants. Our goal is to determine a multi-faceted approach to HEC reduction by (1) experimentally assaying deterrents to reduce crop raiding, (2) improving habitat quality to provide natural

forage, (3) examining ecological correlates that can inform the likelihood of crop raiding, and (4) establishing climate smart agricultural methods to facilitate sustainable human practices harmonious to human-elephant coexistence. We will discuss results of past studies and describe current and future projects to achieve these objectives.

Finding pathways to human-elephant coexistence: A risky business

Anna Songhurst
Ecoexist Project

Finding ways for people and wildlife to coexist requires affording both parties access to critical resources and space, but also a behavioural change by both to avoid conflict. We investigated pathway use in a population of free-ranging African elephants (*Loxodonta Africana)* in the Okavango Panhandle, Botswana that share their range with humans in a multi-use, heterogeneous landscape. We used detailed ground surveys to identify and map elephant movement pathways, and mixed-effect models to explore factors influencing elephant numbers and movement behaviour on and around these pathways. We found deviation in pathway use among the elephant population, suggesting behavioural adaptations to avoid human-associated risk: avoiding pathways near settlements, particularly near larger settlements; avoiding pathways close to cultivated land; and adopting a safety-in-numbers strategy when moving through areas of human use. Our findings suggest there is opportunity to capitalize on risk avoidance by elephant populations, to minimize resource-use overlap and reduce conflict between humans and elephants. We discuss a strategy that involves ensuring appropriate protection of elephant pathways in land-use planning, using development-free buffer zones, combined with mitigation techniques along the interface with agricultural lands to increase risk levels and reinforce human–elephant interface boundaries. We recommend further examination of the use of landscape-level mitigation techniques that encourage elephants to use pathways away from human activity and help define spatial boundaries for management of human–elephant conflict in multi-use landscapes. Our presentation will also inform on how this research has been used to inform management decisions and actions. We have been working with relevant land authorities and communities in the eastern Okavango Panhandle, Botswana to incorporate main elephant corridors into the land use plans. This will ensure that these corridors are left free from development in the future. To date, we have thirteen elephant corridors incorporated into land use planning maps.

Socio-economic profile of human wildlife conflict affected farmers and their perception towards human wildlife conflict in Tamil Nadu, India

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Human-wildlife conflict (HWC) is an increasingly significant obstacle to the conservation of wildlife. The growing body of HWC literature tends to focus on biological, economic and local aspects associated with

HWC. HWC occurs when humans or wildlife harm or threaten one another in the course of pursuing their needs or interests. In order to find out the socio-economic profile and perception towards HWC by the HWC affected farmers, a survey was conducted among 240 human-wildlife conflict affected farmers in four top most HWC affected districts in Tamil Nadu, India. Stratified random sampling followed by simple random sampling was applied to collect information through interview schedule. As far as profile of the HWC affected farmers was concerned, nearly one-half of the respondents belonged to old age at the time of enquiry. About three-fourth of the respondents were males. Majority (93.3 %) of the respondents belonged to Hindu religion. More than one-half of the respondents were educated. Nearly one-half of the respondents belonged to medium income group and maintained a nuclear family (67.50 %). Majority (99.20 per cent) of the respondents were practicing agriculture along with livestock as their primary occupation. Majority (67.5 %) of the respondents were residing within 0.5 to 1 km proximity to forest with marginal land holdings (75.0 %). The respondents maintained moderate livestock units (74.2%) and moderate ICT tools (81.7 %). Almost three-forth (74.2 %) of the respondents had medium level of farming experience. About 40 per cent of the respondents cultivated paddy and ragi followed by banana. Majority (57.1 %) of the respondents possessed 5-8 HWC exposures per year. About one-fifth of the respondents underwent training in animal husbandry. Two-thirds of the respondents were found to drive away the intruding wild animal. Majority (87.5 %) of the farmers were having medium level of information of behaviour. With regard to farmer's perception on HWC, majority of the farmers (75.0 per cent) possessed medium perception level on HWC and 15.4 per cent farmers possessed low and nearly one-tenth (9.6 %) possessed high level of perception on HWC. The HEC topped the list of perception on HWC with a mean rank of 141.68 followed by gaur (116.25), monkey (113.65) and wild pig (110.43) Better education and increased number of exposures to mitigate HWC, information seeking behaviour and knowledge on HWC, will improve the farmers' perception of HWC.

Hunger Games: Understanding Human–Elephant Relationships in a Landscape Matrix of the Western Ghats, India

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Intense human-elephant conflict (HEC) has led to loss of property and lives of both protagonists across Africa and Asia. Overall, two approaches—reactive and proactive—influence efforts to manage HEC. Reactive measures such as electric fences, elephant proof trenches, crackers, and elephant drives show mixed results in dealing with HEC. On the other hand, conflict resolution founded on careful site-specific understanding of human-elephant relationships can yield pro-active measures that are locally appropriate, and more importantly, enable the active involvement of stakeholders which is often overlooked in the management of HEC . The Alur, Sakleshpur and Somawarpet taluks of Hassan and Madikeri forest divisions of Karnataka, southern India, have been an apex of negative interactions between elephants and humans. This has led to episodic removal of elephants from the landscape, the largest involving removal of 22 elephants in a single operation in 2014. The landscape is dominated by coffee plantations interspersed with forest fragments, paddy fields, and banana plantations. In this study, we monitored 85 villages, used by nearly thirty elephants, home to about 30,000 people who are dependent on plantations and agriculture for their livelihoods. Elephant movements and conflict incidents were monitored on a daily basis through direct surveys and informant networks between March 2015 and February 2016. GPS locations of elephants and conflict incidents were recorded along with habitat variables. Data on human death incidents (between 2010 and 2016) were obtained from the state Forest Department records and each incident was investigated to

understand circumstances. We have also recorded response calls from people and categorized the nature of these calls to understand people's perception as a part of Elephant Information Network. Elephant activity was noticed throughout the year in the study area. Elephant locations showed seasonal distribution, switching between coffee during wet season and forest fragments and reservoir catchments during dry season. 190 incidences of crop damage were recorded throughout the year, of which, damage to paddy was highest, during the harvest season (October to December), followed by banana (January and February). Between 2010 and 2016, 30 human deaths were recorded, of which the majority of incidents occurred due to lack of early intimation about elephant presence (n=11) and safety at work and home (n=8). We have established the Elephant Information Network with 178 informants who intimate about elephant presence. During the study period, we have received 203 response calls across 45 villages from local people, of which 61% of calls (n = 125) were about conveying elephant locations, 29% of calls reported crop damage by elephant, and 10% of calls about enquiring whereabouts of elephants. The study elucidates that removal of elephants neither resolved conflicts nor benefitted elephant conservation. Understanding elephant movements and spatio-temporal patterns of conflict, and establishing reliable informant network would help identify locally appropriate mitigation measures to deal with HEC. The study also underpins the importance of pro-active steps such as adoption of early warning systems and empowering people with elephant information, which have been implemented elsewhere in the management of human-elephant conflict.

Finding joint solutions for Human-Elephant Conflict in an intensifying plantation landscape in Sabah, Malaysian Borneo

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Land use plans in Asian elephant range often fail to factor in the large land area elephants need to survive, and therefore result in obstructions to their free movement and access to habitat. In addition to habitat loss for elephants, such situations lead to crop damages, risks to elephant and human life and other forms of human-elephant conflict (HEC). In a forested landscape being developed for tree and oil palm plantation in Kalabakan in southeastern Sabah, Malaysian Borneo, the Borneo elephants are being exposed to such a situation. As the plantations are being developed, more electric fences and such barriers to elephant movement into plantations are constructed, teams of plantation workers are formed to chase elephants away from plantations, and elephant translocations, particularly for bull elephants, are conducted more frequently. The effectiveness of these HEC reduction methods depend on, but do not adequately consider the habitat and movement needs of elephants. Knowledge on elephant movements in the landscape, and cooperation of all land owners and managers are essential for integrating both these objectives - HEC reduction and elephant persistence. A strategy was developed by WWF over the past three years to reduce HEC in this landscape which includes two components: 1) forming a working group comprising representatives of oil palm and tree plantations that are experiencing HEC, forest concession holders, the state forest and wildlife departments, to discuss HEC issues and find joint solutions; and 2) identifying elephant habitat needs by studying their movements using satellite-collars, and using that information in discussions and development of joint solutions by the working group. Four groups of elephants that use the plantation areas in the landscape were fitted with satellite-collars and their movements have been studied over the past two years. The working group has now become functional and begun to identify site-specific management options for HEC reduction and collaboratively implement the options. These

include re-alignment of electric fences, and land use allocations in plantations including setting aside parts of the land to enable movement of elephants. In April 2016, as a first case of implementation of a joint solution, Sabah Softwood Berhad, a tree and oil palm plantation company agreed to set aside a corridor (of approximately 80 ha) to allow elephants to move through an area being newly planted with oil palm. This corridor promotes connectivity and allows elephants to move between forest patches and tree plantation areas. These efforts are expected to help reduce the frequency of HEC and increase the long-term survival of elephants in this landscape. This strategy of including evidence-based identification of solutions, collective decision-making and cooperative implementation among land managers, presents a new model of conservation practice for HEC reduction in Asian elephant landscapes.

Spatial and temporal trends in human-elephant encounters in north-eastern India

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Asian elephants (*Elephas maximus*) are globally endangered due to their steep decrease in numbers over the last century. Conserving elephants in a densely populated country like India is particularly difficult since protected forests account for less than 5% of the land area and more than 80% of the elephant range is presently shared with people, which leads to frequent interface between people and elephants. Conservation efforts are seriously undermined when people face adverse impacts due to presence of wildlife, hence such conservation conflicts need to be understood and resolved. We studied human casualties due to elephants in a high conflict region of northern West Bengal in the district of Jalpaiguri to understand spatial and temporal trends in human injuries and fatalities that occurred between January 2009 and December 2016. One hundred and six people died in the 2500 km2 study area (Figure 1) and 196 people were injured by elephants in this period. Most of the incidents occurred in the monsoon between June and August and again during November and December, the reasons for the temporal skew in attacks are currently being investigated. In order to identify the reasons behind the high number of human casualties, we sampled ~100 cases where people were involved in encounters with elephants by interviewing family members using semi-structured questionnaires. Preliminary analyses suggests that the majority of the incidents occur when people are trying to chase away elephants from the crop fields or human habitations and another significant proportion of the cases occur when people move about in the dark oblivious to the presence of elephants. Alcoholism is rampant in the region and in a majority of the cases investigated, the victim was drunk. We find that more than 70% of the victims were tribal in origin, a community where alcohol consumption is also extremely common. Detailed analyses of the nature of attacks are being conducted and the results will be presented at the conference. Our results also indicate that most of the incidences of human casualties may be avoided by adopting better crop protection methods and by making people aware of the best behavioural practices when sharing space with elephants. We propose to use the results from the study to identify high conflict regions and implement locally acceptable and relevant mitigation measures to reduce the risk of human injury due to elephants. If the mitigation measures are found to be effective, then the measures may be replicated over a larger landscape leading to a reduction in conflict and safer cohabitation between people and elephants.

Sensitizing local communities in India in conservation of the declining greater one-horned rhino (*Rhinoceros unicornis*) with training and education

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The greater one-horned rhino (*Rhinoceros unicornis*) population in India is concentrated mainly in Assam, particularly in Kaziranga National Park with 69% (2290 out of the total number of 3306 rhinos in India and Nepal) of the total rhino population. In India, small populations of rhino are found in Uttar Pradesh and North Bengal. Most of the ongoing conservation efforts are focused in Assam, which has 69% of the total population but it is necessary that Protected Areas (PA) having small populations should be given equal importance. It is evident that the existing rhino range that holds meta-populations and its habitats should be preserved so as to have a viable global rhino population in this region. One of the major impediments of rhino conservation is lack of support from local communities. The primary requirement for Rhino conservation is to bring about attitudinal and behavior change among local people living in and around Pas holding Rhino small populations. To achieve this, conservation educators in rhino range areas holding meta-populations in states other than Assam were identified and given lively training and effective education materials on the Great One-horned Rhino ultimately reaching to wider communities. The program also addressed the issue of human rhino conflict by conveying positive attitudes and effective preventive and practical behavior with respect to rhino and human-rhino conflict; and to create a network of conservation educators in northeast India. The paper explains the contents of the education module developed exclusively for the audience and supporting education materials printed in English and local language for the educators to use and promote rhino conservation. This education module has been tested before and proved to be a successful tool to use in rural areas and hence this worked well with our target group. During the training, active learning and teaching tools were introduced which is completely new to 69% of the participants. The training uses drama, games, maps, personalities, stories, debates, demonstrations, arts, mock conferences, etc. to change attitudes and enhance interest in rhino conservation. The greatest advantage of this module is that it can be used with a variety of audiences such as children, school and college students and also literate and illiterate adults. After each education program the trainees completed a report for us. Thus the reports helped us to evaluate the success rate of the effort. The project also achieved to identify and create a network of dedicated educators in North Bengal to continue the work of conservation education about Rhino. Some of them utilized the Rhino teaching module to teach about other fauna of their interest. As an incentive Zoo Outreach gave free membership in ZEN, a network of educators run by Zoo Outreach Organization, for interested participants. Thanks to Ocean Park Conservation Fund, Hong Kong and USFWS for their support.

The use of audio playback to deter crop-raiding Asian Elephants

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Human–elephant conflict (HEC) and poaching are the foremost threats to the survival of elephants (African, *Loxodonta africana*; Asian, *Elephas maximus*) in their natural environments. Reducing HEC has the potential to save hundreds of elephant and human lives annually across Asia and Africa. Lone adult

male elephants are the principal crop raiders; therefore, we investigated the effectiveness of a variety of audio playbacks at deterring 22 wild adult male Asian elephants from food sources in a wildlife reserve in southern Sri Lanka. Food was provided ad libitum, and the reactions of the elephants in response to various stimuli were recorded and analyzed. Vocalizations from a wild Asian elephant matriarchal group resulted in a flight response in 65% of trials conducted, in contrast to a control sound, a chainsaw, which produced no flight responses from any adult male. We demonstrated that audio playbacks could be used as a short-term deterrent to wild adult male Asian elephants from crop raiding; thus, providing a simple, natural, cost-effective, and humane way of mitigating HEC.

Population modeling of Asian elephant in a rain forest

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Aaranyak

Reportedly, in Dehing Patkai Wildlife Sanctuary the elephant population ranges from 200 – 300 based on non-systematic direct count. Given the importance of the forest as a potential trans-boundary conservation area with Myanmar; we estimated the density of elephant as 2.02 ± 0.43 per km2 using line transect and dung decay rate method. This can now serve as new baseline data for elephant population in the Sanctuary. Information on the population of a species in the wild is an important attribute for judging its future for conservation and management (Easa and Sabu Jahas, 2002) and hence reliable assessment of large mammal population sizes becomes crucial for the management of protected areas (Waltert et al., 2008). Reliable estimation of elephant population abundance and density assumes great importance in the context of today's massive threats from illegal hunting and habitat loss (Jathanna et al., 2015). It is a major challenge to estimate accurate elephant population size in a tropical rain forest like Dehing Patkai, which is crucial for formulating future management strategies. A detailed line transect survey and monitoring of dung decay rates were conducted during 2014-2015 in the study area to estimate the elephant density and population size. The study area, Dehing Patkai Wildlife Sanctuary (111.19 km2), is a part of the Dehing Patkai Elephant Reserve (937 km2) falling under the Assam valley tropical wet evergreen forests and forms the remaining patches of rain forests in India. A total of 23 transects of 1 km length were systematically placed in a stratified random manner in a 1 km2 grid map across the study site during the survey. We recorded the perpendicular distance of the dung-piles from the transect center-line. We used defecation rate of 18.07 defecations/day and standard error 0.0698 as suggested by Hedges and Lawson (2006). A total of 13 fresh dung piles were marked in forests to see decay rate. Finally, program DISTANCE v6.2 was used to estimate the elephant density. The dung decay rate was estimated as 75.46 ± 6.51 days. The elephant density is calculated as 2.02 ± 0.43 per km2 at a CV of 21 %. The total number of elephants was found to be 225 ± 48.78. We ran six models recommended by Buckland et al., (2001). Based on minimum AIC criterion, we selected Hazard rate cosine model. The total estimate of 225 ± 48.78 elephants (2.02 elephants/km2) in the Sanctuary should not be compared with the estimates of the Forest department's estimate. On both occasion, different sampling methods were used. This result may serve as new baseline information. The population in Dehing Patkai has drawn attention because of international importance as the Reserve is touching with Myanmar and reserve forests of Arunachal. This 'open' population gains added importance as it continuously crossing into Myanmar and maintaining a better genetic sustainability across the larger landscape.

Prerequisites to prevent extinction of the genus Dicerorhinus

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Dicerorhinus sumatrensis represents an equatorial rainforest form of an ancient and critically endangered mammalian genus. Popular media tend to lump all extant rhino species as a single group. Yet the prevailing situations for African rhinos and Dicerorhinus are as different as are those for gorillas and orang-utans. Work to save Dicerorhinus has become mired in cognitive bias. Some reasonable assumptions can be made: (1) fewer than 100 Dicerorhinus are alive today, (2) at best, only one wild concentration is potentially viable if left in situ, (3) the key threat is extreme Allee effect, rather than poaching or habitat loss, (4) the genus will drift to total extinction in the absence of a single program with the goal to boost rhino births. Relevant to a single program are the following facts : (1) captive husbandry of Dicerorhinus has advanced far beyond the disasters that occurred from 1980s to 2003, (2) Dicerorhinus have been bred successfully in captivity, (3) proven methods exist to safely capture and translocate wild Dicerorhinus, (4) female reproductive pathology is significant in some areas, (5) apart from keeping rhinos alive, the big need is to bring Dicerorhinus gametes together to boost potential for pregnancies, (6) profit motive has led to established systems that produce thousands of embryos annually from three mammalian families, (7) advanced reproductive technology work is underway on the rhino genus Ceratotherium. Key elements of the necessary Dicerorhinus rescue program are: (1) one meta-population, (2) capture of more rhinos and husbandry in excellent managed facilities, (3) increase births through natural breeding, (4) rapid experimentation and development of in vitro fertilization, embryo transfer and other advanced reproductive technology for Dicerorhinus, so that gametes are not wasted and can be transferred easily between facilities. Current constraints that need to be ameliorated in order to launch the necessary program to boost Dicerorhinus births include: (1) factions, at and between national, sub-national and institutional levels, which occasionally meet but do not budge from entrenched positions, (2) lack of leadership and support from international nature conservation organizations, (3) national decision-making in Indonesia is centered on a conservative forestry view, rather than a customized species view, (4) worries over lack of funding get in the way of focusing on making necessary policy decisions, (5) information on Dicerorhinus available in the media consists of misleading incidents and anecdotes that ignore the big picture, (6) unnecessary worries such as funding competition with other projects, "stakeholder" views, and availability of future habitat interfere with sensible debate.

Lessons learned from the decline of the Sumatran rhino (*Dicerorhinus sumatrensis harrissoni*) in Sabah

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Effective conservation of endangered species requires a thorough understanding of the population size, its ecological needs as well as the factors responsible for its decline. Yet, this information is still lacking for a variety of endangered species and the question arises of how to use these limited and uncertain data to

improve decisions for conservation management. The Sumatran rhino (*Dicerorhinus sumatrensis*) is a good example to illustrate the challenges in the conservation of a highly endangered species. Less than 100 Sumatran rhinos still exist in the wild. They are remnants of the two extant subspecies*, D. s. sumatrensis* in Sumatra, Indonesia, and *D. s. harrissoni* in Borneo in Kalimantan, Indonesia who live in very small and highly fragmented populations. Several conservation strategies have been proposed to stop the decline of the species and to increase its numbers. However data suitable and relevant for such measures hardly exist. Despite intensive research on Sumatran rhinos in the past, the exact number of the remaining individuals as well as their sex and age ratio are still unknown. This lack of data makes the conservation of the species challenging. The size of the population is easily overestimated and conservation measures such as the consolidation of isolated subpopulations to enhance the chance of mating are being delayed. We reviewed the literature on rhinos and assembled a comprehensive dataset on surveys of the Sumatran rhino subspecies (*D. s. harrissoni*) in the Malaysian state of Sabah on Borneo to chart the historical development of the population in Sabah and its exploitation until the present day. We ran a series of population viability analyses (PVAs) to extract the key demographic parameters most likely to affect population dynamics. The analysis revealed that unrestrained hunting between 1930 and 1950 drastically reduced the historical rhino population in Sabah and that the remnant population could have been rescued by combining the effort of total protection and stimulation of breeding activity. Two factors were identified as crucial parameters driving population dynamics: the percentage of breeding females and female lifetime reproductive period. In combination with total protection against poaching, even moderate improvements in these parameters could elevate population viability substantially. The experiences with the rhinos in Sabah illustrate that remnant populations with less than 15 individuals have a high chance of extinction if left to their own devices. We therefore recommend to translocate isolated individuals or small subpopulations to protected locations and to undertake measures to maximize conceptions. One possible option would be to run state-of-the-art reproductive management with assisted reproduction techniques to improve the reproductive performance of the female rhinos. The next few years are crucial for the survival of the species. Concerted efforts of the governments, NGO´s and scientists in terms of a one plan approach are needed to save the Sumatran rhino from extinction.

Saving the Sumatran rhino: Amalgamation in the Leuser Ecosystem

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Leuser Conservation Forum

The Leuser Ecosystem (LE) is one of four locations left in the world where Sumatran rhinos still exist in the wild. In LE there are at least four locations where the Sumatran rhino populations are relatively small: the western LE, Beutong, Samarkilang and Kappi. According to a PVA from 2015, there are at least 8-10 rhinos in Kappi, 3-5 in Samarkilang and 2-3 in Beutong. From our patrol reports over the last 3 years in Kappi, the last 2 years in Samarkilang, and from intermittent survey activities in Beutong, we could not find any indication that this critically endangered species is breeding in these 3 sites. Without intervention, there is a high chance that these populations will go extinct no matter how intensely we patrol and protect their habitat. One way to save these isolated individuals is by translocating them all to one location. After ascertaining population numbers and assessing the health and reproductive capability of these individuals, an appropriate breeding center should be built. This is the most viable option for conserving these small Sumatran rhino populations remaining in the eastern part of Leuser Ecosystem. Before we take the major step described above, we intend to conduct population surveys in these three locations using the occupancy method and camera trapping. Our next step would be capturing them and building a breeding center. The intensity of wildlife patrols would be concurrently heightened in the new

habitat or breeding center to ensure the safety of the rhinos. Veterinarians and rhino experts would need to be present during the capture, health assessment and translocation process. The best possible site for translocation is the Kappi plateau due to its high variety of preferred foods for rhinos (149 species), at least 6 saltlick complexes, a relatively flat landscape, and the area has a strong legal status. The biggest threat right now in this area is a geothermal project plan and the frequent presence of locals coming into the forest to fish, hunt, and harvest non-timber forest products. An ideal site for a breeding center can be developed in Samarkilang, which is a relatively lowland forest landscape and is still naturally regenerating after logging activity halted a decade ago. There is a high variety of biodiversity in Samarkilang due to the continuing regeneration of secondary forests, which will provide a high variety of food for rhinos. The main threats in this area are illegal poaching, logging, and forest encroachment. Strong legal protection of these two areas is a critical precondition to be fulfilled before we designate them as translocation and breeding center sites.

Conserving Javan rhino through special interest ecotourism in Ujung Kolon National Park

Ofat Sofwatuddin, S. Ip
Friends of Rhino

The Javan rhino (*Rhinoceros sondaicus*, Desmarest 1822) is one of two species of rhino found in Indonesia (the other is the Sumatran rhino). The Javan rhino is critically endangered and can now be found in the wild only in Ujung Kulon National Park (UKNP), Indonesia. It was also previously found in Vietnam, but was declared extinct there in 2011. Only about 60 individuals are found in the UKNP, and they face threats from loss of habitat, encroachment (by local people) for farming, invasive vegetation, and competition from other species (wild cattle). Poaching, although not currently occurring, is also a potential threat. Despite the problems the Java rhinos face in UKNP, it is considered still possible to save this population from extinction through a concerted effort by all parties. Both commitment and substantial funding are required to save this species. Special interest ecotourism offers an opportunity to both raise funds for the conservation of the species, and to increase awareness of its plight. Friends of Rhino is a local NGO which is developing special interests ecotourism through community-based partnerships. The concept is to accompany small groups to UKNP, so they can observe rhino behaviour and feeding in their natural habitat. There will be strict rules to protect the fauna and the ecosystem. Tours will center on the Cikeusik area, in the core zone for Javan rhino, so groups will be limited to a maximum of three people. Tours are restricted to July to mid-September (dry season period is the best time), Participants will spend at least 7 to 10 days in UKNP, travelling through coastal areas, estuaries and along the river where they are most likely to observe rhino. The anticipated benefits of this special interest ecotourism development are: (a) to increase awareness and knowledge about the conservation of rhinos for visitors; (b) Creating business opportunities and employment so as to increase the income of local communities and the economic growth of local, regional and national levels; (c) as an alternative and sustainable sources of income for local communities and (d) provide a funding source for rhino conservation.

Current threats to Asian rhinos from illegal rhino horn trade

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Illegal trade in rhino horn has triggered an increase in rhino poaching in South Africa over the past five years. The poaching scenario in South Africa and also in some other African countries in past few years has raised concern about the future of rhinos. Whether the rhinos are poached in Africa or in Asia, research on illegal trade of rhino horn has revealed that few Asian countries who are not rhino range states are using the rhino horns, triggering continued illegal killing of rhinos in rhino range states in Africa and Asia. In contrast to the African rhino poaching scenario, the state of rhino conservation in Asia seems encouraging. However, rhino poaching in India increased during 2011-2013. Thanks to concerted efforts, the poaching trend declined in 2014 and 2015 by about 25% and 40% respectively. The rhino poaching increase in India is linked to the poaching decline in Nepal, which is the result of successful anti-poaching efforts in Nepal over past 5-6 years. The rhino poaching dynamics in India and Nepal is changing, as are the transport routes of rhino horns from India to consumer countries. This paper highlights the change in trade route of rhino horn from India to end user countries as well as the changes in modus operandi of rhino poachers operating in India over the past 5-6 years.

Is Elephant Proof Trench an effective mitigating measure against human-elephant conflict?

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Human-elephant conflict (HEC) is one of the challenging issues of elephant conservation in all its ranges. India experiences approximately 175–200 cases of human deaths caused by elephants, about 10 lakh hectares of crop loss and 15,000/- houses damaged by elephants annually. The amount spent on control measures and ex-gratia payment towards HEC is about Rs. 15 crores annually. However, the affected communities feel the ex-gratia payment is negligible given the magnitude of conflict and its adverse impact on their socio-economic status. Therefore, goodwill and tolerance level is decreasing among the affected people over time that could lead to animosity towards elephant conservation. Various methods include traditional farm-based deterrents (the use of watchtowers, fires, ditches and loud noises) and novel farm-based deterrents have been tried to reduce HEC. The Elephant Proof Trench (EPT) is recognized as a potential means of reducing HEC. The effectiveness of EPT in controlling HEC (particularly by large species such as elephants) depends on various factors which have not been looked at thus far. This paper describes the effectiveness of EPT in two different geographical landscapes in Tamil Nadu south India. In a total hundred and ten kilometres in Coimbatore Reserve Forest Division (CRFD) and forty four kilometers in Grizzled Giant Squirrel Wildlife Sanctuary (GSWLS) EPT was taken up for this study with the following major objectives such as to record number of wild animals and livestock crossing points, to find out extent of use by wild animals along the EPT and people's perception on EPT. The entire EPT length was walked by foot to record wild animal and livestock crossing points, line transect method was deployed to find out extent of use by wild animals along the EPT and questionnaire method was used to understand people's perception on EPT. The result revealed that there were 242 and 114 locations of wild animal crossing points and 127 and 52 locations of livestock crossing points recorded in the length of 110 km and 44 km length of EPT in CRFD and GSWLS respectively. The depth ranging from 1.5 m to 2.5 meters in CFRD and from 2.5 meters to 3 meters in GSWLS, similarly width varies from 1.5 m to 2.5 meters in CFRD and from 2 m to 3 meters in GSWLS. Due to insufficient direct sightings, indirect evidences were considered

to estimate extent of use by wild animals. Elephant (60.6 dung piles/Sq.Km) density was high followed by Gaur (27.3 dung piles/Sq.Km) and Sambar (12.1 pellet groups/Sq.Km) along the EPT in CRFD and GSWLS. The people opined that there was no change in area of cultivation (82%), crop species (85%) and their efforts to protect the crops (98%). Most of the people (90%) have perception that the maintenance is duty of forest department. This present study found that the EPT was not up to the mark (2.5m length; 2.5m width; 1m basal area), there is no provision for annual maintenance of the forest department, the geographical selected for EPT was abutting steep slope and finally lack of community participation resulted in poor effectiveness of EPT against HEC. A huge amount is being spent on digging EPT every year by the forest department therefore ending with a poor result is unfortunate. Policy level change is urgently warranted for successful use of EPT against HEC. There is a need to evaluate past efforts in terms of costs, quality of application and the effectiveness (factors that contributed to success or failure). There is also a need to develop best practices manual whose guidelines must be mandatory for erection of any barrier.

Spatial Distributions of Sumatran Rhino Calf at Way Kambas National Park Based on its Footprint and Forest Fire in One Decade (2006 to 2015)

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Counting rhino footprint numbers is often a basic requirement for determining the existence of the species. Then, counting animals to estimate their population sizes is often essential for their management and conservation. However, this task is deceptively simple and no single best approach exists; techniques that work well in some situations are useless in others. Movement processes are, however, difficult to model mathematically. They are the result of extremely complex interactions between an organism's internal state, behavioral tendencies and environmental cues. The data are multi-dimensional and almost always non-independent, and there is no consensus on the appropriate statistical summaries or underlying models. This article intends to map rhino calves' footprints and forest fires findings to ensure the existence of rhino calves over one decade. Rhino Protection Units (RPUs) provides basic data on the spatial distributions in the Way Kambas National Park (WKNP). There are only 66 rhino footprint findings between 2006 and 2015 in the area longitude between 105.4107 to 105.5157 and latitude between -4.4950 to -5.0357. Spatial distribution also shows that disturbances have covered spatial distribution of footprints finding. The data from RPUs indicates that forest fires had increased significantly from 40 events in 2006 to 48 and 86 in 2014 and 2015, respectively. However, the size of areas burned decreased from 32,049 hectares in 2006 to 1,631 hectares and 465 hectares in 2014 and 2015, respectively. An increase in the amount of forest fires in the last two years must be recognized as a threat to the survival of the Sumatran rhino or other species. Furthermore, spatial distribution also describes that the outspread of human disturbances in line with the outspread of rhino footprint findings. It is certainly more pressure on the habitat and the existence of the Sumatran rhino. Through active patrolling between WKNP forest rangers and RPU teams, the poaching and forest fires are monitored and legal actions are taken. However, this approach still must be intensified and focused on bringing the perpetrators to justice.

The African Rhino Community Centre (ARCC): A Collaborative Strategy to Protect Rhino in the Eastern Cape of South Africa

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The black and white rhino (*Diceros bicornis* and *Ceratotherium simum*, respectively) are being poached at a rate of approximately 1,500 per year in Africa. The crisis is most acute in South Africa where poaching has increased by more than 9,300% since 2007. The indications are that the wild populations of rhino may have surpassed the "tipping point" and are now in decline. While strict law enforcement is certainly critical in the fight against poaching, there appears to be no single answer to combat the current crisis. However, conservationists generally agree that a multi-faceted approach is needed, that includes:

1)strengthening ongoing anti-poaching and monitoring patrols, including enhanced aerial surveillance, the deployment of K9 and equine units, and real-time GPS tracking of animals;

2)developing a nationally-coordinated enhanced breeding and population recovery plan, including veterinary care for the region's rhino populations and translocation of animals where appropriate;

3)targeted demand reduction and awareness campaigns across Asia; and

4)socio-economic development programs based on the conservation of wildlife for rural communities living with, and adjacent to, wildlife areas.

We believe this last point is a vital, albeit frequently overlooked, component of rhino protection programs, because the vast majority of poaching incidents can be linked to information on animal location leaking from local communities adjacent to the reserves, if not to direct participation of individuals from those communities. Thus, community outreach and education programs must be focused on developing sustainable community benefits and buy-in. In this paper we present the vision and strategy behind the African Rhino Community Center (ARCC). Located in the Eastern Cape of South Africa, the ARCC project is establishing a facility from which to develop a holistic conservation program that brings together protection, awareness, wildlife management, community participation, and law enforcement in a coordinated collaboration of individuals, rural communities, organizations, and government to ensure the future of rhino and other wildlife in the wild. For the past year, Texas Christian University (TCU) has partnered with the Amakhala Game Reserve, along with several other non-profit organizations, to help conceptualize, design, and build this collaborative education, research, and protection facility. The role of ARCC is to provide protection; to enhance the breeding and, thus, grow the population of rhino; to create awareness and educate people as to the plight of the rhino and to the ramifications of poaching and, ultimately, the loss of the species. It is also to use the conservation of the rhino to, critically, further the socio-economic aspirations of the rural people of Africa, and to do so by recruiting the active participation of those communities in wildlife conservation. We highlight examples of programs that we are piloting and beginning to implement including, among others, an ongoing educational program for young South Africans (ages 10-12) from rural, economically-disadvantaged communities that is focused on wildlife conservation. It is these young people who are able to spread the word, influence their elders and who will become the decision makers of the future.

Pointless: A quantitative assessment of supply and demand in rhino horn and a case against trade

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The world is witnessing an unprecedented upsurge in poaching and illegal wildlife trade, which is undoing decades of conservation efforts. Some of the most profitable species include iconic animals such as rhinos, elephants, tigers and even fish. The notion that wildlife trafficking is worth 7-23 billion US dollars (UNEP-Interpol 2016) and ranks amongst the four most lucrative illicit trade commodities has become cliché. Rhinos have been especially hard hit by these developments. Last year, poachers killed at least 1,342 rhinos in Africa, the highest number since records began in 2006. Rhino populations everywhere are under siege from poachers, illegal traffickers, national and international criminal networks, art collectors, status and pleasure seekers, medical patients and financial speculators intent on cashing in on their increasing rarity. Most wildlife and enforcement experts consider resolutely enforced international and national trade bans and effective demand reduction initiatives the most promising route towards reversing the current trend. Others vociferously advocate the legalization of trade in rhino horn as the only viable option that can ensure a future for the world's remaining rhinos. The debate about whether legalized rhino horn trade might benefit rhino conservation has produced an abundance of academic and other publication, which include a large number of theory-based analyses. A quantitative appraisal of supply and demand has so far been lacking. This study provides the first quantitative assessment of the relationship between rhino horn supply and demand. Scrutinizing a variety of different supply and demand scenarios it illustrates the significant discrepancy between the reservoir of approximately 141 tonnes of horn carried by the world's remaining rhinos and those in South Africa and the two main consumer markets in Vietnam and China.

Directing rhino metapopulation management 'best practice' during a poaching crisis

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The white rhino, *Ceratotherium simum Burchell*, has been conservation dependent since their first major recorded population crash in 1885. Prior to the poaching spike of 2008, management-related losses such as fighting mortalities and overstocking-induced unborn calves exceeded those of poaching in South Africa. However, the country has recently reached the point where poaching mortalities have exceeded natural birth rates. The focus of this research is to assess critical rhino metapopulation management questions arising at this time of population decline, to develop proactive best practice protocols for species recovery. And more significantly, this study will apply these new data as a biological management tool for the future, in accordance with the WWF and IUCN/AfRSG Rhino Action Plans, to maximize the genetic fitness of a consistently threatened species of integral economic and ecological importance to Africa. Utilizing baseline population genetic data and ecological and evolutionary modelling techniques such as Population Viability Analysis, we are able to address metapopulation level genetic questions pertaining to reintroductions, reproductive success and population growth. The first aspect investigated the levels of relatedness in social groupings of rhinos in effort to advise managers on the genetic implications of translocating rhinos from close and overlapping geographic ranges. The second aspect to be reported on here is the establishment of breeding values of dominant bulls with range/territory data and horn size included as parameters, in order to better understand the optimal length of term that

dominant bulls are allowed to reign and whether there is any element of heritability with these dominance traits. The development of a rhino population genetic management 'best practice' guide will improve our understanding of synergistic components involved in reintroductions and translocations, and subsequently enhance the efficacy of future rhino movements around Africa in response to the current poaching crisis.

Recurrent keratitis in captive Asian elephants

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Clinical signs of keratitis are seen among the Asian elephants at the "Tisch Family Zoological Gardens in Jerusalem", Israel. Signs are bilateral and included severe photophobia, blepharospasm, copious sero-mucoid discharge, and progressive corneal edema so severe that it led to loss of vision. The inflammation subsequently resolved, though residual corneal pigmentation and infiltration were observed. Subsequently, at roughly three to four month intervals, episodes would reoccur. In spite of intensive diagnostics efforts no clear pathogen was detected. Diagnostic examinations included culture for viruses, bacteria, fungi, Mycoplasma, and Chlamydia. Conjunctival biopsy revealed chronic lymphoplasmatic inflammation of unknown etiology. PCR tests for Elephant Endotheliotropic Herpesviruses (EEHV) were conducted on blood, lymph node biopsy, conjunctival swabs, tears and wart like lesions on the vulva at the IZW lab in Berlin and all were negative. Repeated blood work was consistently normal. No significant differences were noted between several treatment regimens, including combinations of topical and systemic treatment including local antibiotics, anti-herpes ointment, anti-viral drops, anti-fungal drops, anti-inflammatory drops (steroids and NSAIDs), autologous serum eye drops, mydratics, systemic anti-inflammatory and anti-herpes drugs. There is no apparent correlation with seasonal, environmental or management changes. Over the last 20 years there have been 30 outbreaks, at increasing intervals and with decreasing severity. During the last few outbreaks, skin lesions including lichenification, vesicles and crusts appeared, first along the lateral edge of both ears then along the dorsal trunk. Clinical signs resolved after topical treatment. There are literature reports of ocular disease in elephants, including follicular conjunctivitis, traumatic corneal injuries, foreign bodies etc. Positive EEHV PCR results from conjunctival swabs of healthy elephants have been reported, raising the possibility that they are part of the normal conjunctival flora in elephants. During the last year we evaluated the use of next generation sequencing to screen for the pathogens associated with the inflammation. Comparison of the flora in the right and left eye of each individual during and after keratitis outbreak was conducted. The analysis enabled the study of the "normal" versus the inflamed flora which included bacterial, fungi and viral pathogens. Differences were found between individuals especially between the females and the bull.

Periodontal disease in black rhinoceros (*Diceros bicornis*)

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Periodontal disease is a common condition in domestic horses that often goes undetected due to inadequate and infrequent examination of the oral cavity. It is likely that this is also the case for the zoo-based Rhinocerotidae due to the logistical challenges inherent in physical and radiographic examination of rhinoceros orodental structures. Periodontal disease in the horse, a grazing hypsodont, is generally considered to be attributable to abnormal shearing forces upon the peridontia generated by altered chewing patterns imposed by abnormal patterns of dental wear (eg points, hooks etc). Conversely, the pathophysiology of periodontal disease in zoo-based black rhinoceros, a brachydont herbivore with a browsing ecology, is unknown. In one zoo-based, black rhino group, periodontal disease was notable for the absence of dental wear patterns typical of similar disease in horses and for the presence of hypercementosis, which is not a feature of periodontal disease in domestic equids. Periodontal disease has significant potential to impact the health and welfare of zoo-based rhinoceros, undermining the goals of cooperative conservation breeding programs. Potential sequelae include pain, maldigestion and systemic bacterial infection. Additionally, it is possible that the chemical mediators associated with undetected chronic periodontal inflammation play a role in female subfertility and in cryptic diseases of zoo-based black rhinoceros including excessive iron uptake. A better understanding of the prevalence, causes, pathophysiology, management and prevention of periodontal disease in zoo-based rhinoceros is required.

Management of tusk fractures in captive elephants.

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Elephant tusk fractures are common in captive elephants and their prevention and treatment poses significant challenges. 10,000 African elephant photos across the southern African region were studied. The incidence of tusk fractures were recorded and correlated to the annual rainfall of different areas. There appeared to be a West to East reduction in the incidence of tusk fractures in contrast to an increase in annual rainfall. The Etosha game reserve in Namibia was the only natural habitat where African elephants had a higher incidence of fractures when compared to previously published data on captive elephants in North American zoos. The causes of tusk fracture in the wild have not been well studied, but we suggest desiccation of the tusks and the increased social activity around waterholes/springs may play a role in Etosha. Rainfall may also account for differences in nutrients, however we postulate that if indeed this is the cause other teeth, not only tusks, should have been affected, not to mention the teeth of other species. In Etosha per se animals such as warthogs also have exposed tusks, but the incidence of fractures is minimal. If indeed dry air does play a role in predisposing tusks to fractures, the fact that warthogs spend several hours per day underground in Aardvark burrows where the humidity is higher may partially explain the lack of fractures in this species. Management of elephants in captivity to reduce the incidence of tusk fractures should be the ultimate goal of any facility housing these megaherbivores. Common causes of tusk fractures in captivity include:

- the use of metal bars and doors to separate individuals and funnel them,
- the use of low cement walls to separate individuals,

• cement coverings of walls,
• feeding elephants outside the enclosure, forcing them to stretch with their trunks and bump their tusks on the enclosure boundary,
• chaining elephants,
• using cement flooring (especially if smooth). This to facilitates rapid cleaning of pens, but the smooth wet surface increases the risk of slipping,

Good management practices include keeping tusk trimming to a minimum, understanding pulp anatomy in order to prevent exposure when trimming, and managing herd structure correctly. When it comes to successful treatment, the identification of pulp exposure when tusks are fractured/cut is paramount. Immediate treatment of the pulp (partial pulpectomy) with appropriate medications and the effective sealing of the tusk has been shown to have excellent results. Prolonged periods with no treatment are not recommended as this leads to destruction of pulp tissue and ultimately pulp volume. Tusks with decreased pulp volume may slow down completely with respect to tusk growth (new ivory formation), or may continue to be infected - ultimately leading to pulp necrosis necessitating tusk extraction. In addition, abnormal ivory formation has been described in elephants, with chronic infection being one of the causal mechanisms. This abnormal ivory can complicate the extraction process even further.

Development of a rhino ferritin specific assay for determining the association between serum ferritin concentrations and hemochromatosis in the Sumatran rhinoceros (Dicerorhinus sumatrensis)

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Among the challenges associated with iron overload disorder in rhinos is the inability to distinguish individuals developing and/or suffering from hemochromatosis (iron overload disease) from those merely experiencing hemosiderosis (iron deposits in organ tissues without associated organ damage). Although neither condition is desirable, the former can be fatal, whereas the latter may be tolerated throughout a long, productive life. Serum ferritin concentration is considered the best measure of total body iron stores in many species, but ferritin is species specific and an acute phase protein that increases in response to many inflammatory reactions. When Sumatran rhino serum ferritin concentrations were measured using an antibody for horse ferritin, values for an individual that died of hemochromatosis were no different during the eight months she exhibited clinical signs of disease than values for an old Sumatran rhino that died many years later of other causes (range; 740-2,650 and 382–2,445 ng/ml, respectively). The aim of this study was to develop an enzyme immunoassay (EIA) using Sumatran rhino ferritin specific antibodies to definitively determine if ferritin is a reliable biomarker of hemochromatosis in this species. Through a multi-step process, ferritin was isolated from Sumatran rhino liver tissue. Sample purity was confirmed via polyacrylamide gel electrophoresis and Coomassie blue staining using purified horse ferritin as a control. Staining was also performed with potassium ferricyanide to confirm the presence of iron in the protein bands. Several monoclonal mouse antibodies were generated against the isolated protein at the University of Georgia Bioexpression & Fermentation Facility. Two top-performing monoclonal IgG antibodies were validated for their specificity to rhino ferritin by Western blot analysis and were used to develop a sandwich EIA. Serum samples banked during the lifetimes of five Sumatran rhinos maintained in U.S. Zoos and spanning 4 to 15 years for each individual were retrospectively analyzed for ferritin concentrations. One rhino had produced three calves prior to her death from hemochromatosis, another died of hemochromatosis without reproducing, two had lived long lives and died of other causes and one was still alive. In addition, single serum samples were analyzed from each of nine Sumatran rhinos maintained in S.E. Asia, none of which died of hemochromatosis. For U.S. housed rhinos, serum ferritin

concentrations ranged from 348–7,525 ng/ml across all samples and all rhinos with individual overall means ranging from 1,267 ± 227 to 2,603 ± 1,200 ng/ml. For rhinos maintained in S.E. Asia, the mean serum ferritin concentration was (4,985 ± 4,197 ng/ml) with individual values ranging from 858 to 14,900 ng/ml. Results from the horse and rhino assays differed with correlation coefficients ranging from negative to highly positive values (R = -.36 to .93) for individual profiles. Data from this study indicate that Sumatran rhino serum ferritin concentrations: 1) are not accurately determined with antibodies to horse ferritin; 2) are dynamic over time; 3) may decrease during pregnancy; 4) are elevated in rhinos suffering from hemochromatosis; and 5) are elevated in many rhinos not suffering from hemochromatosis. In conclusion, serum ferritin concentration is not diagnostic of hemochromatosis in the Sumatran rhino. (This study was funded by a grant from Mr. and Mrs. Jeremy S. Hilton and Family with supplemental support provided by Dr. Tom and Rita Bell.)

Clinical case: Gross examination on left rear leg of Sumatran rhinoceros (*Dicerorinus sumatrensis*) Harapan by using digital X-ray

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The Sumatran rhinoceros (*Dicerorhinus sumatrensis*) is one of the most critically endangered of large mammals on earth today. Based on IUCN's Red List of Threated Species, Sumatran rhinoceros is classified as Critically Endangered (and also listed in CITES Appendix 1). The critically endangered Sumatran rhino's future is questionable with a shrinking wild population currently estimated at fewer than 100 rhinos and which needs serious action to save this species. Sumatran Rhino Sanctuary (SRS) is a breeding center for Sumatran rhinoceros in its native habitat run by Yayasan Badak Indonesia (YABI) in collaboration with the Ministry for Environment and Forestry, Government of Indonesia, and financially supported by the International Rhino Foundation (IRF). This sanctuary of about 100 ha is located in Way Kambas National Park. Since 1985, about forty Sumatran rhinoceros have been captured from the wild and translocated around the world. Three wild caught Sumatran rhinoceros were relocated to the Cincinnati Zoo and they successfully produced three calves - Andalas, Suci, and Harapan. Andalas and Harapan were returned to Indonesia, but Suci passed away due to health problems. Harapan, an 8 year old male, was moved to Indonesia by using air, land, and sea transportation. The journey took about 60 hours and he was placed in a crate about 3m x 1.5m x 2 m (l x w x h). A few days after arrival, he was observed with a limp on his left rear leg. Based on daily observation, Harapan's problem was thought to be located in the bone or tendon in the digitalis pedis area. X-ray examination was done without sedation with the rhino inside the stall. The crack observed on X-ray healed by itself, but it took 3-4 months due to the minimal blood vascularization of the phalanx bone. The bone is also actively used when the animal walked. Oral medicines like NSAIDs were not recommended for this case due to long term use. Symptomatic treatment was provided by giving calcium supplement (bone supplement) and by putting mattresses inside his stall for cushioning.

Common foot disorders in captive Asian elephants of Kerala

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Foot disorders are reported to be a major problem affecting captive Asian elephants. A study envisaged the evaluation of common foot disorders in captive elephants by conducting a survey in and around Thrissur over a period of three months from March to May 2014. The elephants in musth were excluded from the study. The general health checkup included anamnesis, examination of temporal glands, condition of the eyes, skin, behaviour pattern, body condition and a detailed screening of foot health. Foot lesions were recorded and categorized based on the conditions and structures involved. A total number of 118 captive elephants were included in the study. The study was conducted during the dry climatic season in Kerala, when the incidence of foot disorders from wet and unhygienic conditions would be less. Being the festival season, and elephants being an integral part of all temple festivals, all the animals were kept in the best possible healthy body condition by the owners and mahouts. Out of 118 animals screened, 113 were male and five were female, indicating that the tuskers were preferred under captive conditions and also for festival programs. Even though there were many young elephants below 20 years and adult elephants above 60 years, the foot lesions were primarily seen in the age group of 20 to 60 years. Foot disorders involving the hind limbs were more prevalent than those involving the fore limbs. Male elephants suffered foot problems more than females. The total number of captive elephants in Kerala is about 450 and when compare to the total population, the 118 animals of the present study is a true representation of the population to evaluate the incidence of foot disorders. The major foot problems were split nails, nail cracks, overgrown nail, overgrown sole, overworn sole, overgrown cuticle, pododermatitis, wounds, hyperkeratinisation, demelanised chain scars and a few other lesions. Prevention of foot lesions with regular care and pedicures is more important than ignoring small lesions and treating them only when they become severe. Attention to foot pad and heel must be a part of the regular foot care to avoid the development of cracks, fissures and trapping of foreign bodies such as stones, which could lead to development of abscesses, laminitis and loss of animals. Proper care and management of the elephants will keep the foot healthy and help maintain the health, utility and life of this magnificent living creature under captive conditions.

Speciation and hybridization in African elephants

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A series of genetic and morphological studies conducted on elephantids have provided insights into speciation among African elephants. Studies of skull morphology and of nuclear DNA have strongly concluded that African elephants comprise two species: the savanna elephant (*Loxodonta africana*) and the forest elephant (*L. cyclotis*). Although hybrids between the two have been detected, there appears to be a dearth of nuclear gene flow between them, suggesting that hybrid elephants between the two species have reduced fitness. Neither nuclear nor mitochondrial genetic variants common among savanna elephants have been detected in tropical forest populations, suggesting that the species barrier separating forest elephants from savanna elephant introgression is complete. By contrast, one marker appears to

have an exceptional distribution: mitochondrial DNA derived from forest elephants is present in savanna elephant populations, suggesting that hybrid females have successfully back-crossed to unhybridized savanna males. Within species, the two markers reflect sex differences in dispersal and reproductive variance. Genetic patterns are in agreement with the observation by Petit and Excoffier (Trends Ecol Evol. 2009 24:386-93) that across almost all pairs of species that hybridize, the delimitation of species will be more effective with markers experiencing high levels of gene flow. These findings are placed in the context of similar patterns reported between other species in which the dispersal of one sex is severely circumscribed, to recent reports regarding the ancient "conversion" of populations of bears (genus Ursus) from one species to another through sex-specific dispersal, and to evidence for widespread genetic introgression across felids universally recognized as distinct species. These patterns are also discussed in light of recent reports of inter-species introgression across living and extinct elephantids, and a recent review of molecular studies of elephantids (Annual Review of Animal Biosciences 3:139-167; 2015). (With thanks to the US Fish and Wildlife Service African Elephant Conservation Fund)

Genetic status of the black rhinoceros - from DNA profiling to whole genome analysis

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I describe the results of a range wide conservation genetic assessment of the black rhinoceros and the first assembly of a black rhino genome. We analyzed a large mitochondrial and nuclear dataset containing both extant samples and colonial-era material from museums throughout the world. We found range-wide genetic erosion and pronounced structure in this species for the first time, documenting a remarkable loss of genetic diversity. We were able to identify conservation units to maintain evolutionary potential and for population management. The genome of the southern black rhino has recently been completed and I will describe some preliminary results from the first assembly.

Genetic advances and the conservation of African forest and savanna elephants

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Little or no nuclear gene flow occurs between African savanna elephants (*Loxodonta africana*) and African forest elephants (*L. cyclotis*), establishing that they comprise separate species. In elephant species, males disperse, whereas females remain with their natal social group, leading to discordance in the phylogeography of nuclear and mitochondrial (mt) DNA patterns. Nuclear gene flow is mediated by the dispersing males, while maternally inherited mtDNA exhibits low geographic dispersal. We examined the effectiveness of mtDNA for assigning the provenance of African elephants or their ivory, so that law enforcement efforts could be targeted toward poaching hot spots. For 653 savanna and forest elephants from 22 localities in 13 countries, 4258 bp of mtDNA was sequenced. We detected eight mtDNA subclades, seven of which had regionally restricted distributions. Among 108 unique haplotypes identified, 72% were found at only one locality and 84% were country specific, while 44% of individuals carried a haplotype detected only at their sampling locality. We combined 316 bp of our control region sequences with those generated by previous trans-national surveys of African elephants. Among 101 unique control region

haplotypes detected in African elephants across 81 locations in 22 countries, 62% were present in only a single country. Applying our mtDNA results to a previous microsatellite-based assignment study would improve estimates of the provenance of elephants in 115 of 122 mis-assigned cases. Nuclear partitioning followed species boundaries and not mtDNA subclade boundaries, consistent with the species barrier between them. For taxa such as elephants in which nuclear and mtDNA markers differ in phylogeography, combining the two markers can triangulate the origins of confiscated wildlife products. This may be especially relevant given that record numbers of ivory seizures have been reported in recent years. We will also discuss other recent findings based on genetic analyses of elephant populations and how they may impact the conservation of Africa's elephants. Funded by a US Fish and Wildlife Service African Elephant Conservation Grant.

Conservation genetics of Greater One-horned Rhinos in India – from identifying individuals to determining conservation priorities

Udayan Borthakur, Pranjal Kumar Das and Bibhab Kumar Talukdar
Aaranyak

Being a major flagship species in its range distribution and emerging from a catastrophic population decline in the past, the greater one-horned Rhino (*Rhinoceros unicornis*) population management and conservation requires a multi-disciplinary effort, including the use of molecular tools for genetic monitoring of natural populations. In India, seven protected areas harbour more than 70% of the extant global population of this species. The contemporary populations of rhino are distributed across a landscape of fragmented habitat patches of protected areas, with restrictions to the natural movement and gene flow among them due to various land use patterns. This demanded an investigation on whether this distribution pattern facilitates any demographic and genetic exchange of rhinos among the protected areas in India and whether any genetic management of these populations are required in order to ensure their future survival. Genetic population monitoring of rhinos was initiated in 5 different protected areas of India, Viz. Kaziranga National Park, Orang National Park, Pobitora Wildlife Sanctuary of Assam and Gorumara National Park and Jaldapara National Park of West Bengal, with 98% of the total rhinos present in the country. Microsatellite markers were optimized to identify individual rhinos and Y-chromosome linked markers to identify gender from noninvasively collected dung samples, along with optimization of sampling techniques to meet the requirements of genetic studies. Using these techniques, genetic census of rhinos was carried out successfully in Gorumara National Park. The optimized technology finds wider applications in forensic DNA investigation of rhino poaching cases.The same genetic markers were used to carry out a wider investigation of genetic population structuring and gene flow among the protected areas. Significant level of genetic differentiation was observed between Assam and West Bengal, especially, Gorumara National Park showing a unique genetic signature. Given the degree of population genetic structure observed, prolonged separation of these protected areas is unwanted as this could lead to further loss of genetic diversity, consequently, affecting long term viability of the species.

Developing effective markers for censusing of Sumatran and Javan rhinos by local researchers

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The two most endangered species of rhinoceros are the Javan rhinoceros (*Rhinoceros sondaicus*) and the Sumatran rhinoceros (*Dicerorhinus sumatrensis*), both restricted in the wild to small populations in Indonesia. To permit censusing of these two species non-invasively, we developed microsatellite markers for use with fecal DNA. Since the available samples are often limited for endangered species such as rhinos, we developed a bioinformatics routine that would rely on just one or two individuals. Large numbers of next generation sequencing (NGS) reads were generated and screened to find loci with short tandem repeats (STRs or microsatellites), excluding those in repetitive elements. The bioinformatics routine determined whether the locus was polymorphic in the individual(s) sequenced, precluding the need for large-scale laboratory screening of markers to determine which were polymorphic. We modified PCR conditions and routines to maximize success when using DNA from fecal samples, relying on the more widely available samples from black rhinoceros (*Diceros bicornis*) for initial testing of modifications. The Javan rhinoceros historically ranged from the northern Indian subcontinent to the Indonesian islands of Sumatra and Java. The only remaining population of ca. 60 rhinos occurs in Ujung Kulon National Park in Java. For Javan rhinoceros, neither modern nor fecal DNA samples were available. We instead obtained bone samples from museum specimens, isolating their DNA in an ancient DNA facility. Specimens were sequenced for mitochondrial control region to verify their species and their origin in the island of Java. Four DNA samples were subject to NGS, of which one had a large proportion (ca. 40%) of target species DNA. From this museum specimen, 915 potentially polymorphic STR loci were identified using bioinformatics. Primers designed for these loci are initially being tested for their ability to amplify DNA in the related Indian rhinoceros (R. unicornis), and will then be tested for polymorphisms in Javan rhinoceros samples collected from the wild. The Sumatran rhinoceros, previously widespread across Southeast Asia, now consists of ca. 100 individuals in isolated populations in Borneo and Sumatra. We used DNA from 2 blood samples from North American zoos for NGS, conducting a similar bioinformatics routine to identify polymorphic STR loci. From 861 potentially polymorphic STR primers identified from NGS, a set of 29 that were variable will be further tested and used to genotype non-invasively collected fecal samples from wild rhinos. Based on PID and PID(sib) values, the Sumatran rhino markers should be sufficient for identification of individuals. For both species, development of genetic markers can aid in conservation and management through assessment of genetic diversity and relatedness, identification of conservation units, and census estimates. Funding from the International Rhino Foundation, US Fish and Wildlife Service, World Wildlife Fund, National Science and Engineering Research Council (Canada), UIUC ACES Office of International Programs Seed Grant and UIUC ACES Graduate Student International Research Grant.

Expression of elephant p53 (EP53) increases cell death in human cancer cells

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Huntsman Cancer Institute

We previously reported that compared with other mammalian species, elephants have a lower than expected rate of cancer (Abegglen JAMA 2015). While exploring cancer resistance in elephants, we discovered that elephants have 20 copies of TP53 (1 ancestral gene with introns and 19 retrogenes) compared to humans with 1 copy. TP53 amplification was associated with increased p53-mediated apoptosis induced by DNA damage in elephant cells compared to human cells. As a follow up to this study, we further explored the function of these elephant TP53 retrogenes by expressing their protein (EP53) in both normal and cancer cells with 2 functional TP53 alleles. Various elephant TP53 retrogene proteins (EP53rs) were expressed in normal mouse fibroblasts (NIH/3T3) and human osteosarcoma (U-2 OS) bone tumor cells. Western blot analysis was used to confirm expression of EP53rs. To measure the functional consequence of expression, we compared apoptosis of cells transfected with empty vector to cells transfected with myc-tagged EP53rs after treatment with doxorubicin, a chemotherapeutic drug that induces DNA damage. Apoptosis was measured with reagents that assesse cell viability and caspase activity (Promega). We observed a significant increase in apoptosis of both NIH/3T3 (normal) cells and U-2 OS (osteosarcoma) cells expressing EP53rs compared to empty vector transfected control cells. These results suggest that EP53rs are functional proteins that contribute to cancer resistance in elephants, and that elephant EP53 retrogenes can function in cells from other species to enhance their apoptotic response to DNA damage. These findings may hold significance for human cancer prevention and treatment. Importantly, this study provides yet another important demonstration of what elephants can teach us about our own health and why elephants must be protected from extinction.

An Assessment of Human Elephant Conflicts and mitigating measures taken to resolve the conflict in Dharamapuri Forest Division, Southern India

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A study on human elephant conflict and mitigating measures was carried out in Dharmapuri Forest Division. The conflict situation in the division is minimal unlike elsewhere in the state. At the same time the conflict situation may increase in the near future due to the increase in the human and elephant population in the state. Elephants are distributed in three forest ranges in the division namely Pennagaram, Palacode and Hogenakkal. Among three ranges Pennagaram range was affected more when compare to that of other two Forest ranges in the Division. An average of 20-25 acres of crops are being damaged by elephants annually across the division. The result shows that the elephants are frequently raiding crops in peripheral and enclosure villages. The crop damage caused by elephants was more on Ragi (38%) and Sugarcane (16%), than other crops cultivated in the district. A X^2 test performed to look at the significance of crops preferred by elephants, shows that there is significant difference in the crop preferred by elephants (χ^2= 5.00, df=4.p=.287), than the availability of crops cultivated. The mitigating measures (EPT, Solar fence) taken to prevent the crop damage by elephants are ineffective due to poor maintenance. Therefore, the preventative measures required regular maintenance. Elephants being intelligent animals can easily habituate to any preventive measure taken by Humans. Thus, effective

management strategies are required to prevent elephants entering into crop fields. We suggest management recommendations to manage the human elephant conflict in the division.

The EleFriendly Bus Service Initiative: A case study in implementing a conflict specific mitigation strategy to mitigate human-elephant conflicts in Wasgamuwa, Sri Lanka

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Sri Lanka Wildlife Conservation Society

Today most of the remaining elephant habitats in Sri Lanka is a mosaic of human dominated landscapes where both people and elephants overlap spatially leading to intense human-elephant conflicts (HEC). HEC is one of the biggest socioeconomic and environmental problems in Sri Lanka. The current framework and policies to reduce HEC and to conserve elephants mainly focuses on implementing broad-scale mitigation measures such as establishing national parks, management areas, corridor networks, relocating and/or fencing elephants. These broad mitigation strategies do not recognize the specific HEC issues at the local or regional scale. This is one of the main reasons why efforts to mitigate HEC at local and regional levels have failed. This paper highlights the importance of identifying the different HEC situations at local and regional levels and developing "Conflict Specific Mitigation Strategies (CSMS) to reduce HEC. Further, this approach highlights the significance of providing socioeconomic benefits to the affected communities to garner their support for elephant conservation. The Weheragala Human Elephant Corridor is a case study that aptly demonstrates how by implementing a CSMS approach we have been able to resolve HEC at the corridor. The corridor is an un-protected forest/grassland/woodland area that is outside the Wasgamuwa National Park (WNP) and is surrounded by agricultural land. The corridor is the only remaining link for the elephants that move daily to the southern forest reserves from the WNP. Also for people in two bordering villages the only road access to their villages is through the corridor resulting in daily encounters with elephants. Elephant presence in the corridor restricts the movements of the villagers. Especially the aggressive encounters which has increased the people's negative attitude towards elephants resulting in them harassing elephants by making noise to chase them or even shooting to kill elephants in the corridor and surrounding areas. The research conducted by the Sri Lanka Wildlife Conservation Society found the main reason for the high level of conflict is due to the mode of travel of the villagers. The villages use three main travelling modes: walking, cycling and travelling in small vehicles such as motorbikes, tuk tuks and hand tractors. We found by reducing the level of traffic in the corridor, we could reduce the conflict in the corridor and in surrounding areas. As a Conflict Specific Mitigation Strategy, we proposed to the community to operate a bus service—an "EleFriendly Bus Service". The community embraced the idea and agreed to stop harming and harassing elephants in the area. The EleBus currently provides safe transportation for the villagers and has reduced HEC in the corridor and surrounding areas. For the past 18 years the Sri Lanka Wildlife Conservation Society (SLWCS) has been developing sustainable solutions to mitigate HEC at the local level through its Saving Elephants by Helping People (SEHP) project.

Integrating teaching and folklore theatre to promote HECx in Tamil Nadu, India

R. Marimuthu
Zoo Outreach Organisation

Human elephant conflict is a 'burning issue' today in the elephant range countries and it has become a perennial problem in most of the elephant range areas in India. The State Government has initiated several HEC mitigation measures but the problem is increasing. If awareness could be spread to people on saving their own lives, we can have a sigh of relief. The sensitization and participation of the public is very much eminent to solve the conflict in the long run. In 2015, Zoo Outreach Organization conducted street plays with the funding from International Elephant Foundation in ten selected villages around Sathyamangalm Tiger Reserve, Erode district with an objective to sensitize villagers from different conflict villages to promote Human Elephant Coexistence HECx by using folklore art "Veedhi Natakam". The street play helped the villagers to understand the themes and issues related to HEC and the need for coexistence. The street play also taught them the important daily practices that they have to follow in the elephant range areas such as "do's and don'ts" in the elephant conflict areas. The highlight of this new approach is unlimited reach of the subject through street dramas and reaching out to villagers of all age levels within a stipulated time. This similar kind of approach now has been extended to Hosur Forest Division with again IEF funding in 2016.

Participatory management of human-elephant interactions in the Anamalai: Role of technological interventions

Ganesh Raghunathan and M Ananda Kumar
Nature Conservation Foundation

The Asian elephant (*Elephas maximus*) is faced by numerous anthropological threats in its range of habitats. Human-elephant interactions lead to intense and wide spread conflicts resulting in loss of human and elephant lives besides property damage in modified landscapes. This warrants extending conservation efforts beyond protected areas (PA) into human-modified elephant landscapes. The Valparai plateau, with 220 km2 of tea and coffee plantations interspersed with forest fragments and Eucalyptus plantations surrounded by PAs, in the Anamalai hills of the Western Ghats is a critical conservation area for Asian elephants in India. The plateau has been intensively used by around 100 elephants annually and nearly 70,000 people dependent on tea and coffee plantations for their livelihood, leading to frequent incidences of conflict. Damage to property and human deaths by elephants cause trauma and fear, and result in people indulging in retaliatory measures against elephants. Based on a long-term study in this region, we present results of implementation of Elephant Information Network (EIN) using advanced intimation systems as early warnings to people, its reception by local communities and effectiveness on the occurrence of incidents of conflicts in the Valparai region between 2011-2016. Daily tracking of elephant herds through direct surveys and an informant network of local people was followed to locate elephants within plantations and systematically record along with elephant presence details in a database. Based on this, elephant information is conveyed to people by means of (i) a 'crawl' on local television channel (ii) SMS text and voice call alerts in English and Tamil (vernacular) sent to registered mobile phones residing within 2 km radius from elephant locations (iii) installation of mobile phone-operated elephant alert indicators in 25 strategic locations to warn people of elephant presence. We have systematically recorded, categorized, and analyzed response calls to SMS text, voice call, and TV crawl alerts from people to understand their reception to early warning systems. At least two persons in each elephant alert light

location were assigned the responsibility of operating alert beacons and analyzed their participation in warning people in respective beacon localities. On average, nearly 1000 alert messages are sent out daily, to people from the database (n=4400) who have registered for elephant alerts. Gradual shift in response calls of people from enquiring about elephant presence to conveying elephant locations elucidate participatory involvement in the system. Active involvement in operating elephant alert beacons is visible from the fact that 98% of light operations are carried out by local communities. Early alerts about elephants also facilitated people to take adequate precautionary measures and have resulted in more than 50% decline in property damage incidents over years. These pro-active steps have reduced human fatalities from an average of 3 people/year prior to our long-term study between 1994–2002 to 1 person/year between 2003 and 2016. Our study suggests that a shift from conventional reactive strategies of problem animal approach to pro-active problem location approach with sustained participation by stakeholders could promote human-elephant coexistence in modified landscapes.

Cultivating alternative crops reduces crop losses due to elephants

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In the farmlands adjacent to protected areas in which populations of African elephants *(Loxodonta africana)* and Asian elephants *(Elephas maximus)* still exist, farmers frequently come into conflict with these pachyderms. Attracted by nutritious crops on the fields they destroy substantial amounts of harvest by crossing through the plantations and feeding on the crops. For a peaceful coexistence of people and elephants new ways need to be found to repel or not attract the pachyderms to fields. The replacement of crops, which are attractive to elephants by such, which are not attractive, might be a solution for the agricultural sector in and close to elephant habitats. In the Lupande Game Management Area close to South Luangwa National Park, Zambia, a field experiment has been conducted in the years 2010-2011 to test the attractiveness of potential alternative crops (ginger, onion, garlic and lemon grass) compared to a control plot with maize as a very attractive crop. Elephants visited both, the test crop plots and the control plot of maize and completely destroyed the maize six weeks prior to its harvest time. In contrast, the test crops were only slightly damaged, mostly through trampling. In a very late state of the experiment lemon grass and ginger were consumed by the elephants in small quantities. Yields that have been obtained from the test crops would have exceeded the yields of the maize. However, the ecological suitability as well as market value of the grown crops have to be taken into consideration when making the crop choice for farming. It can be concluded that garlic, ginger and lemon grass are less attractive to elephants than maize. However, even though the test crops are less attractive to African elephants, they may not be completely unpalatable or even repellent to them. A similar field experiment has been repeated in the Western Buffer Zone of Bardia National Park, Nepal. Mint, basil, turmeric, lemon grass and citronella have been tested on three plots against controls of rice and maize. Although frequency of elephant visits was less than on the Zambian test plot, it can be concluded that elephants did not consume any test crops, whereas they fed on the control crops. The selection of appropriate, less attractive or even unpalatable crops is an important step to tackle human-elephant conflicts. If the pachyderms do not find nutritious and attractive crops on the farms in their home range, reduction of crop losses is very likely. To foster this approach however, more detailed studies are needed, to observe the resistance of the crops in long-term and to identify a larger diversity of unattractive crops.

Behavior and social dynamics of crop-raiding elephants (*Elephas maximus*): Can beeline fencing mitigate human-elephant conflict in a highly crop-raided region of Sri Lanka?

Kylie M. Butler
University of Newcastle

Human-elephant conflict (HEC), specifically crop-raiding, is a major conservation challenge. Many methods have been trialled to deter elephants from crops with varying success. One community-based deterrent demonstrating success in Africa is beehive fencing. A beehive fence is a simple construction of beehives hung from posts and connected to each other with wire, surrounding an area to be protected. If an elephant attempts to enter the protected area, the beehives are disturbed and the bees swarm and sting the elephants, causing the elephants to leave. Trials show that farms protected by beehive fencing experience less crop raids then nearby farms without. Thus, beehive fencing may play an important role in reducing farmer-elephant conflict. However, it is not yet known if this deterrent will work in Asia. This project is the first to investigate beehive fencing as an Asian elephant crop-raiding deterrent. We have established a research site of 10 beehive fences in Dewagiriya Village, Sri Lanka – an area badly affected by crop-raiding. We work with farmers to maintain fences and teach beekeeping, including honey harvesting as an additional income source. Since 2014, data has been collected on elephant sightings (> 300) and damage caused (71% of sightings) from experimental and control farms, to evaluate the deterrent effect of beehive fences and create a profile of crop-raiding. Simultaneously, we are investigating characteristics and social patterns of the local elephant population to assess whether crop-raiding individuals share common traits (that may be used as predictors of crop-raiding behaviour), or if social patterns can provide insight into how elephants acquire crop-raiding behaviour and/or learn to respond to mitigation techniques. We categorised our study site into 3 'zones', each representing different levels of risk to the elephants, posed by humans:

- Wasgamuwa National Park, low-risk, as interactions with humans are limited to tourist vehicles.
- Weheragala Corridor, medium-risk, as humans and elephants share resources but are not directly competing for them.
- Dewagiriya Village, high-risk, as people commonly scare or injure elephants to deter them from crops.

Here, we record demographic factors (age, sex, herd structure, abundance) and capture video footage for personality assessments (behaviour coding) and to identify association patterns. Data collection will be complete in Dec-2016. Preliminary analyses indicate lone males are the dominant crop raiders, male or mixed groups are the most common associations, and females typically respond to disturbance more aggressively. In-depth analysis will be performed at the end of the data collection period. Accurately determining demographic and behavioural traits can provide valuable baseline information relevant to the social behaviour and structure of a population, and to management and conservation planning. We expect farmers to benefit from reduced crop-raiding and improved harvests, and also from additional income generated through honey sales. Generating in-depth knowledge of elephant crop-raiding characteristics and the overall potential of beehive fencing as an Asian elephant deterrent will enable identification of other HEC hotspots in Asia that may benefit from this technique, and help to facilitate its appropriate expansion to other locations.

Engaging legislators in wildlife conservation in Aceh, Indonesia

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The fact that most of the Sumatran elephant home ranges are outside the conservation areas covering various land status, management, and scale issues, demands a broad and comprehensive strategy to conserve this critically endangered species. The human elephant conflict as a main issue added to the complexity of the multi-dimensional problem requires a comprehensive cross sectoral, and integrated approach from the Development branches of Government. The magnitude of the required solutions needs to be communicated to the right audiences since it is clearly beyond the Forestry Department capacity. A survey conducted in Aceh, assessing how civil society organizations (CSO) select target audiences and how they spend communication resources across the target audiences, reveals that legislators have been neglected by the majority of the environmental CSOs working in Aceh in the past, despite the fact that legislators are the ones who legalize the spatial planning and regulations, and approve the development budget. This paper presents an effort to engage the legislators in Aceh province, Indonesia to support wildlife conservation efforts using sustainable development as the overall concept and establishing a Caucus in the Aceh Parliament as the main platform to generate awareness and intensive communication between Parliament and multi-stakeholders. This effort has resulted in the Aceh Sustainable Development Caucus.

Knowledge on Bio diversity, elephant and elephant conservation among the school students of Megamalai estate, Theni District Tamil Nadu, India

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CSI Jeyaraj Annapackiam College of Nursing and Allied Sciences

Meghamalai, is a cool and misty mountain range situated in Western Ghats, India. It is a virgin forest, hidden paradise, with a lot of flora and fauna. Many elephants cross the estates during November each year so human-elephant conflict management is very important. Awareness on bio-diversity is an important socio-scientific issue that is often regarded as a pre-condition to sustainable eco-development. Multi-level integrated governance must be strengthened and education of children and students on elephant conservation is essential to reduce human-elephant conflicts in the village.
Objectives:
1. To understand the knowledge on Bio-diversity among the school going students.
2. To identify the scientific knowledge on elephants and its acts in the forest.
3. To identify the student's knowledge on elephant conservation
4. To understand the knowledge on ecology and its conservation
Research findings:

- 35% of the respondents are saying that knowledge on elephant conservation is essential for the students and remaining 65% of the respondents are saying that it is not necessary for the students.
- 55% of the respondents are saying that knowledge on bio-diversity is essential for the students and remaining 45% of the respondents are saying that it is not essential for the students.
- 62% of the respondents are saying that plastic bags and plastic sheets will give digestive problem to the elephants if they eat in the forest, remaining 48% of the respondents are saying that if will not give problem to them.

- 43% of the respondents are saying that elephants can swim in the water, remaining 67% of the respondents are saying that they cannot swim in water.
- 25% of the respondents are saying that elephants will sleep in the forest in night remaining 75% of the respondents are saying that elephants cannot sleep in the forest.
- 27% of respondents are saying that elephant live more than 80 years, 48% of the respondents saying that elephant live 60 years and remaining 25 percentage of the respondents are saying that they live 50 years only.
- 62% of the respondents are saying that Ecology education is essential for the public and remaining 38% percentage respondents are saying that ecology education is not essential for the public.
- 45% of the respondents are saying that conservation effort can start from the school 27% of the respondents are saying that conservation efforts can start from the family remaining 28% of the respondents are saying conservation is Government work.

Education programs of Asian Elephant Support (AES)

Linda Reifschneider
Asian Elephant Support

Asian Elephant Support was founded in 2006 and now has completed its first decade focusing on supporting the care and conservation of elephants in Asian range countries. Our officers/directors are Linda Reifschneider, April Yoder, Vanessa Gagne, and Barbara Davis. In addition, we have four all-year volunteers and over thirty individuals, many elephant keepers, who step up to host a location at our annual California Pizza Kitchen event. While we are a small nonprofit, we have funded projects in India, Laos, Myanmar, Sri Lanka, Sumatra, Thailand, and Vietnam. Several of the veterinarians we have supported have presented at international workshops and symposiums over the years. A substantial part of our effort addresses the education aspect of caring for today's elephants in Asian range countries as well addressing the future of the species. We appreciate the opportunity to recap the funding we have done since the EMA in 2015:

- Elephant foot care training in Myanmar, a follow up to the vet workshop held earlier in 2015
- Workshop attendance funding for seven veterinarians from range countries
- Facilitating the second phase of the USFWS-funded program, "An Innovative Partnership Program for Human-Elephant Coexistence and Forest Conservation in Aceh, Sumatra, Indonesia"
- Funding Dr. Kushal Sarma's elephant health clinics in the Kaziranga area of Assam, India, as well as his medical care for the two elephants at the Mayapur temple
- Funding for the Biodiversity & Elephant Conservation Trust's 2016 school outreach program in Sri Lanka

Our board's outreach efforts include reaching audiences of varying size, age, and education, about the challenges today facing Asian elephants as well as those whose lives are so entwined with them. Being a totally voluntary nonprofit, we make sure every dollar of every contribution goes directly to the projects that we feel best fit our vision and mission statements.

Raising Awareness and Funds from the Field: Effective Strategies in the Age of Interconnectivity

Sarah Conley[1], Nikki Sharp[2]
[1]International Elephant Foundation
[2]Wildlife SOS

Research requires funding, and in our uncertain economy you cannot rely solely on the generosity of others to continue your work—you must take action yourself and become partners in raising funds to support your project. The work you do is important, but its impact becomes more powerful the further it reaches. Participating in fundraising is an excellent opportunity to educate outside of your region and outside of the conservation sector to people around the world of all ages and backgrounds. Increased visibility can create a unity of voices that will create traction for elephant conservation programs every time information is shared. The world has changed with respect to communication. With the advent of the internet and development of social media, it is easier than ever to reach people who previously would have never come across your material. With this increased connectivity comes greater expectations. Donors want more than a scholarly publication. This presentation shares some 'best practices" for raising awareness for your research and cause, while also helping to raise funds. Communication is more content-driven than it has ever been. In 2015, Facebook estimated that 2 billion photographs were shared on its network every single day. These images are viewed and then forgotten, highlighting the need to have a constant stream of memes, photographs, videos, and articles so your organization/project/cause stays present in the minds of your donors. Effective content starts with telling a story. What are you doing? Why do you do it? Why should others care? Since your audience is not restricted to those who get scientific journals, information must be digestible for a larger audience who may think more emotionally than technically. Utilize technology to bring people into your world and create an investment by the viewer. Social media is a powerful tool for raising awareness. Whether it is through Twitter, Facebook, a blog, short YouTube videos, or the next hot new app, keep active and update regularly. Donors will feel like they are getting the most out of their sponsorship of you, and you will be able to increase your visibility and create new potential supporters. Frequent communication, good reports, and interesting content will go a long way towards helping your cause. Everyone loves animals; it is your job to turn that emotion into action.

Making the Shortlist: Grant Writing Best Practices to Improve Funding Success

Deborah Olson and Sarah Conley
International Elephant Foundation

The International Elephant Foundation (IEF) accepts proposals for elephant conservation and research funding support annually. IEF offers financial support for i*n situ* and *ex situ* projects for Asian and African elephants, including protection of wild elephants and their habitats, scientific research, education efforts, and improvements in captive elephant care. Proposals are peer-reviewed by a panel of advisors from the fields of medicine, research, academia, and elephant management. Awards typically range about US$10,000 per year.

Proposals are preferred that meet some or all of the following objectives and criteria:

- Project is collaborative in nature.
- The proposal should clearly contribute to the *in situ* or *ex situ* conservation of African or Asian elephants or their habitats.

- Project is part of an established conservation program or is well-suited to become a long term program.
- Project is grounded in sound scientific methodology, is logistically feasible, and has a high probability of success.
- Project has conservation value and measurable impact.

In this presentation, we will discuss helpful hints for the completion of the funding application to improve the success of a project being selected for funding.

Posters

Poliwire electric fencing systems as farm-based deterrents for elephant crop-raiding

Kerryn D. Carter PhD
Elephant Connection Research Project

Human-elephant conflict is widespread across Africa due to crop raiding by elephants, which can severely affect the livelihoods and security of subsistence farmers. Farming communities adjacent to protected areas often regard wildlife authorities as responsible for crop damage by wildlife, which can undermine wildlife conservation efforts. In some areas a direct link has been made between crop damage and levels of elephant poaching. Our study in Zambia aimed to mitigate the impact of elephants on the livelihoods of farmers through trials of *Poliwire electric fencing systems,* which are small, farm-based fencing systems erected seasonally to deter elephants from maize fields while allowing them to continue to move through the landscape. Poliwire is a mix of fine wire strands interwoven with polyethylene**,** and due to its flexibility, it is not stiff enough to form wildlife snares; thereby eliminating potential collateral damage to wildlife. Electrification of the poliwire was achieved with a solar panel, solar charge regulator, battery and energiser unit, which were placed in farm buildings that were adjacent to fields. A single-strand of poliwire was placed on poles 15 m apart at a height of approximately 1.5 metres and extended 500 m in either direction from the farm buildings to completely encircle fields. The poliwire was flagged with plastic strips to ensure visibility. Our aim was to have a minimum voltage of 7.0 kV, based on studies in Kenya with the use of electrified fences to mitigate HEC on the Laikipia Plateau. We found that due to the greater resistivity of the poliwire's six stainless steel strands compared to conventional fencing wire, it only maintained a voltage of 7.0 kV on farms that were one kilometre in circumference or less. Therefore this poliwire product is more suited to mitigation of HEC on smaller farm plots and its cost-effective pricing makes it suitable for small-scale subsistence farmers. The single-strand of poliwire was very effective in deterring elephants; by encircling the entire field, elephants were completely prevented from entering. Once elephants had touched the poliwire once, there were no further challenges to the fence-line thereafter, regardless of the elephant visitation rates or the length of time after the contact. Therefore elephants did not habituate to the electrified poliwire once they learned the danger of it. So instead of elephant encounters increasing towards the end of the maize growing season as expected (when the maize was mature and more preferred by elephants), the elephant visitations ceased. This poster outlines the technical aspects of installing a *Poliwire electric fencing system* as an additional deterrent method for HEC managers to use, especially in areas where elephants may have become habituated to other methods. In addition, it provides a relatively low-cost, low-labour, low-maintenance method, which will be important in HEC areas where it is difficult to instil community ownership/management of wildlife conflict. By implementing farm-based deterrent measures that can help to alleviate human-elephant

conflict, farming communities may become more accepting of elephants and thereby work together with wildlife authorities for their long-term conservation.

Effects of environmental pressures on patterns of gastrointestinal parasitism in black rhinoceros in Addo Elephant National Park, South Africa

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[3]Department of Conservation and Science, Lincoln Park Zoo
[4]School of Integrative Studies, George Mason University

Once the most numerous of rhinoceros species, black rhinoceros (rhino; *Diceros bicornis*) is now critically endangered due to habitat degradation and poaching. Our understanding of natural patterns of parasitism in this species is limited. We examined gastrointestinal parasitism in the Main Camp and Nyathi black rhino populations of Addo Elephant National Park (AENP), South Africa, in relation to environmental factors and adrenocortical activity (via fecal glucocorticoid metabolite, FGM, analyses). A total of 119 fecal samples were collected from 25 individually identified rhinos. Fresh feces were stored in 10% formalin at ambient temperature until they were processed at Emory University using sodium nitrate floatation, fecal sedimentation, and immunofluorescent antibody (IFA) detection to isolate helminth eggs, larvae, and protozoal cysts. Parasites were identified on the basis of coloration, shape, contents and size; samples were scored for the presence/absence of pathogens. Fecal hormones were extracted in the field using a validated homogenization technique and analyzed at Lincoln Park Zoo for FGM concentrations using a corticosterone EIA (CJM006). A total of 21 parasite species, including five nematode and 16 protozoans, were detected. No pathogenic protozoa (i.e., *Cryptosporidium* sp. and *Giardia* sp.) were found in any of the feces examined. Parasitism did not vary ($P>0.05$) with sex or age category. However, rhinos residing in the section of AENP with low elephant density (Nyathi) had significantly higher prevalence and diversity of ciliates ($P<0.001$) and lower diversity of nematodes ($P<0.001$) than rhinos living among high elephant density (Main Camp). There was a negative relationship between total monthly precipitation and total nematodes ($r=-0.20$, $P= 0.03$) and average monthly temperature with total protozoans ($r=-0.22$, $P=0.02$). A positive relationship existed between FGM concentrations and total protozoans ($r=0.21$, $P=0.02$). The results of this study demonstrated patterns of infection that provided an index of black rhino population health directly related to habitat quality and usage. For AENP rhinos, parasite prevalence was most strongly affected by site, suggesting that ecological factors may be more relevant than physiological ones. A difference in the positive impacts of ciliates, which aid digestion and serve as a proxy for overall nutritional health, was observed between the two sections in AENP. These differences suggest that the rhinos in Nyathi had access to higher quality nutrition because of less competition with elephants and a greater range of forage options, thus facilitating a more diverse ciliate community. Higher nematode numbers coupled with lower prevalence and number of ciliate species per individual in Main Camp suggests lower diet quality caused by environmental and anthropogenic disturbances in that region of AENP. Due to limited range size and high fecundity, AENP rhinos face eventual overpopulation and increased exposure to anthropogenic activities that may increase parasite exposure and stress. Baseline measures of parasitism and stress prior to this process will allow quantification of habitat quality change through time, permitting proactive and adaptive approaches to mitigating evolving health risks while providing insights for conservation and management of these and similar endangered populations.

A comprehensive evaluation of foot disorders among captive elephants in Kerala

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[1]Veterinary Surgeon, Kerala Animal Husbandry Department
[2]Professor and Head, Department of Veterinary Clinical Medicine
[3]Professor and Head, Department of Veterinary Surgery
[4]Associate Professor, Department of Veterinary Clinical Medicine, Kerala Veterinary and Animal Sciences University
[5]Professor and Head (Rtd), Kerala Agricultural University

Over a period of two years, a study was conducted to identify the foot problems among captive elephants in Kerala to identify the etiological factors and develop effective management and treatment protocols. Fourteen different types of foot disorders were identified, like overgrown nails, overgrown cuticle, split nails, cracked sole, pitted sole, overgrown sole, cracked heel, worn sole, ingrown nails, pododermatitis, laminitis, arthritis, abscess, and non-specific wounds and injuries. In general, male elephants were more affected with foot disorders than females. Unhygienic management practices during musth was the major reason for higher occurrence of foot disorders in males. The disorder that recorded highest prevalence was overgrown nails. Pododermatitis was found to be the most difficult problem to treat and cure. Antibiotic sensitivity tests were done on different types of bacteria isolated from the foot of elephants with pododermatitis, abscess, injury and laminitis. The most common species of bacteria isolated were Bacillus spp. followed by Streptococcus spp., Staphylococcus spp., Pseudomonas spp., Escherichia coli and Klebsiella spp. Amikacin was the antibiotic to which most species of bacteria were sensitive. Fungal species isolated from diseased feet included Aspergillus spp., Penicillium spp. and Candida spp. In 16 cases of pododermatitis, efficacy of three treatment methods was examined. External application of formalin foot bath and sodium thiosulphate paraffin mole flavum paste, external application of copper sulphate and Castellani's paint and external cryotherapy along with intravenous administration of amikacin were the three treatment methods that were evaluated. Cryotherapy with supportive antibiotic medication was the best technique for better debridement of excessive granulation and faster cure of pododermatitis. Training of elephants to accept foot care was found to be very beneficial. Training of mahouts for rendering better foot care to elephants was also found to be essential. In addition, a unique elephant sandal, useful during the course of treatment and helpful in preventing recurrence of foot disorders was also designed and developed during the course of the study.

Testosterone characteristics and musth onset of young male Asian elephants at African Lion Safari and Oregon Zoo

Sharon S. Glaeser [1], Charles Gray[2]
[1]Oregon Zoo,
[2]African Lion Safari

To safely and effectively manage young male elephants in captivity, it is important that we know the signs of onset of musth. Although we are learning more about male elephant social structure and the relationship of testosterone concentrations to musth, we know relatively little about physiological changes with age and male elephant development with regards to testosterone concentrations and onset of musth. Studies have shown that elephants in captivity can reach sexual maturity at an earlier age than their wild counterparts. A musth survey by Scott and Riddle (2003) showed that musth began at different ages depending on the social situation. In Brown et al (2007) males ages 8-24 showed age-related

increases in testosterone, but a rise in testosterone concentration was not associated with the onset of musth signs. The age of first recorded musth was 12 years. The age range was 8-50 years, so calves and juveniles were not assessed. For younger males we have not yet defined "normal" testosterone concentrations, so we cannot determine what is baseline versus elevated in order to describe the timing of onset of musth with elevated concentrations. The ultimate goal of this study is to further our understanding of the relationship between physiological changes in young males and their social environment. There are currently 5 subjects in the study: 1 male at Oregon Zoo (age 9 months to 8 years), and 4 males at African Lion Safari (age range 5 to 15.5 years). Age categories are: Calf (0-1 yr), Juvenile (1-5 yr), Sub-adult (5-15 yr) and Adult (>15 yr). Testosterone is measured as part of routine management and musth signs are documented in management records. At both the Oregon Zoo and African Lion Safari male calves and juveniles have interactions with adult bulls, which reflects the situation in a typical elephant herd where dominant bulls come into the herd to breed cycling females, and therefore provides a good model for studying testosterone profiles in the early development of males. This study will provide testosterone profiles, age of first musth, musth signs, and a general description of the social management of each young male. This information will contribute to baseline data needed to investigate the relationship between testosterone concentrations and onset of musth among young males that have exposure to adult bulls and those that do not, which may ultimately influence the social management of young male Asian elephants in captivity.

World Rhino Day in Japan

Kiyasu Kaoru[1], Masaru Senzaki[2], Noriyuki Nonoue[3], Haruo Otsu[4]
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[2]JAZA Indian Rhinoceros Coordinator
[3]JAZA Black Rhinoceros coordinator
[4]Former JAZA Black Rhinoceros coordinator

Promotion of rhino conservation is our most important aim. Japan maintains three species of rhinos, 9 greater one-horned rhino (*Rhinoceros unicornis*) at 4 zoos, 23 eastern black rhino (*Diceros bicornis michaeli*) at 11 zoos and 40 southern white rhino (*Ceratotherium simum simum*) at 14 zoos, amounting to 72 rhinos at 24 zoos (as of August 2016). However many citizens don't know much about rhinos. To make Japanese people more familiar with rhino, we are sending a message through World Rhino Day (WRD). WRD was first announced by WWF-South Africa in 2010. The next year Lisa Jane Cambell of Chishakwe Ranch in Zimbabwe and Rhishja Cota-Larson of ANNAMITICUS made WRD a day of celebration for all five species of rhino. WRD has been celebrated on September 22 every year. It has grown to become a global campaign. In Japan, we started WRD in 2013. We took two approaches. First, with a grant from the wildlife animal fund of Japanese Association of Zoos and Aquariums (JAZA), we made posters and leaflets and distributed them to all zoos keeping rhinos. Each zoo put up the poster and passed out the leaflets to raise public awareness. The Japanese poster gave a rhino overview and a message "There are facts you don't know about rhinos". Leaflets contained information - physical, ecology, life cycle, behavior, diet, communication and breeding of rhinos. Second approach, each zoo held an WRD event on September 22 - for example, special keeper talk, behind the scenes tour, feeding and touching a rhino, quiz tournament, panel exhibition, joint projects between zoo and library, comparison two species of rhino and so on. Some Zoos used websites and social networking services (SNSs) like facebook and twitter for celebrating WRD. Many people participated in the event and learned about rhino. In 2013, when we started joining WRD, half of zoos keeping rhino in Japan, held an event. These events have been taken up by media including TV news and newspaper. Since then, we hold this event every year on September 22.

Effect of the GnRH vaccine Improvac® on testicular size and ultrasonographic appearance in African elephants (*Loxodonta africana*)

Imke Lueders[1,5*], Debbie Young[2], Stephan Botha[3], Ilse Luther [4,5], Liana Maree [5], Gerhard van der Horst[4,5], André Ganswindt[6], Henk J. Bertschinger[6]
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The effect of Gonadotropin Releasing Hormone (GnRH) vaccines on behavior and testosterone secretion has been studied in African and Asian elephant bulls[1,2]. However, little is known about the effect on the reproductive organs. We evaluated the testicles of 17 African elephant bulls either during a treatment period of three years (n=11) or once in long-term treated bulls (n=6). Bull ages ranged from 7-36 years. Four bulls were wild while the remainder were held in human care in South Africa. From the eleven bulls of the follow up study, seven were ultrasonographically examined prior to GnRH vaccination to record normal ranges for testicle size and appearance. A portable, battery driven ultrasound machine (Logic e, General Electrics Healthcare GmbH, 42655 Solingen, Germany) equipped with a 2-7 MHz convex probe was used. The intra-abdominally situated testicles were visualized transrectally either by a hand-held transducer or with the help of an extension (a 42 cm long hollow steel pipe with a T -shaped handle and a 45° angled vent at the tip to hold the ultrasound probe). In the seven elephants examined prior to any GnRH vaccination, testicle size correlated with age at the start of the study ($r=0.897$, $p=0.0062$). For 11 elephants in the follow up study, the testicle diameter measured on average 13.3 ± 2.6 x 15.2 ± 2.8 cm at start of study (0-2 injections) and declined significantly to a size of 7.6 ± 2.1 x 10.2 ± 1.8 cm after >5 injections in these animals ($p=0.0009$, $t=6.121$). The testicle circumference declined from 45.1±10.2 cm to 28.9 ± 5.3 cm. In all follow-up study bulls, the quality and shape of the testicles changed from firm and round to oval or amorphous at the end of the study. The echotexture was echogenic at the beginning, but reduced strongly in echogenicity, likely reflecting the loss in texture and tissue density. A consistent finding with elephants treated >5 times was dilatation of the testicular vein. This could be confirmed by Colour Flow Doppler sonography, showing a very different, diffuse pattern in untreated males compared to repeatedly treated elephants. Elephants that were treated > 5 times in their life had very small and deformed testicles. In the six elephants that received >7 vaccinations, we saw inhomogenous testicular tissue with hyperechoic areas which were regarded as signs of parenchymal degeneration and fibrosis. In summary, the results are similar to a study in one young Asian elephant bull we reported earlier[3]. Testicle size of the African elephant bulls reduced almost by 60% and degenerative signs were noticed after five vaccinations suggesting irreversible damage of the organs. Thus, the vaccine should not be repeatedly administered to any males that may be warranted for future breeding as full reversibility is highly doubted given the results of our study.

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Enhancing Elephant Welfare through Science and Management

Cory Nordin
Zoological Manager/River's Edge Saint Louis Zoo

The Saint Louis Zoo is home to a multi-generational family of Asian elephants which includes one male and nine females ranging in age from 3 to 46. Results from a science-based research project and in house surveillance were used to influence management decisions and enhance elephant welfare. A brief report of this process will be presented. In 2012, the Saint Louis Zoo participated in a multi-institutional study using science to better understand the welfare of elephants. Using the results of the study, specific welfare goals were identified for our elephant family that could be achieved through management changes. The next step of this process was to gather more information through keeper-led projects to identify baseline information on the individuals and scenarios that were being targeted. Some of the areas of focus included: body condition, feeding strategies, social and spatial choice, behavioral husbandry, and stereotypy. Additional data was collected by the keepers using video surveillance and live observations. After gathering baseline information, gradual management changes were implemented and their effects were monitored. Some of the management changes were focused on individuals that were outliers for specific welfare criteria while other changes focused on general management strategies that would enhance the welfare of the entire family. Our elephant care program has a strong focus on behavioral husbandry. Using operant conditioning, our training program specializes in calf training and pre-emergency preparedness. This process has been continually refined to ensure that the highest level of care can be given at all times, including during a health crisis. This requires significant resources by both the caretakers and the animals. Many of the management changes that we identified would directly compete with the amount of time that individual elephants were available for one-on-one training sessions. While considering possible welfare enhancing management changes, a balance had to be maintained to allow this high level of training to continue while maximizing the elephants' amount of social and spatial choice. To achieve this balance, training sessions had to be efficient and effective enough to accomplish training goals in shorter and fewer sessions. While considering the goals identified through the scientific study we have moved to a system that includes integration of all of the females for up to 23 hours per day with spatial choices that include multiple habitats, corridors and indoor space at all times. These changes have allowed for a significant amount of spatial choice and social contact for the bull as well increased choice and socialization for the entire family. Our elephant care program continues to evolve. Using the tools that were inspired by a collaborative scientific study and further developed within our program has fostered a mindset that is constantly reevaluating and testing our processes.

Translocation of problematic tuskers: Lessons learnt from practical experience with an Asiatic tusker (*Elephas maximus*) in Hosur forest division, Tamil Nadu, INDIA.

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[1]Conservator of Forests
[2]Executive member, TASPEF
[3]Forest Veterinary Officer

Man-Elephant conflicts are common in most of the elephant countries all over the world. Invasion of elephant herds or single tusker to human habitation is occasion or regular depending upon the places. Since it is a problem involving life and damage to human, it is viewed seriously by the government agencies and various measures to tackle the problem are in vogue in different parts of the country. Of all problematic issues concerning invading elephants, the issue of invasion by single adult tuskers is considered the most serious one since driving away an adult tusker from human habitations into the forests involve risks of more damage to property and human life. Many occasions, translocation would be the most practical solution to solve the problem of the invaded tuskers. By our practical experience with translocation of tusker, we learnt a lot in solving problems connected with translocation of tuskers. The whole episode has been videotaped for presentation. The following are the common problems encountered with the translocation of tuskers: i. Restricting the area of the movement, ii. Successful tranquilizing techniques, iii. Loading onto the truck and transporting and iv. Releasing into the forests and monitoring. Our practical experience with successful translocation of a problematic adult tusker, we learned a lot that can pave the way to further translocations of tuskers without problems. The present paper outlines various problems that are likely to occur with translocations and explains how to tackle them successfully.

The impacts of dehorning on the southern white rhinoceros (*Ceratotherium simum simum*)

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School of Pharmacy and Biomolecular Science, Huxley Building, University of Brighton

Despite high rates of dehorning, few studies have investigated whether horn removal has an abject effect on rhinoceros health or behaviour. The process of dehorning removes a large portion of a rhino's horn mass without causing apparent injury to the animal. This is done for either conservation reasons, in the hope that it reduces their attractiveness to poachers, or for economic reasons, through the speculative stockpiling of horn. This study seeks to determine whether southern white rhinoceros (*Ceratotherium simum simum*) exhibit an observable physiological or behavioural response to dehorning, through either temporal variation in hormone levels or changes in sociality. It is hoped that this will inform future conservation policy and aid the debate on the reestablishment of the horn trade. Following exposure to a stressor, rhinos have been shown to experience elevated concentrations of adrenal steroids and suppressed concentrations of gonad steroids; these hormones can be reliably detected through the analysis of faeces. Faecal samples were collected from horned and dehorned rhino, both of which were darted over the course of the study period. Samples collected before or during immobilization will indicate baseline hormone levels, with subsequent samples collected at one to two week intervals indicating any consequent changes. Ongoing monitoring of hormone levels over a six-week period allows for the decoupling of the impact of immobilization on recorded levels from any effects of dehorning. Hormone metabolites were extracted in the field by adding faecal matter (0.15 g) to 90° ethanol (0.75 ml) and distilled water (0.75 ml). Samples were then vortexed (5 mins) and centrifuged (15 mins, 1,500 rpm) and

the resultant supernatant removed and refrigerated until analysis. Concentrations of corticosteroids, testosterone and progesterone were then determined by immunoassay. Preliminary analyses indicate that hormone levels can be reliably detected following storage for a number of months, with initial corticoid levels averaging 778 ± 876 ng g-1 (n = 30). Faeces collected from an injured female shortly before death produced the highest value, at 4729 ng g-1. The horns of rhinoceros are important for territorial defense but their evolutionary significance may also relate to foraging behaviour, maternal care and mate choice. The few existing studies to look at horn status have focused on black rhinoceros (*Diceros bicornis*), where horn size was found to confer dominance advantages. To investigate impacts on white rhinoceros, groups of horned and dehorned individuals were observed at two field sites in South Africa and classified by their age (based on body sizes) and gender. All dyadic interactions were recorded, with agonistic interactions scored as either a win or a loss to assess the dynamism of within-group dominance hierarchies. Data on location, group composition and habitat type were also recorded. Preliminary analysis (using generalized linear mixed models) will be presented here in order to establish how horn status influences group stability and sociality. Further data collection will continue to help identify whether behavioural or physiological changes exist between horned and dehorned rhino and provide insight into how effective dehorning is as a conservation technique.

Stress physiology in free-ranging Asian elephant: Influence of ecological factors.

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[1]Center for Ecological Sciences
[2]Department of Molecular Reproduction and Developmental Genetics, Indian Institute of Science

Conservation of flagship species like elephants is the major concern in the current scenario of degrading habitats and increasing anthropogenic activities, which might be adversely impacting the animal welfare in terms of health and reproduction. But before understanding the role of such activities in defining the health status of animals, it is very essential to study the influence of natural variations. Various ecological challenges like seasonal variations and resource availability are known to influence stress status of free-ranging Asian elephants. However, how such eco-variations influence animals' stress physiology is not yet assessed. We evaluated the influence of eco-variations, particularly seasonality, animals' body condition, sexes, age and habitat on the stress status of free-ranging Asian elephants in the Bandipur National Park (BNP), the Nagarhole National Park (NNP) and few samples from the Hassan district (H) of Karnataka, India. For this, we collected 296 fecal samples of elephants (in BNP, NNP and H) during two ecological seasons (wet and dry) in two years. We assessed animals' body condition score (BCS); scale: 1 to 5; 1, emaciated and 5, obese conditions. Fecal glucocorticoid metabolites (fGM) were measured (µg/g) using a group-specific 11-oxoetiocholanolone EIA (11-oxoaetiocholanolone-17-CMO:BSA as an antibody and biotinylated-11-oxo-aetiocholanolone as a label). Our results show that while dry and wet seasons did not show any difference in fGM levels, individuals from BNP had a higher fGM level than those from the NNP. BCS and fGM levels showed strong negative correlation. Moreover, levels of fGM were more in females than in males and also including both sexes, they were more in adults than in sub-adults or juveniles. These results indicate that among the investigated parameters, BCS, habitat and sex of animals influence the stress status of free-ranging Asian elephants. Our ongoing studies on a large sample size would provide a detailed understanding of ecological factors affecting stress physiology of Asian elephants.

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INTERNATIONAL RHINO FOUNDATION

15th International Elephant & Rhino Conservation and Research Symposium





14 - 18 November 2016

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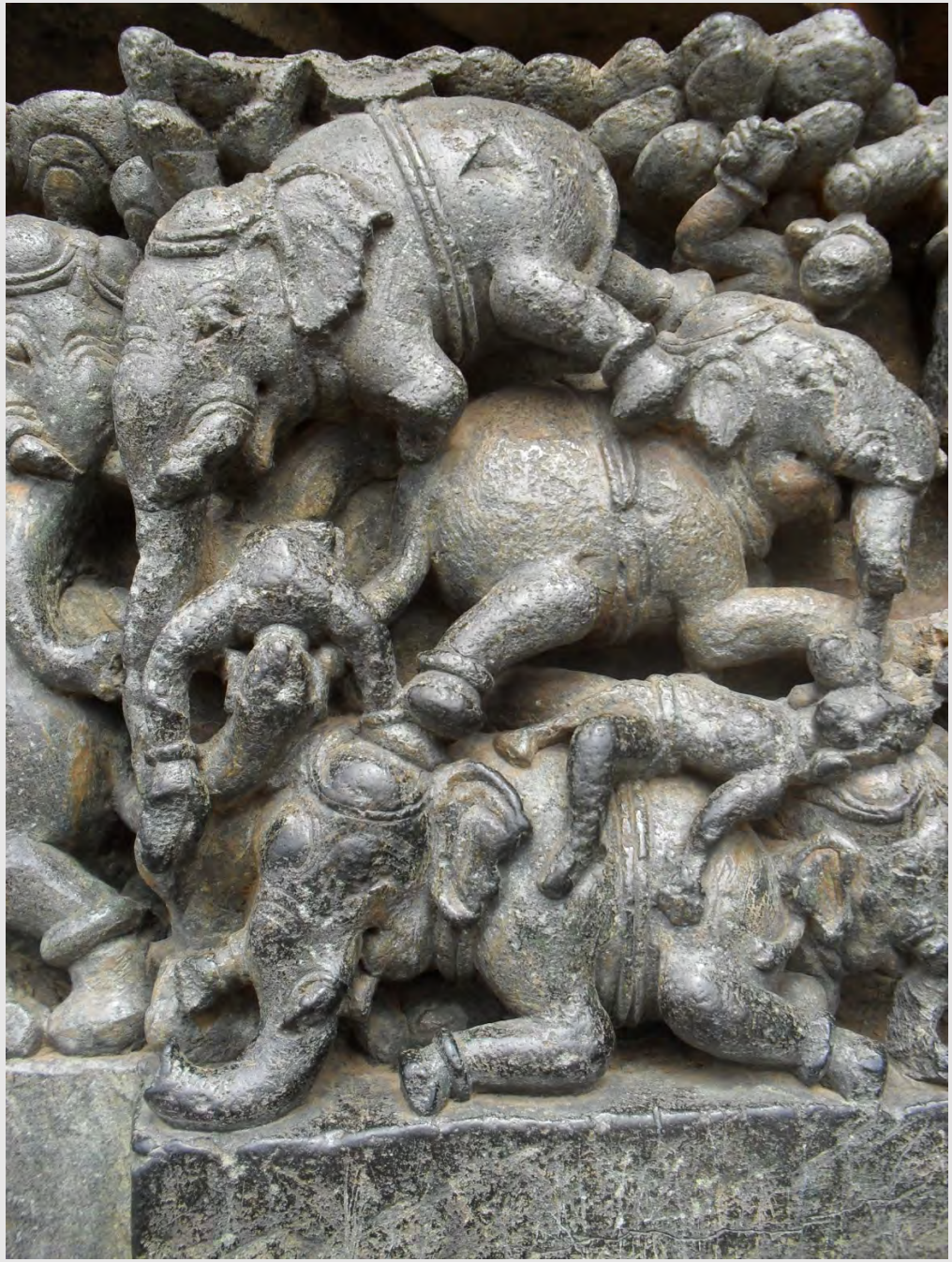
The Impact of Captive Elephants on Conservation

Heidi S. Riddle
Riddle's Elephant and Wildlife Sanctuary



History of Captive Elephants





Traditional Uses of Captive Elephants

- Labor
- Forest patrolling
- Ceremonial
- Display
- Entertainment

Logging Work





Captive Elephant Management









Early Display



Improved Environments





ELEPHANT CONSERVATION

Major Threats

Habitat Loss and Fragmentation

Human Elephant Conflict

To Minimize Conflict Elephants Are:

* Deterred
* Removed via
    - Capture
    - Translocation
    - Culling or Illegal Killing









Evolving Needs and Uses of Captive Elephants

Asian Elephant Range Country	Number Captive Elephants
Bangladesh	100
Bhutan	8
Cambodia	100
China*	243
India	3600
Indonesia	498
Lao PDR*	446
Malaysia	40
Myanmar*	5634 + 300-500
Nepal*	216
Sri Lanka	250
Thailand*	3444
Vietnam*	70
TOTAL	**15149**



Conservation Response Unit
Seblat - Bengkulu

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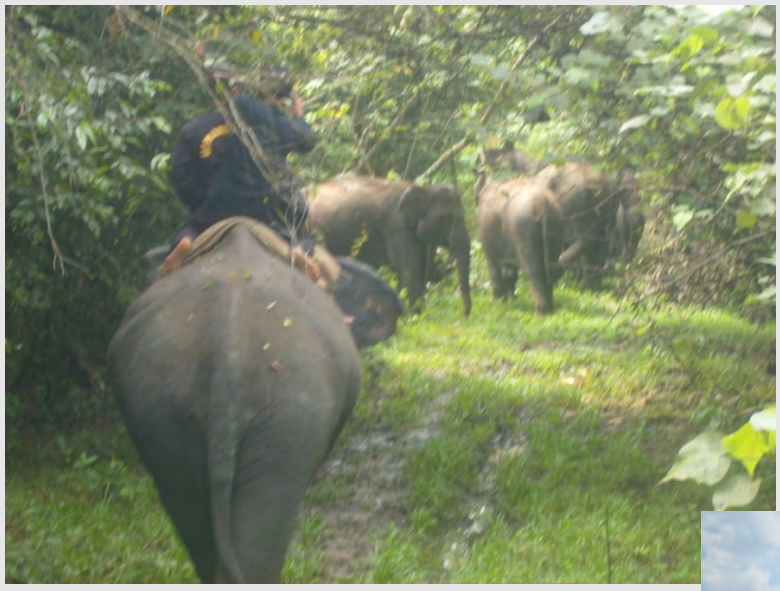


Way Kambas National Park Indonesia



Conflict Mitigation by Elephant Patrol Teams

Building Capacity of Captive Elephant Management Staff to Support Wildlife Conservation and Forest Protection







1st Sumatra Mahout Workshop

November 2006





In 2015 and 2016 Exchanges of Field Staff between Sumatra and Myanmar

GPS Training









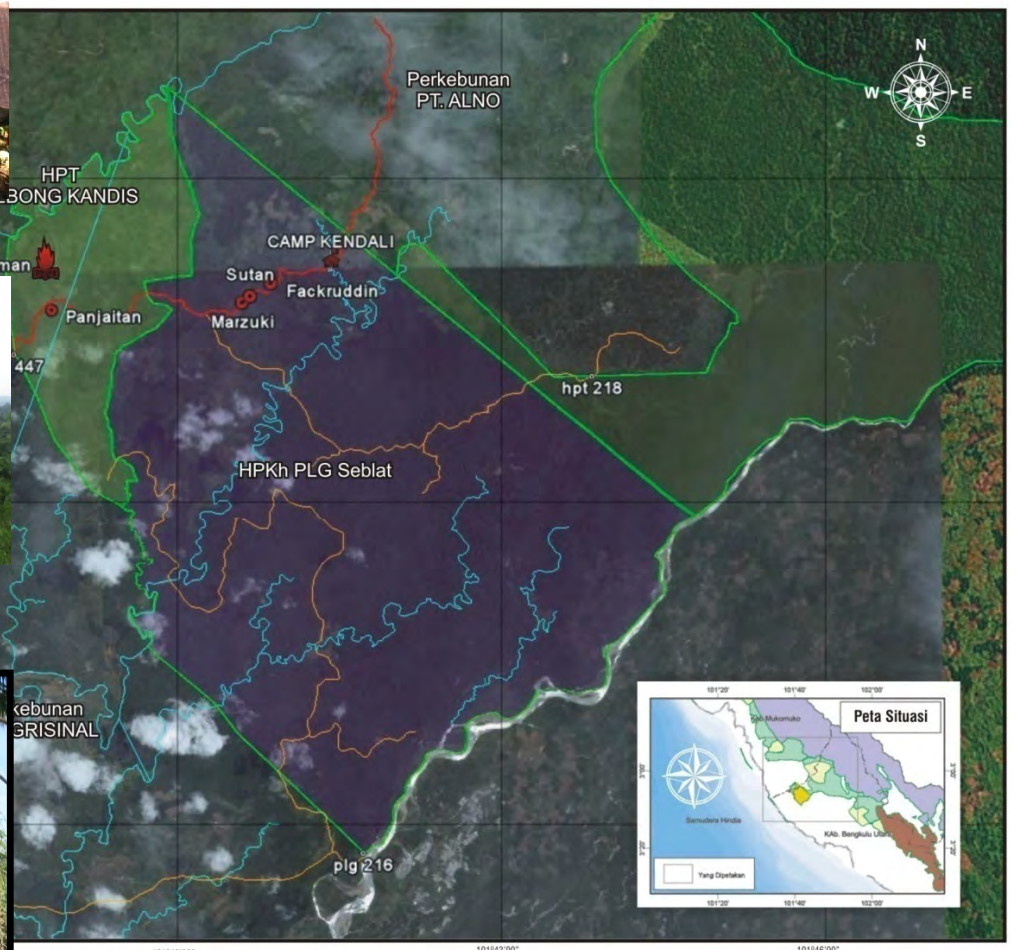
Training Deterrent Methods

Law Enforcement









PETA
Hasil Operasi Gabungan
Pengamanan Hutan
Dikawawan PLG Seblat

Skala 1 : 10.000

Sumber Peta:

1. Peta Paduserasi TGHK dan RTRWP Provinsi Bengkulu
2. Peta digital *Google Earth scan Digital Globe Coverage* tahun 2003 dan 2004
3. Digitasi GPS garmin akurasi minimal ± 4 m

Keterangan:

- Pal batas yamg ditemukan
- Titik pemusnahan tanaman kelapa sawit illegal
- Titik pemusnahan rumah perambah kawasan
- Kawasan PLG Seblat
- Kawasan HPT Lebong Kandis
- Jalan Poros
- Jalan eks HPH
- Sungai

Mengetahui
Keapala Balai

Drs. ANDI BASRUL
NIP. 080 054 121

BKSDA BENGKULU

Prevention of Wildlife Crime







Community Outreach





Other Field Conservation Activities



Camera Trapping
TWA Seblat Conservation Area, Bengkulu, Sumatra

WILDLIFE LEGISLATION

Illegal Trade in Live Asian Elephants: a review of current legislative, regulatory, enforcement, and other measures across range States

CITES CoP 17
Working Document 57. 1
Annex 5
cites.org/sites/default/files/eng/cop/17/WorkingDocs/E-CoP17-57-01-A5.pdf

National Legislation
 * CITES Trade Regulations

Captive Elephant Registration







Elephant Tourism



Non-interactive

Interactive







Welfare?
Management?
Training?
Ideology?







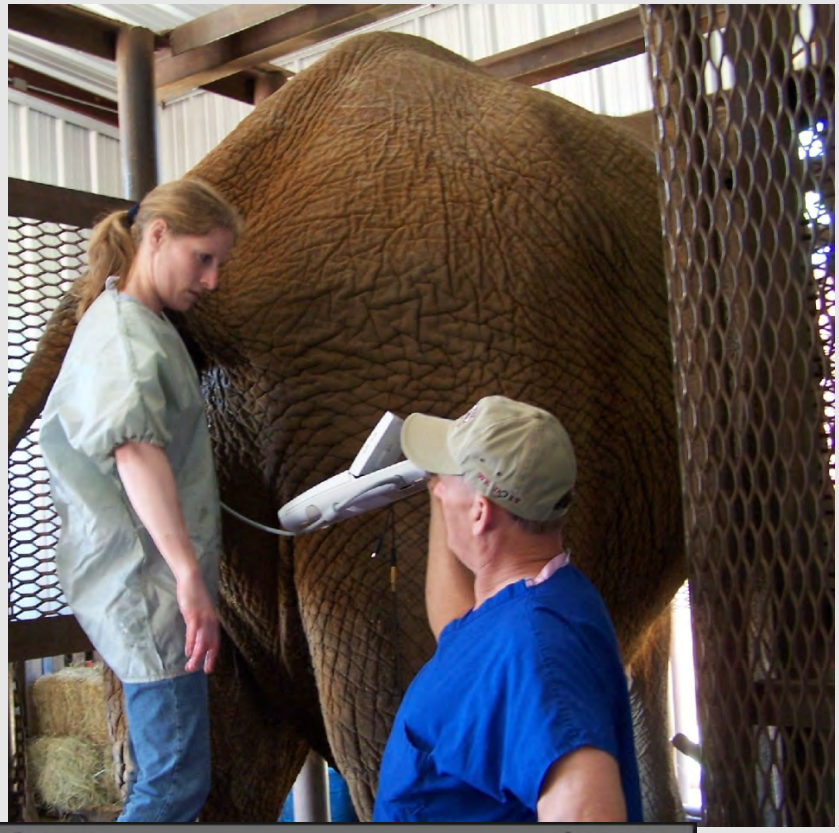


BIOLOGICAL STUDIES

Reproduction



Use of Ultrasound









Immuno-contraceptive Vaccine for Female Elephants

GnRH Vaccine for Male Elephants



Biological Sample Collection and Analysis





Diseases in Wild Elephant Populations

Dung DNA Analysis
Non-invasive Tool to Assess Wild Elephant Populations





Male Elephants and Musth





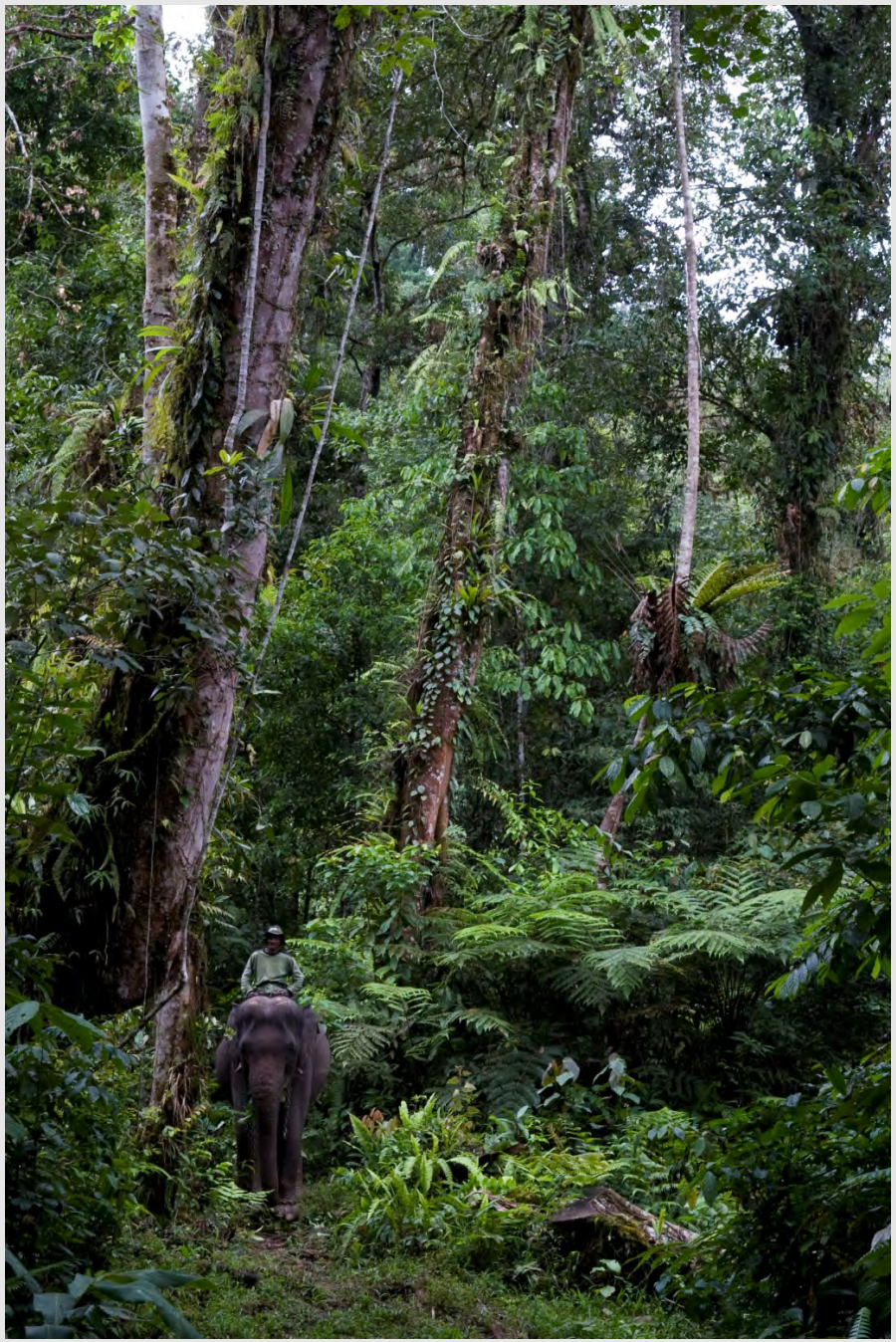
Asian Elephants Changing Chemical Scenario from Sub-adult to Adult Musth

Biological Convergence

Temporal gland secretions of sub-adult Asian bulls smell like honey



Same compounds (leaf alcohol) give honey its odor and are honeybee pheromones



- Education
- Fundraising in Support of Elephant Conservation

- The current situation regarding captive elephants, especially in Asia, is complex with no simple solutions
- Building capacity of captive elephant management staff benefits conservation
- A comprehensive management approach that includes wild and captive elephant populations is needed; captive elephants continue to impact the conservation of wild elephants

Acknowledgments

- International Elephant Foundation
- Wildlife Reserves Singapore
- U.S. Fish and Wildlife Service Asian Elephant Conservation Fund
- Asian Elephant Support
- Elephant Managers Association
- Berdiri Foundation
- Forum Komunikasi Mahout Indonesia
- Forum Konservasi Gajah Indonesia
- Myanma Timber Enterprise
- **Mahouts and Field Staff in Forest and Wildlife Departments across the Asian Elephant Range Countries**


THANK YOU!

STATE OF THE RHINO



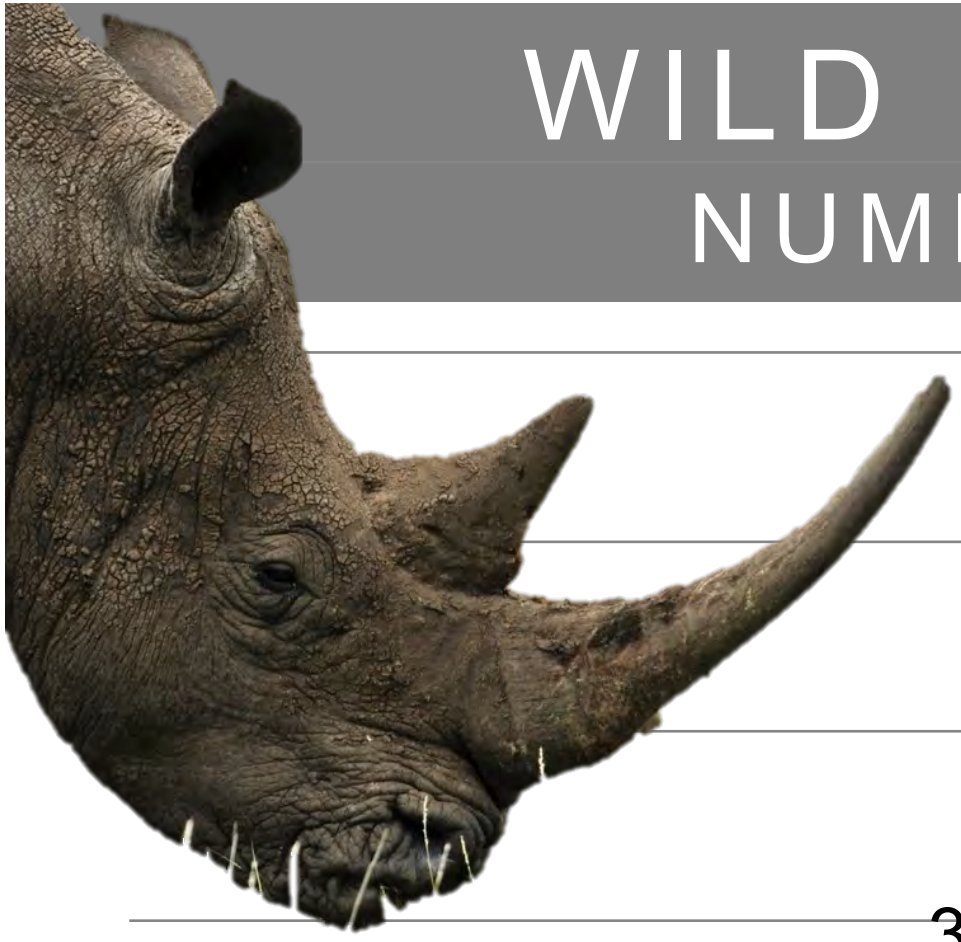
Susie Ellis, PhD
Executive Director

Presented by Terri Roth, PhD
IRF Board Member and
Cincinnati Zoo Center for Conservation and
Research of Endangered Wildlife

INTERNATIONAL RHINO FOUNDATION


Photo: Tom Collier
~29,000

WILD RHINO NUMBERS




EVERY 7 HOURS


13
83
122
333
448
668
1004
1215
1175
702
as of
09/11
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
SOUTH AFRICA

Why?





DISPOSABLE INCOME

CHINA AND VIETNAM

ILLEGAL TRADE




RHINOS 2016

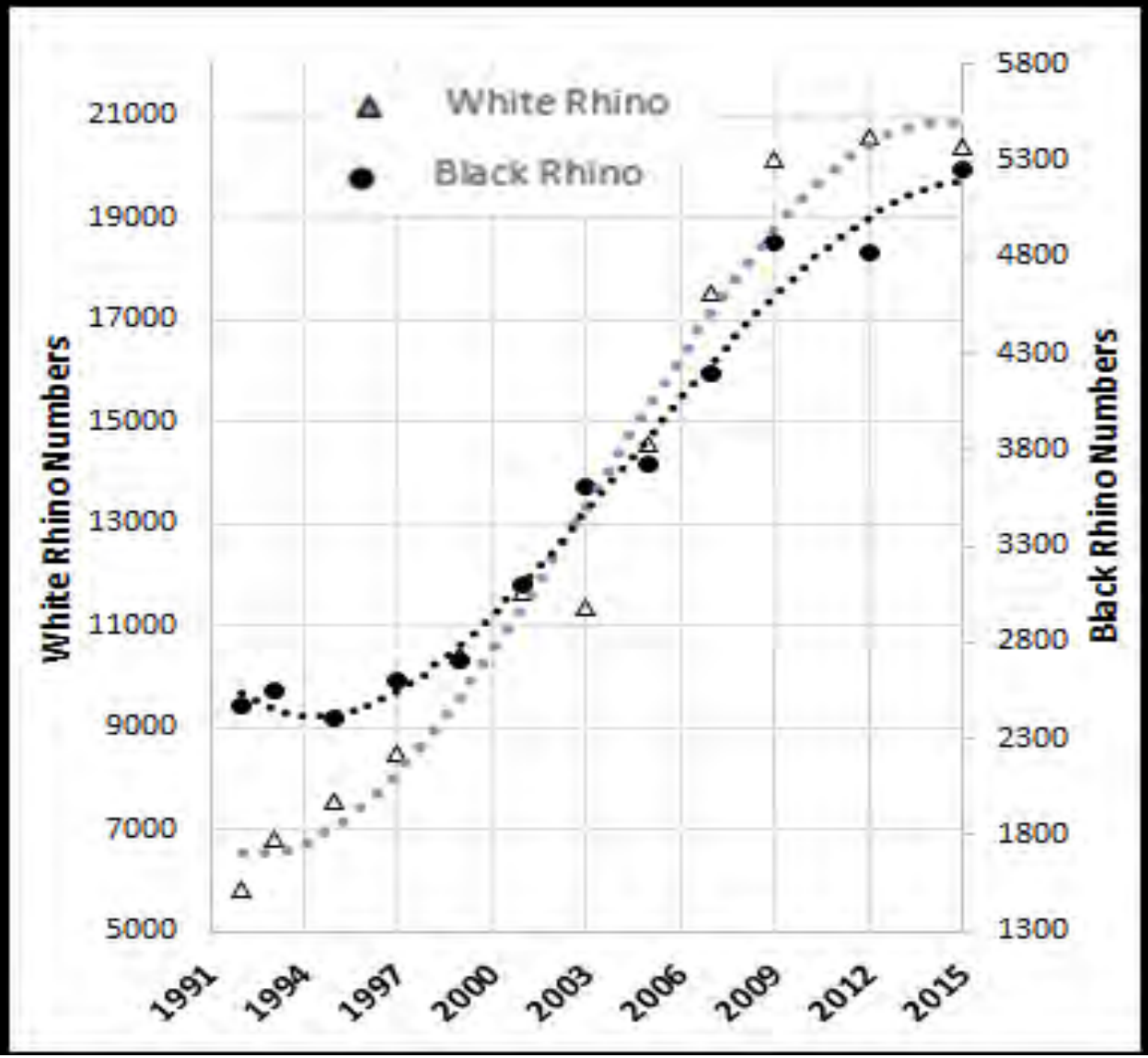

White rhino ~20,000



Black rhino **~5,200**

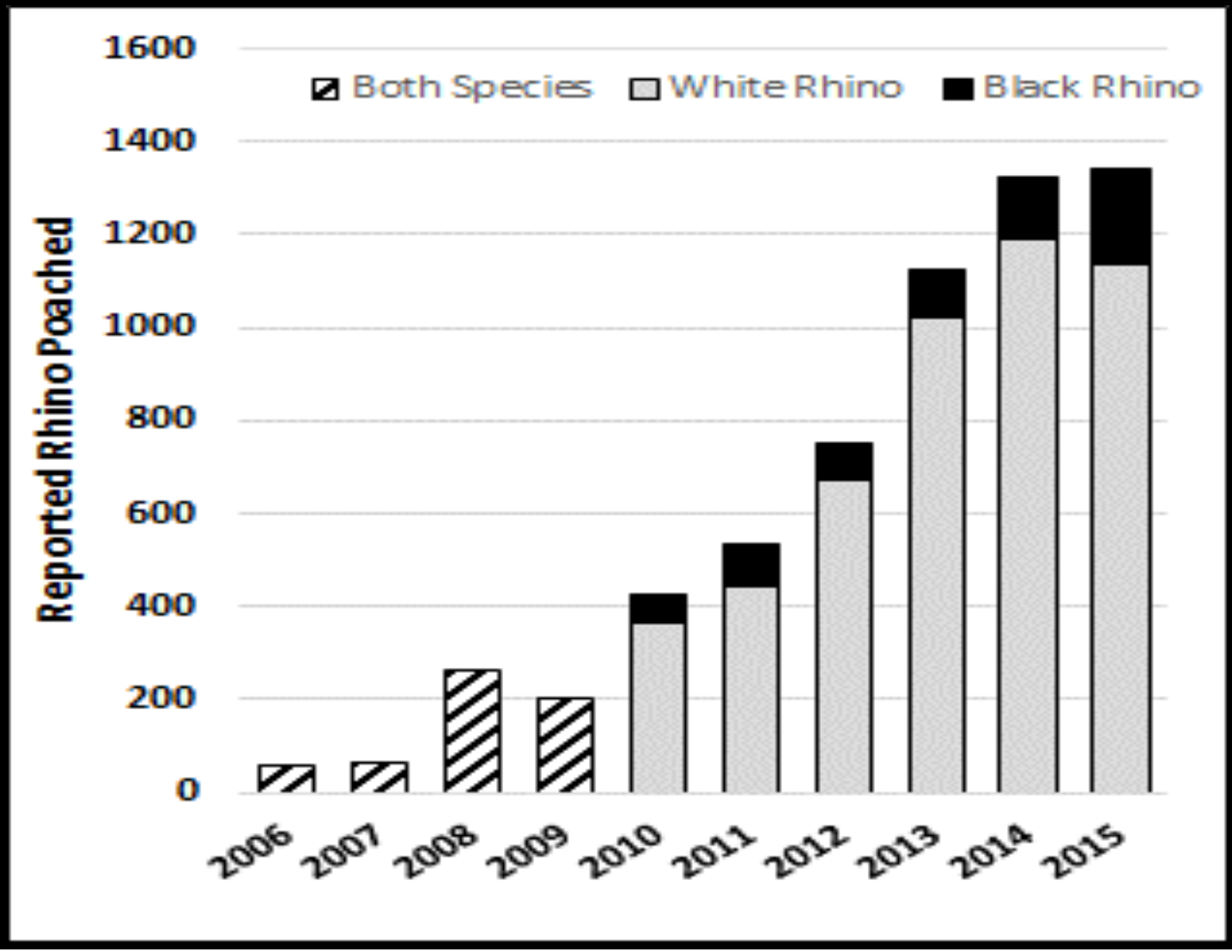
Growth for both species since 1991

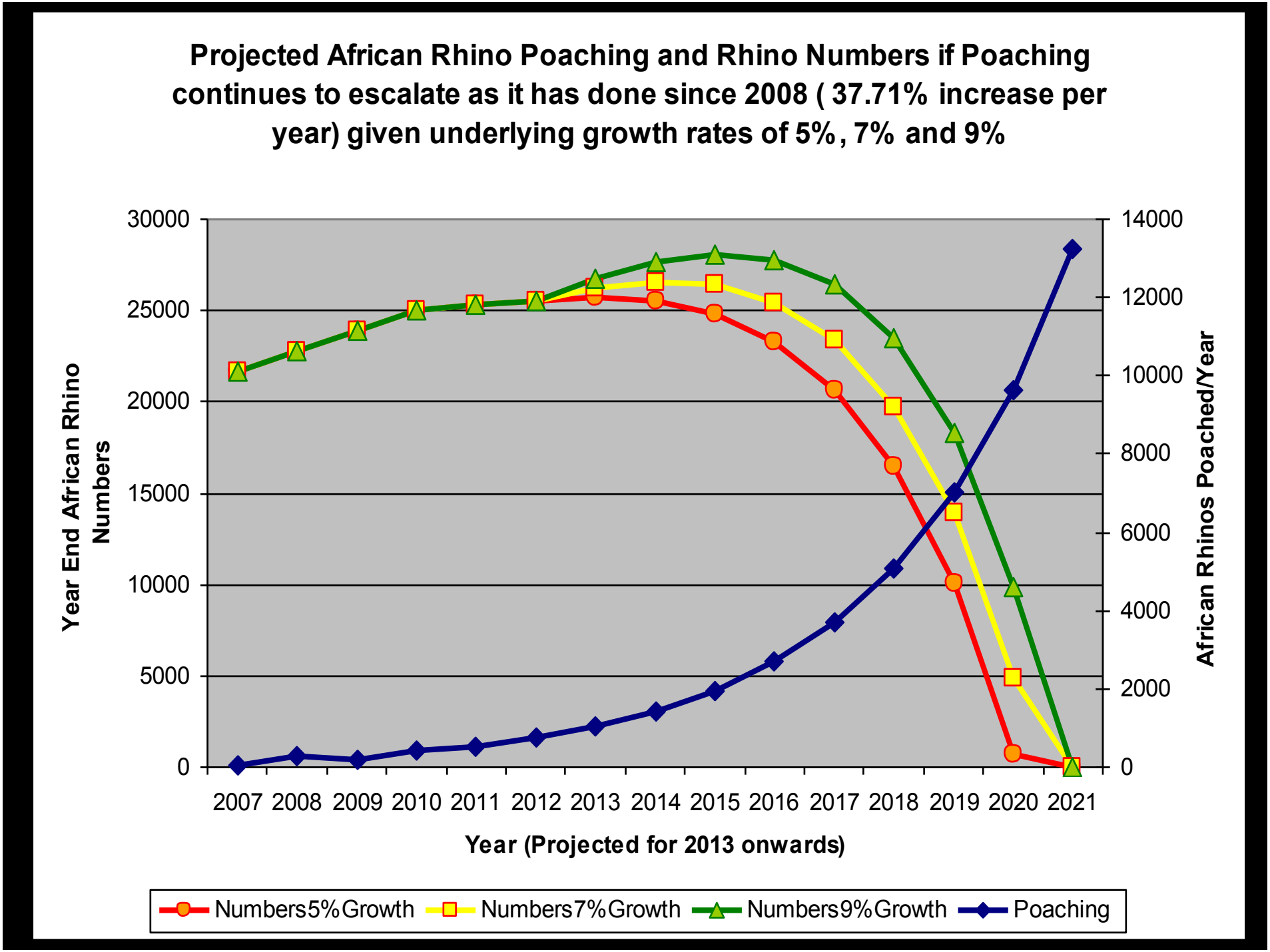
AfRSG, TRAFFIC and CITES Rhino Working Group data with range states input



Poaching numbers 2006 – 2015

AfRSG, TRAFFIC and CITES Rhino Working Group data with range states input




Projected African Rhino Poaching and Rhino Numbers if Poaching continues to escalate as it has done since 2008 (37.71% increase per year) given underlying growth rates of 5%, 7% and 9%
Year End African Rhino Numbers
African Rhinos Poached/Year
30000
25000
20000
15000
10000
5000
0
14000
12000
10000
8000
6000
4000
2000
0
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Year (Projected for 2013 onwards)
Numbers5%Growth
Numbers7%Growth
Numbers9%Growth
Poaching



LOWVELD RHINO TRUST

MANICALAND PROVINCE

MASVINGO PROVINCE

MATABELELAND SOUTH PROVINCE

BIKITA DISTRICT

Save Conservancy

Chipinge Safari Area

CHIPINGE DISTRICT

Malilangwe/ Hippo Valley

MWENEZI DISTRICT

CHIREDZI DISTRICT

Gonarezhou National Park

Bubye Conservancy

BEITBRIDGE DISTRICT

Malapati Safari Area

Tuli Circle

LOWVELD

Area approx 54,000 km2

0 25 50

kilometers

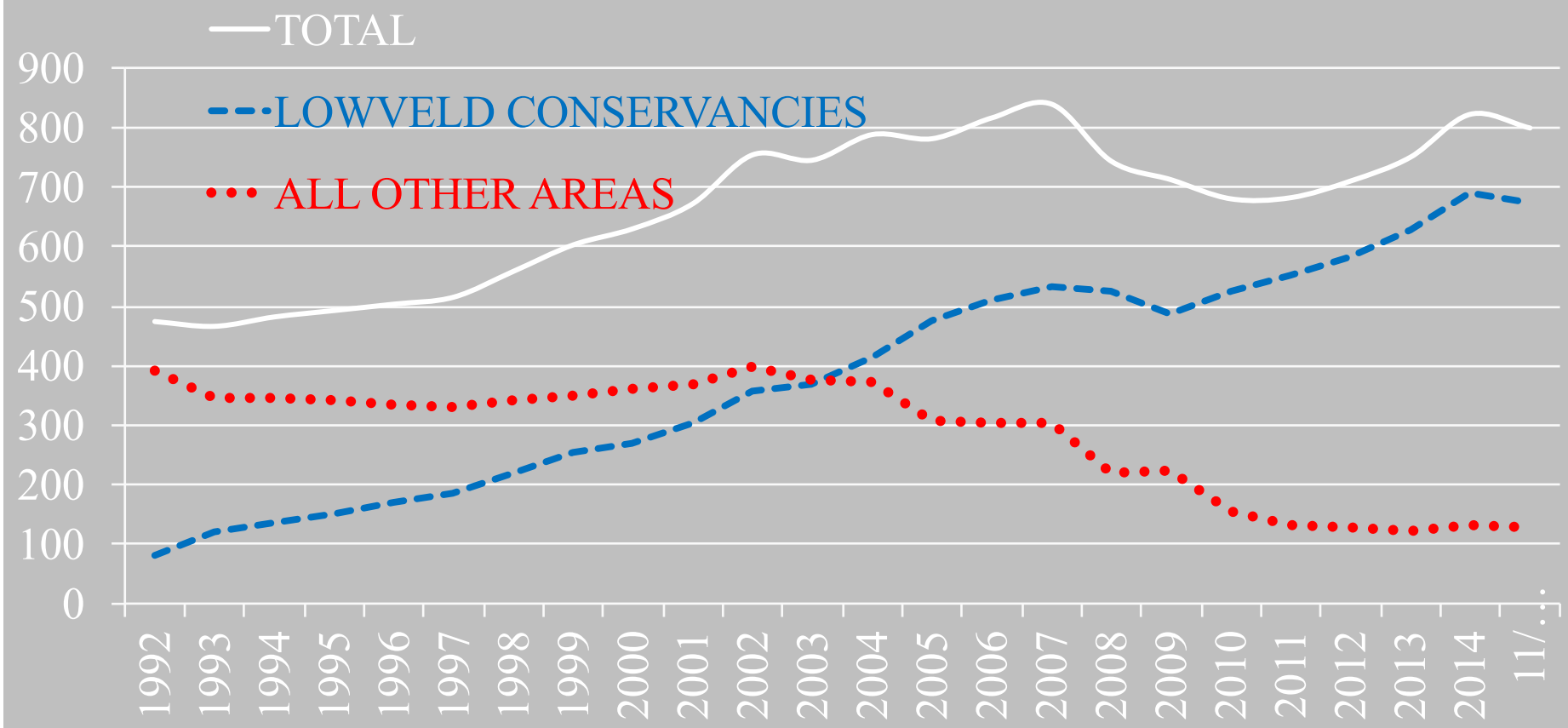


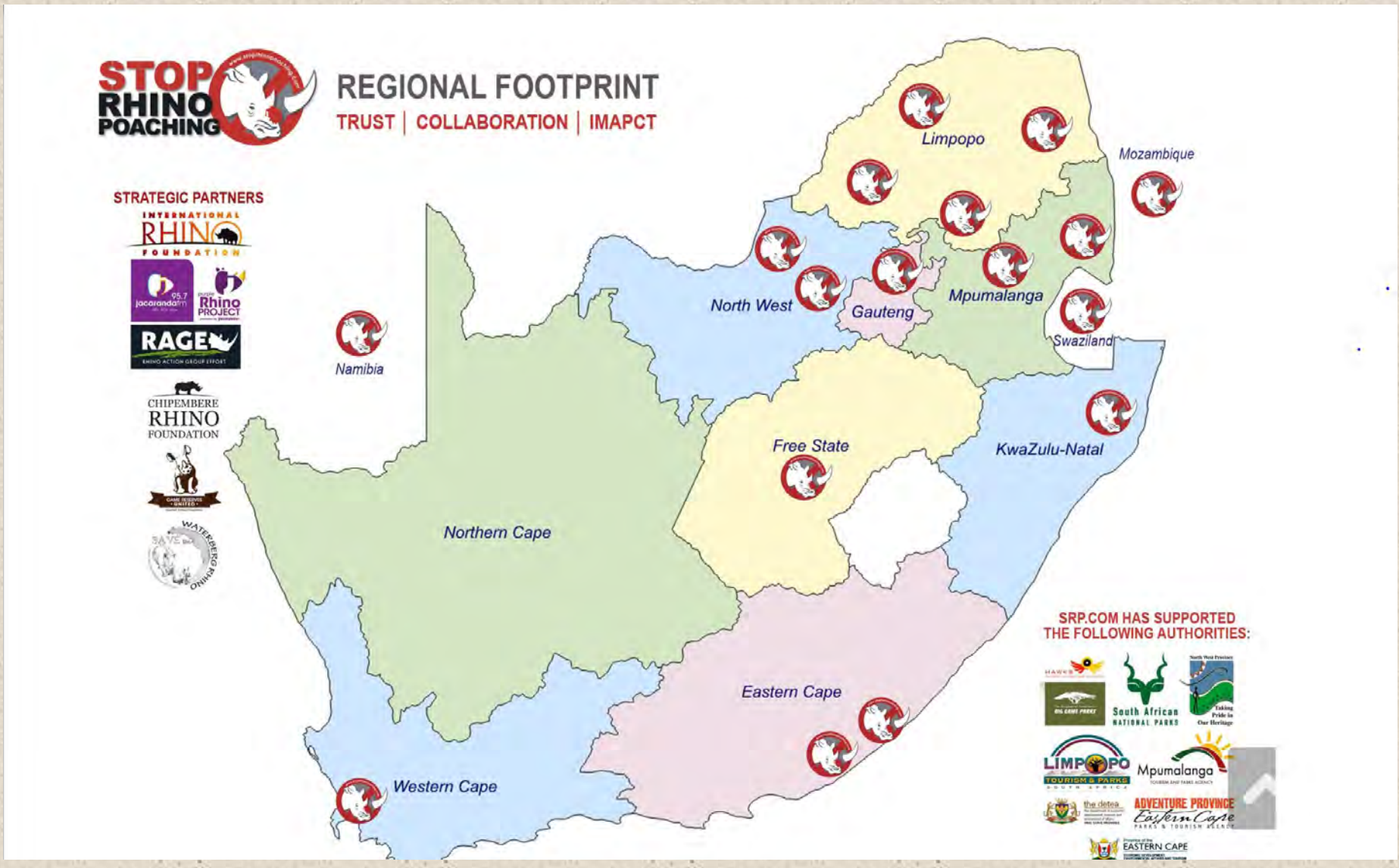
Rehab/rescue



Translocations

ZIMBABWE RHINO POPULATIONS - BOTH SPECIES

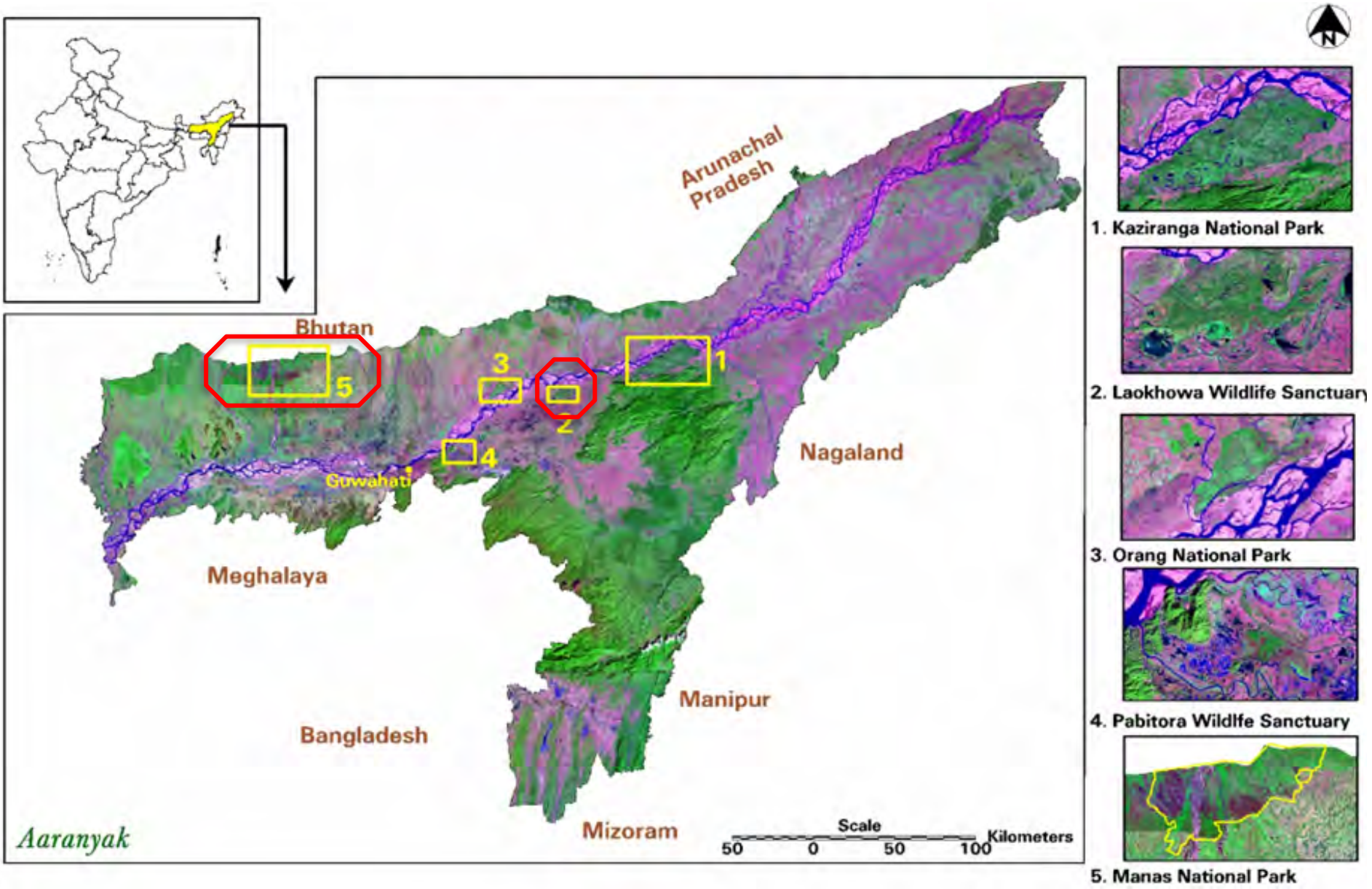



STOP RHINO POACHING
REGIONAL FOOTPRINT
TRUST | COLLABORATION | IMAPCT
STRATEGIC PARTNERS
INTERNATIONAL RHINO FOUNDATION
RAGE
CHIPEMBERE RHINO FOUNDATION
Limpopo
Mozambique
North West
Gauteng
Mpumalanga
Swaziland
Namibia
Free State
KwaZulu-Natal
Northern Cape
Eastern Cape
Western Cape
SRP.COM HAS SUPPORTED THE FOLLOWING AUTHORITIES:
South African NATIONAL PARKS
LIMPOPO TOURISM & PARKS
Mpumalanga
ADVENTURE PROVINCE Eastern Cape
EASTERN CAPE


Indian rhino
>3,500


INDIAN RHINO VISION 2020
3,000 wild rhinos
7 Protected Areas
By 2020
IRV 2020
Department of Environment & Forests, Govt. of Assam
WWF
INTERNATIONAL RHINO FOUNDATION
BODOLAND TERRITORIAL COUNCIL

Assam Rhino Areas

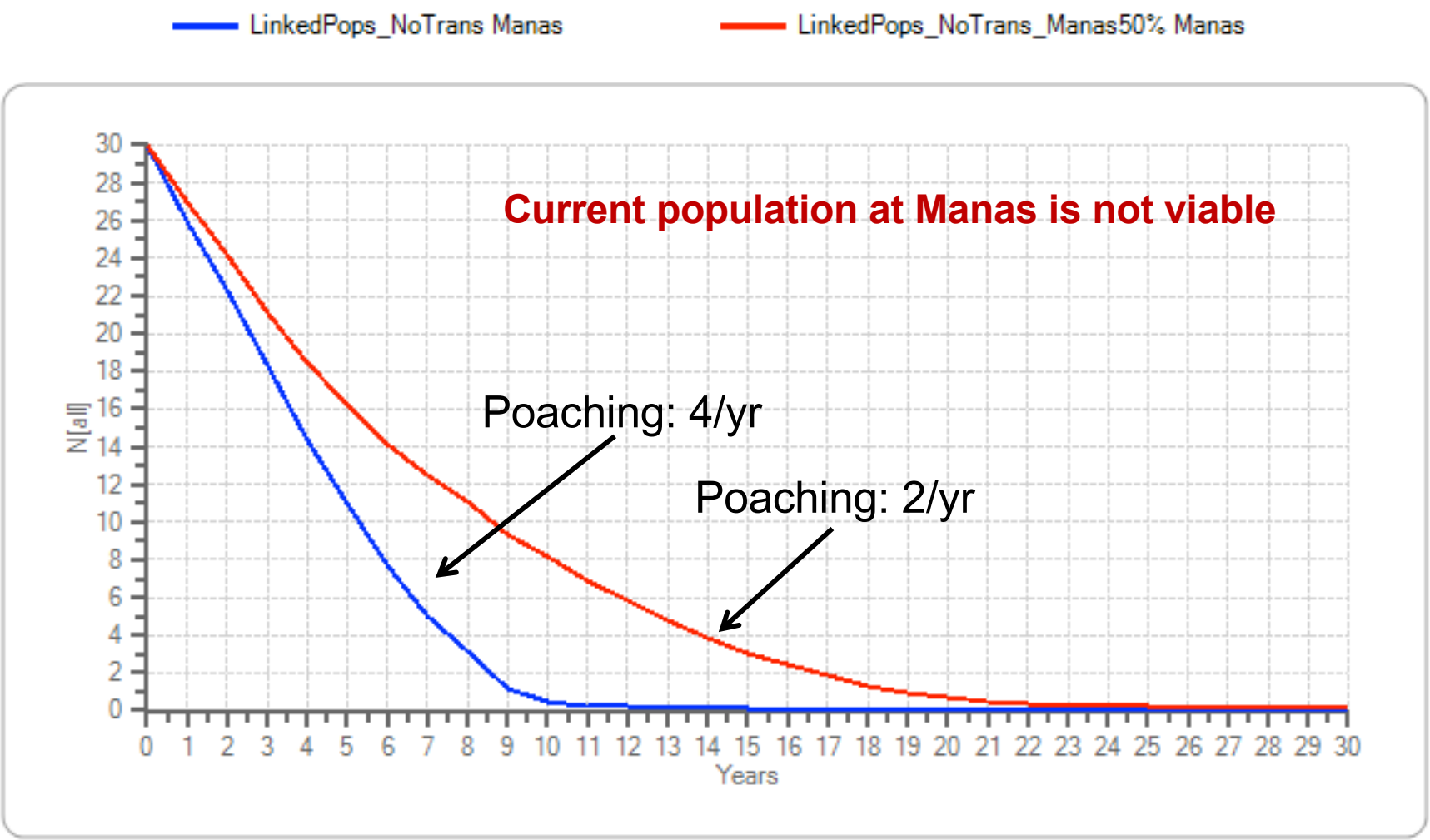



18 IRV rhinos + 8 rescued animals
moved to Manas NP

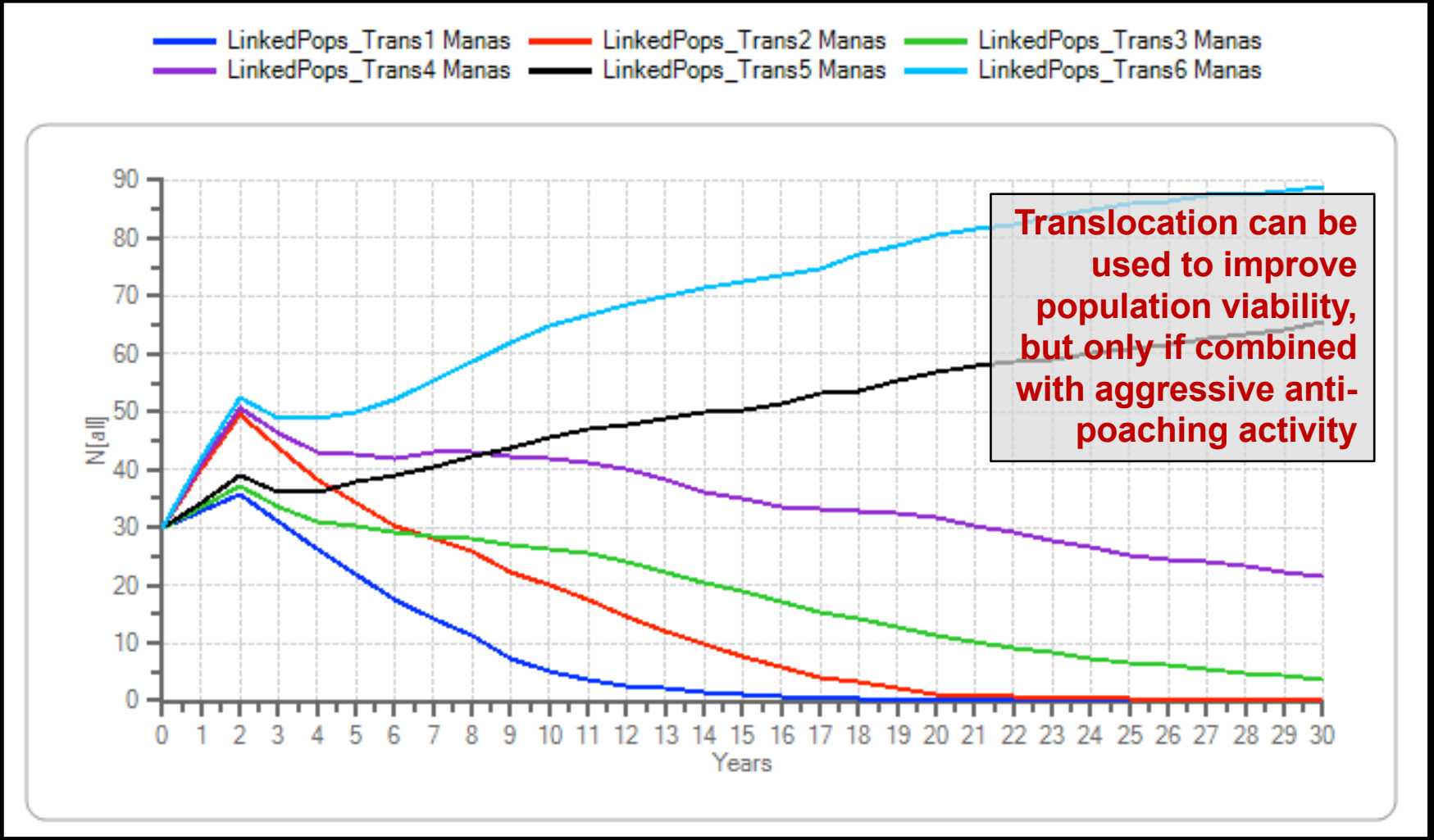

13 calves

Rhino PVA Results for Manas: No Translocation

Ellis et al., 2015

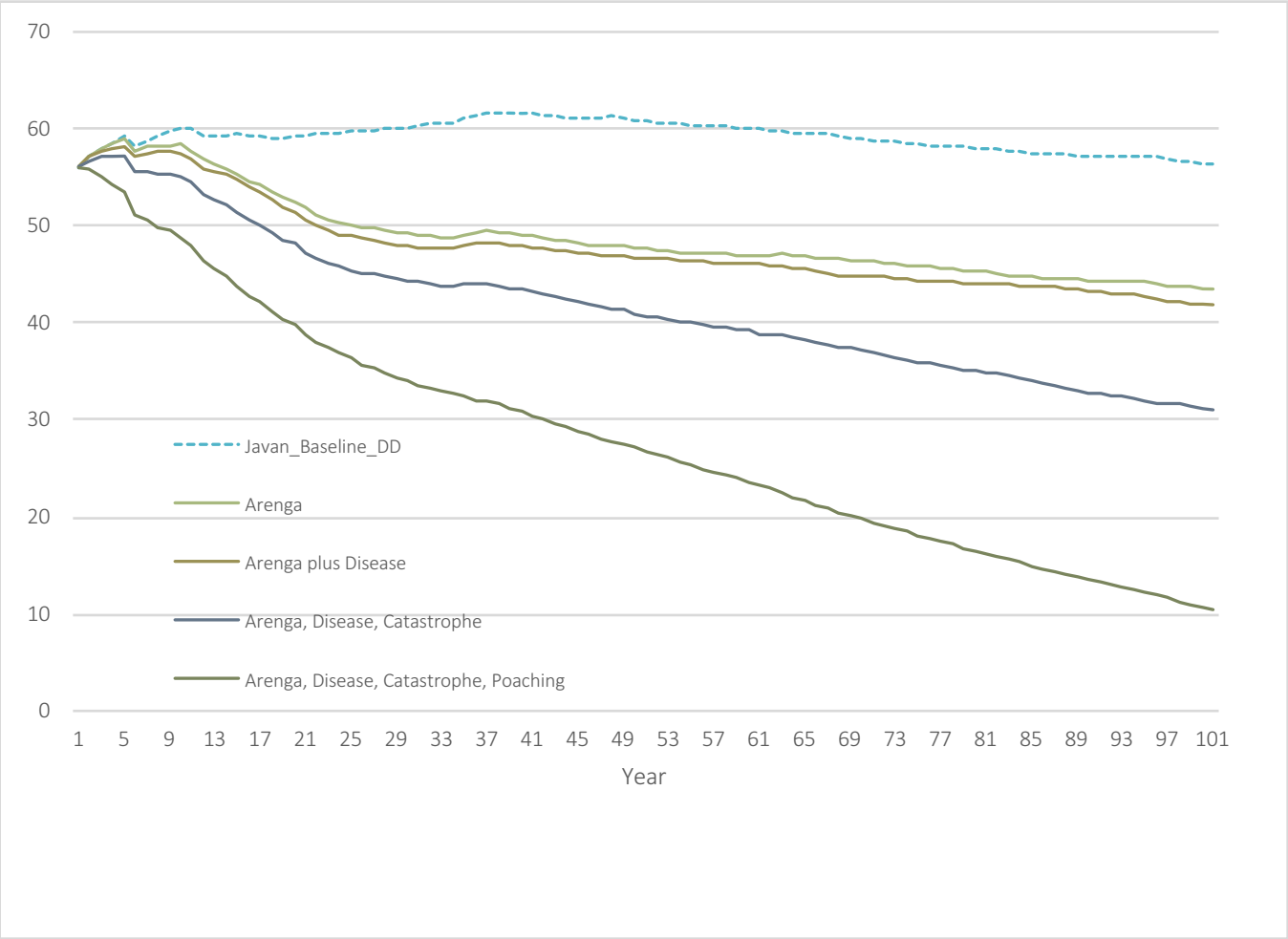


Rhino PVA Results for Manas: Translocation, Minimal Poaching Pressure (0-1/yr.) Ellis et al., 2015




Javan rhinos 61-63
© Stephen Belcher

Modeled impacts of multiple threats on Javan rhino population



- Arenga Palm encroachment (at 1% per year, for 20 years).
- Disease risk (once every 50 years causing 10% mortality)
- Environmental catastrophe (once every 100 years causing 50% mortality)
- Poaching (1% harvested per year)

Miller et al., 2015

Arenga
palm

Arenga obtusifolia





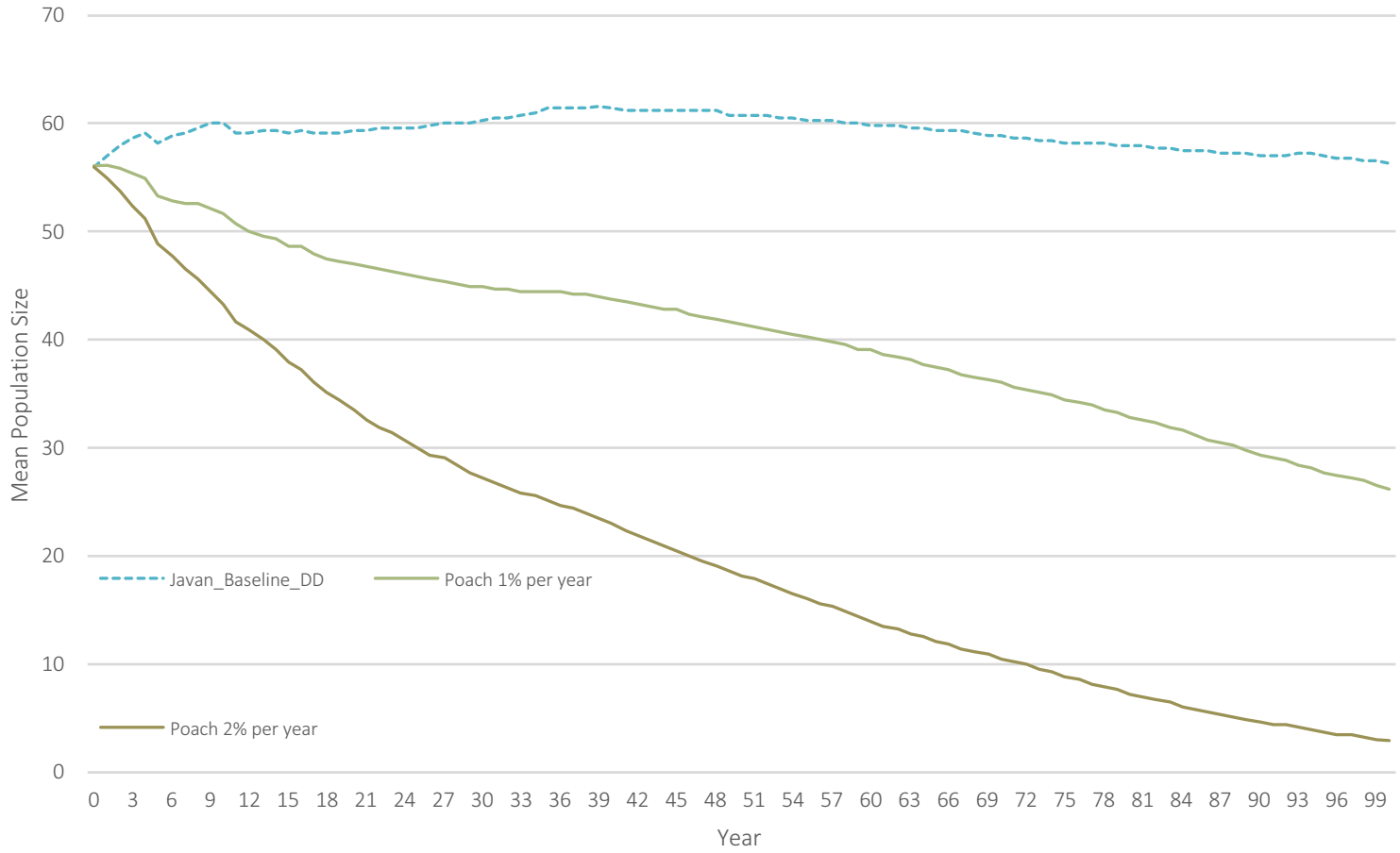








Impact of poaching at UKNP



CRITICAL NEEDS

Continued zero poaching

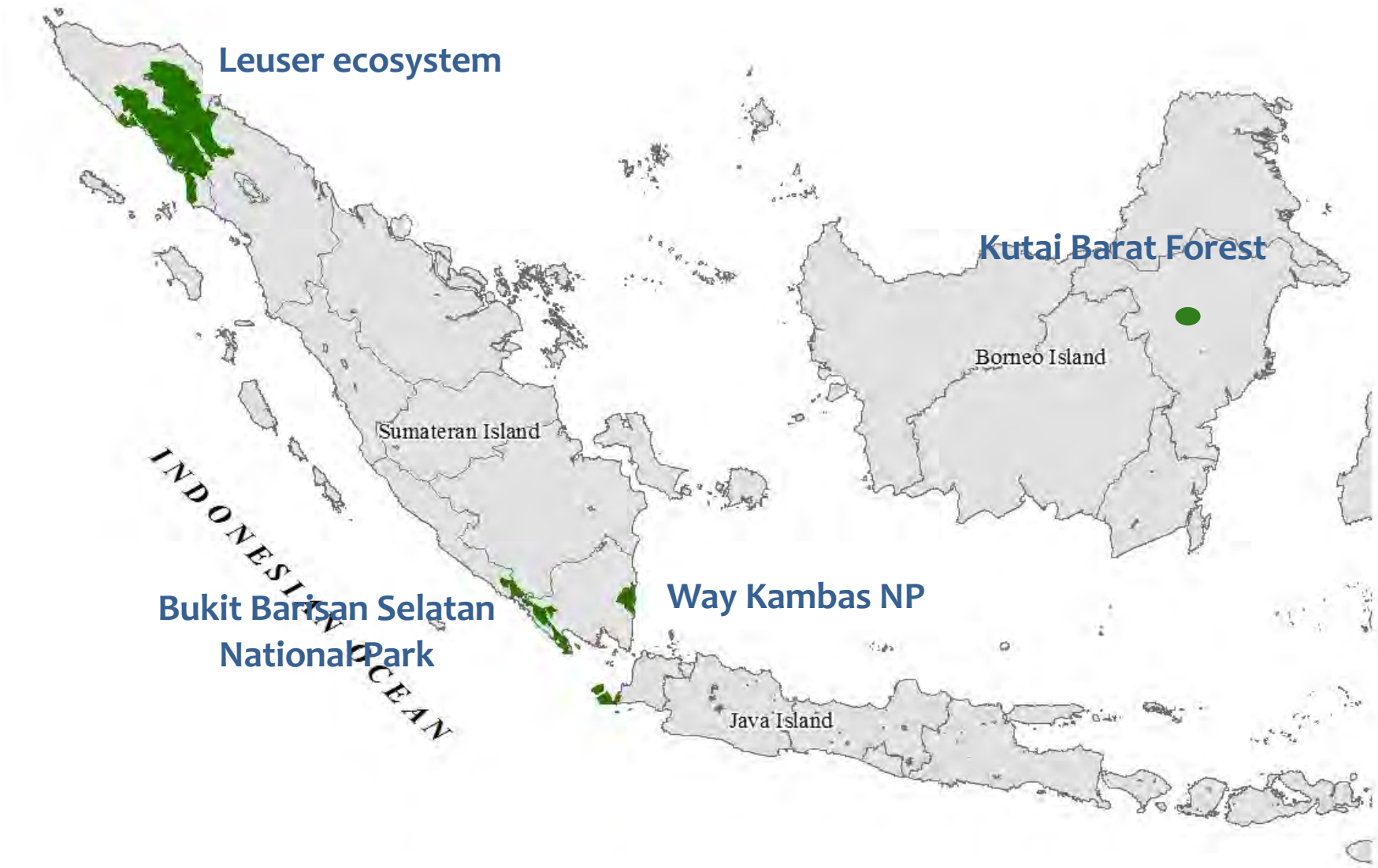
Space for population growth

Second population




Sumatran rhino <100

CURRENT DISTRIBUTION OF SUMATRAN RHINO





THREATS

- Small population effects
- Poaching
- Habitat loss and fragmentation
- Disease
- Catastrophes





Sumatran Rhino Crisis Summit

April 2013

Hosted by Wildlife Reserves Singapore

SUMATRAN RHINO CRISIS SUMMIT



Disney Reverse the Decline 2014-2024

10-year grant for Sumatran Rhino Conservation

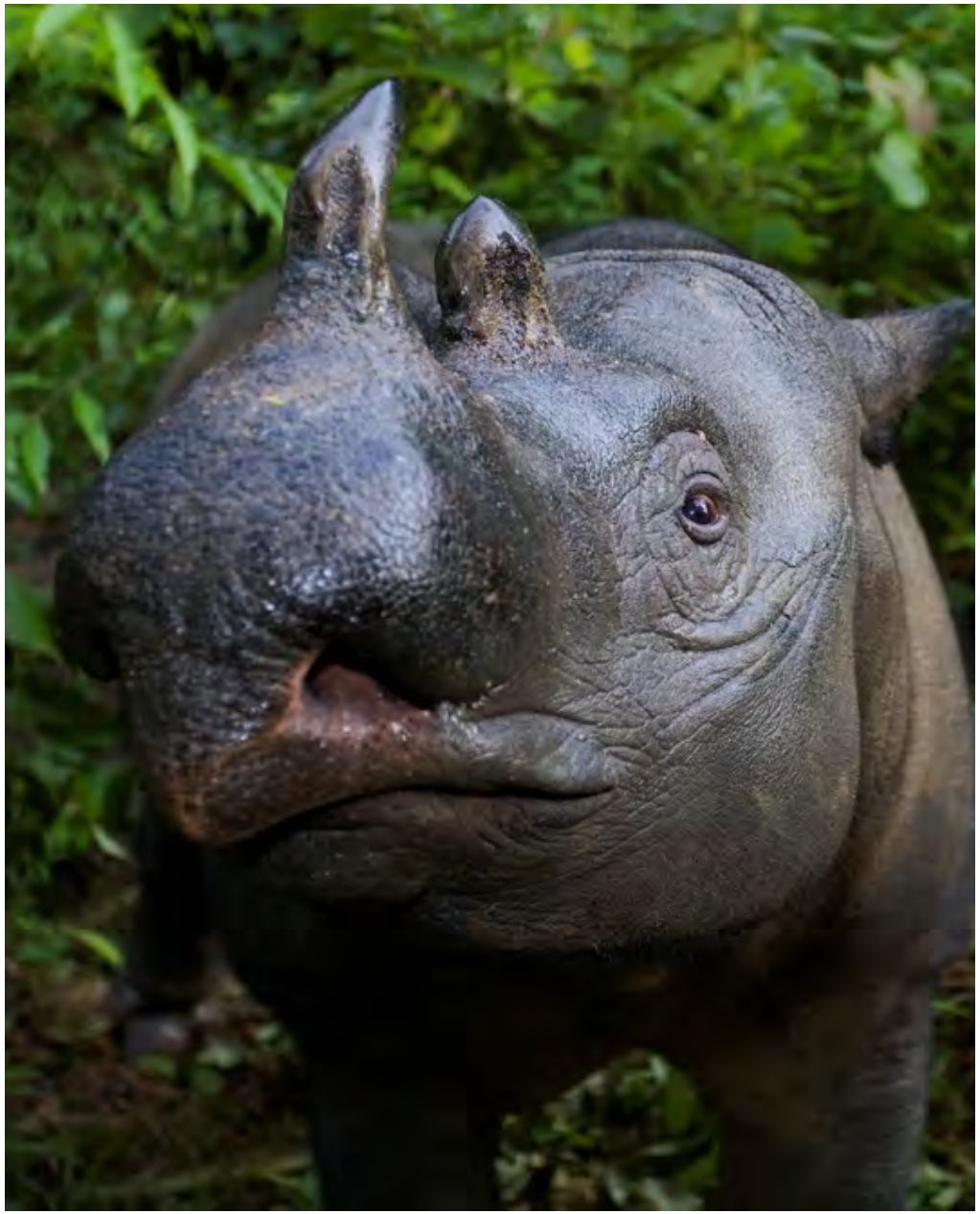
Grant Overview

IRF secured $250k/year for 10 years

NGO Partners: FKL, LIF, WCS, WWF-I, YABI

Year 1 - planning grant

Year 2-10 - implementation of high priority protection activities, communications



Population size estimates

4 wild sites

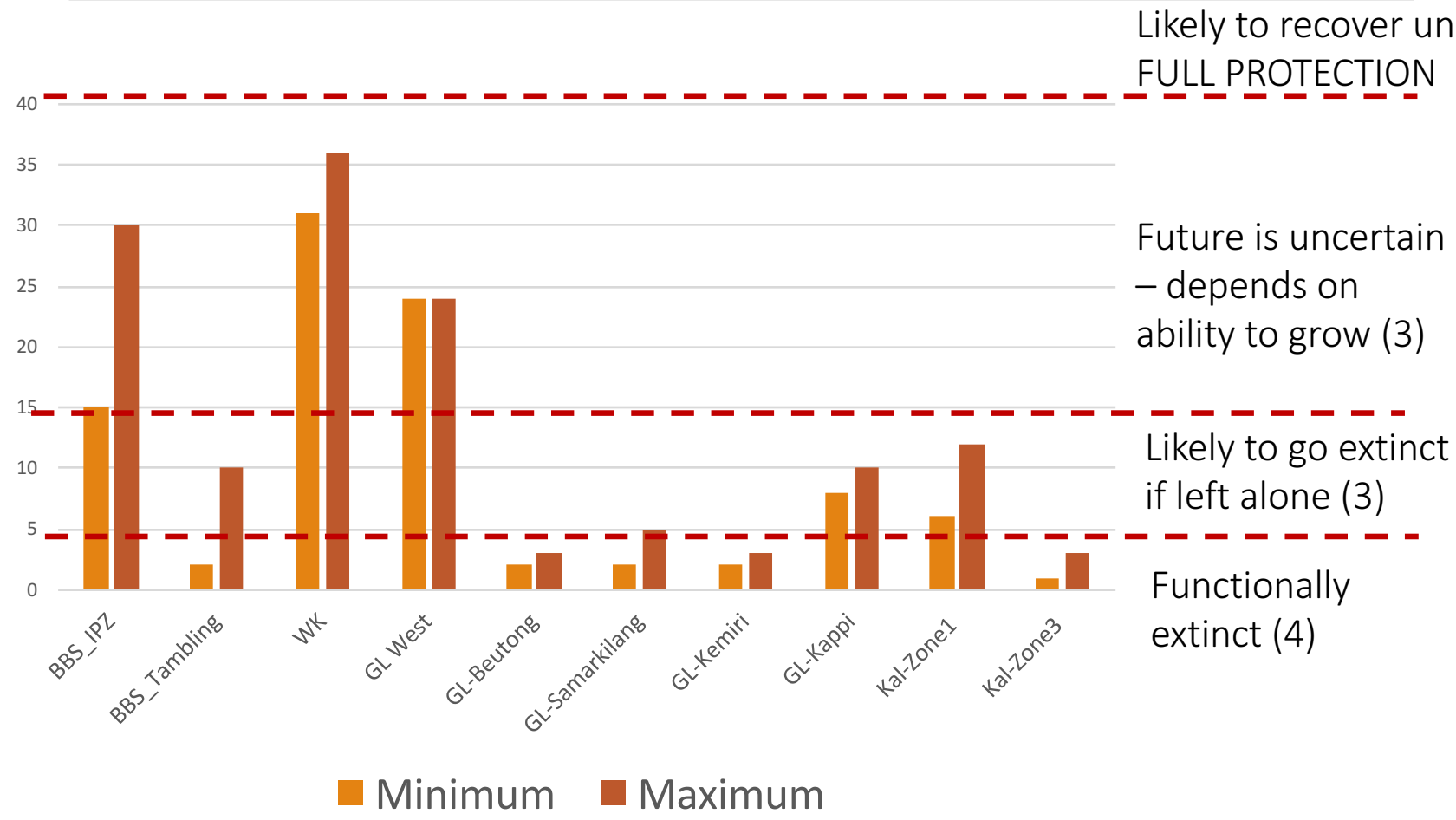
94 – 138 (BG 112) rhinos total

At least 10 sub-populations 2-50 rhinos each

Plus 7 captive rhinos SRS, 3 Sabah

Site	Min	Best Guess	Max	K est
Bukit Barisan Selatan - IPZ - Tambling	 15 2	 22 2	 30 10	 120-200
Gunung Leuser (GL) - West Leuser - Outside	 24? 14	 24 20	 24? 21	 ?
Way Kambas (WK)	31	33	36	?
Kalimantan (K)	8	8	17	?

How viable are Sumatran rhino sub-populations?



Joint Rhino-Tiger Miradi Workshop



Rhino-Tiger Stakeholder Workshop



Strategic Planning



Sumatran Rhino Consortium Meeting

- January 2016 – Bogor, Indonesia
- IRF, FKL, LIF, WCS, WWF-I, YABI

Developed Objectives, Activities, and Indicators in MIRADI



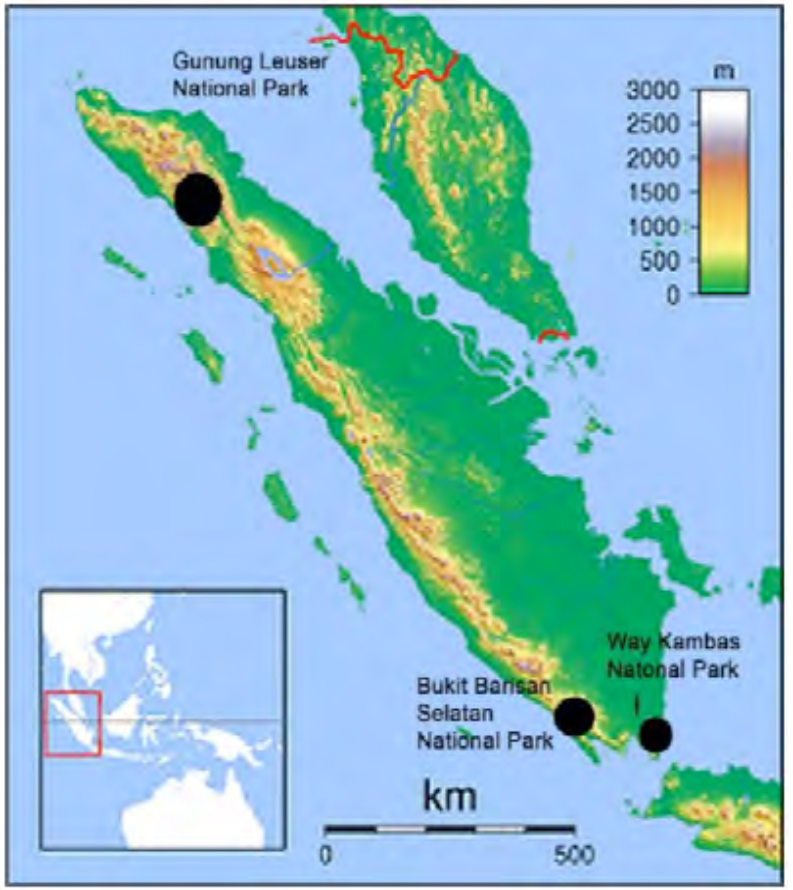
Discussed meta-population management plan

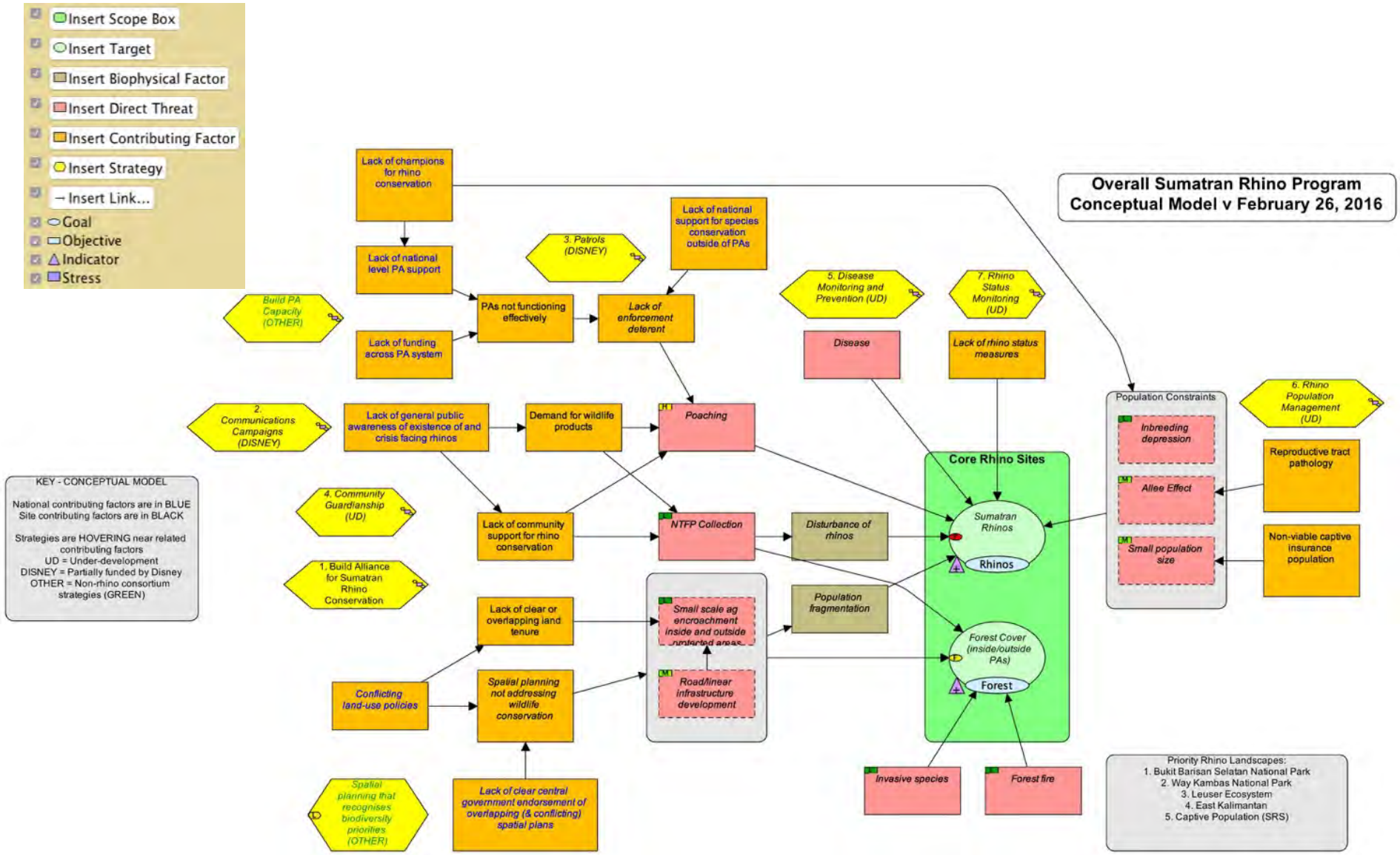
- Enhanced Protection
- IPZs
- Population Consolidation
- Expanded Captive Breeding

Goals

1. By 2025, Sumatran rhinos will have experienced no net loss to the meta-population and the population is increasing at the three Intensive Protection Zones (IPZs) in (WKNP, GLNP, BBSNP) and the SRS, relative to initial baseline data from the 2015 PVA and confirmed by surveys to take place in 2017-2018.

2. Over the entire project period [2016-2025], no additional forest cover is lost in rhino habitat, including park lands (including IPZs), and in rhino habitat outside of national parks in Aceh.




Insert Scope Box
Insert Target
Insert Biophysical Factor
Insert Direct Threat
Insert Contributing Factor
Insert Strategy
Insert Link...
Goal
Objective
Indicator
Stress
Overall Sumatran Rhino Program
Conceptual Model v February 26, 2016
KEY - CONCEPTUAL MODEL
National contributing factors are in BLUE
Site contributing factors are in BLACK
Strategies are HOVERING near related contributing factors
UD = Under-development
DISNEY = Partially funded by Disney
OTHER = Non-rhino consortium strategies (GREEN)
Lack of champions for rhino conservation
Lack of national level PA support
Lack of funding across PA system
PAs not functioning effectively
Lack of national support for species conservation outside of PAs
Lack of enforcement deterent
3. Patrols (DISNEY)
Build PA Capacity (OTHER)
5. Disease Monitoring and Prevention (UD)
7. Rhino Status Monitoring (UD)
Disease
Lack of rhino status measures
2. Communications Campaigns (DISNEY)
Lack of general public awareness of existence of and crisis facing rhinos
Demand for wildlife products
Poaching
4. Community Guardianship (UD)
Lack of community support for rhino conservation
NTFP Collection
Disturbance of rhinos
1. Build Alliance for Sumatran Rhino Conservation
Lack of clear or overlapping land tenure
Small scale ag encroachment inside and outside
Population fragmentation
Conflicting land-use policies
Spatial planning not addressing wildlife conservation
Road/linear infrastructure development
Spatial planning that recognises biodiversity priorities (OTHER)
Lack of clear central government endorsement of overlapping (& conflicting) spatial plans
Core Rhino Sites
Sumatran Rhinos
Rhinos
Forest Cover (inside/outside PAs)
Forest
Invasive species
Forest fire
Population Constraints
Inbreeding depression
Allee Effect
Small population size
6. Rhino Population Management (UD)
Reproductive tract pathology
Non-viable captive insurance population
Priority Rhino Landscapes:
1. Bukit Barisan Selatan National Park
2. Way Kambas National Park
3. Leuser Ecosystem
4. East Kalimantan
5. Captive Population (SRS)

Project Logical Framework

Outlines Steps To Meet Project Goals and Objectives

Output 1	An alliance for Sumatran rhino conservation is regularly responding to rhino consortium guidance and recommendations
Output 2	Communication campaigns build a constituency for rhino conservation in Indonesia
Output 3	Patrols implemented using SMART to detect and reduce highest ranked threats to rhinos in IPZs in BBS, Way Kambas, and Leuser
Output 4	Community Guardianship
Output 5	Disease monitoring and prevention protocols in place to quickly detect and respond to rhino disease outbreaks
Output 6	Rhino populations managed to optimize breeding
Output 7	National and landscape level standards and capacity in place for rhino and forest status monitoring

Budget Estimate to Save Sumatran Rhinos

Projected Budget for Full Sumatran Rhino Meta-Population Management for 10 Years

Disney Funding: $2,500,000

Funding Gap: $87,995,201

Bukit Barisan Selatan (BBS)		**$19,176,965**
	Patrols	$16,049,965
	Population Management	$3,127,000
Way Kambas National Park (WKNP)		**$19,418,180**
	Patrols	$9,426,180
	Population Management	$5,692,000
	Community Work	$3,300,000
	Disease Monitoring	$1,000,000
Leuser Ecosystem		**$24,691,645**
	Patrols	$10,384,645
	Population Management	$6,707,000
	Community Work	$6,600,000
	Disease Monitoring	$1,000,000
East Kalimantan		**$23,480,498**
	Patrols	$9,426,180
	Population Management	$9,754,318
	Community Work	$3,300,000
	Disease Monitoring	$1,000,000
National Strategies		**$3,727,913**
GRAND TOTAL BUDGET		**$90,495,201**

Sumatran Rhino Communications

CURRENT SITUATION

Lack of Awareness

Indonesians don't know that there are unique and critically endangered rhinos living in their country.

Lack of Interest

Indonesians do not value Sumatran rhinos and do not advocate for them.

Lack of Political Will & Funding

Indonesia government officials promise support but do not follow through

GOAL

Rhino Pride

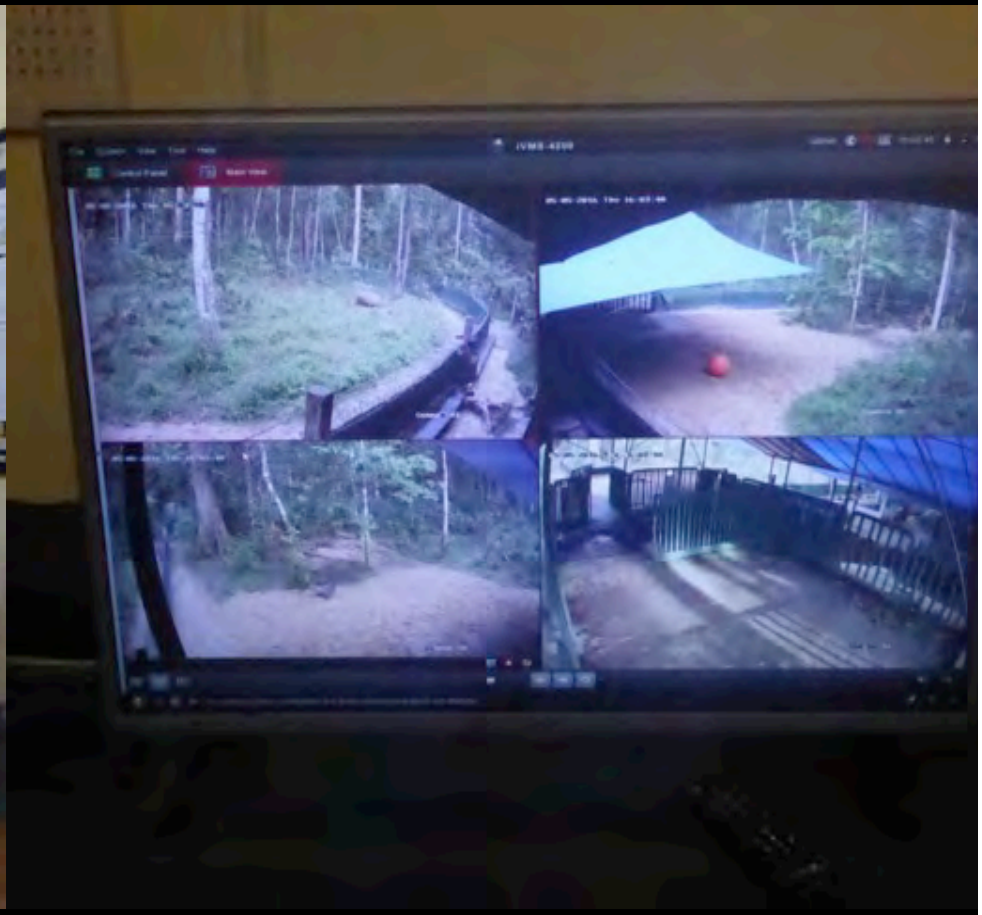
Create a new generation of Indonesians who value rhino conservation and "own" the quest to save Sumatran rhinos.

" Team Badak"
(Selamakan Badak Sumatera)

Ratu Calf Watch Team, May 2016








© Stephen Belcher/Canon/IRF/YABI


November 2016 – three days ago


IRF Mission
ensure the survival of
rhinos through
conservation and research

2014 RFP: Priorities

- Factors affecting health and reproduction *ex situ*
- Improve rhino population census, monitoring and tracking devices
- Identify most important factors in translocation success
- Determine ecological factors impacting rhino populations
- Conserve genetic diversity via cell/gamete rescue from remnant populations

Full Research Grant Proposals

12

Student Pre-Proposals

5

Five Proposals Funded

Michael Bruford, Cardiff University
Assessing the Genetic Health of Southern Black Rhinoceros Populations Using Genomic Tools

Mary Beth Manjerovich, Lincoln Park Zoo
Investigating Important Factors Affecting Health and Reproduction *Ex Situ*

Dimitri Petrov, Stanford University
Genetic Studies Relevant to Management of Black Rhino Populations

Budhan Pukazhenthi, Smithsonian Institution
Role of Gut Microbiota in Health and Disease Sensitivity of the Black Rhinoceros

Alfred Roca, Queen's University
Developing Effective Markers for Censusing of Sumatran and Javan Rhinoceros by Local Researchers

2 Student Proposals Funded

Krisztian Gyongyi, University of Kent
Conservation Ecology and Management of the Reintroduced Black Rhinoceros in Liwonde National Park, Malawi

Kathleen Sullivan, University of Florida
& Disney's Animal Kingdom
Validation of Best Practices for Measurement of Iron Status in Black Rhinoceros


IRF RFPP early 2018
Photo Mark Davis



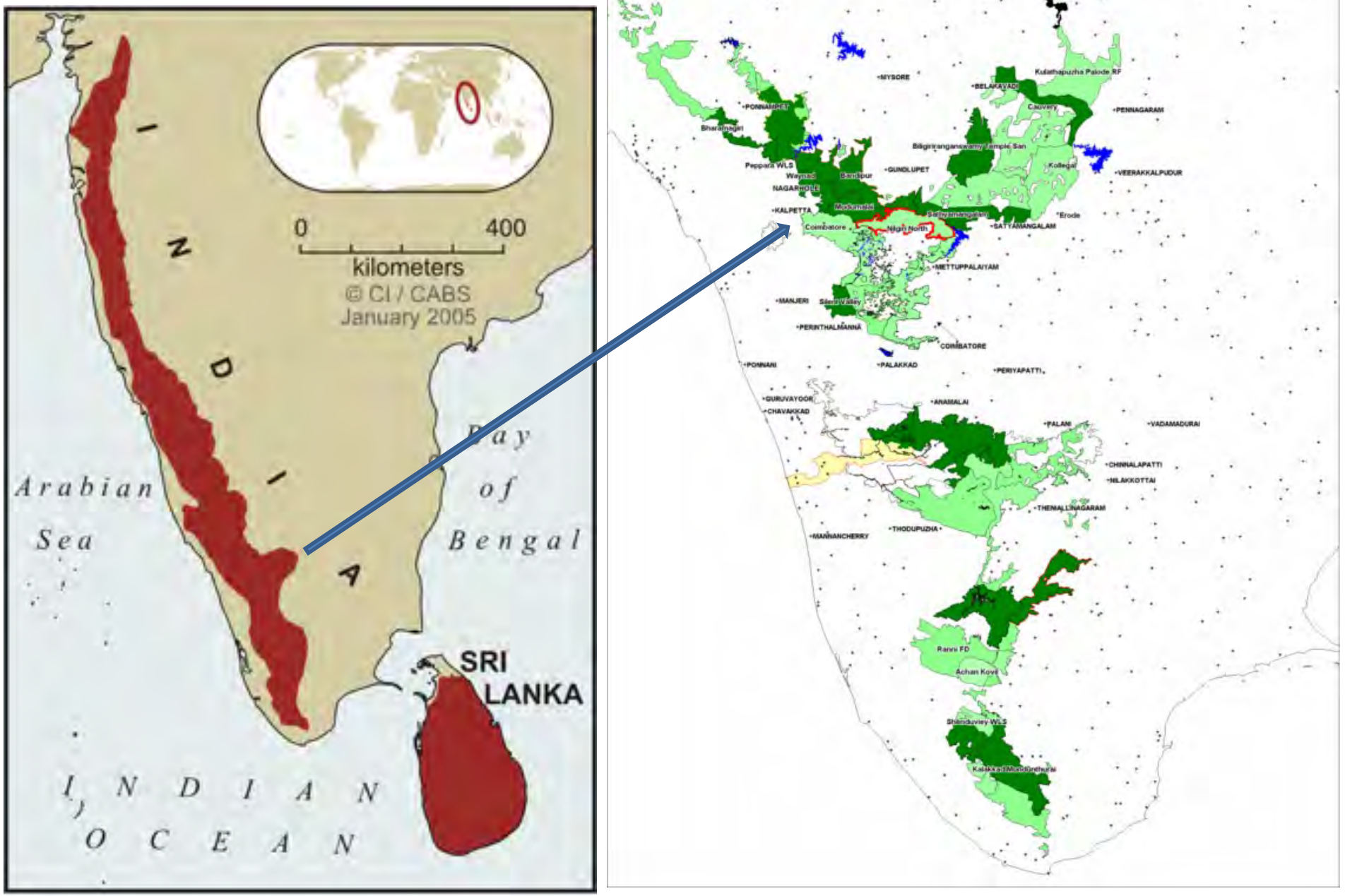

Thank you!
INTERNATIONAL
RHINO
FOUNDATION
www.rhinos.org



Nilgiris – Eastern Ghats Landscape: *Seeking Long-Term Persistence of Asian Elephants and Tigers in a Connected Landscape*

Ajay A Desai




0
400
kilometers
© CI / CABS
January 2005
Arabian Sea
Bay of Bengal
INDIAN OCEAN
SRI LANKA
MYSORE
BELAKAVADI
PONNAMPET
Bharatnagar
Peppara WLS
Wayanad
Bandipur
GUNDLUPET
NAGARHOLE
KALPETTA
Mudumalai
Coimbatore
Nilgiri North
Sathyamangalam
SATYAMANGALAM
Erode
METTUPPALAYAM
MANJERI
Silent Valley
PERINTHALMANNA
COIMBATORE
PONNANI
PALAKKAD
PERIYAPATTI
GURUVAYOOR
CHAVAKKAD
ANAMALAI
PALANI
VADAMADURAI
CHINNALAPATTI
NILAKKOTTAI
THENALLINAGARAM
MANNANCHERRY
THODUPUZHA
Ranni FD
Achan Kovil
Shendurney WLS
Kulathupuzha Palode RF
Cauvery
PENNAGARAM
Billigiriranganswamy Temple San
Kollegal
VEERAKKALPUDUR

Do we need to rethink our strategy?



HEC is a serious & increasing problem

- **Adverse impact on people**
  - Nearly half a million to a million hectares of agriculture land affected by crop raiding i.e. An equal number of families are adversely impacted!
  - 400 people killed, many more injured and countless others charged/threatened by elephants. The implications of fear psychosis are huge!
  - Normal daily lives of millions of people in thousands of villages is affected adversely
- **Adverse impacts on conservation**
  - Erodes wildlife managers authority
  - Generates resentment towards conservation
  - Retaliatory killing of elephants (more males lost)
  - HEC mitigation itself can sometimes have an adverse impact on elephants

Our basic attitude to HEC needs to change

- **False beliefs about historic interaction between people and wildlife (people lived in harmony with wildlife)**
  - Tens of thousands of elephants captured and killed in the past
- **Blaming people – they intrude into wildlife habitat**
  - There is no 'cut off' date and we are all intruders (no need for finger pointing)
- **Blaming changing perception i.e. <u>reduced tolerance</u> towards conflict**
  - They too face the socio-economic challenges as us and have the same aspirations for a better life
  - Subjugated societies are beginning to assert their rights – they are no longer the subservient society of yesterday

- **Illogical comparisons**
  - **Comparisons with natural calamities, plant disease, insect pests, rodents, etc.**
    - Natural calamities cannot be controlled.
    - When people are empowered and have the capacity they deal with the problem and do not complain (10 – 45 thousand people die of snake bites annually)
- **Placing the responsibility on people**
    - Schedule I species – People have the right to kill while protecting themselves or others (but not inside the forest)
    - Schedule II and lower – Original Act (1972) allowed you to kill while protecting life and property (including crops – crop protection gun license was issued); removed in the 1988 amendment this right taken away. But power vested in the CWW to allow this.

Whose elephant is it?

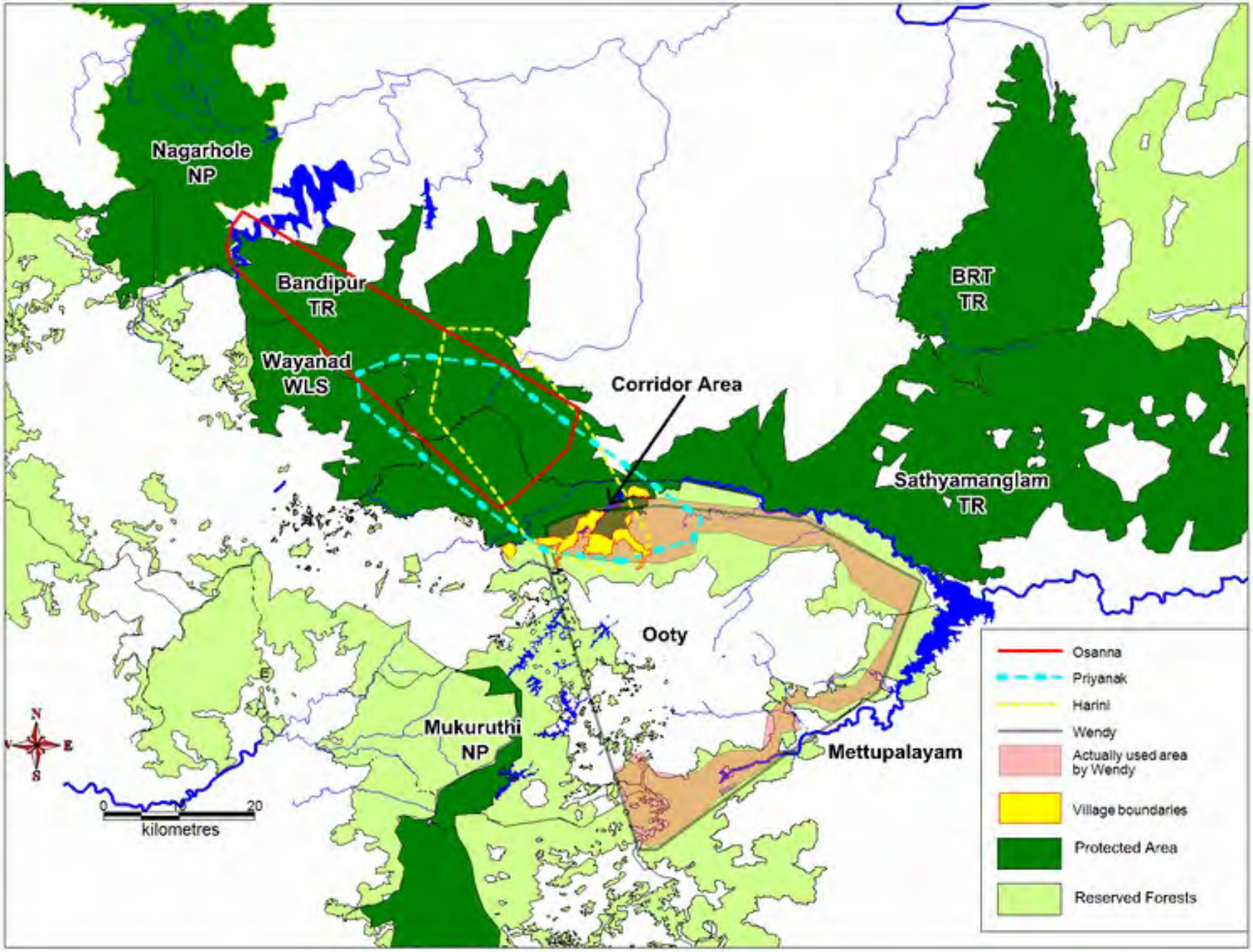
- Section 11 (3) – '**Any wild animal killed or wounded in defence of any person shall be government property**'
  - Government is therefore responsible for any damage these wildlife cause to people outside the designated forest areas
- **In terms of managing conflict the government can**
  - ***act alone***
  - ***collaborate with people and take collective action***
  - ***empower people to take action independently***

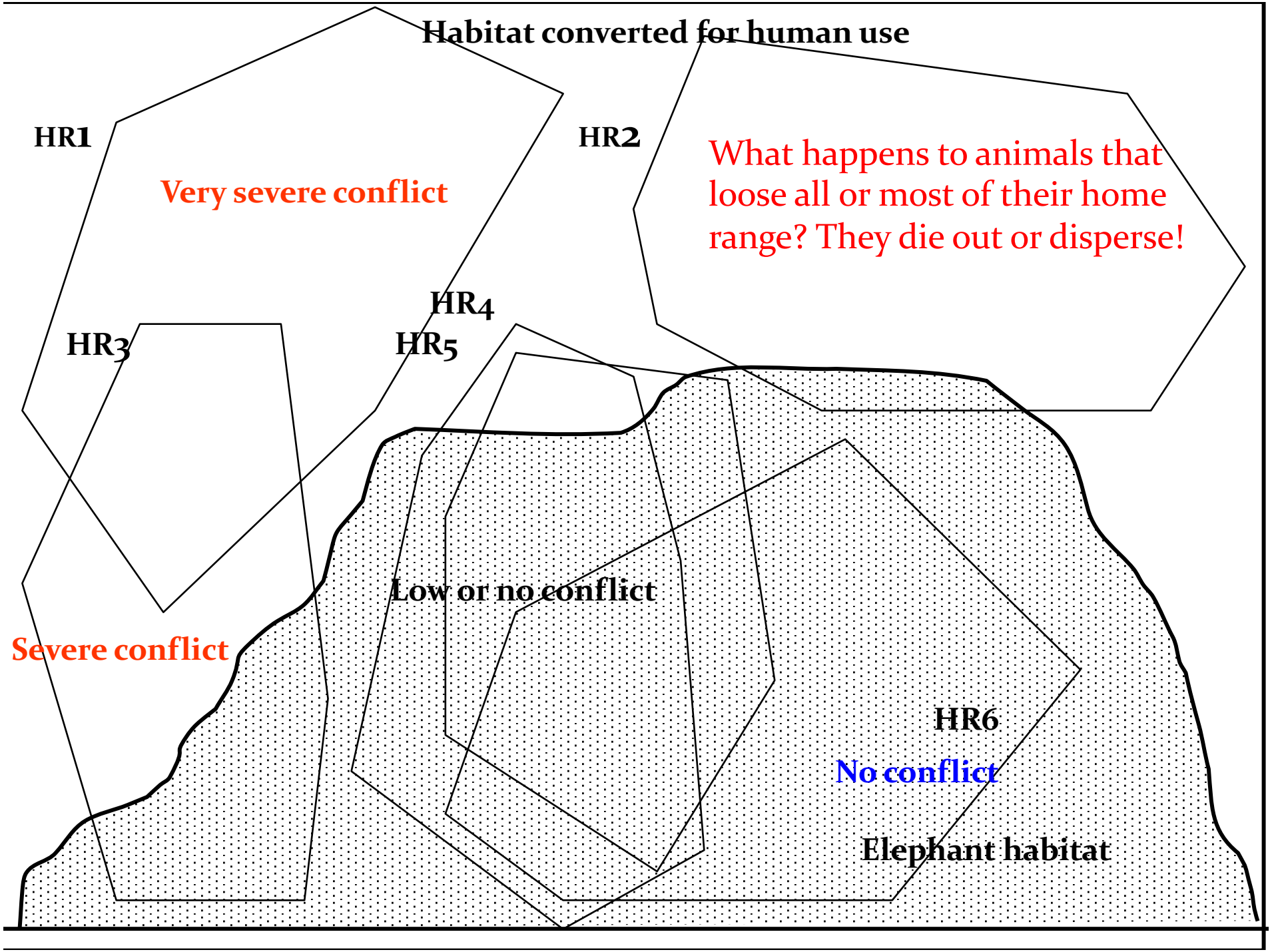
Need for science: Did the lion read the book?

- Animals do not behave the way we want them to, they behave the way they have been programmed to, by evolution
- Behaviour determines how and why conflict occurs and hence how best to address it
- It would also inform of about conservation requirements and understand how mitigation impacts the species

Females: Social and ranging behaviour in elephants

- **Strongly bonded social groups (clans)** and well defined home ranges and seasonal ranges to which they show strong fidelity
- **Social dominance hierarchies** which control and regulate space use by different clans with overlapping home ranges
- They cannot adjust to significant habitat loss/degradation or fragmentation within their home range. They will cause severe HEC


Nagarhole NP
Bandipur TR
Wayanad WLS
Corridor Area
BRT TR
Sathyamanglam TR
Ooty
Mukuruthi NP
Mettupalayam
N
E
S
W
0
10
20
kilometres
Osanna
Priyanak
Harini
Wendy
Actually used area by Wendy
Village boundaries
Protected Area
Reserved Forests


Habitat converted for human use
HR1
HR2
Very severe conflict
What happens to animals that loose all or most of their home range? They die out or disperse!
HR4
HR3
HR5
Low or no conflict
Severe conflict
HR6
No conflict
Elephant habitat

Every elephant cannot be saved: Dispersing elephants and pocketed populations



Male behaviour

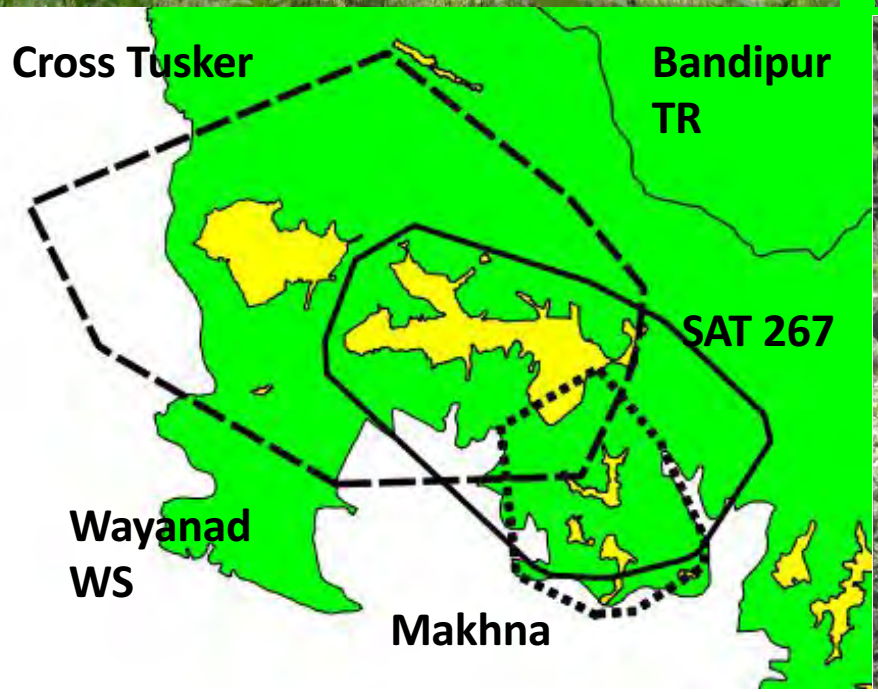


1. Disperse and form new home range
2. Associate with other herds and males and learn from them
3. Are not encumbered by family

Behavioral differences & habitual crop raiders



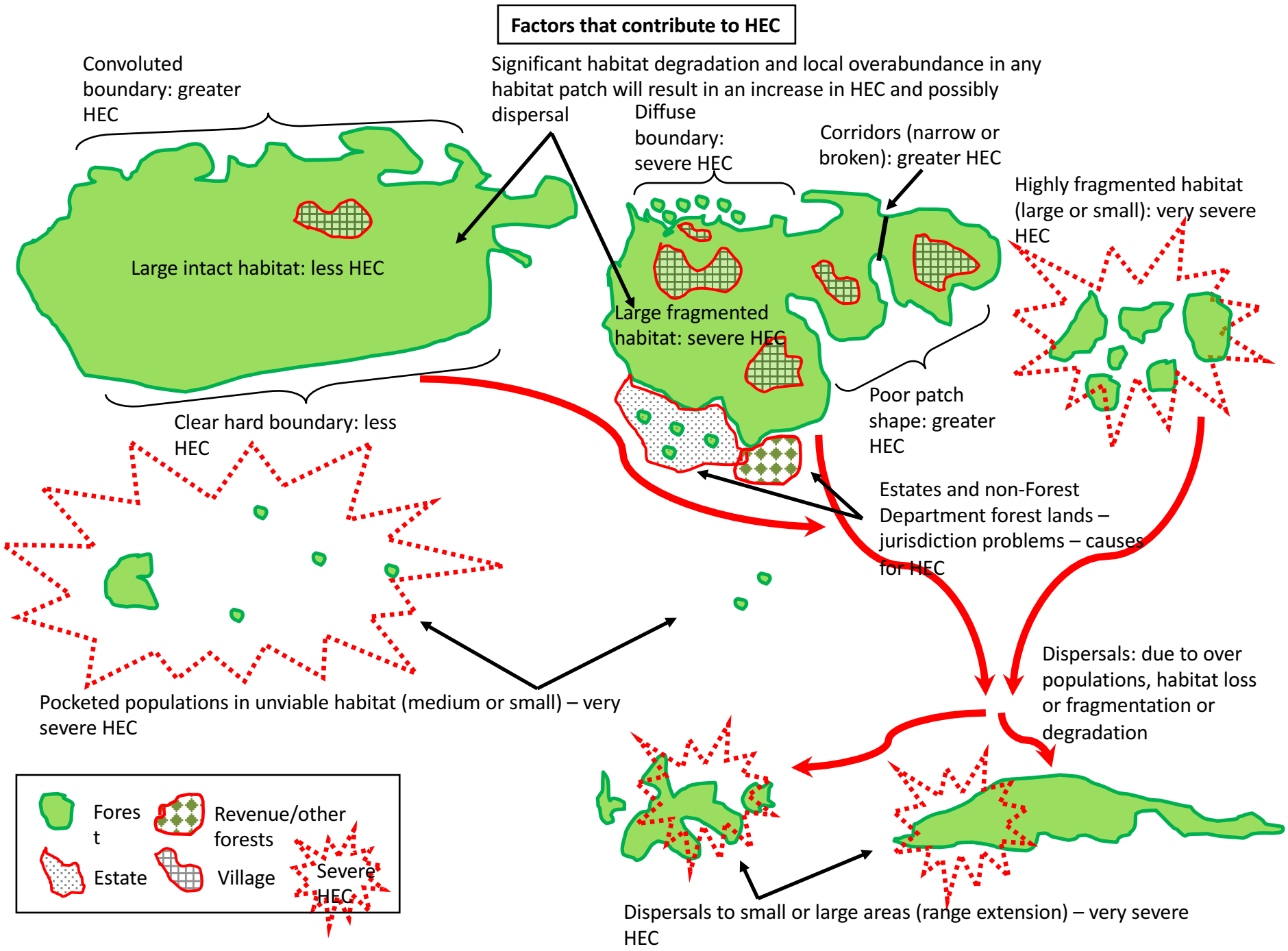


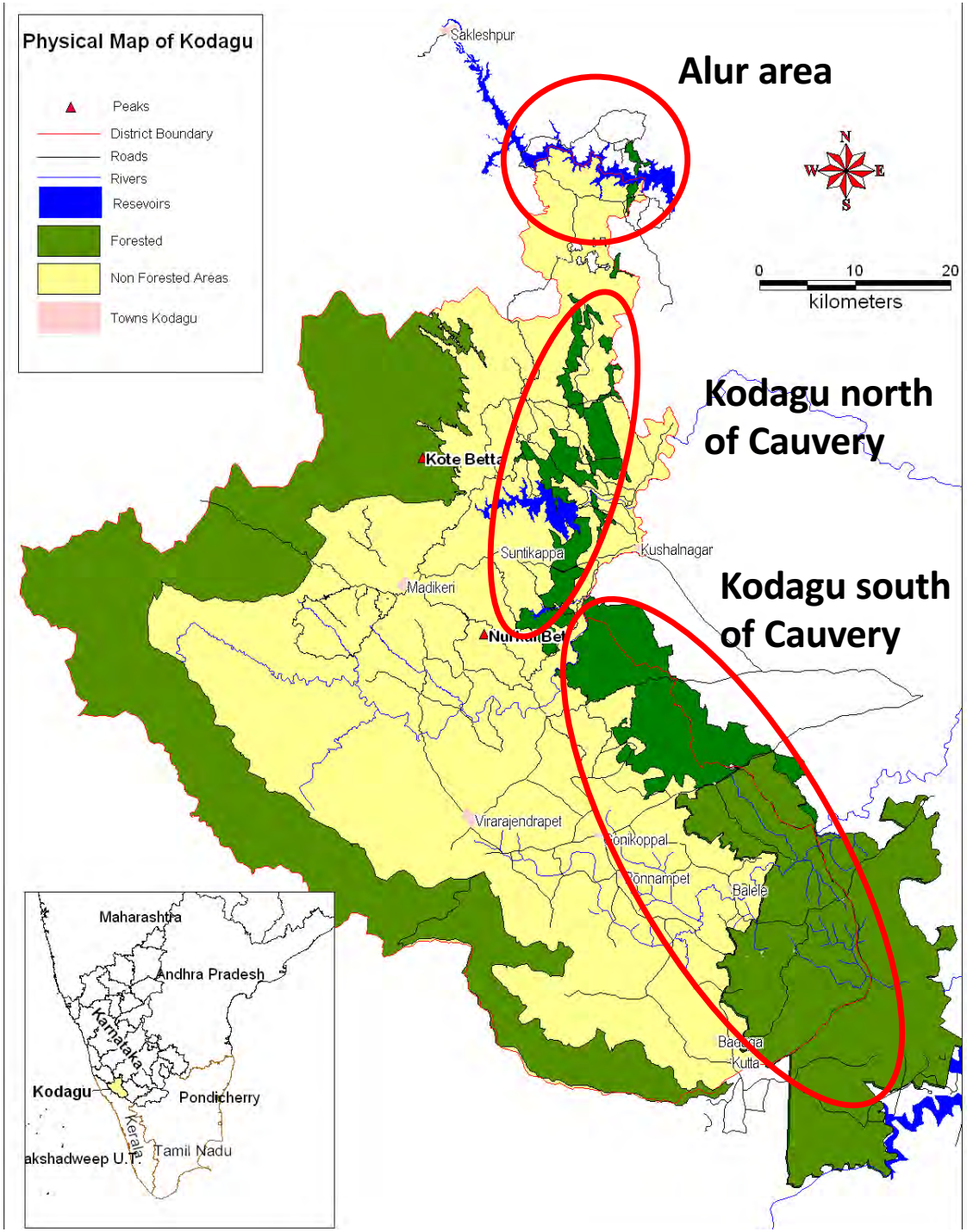


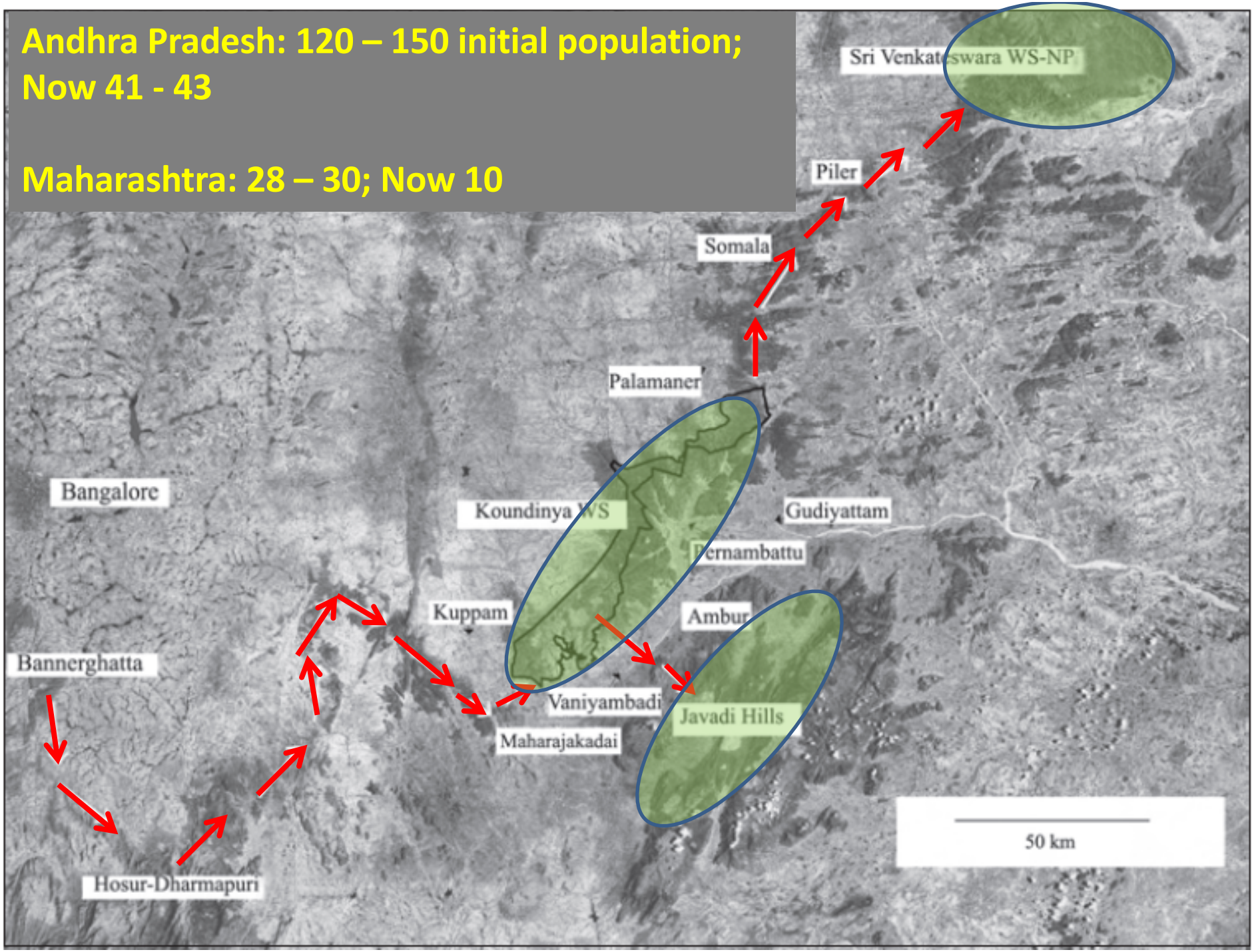


Why Do Elephants Raid Crops?

- **Opportunistic raiding** – if given the opportunity (no protection or disturbance), elephants will raid crops when they encounter them in or adjoining their home range. Easy to deter such opportunistic raiders.
  - **Habitual raider** – elephants habituated to raiding and difficult to stop
- **Obligate raiding** – When habitat loss, fragmentation or degradation are severe, elephants raid crops because of necessity – they do not have adequate fodder in their home range (or what is left of it). Here the alternate to crop raiding, is slow starvation due to scarce natural food resources being available. Only physical barriers stop them.
- Between these two extremes, a range of HEC intensities exist, requiring varying intensities of HEC mitigation effort.


Factors that contribute to HEC
Convoluted boundary: greater HEC
Significant habitat degradation and local overabundance in any habitat patch will result in an increase in HEC and possibly dispersal
Diffuse boundary: severe HEC
Corridors (narrow or broken): greater HEC
Highly fragmented habitat (large or small): very severe HEC
Large intact habitat: less HEC
Large fragmented habitat: severe HEC
Poor patch shape: greater HEC
Clear hard boundary: less HEC
Estates and non-Forest Department forest lands – jurisdiction problems – causes for HEC
Dispersals: due to over populations, habitat loss or fragmentation or degradation
Pocketed populations in unviable habitat (medium or small) – very severe HEC
Fores t
Revenue/other forests
Estate
Village
Severe HEC
Dispersals to small or large areas (range extension) – very severe HEC

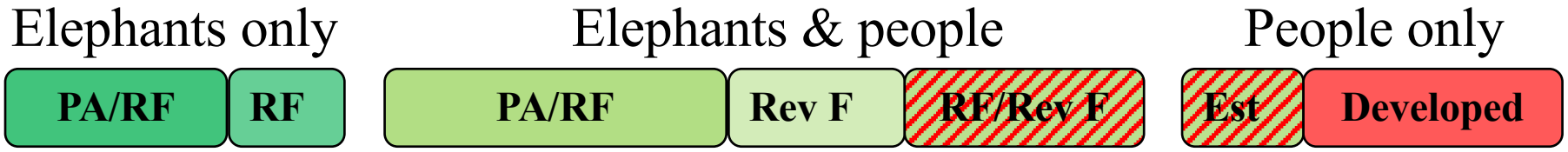

Physical Map of Kodagu
Peaks
District Boundary
Roads
Rivers
Resevoirs
Forested
Non Forested Areas
Towns Kodagu
Alur area
Kodagu north of Cauvery
Kodagu south of Cauvery
Sakleshpur
Kote Betta
Suntikappa
Kushalnagar
Madikeri
Virarajendrapet
Ponnampet
Balele
Kutta
0
10
20
kilometers
N
W
E
S
Maharashtra
Andhra Pradesh
Karnataka
Kodagu
Pondicherry
Kerala
Tamil Nadu
akshadweep U.T.


Andhra Pradesh: 120 – 150 initial population;
Now 41 - 43
Maharashtra: 28 – 30; Now 10
Sri Venkateswara WS-NP
Piler
Somala
Palamaner
Bangalore
Koundinya WS
Gudiyattam
Vernambattu
Kuppam
Ambur
Bannerghatta
Vaniyambadi
Javadi Hills
Maharajakadai
Hosur-Dharmapuri
50 km

Clarity about the conservation requirements

- **Spatial requirements**
  - 150 – 800 km2 for females?
- **Population requirements**
  - Minimum of 120 - 150 elephants?
- **Long-term conservation requirements**
  - Genetic?
  - Population size?
- **Biodiversity conservation requirements**
  - Impact on other species (population growth or confinement)?
- **Human-wildlife conflict mitigation**
  - Are we addressing all aspects of HWC?

Land use, elephant conservation & protection of habitat



- Elephants only areas:
  - PAs and other existing protection status (ESA)
  - RF – ESA/Inviolate areas
- Elephants & people - Multiple use area:
  - PAs/RF – regulated/sustainable exploitation (FRA/ESA)
  - Revenue Forest – (Rev F to RF)
  - RF/Rev F – not suitable for elephants – (How to manage these? Land swap?)
- People only
  - Developed (no elephants)
  - Estates/community – How to deal with these? Participatory approach/no elephant area

What are we trying to mitigate?

- **Threat to life**
- **Threat to livelihood**
  - Direct (Crop and property damage)
  - Indirect (loss of livelihoods)
- **Threat to quality of life**
  - Inability to improve standard of living (also adversely impacting future generations)
  - Inability to carry out normal activities
  - Living in fear/constantly stressed lives
  - Getting caught in debt-traps

Conflict mitigation: 4 critical steps

1. **Address the causal factors**: Stop the creation of new HEC situations and the escalation of existing HEC ones
2. **Reversing causal factors**: Reduce existing HEC
3. **Contain residual HEC**: Inevitable at the interface between human use areas and elephant habitat
4. **Compensate** when containment does not work

Addressing the causal factors for HEC

- **Stopping or minimizing habitat loss, degradation and fragmentation**
  - Integrated land use planning by line departments
  - Elephant specific EIA + developer responsibility
- **Managing local overabundance**
  - Population management (needs a lot of science)
  - Natural regulation - what would nutrition starved elephants do?

Reversing some of the past causal factors

- **Restoring habitat**
  - Limited scope
- **Restoring habitat quality**
  - Reducing dependence on forests (line agencies)
- **Restoring corridors**
  - Afforestation, purchase of land, etc.
- **Managing population**
  - Removal

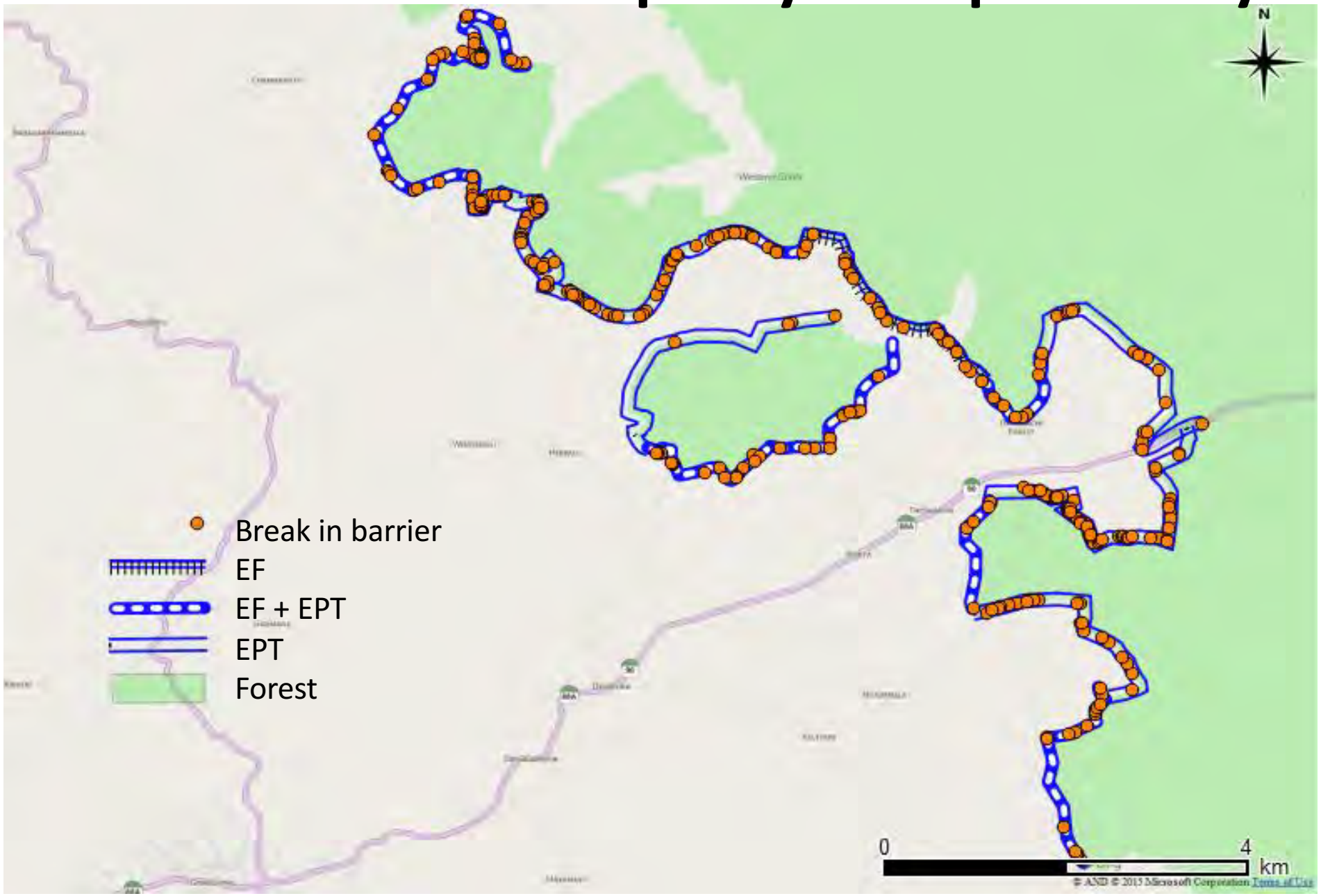
Containing residual HEC

- **Guarding**
  - Dependent entirely on fear of people
  - Ways to improve it (community based, early warning, linking with electric fence, etc)
- **Barriers**
  - Psychological (electric fence)
  - Physical (elephant proof trench, rail barrier, etc)
- **Drives (temporary relief)**
- **Removal**
  - Settlements/agriculture/crop
  - Elephants

Compensation – where all else fails in certain situations

- **Accept responsibility**
- **Developing standards (values and delivery)**
- **Source funds**
  - Government
  - Insurance companies
  - Other mechanisms

Breaks in barriers: capacity & responsibility



Research - issues

- **Fundamentally flawed (Bee, chili fence/ smoke)**
  - Either not likely to work or will not work in most cases
- **Poor testing**
  - Not tested on suitable scale resulting in deflection of elephants
- **Harmful to elephant/wildlife (musth smell, estrus calls, alarm calls, etc.)**
  - Disrupt natural behavior
  - Disrupt area use outside the target zone
- **Studies that only partially address conflict**

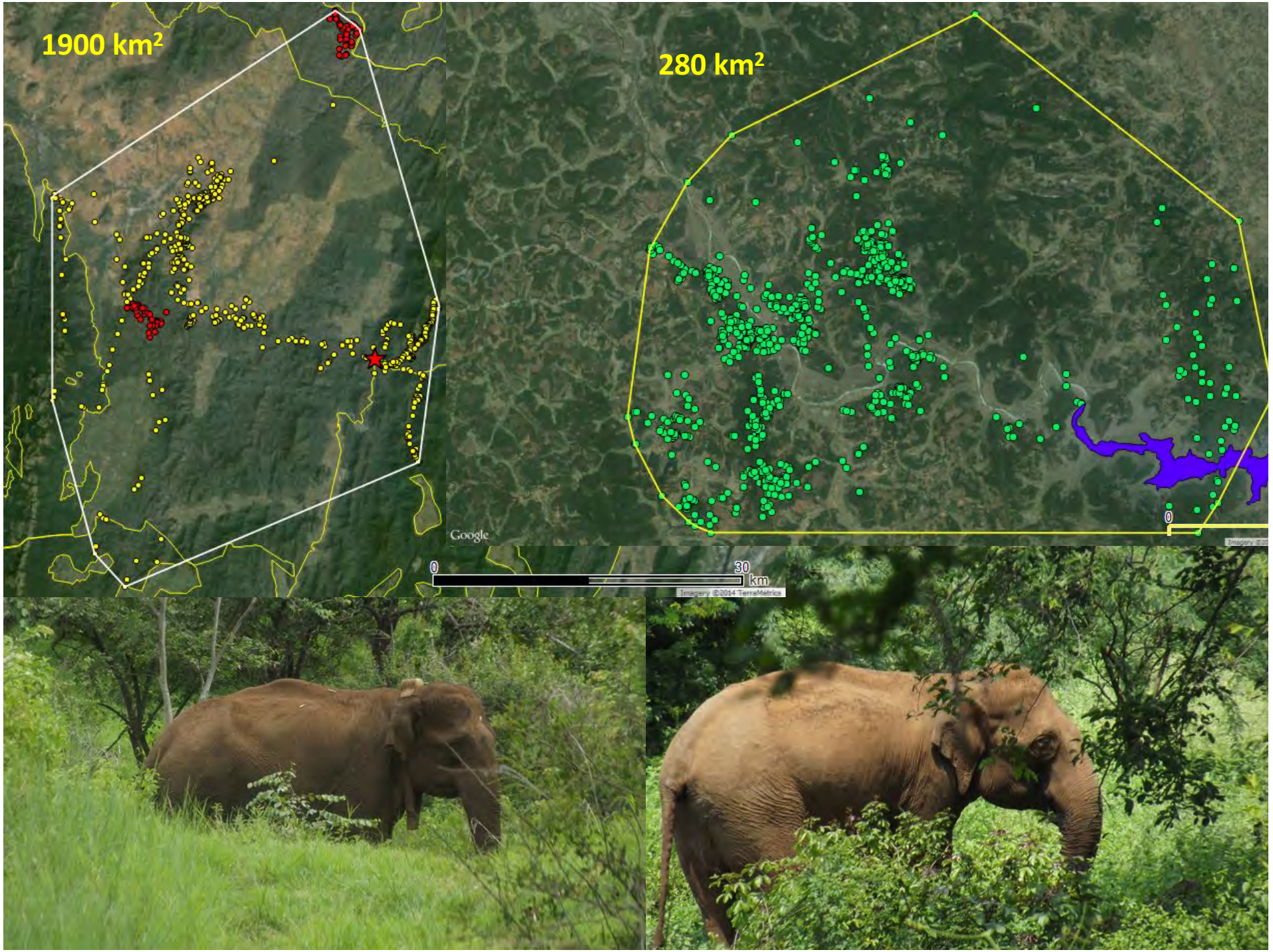
- **Research needs**
  - There is a clear need to bring behavioural, ecological and genetic sciences into understanding and planning for conservation and conflict management
  - Research into mitigation methods
  - Monitoring the impacts of mitigation methods (obligatory crop raiders)
- **Management**
  - Need for clear policy based on science that facilitates pragmatic management at the field level
  - Conservation and conflict management planning should take long-term outcomes into consideration
  - Monitoring of mitigation actions

Elephant are intelligent



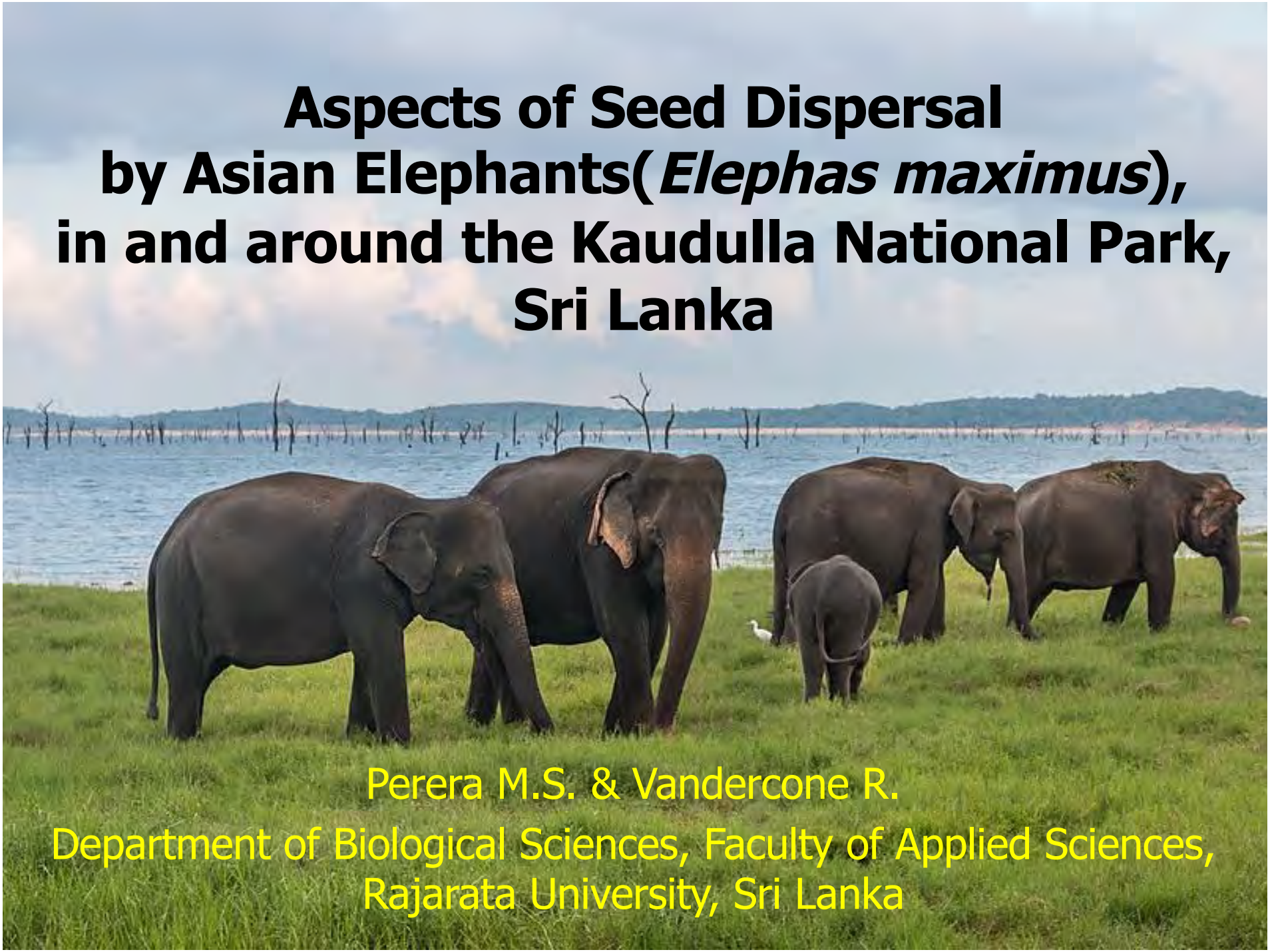





1900 km²
280 km²
Google
0
30
km



Aspects of Seed Dispersal by Asian Elephants(*Elephas maximus*), in and around the Kaudulla National Park, Sri Lanka



Perera M.S. & Vandercone R.

Department of Biological Sciences, Faculty of Applied Sciences, Rajarata University, Sri Lanka

Overview

Conservation requires a good understanding of ecological processes

Seed dispersal determines the potential area for seed establishment *(Traveset et al., 2014)*

An active research area due to the prominent role in plant ecology *(Willson & Traveset, 2000)*

Most plants depend on animals for the dispersal of their seeds *(Howe & Smallwood, 1982)*

Elephants as seed dispersers

Megafauna have always played a critical role in seed dispersal *(Janzen & Martin, 1982)*

Food habits and ranging behavior shape the seed dispersal functions of elephants
(Campos-Arceiz A. and Blake S., 2011)

Face very assorted environment conditions
(Olson et al., 2001)

Naturally their roles as seed dispersers differ accordingly

SDE in operation

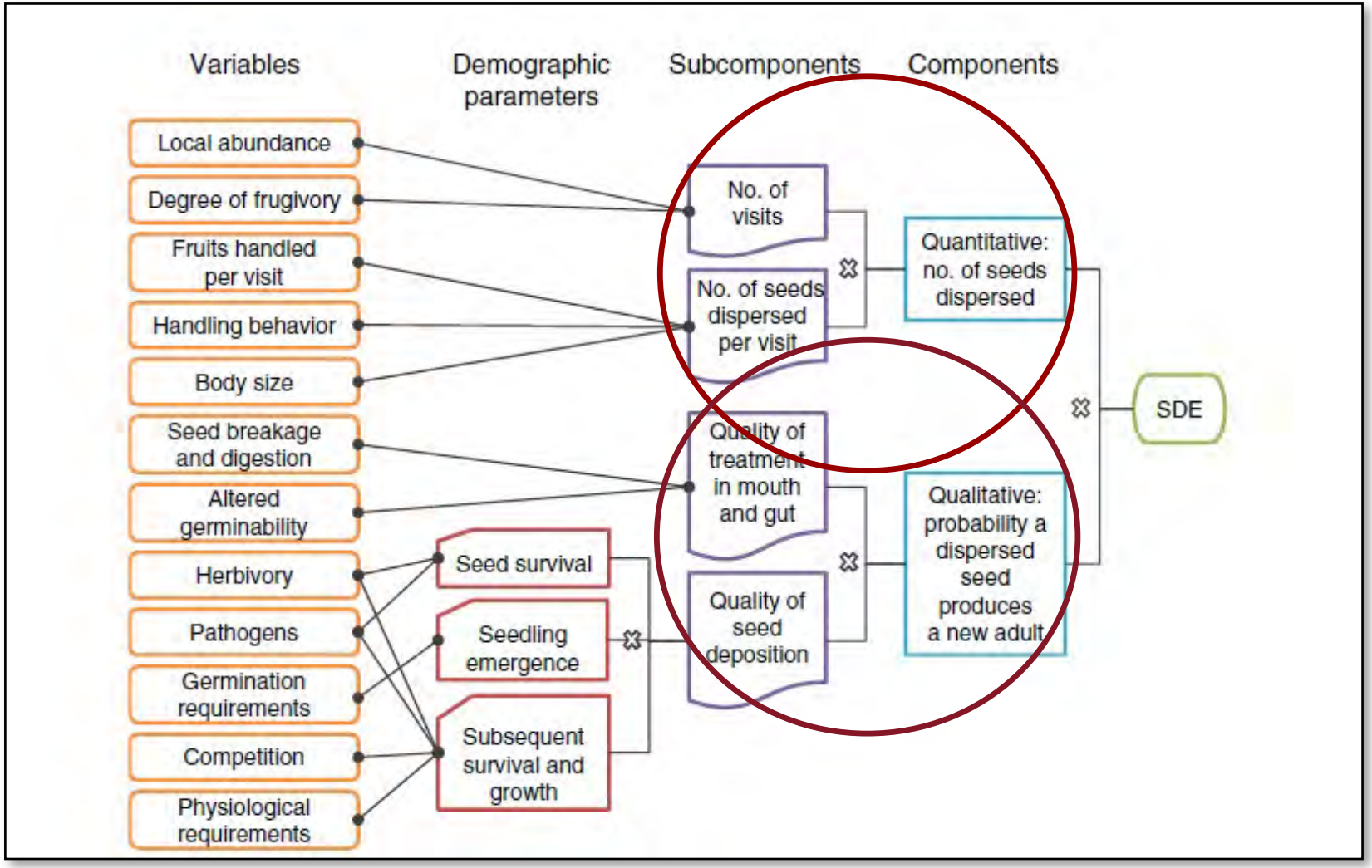


FIG. 1. Determinants of seed dispersal effectiveness *(Schupp, 1993)*

Aim and Objectives

Main objective

Determine aspects relating to the ***potential*** of seed dispersal

Determine aspects relating to the ***quality*** of seed dispersal

Specific objectives

Determining the level of frugivory

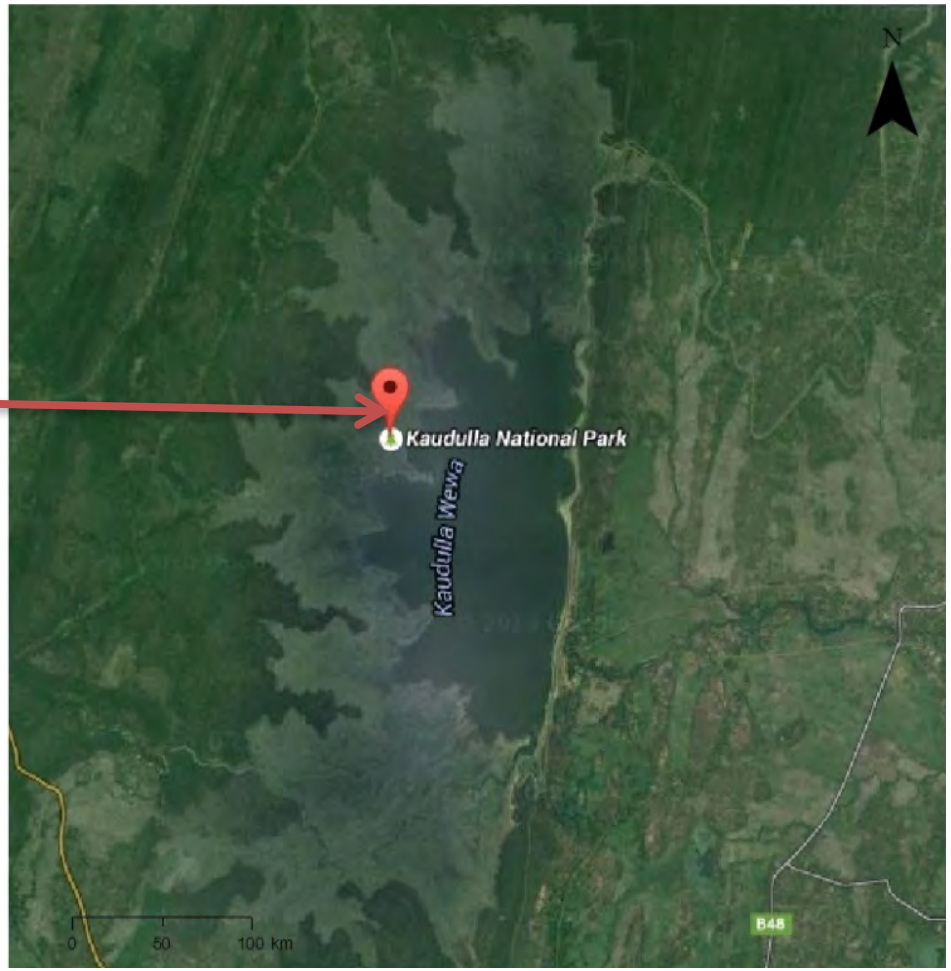
Determining if gut passage enhances seed germination

Determining if gut passage reduces latency

Study Site



(a) Location of Kaudulla National Park in the North Central Province



(b) Map of Kaudulla National Park

Materials & Methods

Sample collection

Field visits made from July to September 2015

66 fresh dung samples collected

Ripe fruits collected at the base of trees



Level of frugivory

Dung piles sampled by hand shredding

Intact seeds were counted and identified



Germination success

Germination trials in wet floral foam

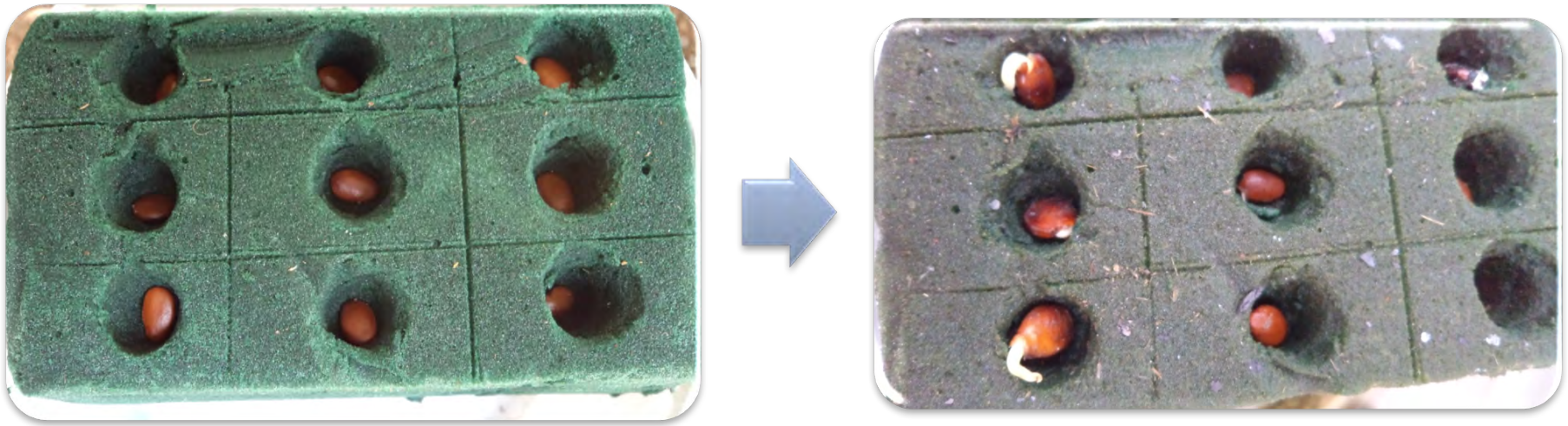
Ingested seeds Vs. fresh seeds

Bauhinia racemosa used due to abundance



Latency period

Time taken for germination noted



Statistical analysis

Pile wise diversity-Shannon-Weiner diversity index

Germination success-Chi-square test of independence

Latency period-t-tests

Data was analyzed by using SPSS 23.0

Results

Seed abundance

25 (37.9%) piles with seeds(1-270)

Total of 690 seeds (27.6 per pile)

1 pile with Shannon-Weiner diversity value>1



Seed diversity



Ziziphus oenoplia



Sp 4



A. *heterophyllus*



Cucurbita sp



Oryza sativa



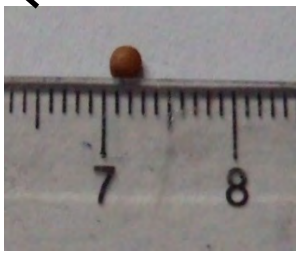
Sp 5



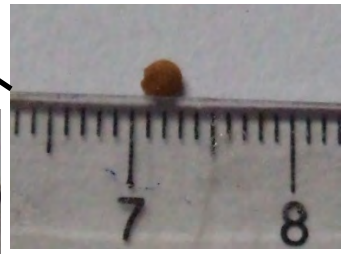
B. *racemosa*



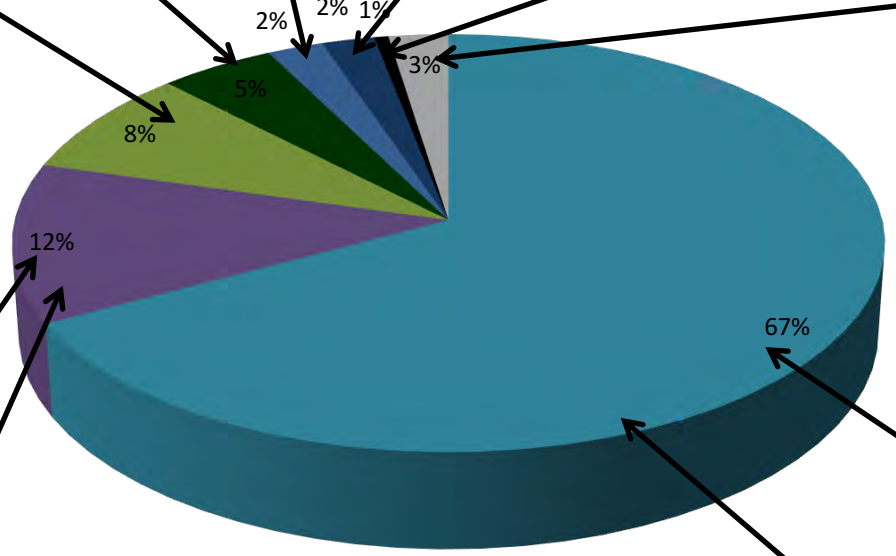
Mimosa pudica



Sp 2



Solanum melongena



Seeds of ten species were noted
(3-34 mm)

Germination success

Ingested seeds 41. 7%, Control seeds 38.8%

(x^2 = 0.028, df = 1, n1=60 n2=40, p≤0.87)

Difference is not statistically significant

Latency period

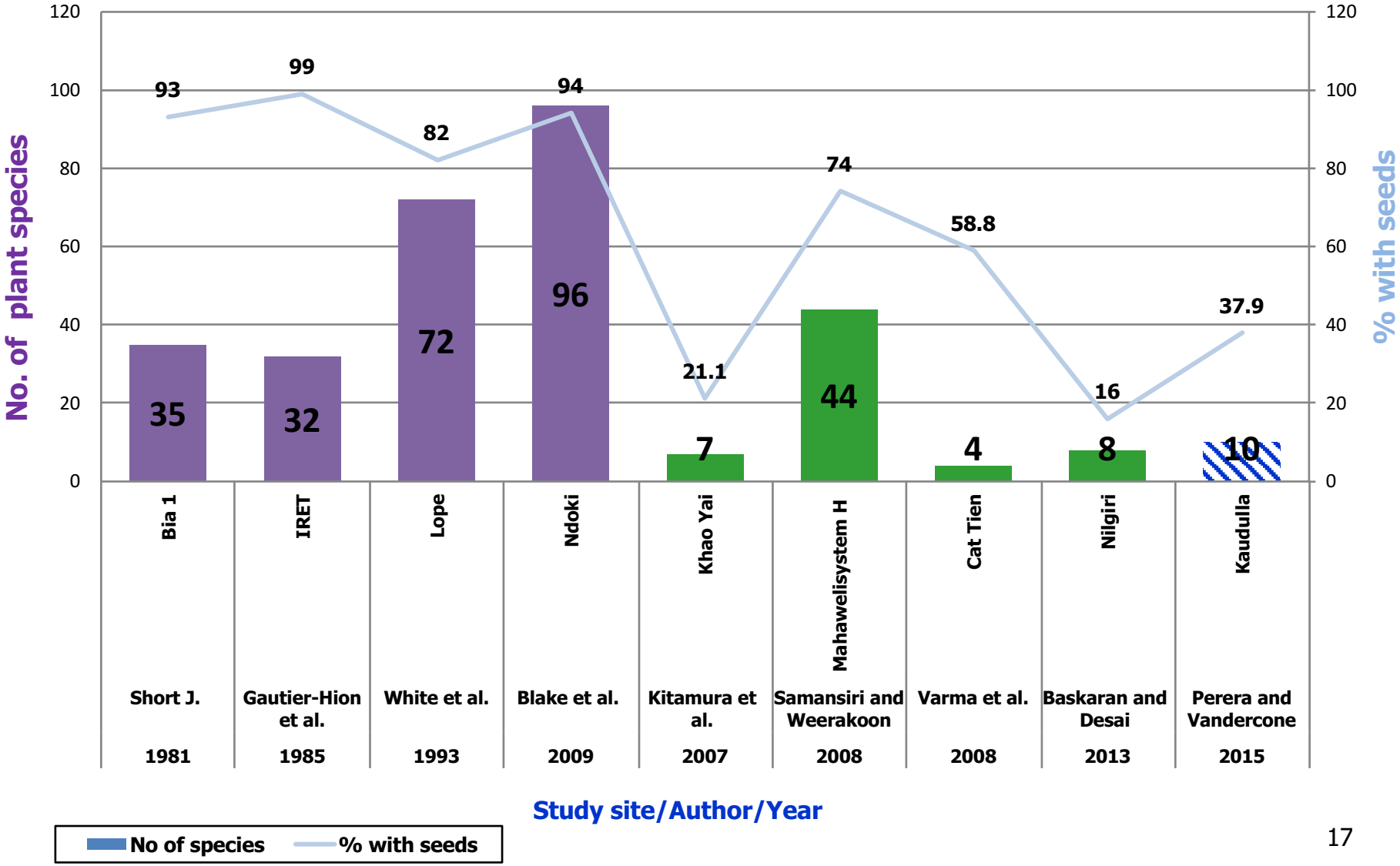
Mean number of days ingested seeds 11, control seeds 17

(t=2.467, df=24,n1=11 n2=15, p≤0.02)

Difference is statistically significant

Discussion

Seed abundance & Seed diversity



Level of frugivory

Variation in habitat quality *(Olson et al., 2001)*

Availability of food resources *(Corlett & Primack, 2005; Moles et al., 2007)*

Germination Success

Lack of specialist plants

Large seeds protected with a thick testa

- *Sclerocarva caffra* *(Lewis, 1987)*

- *Balanites wilsoniana* *(Chapman et al., 1992; Cochrane, 2003)*

Latency period

Mechanical scarification, sulphuric acid and heat lifts *Bauhinia racemosa* seed coat dormancy *(Zodape, 1991; Prasad & Nautiyal, 1996)*

Mechanical abrasion of molar teeth, partial digestion by gastric juice acids and heat action in gut *(Powell, 1998)*

Early emergence favorable for seedlings as they outcompete the later emerging seedlings due to enhanced fitness *(Loiselle, 1990)*

Conclusions

Low level of frugivory

Gut passage does not enhance seed germination

Gut passage does reduce latency

Elephants are important to ensure the success and perpetuation of certain plant species

Acknowledgements

Dr. R.P. Vandercone

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R.C. Priyadarshani

U.A.L.D. Rupasinghe

Facing the habitat crisis: securing, restoring and connecting habitats for elephants and Sumatran rhinos in South East Asia

R. Risch 1 , P. Saner 1 and P. Kretzschmar 2

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2 Department of Evolutionary Ecology, Leibniz Institute for Zoo and Wildlife Research, Alfred-Kowalke-Str. 17, 10315 Berlin, Germany
info@rhinoandforestfund.org

About the Rhino and Forest Fund (RFF):

- RFF was founded in 2009 by
- Petra Kretzschmar (biologist, IZW),
- Philippe Saner (biologist, University of Zurich) and
- Robert Risch (social scientist)
- Project area: East Sabah, Malaysia / Borneo
- Approach: linking species conservation and habitat restoration
- Main activities:
- - forest protection
- - forest restoration
- - establishment of wildlife corridors
- - support of rhino and elephant



Petra



Philippe



Robert

RhinoForest Fund e.V.

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Background

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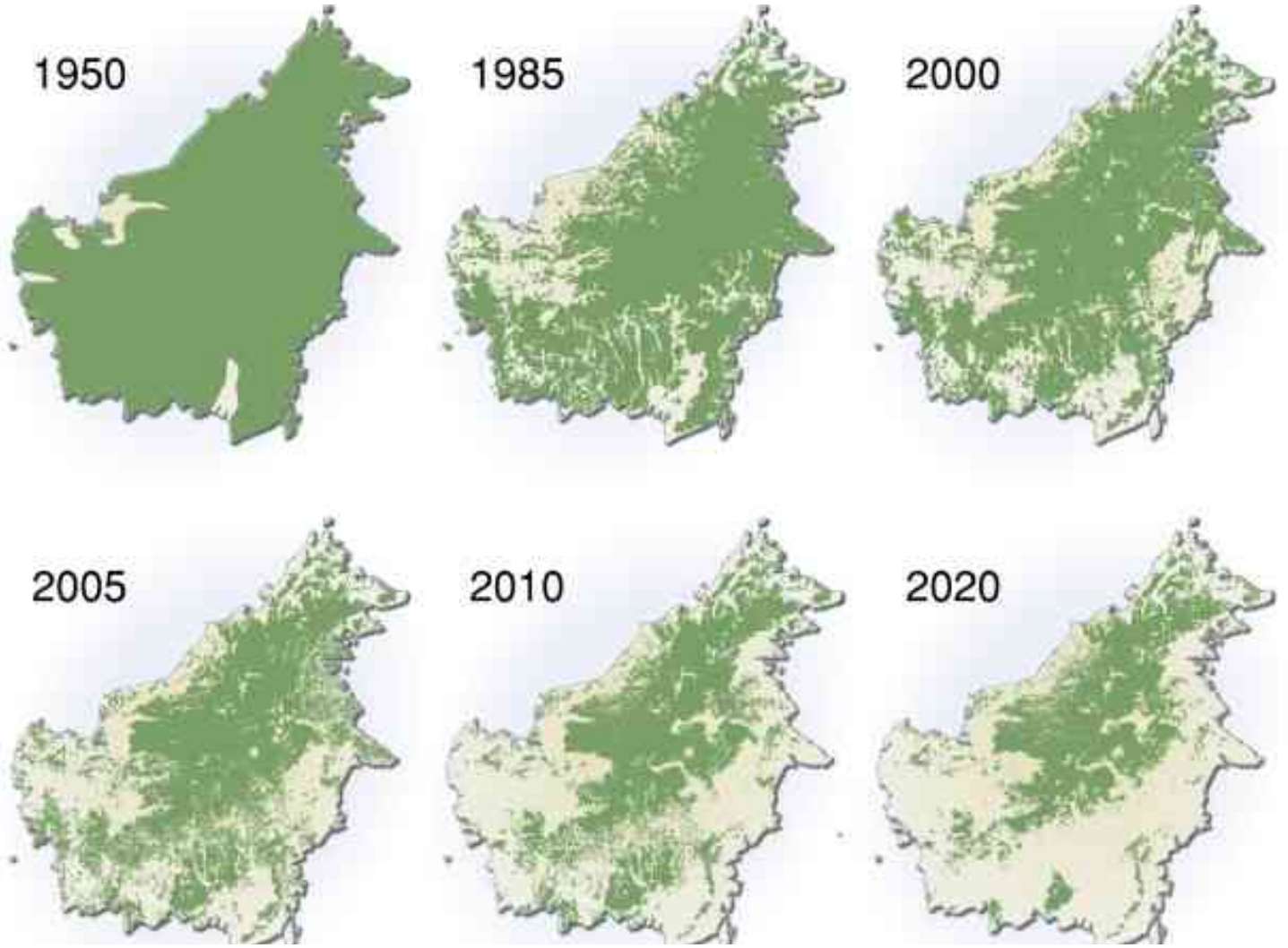
pictures by R.Risch

- **Logging and land conversions for industrial mono cultures have degraded, destroyed and fragmented most of SEA lowland forests**

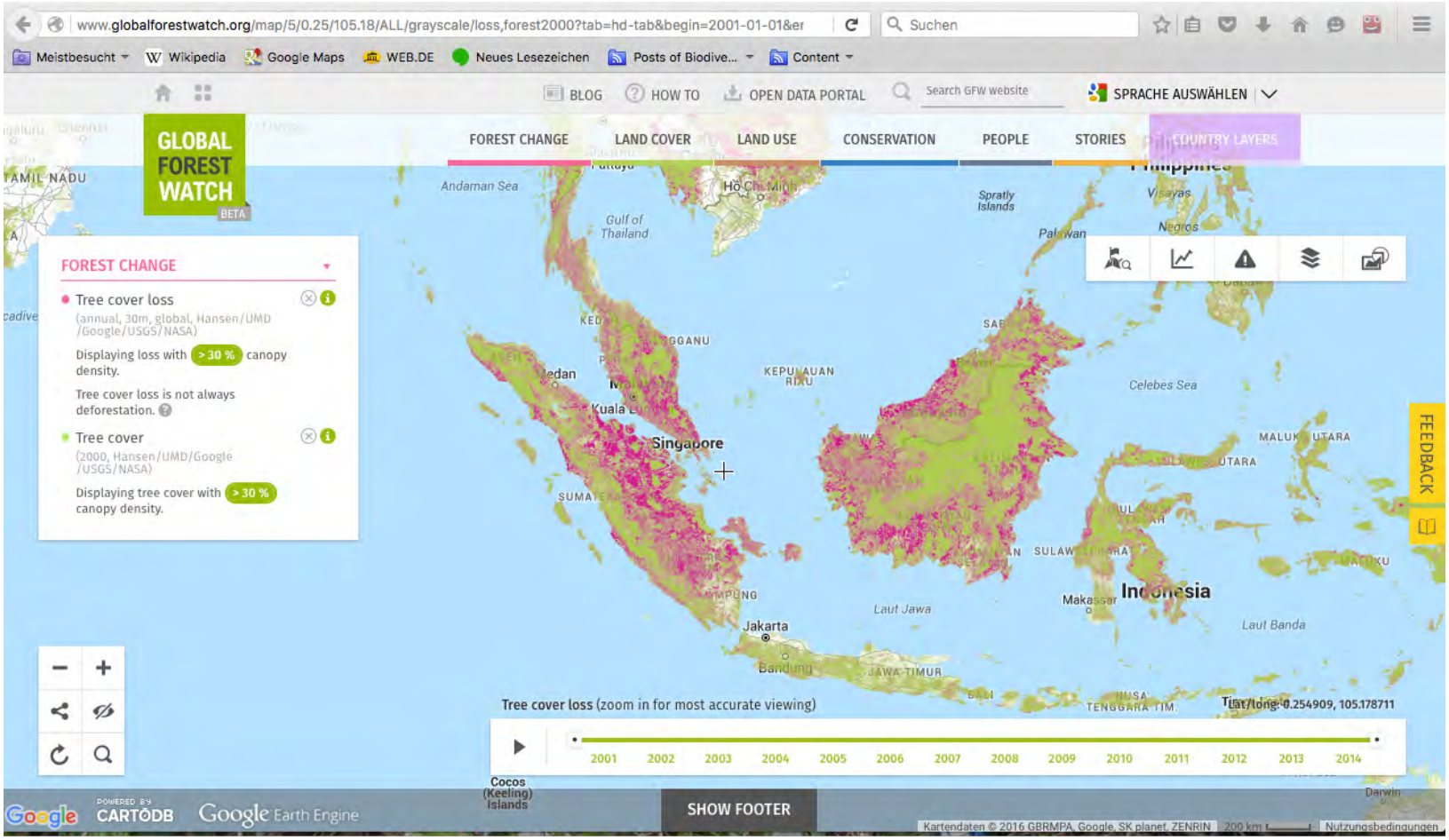
Forest cover loss on Borneo



source: http://maps.grida.no/go/graphic/extent-of-deforestation-in-borneo-1950-2005-and-projection-towards-2020

by Hugo Ahlenius, UNEP/GRID-Arendal

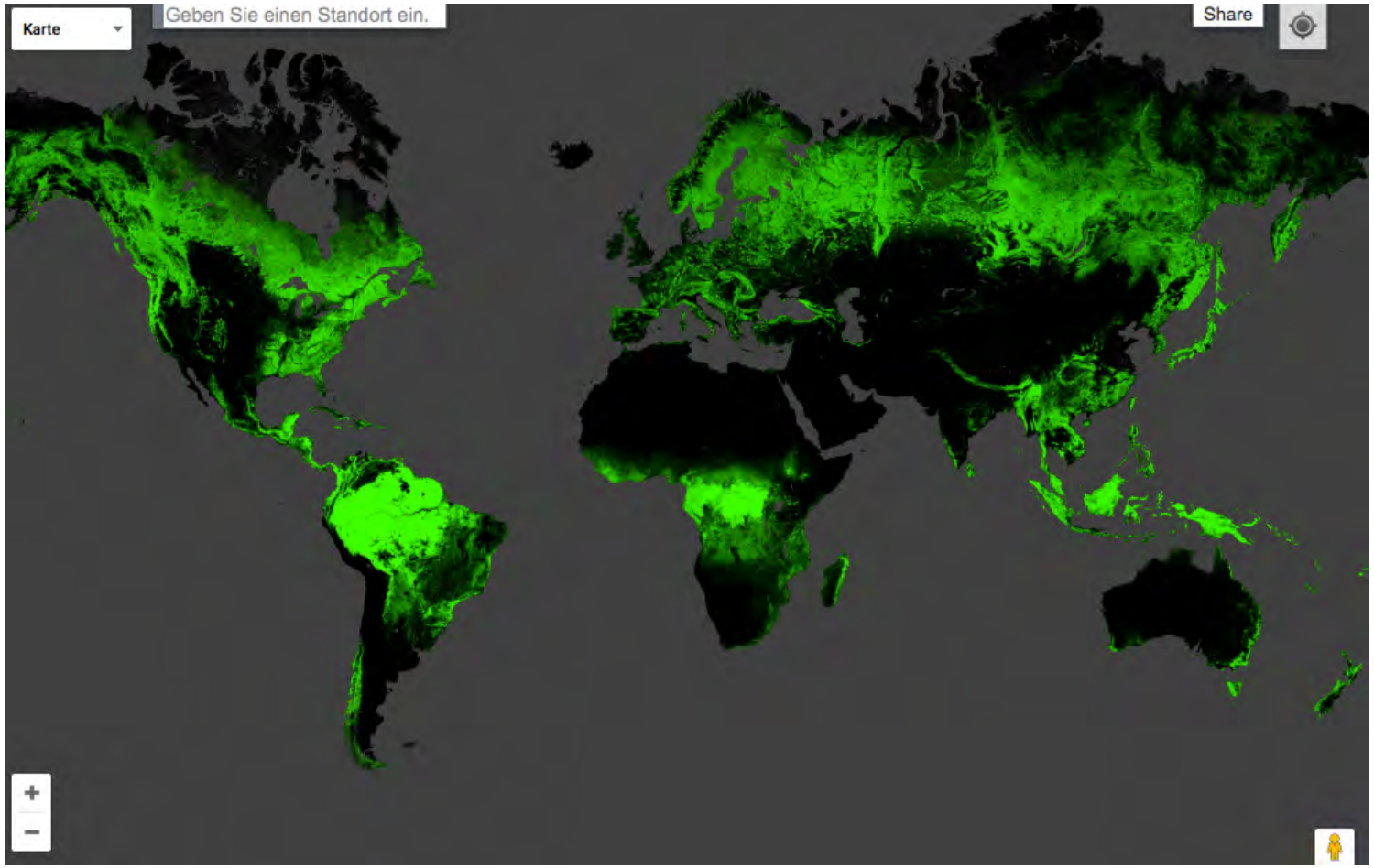
Interactive map of the forests of the world



http://www.globalforestwatch.org/

Map of the world's forest cover 2013

(but not all green areas are really forest)



http://earthenginepartners.appspot.com/science-2013-global-forest

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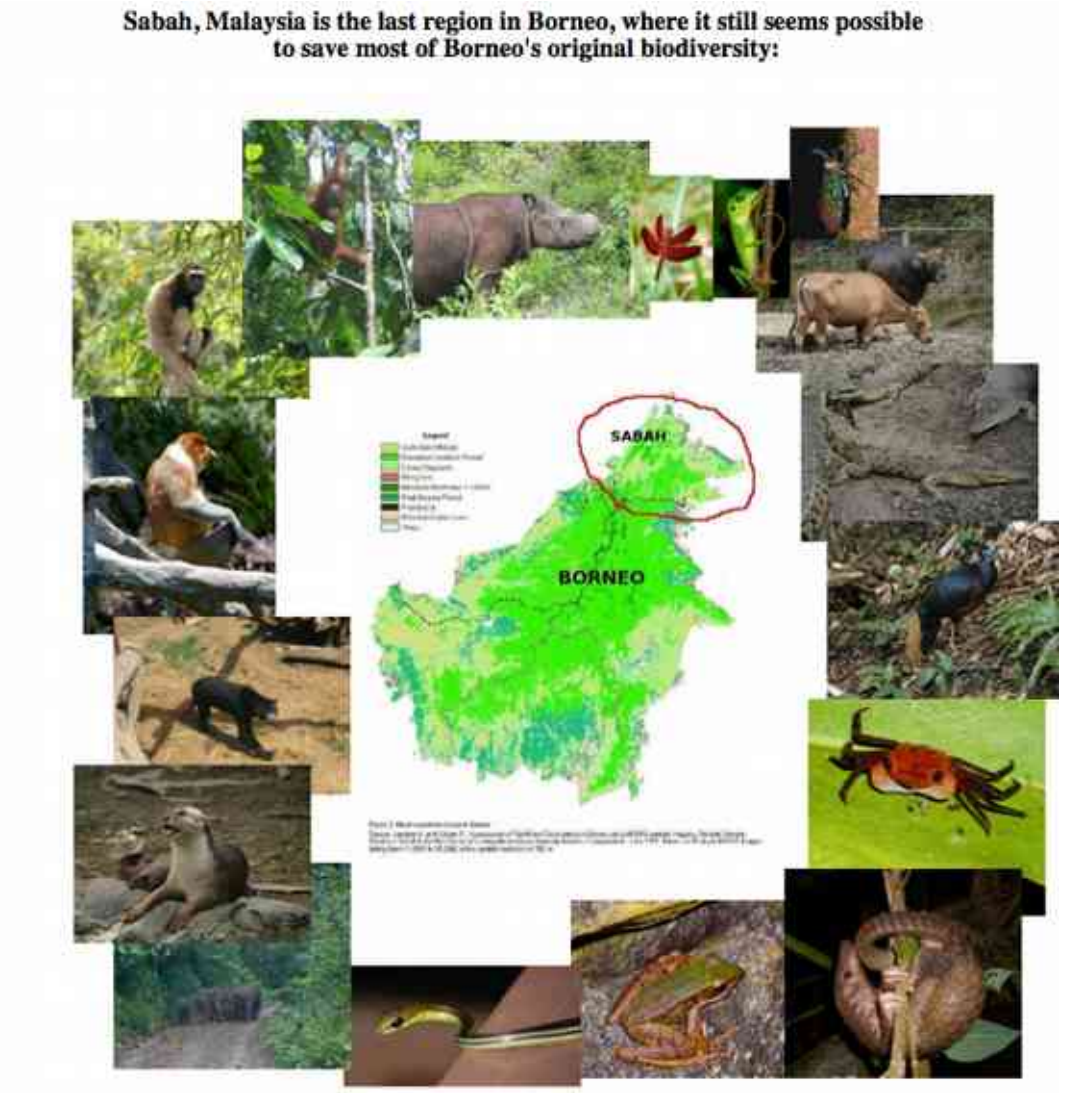
Where are we active?

Sabah, Malaysia is the last region in Borneo, where it still seems possible to save most of Borneo's original biodiversity:



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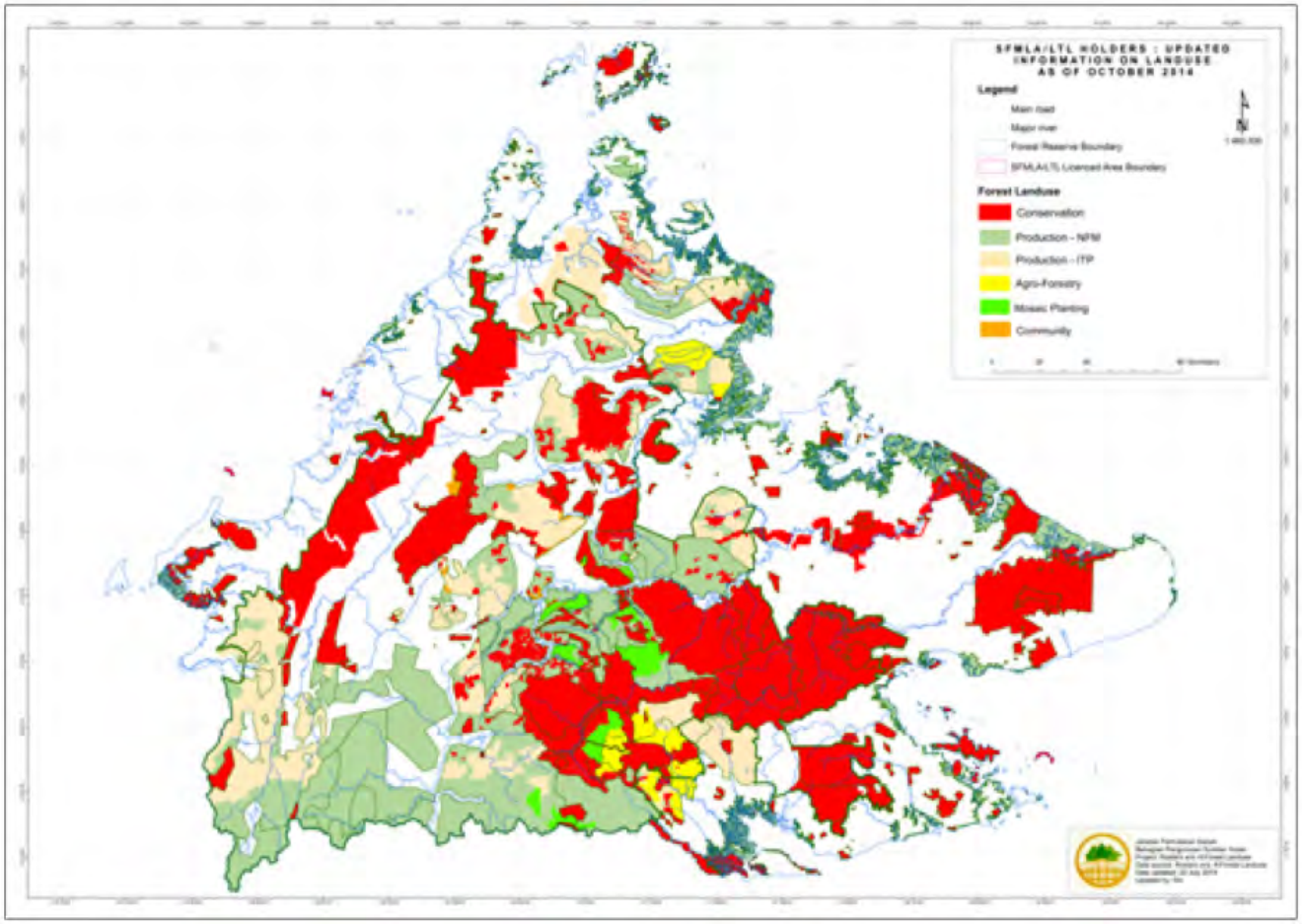
pictures by K. Saner and R. Risch

Sabah is the last region of Borneo that is still supporting nearly the complete original Bornean megafauna with one of the highest species diversities worldwide and the only state in Borneo with considerable institutional support for conservation

Map indicating the *fragmented* totally protected areas (TPAs) in Sabah (red)



map by Sabah Forestry Department

The government aims to reach 30% TPAs by 2025 (currently 26%)

RFF Target :
200,000+ ha of well connected TPAs in East Sabah

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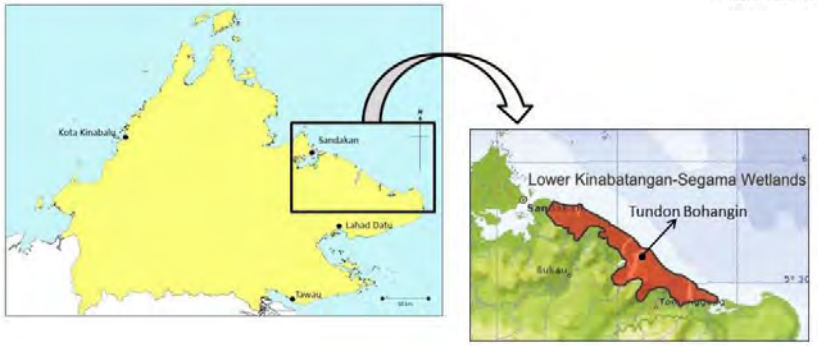
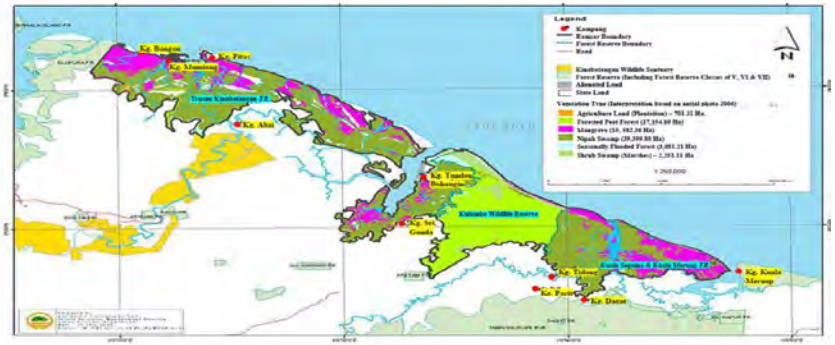
- Restore connectivity between Malaysia's largest Ramsar site and Malaysia's largest wildlife reserve



Lower Kinabatangan and Segama Wetlands (LKSW)



Tabin Wildlife Reserve and LKSW



maps by Sabah Forestry Department

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Objective is to achieve a well connected network of protected “natural” forest of a sufficient size and quality to conserve fauna and flora by:

- **saving habitat**
- **improving habitat**
- **improving habitat connectivity**



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Meaning of RFF's project area

The project area aims to connect different, partly vergin, ecosystems in the most remote region of Sabah ranging from the sea up to around 480m in Tabin and more than 700m in Silabukan:

- upper mixed dipterocarp forest
- lowland mixed dipterocarp forest
- seasonal freshwater swamp forest
- freshwater swamp forest
- lowland peat swamp forest
- mangrove forest
- nipah swamp
- beach forest
- coral reefs



pictures by R. Risch

Endangered species inside the project area

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Pictures by P. Kretschmar / IZW and R. Risch

Borneo orang utan

(pongo pygmaeus)

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picture by R. Risch

The estimated orang utan population in Tabin is around 1000 individuals.
Kulamba has an important population too.

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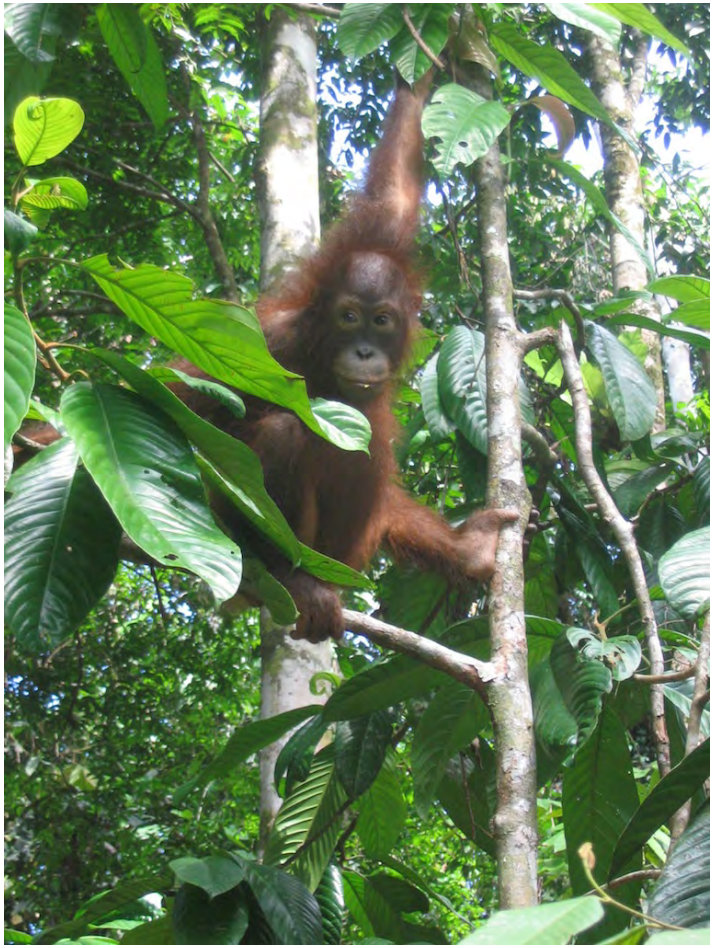

picture by R. Risch

Borneo orang utan in Tabin

Borneo gibbon

(Hylobates muelleri)

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picture by R. Risch

Proboscis monkey

(Nasalis larvatus)



picture by R. Risch

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Bornean sun bear

(Helarctos malayanus eurypsilus)



picture by R. Risch

The project area still support a considerable population of sun bear

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RFF camera trap picture of a sun bears inside the project area (2016)

Sunda clouded leopard

(Neofelis diardi)

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Camera trap picture by P. Kretzschmar / IZW 2013:
Sunda clouded leopard in Tabin

Borneo Banteng

(Bos javanicus lowi)

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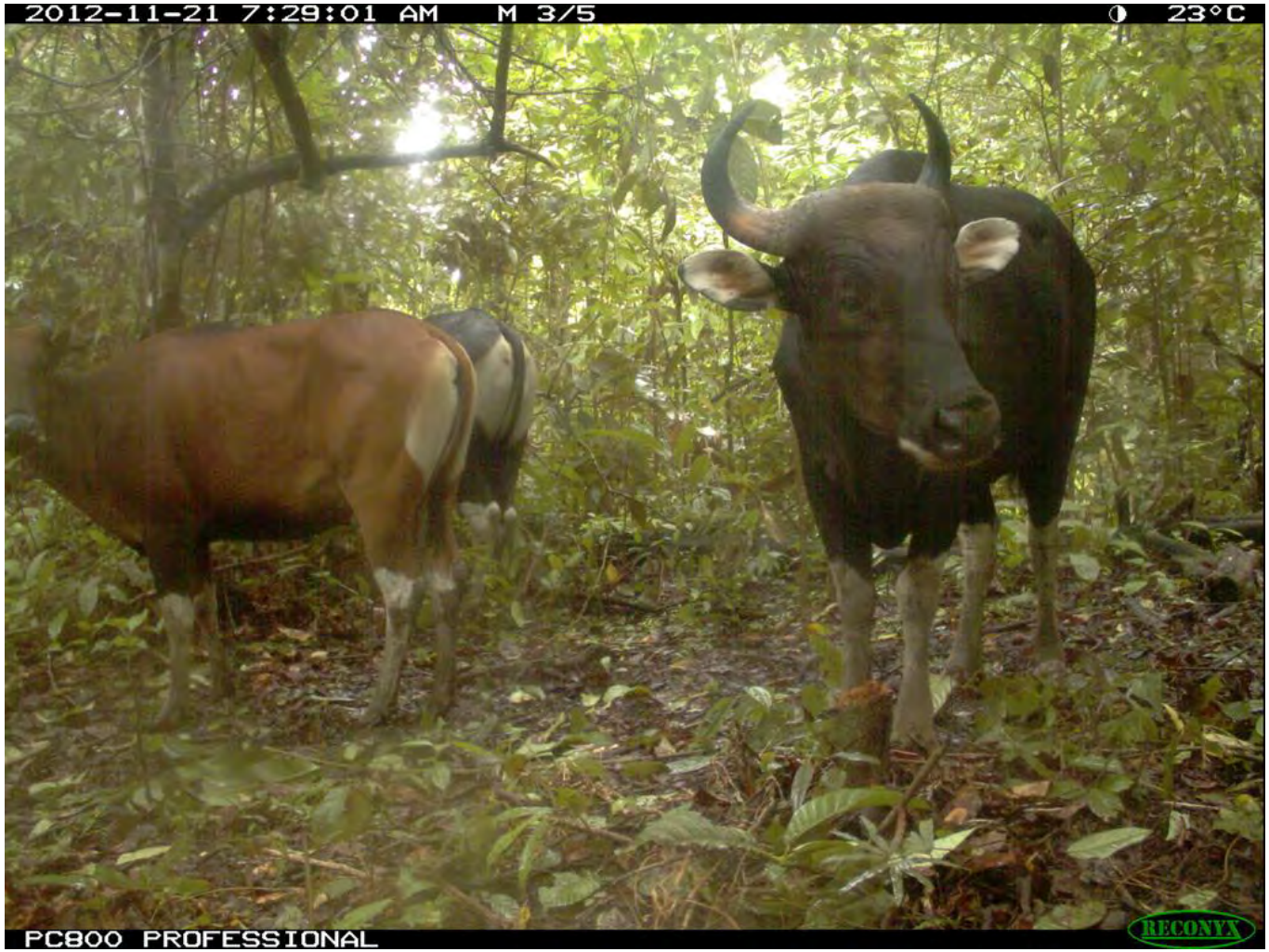

Camera trap picture by P. Kretzschmar / IZW 2012:
Borneo bantengs in Tabin

The project will help to prevent the extinction of the Borneo banteng:

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- the most important banteng population is in Kulamba
- Tabin has banteng too
- the reestablishment of habitat connectivity between Tabin and Kulamba might be crucial for the survival of the rapidly declining Borneo banteng



Source:
http://www.forest.sabah.gov.my/images/8._Ramsar_Abdul_Hamid_Banteng.pdf

Storm's Stork

(Ciconia stormi)

RhinoForest
Fund e.V.



picture by R. Risch

The project area might be the most important refuge of the endangered Storm's stork

Helmeted hornbill

(Rhinoplax vigil)



The critically endangered helmeted hornbill is still present in the project area

Hairy-nosed otter

(lutra sumatrana)

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Fund e.V.



The extremely rare hairy-nosed otter was discovered in the project area in April 2016 by Junichi Ishigami

Borneo pygmy elephant

(Elephas maximus borneensis)

RhinoForest
Fund e.V.



Pygmy elephants in Tabin **picture by R. Risch**

The project area covers a traditional elephant migration route between Tabin, Kulamba and Silabukan and is a refuge for up to 500 individuals (out of approx. 2000)

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RFF camera trap pictures from the project area (2015)

Pygmy elephant population seems to increase

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RFF camera trap picture from the project area (2016):
elephant born in front of RFF camera trap getting up for the first time

Borneo Rhino

(*Dicerorhinus sumatrensis harrisoni*)

RhinoForest
Fund e.V.



picture by R. Risch

There are probably less than 100 Sumatran rhinos left (mostly in Sumatra and a few in Borneo) – due to poaching, trapping, habitat loss and habitat fragmentation.
The Sabah rhinos have been declared extinct in 2014.

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- **Linking species conservation**
- **and**
- **habitat restoration:**

- **RFF's holistic conservation approach**

What does „holistic“ mean?

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Protecting and restoring whole ecosystems

















pictures by R. Risch

Not just for flagship species

















Pictures by P. Kretschmar / IZW and R. Risch

For *all* species

















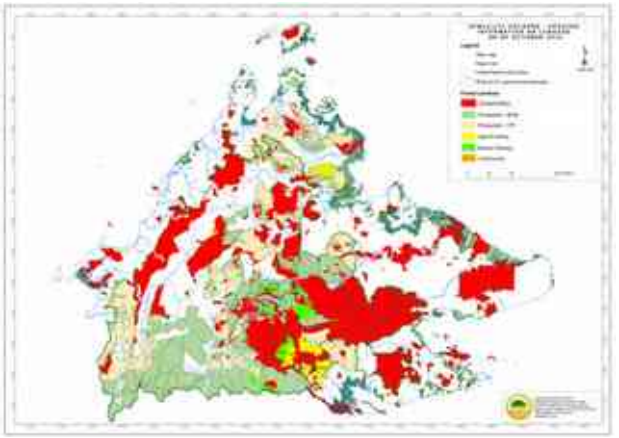
Considering the *whole landscape*

















pictures by R. Risch

Considering the socio-economic / political situation and specific threats and opportunities







§

















pictures by R. Risch

Conservation means first of all: dealing with *people*

















RhinoForest
Fund e.V.

How does our work look like?



Identifying the crucial decision makers

RhinoForest Fund e.V.



2010: MOU signing with the Sabah Forestry Department to work on the restoration and reconnection of the Tabin Wildlife Reserve

Raising public awareness


Local

(From left) Dr Philippe Saner of RFF, Herman Stawin of the SWD and Robert Risch of RFF in Tabin Wildlife Reserve monitoring their joint Reforestation Project.

Part of the area that is being replanted by the Reforestation Project.

Creating a better wildlife corridor

KOTA KINABALU: The State Government, represented by the Sabah Wildlife Department (SWD) and the Rhino and Forest Fund (RFF), signed a Memorandum of Understanding (MOU) to lay foundation for a better wildlife corridor between Tabin (Malaysia's largest wildlife reserve) and adjacent conservation areas.

Tabin Wildlife Reserve is one of the last areas on Borneo where large wildlife still co-exists. It includes the Bornean Rhino, Bornean Elephant, Orang Utan, Banteng and Sun Bear, but Tabin is almost completely isolated from other forests and surrounded by oil palm plantations.

"Connecting forest fragments is an integral part of our strategy to secure wildlife habitat in the long term," said Dr. Laurentius Ambu, Director of the SWD according to a joint press release from the Sabah Wildlife Department and Rhino Forest Fund.

Dr Laurentius added that it was necessary for the SWD to be active in promoting the reforestation work in areas with wildlife as the corridors and forest patches are much needed


NEW SABAH TIMES

Sabah's First Established Paper

Number 14938
PPH 223/04/2012(029617)
http://www.newsabahtimes.com.my

Monday February 6, 2012
Sabah RM1.20
http://ebrowse.bluehyppo.com

Creating a wildlife corridor for Malaysia's largest wildlife reserve

KOTA KINABALU: The State Government of Sabah, represented by the Sabah Wildlife Department (SWD) and the Rhino and Forest Fund (RFF) signed a Memorandum of Understanding (MOU) during the Sabah Wildlife Conservation Colloquium recently.

The agreement lays the foundation to improve a wildlife corridor in Tabin – Malaysia's largest wildlife reserve and adjacent conservation areas.

Tabin Wildlife Reserve is one of the last areas in Borneo where a large number of wildlife still exist. This includes the Bornean Rhino, Bornean Elephant, Orang Utan, Banteng and Sun Bear but Tabin is almost completely isolated from other forests and surrounded by oil palm plantations.

"Connecting forest fragments is an integral part of our strategy to secure wildlife habitat in the long term," said Dr. Laurentius Ambu, Director of the SWD according to a joint press release from the Sabah Wildlife Department and Rhino Forest Fund.

Dr Laurentius added that it was necessary for the SWD to be active in promoting the reforestation work in areas with wildlife as the corridors and forest patches are much needed for wildlife connectivity.

"At present there is an increase of reforestation work within wildlife landscapes in Sabah and we want them to be successful not only for the benefit of wildlife but also local communities who are close to these areas," said Dr Laurentius.

The wildlife corridor will facilitate the migration of critically endangered wildlife through the newly established Segama Corridor Conservation Area.

It is hoped that eventually this will lead to a narrow but continuous corridor from Tabin up to Kulamba Wildlife Reserve, another important refuge for endangered species.

"To save endangered wildlife suffering from habitat fragmentation, we need to establish a network of protected areas of a sufficient size and quality. This will prevent inbreeding of currently separated sub-populations and help to maintain healthy populations. Tabin is absolutely crucial for the long-term survival of many threatened species and needs to be reconnected with adjacent forest land. The outcome of efforts will be a conservation area of 200,000 hectares as big as

rectors of the RFF.

Under the MoU the State Government of Sabah reassures that the restored area will remain protected from any conversion or logging in the future. This emphasises the commitment of the government to wildlife conservation in Sabah and convinces donors to become involved.

"Our approach is to plant a wildlife corridor with many different local canopy and fruit trees that occur in natural forest. Although this may sound evident, the concept of planting trees in high diversities is not practised in most reforestation projects. Our project in Tabin and the surrounding area use a seedling stock that is high in species and genetic diversity to accelerate the regeneration of the original ecosystem," shared Dr. Philippe Saner, another director of RFF.

Leipzig Zoo from and private donors support this project.

RhinoForest Fund e.V.

Going to the field:
exploration of project areas



picture by R. Risch

Understanding the situation of the local people



Identification of crucial areas for wildlife corridors

RhinoForest
Fund e.V.



picture by R. Risch

Searching for signs of rare wildlife

RhinoForest
Fund e.V.



picture by R. Risch

Detecting elephant movement patterns together with estate staff

RhinoForest Fund e.V.



picture by R. Risch

Wildlife surveys with camera traps

RhinoForest
Fund e.V.



Asking the locals about elephant movements

RhinoForest
Fund e.V.



picture by R. Risch

Looking for signs of elephant presence together with plantation staff

RhinoForest
Fund e.V.



picture by R. Risch

Burned tire indicating human-elephant-conflict

RhinoForest Fund e.V.



picture by R. Risch

Looking for opportunities to reconnect fragmented forest

RhinoForest
Fund e.V.



picture by R. Risch

Decoding the landscape puzzle

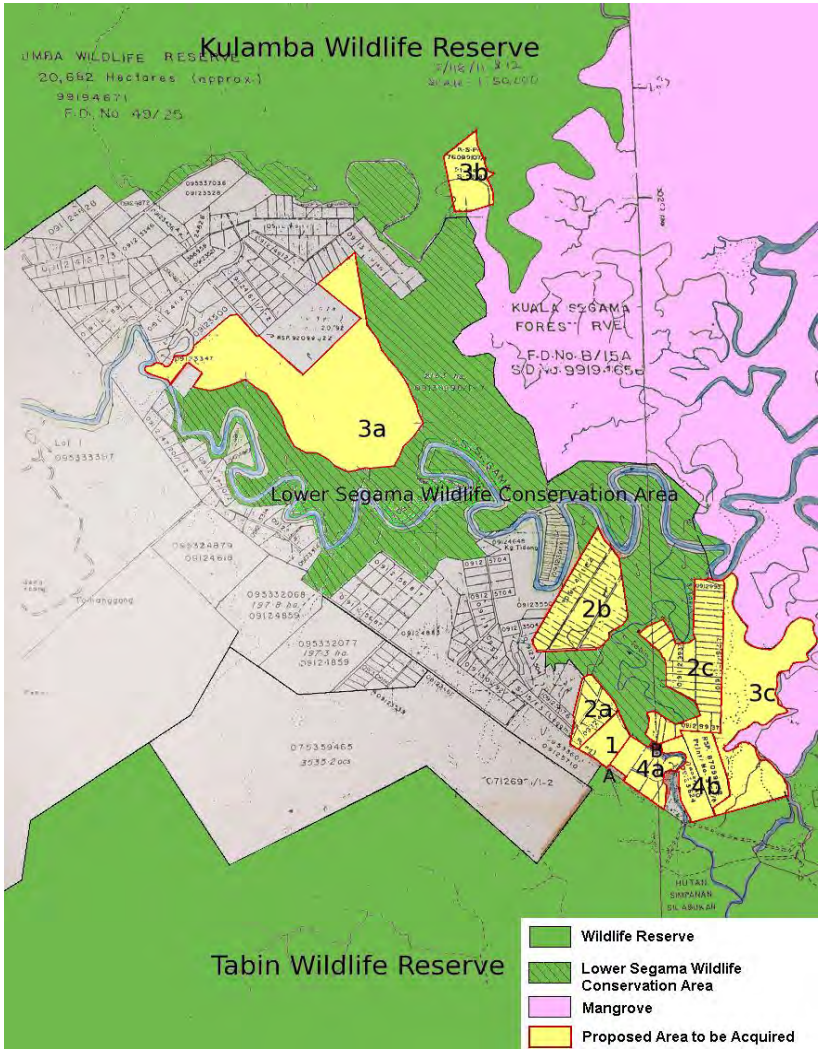
RhinoForest
Fund e.V.



picture by R. Risch

A race against time:
Identifying and securing what is left

RhinoForest
Fund e.V.



November 2015: First ever land donation for conservation in Sabah (462ha of crucial forest) initiated bei RFF

RhinoForest Fund e.V.





http://www.dailyexpress.com.my/news.cfm?NewsID=104419

Left: donated forest land

RhinoForest
Fund e.V.



picture by R. Risch

Front: crucial forest land saved by RFF

RhinoForest
Fund e.V.



picture by R. Risch

Restoring the ecosystem

RhinoForest
Fund e.V.









- March 2011: Start of forest restoration in Tabin by RFF

RFF's first project site in a degraded area of Tabin before planting (2010)

RhinoForest Fund e.V.



picture by R. Risch

Centre: RFF restoration project along Tabin River (since 2012) - currently the only dry land connection under conservation status linking Tabin with any other conservation area

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picture by R. Risch

Purchase of seedlings from community-based nursery

RhinoForest
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picture by R. Risch

Seedling exchange with other project to enhance inter- and intra-specific diversity in both projects

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picture by R. Risch

After 2 - 5 years of maintenance the seedlings out compete the secondary vegetation and can be left alone – the regeneration process will continue without further help

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picture by R. Risch

Dipterocarp in Tabin after 3 years



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Artocarpus altilis after 33 months



picture by R. Risch

Terminalia copelandii after 33 months

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picture by R. Risch

Next steps:

RhinoForest
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- **- Soon we will buy a first piece of crucial forest land**
- **- In 2017 we want to raise funds to buy and restore a palm oil estate blocking wildlife movement between Tabin and Kulamba**
- **- We plan to extent our activities to Sumatra and support rhino conservation and forest restoration in Gunung Leuser**

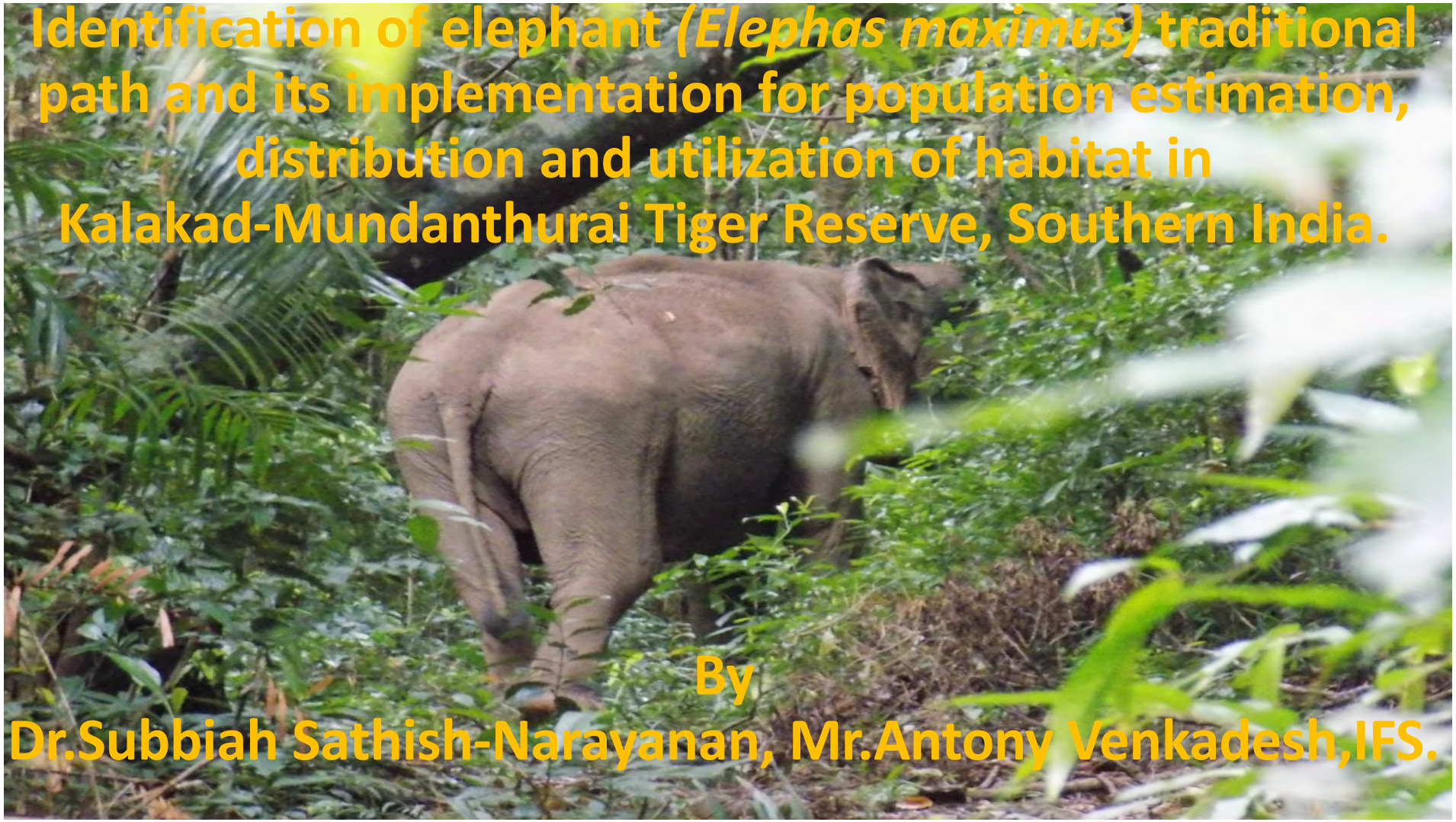
Thank you!

RhinoForest
Fund e.V.



picture by R. Risch

Identification of elephant *(Elephas maximus)* traditional path and its implementation for population estimation, distribution and utilization of habitat in Kalakad-Mundanthurai Tiger Reserve, Southern India.



By

Dr.Subbiah Sathish-Narayanan, Mr.Antony Venkadesh,IFS.

The richness of biodiversity and high level endemism of Kalakad- Mundanthurai Tiger Reserve (KMTR) ranges in the Western Ghats of southern India hold a viable population for the long-term conservation of the Asian elephant.

- **Status of Elephants population in KMTR**

Years	Population	Density
1991	107	0.11/Sq.Km
1997	138	0.15/Sq.Km
2016*	244	0.27/Sq.Km

* **Based on the direct sighting of elephants**

Elephant Habitats of KMTR





Identify the Elephant’s traditional path through tribal knowledge



Interaction with senior staff



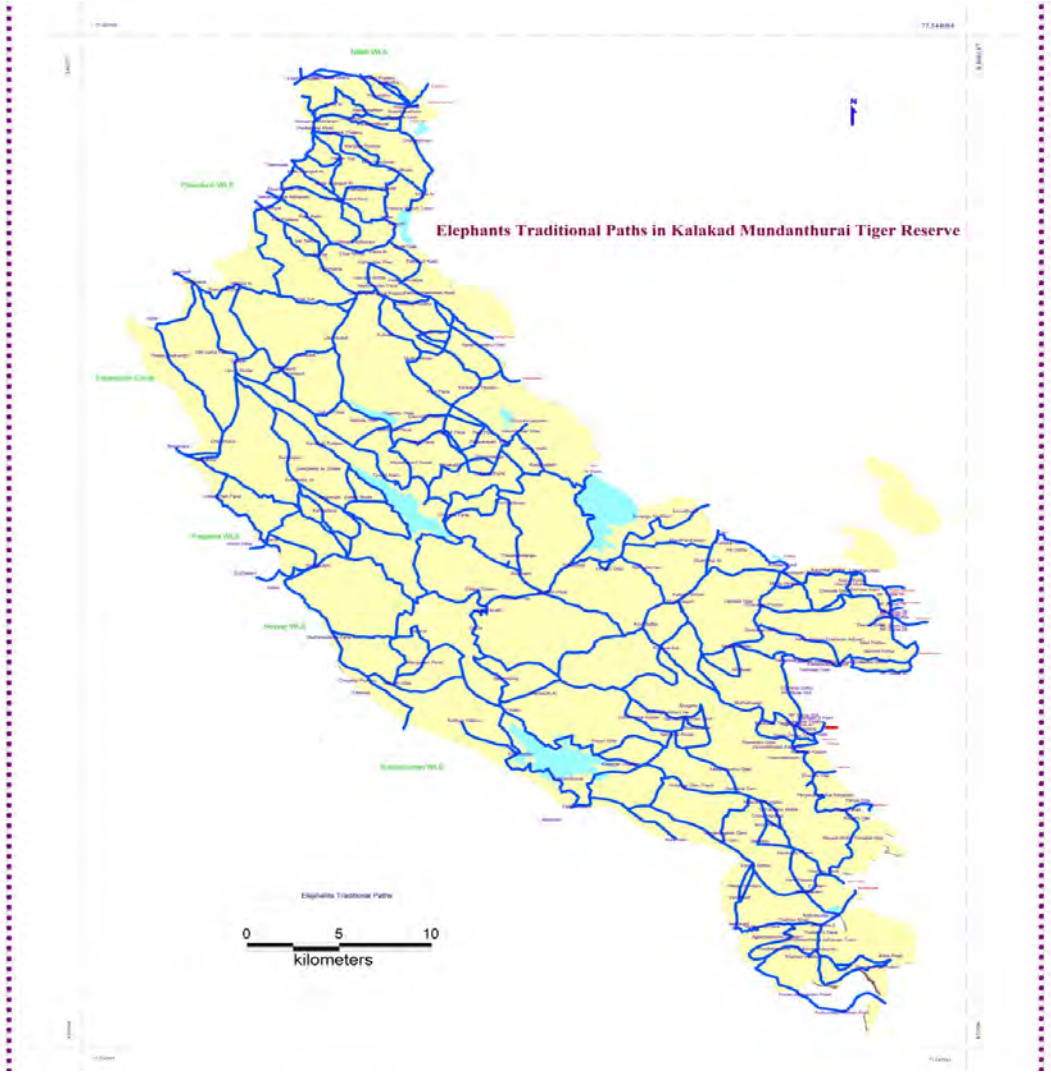


Continuous tracking of elephants movement





Elephant's Traditional Path - KMTR

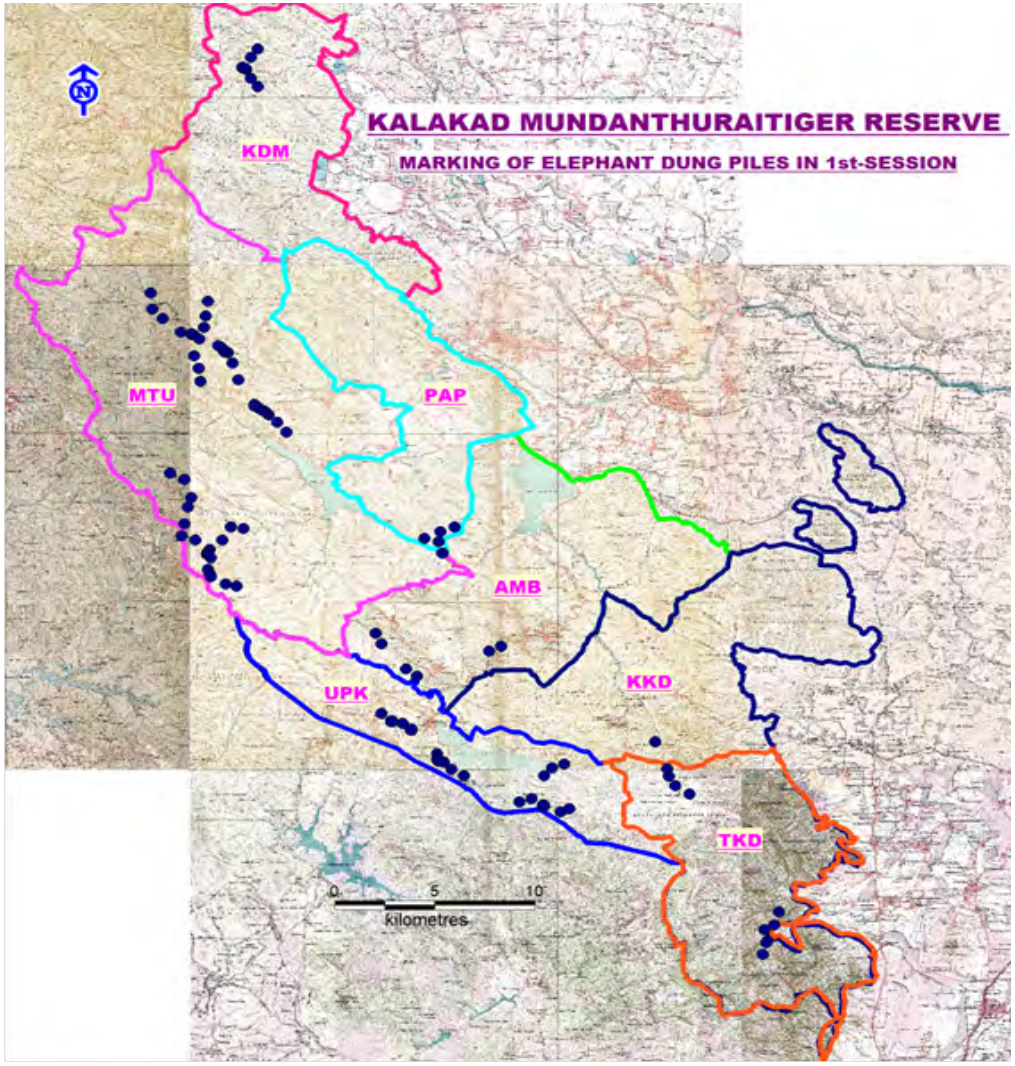


Marking of fresh dung piles – Habitat preferences

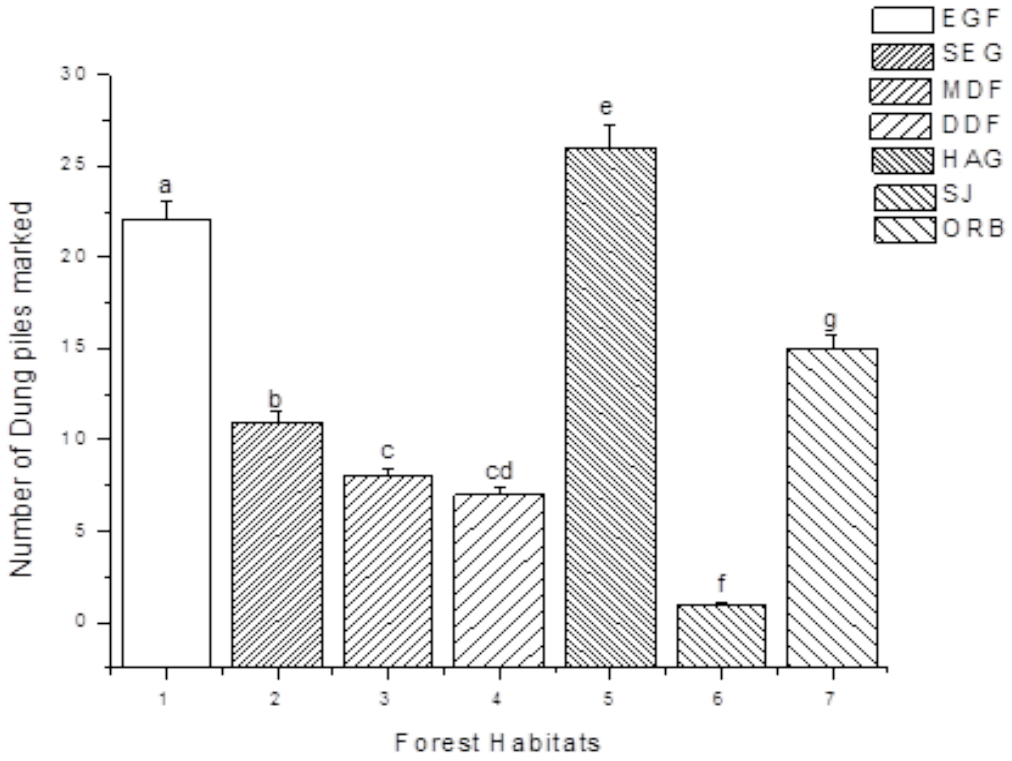




First Season



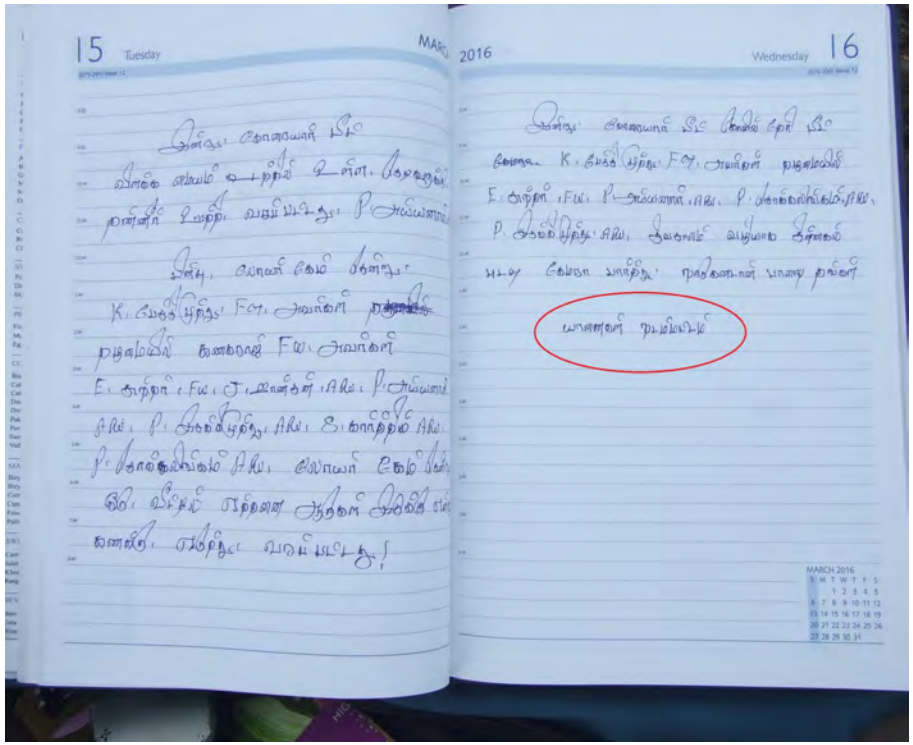
Elephants preferred habitats in the 1st wet season of South-West monsoon in KMTR, has detailed (Graph.1).



Habitat wise Elephant's Food plants selection

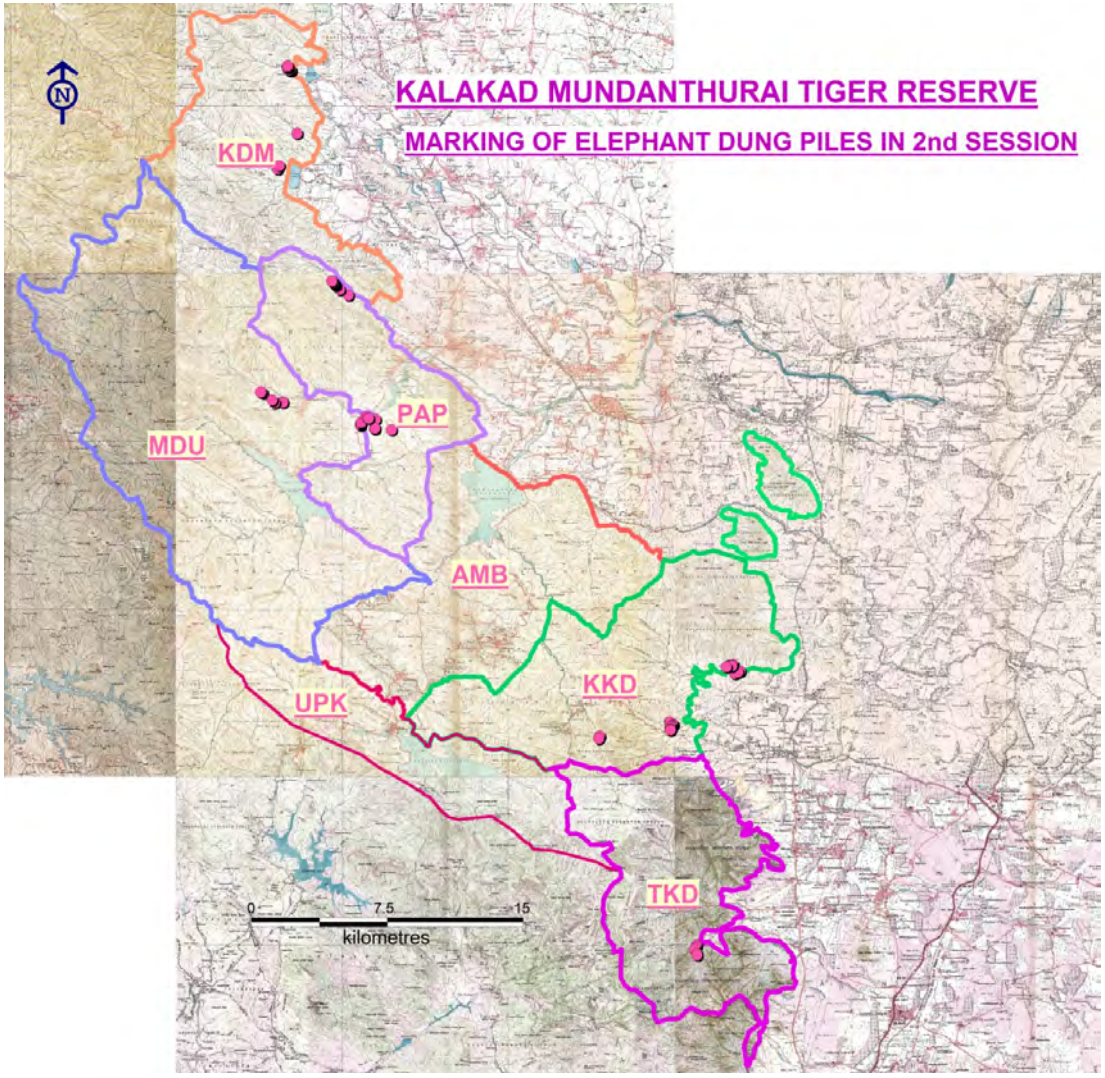


Staff Involvement

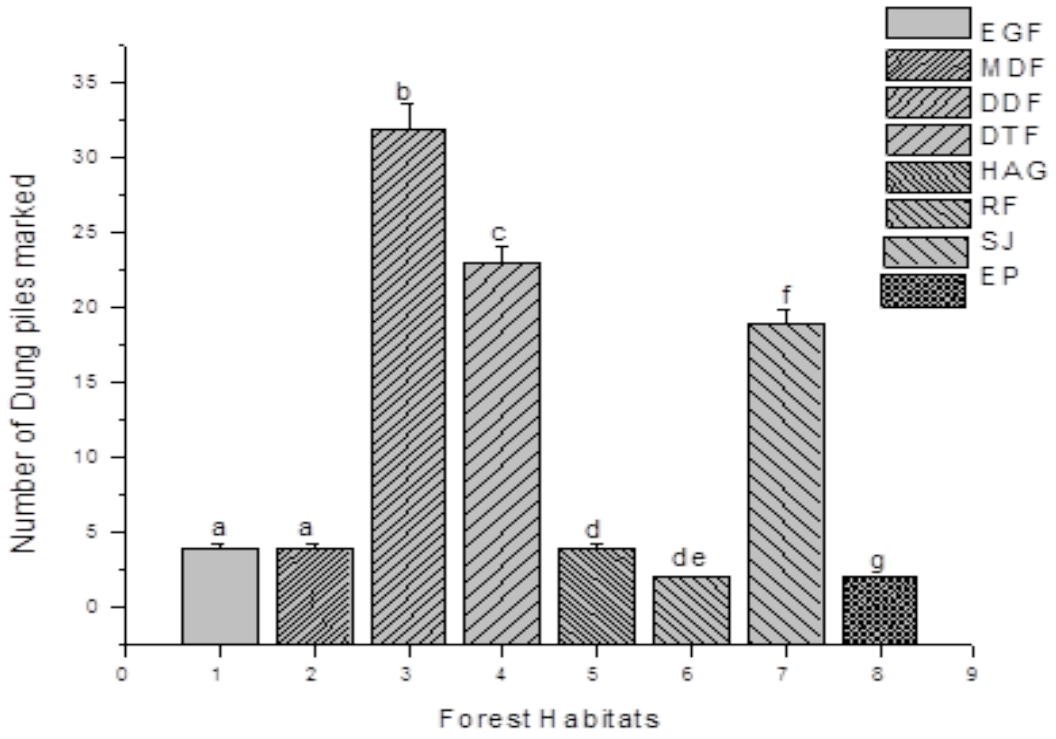




Second Season



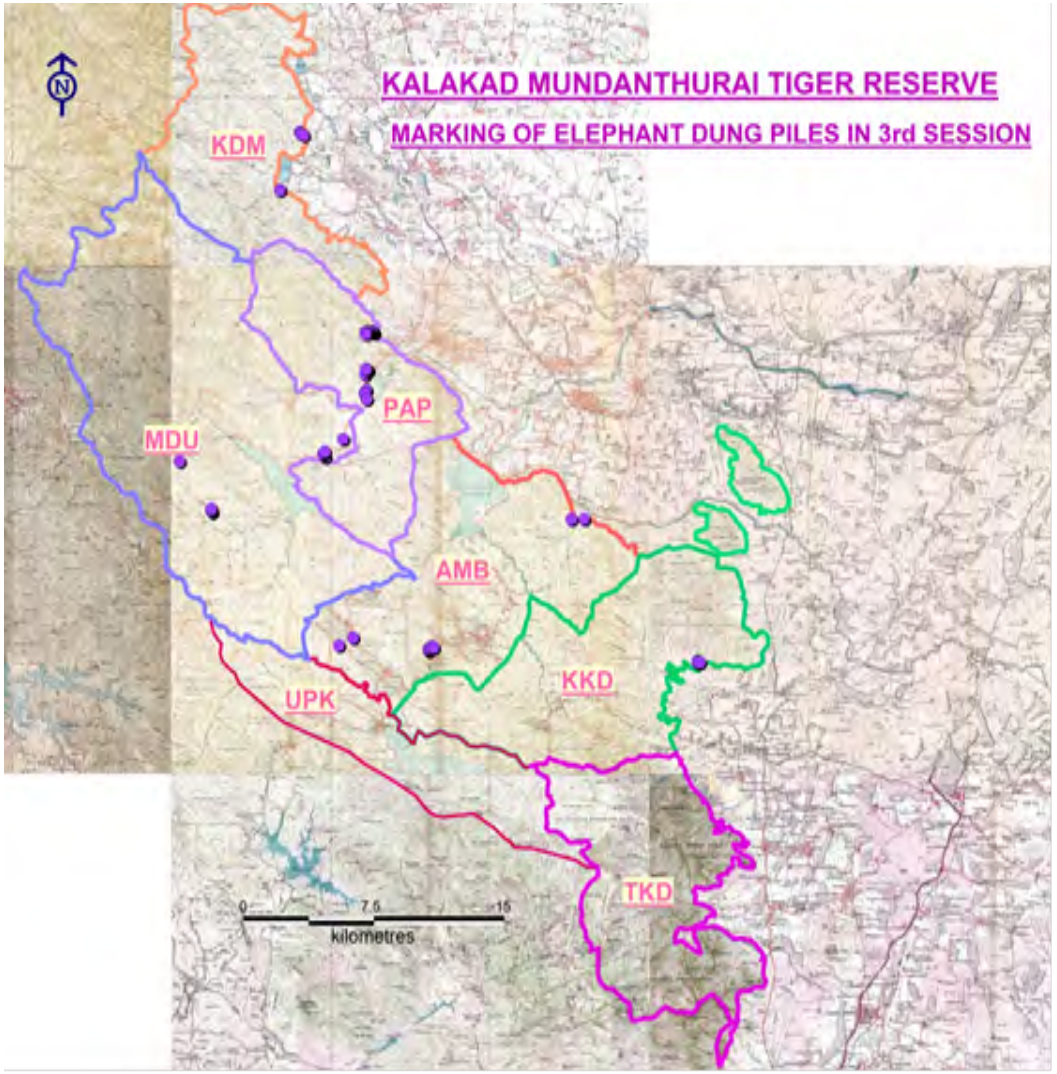
Elephants preferred habitats in the 2nd wet season of North East monsoon in KMTR, has detailed (Graph.2).



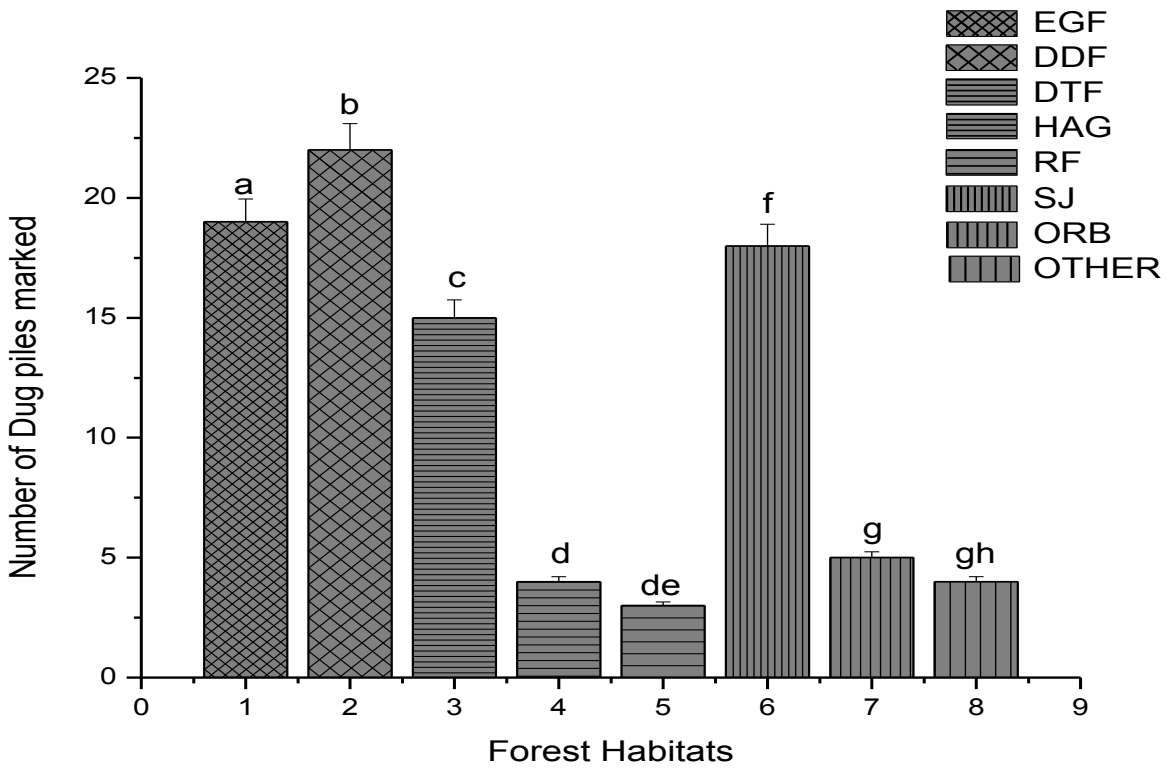




Third Season



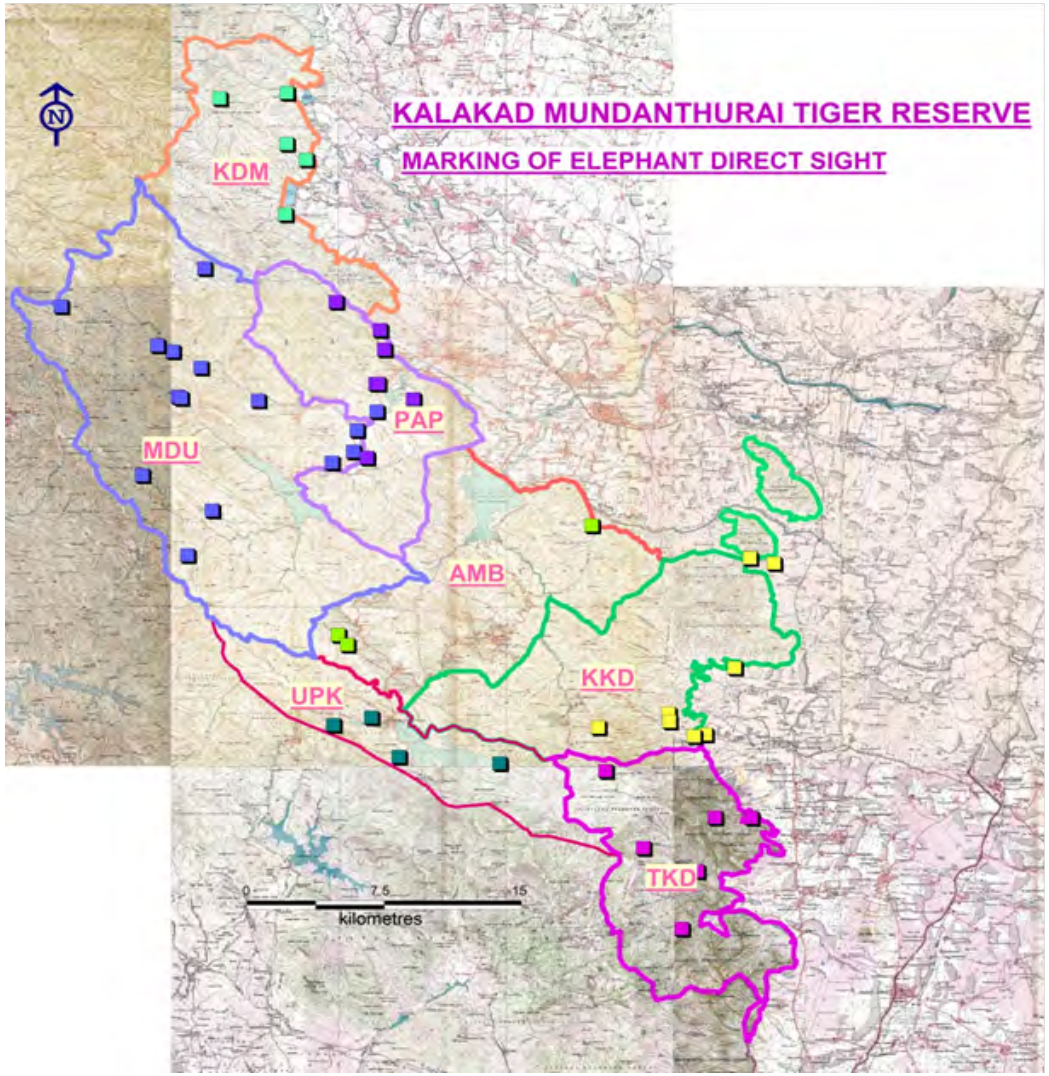
Elephant preferred habitats in the 3rd Dry season in KMTR,has detailed (Graph.3).



Cumulative marking of dung piles in three seasons- Map view



Results on elephants direct sighting through traditional path survey in KMTR



Elephants direct sighting through Traditional path -Survey

Ranges	No. of trail on Traditional path	Effort (km)	Sample encountered (Direct)	Encounter rate (Mean ± SE)/km
Kadayam	5	127.3	20	0.15 ± 1.00
Papanasam	7	106.8	31	0.29 ± 1.55
Mundanthurai	16	222.6	103	0.46 ± 5.15
Ampasamudram	9	124.2	12	0.09 ± 0.60
Kalakad	8	122.0	36	0.29 ± 1.80
Upper Kodayar	4	69.7	21	0.30 ±1.05
Thirukurunkudi	6	99.0	21	0.21 ± 1.05
	55	**871.6**	**244**	**0.27 ± 12.2**

Forecast the elephants movement through Elephants Traditional Path





Importance of Feeding lands!



Impact of Land change activity













Gathering Information from Farmers - Data Collection



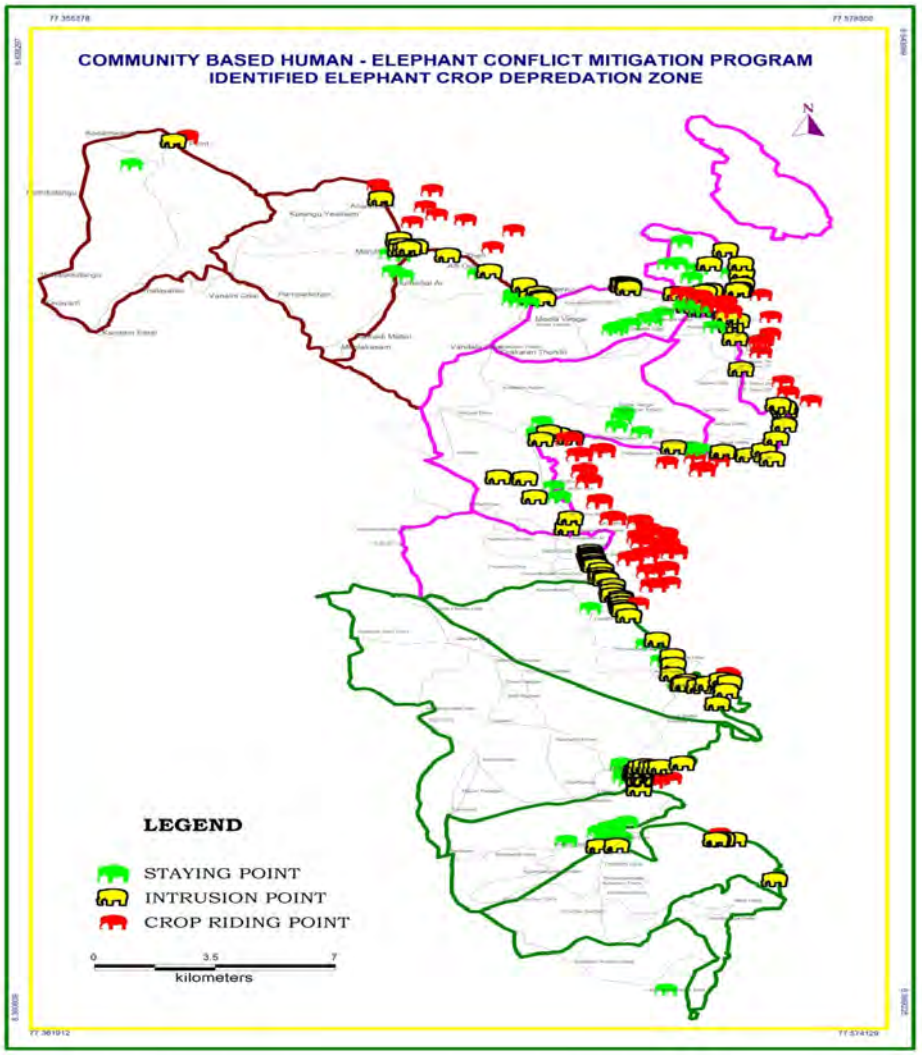


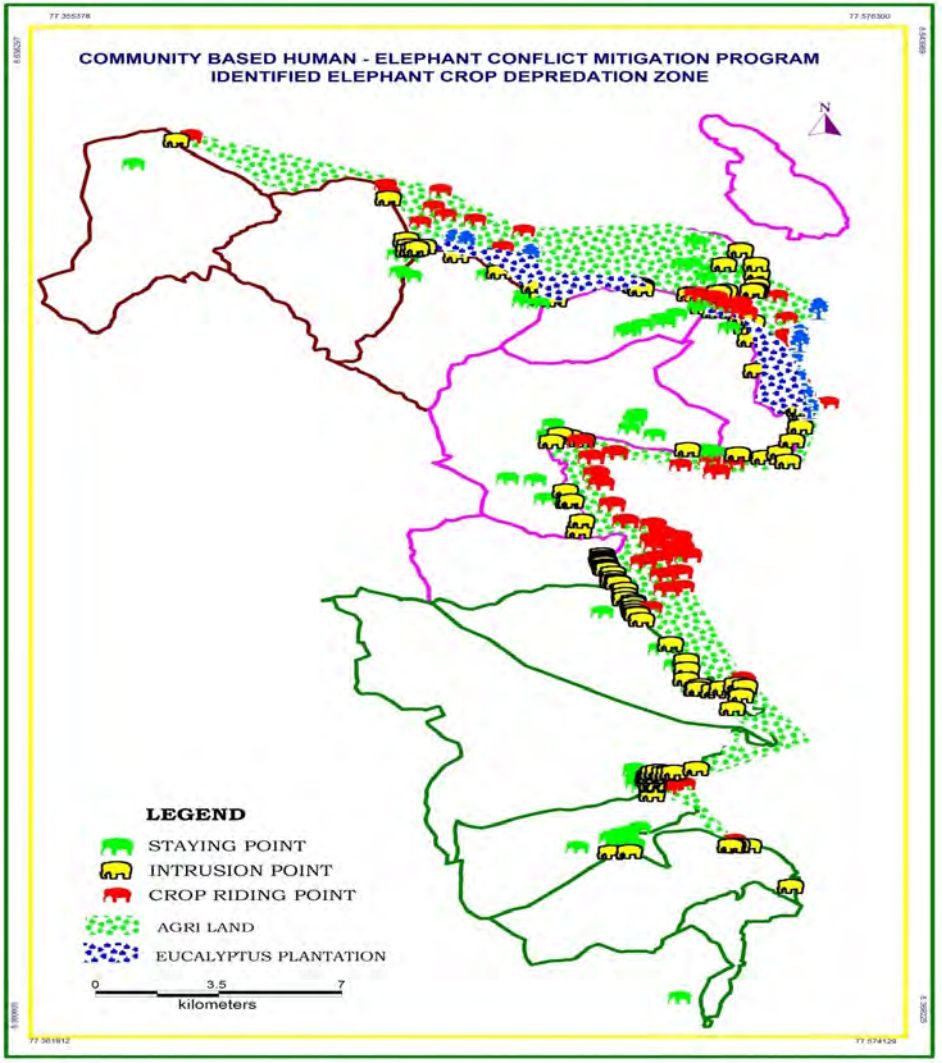
Why We Can Do This!

Elephant Prefer this zone for Pleasant stay
Because
Here Always Available in
Food
Water
Shelter

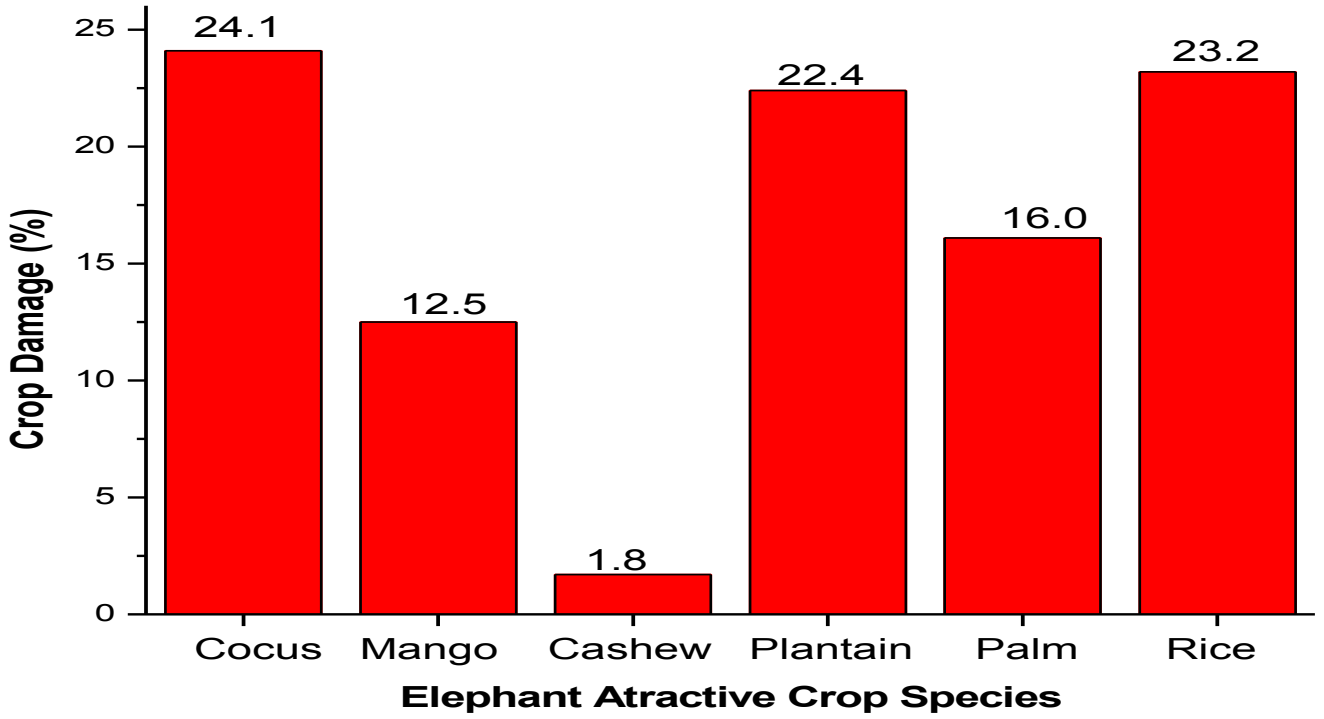
Crop damage Compensation

Year	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Amount	**149100**	**98750**	**169600**	**91350**	**44000**	**228620**

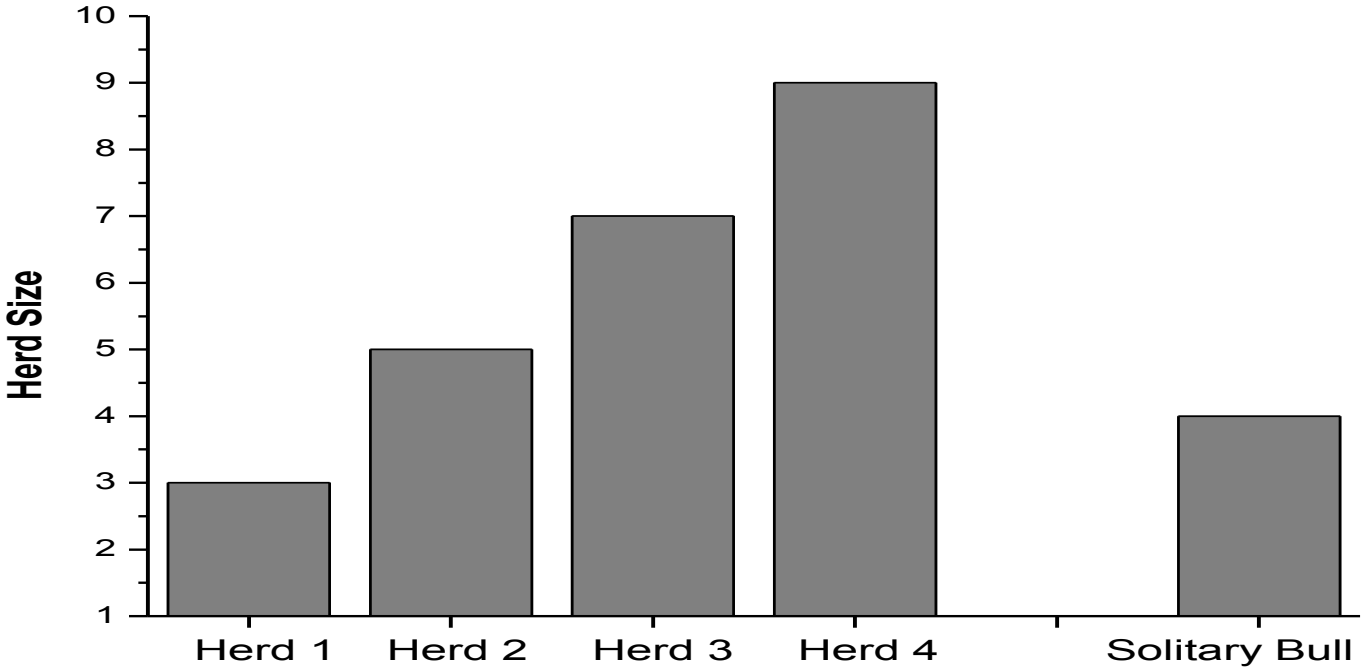

COMMUNITY BASED HUMAN - ELEPHANT CONFLICT MITIGATION PROGRAM
IDENTIFIED ELEPHANT CROP DEPREDATION ZONE
N
LEGEND
STAYING POINT
INTRUSION POINT
CROP RIDING POINT
0
3.5
7
kilometers


COMMUNITY BASED HUMAN - ELEPHANT CONFLICT MITIGATION PROGRAM
IDENTIFIED ELEPHANT CROP DEPREDATION ZONE
N
LEGEND
STAYING POINT
INTRUSION POINT
CROP RIDING POINT
AGRI LAND
EUCALYPTUS PLANTATION
0
3.5
7
kilometers

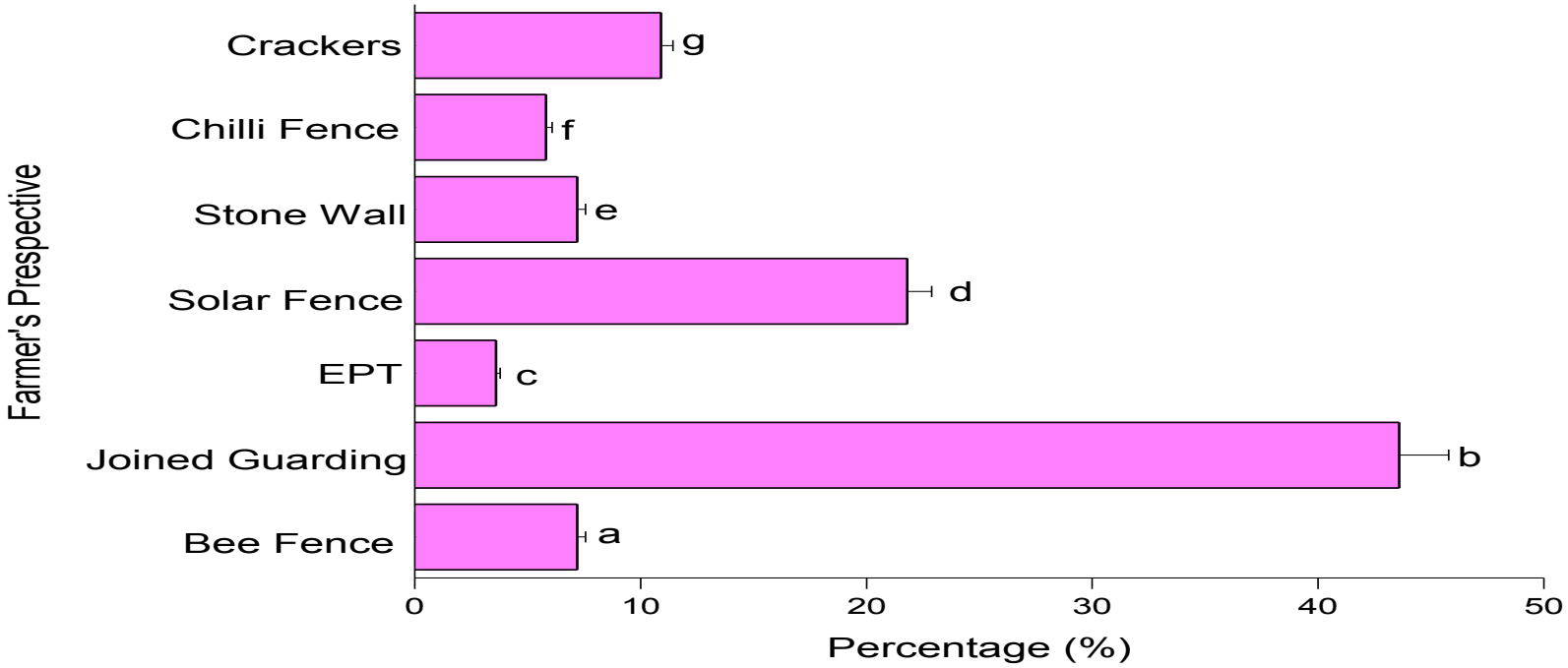
Attractive Crop Species



Crop Raiding Elephants Herd Size

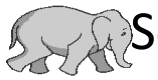


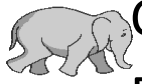
Farmer’s Perspective

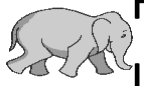


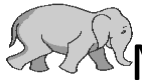
What We Do ! In Out of RF

Cerate Awareness about Elephants

 School

 College

 Farmers

 Local Politicians

Media People

Creating Awareness





Farmers Meeting





Joined Guarding System - CBHECMP



Traditional Way of Approach



We are practicing bee sound and hive fence



My Sincere thanks to

Tamil Nadu Forest Department, INDIA & Kalakad –Mundanthurai Tiger Conservation Foundation (KMTR)

All field staff – Kalakad –Mundanthurai Tiger Reserve, TN, INDIA

International Elephant Foundation

15th International Elephant & Rhino Conservation and Research Symposium

A holistic approach for securing the Thirunelli-Kudrakote elephant corridor, Wayanad, Kerala, India



Kalyanasundaram Ramkumar, Sabu Jahas, Ramith.M, Shajan.M.A, Sandeep Kr.Tiwari and Vivek Menon

Wildlife Trust of India
New Delhi, INDIA

KERALA FOREST DEPARTMENT

ELEPHANT FAMILY

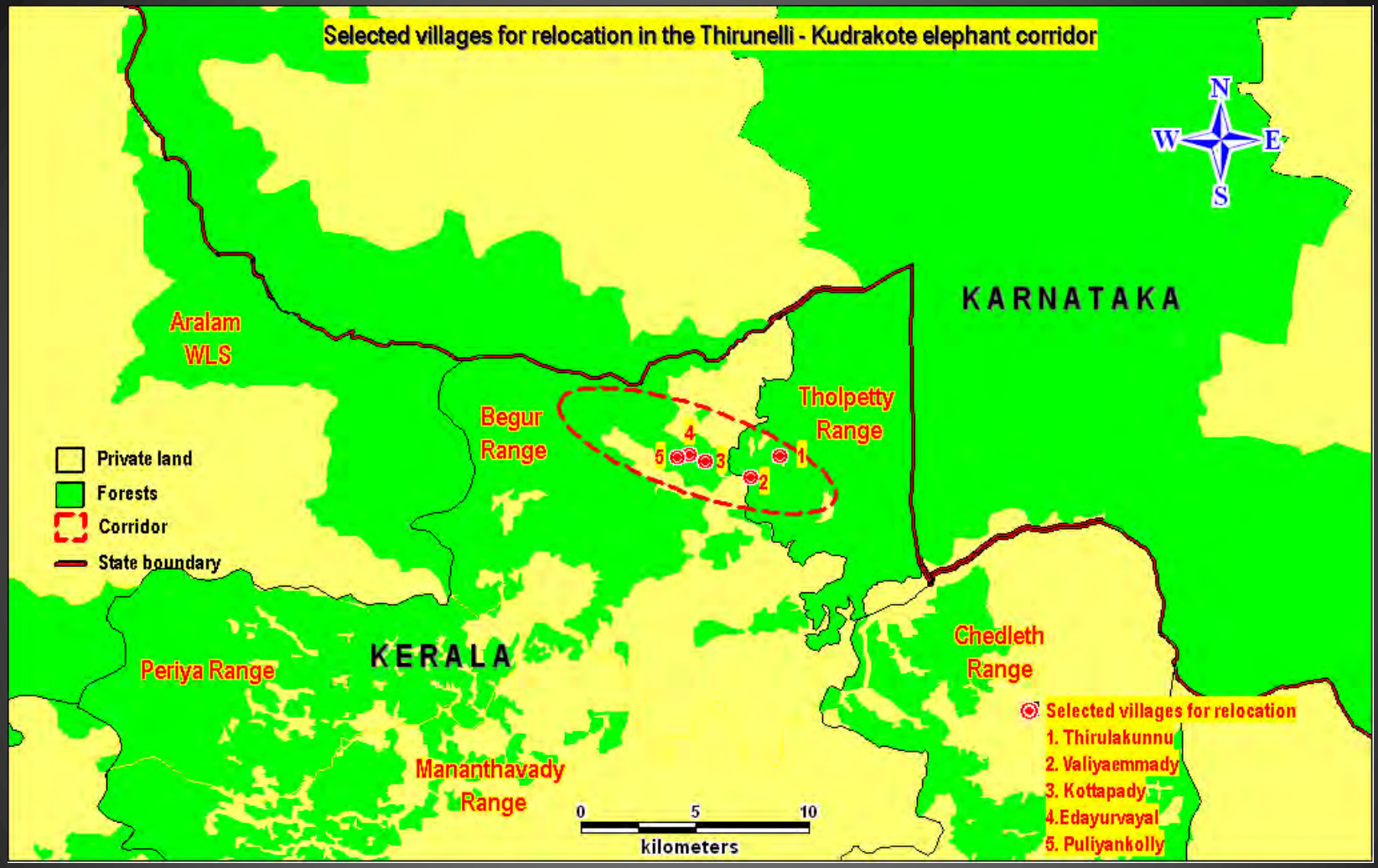
WORLD LAND TRUST

U.S. FISH & WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

National Committee of The Netherlands
IUCN
The World Conservation Union

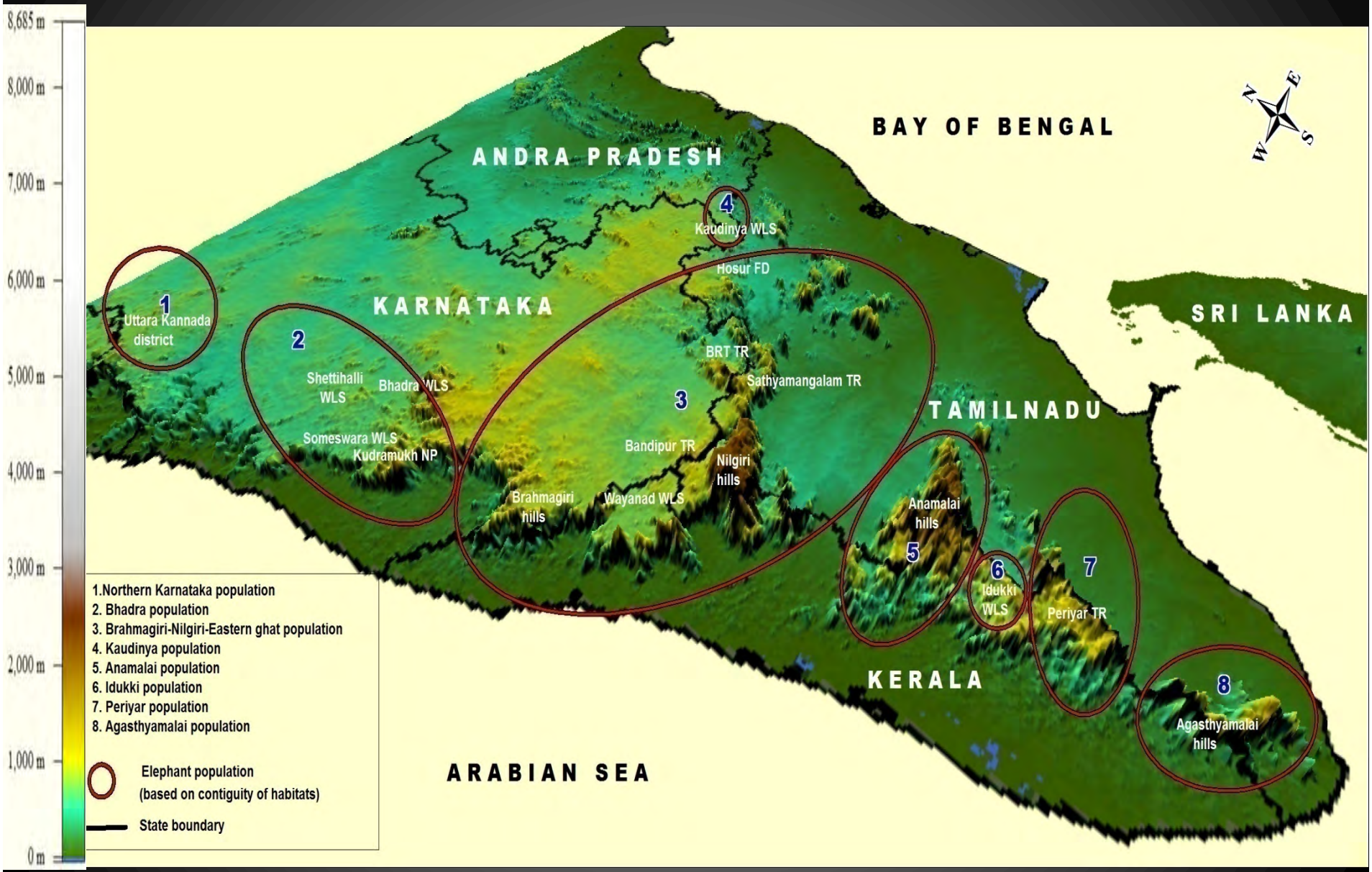
Wildlife Trust of India

What is an elephant corridor?

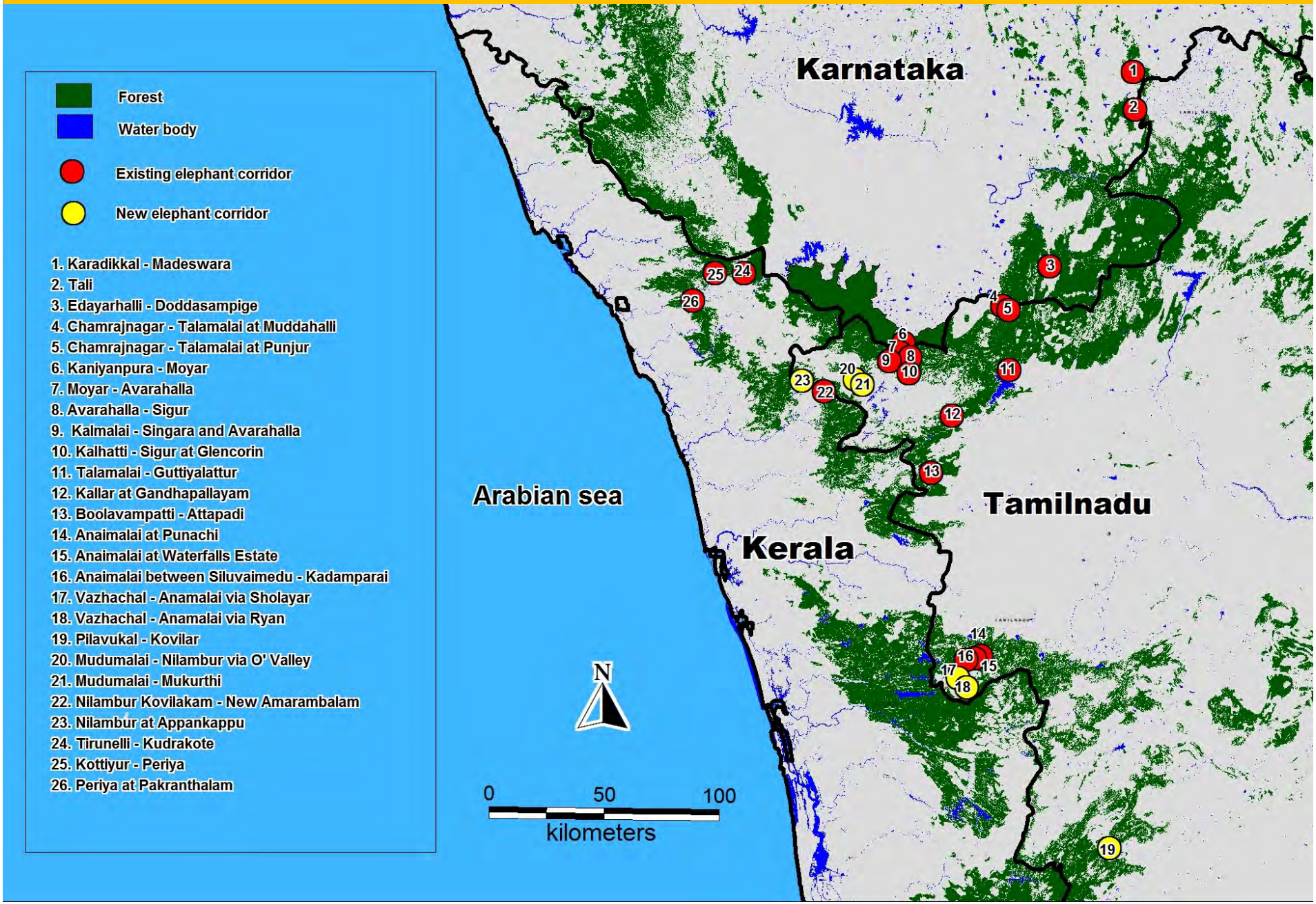


"A linear landscape that connects two or more patches of viable elephant habitats that were connected in historic times; it is meant as a conduit for elephants"

Importance of the landscape



Elephant corridors in Southern India



Objectives

•To facilitate unhindered connectivity for the elephants between viable habitats

• Sensitising people on corridors by erecting sign boards

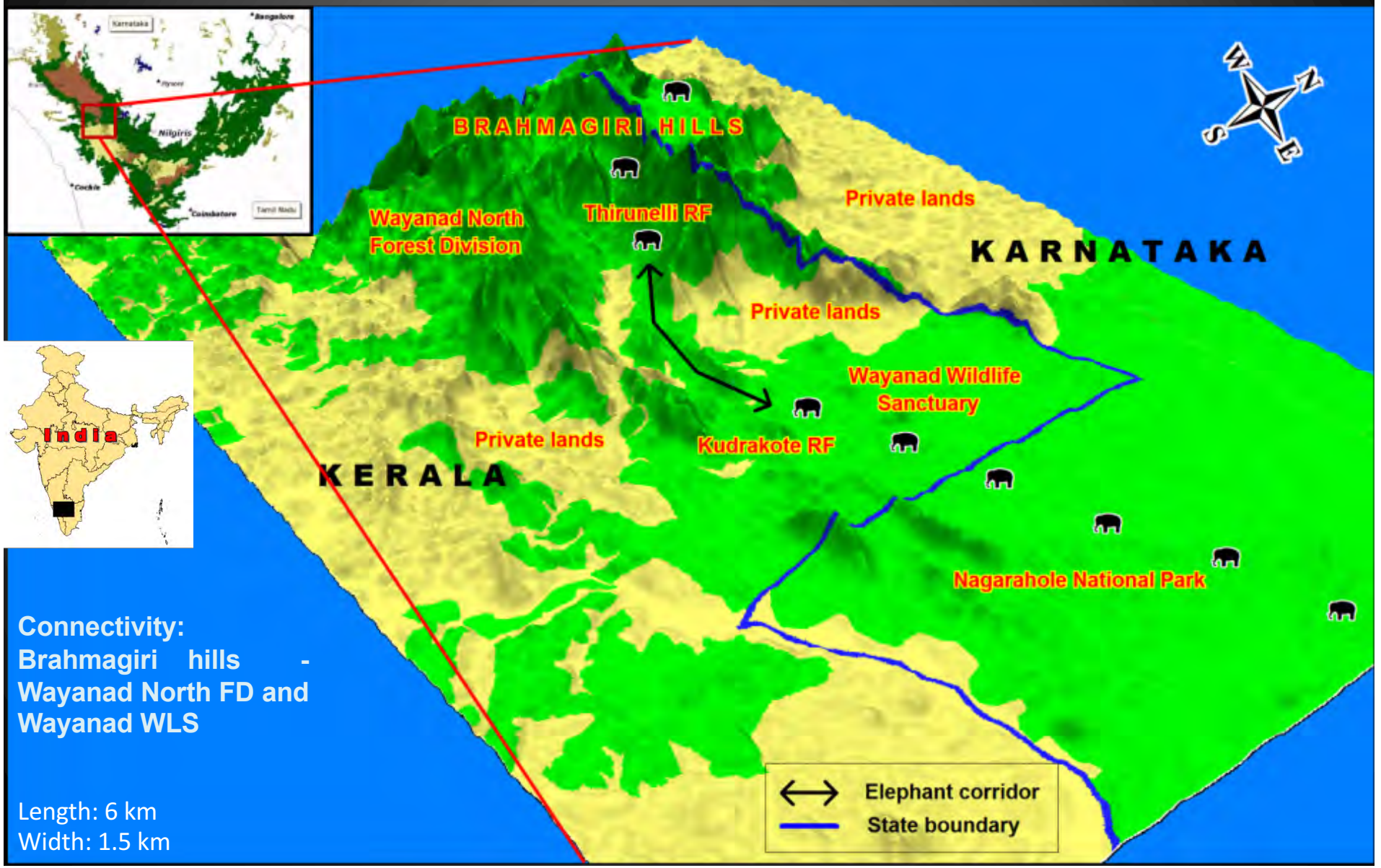
•To secure identified villages which located inside corridor by voluntary relocation of stake holders or giving agreed value of money

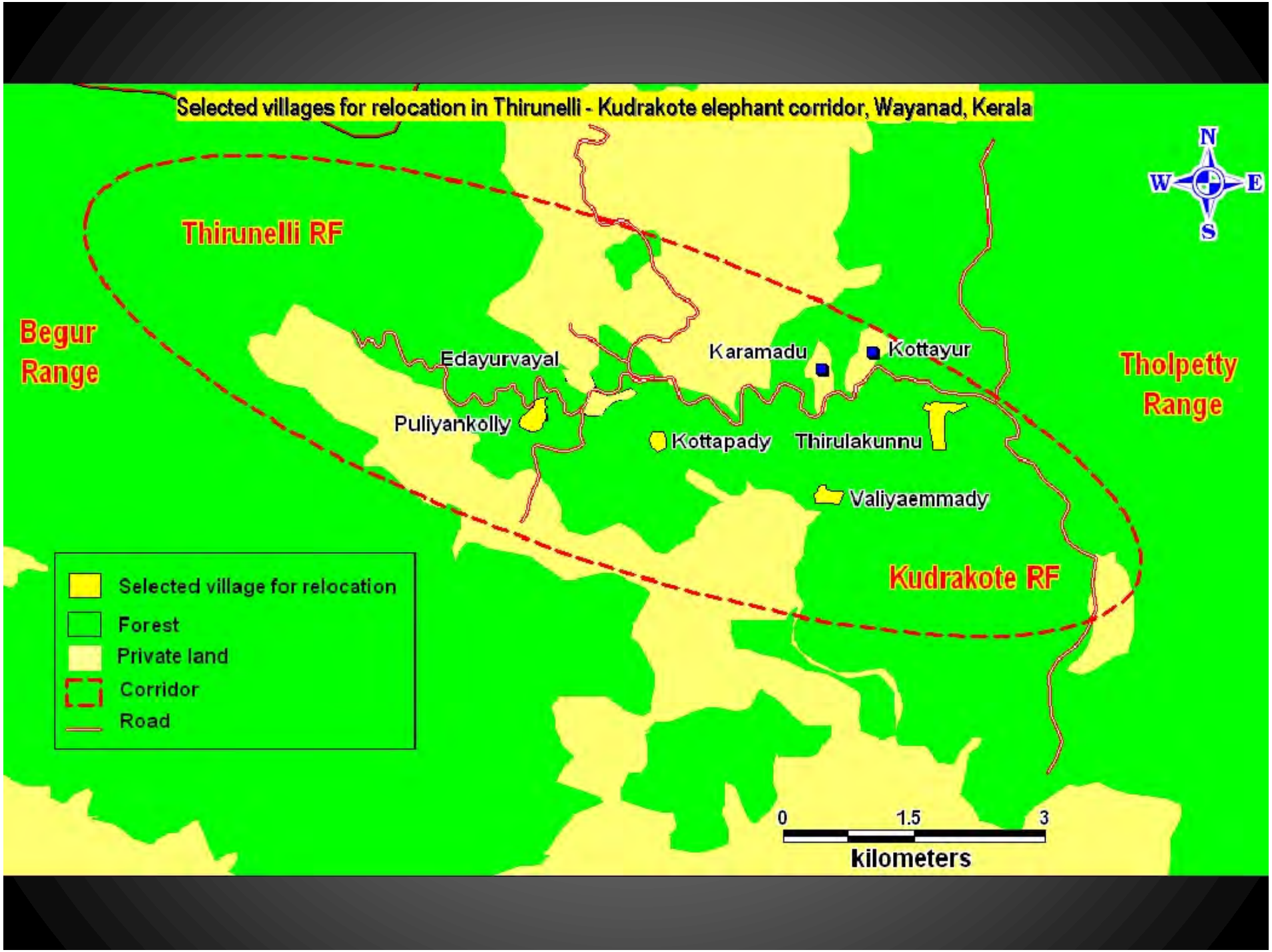
•To monitor the usage of corridor by elephants

• To assist the stake holders in getting financial aids and technical support from various departments after relocation

• To provide legal protection of the secured corridor under the existing laws in India and specifically in the state.

Project location - Tirunelli- Kudrakote corridor, Kerala




Selected villages for relocation in Thirunelli - Kudrakote elephant corridor, Wayanad, Kerala
N
W
E
S
Thirunelli RF
Begur Range
Tholpetty Range
Edayurvayal
Karamadu
Kottayur
Puliyankolly
Kottapady
Thirulakunnu
Valiyaemmady
Kudrakote RF
Selected village for relocation
Forest
Private land
Corridor
Road
0
1.5
3
kilometers

The securement process

- Identifying critical areas for securement
- Socio-economic survey with stakeholders
- Consent from stake holders
- Negotiation and finalising suitable package
- Permission from concern authorities
- Land registration in the name of stake holders
- House construction and basic amenities in alternate site
- Relocation
- Handing over of the secured land to the Forest Department
- Declaration & demarcation of legal protection for the corridor
- Monitoring the usage of corridor by elephants
- Monitoring the Socio-economic condition of the families (Pre and Post Relocation)

Results

The corridor was threatened because of settlements

No. of households/ population in the settlements

Sl. No:	Name of the settlement	Range	Tribes (households)	Non tribes (Households)	Total house holds	Total pop	Land owned (acres)
1	Pulayankolly	Begur	26	-	26	120	2.05 (20 acres occupied)
2	Kottapadi	Begur	-	1	1	1	8.3
3	Valiyaemmady	Tholpetty	4	2	6	35	13.5
4	Tirulakunnu	Tholpetty	-	4	4	39	20

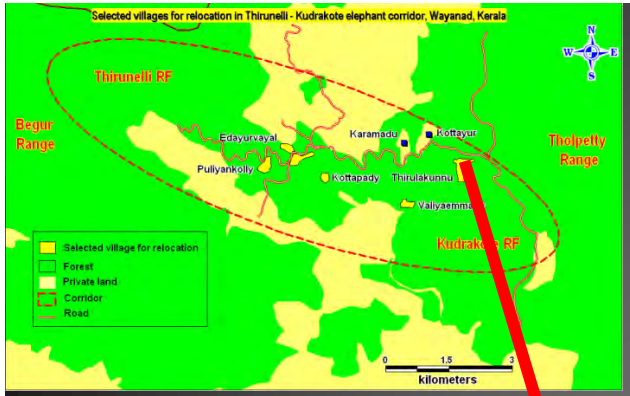
WTI has secured the corridor by purchasing land owned by the villagers either by payment of the agreed value/by providing suitable alternate land and rehabilitation packages

Sensitizing People on corridors

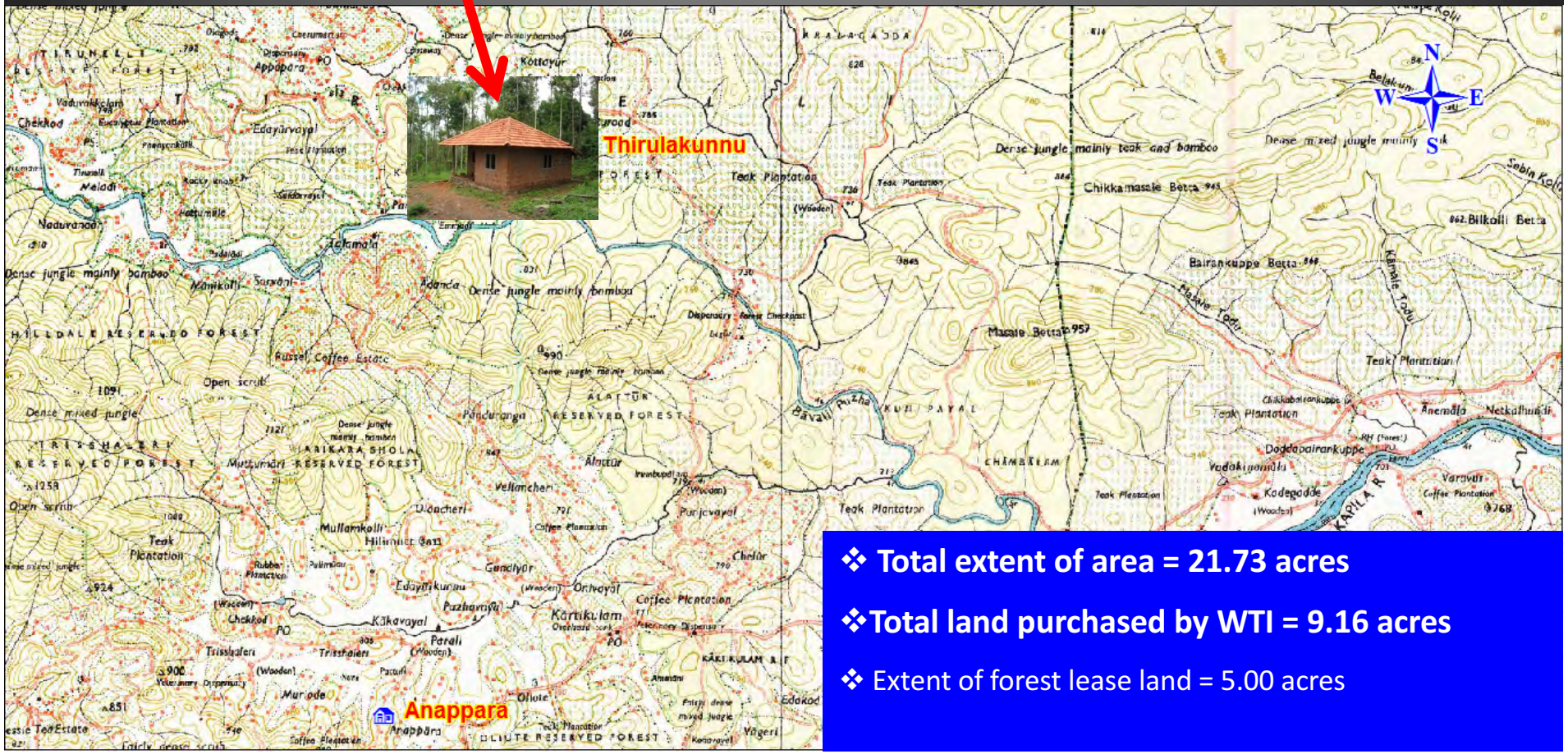
Signages in corridors: Informing people, land planners and other developing agencies



Pixs: Ramith/ WTI



Village 1. Thirulakunnu



- **Total extent of area = 21.73 acres**
- **Total land purchased by WTI = 9.16 acres**
- Extent of forest lease land = 5.00 acres

1st Settlement: Thirulakunnu


Pre rehabilitation


Post rehabilitation

- About 9.5 acres of corridor land secured
- Four families voluntarily relocated






THE WINS







Village 2. Valiyaemmady

- Seven families (4 tribal and 3 non tribal) with a population of about 35 individuals

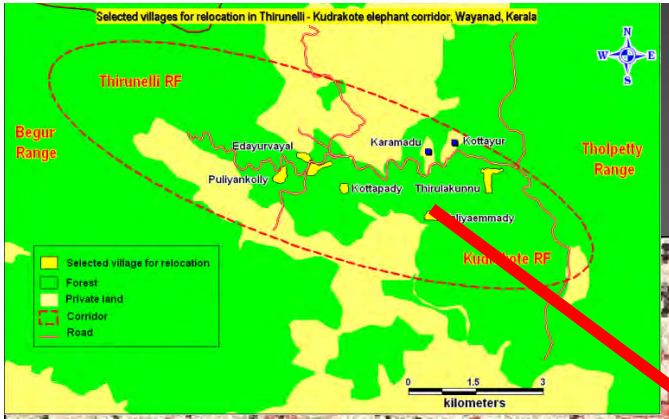








Village 2. Valiyaemmady





Total extent of area – 12.2 acres

WTI purchased - 6.1 acres

Remaining land - 6.1 acres

2. Valiyaemmady & Alternate site

- Six families voluntarily relocated to alternate site at Panavally on April 2009









Demolishing existing structures





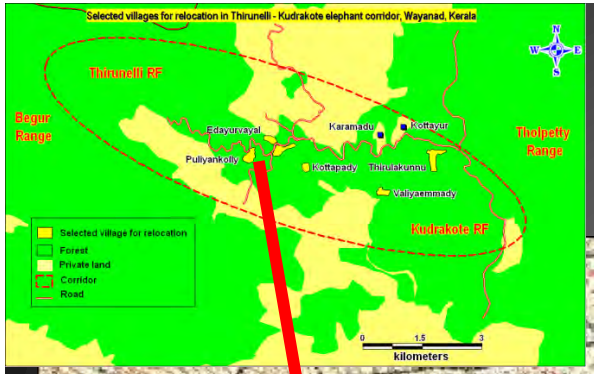
This is my land…..!
Already it’s ruined….! Isn’t that wonderful?



Village 3. Puliyankolly

Extent of land with Tribes (as per paper)= 2.05 acres

Extent of occupied land = 20 acres





Sekady

Puliyankolly

Edayurvayal

Kottapady

Thirulakunnu

Valiyaemmady

0 0.75 1.5

kilometers

Negotiation for relocation





- **0. 15 acres of dryland and 0.20 acres of wet land and a new house 15 families**
- **0.07 acres of dry land for 11 married childrens**
- **0.1 acre land with arts and sports club**

Obtaining Willingness







Negotiation for purchasing alternate land

- Total extent of dryland: 2.50 acre
- Total extent of wet land: 3.16 acre





Land Registration to Tribes





26 families from the third settlement in corridor voluntarily relocated by January 2011 to alternate site









Recreation club





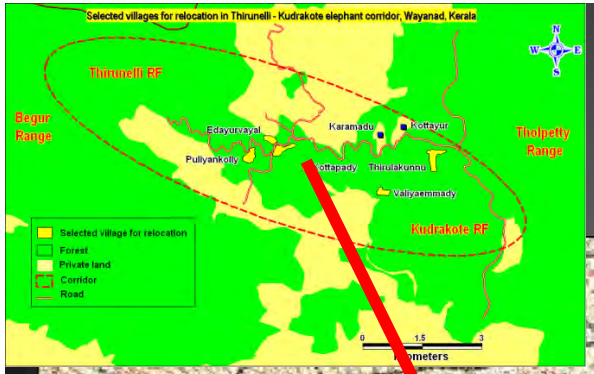
Demolishing existing structures





Village 4. Kottapady

7.32 acres of land with a private tourism party
Lakshmi ouwa , a non-tribe is holding the 0.90 acres





Lakshmi Amma was voluntarily relocated on 20th Sept, 2010



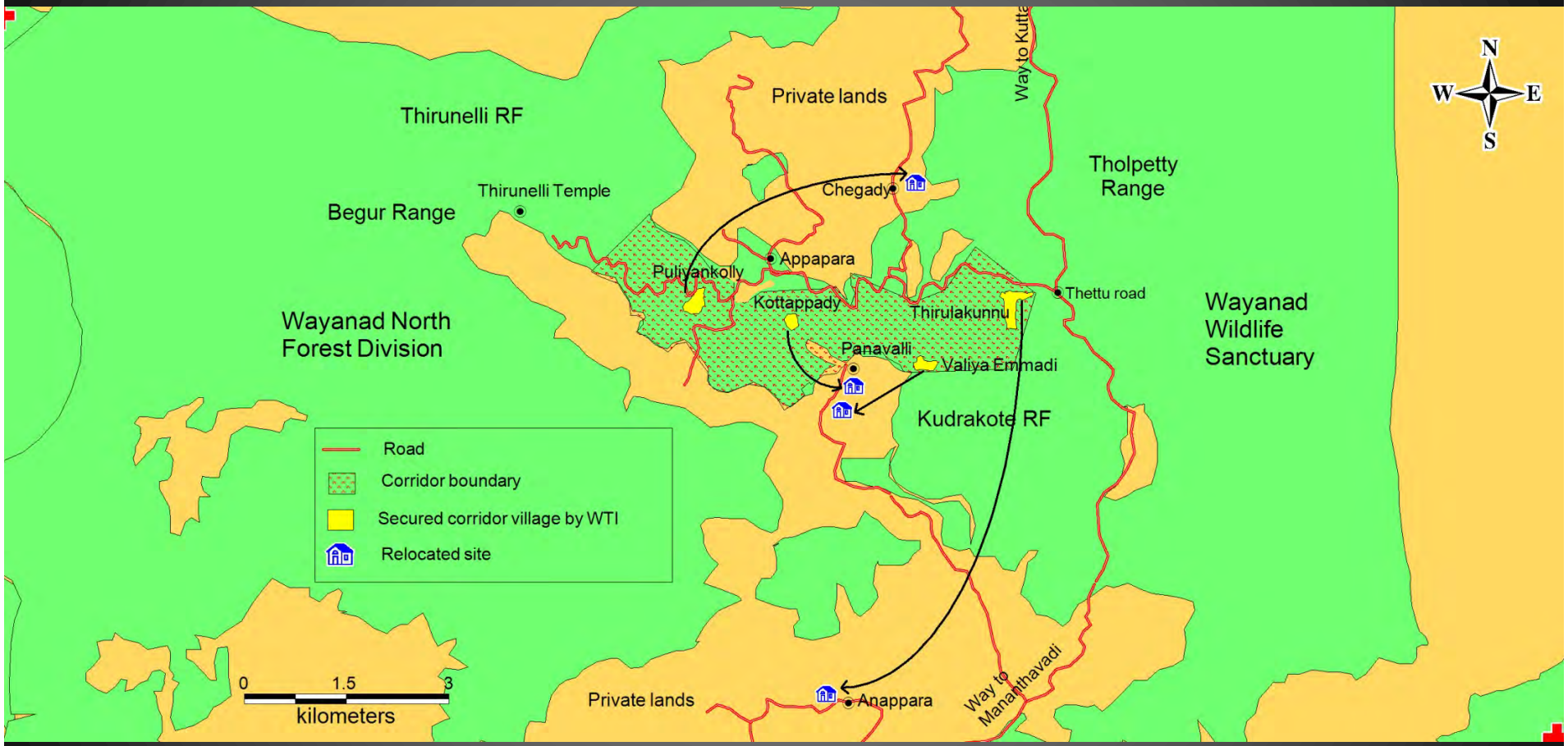


Alternate house

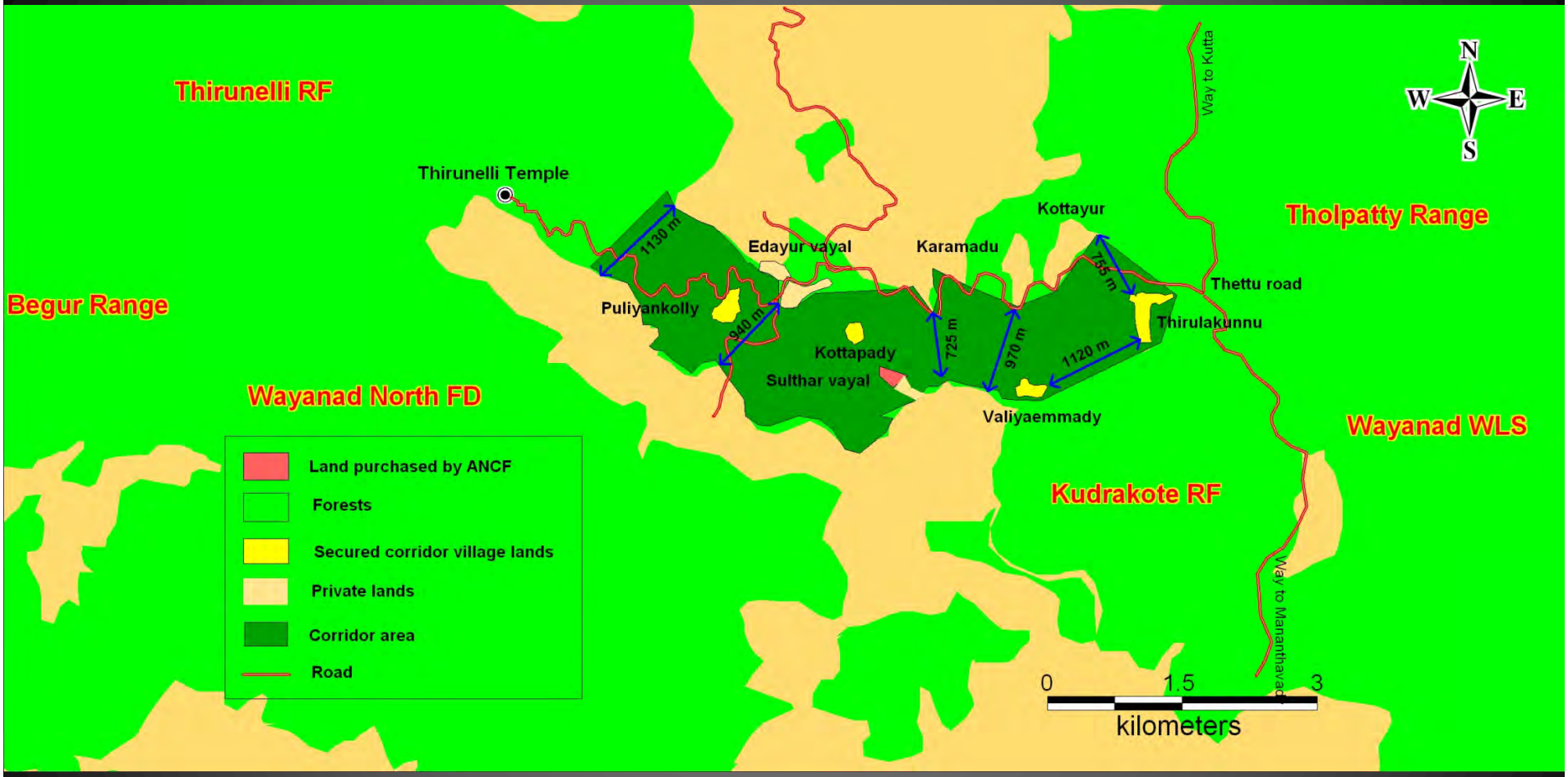
Purchased the land of Tourism company

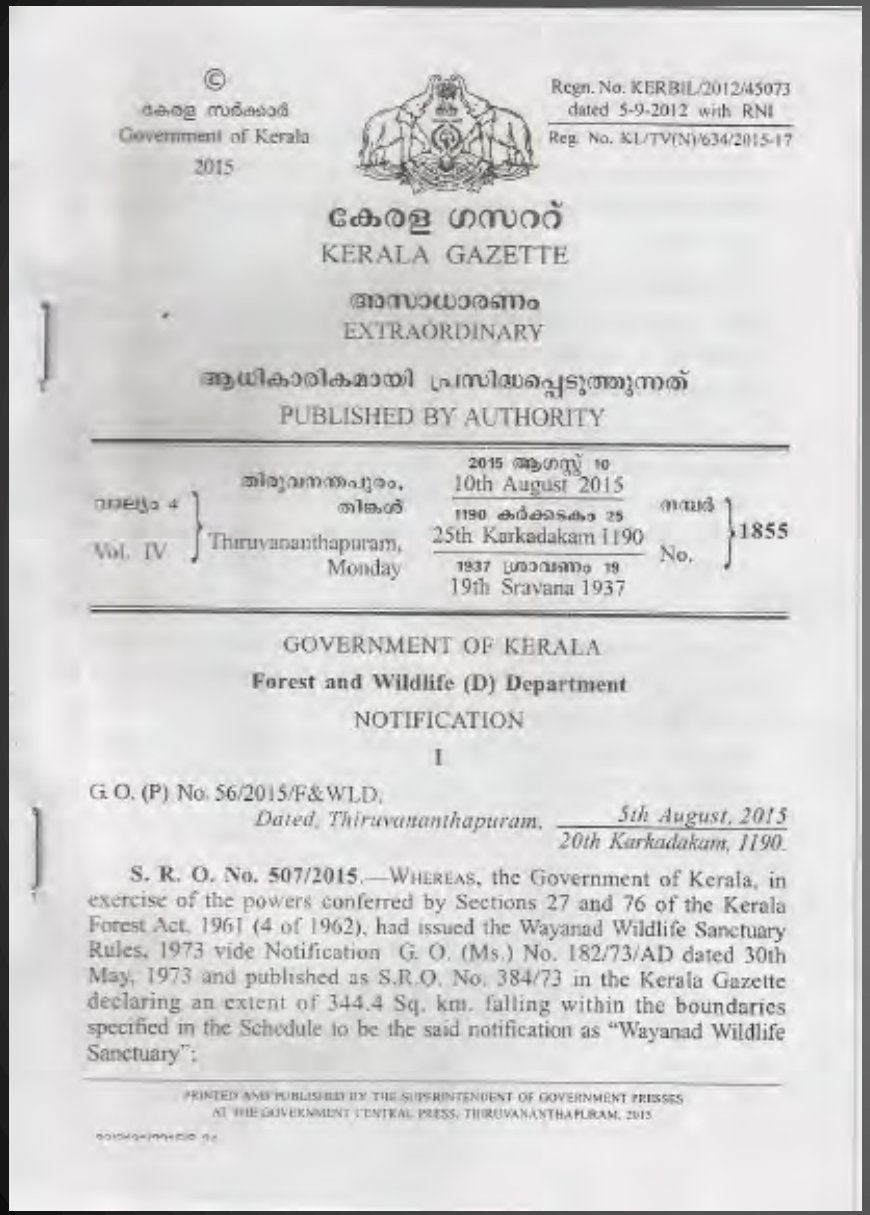





Thirunelli RF
Private lands
Way to Kutta
Tholpetty Range
Thirunelli Temple
Begur Range
Chegady
Appapara
Puliyankolly
Kottappady
Thirulakunnu
Thettu road
Wayanad North Forest Division
Panavalli
Valiya Emmadi
Wayanad Wildlife Sanctuary
Kudrakote RF
Road
Corridor boundary
Secured corridor village by WTI
Relocated site
0
1.5
3
kilometers
Private lands
Anappara
Way to Manantthavadi
N
W
E
S

Dimension of Corridor after securement





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Regn. No. KERBIL/2012/45073 dated 5-9-2012 with RNI
Reg. No. KL/TV(N)/634/2015-17

കേരള ഗസറ്റ്
KERALA GAZETTE

അസാധാരണം
EXTRAORDINARY

ആധികാരികമായി പ്രസിദ്ധപ്പെടുത്തുന്നത്
PUBLISHED BY AUTHORITY

വാല്യം 4 Vol. IV	തിരുവനന്തപുരം, തിങ്കൾ Thiruvananthapuram, Monday	2015 ആഗസ്റ്റ് 10 10th August 2015 / 1190 കർക്കടകം 25 25th Karkadakam 1190 / 1937 ശ്രാവണം 19 19th Sravana 1937	നമ്പർ No.	1855

GOVERNMENT OF KERALA

Forest and Wildlife (D) Department

NOTIFICATION

I

G. O. (P) No. 56/2015/F&WLD. *Dated, Thiruvananthapuram, 5th August, 2015 / 20th Karkadakam, 1190.*

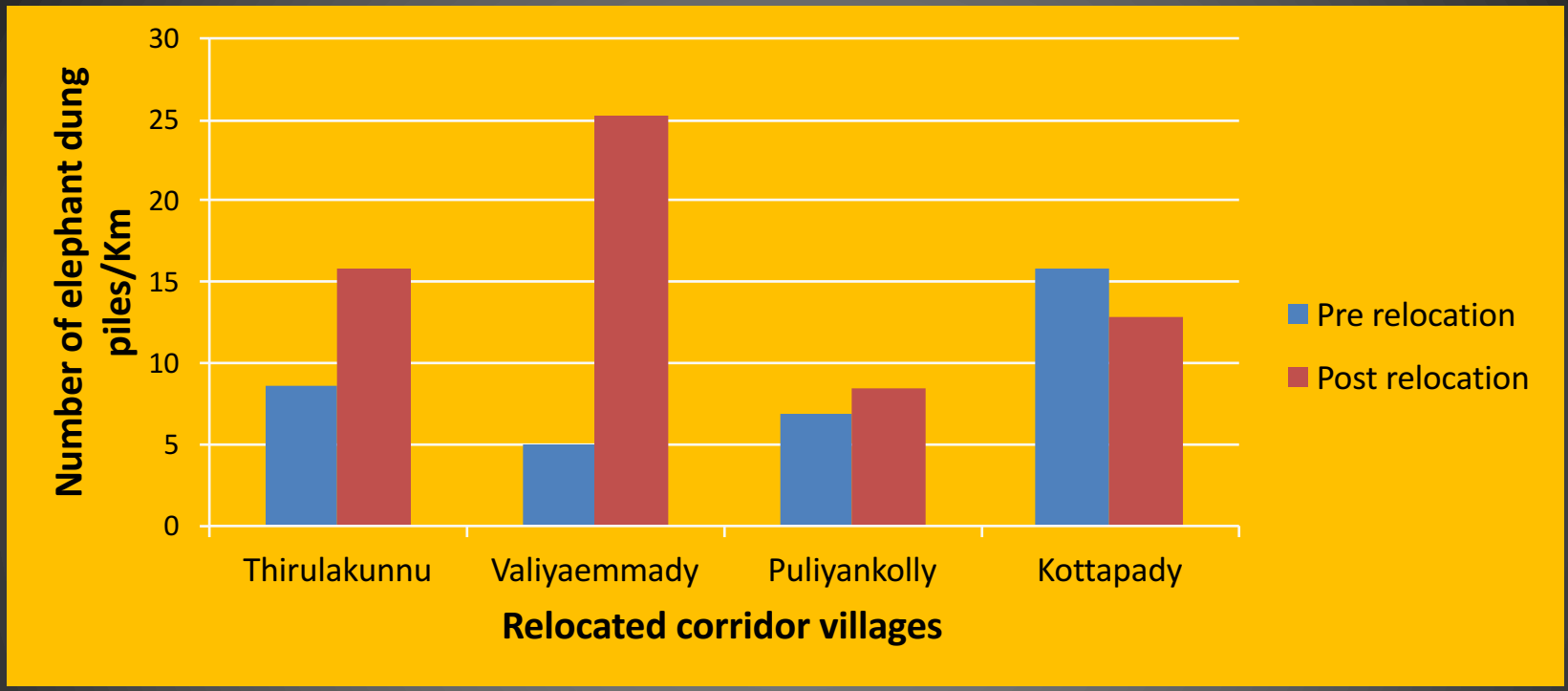
S. R. O. No. 507/2015.—WHEREAS, the Government of Kerala, in exercise of the powers conferred by Sections 27 and 76 of the Kerala Forest Act, 1961 (4 of 1962), had issued the Wayanad Wildlife Sanctuary Rules, 1973 vide Notification G. O. (Ms.) No. 182/73/AD dated 30th May, 1973 and published as S.R.O. No. 384/73 in the Kerala Gazette declaring an extent of 344.4 Sq. km. falling within the boundaries specified in the Schedule to be the said notification as "Wayanad Wildlife Sanctuary";

PRINTED AND PUBLISHED BY THE SUPERINTENDENT OF GOVERNMENT PRESSES AT THE GOVERNMENT CENTRAL PRESS, THIRUVANANTHAPURAM, 2015

Secured corridor land incorporated as part of Wayanad WLS and Wayanad North FD

.....has all this made any change to elephants

Elephant dung encounter rate of relocated villages



Overall encounter rate

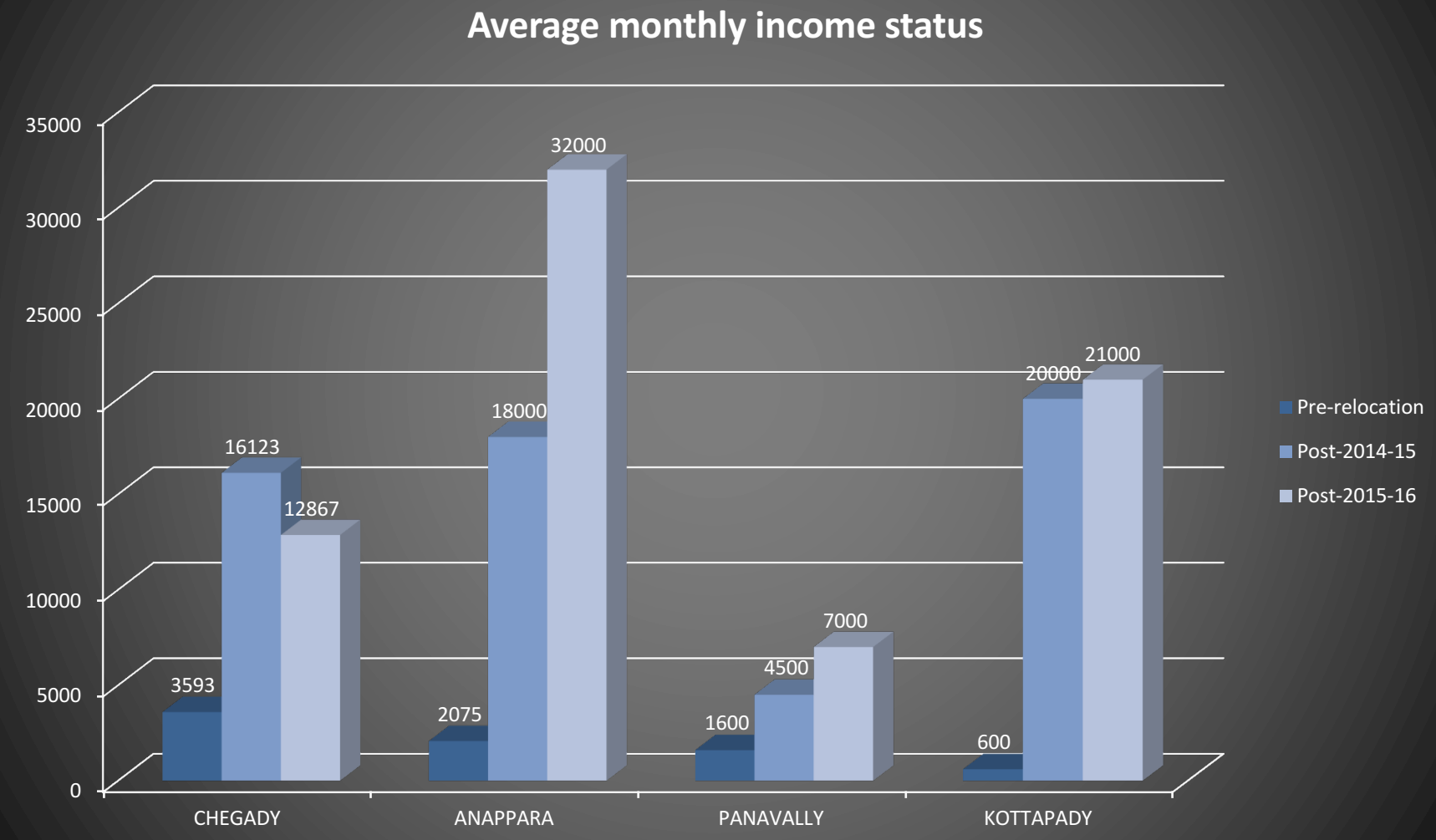
Pre relocation 9.13 dung piles/Km
Post relocation 15.7 dung piles/Km


WINS
After securing.....
1/05/2013 8:28 PM

Monitoring welfare of rehabilitated villagers

- Help them in getting financial aids and technical support from other departments.
- 1) Animal Husbandry Scheme Funded By NABARD 2) Nutrition and health guarantee programme 3) Check dam project by NABARD:
- Conduct awareness among rehabilitated villagers about the importance of education.
- Help them in finding job opportunities.
- Monitoring welfare of rehabilitated villagers for five years

Pre and post relocation status of average monthly income of relocated villages



Socio economic status of the beneficiaries improved significantly after relocation from the corridor forest to alternate site

Characteristics	Significant difference on Improvement after relocation
Income	Yes
Access to main road	Yes
Access to LP school	No
Access to HS School	yes
Access to College	yes
Access to Hospital	Yes
Access to Ration shop (PDS)	Yes
Access to Gramapanchayath	Yes
Access to Forest station	No
Access to Police station	No
Access to Post office	No
Access to Bank	No
Access to Shopping centre	Yes

Our Team



Ramkumar



Sabu Jahas



Ramith



Shajan



Sandeep Kr.Tiwari

Vivek Menon




Thanks

Landscape Ecological Analysis and Characterization of Elephant Migration through GIS Application



Nilanjana Das Chatterjee

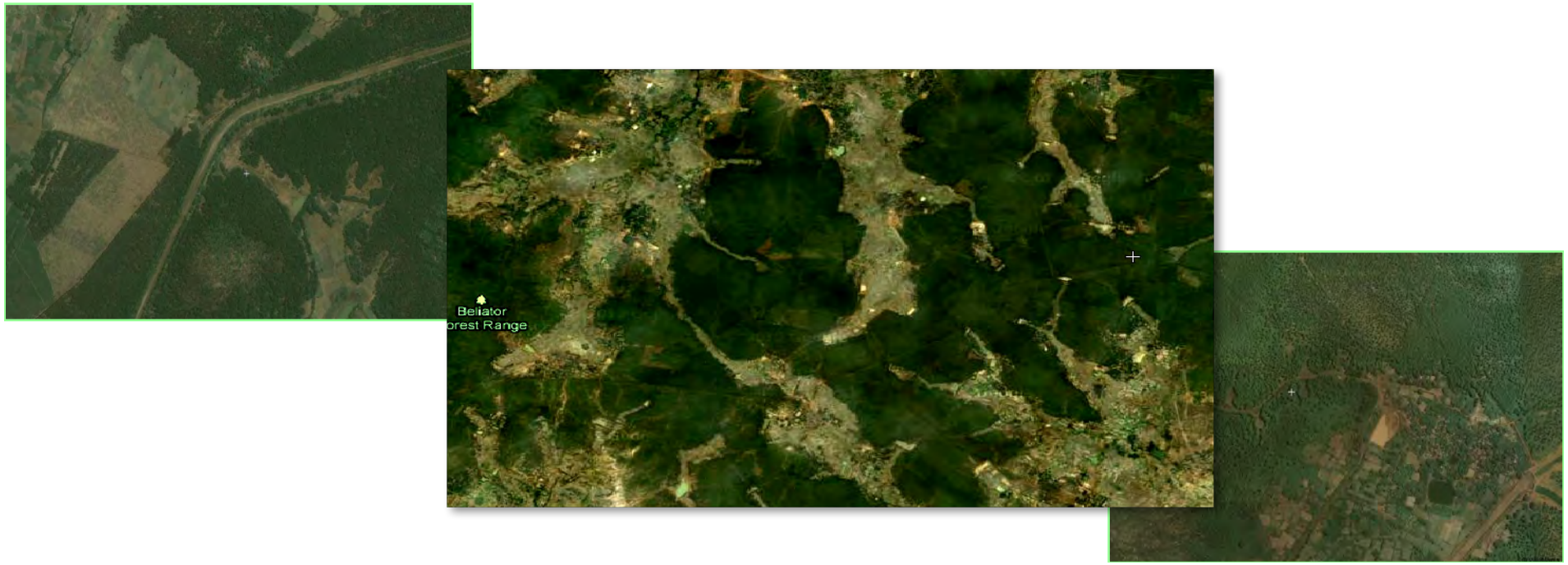
Dept. of Geography and Environment Management,Vidyasagar University, Midnapore-721102, W.B.India

CONCEPTUAL BACKGROUND

•**Landscape** commonly refers to the landforms of a region and its associated features at **scales of hectares to many square kilometers** and considered as **spatially heterogeneous** area

•**Landscape patterns** were generated by independent variation of two parameters: **composition** (the amount of a given habitat) and **configuration** (its arrangement, amount of spatial autocorrelation) of a single habitat type

•**Habitat** the physical space within which an organism lives, and the abiotic and biotic entities (e.g., resources) it uses and selects in that space



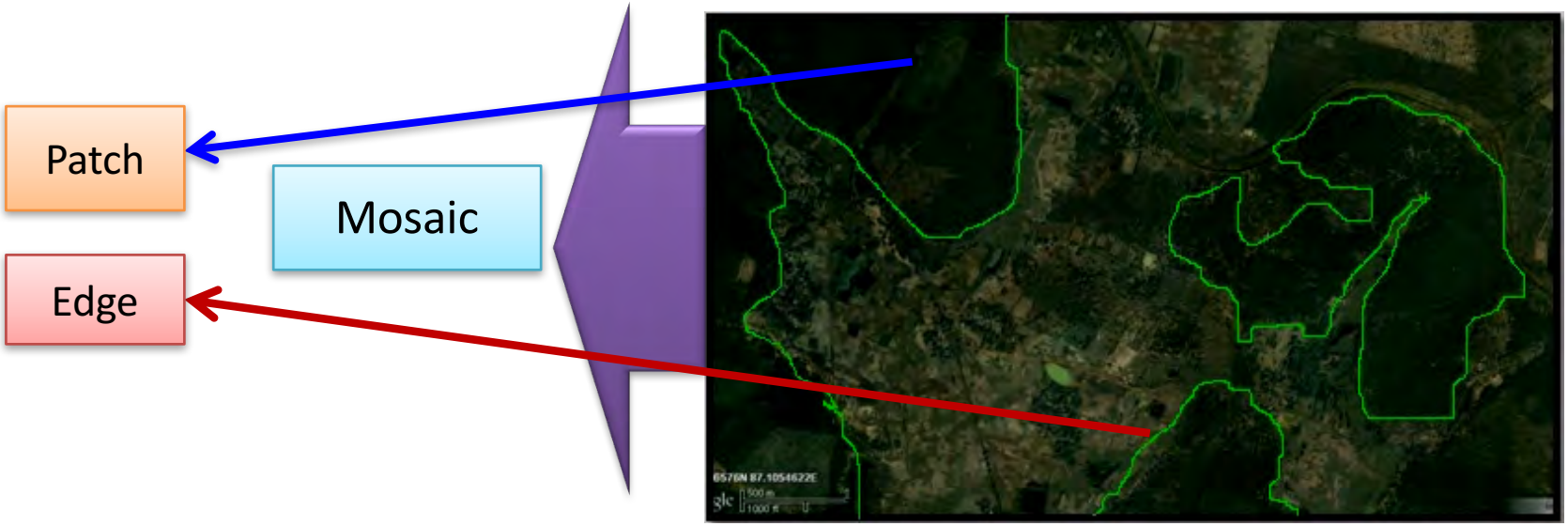
LANDSCAPE ELEMENTS

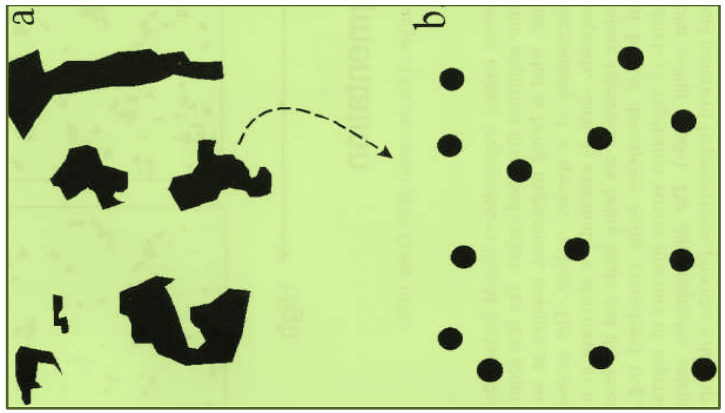
- **Patch:** In landscape; patch is the land of homogeneous entity that differs from the surrounding matrix. In forest matrix patch is the key word for habitat, function, structure, resource, corridors.

- **Edge:** An edge is defined as an outer portion of a selective patch where significant change remains still in horizontal structure of the patches and species composition within the patch.

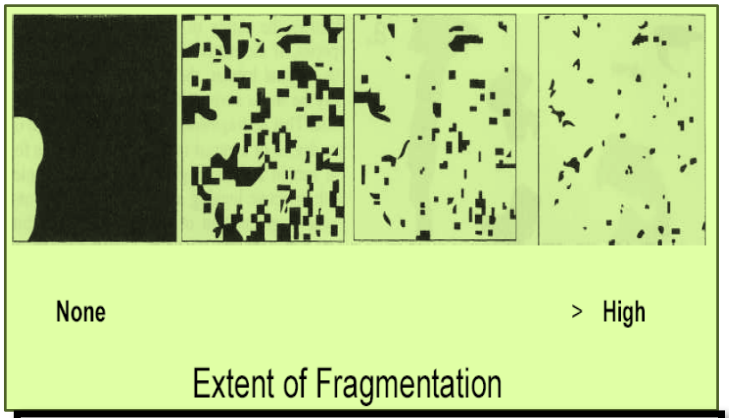
- **Mosaic:** Mosaic normally consists of patches, corridors, edges, and habitats etc.

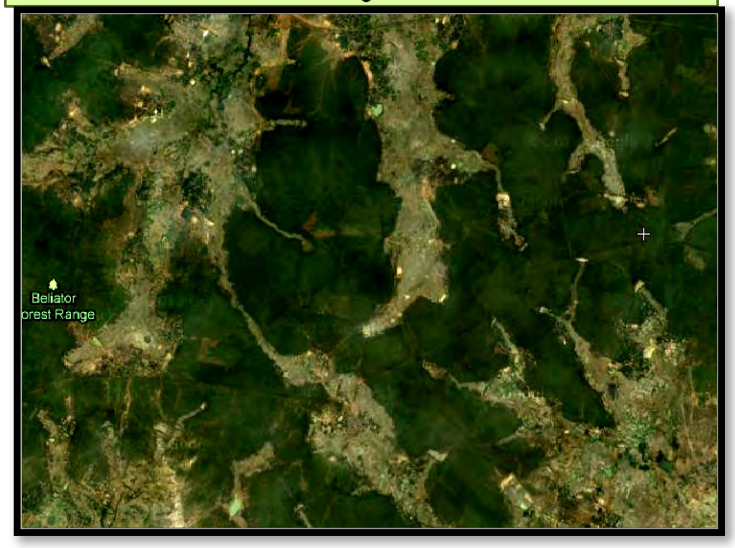
- **Corridor:** Corridor can be defined as narrow strip of habitat surrounded by other habitats. Across a corridor plants and animals can move easily.





Geographical fragmentation and Structural fragmentation of habitats





LANDSCAPE ANALYSIS

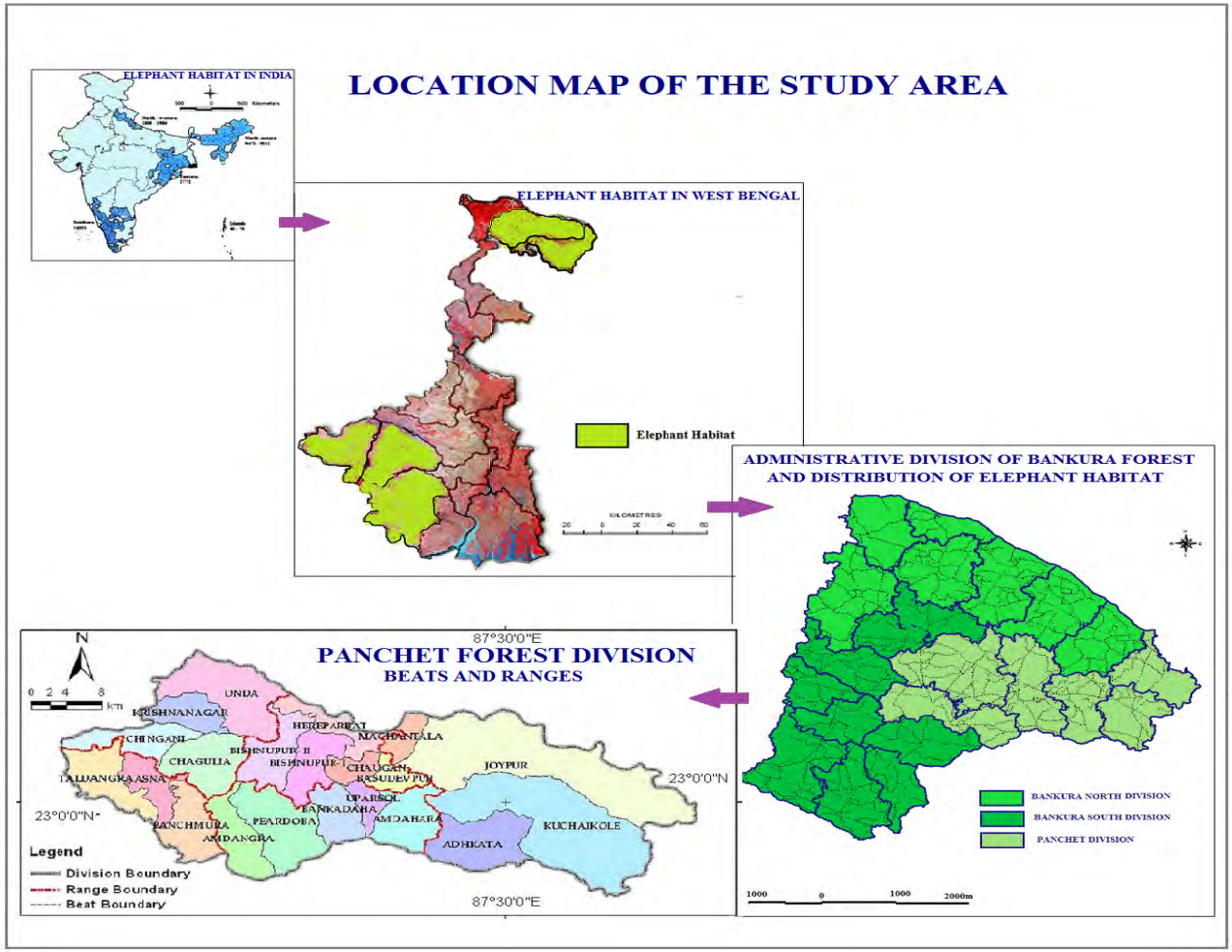
Patchiness: Relative size and isolation of vegetation cover patches

Porosity: Number of patches or density of patches within a particular vegetation type regardless of patch size

Interspersion: A count of dissimilar neighbours of a given patch and the intermixture of vegetation cover types across a landscape

Shape: Degree of deviation from a circle

Area, Shape, Core area Metrics ,Isolation and Proximity, Contrast and Diversity

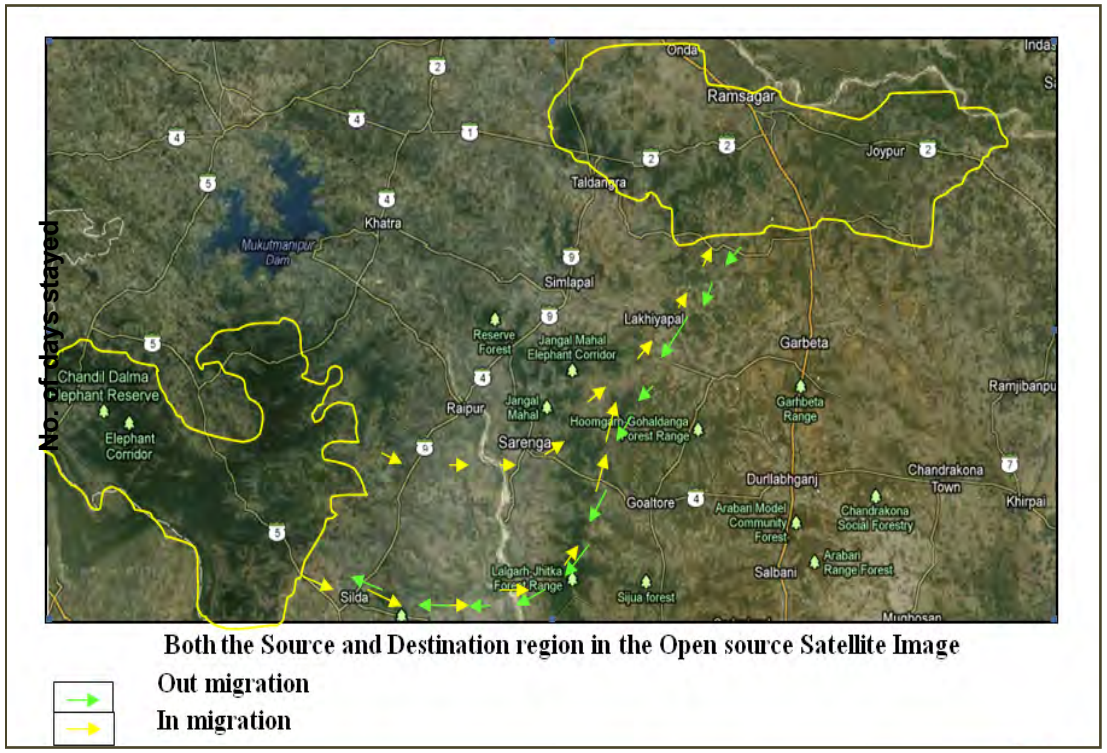


Legal Status of Forest	Area in Sq Km
Reserved Forest	0.929
Protected Forest	335.110
Un classed Forest	7.617
Non-forest land	0.0016

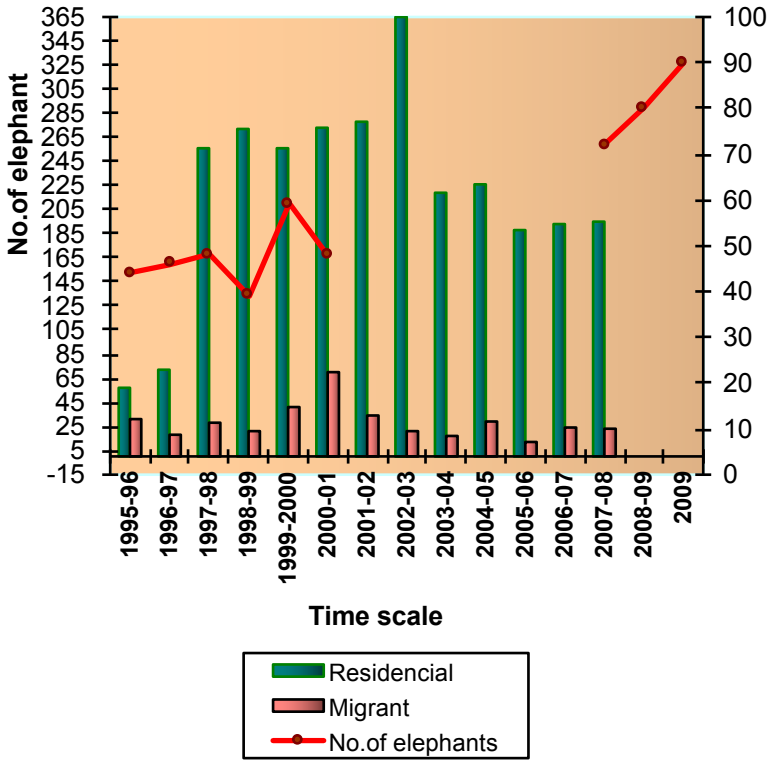


NAME OF THE RANGE	NAME OF THE BEAT
Bishnupur	1. Bishnupur I
	1. Bishnupur II
	1. Basudevpur
	1. Chaugan
	1. Hereparvat
Joypur	1. Adhkata
	1. Joypur
	1. Machantala
	9. Kuchiakole
Taldangra	10. Taldangra
	11. Asna
	12. Panchmura
Bankadaha	13. Bankadaha
	14. Amdangra
	15. Peardoba
	16. Uparsole
	17. Amdahara
Onda	18. Chhagulia
	19. Krishnanagar
	20. Onda
	21. Chingani

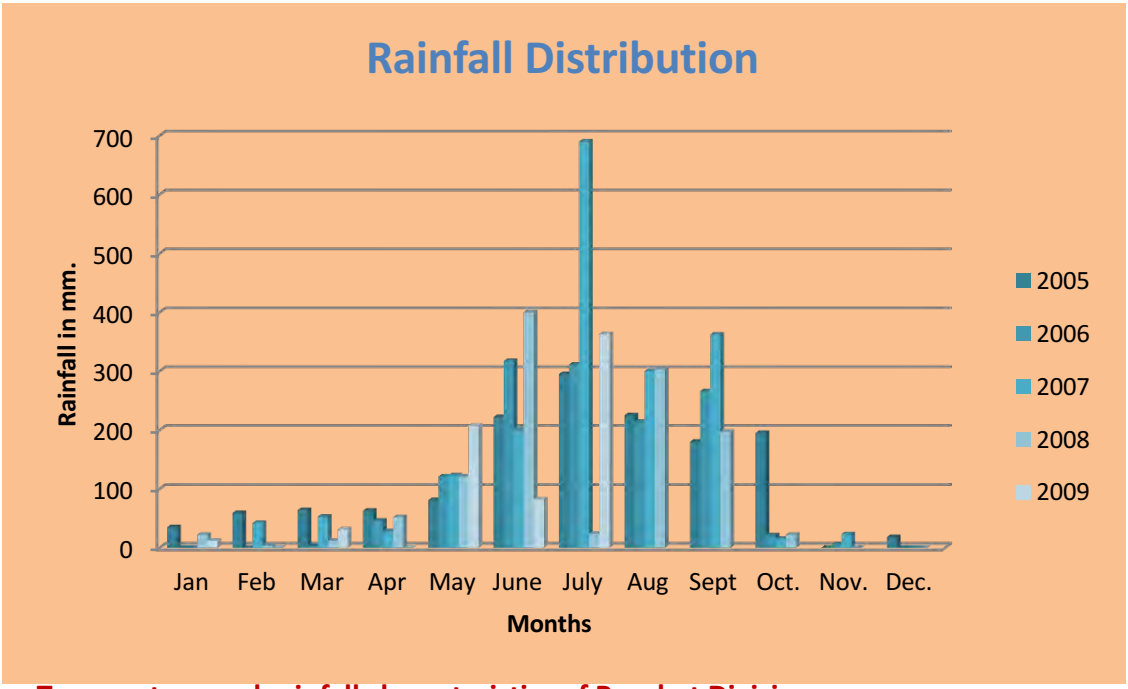
HISTORY OF ELEPHANT MIGRATION IN THE STUDY AREA



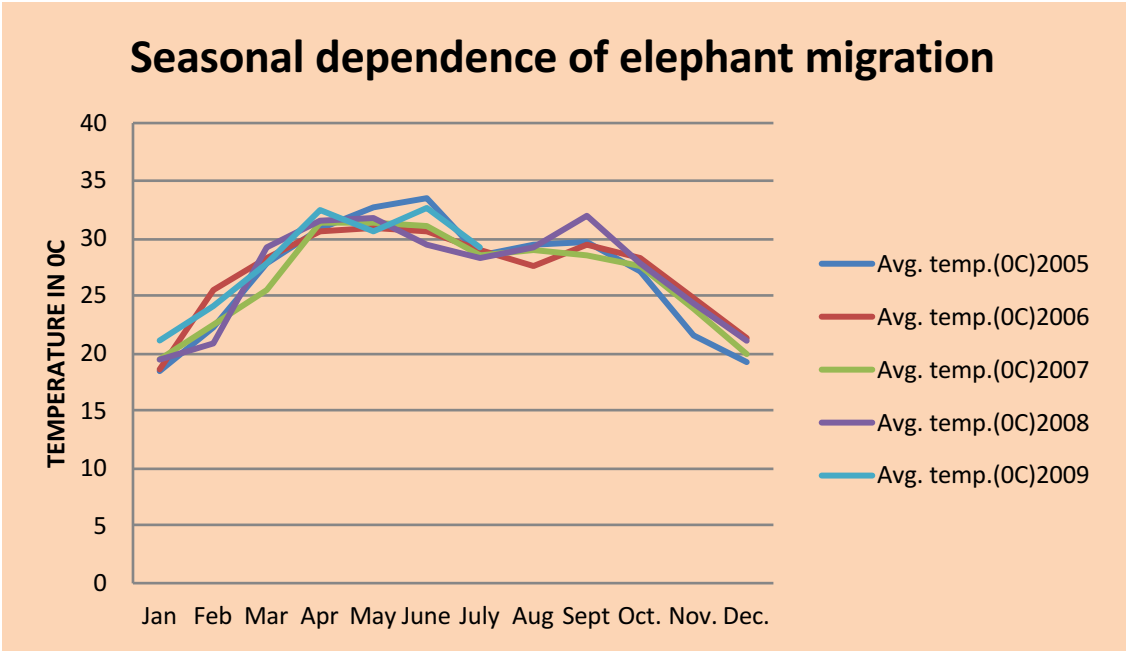
Trend in volume of elephant migration and duration of stay



- ❖Problem in the study area started with the intrusion of elephant from Dalma Wildlife Sanctuary, Jharkhand.
- ❖Movement of the elephants deepened towards east in consecutive years
- ❖ In 1987, a herd of 40 elephant entered into the study area
- ❖During 1995-96, the number of days the elephants stayed in Panchet Forest Division was 31
- ❖It increased to 70 days by 2006-07



Temperature and rainfall characteristics of Panchet Division



MONSOON FOREST ECOSYSTEM AS ANIMAL HABITAT

- **Rainfall is seasonal, increased periodicity in plant growth and reproduction.**

- **For vegetal feeding animals food supply is less varied and less continuously available.**

- **In certain places and in certain time foods become more abundant.**

- **Patches of cultivated lands within or at the margins of forests acts as centre of attraction as edible substances are concentrated here.**

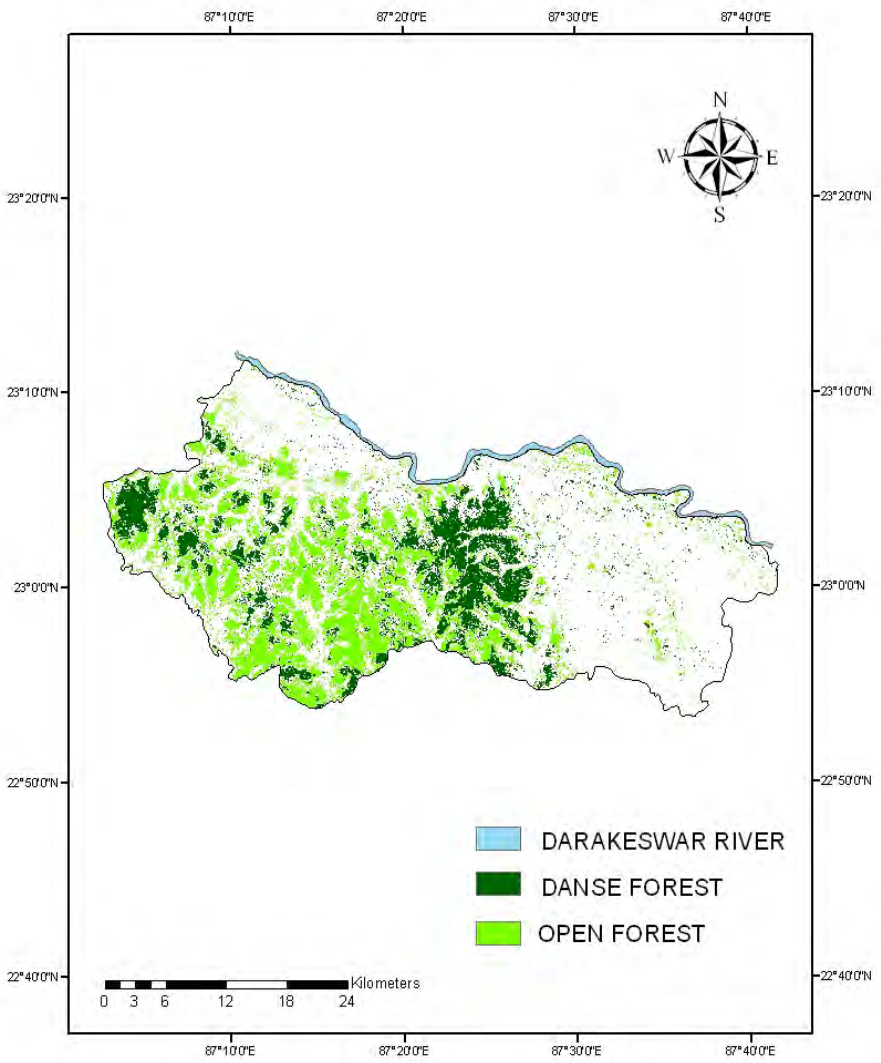
HABITAT REQUIREMENT OF ELEPHANTS

Wide ranging animal requiring larger extent of continuous stretches of forests for food, shelter and water

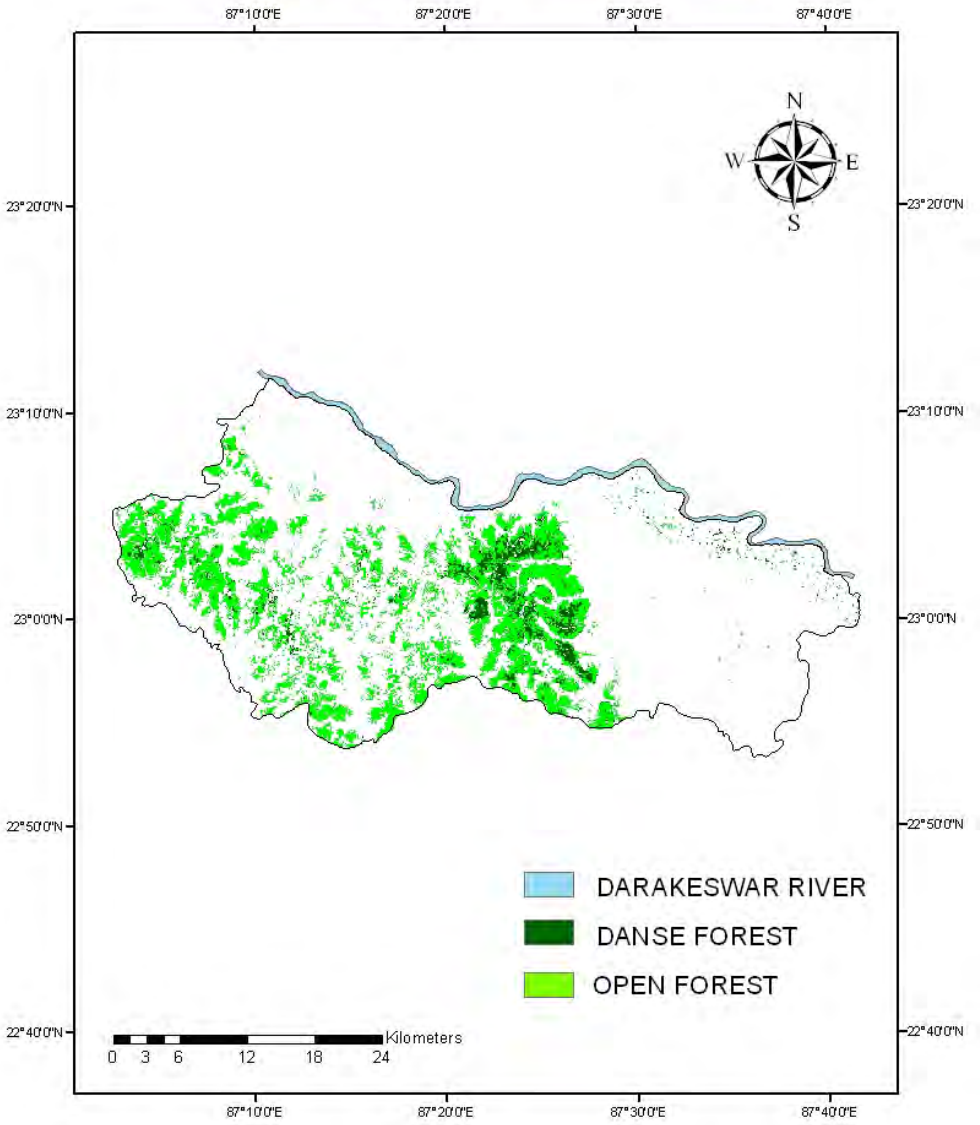
- A herd of 100 elephants would require minimum of about 650 km^2 of area.
- Home range size vary according to topography and types of vegetation
- Spend about 70% of the time for feeding which varies with seasons.
- Foods- grasses, bamboo, paddy, any kind of vegetation.
- Iron, Copper, Boron, calcium and Sodium are the important minerals which are required for which they have developed bark feeding behaviour.
- Consume 1.5% of their body weight in 12 hour feeding.
- Require 100 lit. water at one time and 225 lit. of water in a day.



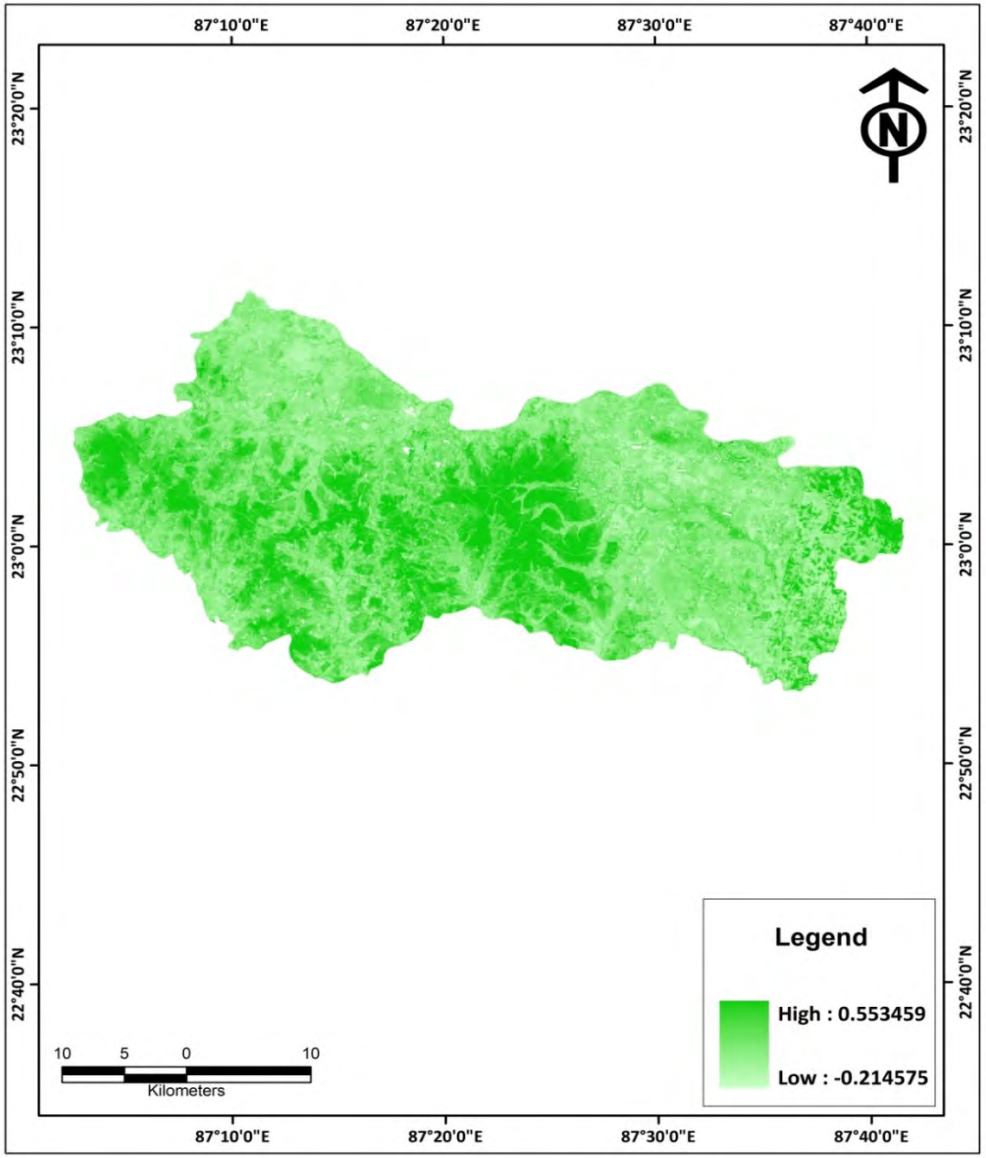
FOREST COVER MAP OF PANCHYET FOREST DIVISION 1973



FOREST COVER MAP OF PANCHYET FOREST DIVISION 2013

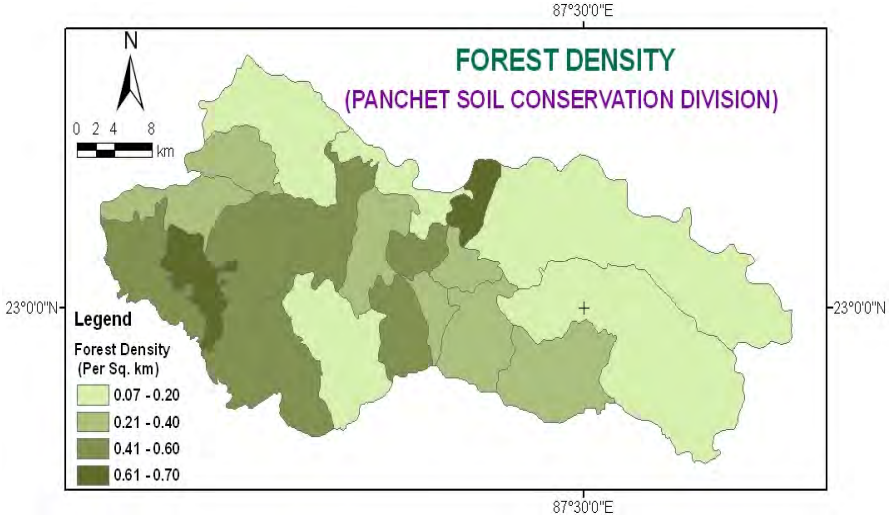


Normalize Difference Vegetation Index

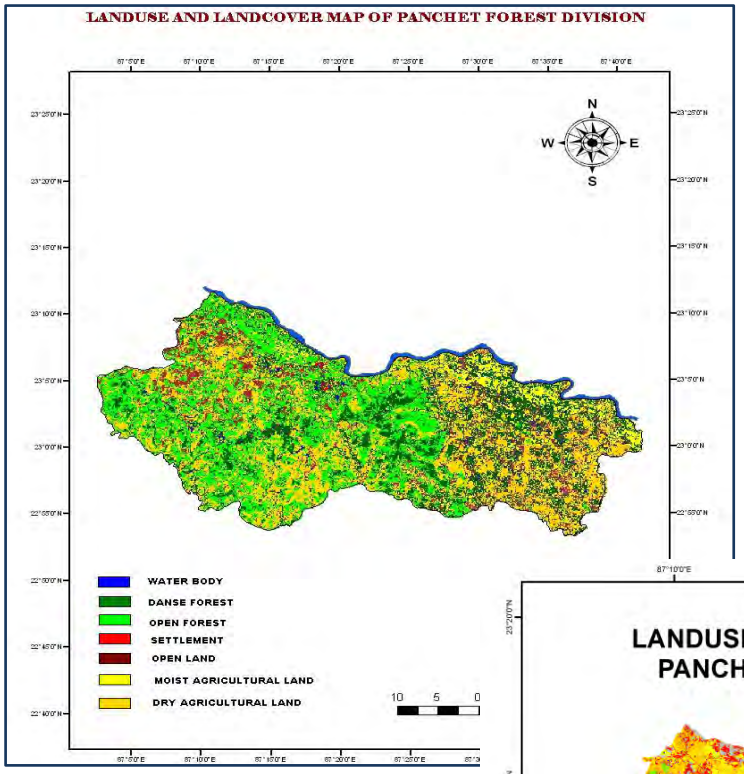


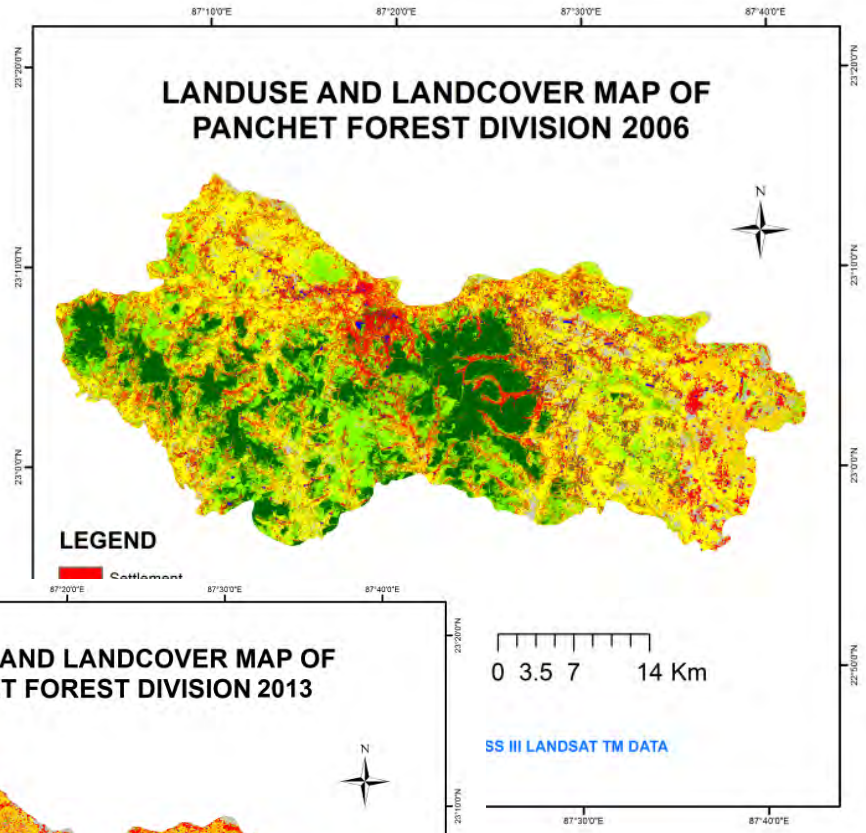
FLORAL SPECIES DIVEERSITY

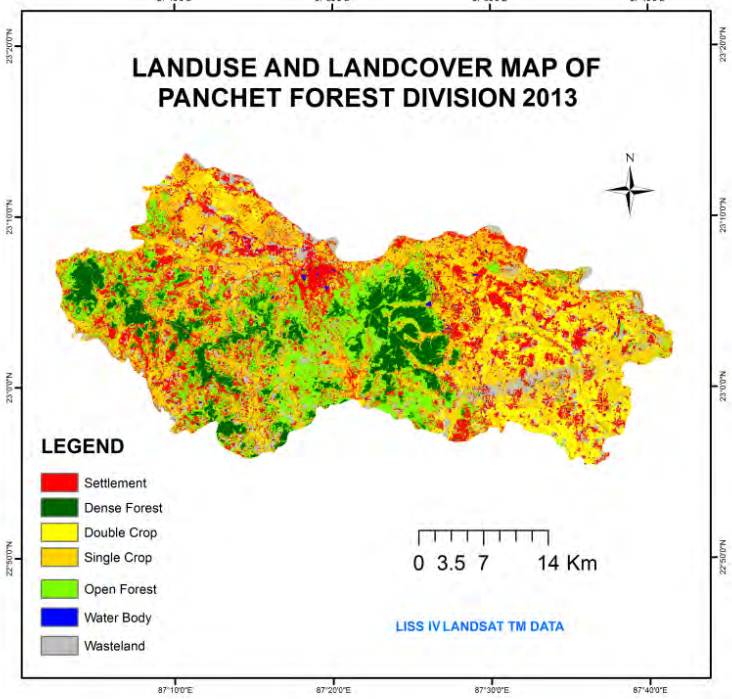
LOCAL NAME	BOTANICAL NAME
Am	*Magnifera indica*
Arjun	*Terminilia arjuna*
Asan	*Terminalia tomentosa*
Sal	*Shorea robusta*
Kusum	*Schleichera trijuga*
Mahua	*Madhuka latifilis*
Minjiri	*Cassia siamea*
Neem	*Azadirachta indika*
Palash	*Butea monosparma*
Simun	*Bombax malabaricum*
Siris	*Albizzia lebbek*
Teak	*Tectona quandis*



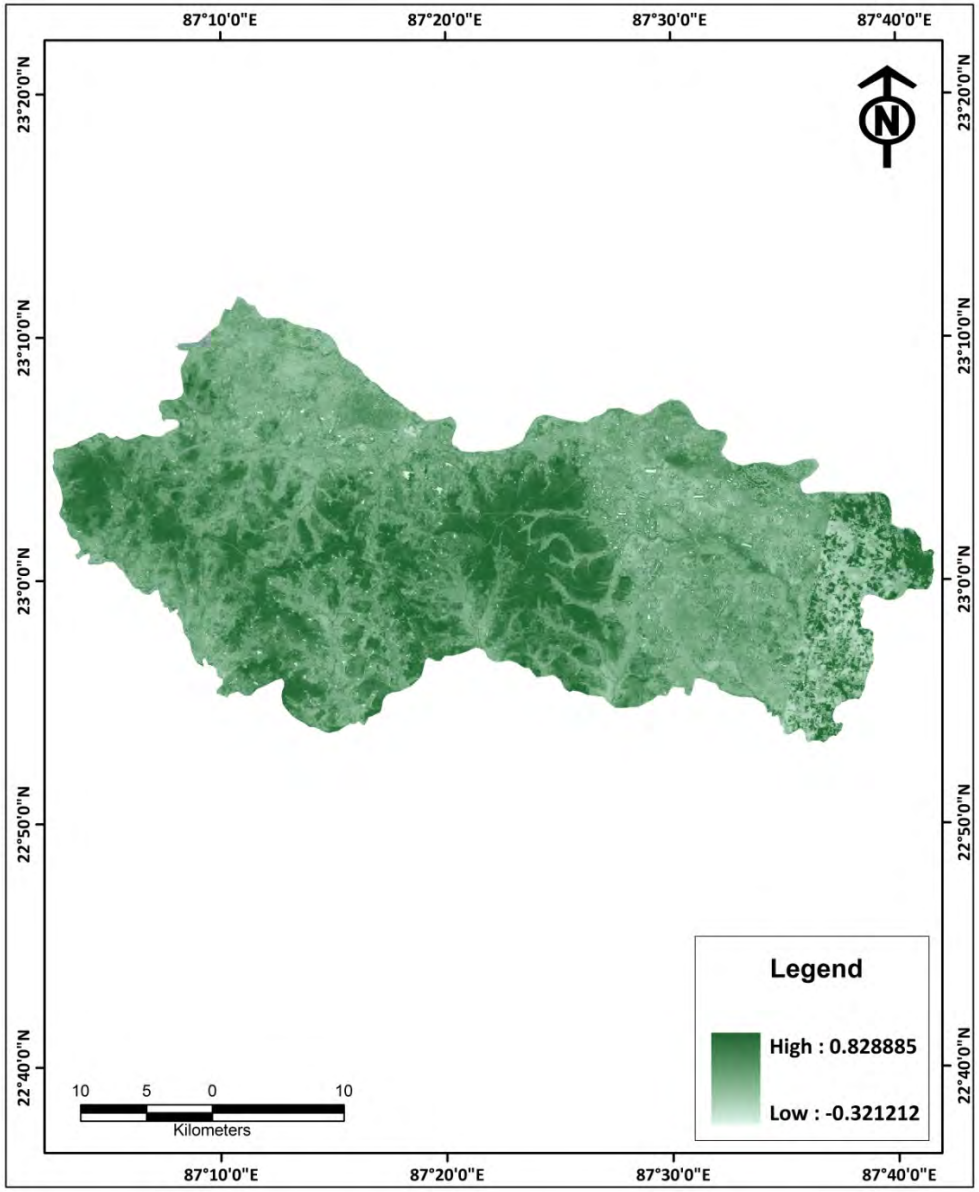
Changing Land use/Land cover



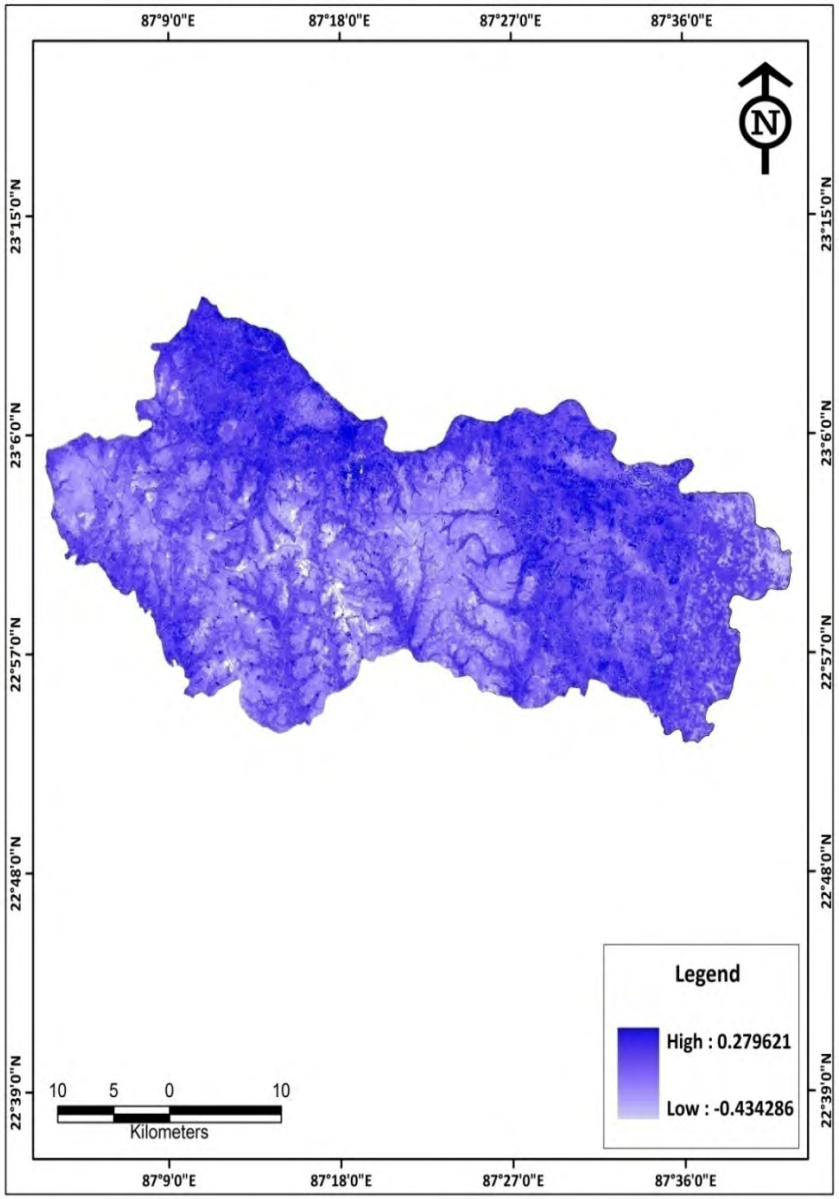


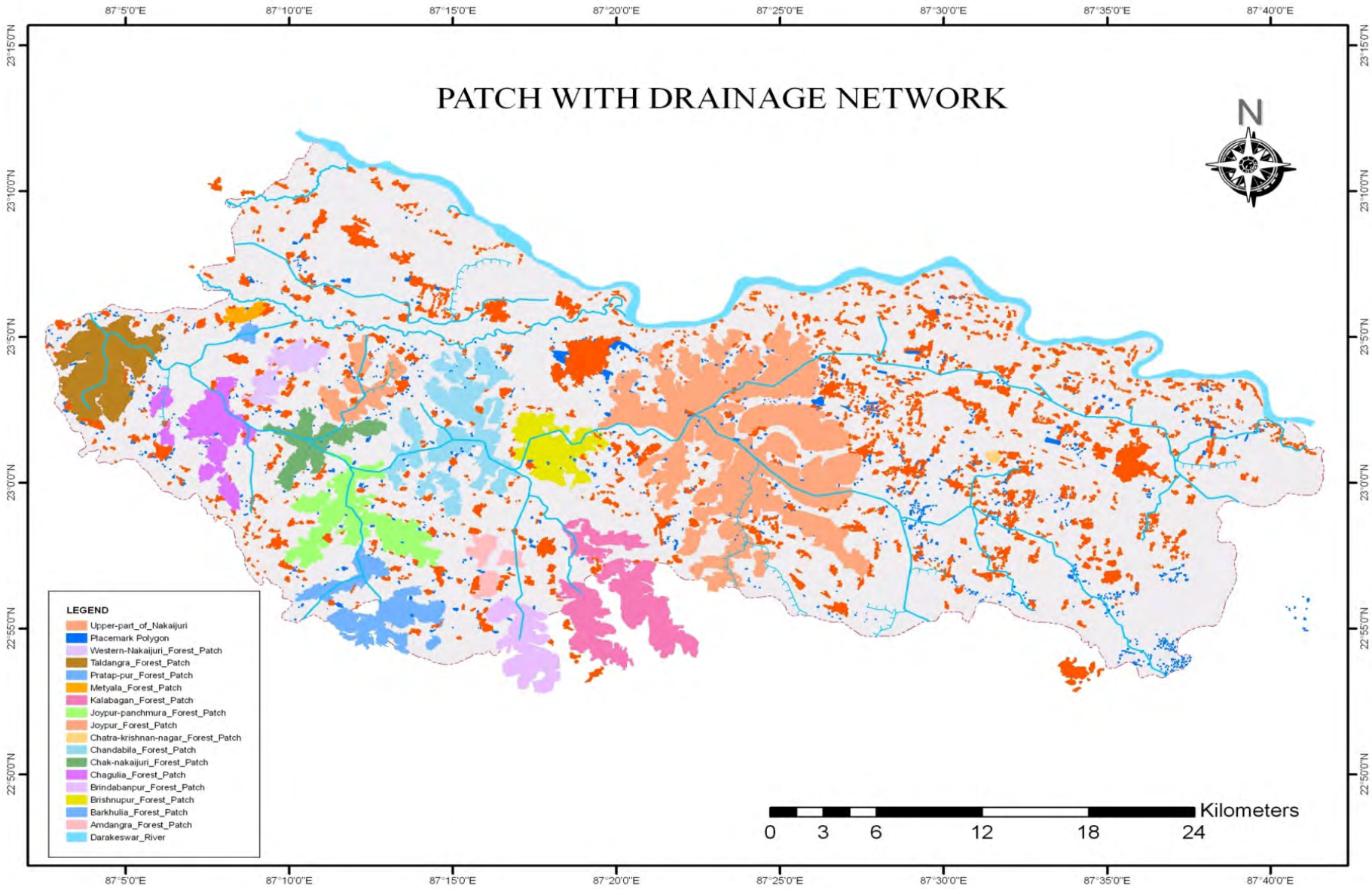


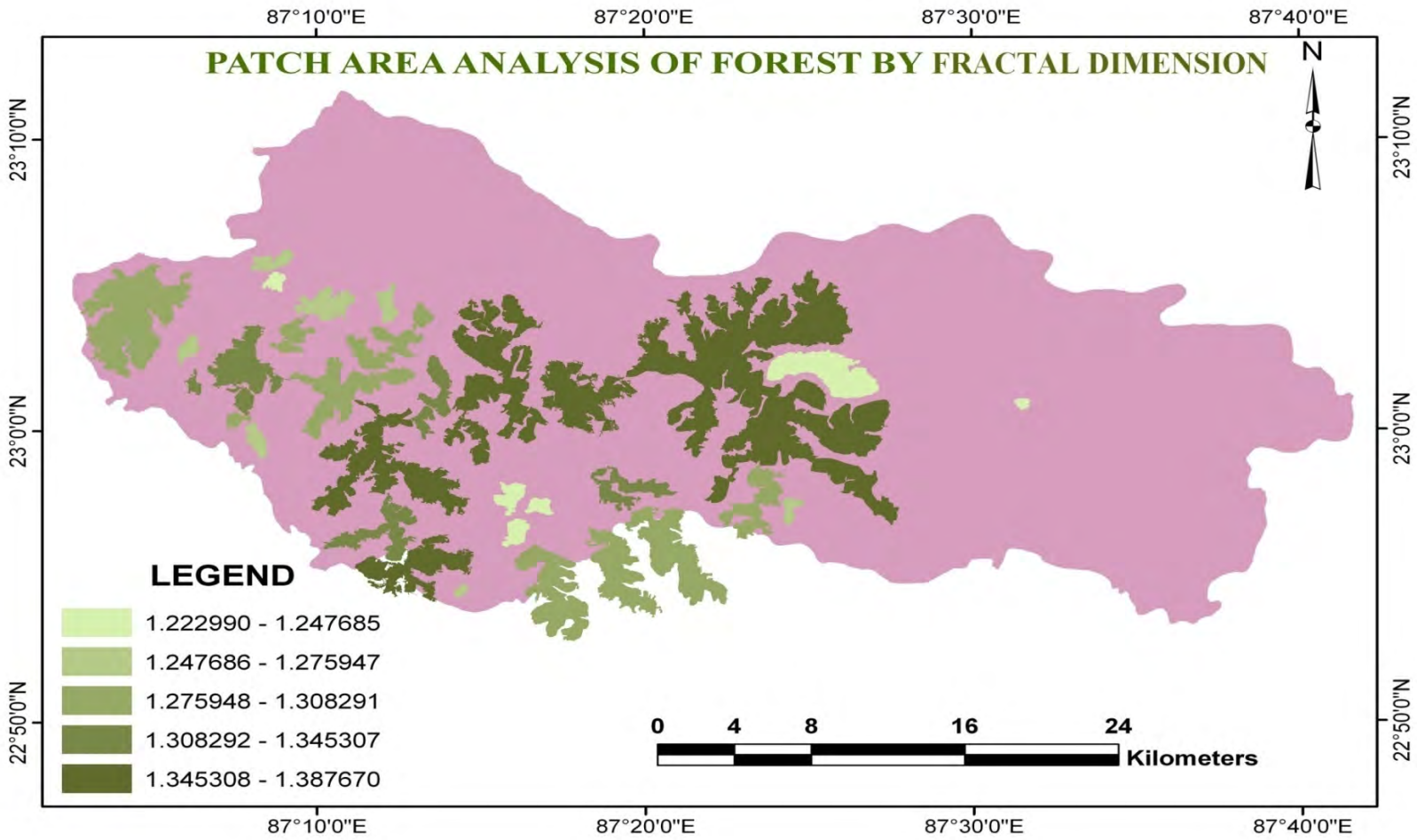
Soil Adjusted Vegetation Index



Normalised Difference Water Index

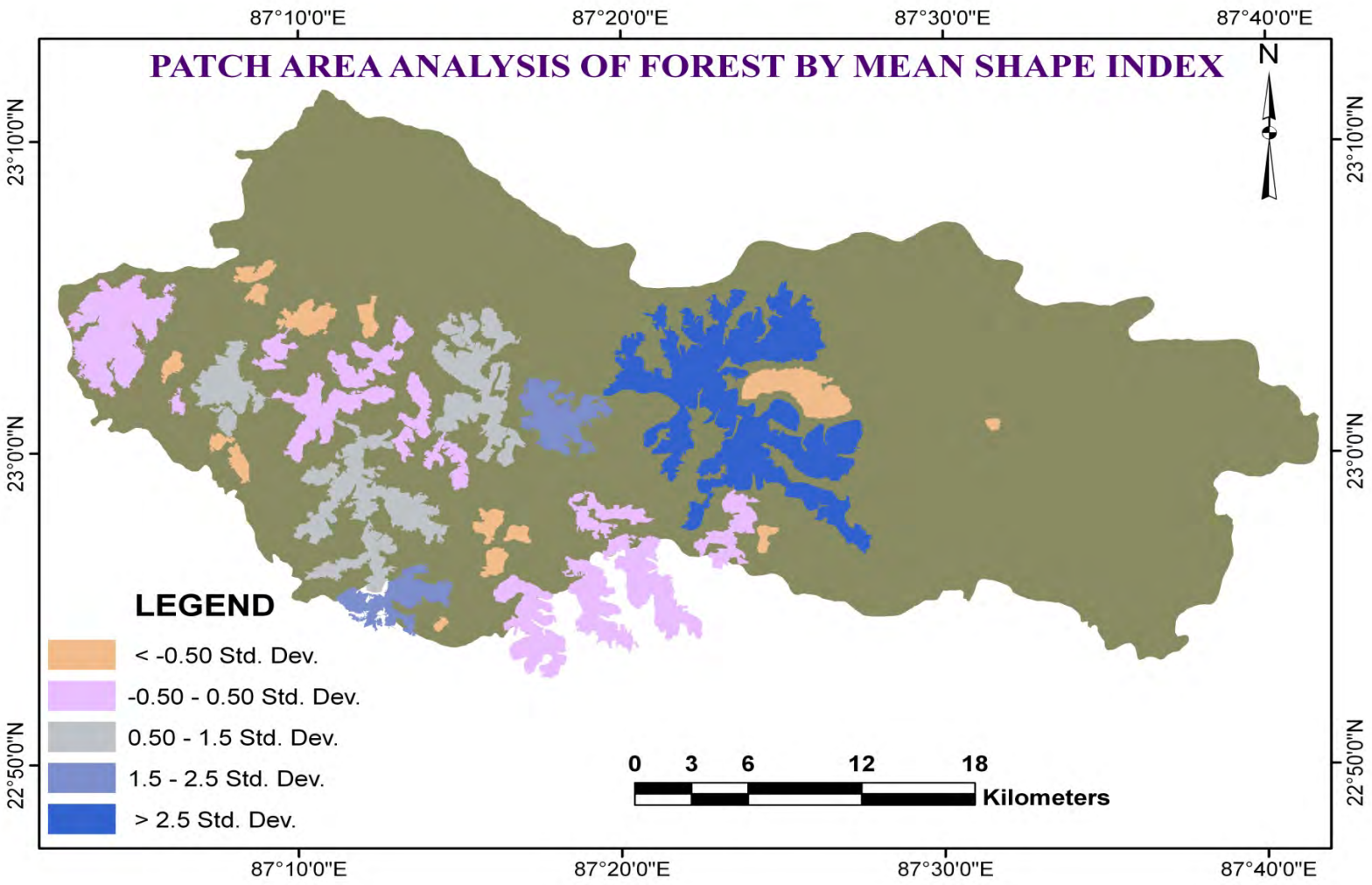



PATCH WITH DRAINAGE NETWORK
N
87°5'0"E
87°10'0"E
87°15'0"E
87°20'0"E
87°25'0"E
87°30'0"E
87°35'0"E
87°40'0"E
23°15'0"N
23°10'0"N
23°5'0"N
23°0'0"N
22°55'0"N
22°50'0"N
LEGEND
Upper-part_of_Nakaijuri
Placemark Polygon
Western-Nakaijuri_Forest_Patch
Taldangra_Forest_Patch
Pratap-pur_Forest_Patch
Metyala_Forest_Patch
Kalabagan_Forest_Patch
Joypur-panchmura_Forest_Patch
Joypur_Forest_Patch
Chatra-krishnan-nagar_Forest_Patch
Chandabila_Forest_Patch
Chak-nakaijuri_Forest_Patch
Chagulia_Forest_Patch
Brindabanpur_Forest_Patch
Brishnupur_Forest_Patch
Barkhulia_Forest_Patch
Amdangra_Forest_Patch
Darakeswar_River
Kilometers
0 3 6 12 18 24



$1 \leq FRAC \leq 2$

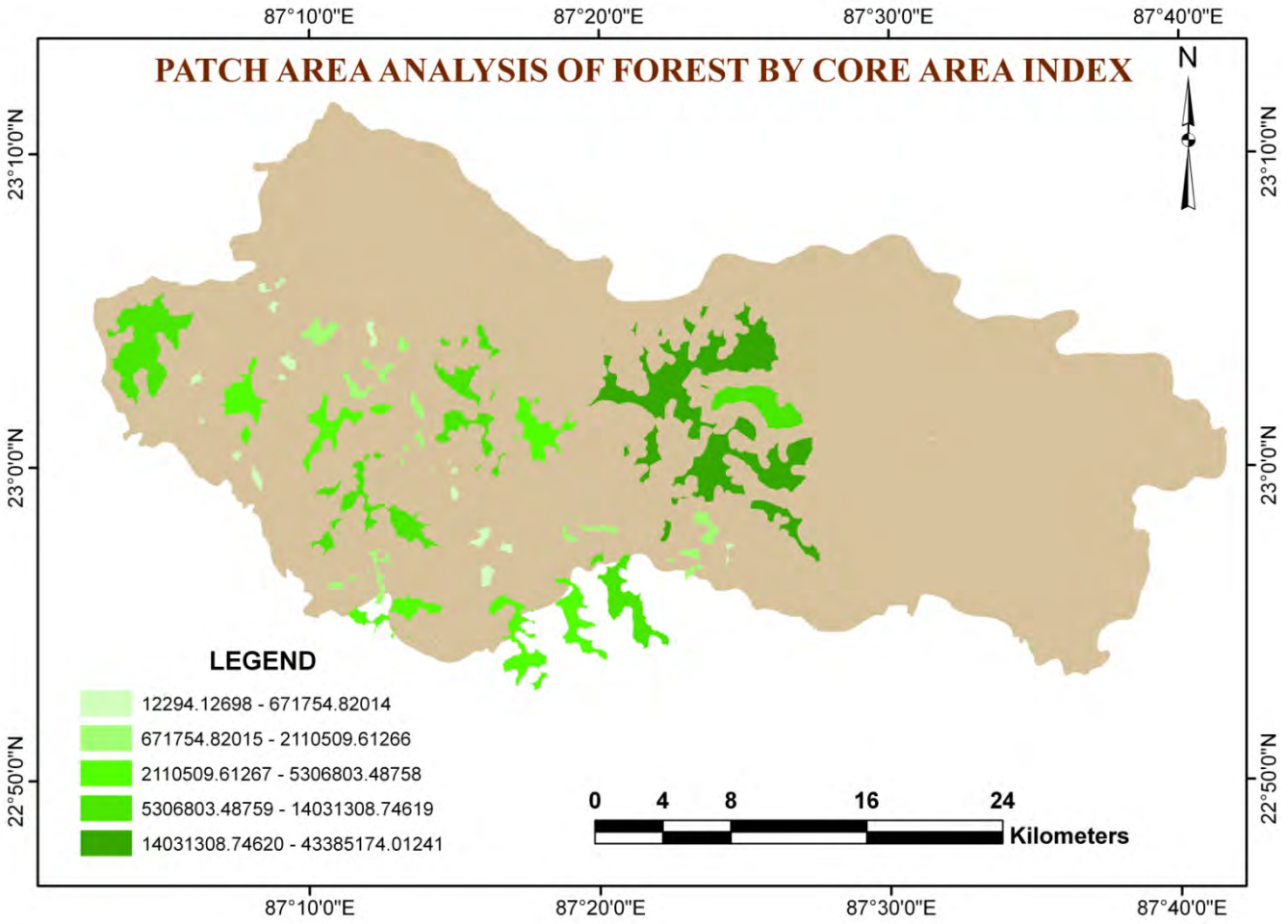
A fractal dimension greater than 1 for a 2-dimensional patch indicates a departure from Euclidean geometry (i.e., an increase in shape complexity). FRAC approaches 1 for shapes with very simple perimeters such as squares, and approaches 2 for shapes with highly convoluted, plane-filling perimeters.



$0 < LPI \leq 100$

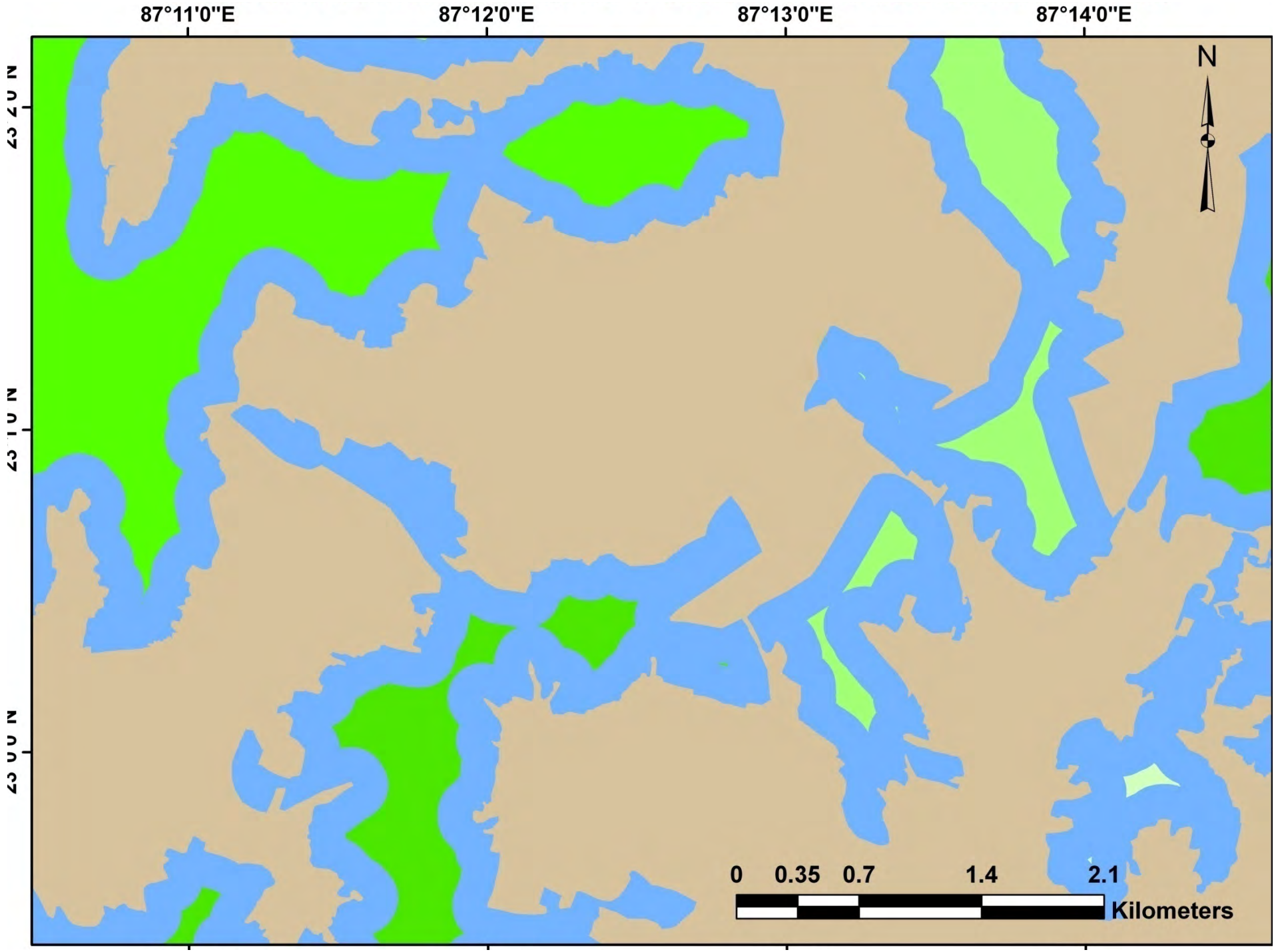
LPI approaches 0 when the largest patch of the corresponding patch type is increasingly small. LPI = 100 when the entire landscape consists of a single patch of the corresponding patch type; that is, when the largest patch comprises 100% of the landscape.

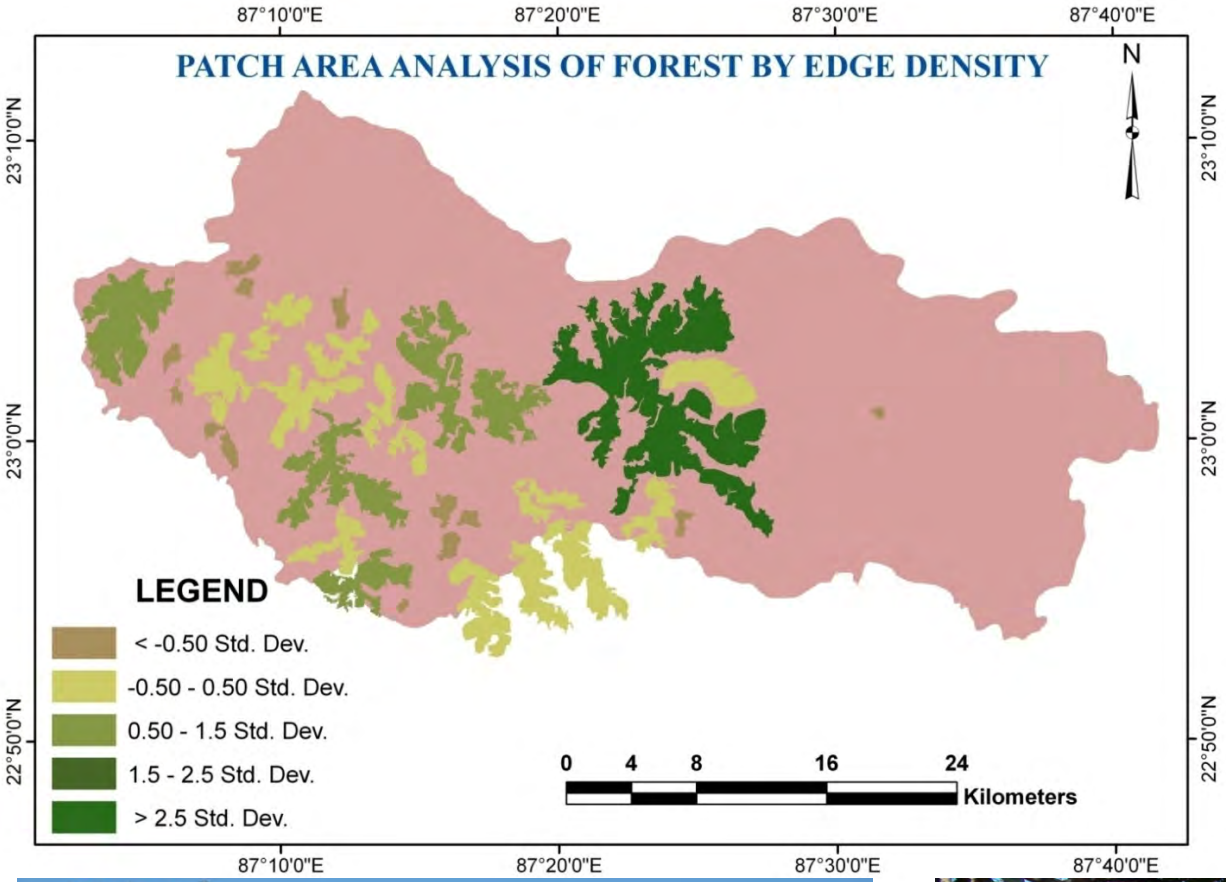
Core Area Index



$0 \leq CAI < 100$

CAI = 0 when CORE = 0 (i.e., every location within the patch is within the specified depth-of-edge distance(s) from the patch perimeter); that is, when the patch contains no core area. CAI approaches 100 when the patch, because of size, shape, and edge width, contains mostly core area.


87°11'0"E
87°12'0"E
87°13'0"E
87°14'0"E
N
0 0.35 0.7 1.4 2.1
Kilometers



ED ≥ 0, without limit.
ED = 0 when there is no class edge in the landscape; that is, when the entire landscape and landscape border, if present, consists of the corresponding patch type and the user specifies that none of the landscape boundary and background edge be treated as edge.





$$\text{Shannon Index (H)} = -\sum_{i=1}^{s} p_i \ln p_i$$

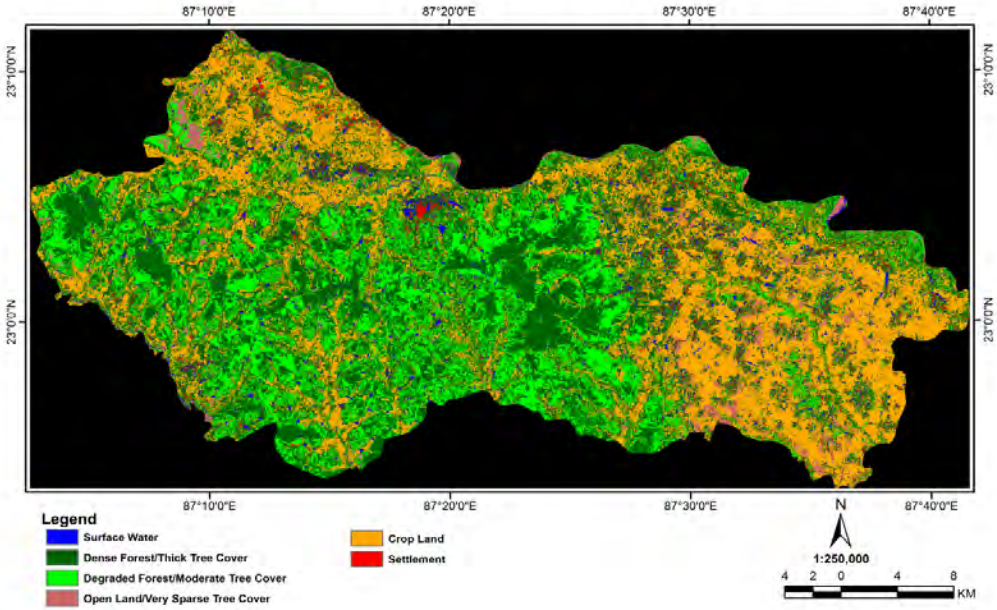
The Shannon index is an information statistic index, which means it assumes all species are represented in a sample and that they are randomly sampled.

$$\text{Simpson Index (D)} = \frac{1}{\sum_{i=1}^{s} p_i^{\,2}}$$

The Simpson index is a dominance index because it gives more weight to common or dominant species.

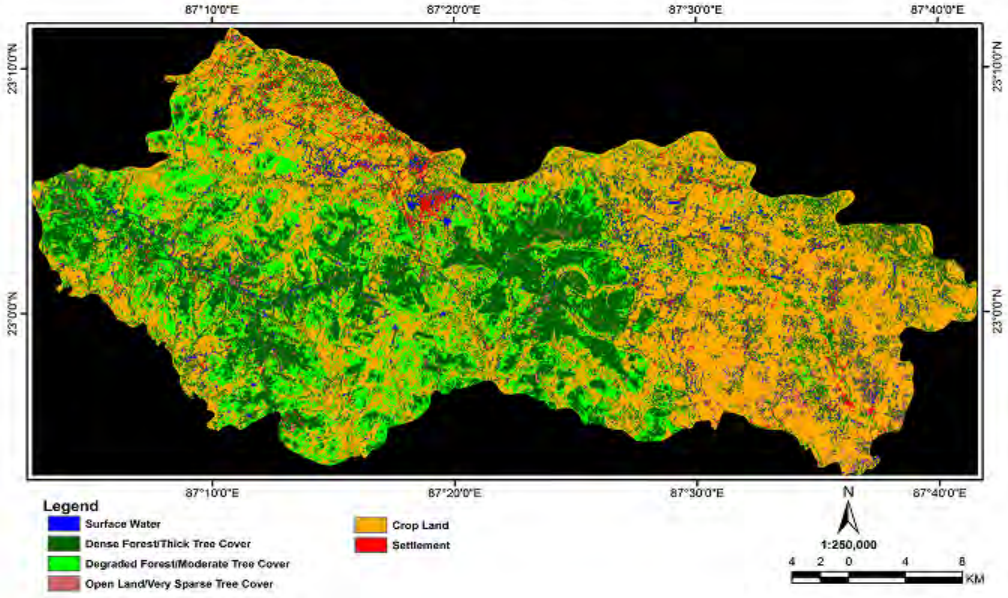
	Number of patches		Patch density (#/100 ha)		Largest patch index (%)		Edge density (m/ha)		Mean Patch Area (ha)		Total core area (ha)		Core Area Mean		Mean Euclidean Nearest Neighbour Distance		Interspersion and Juxtaposition index (%)		Connectance Index		Patch richness (#)		Shannon's diversity index		Simpson's diversity index	
	1990	2013	1990	2013	1990	2013	1990	2013	1990	2013	1990	2013	1990	2013	1990	2013	1990	2013	1990	2013	1990	2013	1990	2013	1990	2013
Landscape level metrices	105569	91168	46.7724	40.4687	6.7193	12.4409	130.9747	112.145	1.1909	1.376	84744.723	66713.243	0.8027	0.7318	82.8203	72.3664	70.2171	73.5522	0.0097	0.0118	6	6	1.3757	1.3168	0.7066	0.681

MAJOR LAND USE/LAND COVER TYPES 1990
(Panchet Forest Division, West Begal)



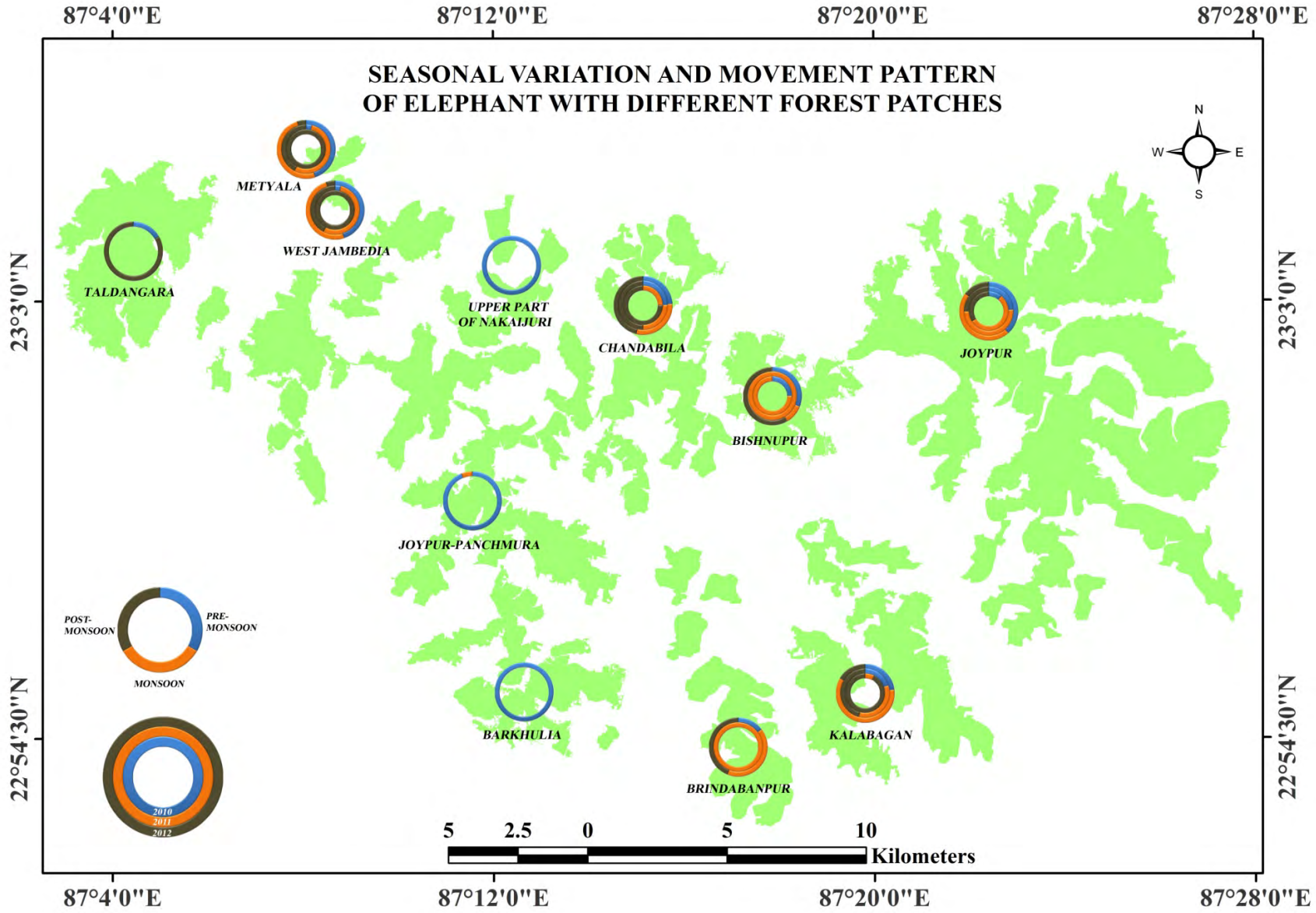


MAJOR LAND USE/LAND COVER TYPES 2013
(Panchet Forest Division, West Begal)





Class level metrices							
water	settlement	openland	densefore st	degradedf orest	croplan d		
8099	22123	4168	22476	29472	19231	1990	Number of patches
5911	11636	15371	17554	27350	13346	2013	
3.5883	9.8016	1.8466	9.958	13.0576	8.5203	1990	Patch density (#/100 ha)
2.6238	5.1651	6.8231	7.7921	12.1404	5.9242	2013	
0.0103	0.0299	0.1214	5.4049	0.4124	6.7193	1990	Largest patch index (%)
0.0079	0.0389	0.0117	3.6628	0.3777	12.4409	2013	
9.919	21.7507	7.0524	97.3787	65.6871	60.1616	1990	Edge density (m/ha)
6.55	13.4207	16.564	61.5471	56.8424	69.3658	2013	
0.3924	0.225	0.7775	2.1845	0.9297	1.967	1990	Mean Patch Area (ha)
0.357	0.302	0.2822	2.0765	0.8485	4.1828	2013	
3177.8469	4977.7117	3240.7963	21611.455	16278.79	35458.124	1990	Total core area (ha)
1571.04	3514.1625	1946.565	16631.955	6556.4325	36493.088	2013	
1.4079	2.2054	1.4358	9.575	7.2123	15.7097	1990	Core area percent of landscape (%)
0.6974	1.5599	0.8641	7.3828	2.9103	16.199	2013	
0.3924	0.225	0.7775	0.9615	0.5523	1.8438	1990	Core Area Mean
0.2658	0.302	0.1266	0.9475	0.2397	2.7344	2013	
140.2651	89.9724	150.5473	64.9644	71.2557	74.3135	1990	Mean Euclidean Nearest Neighbour Distance
140.0425	89.6935	82.3029	58.6772	61.6759	55.7544	2013	
77.5551	76.8328	70.2979	73.1705	60.486	68.1364	1990	Interspersion and Juxtaposition index (%)
85.2131	86.5778	87.8377	79.6638	53.3374	71.9174	2013	
0.009	0.0073	0.0192	0.0135	0.0079	0.0116	1990	Connectance Index
0.0139	0.013	0.0104	0.0141	0.0087	0.0214	2013	


SEASONAL VARIATION AND MOVEMENT PATTERN
OF ELEPHANT WITH DIFFERENT FOREST PATCHES
87°4'0"E
87°12'0"E
87°20'0"E
87°28'0"E
23°3'0"N
22°54'30"N
N
W
E
S
METYALA
WEST JAMBEDIA
TALDANGARA
UPPER PART
OF NAKAIJURI
CHANDABILA
JOYPUR
BISHNUPUR
JOYPUR-PANCHMURA
BARKHULIA
KALABAGAN
BRINDABANPUR
POST-
MONSOON
PRE-
MONSOON
MONSOON
2010
2011
2012
5
2.5
0
5
10
Kilometers

1	Acacia arabica	Babul
	Acacia catechu	Khair
3	Adina cordifolia	Karam
4	Aegle marmelos	Bel
5	Ailanthus excelsa	Ghorkaranj/ Ghorkaram
6	Alangium Lamarckii	Dhela
7	Albizzia lebbek	Siris
8	Albizzia odoratissima	Jang Siris
9	Albizzia procera	Safed Siris
10	Alstonia scholaris	Chatni
11	Anogeissus latifolia	Dhautha
12	Antidesma ghaesembilla	Bhabiranj
13	Arotocarpus integrifolia	Kathal
14	Artocarpus lakoocha	Barhar
15	Azadirachta indica	Neem
16	Bauhinia retusa	Kathul
17	Bauhinia purpurea	Koenar
18	Bauhinia racemosa	Katmauli
19	Bauhinia variegata	Kachnar
20	Bombax ceiba	Semal
21	Boswellia serrata	Salia
22	Bridelia retusa	Kajhi
23	Buchanania lanzan	Piar
24	Butea frondosa	Palas
25	Careya arborea	Kumbhi
26	Casearia tomentosa	Beri
27	Cassia fistula	Dhanraj/Amaltas
28	Chloroxylon swietenia	Bharhul

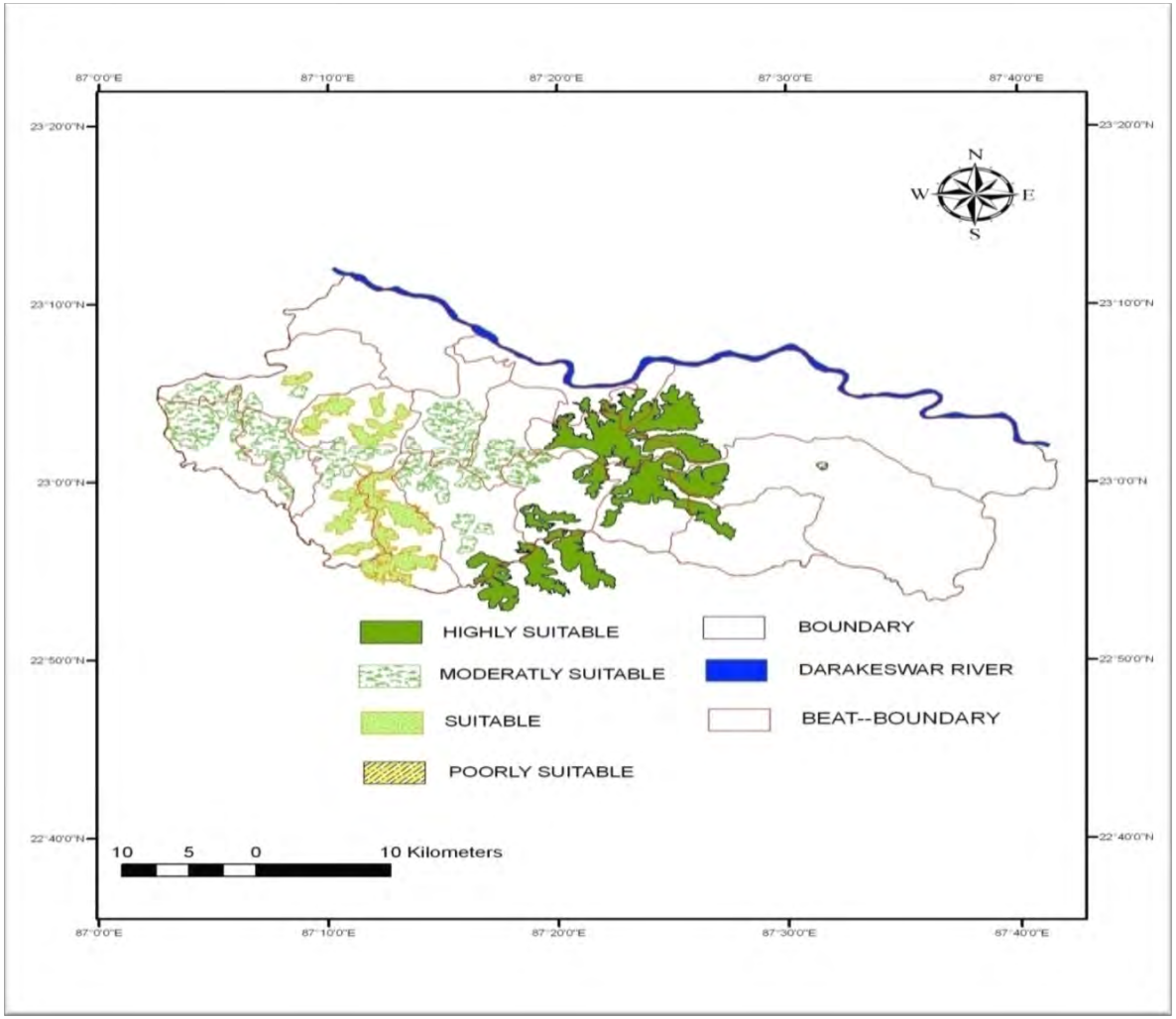
Site specific Studies to assess species composition in Panchet



Habitat Suitability Index

Sl no:-	Name of patch	Road density	Average distance from core	Nature of micro climate	Canopy cover	Water availability	Management steps	Fragmented nature	Density of forest	Ground cover	Health of trees	Total score out of 50
1	Bishnupur forest	2	3	3	3	2	2	2	3	5	3	28
2	Taldangra forest	4	4	2	2	3	1	3	2	3	2	26
3	Chak-nakaijuri forest	1	3	4	2	4	1	4	2	3	2	26
4	Joipur forest	3	5	5	5	1	2	1	5	5	4	35
5	Chandabila forest	3	4	3	3	2	1	1	4	4	3	28
6	joipur-panchmura	2	3	4	2	3	1	2	2	4	2	25
7	Chaguliya	2	4	4	4	2	1	1	3	4	2	27
8	Barkhuliya	1	3	2	2	4	1	1	2	4	2	22
9	Upper part of nakaijuri	1	3	4	3	2	1	3	2	3	2	24
10	Western part of nakaijuri	1	2	4	3	4	1	2	2	3	2	24
11	Westjambedia	3	2	2	2	5	1	4	2	2	2	26
12	Amdangra	1	2	4	4	2	2	4	2	3	2	26
13	Brindabanpur	4	3	3	2	3	1	4	4	4	3	31
14	Kalabagan	3	4	4	4	3	2	2	3	4	3	32
15	Chatra Krishna nagar	1	1	1	1	4	1	4	1	2	1	17
16	Metalya	1	2	2	2	4	1	4	2	2	2	22

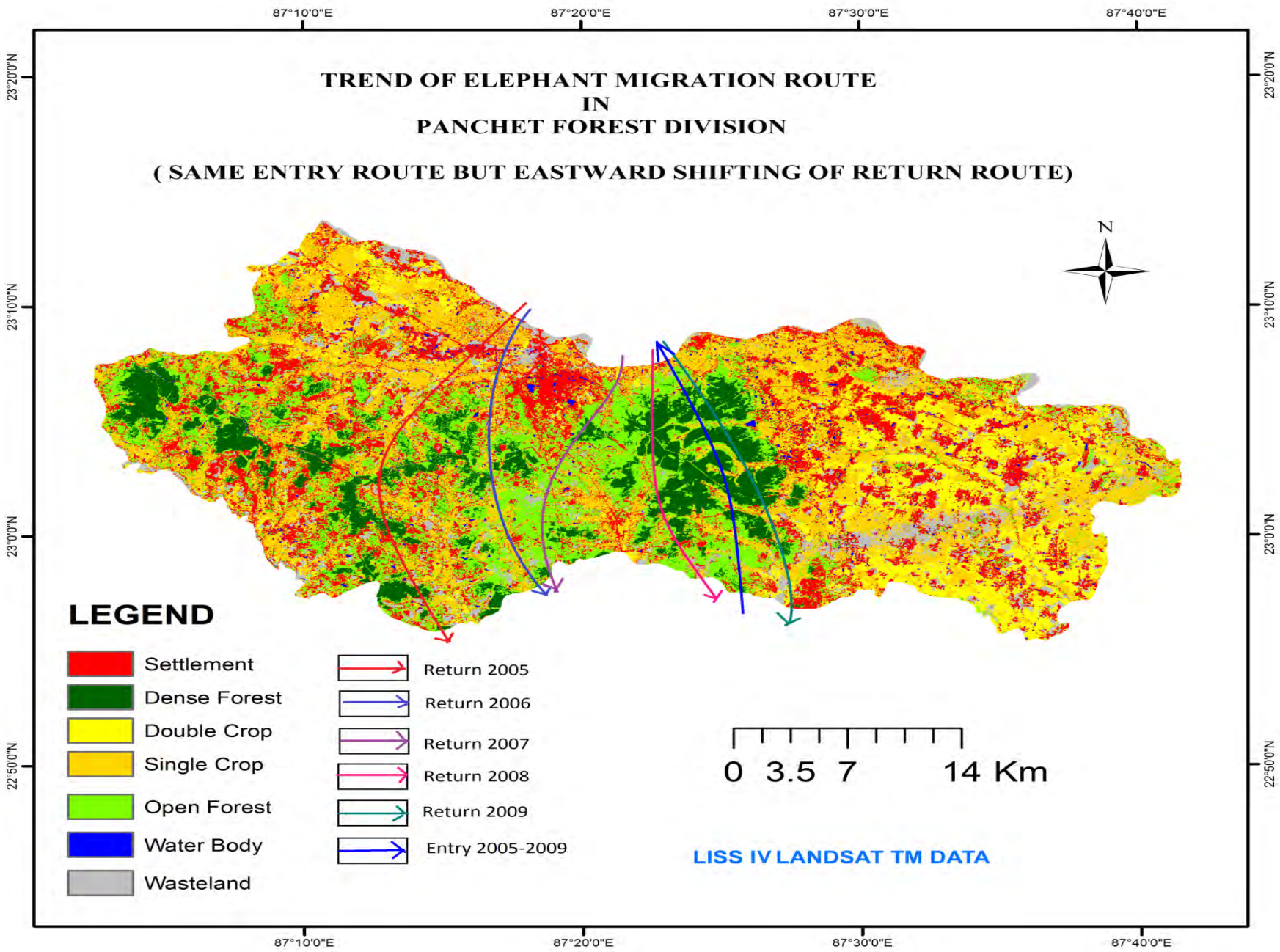
HABITAT SUITABILITY INDEX MAP OF PANCHET FOREST DIVISION







Landscape Analysis shows that the area having thick ground cover, isolated forest patch near the settled areas and availability to water sources are the most preferable place for elephants.


87°10'0"E
87°20'0"E
87°30'0"E
87°40'0"E
23°20'0"N
23°10'0"N
23°0'0"N
22°50'0"N
TREND OF ELEPHANT MIGRATION ROUTE
IN
PANCHET FOREST DIVISION
(SAME ENTRY ROUTE BUT EASTWARD SHIFTING OF RETURN ROUTE)
N
LEGEND
Settlement
Dense Forest
Double Crop
Single Crop
Open Forest
Water Body
Wasteland
Return 2005
Return 2006
Return 2007
Return 2008
Return 2009
Entry 2005-2009
0 3.5 7 14 Km
LISS IV LANDSAT TM DATA

Major Findings

❖since 1987 the event of elephant migration from Dalma forest to Panchet forest become a regular phenomena

❖ Since 1988 they invaded into Bishnupur forests after crossing Silabati River

❖ since 1995 they have crossing Darakeswar and moving towards northern forest division of Bankura

❖ There are about 3-4 herd consisting 12-50 elephants come each year in the Panchet Division.

❖ So there is a permanent elephant migration route between Dalma to Panchet and adjoining areas.

❖Along with the increasing number of elephants in the destination region the duration of stay has also been increased.

❖ In 2006-07 this number increased into 70 days and in 2012 it further increased to 180 days

❖ they are entering the Panchet area by same route but their return routes shifting towards the east where the landuse consists of more agricultural land.

❖ They have changed their food habits from agricultural crops to juicy and palatable horticultural crops like cabbage-cauliflower, cucurbits, pumpkin, potato, brinjal, jack fruit etc.

❖Ultimately the migrated forest become their new habitat.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Picture by Dr.S.Kulandavel, IFS






THANK YOU

Existing and potential elephant corridors in the North Western Province of Sri Lanka and recommendations for reducing HEC

By

Pubudu Weerarathna

wildpubudu@gmail.com

SPECIES
Let Them Live
ජෛව සංරක්ෂණ මධ්‍යස්ථානය
Species Conservation Center

Funded by

INTERNATIONAL ELEPHANT FOUNDATION.ORG



Introduction

The North Western Province comprising nearly 20% of the estimated elephant population of Sri Lanka (DWC, 2011).

Highest number of elephant and human deaths were recorded from this region. Location and the number of elephants in region were identified in conflicted areas of the North West wildlife zone.

When analyzing the data of Department of Wildlife Conservation during 2005-2012; 226 humans and 556 elephants have died in this region (DWC 2012).



Background



The NWP is the area most affected by HEC in the country. In 2010-2015, 90 humans and 300 elephants died due to HEC in the NWP,

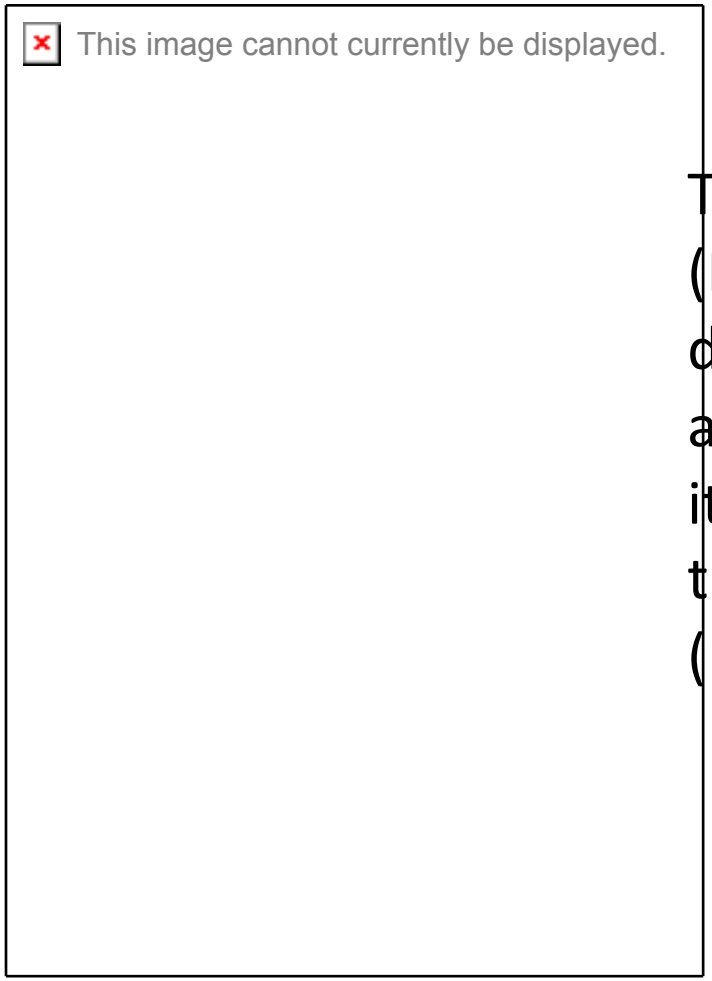


Problem Statement

Human elephant conflict is today the most pressing conservation problem in wildlife management in Sri Lanka. The Department of Wildlife Conservation (DWC) is capable of protecting the wildlife within the protected areas, but acknowledges the fact that ensuring the long-term survival of such a large and highly mobile animal as the elephant outside the network of protected areas though difficult is critical for the long term conservation of the Sri Lankan elephant.



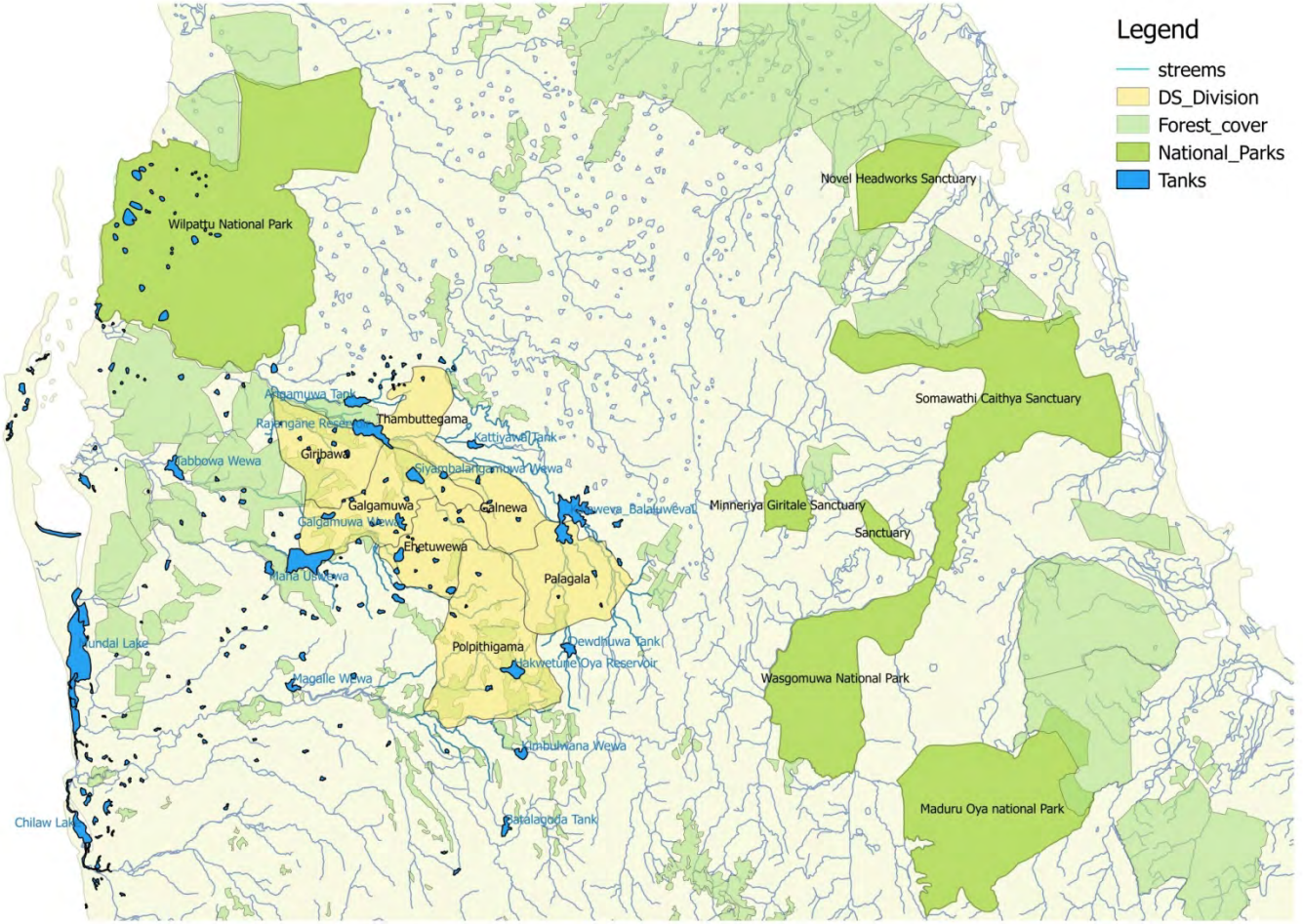
Project Location



The North Western Province (NWP) of Sri Lanka comprises two districts, Puttalam (3,013 km^2) and Kurunegala (4,813 km^2), and it estimated that nearly 20% of the nations elephant population (1189 elephants)



Protected area distribution



Objectives

1. To identify the areas with escalating human elephant conflict in the Kurunagala and Puttlam Districts.

2. To identify isolated forest areas used as refugees by the elephant population.

3. To document the activities carried out by both government and non government organizations who are engaged in providing solutions to this problem.

4. To document how local organizations/communities cope with the problem



Methodology

1. The location of electric fences, isolated forest areas, forest boundaries and traditional elephant corridors will be mapped based on data collected using a GPS (Global Positioning System).
2. 2. Based on the data obtained on conflict sample villages are to be identified and a socioeconomic survey will be conducted by visiting these villages with Grama Niladari (GN) (Village administrative officer).
3. 3. The conflict data is expected to be gathered from the Department of Wildlife Conservation (DWC) and the office of the Divisional Secretary (DS).

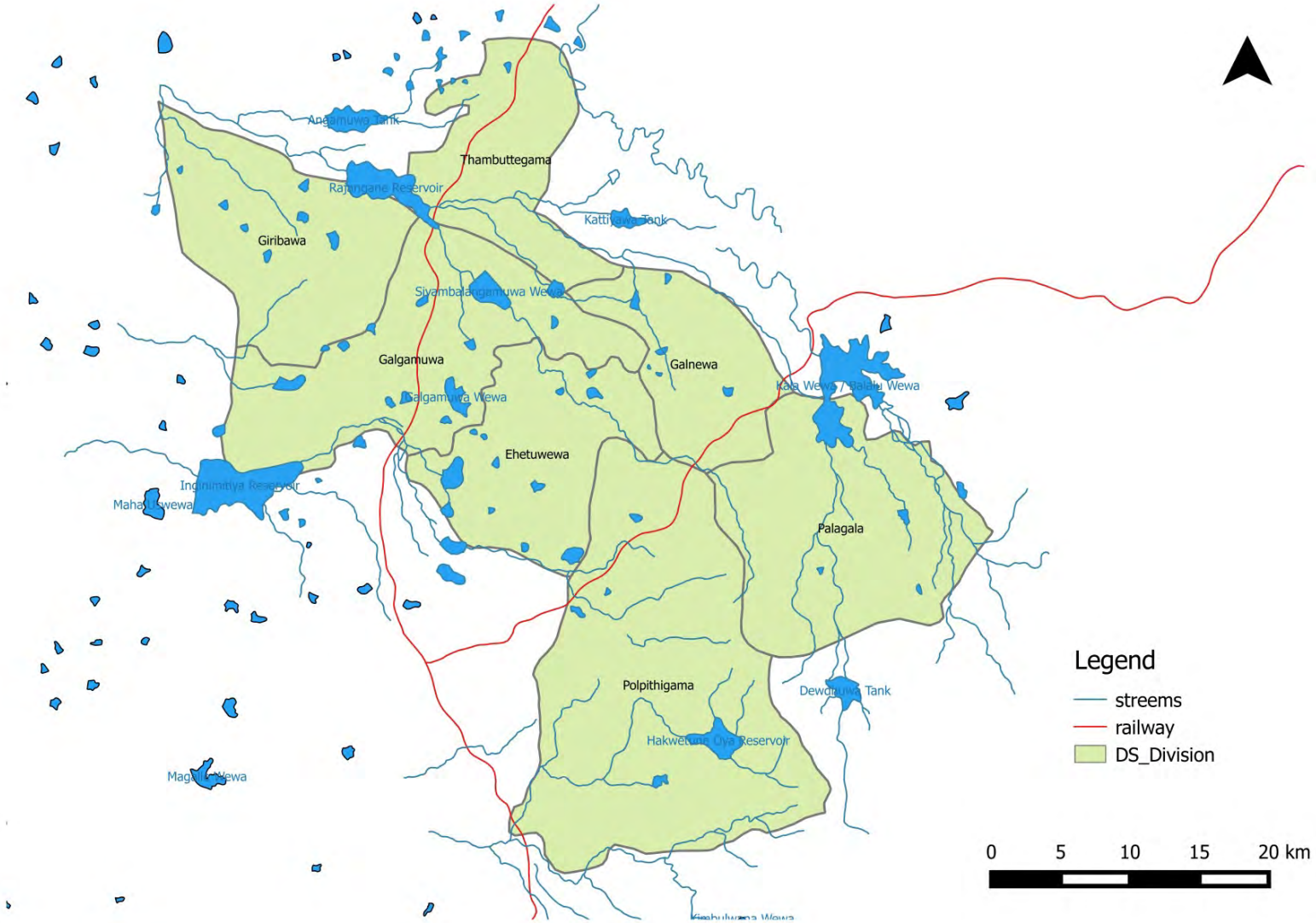


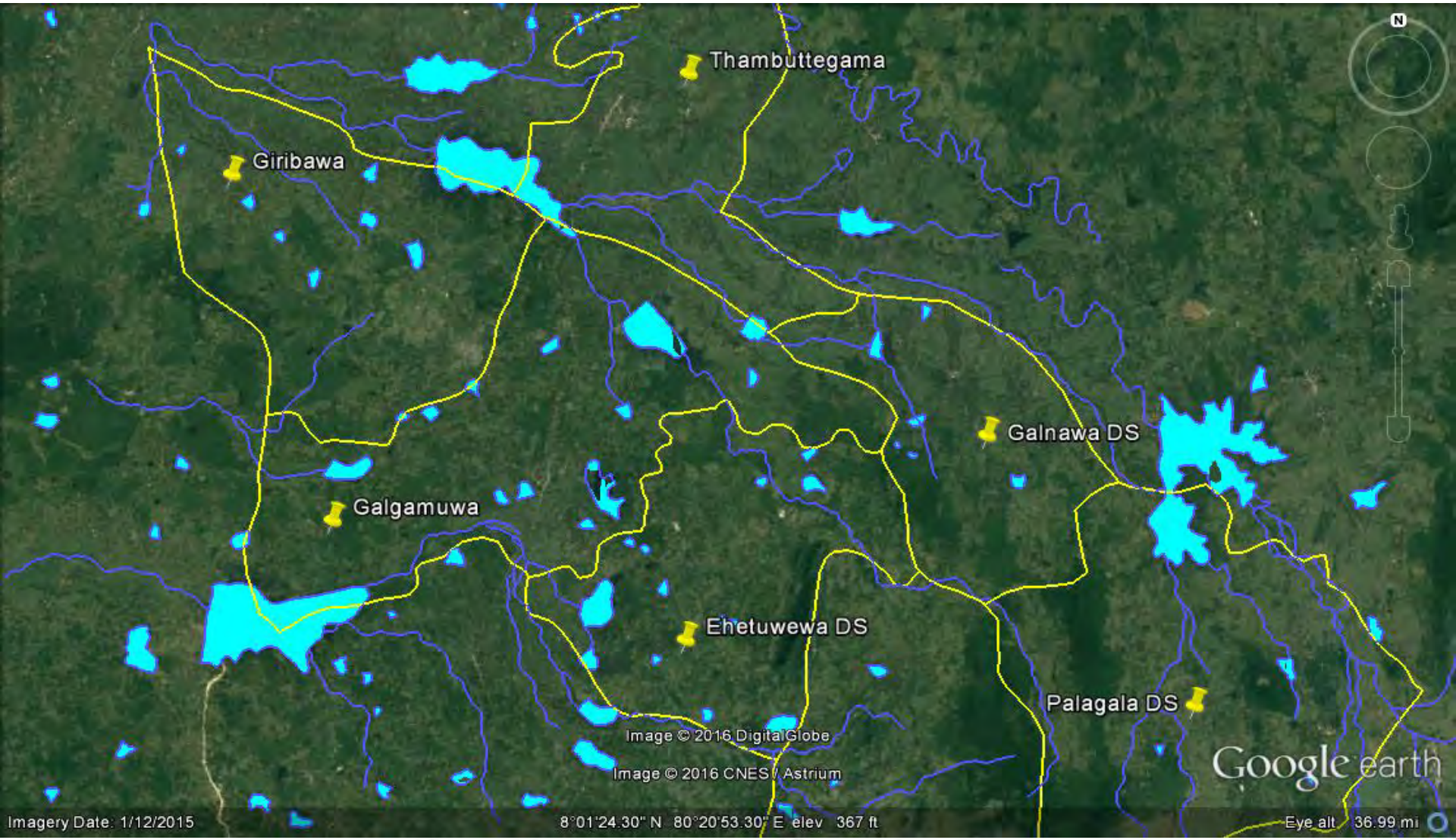
Findings

1. Identified 11 vulnerable administrative areas, 9 were critical HEC areas.
2. Identified and mapped out
    - 12 major existing elephant corridors,
    - many miner corridors,
    - 17 large scale elephant habitats,
    - 22 small isolated elephant habitats.
3. Mapped out
    - 8 state forest boundaries.
    - 4 proposed forest reserve boundaries,
    - 11 existing or abandoned electric fences,
    - 2 sanctuary boundary electric fences.



Identified 11 vulnerable DS areas.




Thambuttegama
Giribawa
Galnawa DS
Galgamuwa
Ehetuwewa DS
Palagala DS
Image © 2016 DigitalGlobe
Image © 2016 CNES / Astrium
Google earth
Imagery Date: 1/12/2015
8°01'24.30" N 80°20'53.30" E elev 367 ft
Eye alt 36.99 mi



Map of a existing elephant corridors

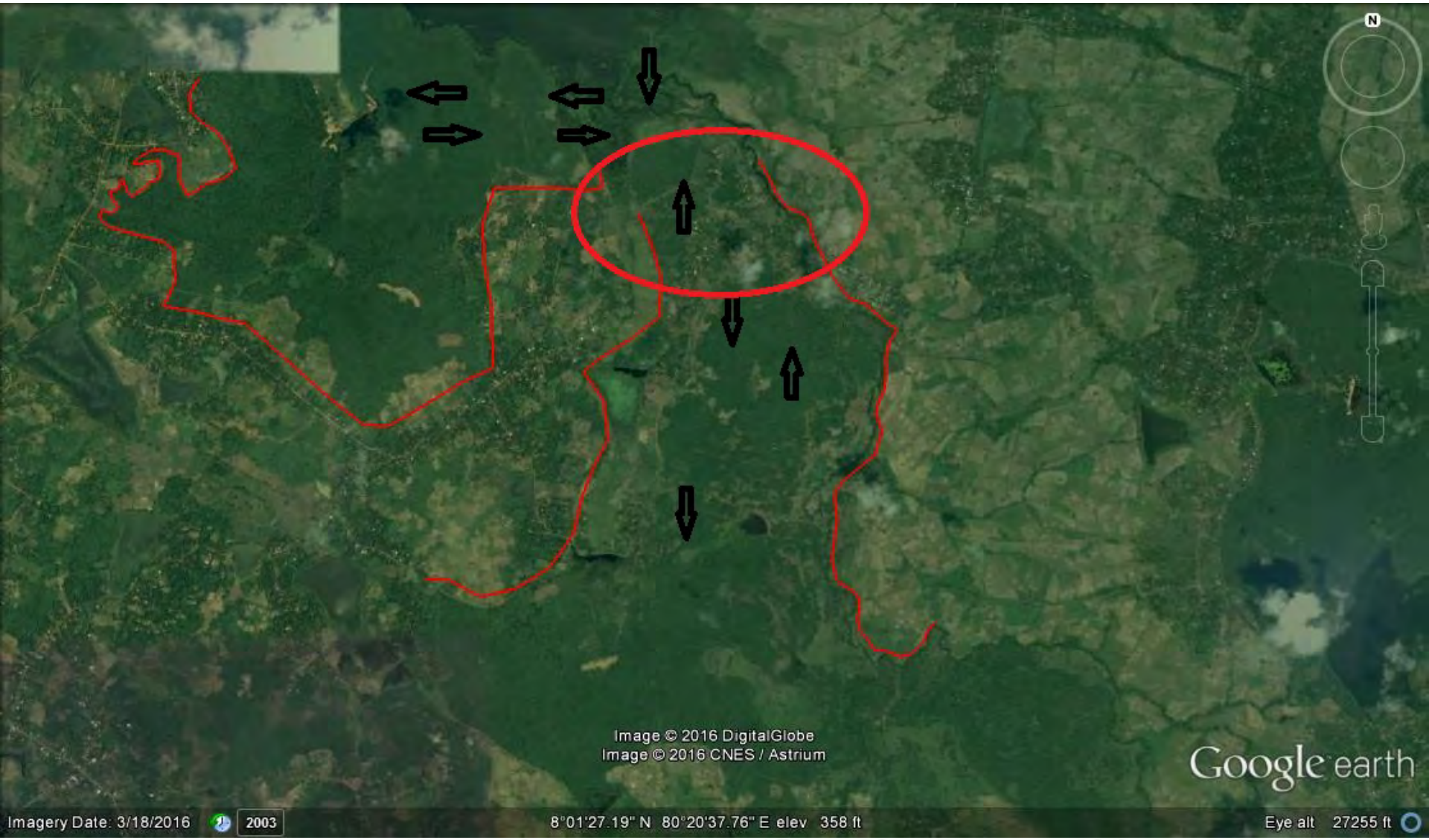
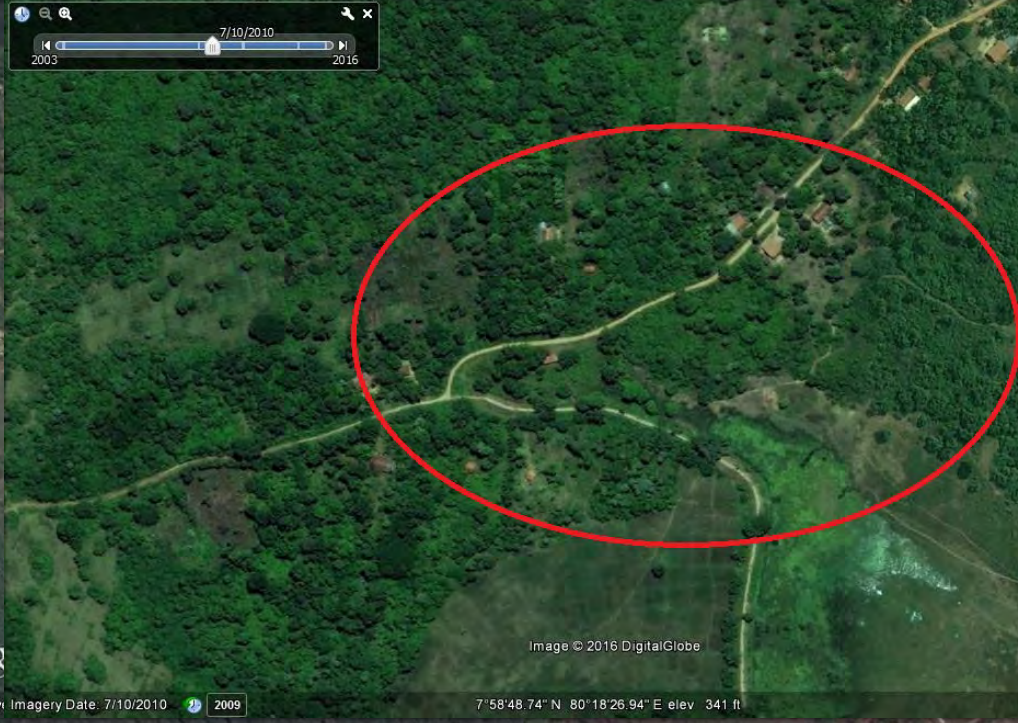







Image © 2016 DigitalGlobe
Image © 2016 CNES / Astrium
2009
7°58'48.61" N 80°18'26.76" E elev 341 ft

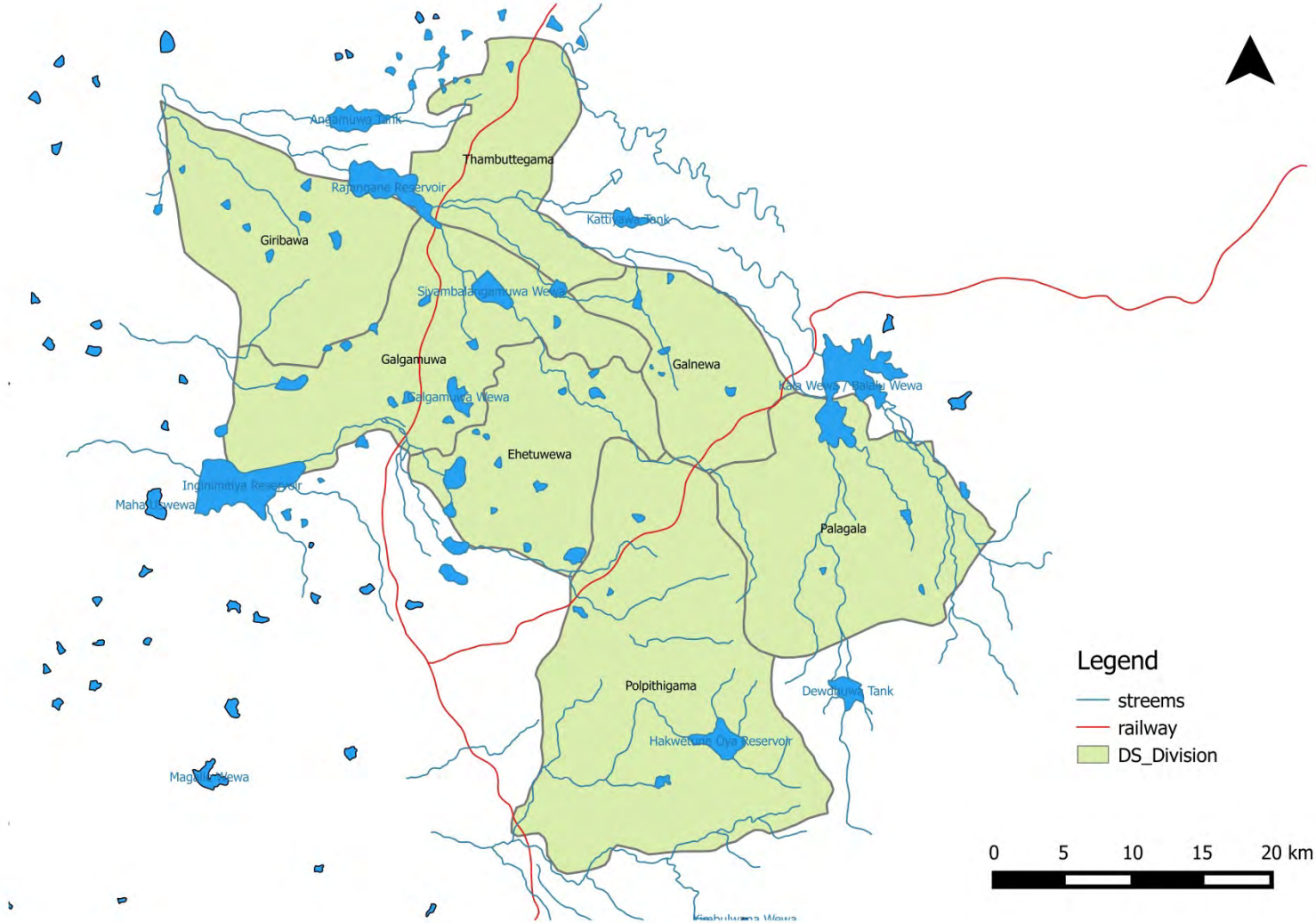

7/10/2010
2003
2016
Image © 2016 DigitalGlobe
Imagery Date: 7/10/2010
2009
7°58'48.74" N 80°18'26.94" E elev 341 ft

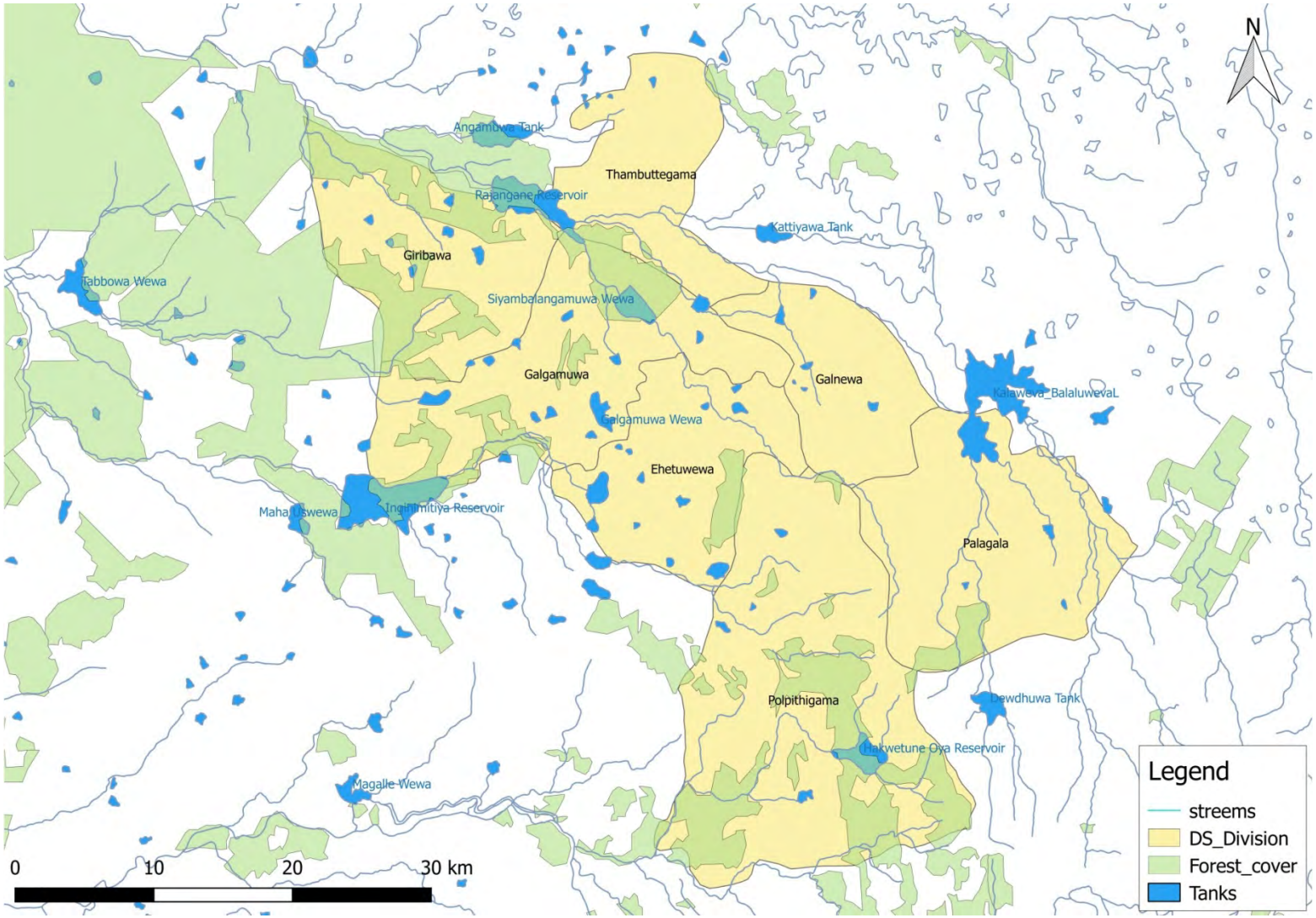

1/30/2012
2016
N
Image © 2016 DigitalGlobe
Google earth
7°58'48.74" N 80°18'26.94" E elev 341 ft
Eye alt 2909 ft


11/7/2014
Image © 2016 DigitalGlobe
nagery Date: 3/18/2016
2009
7°58'48.74" N 80°18'26.94" E elev 341 ft



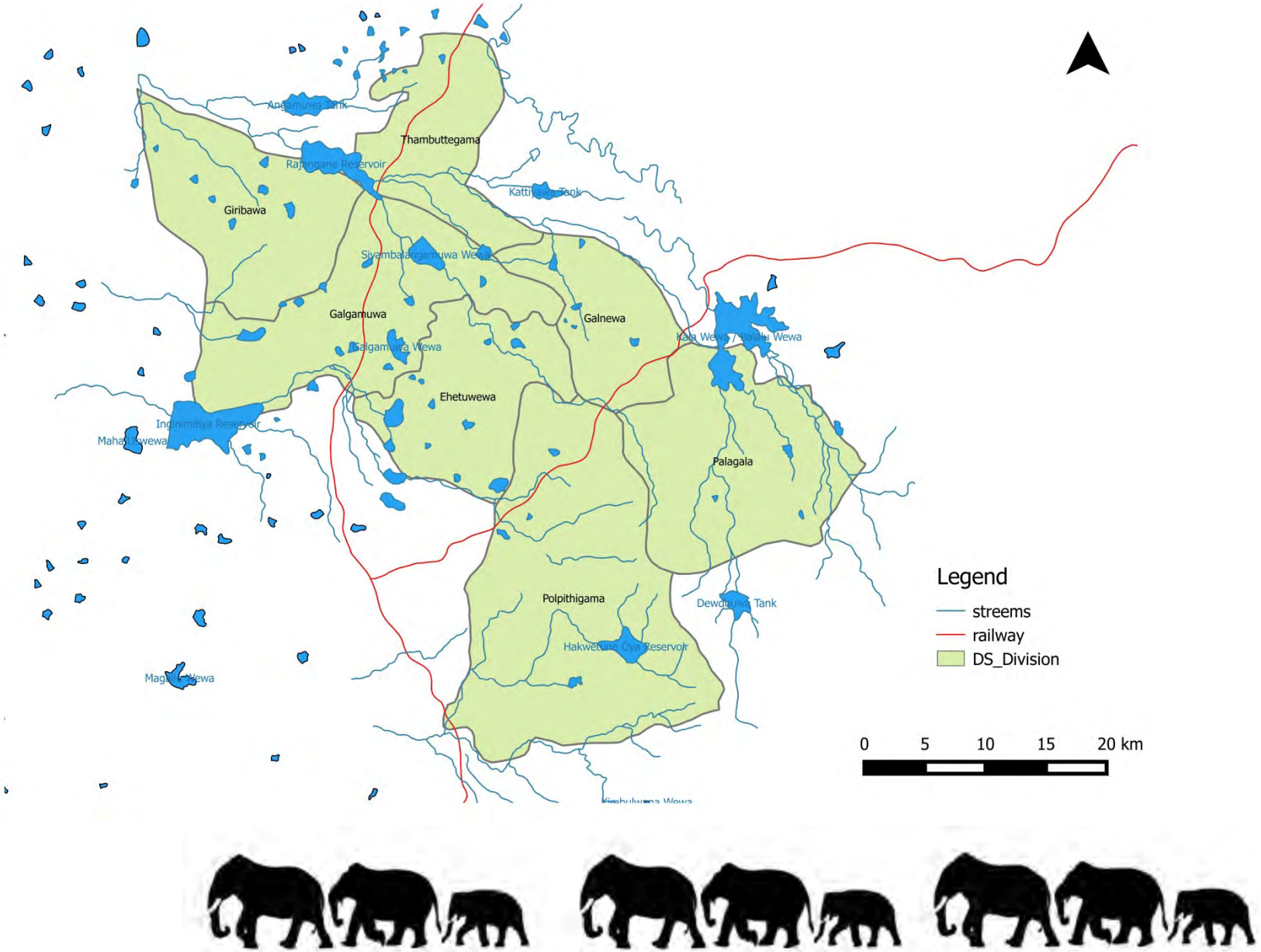
Isolated elephant habitats



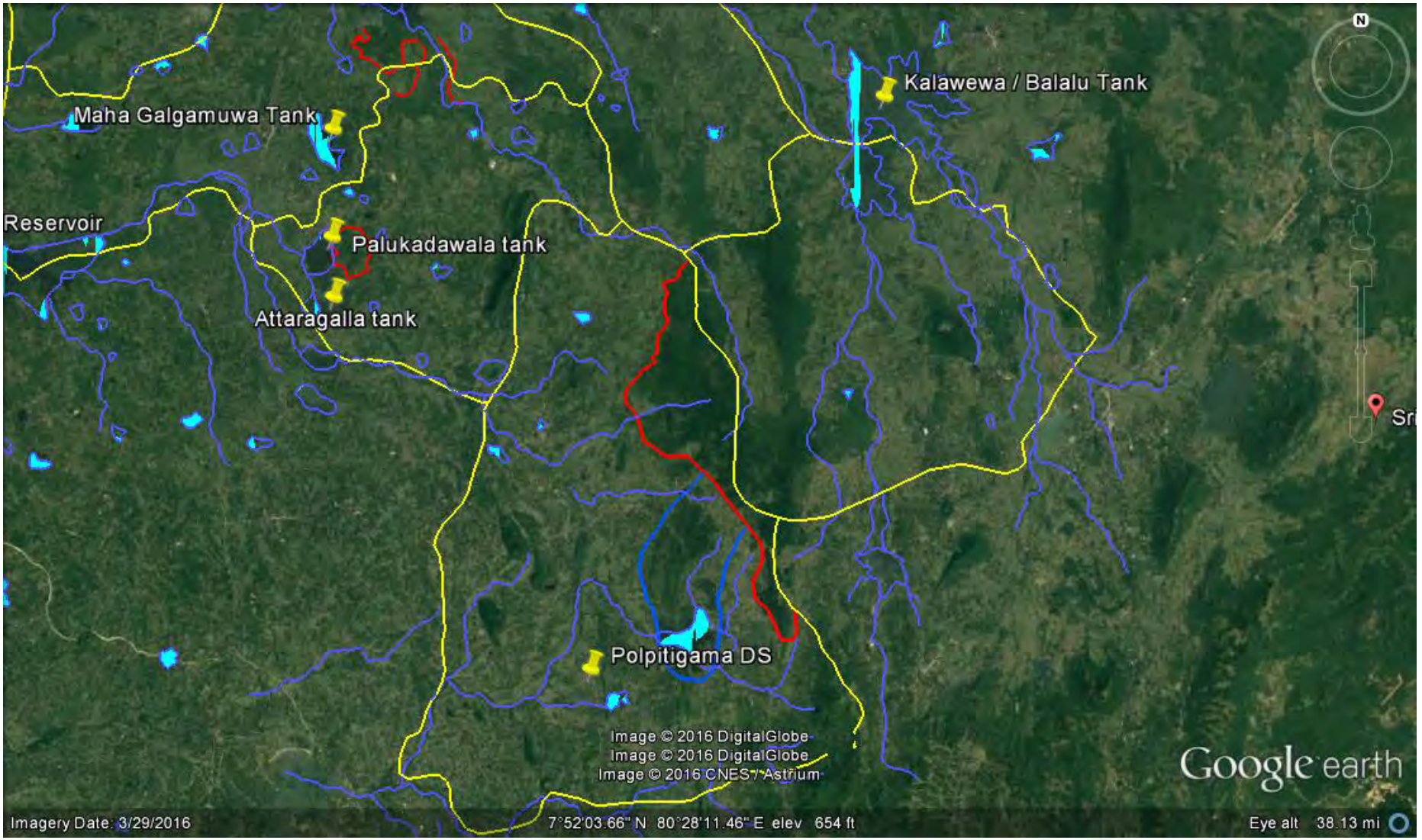

N
Angamuwa Tank
Thambuttegama
Rajangane Reservoir
Kattiyawa Tank
Giribawa
Tabbowa Wewa
Siyambalangamuwa Wewa
Galgamuwa
Galnewa
Kalawewa_Balaluweva
Galgamuwa Wewa
Ehetuwewa
Maha Uswewa
Inginimitiya Reservoir
Palagala
Polpithigama
Dewdhuwa Tank
Hakwetune Oya Reservoir
Magalle Wewa
Legend
streems
DS_Division
Forest_cover
Tanks
0
10
20
30 km


Palukadawala tank
Image © 2016 DigitalGlobe
Image © 2016 CNES / Astrium
© 2016 Google
Google earth
Imagery Date: 3/18/2016
2011
7°56'30.95" N 80°18'35.90" E elev 356 ft
Eye alt 14879 ft

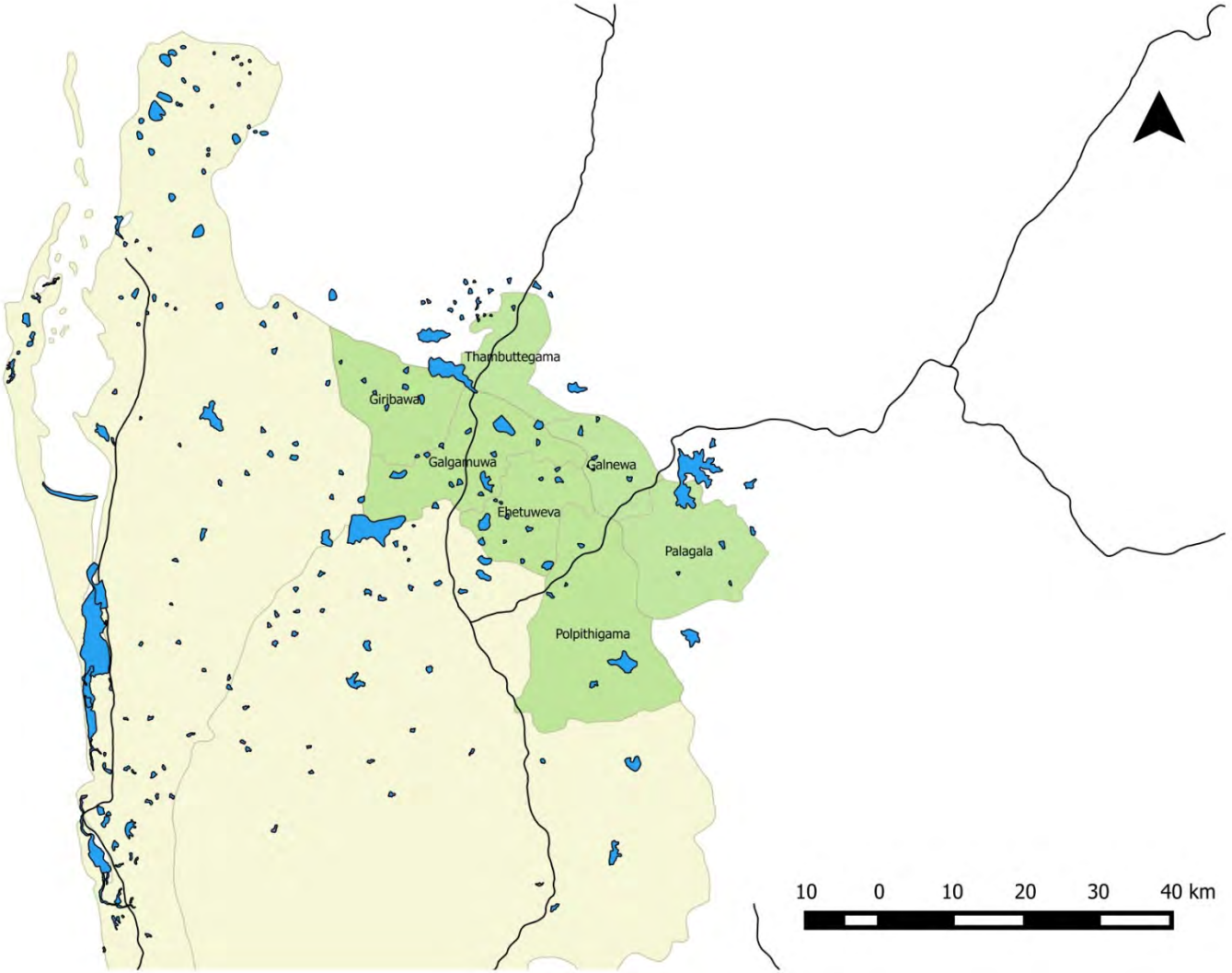



Thambuttegama
Giribawa
Galgamuwa
Galnewa
Ehetuwewa
Palagala
Polpithigama
Legend
streems
railway
DS_Division
0
5
10
15
20 km

Existing or abandoned electric fences



Train Tracks

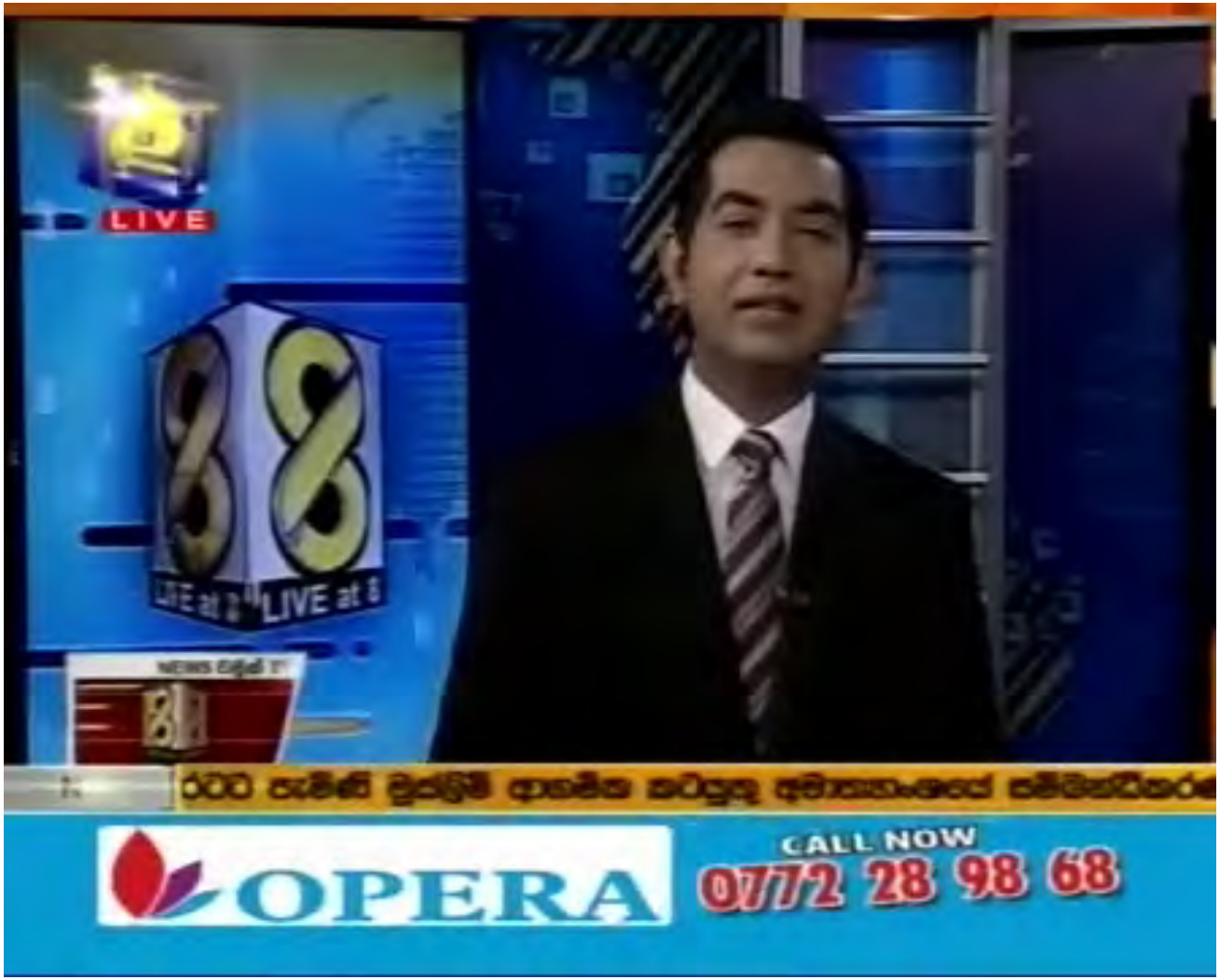




Lobbing for the use of policy makers to formulate a sustainable long term land use practice to reduce the conflict between man and animals






LIVE
LIVE at 8
OPERA
CALL NOW
0772 28 98 68

Recommendations

1. Declaration of tank catchment areas as protected areas
2. Promoting of community electric fences and temporary electric fences for agricultural land
3. Re opening of existing traditional elephant corridors and protected areas
4. Promoting elephant base eco-touristism activities
5. Law enforcement



Acknowledgement

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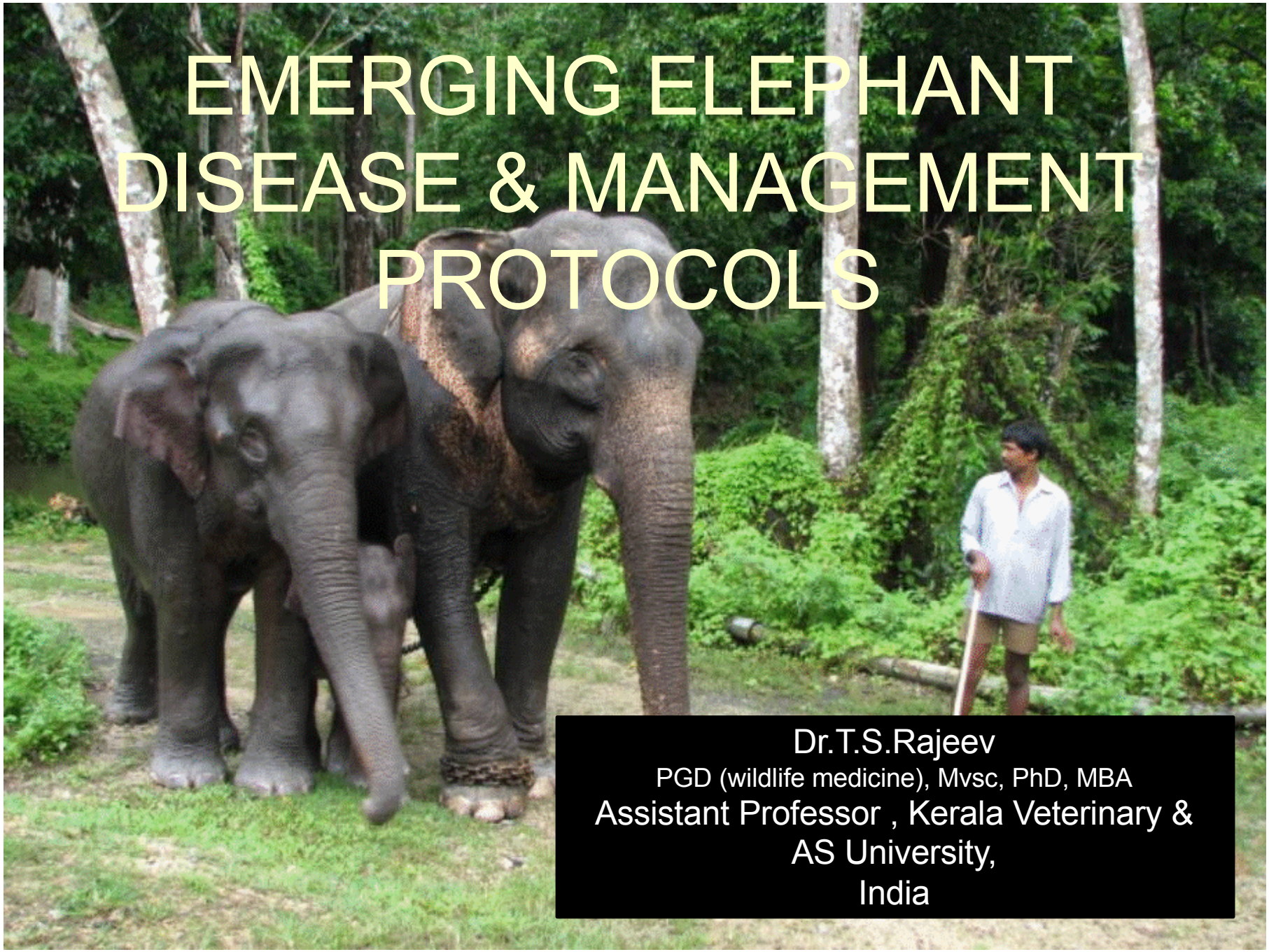
Department of forest conservation
This research was conducted by Species conservation Centre

I am really grateful for the contribution of all to make this research success.

Thank you!



EMERGING ELEPHANT DISEASE & MANAGEMENT PROTOCOLS



Dr.T.S.Rajeev
PGD (wildlife medicine), Mvsc, PhD, MBA
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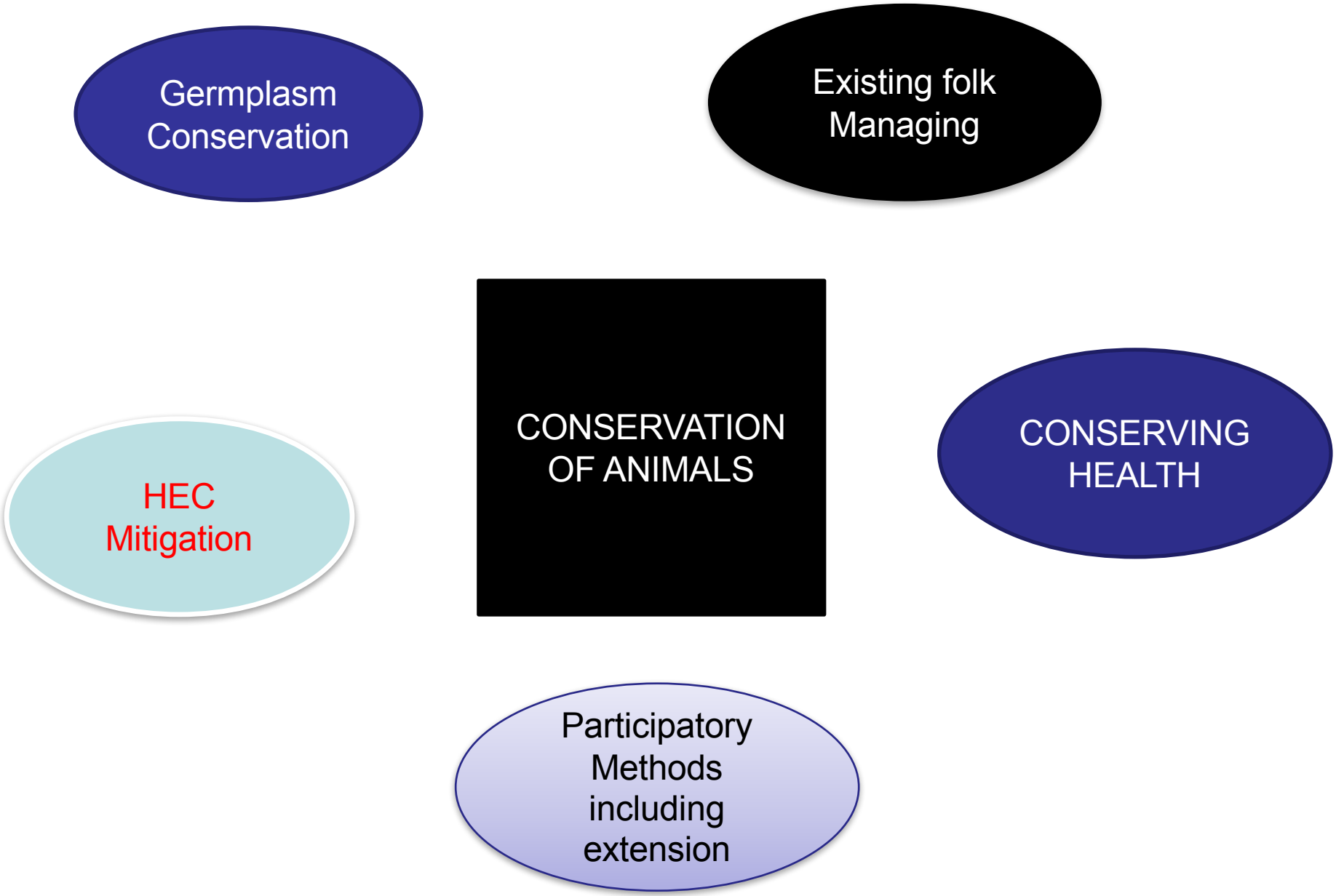

Germplasm Conservation
Existing folk Managing
CONSERVATION OF ANIMALS
HEC Mitigation
CONSERVING HEALTH
Participatory Methods including extension

EMERGING DISEASES??

- Reappearing?
- Mostly from the domestic animal folk?
- Nutritional imbalance?
- Climatic Changes?
- Defective management?
- Ignorance?
- Non cooperation?
- ANSWER IS : ALL THE ABOVE?

Common diseases of captive elephants



Parasitic Diseases

- Gastro –Intestinal helminthiasis
- Cutaneous filariasis • Trypanosomiasis
- Louse infestation • Gastric myiasis

Bacterial diseases

- Tuberculosis • Tetanus
- Haemorrhagic septicaemia
- Anthrax • Salmonellosis

Viral diseases

- Elephant pox • Foot and mouth disease

Non – Specific diseases

- Impaction of colon • Foot rot • Corneal opacity
- Arthritis • Decay of tusk pulp • Injury on the trunk
- Abscess on the body etc.

FOOT AND MOUTH DISEASE-FMD

- Ulcers in the mouth and foot pads
- High temperature
- Separation of food pads
- Peeling of trunk mucosa and outer skin
- Salivation

TREATMENT:

- External application of antibiotic agents and fly repellants
- Foot bath and artificial shoes
- Antibiotics Shower –Penicillin groups 4-5 mg/kg twice daily for 5 days with supportive therapy I/V

FMD



കൊമ്പനു കുളമ്പുരോഗം: പരിശോധനാ ഫലം ഇന്നു ലഭിക്കും







FOOT ROT

- Managemental defect in captive elephants
- Defective floor, contaminated premises and absence of proper foot care
- *Complicated with fusiforum necroforum –fungal growth*
- Ulcerative and vegetative forms
- Ulcerative- mostly on foot pads of hind legs
- Ulcers around foot pads,Itching and rubbing
- Vegetative form mostly on front limbs
- Spongy growth in between or above the nails
- Abscess and suppuration
- Splitting of nails and degeneration of foot and underlying tissues

Management

- Cleaning and removing debris
- Expose the infective area
- Draining contaminants
- Proper foot care
- Cauterization – As per the condition
- Foot bath – Castellanies paint or 1 % formaldehyde
- Antibiotic shower initially
- Rest and dry floor and no re exposure

Vegetative foot rot on fore limbs



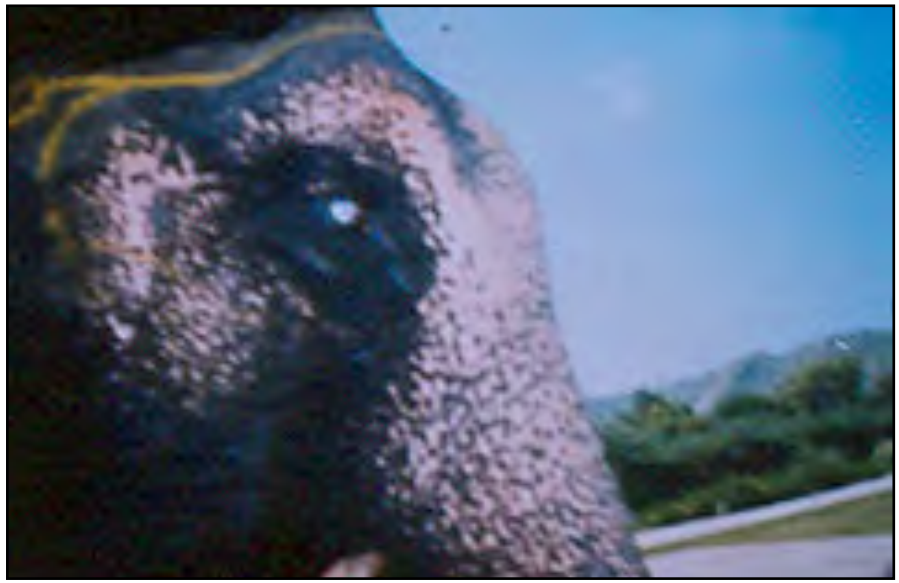
EYE DISORDERS



CORNEAL OPACITY

- Caused by trauma in captive or nutrient deficiency

SYMPTOMS



- Photophobia
- Lacrimation
- Reddish or whitish colour
- Some time ulcer
- Partial or total blindness

TREATMENT

- Eye wash with NS or alike preparations
- Anti inflammatory and antibiotic support –drops
- Application of Sub - conjuctival injection through the upper lid with is painful and better to avoid as far as possible
- Cleanliness or hygienic practices

CORNEAL OPACITY



EXCESSIVE LACRIMATION, IRRITATION





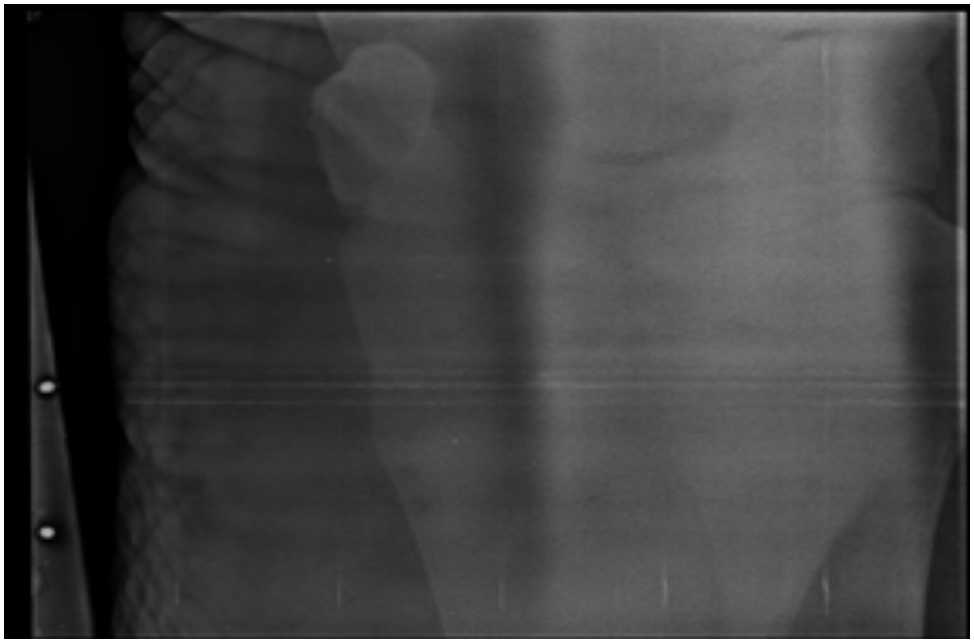
ORTHOPAEDIC DISORDERS



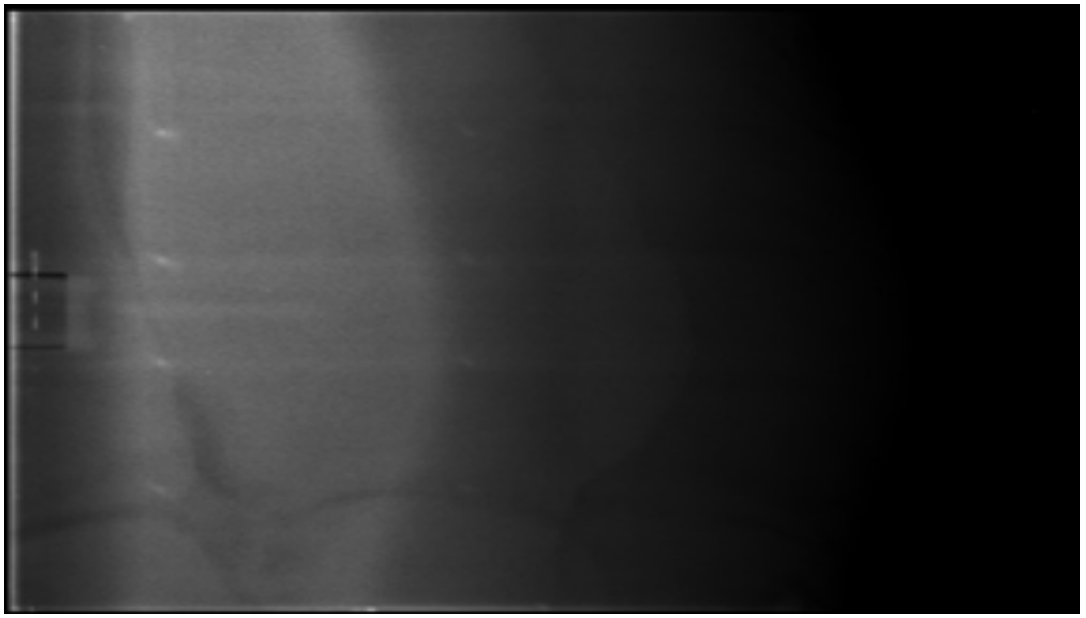








RADIOLOGY









Fatal suppurativ e Arthritis

HAEMORRHAGIC SEPTICAEMIA

Pasteurella - HS

- Emergence as complication or due to immuno suppression
- Sudden on sett - duration 3 to 36 hours
- Terminal stage - weakness-bloody diarrhea-straining severely
- Some times edema on throat, lower abdomen with
- Labored respiration and death after collapsing

Diagnosis by I examination of blood for bipolar organisms and PM ?

- TREATMENT

The traditional treatment of Sulphamethazine 200-250gm initially and repeat 100-125gm three days more orally
or Sulphamethazine sodium 33 1/3% 800ml and half the dosage 2 more days –I/V may be useful in major number of cases…BUT…

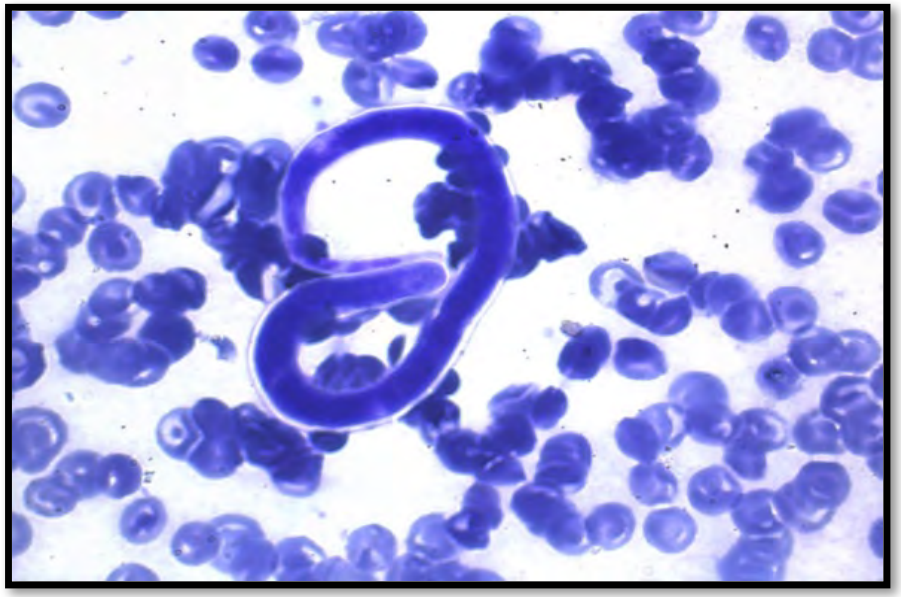
CUTANEOUS FILARIASIS

- Caused by *Indofilaria pattabhiramani*
  Indofilaria elephantis
  Stephanofilaria srivastavi
- Tranmitted by biting flies.
- More in elephants working in forest
- Small nodules of 1-2cm size on sides, lower abdomen, limbs-skin
- Stop bleeding spontaneously
- Later nodules become fibrotic
- New nodules develop.
- Microcopical examination of discharge or blood from nodules reveals microfilaria
- Anthiomalin 50ml/2000 kg BW S/C at weekly interval for
- 8 weeks, give good results



Gastric myiasis

- Caused by maggots of the fly C*obboldia elephantis.*
- Off-feed, colic, weakness
- Emergence of adult flies through mouth
- Albendazole 5mg/kg BW gives good results



CANINE BUNOSTOMUM LARVAE INFECTION

- Skin lesions
- Irritations
- Eczematous lesions
- Animal lethargic
- No internal issues normally

Approach

- Identification of larvae from the skin leisons (KOH medium)
- Fenbendazole orally 15 days interval .
- At the dose rate of 5 to 7mg per Kg
- Repeat in 15 days

SAMPLING FOR INFECTOIUS DISEASES





PURPOSE OF SAMPLE COLLECTION

- Quick disease diagnosis
- To obtain health surveillance
- To monitor immune response to vaccination
- To monitor the disease status
- Co-operation between the biologist and Vet





Materials needed for Microbiological disease

Virology	Transport medium, Swabs, filter paper, serum storage vials and sample container
Bacteriology	Slides, swabs, filter paper, Transport medium, serum vials and sample container.
Serology	Vacutainer, adopter, needle ,syringe and serum storage vials





Guidelines for Microbiological Examination

- Separate samples – **Virology, Bacteriology and Serology**
- Collect specimen **before Therapy**
- Obtain a **detailed History**
- Obtain a **Tentative diagnosis**
- Appropriate samples





Guidelines for Microbiological Examination – cont…

- Adequate in **Number and amount**
- Avoid **Unnecessary stress** (or) damage to the animals
- Avoid **cross contamination**
- Collect **aseptically**
- Collect samples at the **edge of lesions**
- Samples should be collected at the **onset of clinical signs**





Transport medium for Microbiological Examination

Bacteriology	Virology	Serology
➢ NSS (0.9%) ➢ PBS (pH7.2 to 7.6) ➢ Nutrient broth ➢ Brain Heart Infusion Broth ➢ Gel pack ➢ Dry and Wet ice ➢ Stuart medium ➢ Charcoal medium	➢ 50% glycerin buffer (contra indicator for **PPR**) ➢ NSS ➢ PBS ➢ MEM ➢ HBSS	➢ Sodium Azide (0.1%) – contra indicator for **ELISA** ➢ Merthiolate (0.01%)





Specimens for Microbiological Examination

Bacteriology / Mycology	Virology	Serology
Live: Blood smear, Whole blood, Heparinized blood, Serum, Faeces, Urine, CSF, Swabs, Milk, Pus, Semen and Skin Scrapings **Dead:** Tissues (2 gm), Heart blood swab, Lymphnodes	**Live:** Swabs, Scabs, Faeces, Skin scrappings, Body fluids, Whole blood, Heparinized blood and Serum **Dead:** Organs and Lymphnodes	**Live:** Paired serum





Diagnosis of Microbial diseases

Bacteriology	Virology
➢ History	➢ Isolation
➢ Clinical signs	➢ Egg inoculation
➢ Colony morphology	➢ Cell culture system
➢ Staining	➢ Animal inoculation
➢ Isolation	➢ Serological test
➢ Biochemical test	➢ Molecular techniques
➢ Antibiogram test	
➢ Serological test	
➢ Animal inoculation	
➢ Molecular techniques	



To conclude

- The elephants going to face serious health issues – especially from dmestic folk.
- Strict vigil in diagnosis, identification and management measures –need of the hour
- Extensive research is needed- lacunae is the fund
- Public, and different stake holders---action.
- Please .. discuss

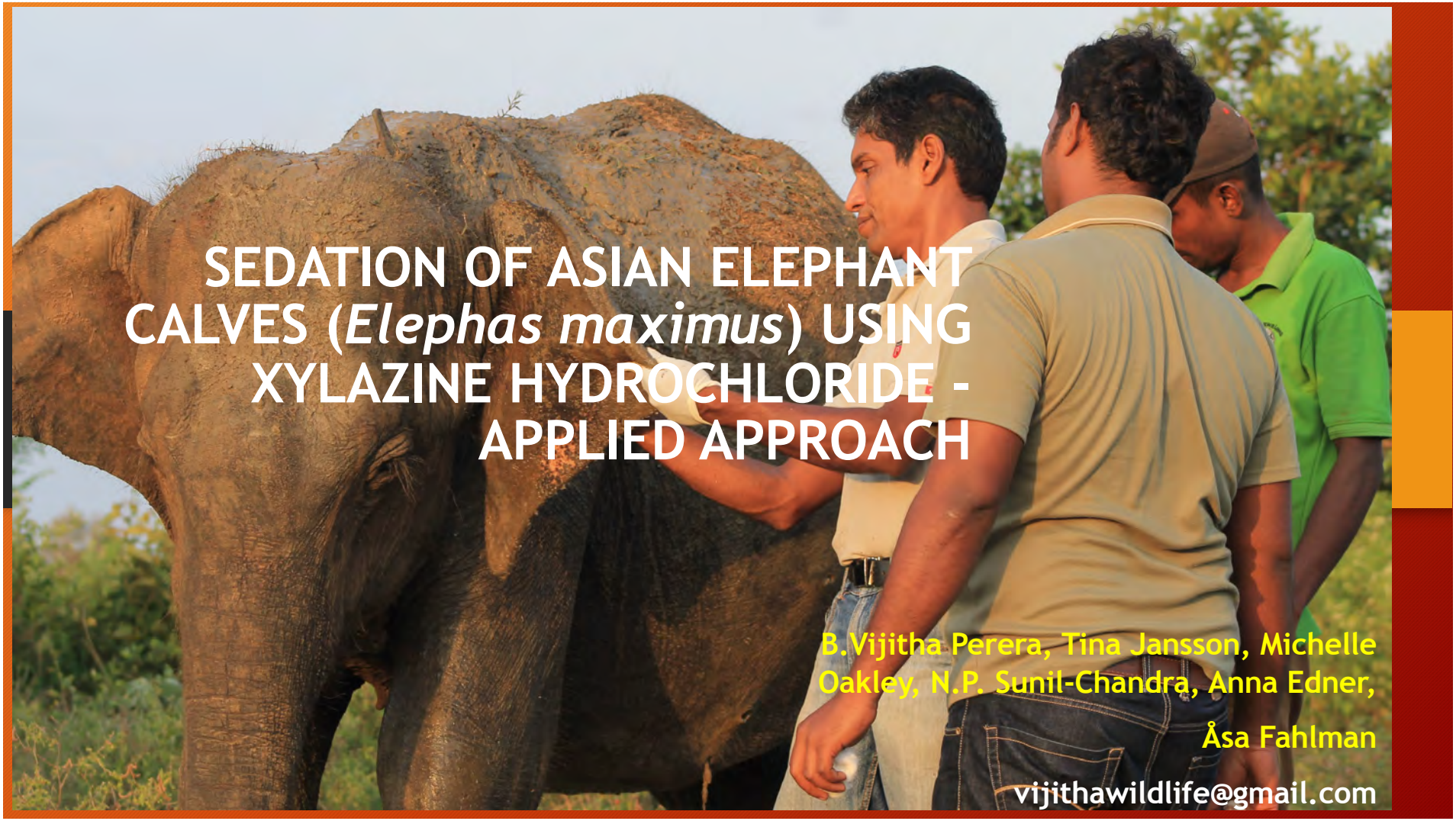
CAN WE STOP EMERGING DISEASES MORE ?

- Reappearing?....Research
- Mostly from the domestic animal folk?
- Nutritional imbalance?
- Climatic Changes? ….Impossible ?
- Defective management? …Awareness
- Ignorance? … yes please correct
- Non cooperation?; Participatory methods
- ANSWER IS : YES?



Thank you

Discussion sir?
Welcome



SEDATION OF ASIAN ELEPHANT CALVES (*Elephas maximus*) USING XYLAZINE HYDROCHLORIDE - APPLIED APPROACH

B.Vijitha Perera, Tina Jansson, Michelle Oakley, N.P. Sunil-Chandra, Anna Edner,

Åsa Fahlman

vijithawildlife@gmail.com

Overview



- Elephants in Sri Lanka
- Elephant Transit Home, Sri Lanka
- Sedation of Elephants
- Results
- Conclusion

Elephants in Sri Lanka

- 65,640 km^2
- 22 million people.
- 250 captive elephants
- ≈ 6000 wild elephants.





Anesthesia of elephants


















1/11/17



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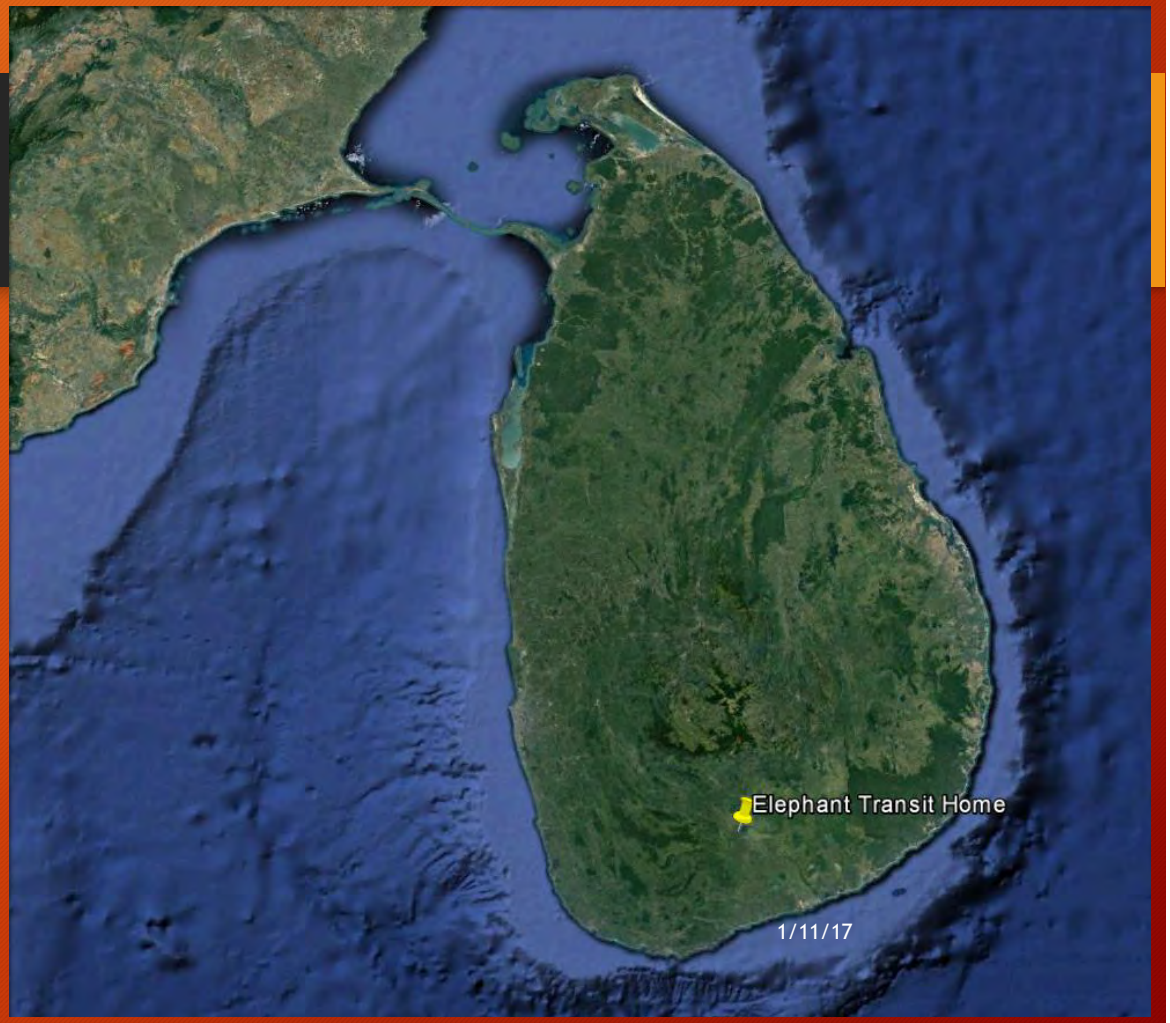
Elephant Transit Home
Sri Lanka





Elephant Transit Home Sri Lanka









Vijitha Perera

















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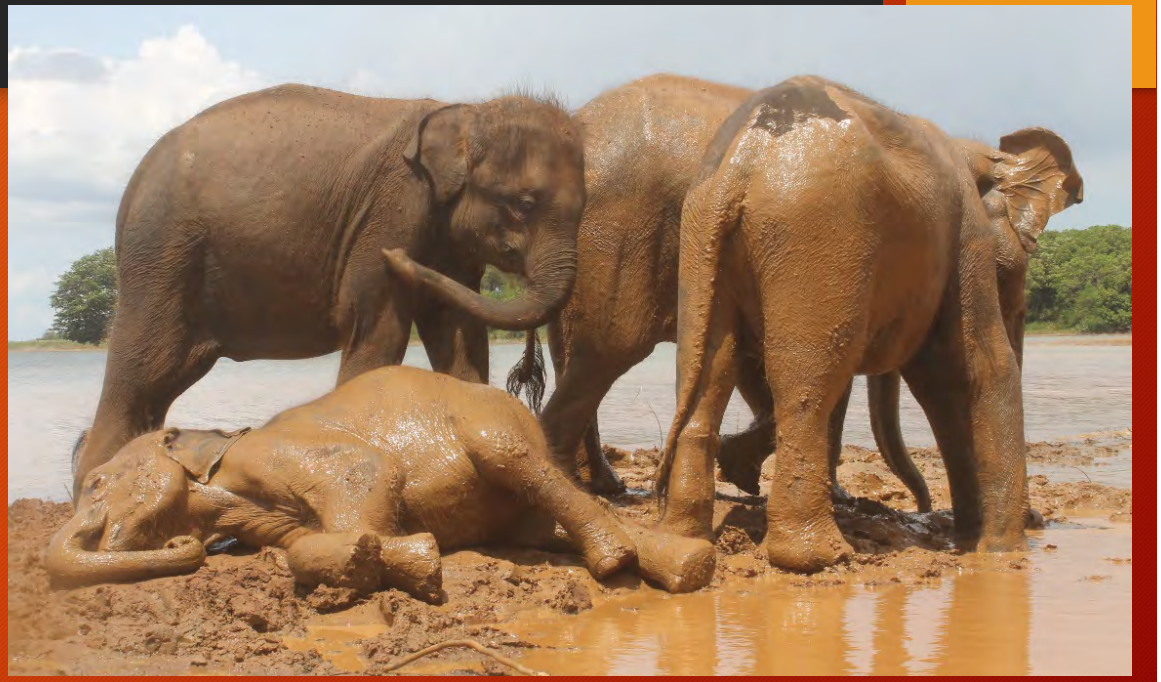






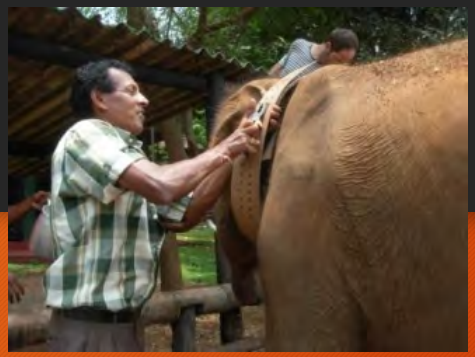




Sedation of elephant calves in Elephant Transit Home



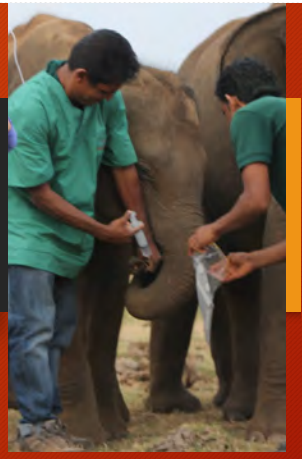
Treatments



Collaring



Loading to lorry



Trunk wash



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Research



Micro chipping



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Transport









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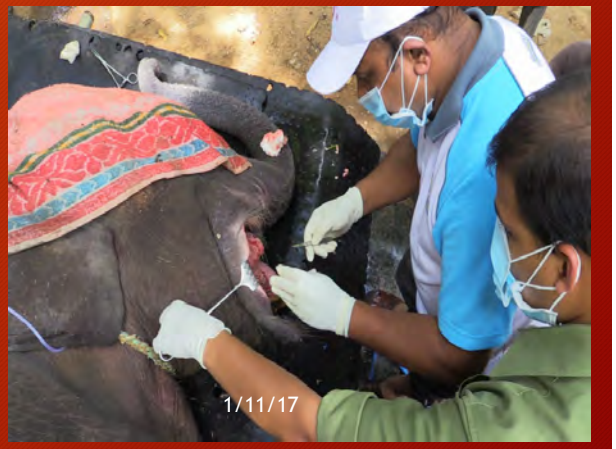

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•In this presentation

157 sedation events (91 elephant calves)

August 2010 to June 2016

Age range 4 months-6 years

Weight range 70kg - 1050kg

Mild sedation

20mg/100kg (+10 mg for every additional100kg)











Top up doses given if needed.

Deep sedation

40mg/100kg (+20mg for every additional 100kg)











Top up doses given if needed.

Physiological variables

pulse rate 30-45 beats / min,

respiratory rate 4-12 breaths / min,

rectal temperature 35.6-37.2 °C).





- **Pulmonary function - range of PaO_2 89-123 mmHg**
- **acid-base balance - $PaCO_2$ 33-52 mmHg,**
- **pH 7.35-7.54,**
- **lactate 0.9-2.5 mmol/L).**



Reversal
Yohembine HCl - intravenously at 1mg per 10mg xylazine HCl









The induction and recovery times, and the level of sedation varied unpredictably between individuals, as well as within calves that were sedated repeatedly.









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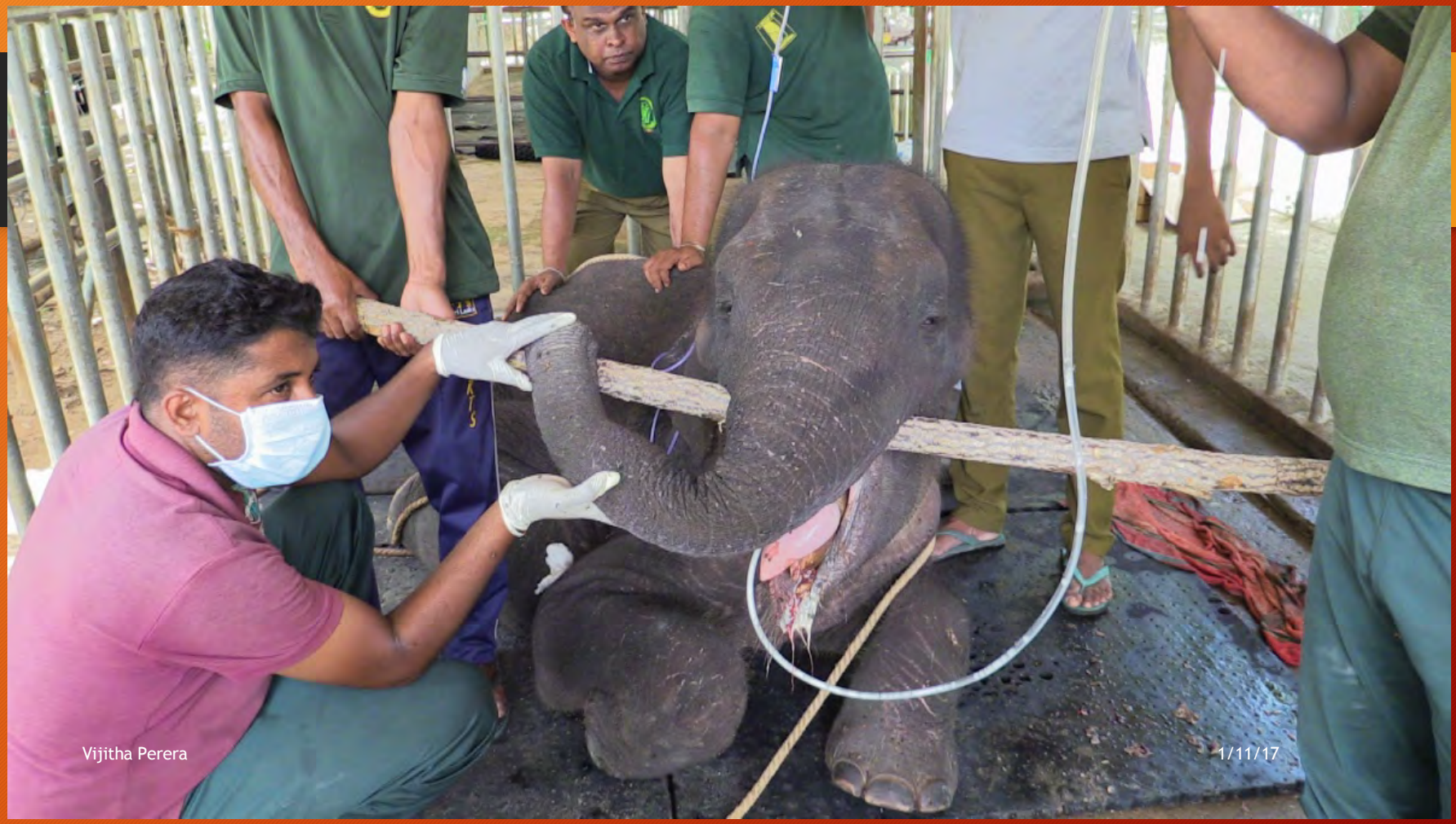
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- Conclusion
  - Xylazine is safe drug for both mild and deep sedation of elephant calves.



Thanks

Identification of Protozoa Gastrointestinal to the Wildlife (Tiger, Rhino and Elephant) and Domestic Livestock (Cattle, Buffalo and Goat) In Way Kambas National Park, Lampung Indonesia

Dedi Candra, Efrida Warganegara, Samsul Bakri, Agus Setiawan, Sumadi H and Diah Esti Anggraini

15th International Elephant & Rhino Consevation and Research Symposium
November 14-18, 2016 Singapore

Introduction





WAY KAMBAS NP

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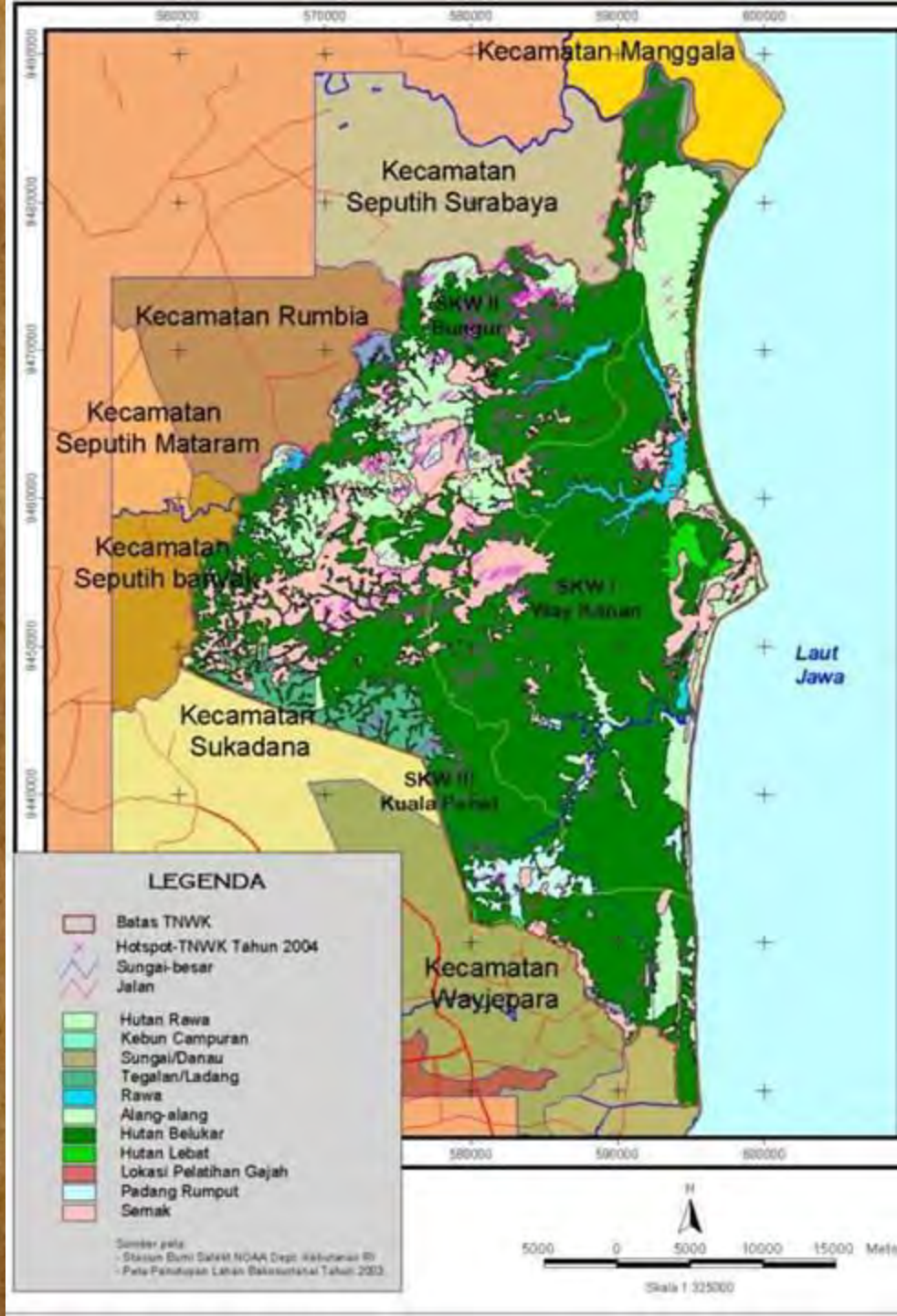
Way Kambas National Park

Way Kambas National Park (WKNP) located in Lampung province is a forest habitat of primary importance for conservation of the large mammals in Indonesia.



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Elephant conflict









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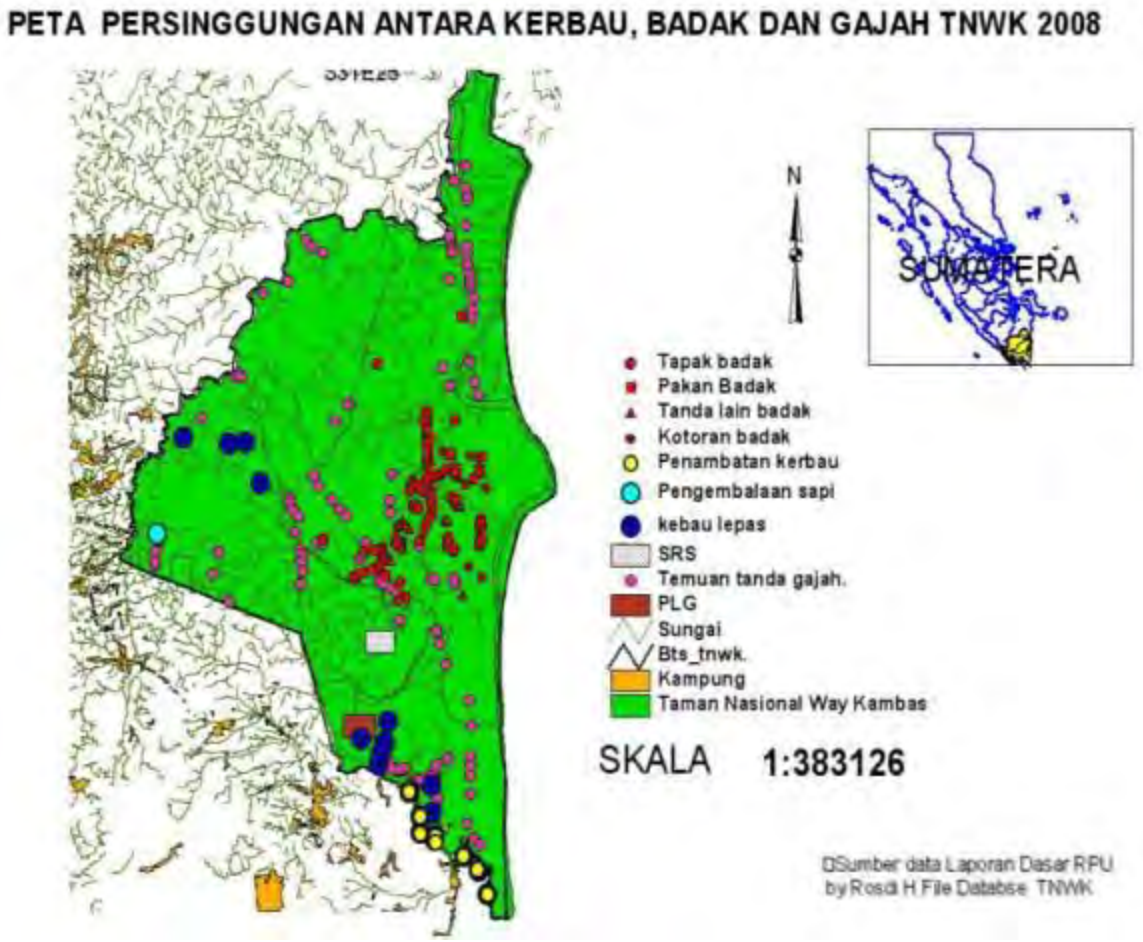
Way Kambas National Park

..... Wildlife vs Domestik Animal ....

- 37 Villages
- Buffalo and cattle in the NP
- Elephant conflict
- Overlaping habitat - inteaction



Infectious Dieseases

From **1415** diseases organism sp potential patogen to human.:

217 virus and prion, **538** bacteria and rickettsia, **307** fungi, **66** **protozoa**, dan **287** **helminth**.

872 (61,6%) sp from animal. **616** (70,6%) from domestic animal and **476** (77,3%) will be infection multi species.

175 *emerging infectious diseases* and **132** (75%) is zoonosis (Cleaveland *et al.*, 2001),

Parasites

-ENDOPARASITES
-EKTOPARSITES
-BLOOD PARSITES

ENDOPARASIES:

- Helmint
- Protozoa

This study aimed to identify protozoa were examined from faecal samples of wildlife and domestic livestock from around WKNP and was collected in the period February - July 2014 and October 2014 - February 2015, with sampling area includes 36 locations (25 villages and 11 WKNP).

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Material and Method

Fecal samples have been examined using the native, sedimentation and flotation methods for the parasitese identification and analysis of potential protozoa zoonotic with literature study.

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Data Analysis

- Descriptive and kuantitative
- Mapping distribusi geografis of parasites with GPS – Arc GIS
- Statistik test (T, Regresi Linier and Korelation) with minitab software



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Material



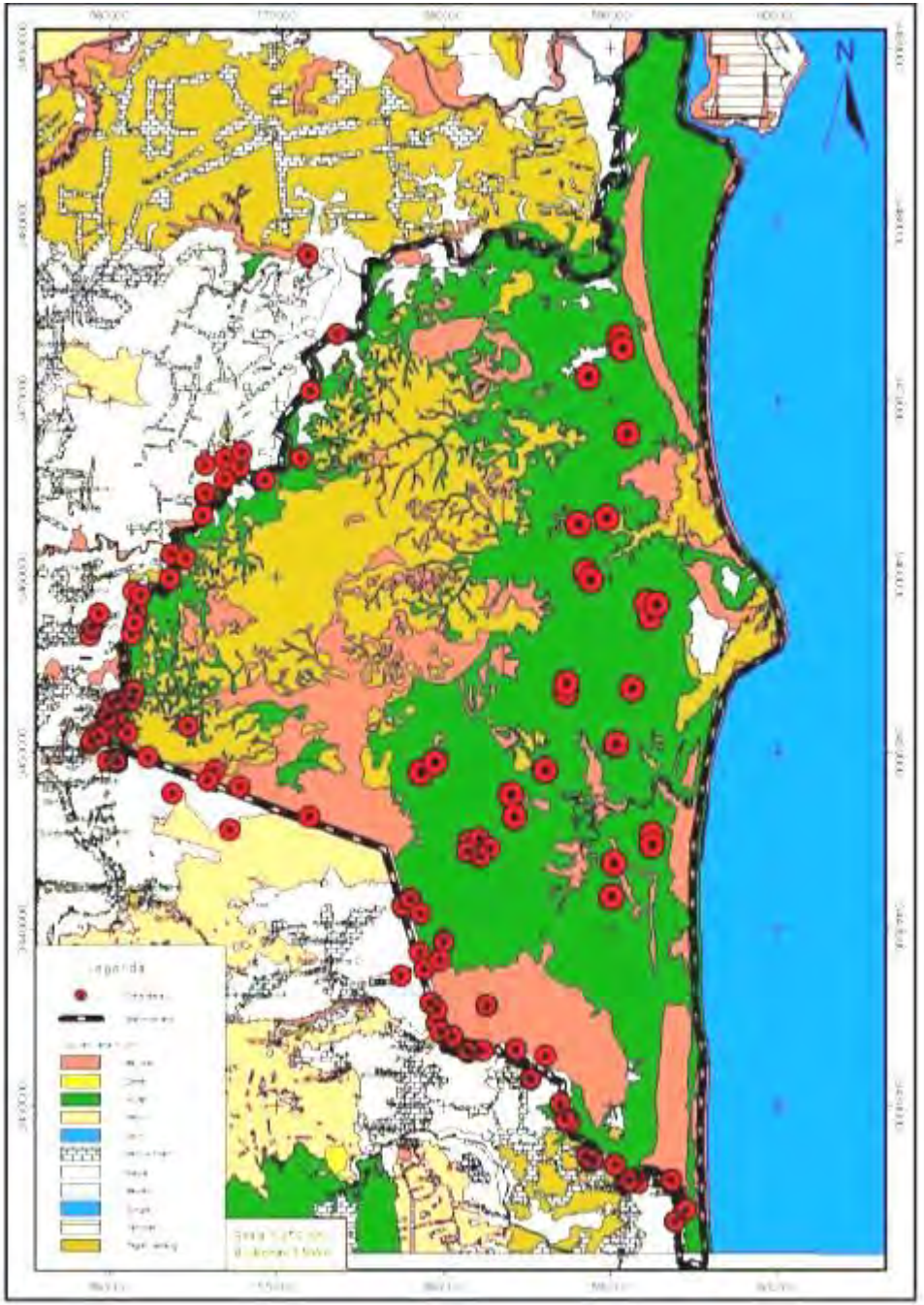
kalium bikromat
($K_2Cr_2O_7$) 2%



Fecal

Fecal samples collected loaction in way kambas

36 spot



Sampel

Fecal wild rhino - **11** sampel (population ~25); SRS's rhino - **15** sampel, wild elephant - **26** sampel (population ~200), ECC's elephant- **48** sampel, tiger - **4** sampel (population ~20) dari 11 Location, and domestik animal – cattle - **86**, buffalo (**24** sampel) and goat (**40** sampel) from 25 villages

TOTAL **254 sampel !!!!**











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Buffalo









Cattle

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Goat

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Elaphant

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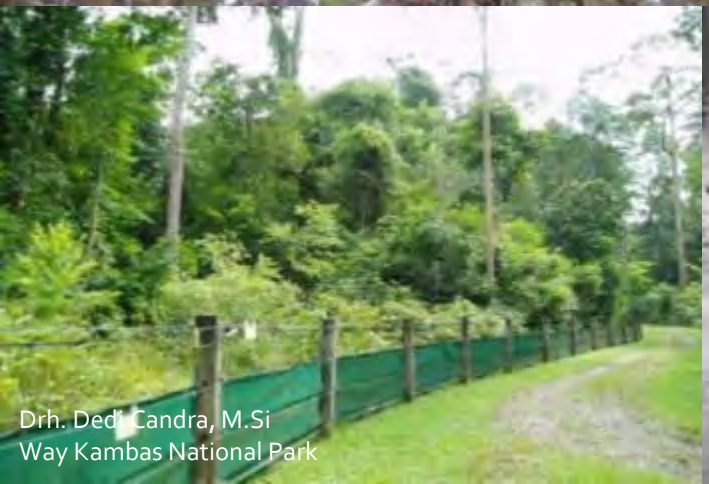

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Rhino

Result and discussion

RESULT

No	Lokasi	PAR	EIM	BAL	FAS	TRI	CYC	SLS	STR	HAE	MEC	OES	BUN	ENT	NEM	TLS	TOT
1	Muara Jaya	+	+	+	+			+		+	+	+			+		9
2	Karang Anyar	+	+	+	+		+			+		+					7
3	Braja Asri	+	+	+	+				+		+						6
4	Margahayu	+	+	+	+	+				+							6
5	Gambas	+	+		+	+			+			+					6
6	Taman Endah	+	+	+	+				+					+			6
7	Tambah Dadi	+	+	+	+			+						+			6
8	Taman Fajar	+	+	+	+					+			+				6
9	Tegal Ombo	+	+	+	+			+								+	6
10	Braja Harjosari	+	+			+		+	+								5
11	Plang Ijo		+	+		+		+	+				+				5
12	Bungur	+	+	+		+								+			5
13	Toto Projo	+	+					+			+		+				5
14	PLG - Gajah	+		+			+	+	+								5
15	Braja Kencana	+	+			+			+								4
16	Proyek Pancasila	+	+			+					+						4
17	Tanjung Tirto		+		+	+									+		4
18	Tegal Yoso	+	+		+	+											4
19	Braja Luhur	+	+						+								3
20	Meranggi	+	+		+												3
21	Braja Yekti	+	+														2
22	Kertosono	+	+														2
23	Rantau Jaya	+	+														2
24	Rantau Jaya Baru	+	+														2
25	Sri Rahayu	+															1
26	Rantau Jaya Ilir	+															1
27	SRS - Badak	+															1
28	Selatan. P. Ijo - G	+															1
29	Selatan. Pro - G	+															1
30	Selatan. Yekti - G	+															1
31	Tengah. R.Bun -G	+															1
32	Tengah. S.Br - G	+															1
33	Utara. Bungur - G	+															1
34	WK. SRS - BG																0
35	Selatan Marga - G																0
36	Wako HBG																0
	PARASIT	129	55	47	31	18	17	14	10	9	7	5	4	3	3	1	392
	TOTAL LOKASI	31	23	11	12	9	2	7	8	4	4	3	3	3	2	1	123
	DESA	23	23	10	12	9	1	6	7	4	4	3	3	3	2	1	111
	TNWK	8	0	1	0	0	1	1	1	0	0	0	0	0	0	0	12

Distribution endoparasite

Muara Jaya (9) - Karang Anyar (7) - Braja Asri, Margahayu, Plang Ijo, Gambas, Taman Endah, Tambah Dadi, Taman Fajar, Tegal Ombo (6) - Braja Harjosari, Bungur, Toto Projo, PKG - Gajah (5) - Braja Kencana, Proyek Pancasila, Tegal Yoso (4) - Braja Luhur, Meranggi (3) - Braja Yekti, Kertosono, Rantau Jaya, Rantau Jaya Baru (2) - Sri Rahayu, Rantau Jaya Ilir, SRS-Badak, Selatan (Plang io) - gajah, Selatan (Proyek) - Gajah, Selatan(Braja Yekti) - Gajah, Tengah (Rawa Bunder) - Gajah, Tengah (Susukan Baru) - Gajah, Utara (Bungur) - Gajah (1) - Way Kanan (SRS) - Badak Gajah, Selatan (Margayahu) - Gajah, Wako - Badak Gajah Harimau (0)

Statistic descriptive of endoparasit in the study area

No	Variable	N	Rata-rata	St.Dev	Min	Q1	Media	Q3	Max	Range
1	*Paramphistomum spp*	129	356.5	505.4	100	100	200	400	4900	4800
2	*Eimeria spp*	55	898.0	866.0	100	400	500	1200	5600	5500
3	*Balantidium coli*	47	297.9	204.8	100	200	200	400	1200	1100
4	*Fasciola spp*	31	216.1	146.3	100	100	200	300	500	400
5	*Trichuris spp*	18	133.3	59.4	100	100	100	200	300	200
6	*Cyclophosthium spp*	17	252.9	80.0	100	200	200	300	400	300
7	*Strongyloides spp*	14	1050.0	1766.0	100	175	200	950	5000	4900
8	*Strongylus spp*	10	330.0	170.3	100	200	300	425	700	600
9	*Haemonchus spp*	9	411.0	752.0	100	100	100	300	2400	2300
10	*Mecistocirrus digitatus*	7	300.0	238.0	100	200	200	400	800	700
11	*Oesophagustomum spp*	5	100.0	0.0	100	100	100	100	100	0
12	*Bunostomum spp*	4	125.0	50.0	100	100	100	175	200	100
13	*Entamoeba coli*	3	533.0	416.0	200	200	400	1000	1000	800
14	*Nematodirus spp*	3	100.0	0.0	100	100	100	100	100	0
15	*Trichostrongylus spp*	1	100.0	*	100	*	100	*	100	0

Protozoa

- *Eimeria* spp (23):
- *Balantidium* spp (11)
- *Entamoeba* spp (3)
- *Cyclopostium* spp (2)

⟹ diarrhea, enteritis

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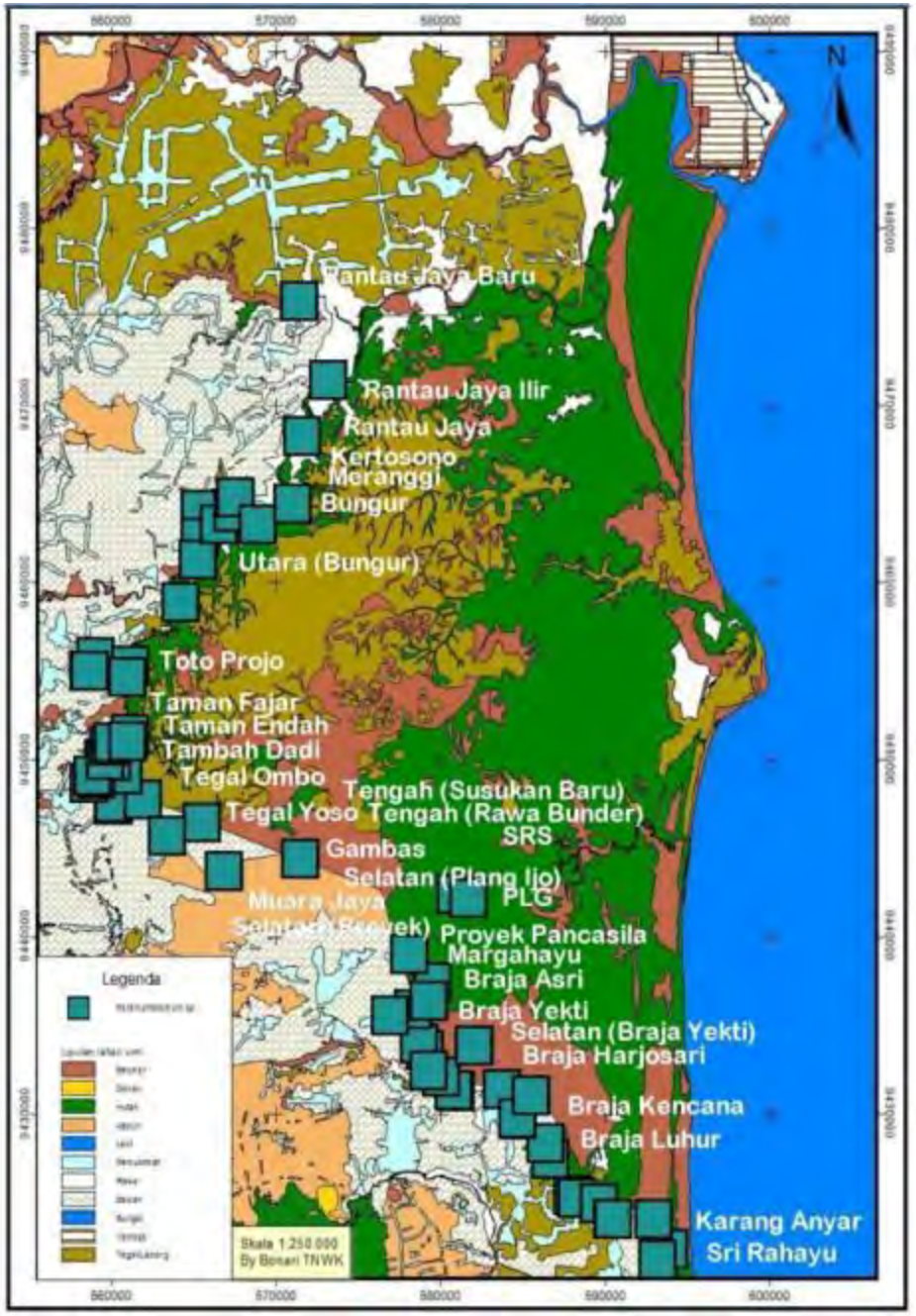
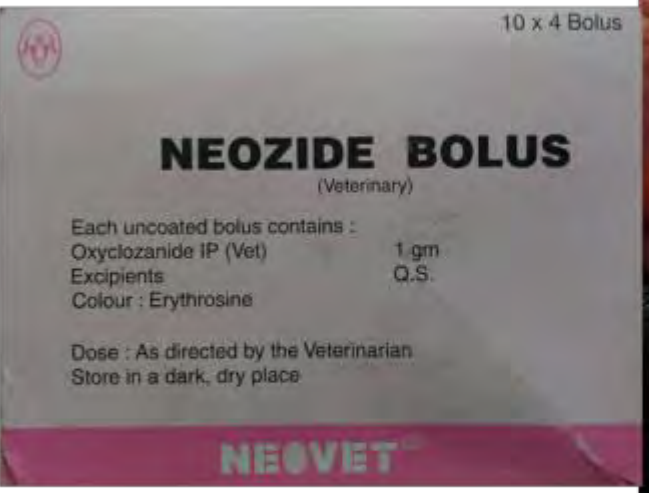
Paramphistomum
(rumen fluke)
31 Location











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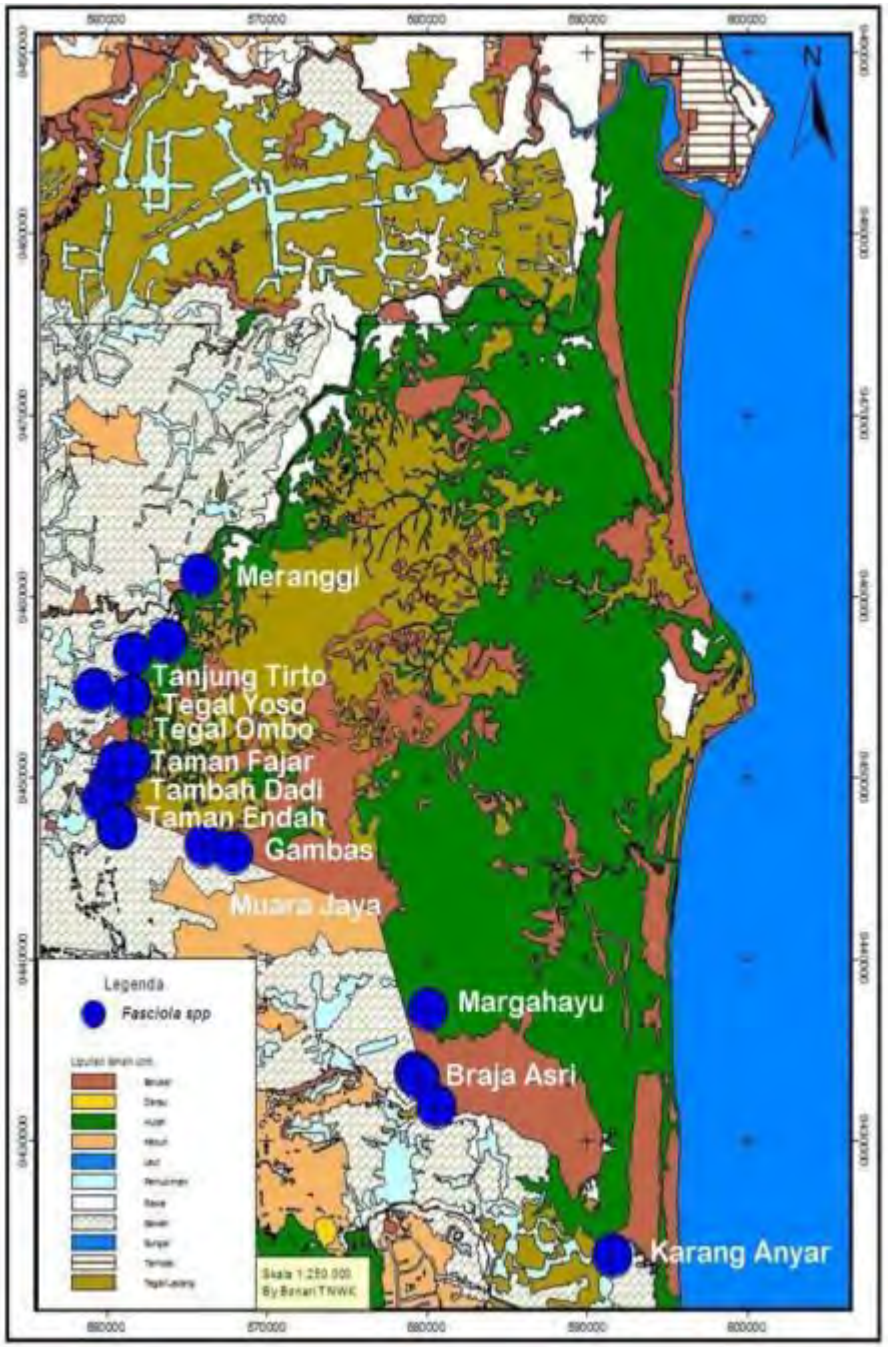
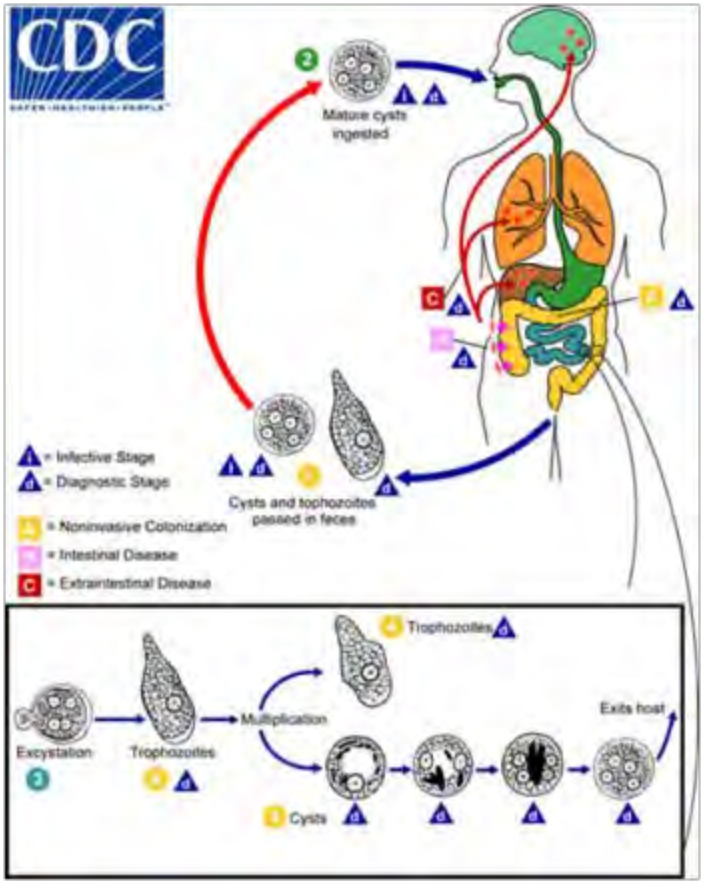
Fasciola spp
(liver fluke)

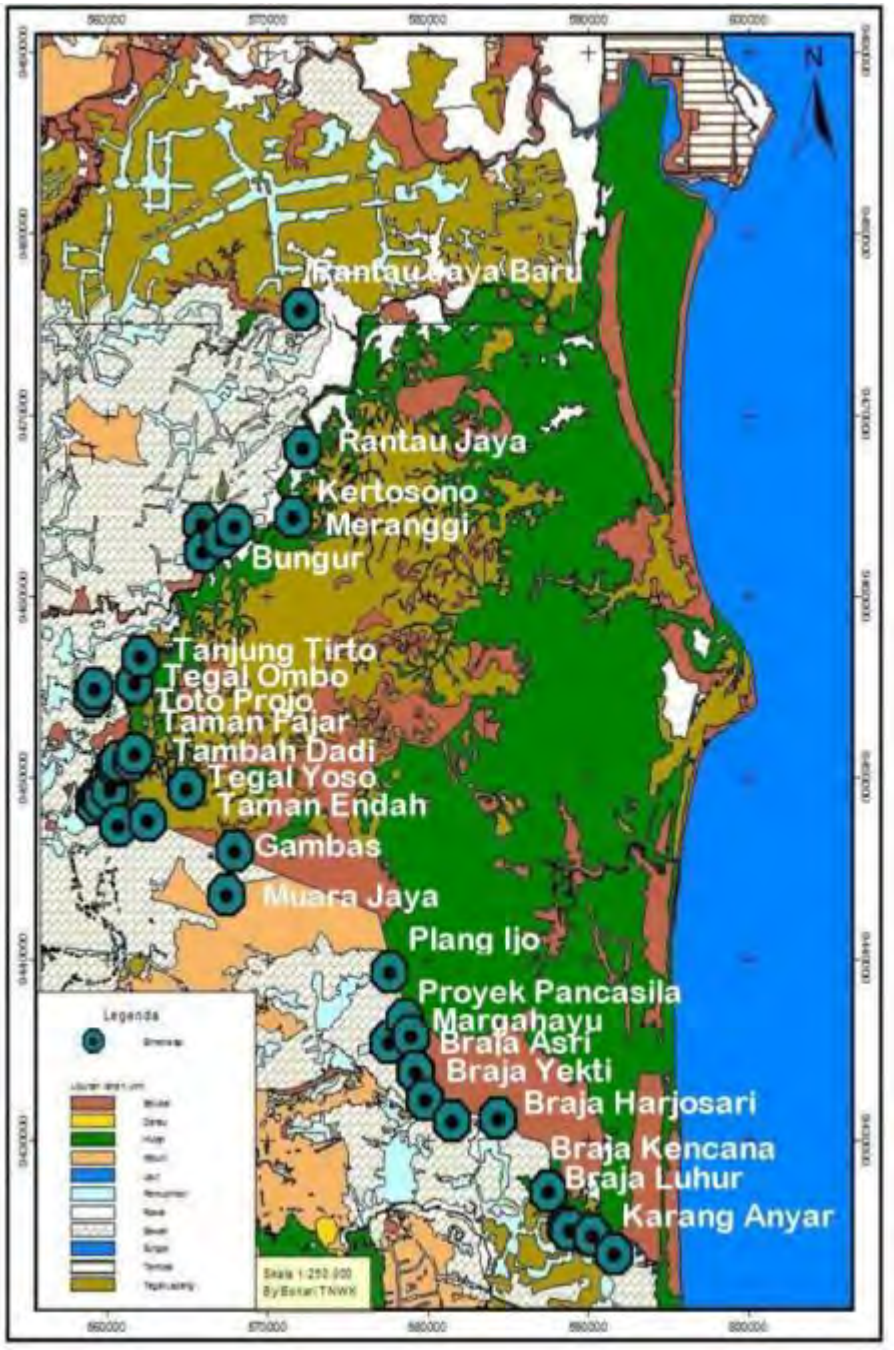
12 Location



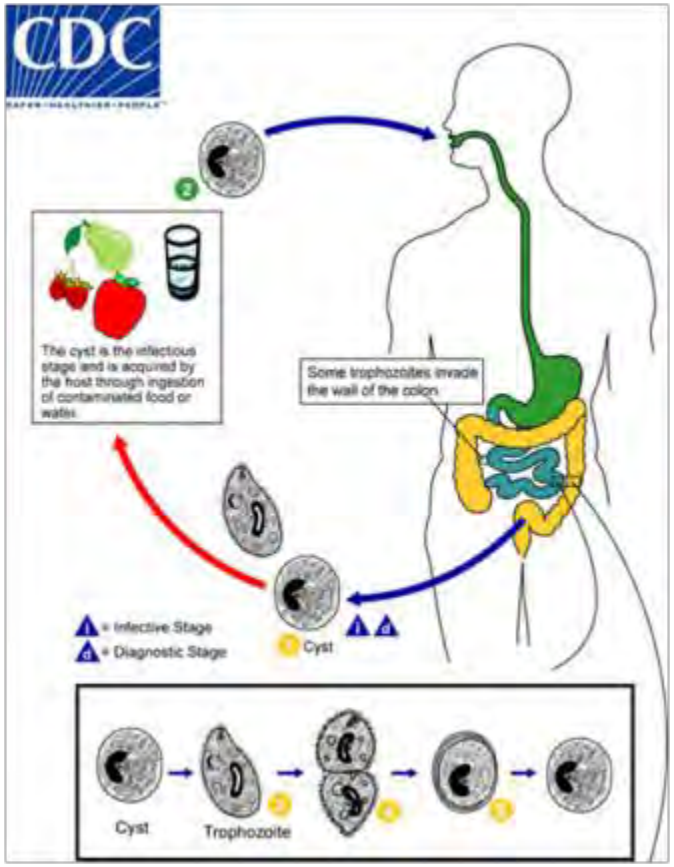
Eimeria spp (Coccidia)

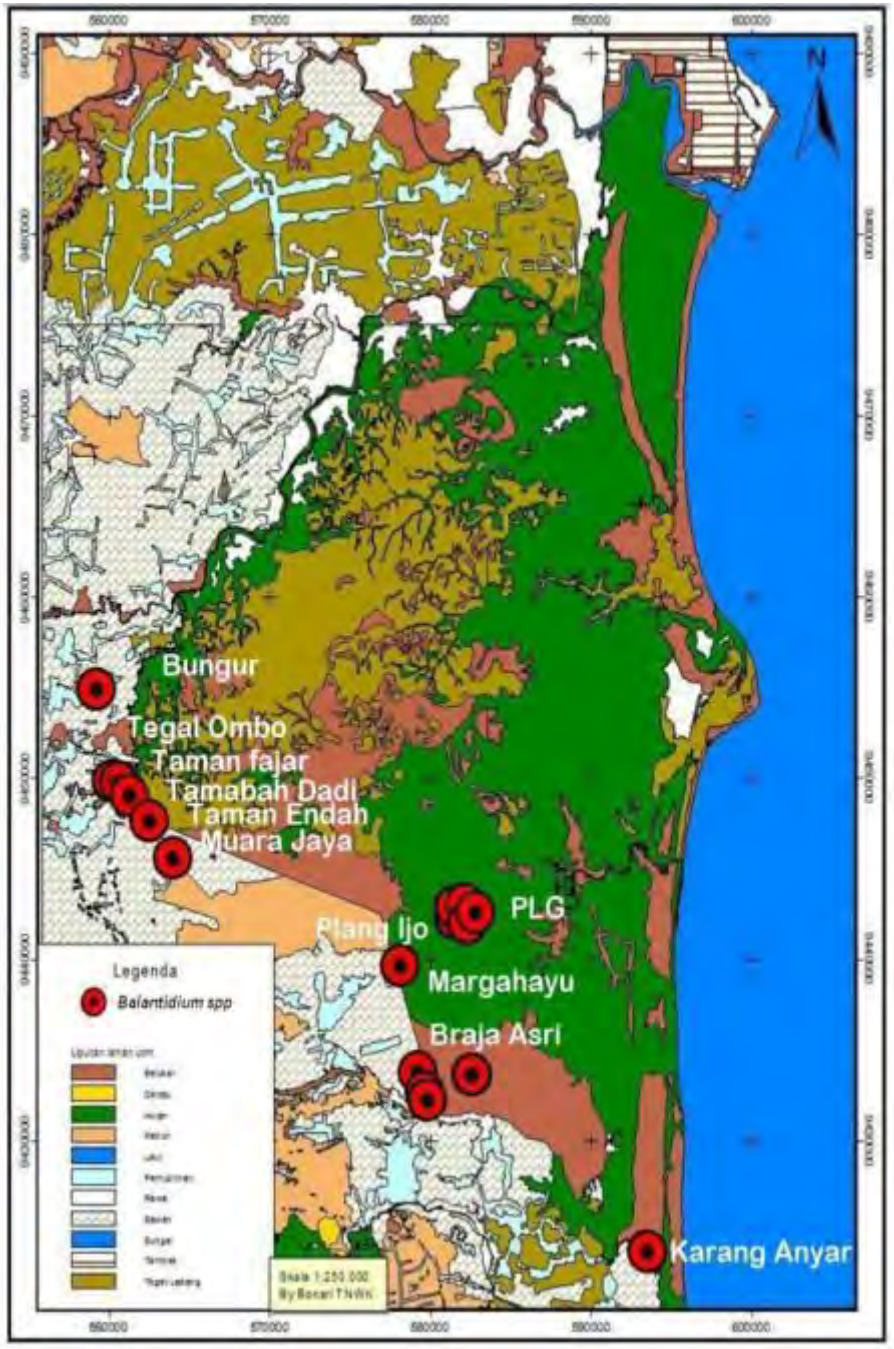
23 Location





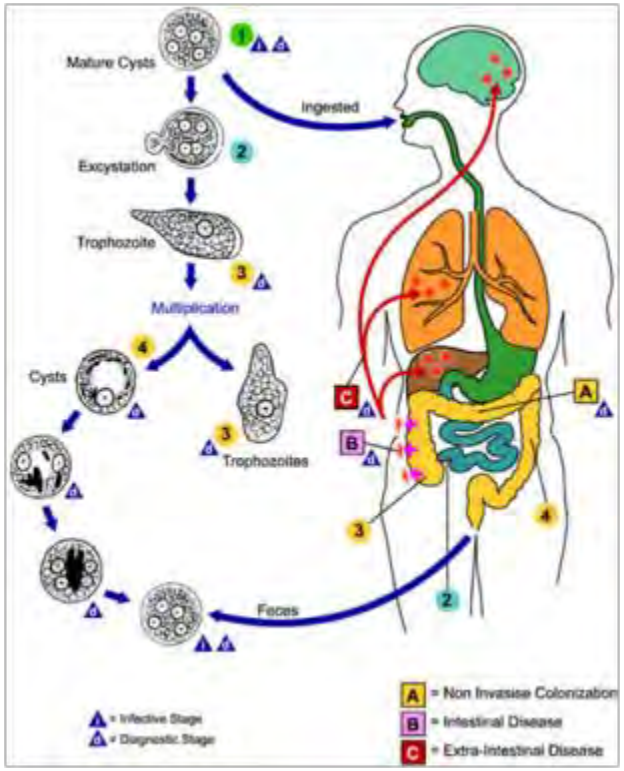
Balantidium spp
11 Location

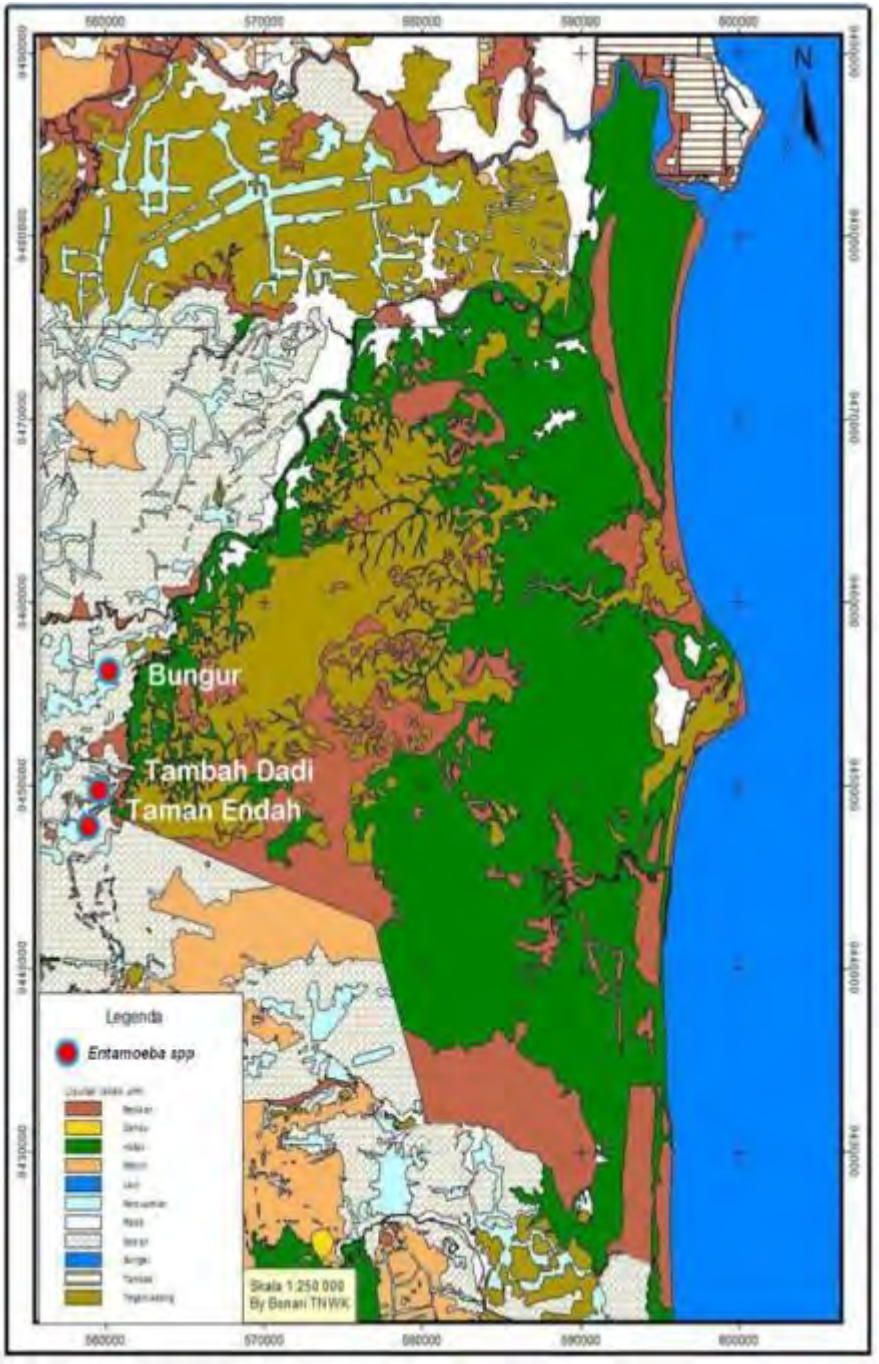




Entamoeba spp

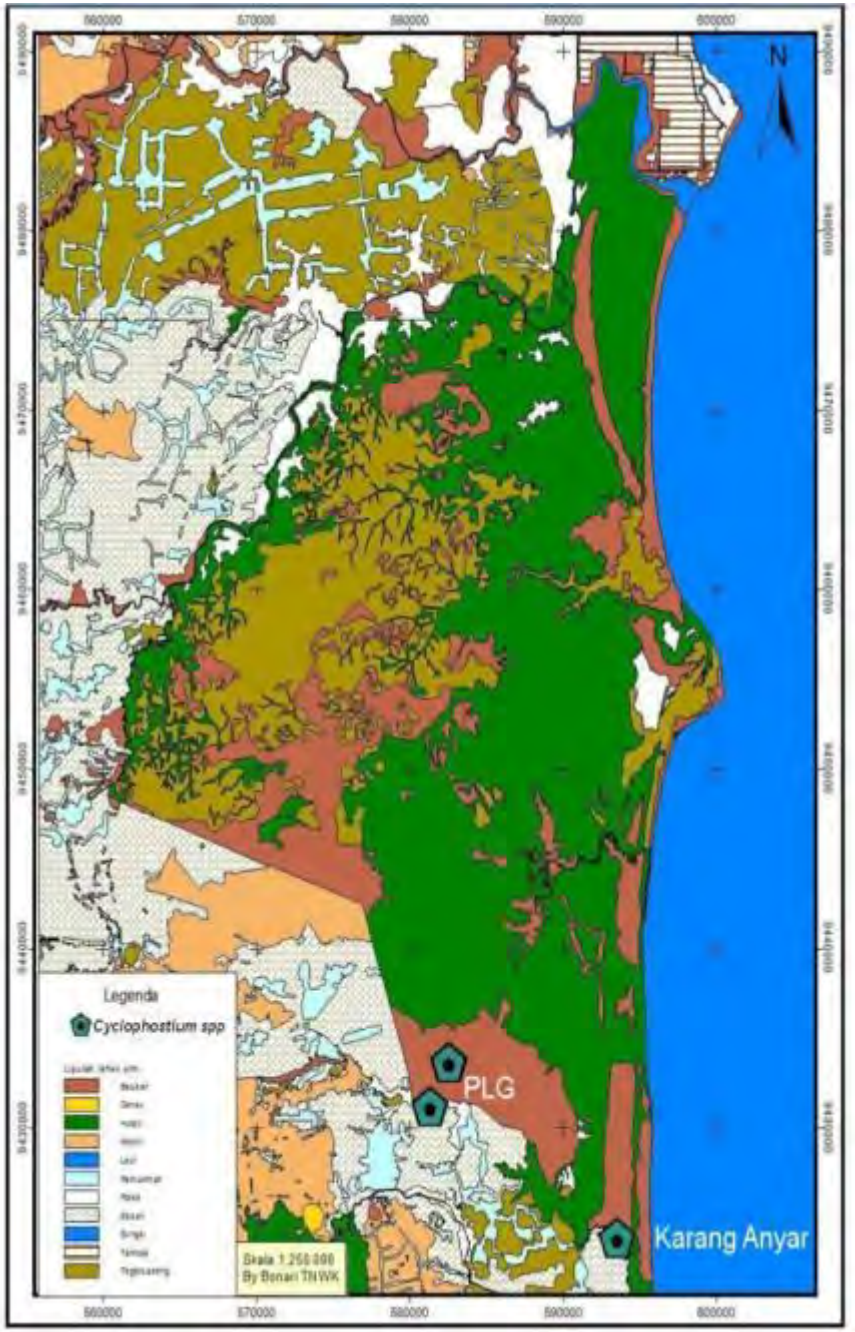
3 Location





Cycloposthium

2 Location



Zoonosis

Eimeria spp (Radostits *et al.*, 2008), *Balantidium* spp (Ramachandran dan Ambili, 2003), and *Entamoeba* spp (Heejeong Youn, 2009; Chomel *et al.*, 2007)

Interaction parasite gastrointestinal especially protozoa in the buffer zone of Way Kambas National Park (WKNP) is a problem that should receive serious concern in the WKNP conservation management and livestock husbandry in the villages of WKNP buffer zone because some of protozoa are zoonotic.

Drh. Dedi Candra, M.Si
Way Kambas National Park

Conclusion

Protozoa found in the buffalo, cows and goats are: *Eimeria spp*, *Balantidium coli*, *Cycloposthium spp* and *Entamoeba coli*. Protozoa founded in the Sumatran rhino and elephants are *Balantidium coli* and *Cycloposthium spp*. Protoza founded in the wildlife and domestic livestock are *Balantidium coli* and *Cycloposthium spp*.

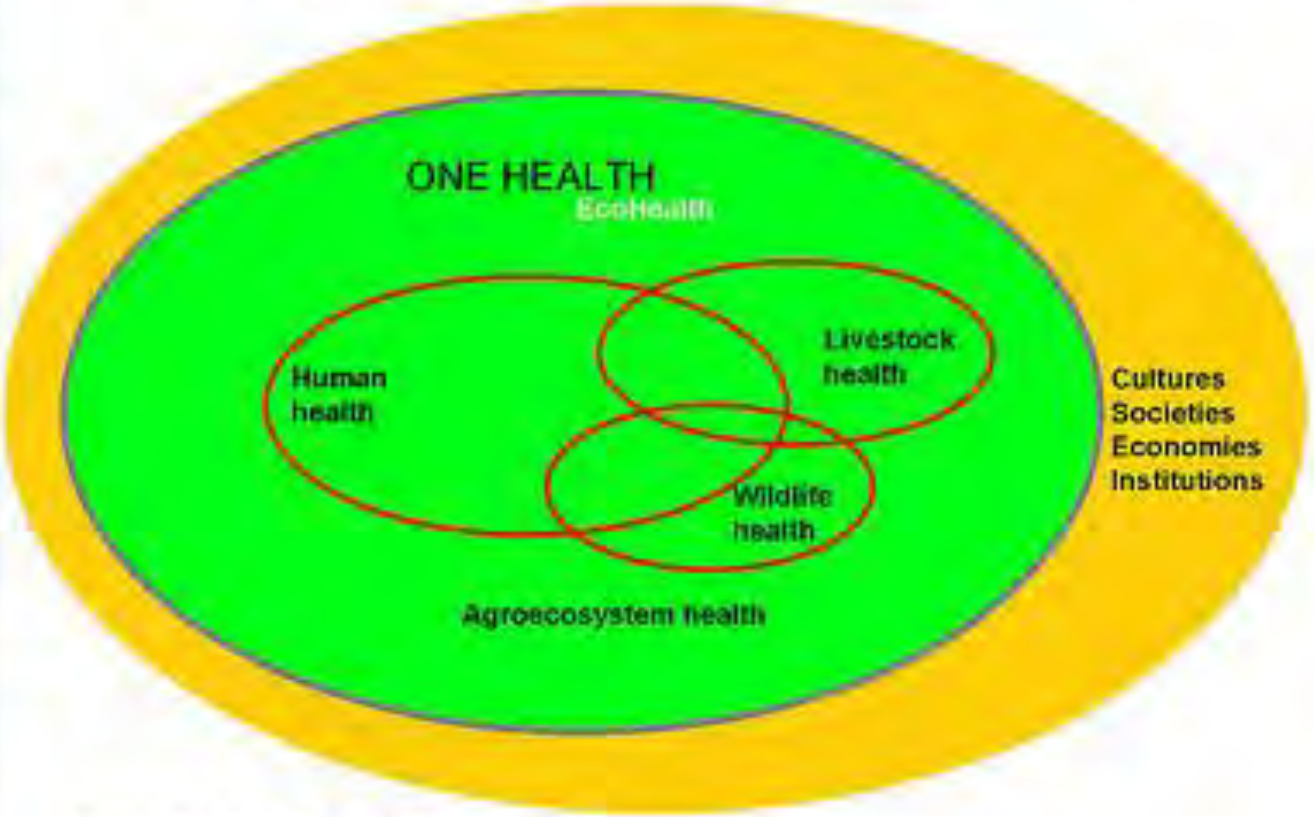
Drh. Dedi Candra, M.Si
Way Kambas National Park

Possible parasite protozoa as potential zoonotic in this study are *Eimeria* spp, *Balantidium* spp, and *Entamoeba* spp.

Transborder Management

- Canal
- Human – Elephant conflict patrol
- Elephant GPS satellite collars
- Ecology innovation
- Grazing land management
- Elephant and rhino food garden
- Medic Conservation (Ecohealth - one health)

Health of people, livestock and ecosystems are interdependent



Adapted from EstherSchelling, STI

Acknowledgement













Investigation of an Emerging Infectious Skin Disease in Black Rhinoceros (Diceros bicornis)

Smithsonian Global Health Program
Smithsonian Conservation Biology Institute
National Zoological Park

Kali Holder, DVM, DACVP
presented by: Marc Valitutto, VMD



PC: lewa.org; Martin Harvey

Translocation to Sera Rhino Sanctuary

Northern Rangelands Trust
Kenya Wildlife Service
Lewa Wildlife Conservancy
Kenya Government
USAID & USFWS
NGO's & Private Philanthropists



PC: lewa.org



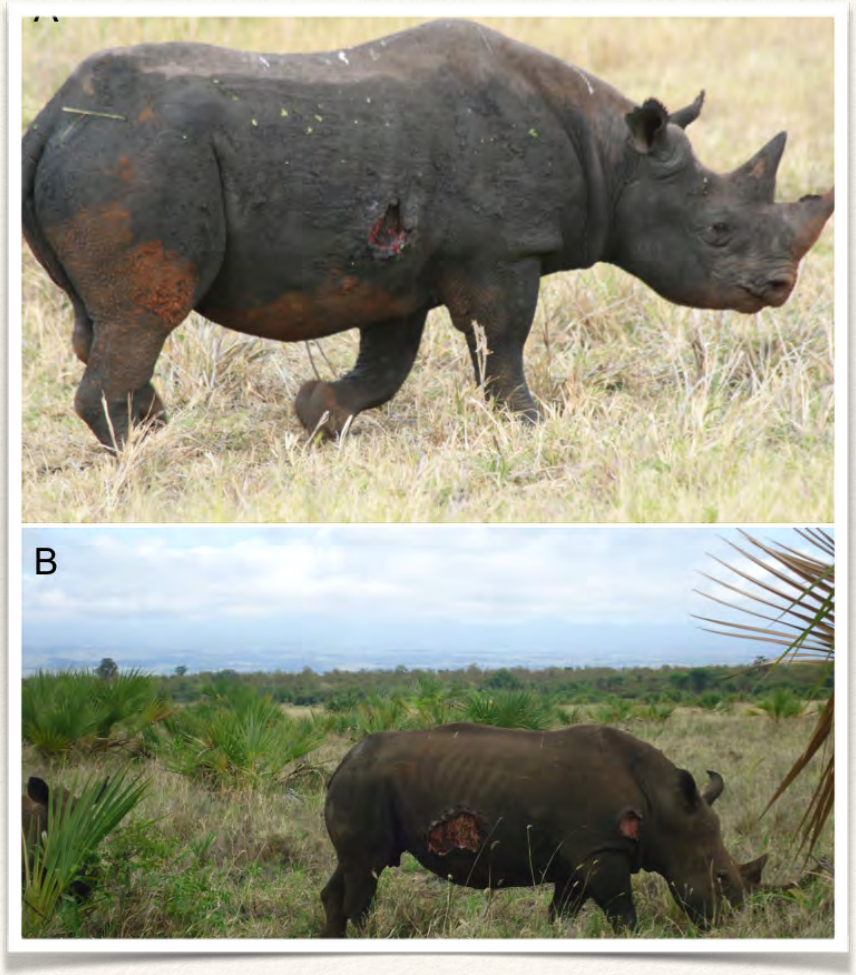
PC: lewa.org



PC: lewa.org

Examination

- 12 animals moved so far - founders
- Skin condition noted
- Cause not identified
- Critical need to diagnose
- Similar to 2011 outbreak in Meru National Park - both white and black rhinos



PC: Mutinda 2011

Macroscopic Evaluation

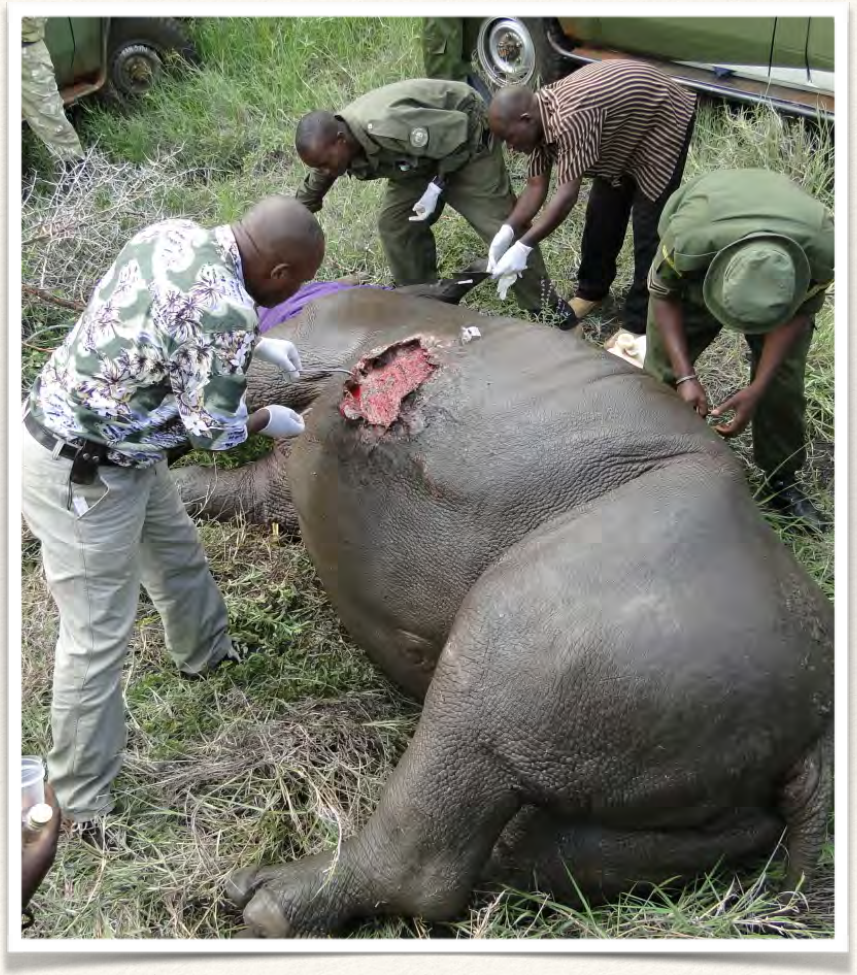


PC: Mutinda 2011

- Full thickness, deep ulceration
- Thickened margin
- Behind shoulder / on flanks
- 23 +/- 8 cm diameter
  - white rhinos
- 15 +/- 5 cm diameter
  - black rhinos

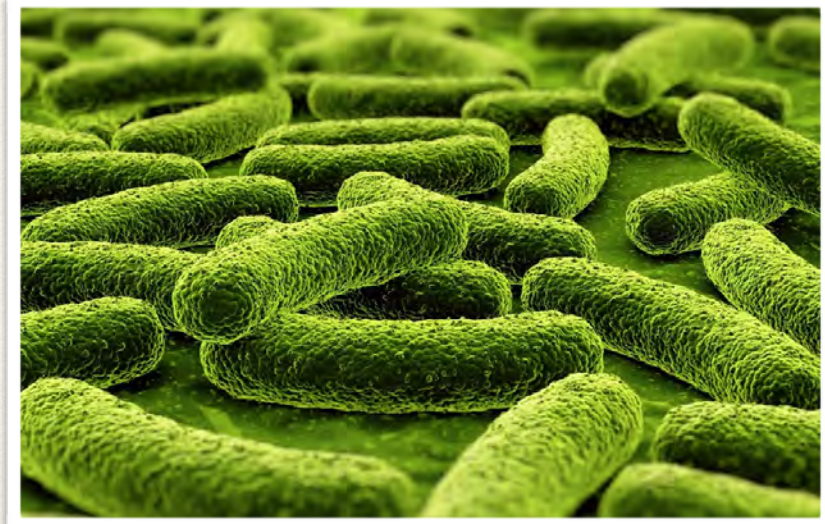
Operation & Treatment

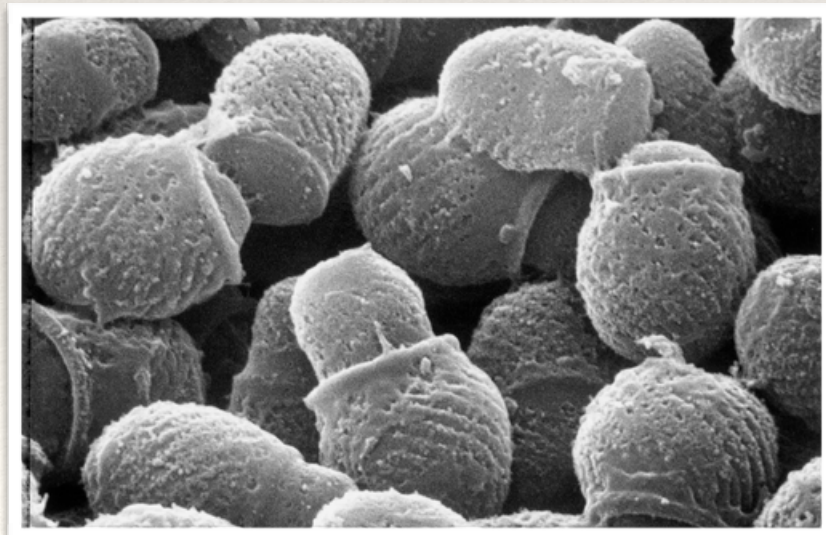
- Tissues collected
  - Formalin - histopathology
  - RNA later - molecular dx
  - Blood and serum
- Debridement
- Empirical therapy



PC: Mutinda 2011









Collaboration

SMITHSONIAN'S NATIONAL ZOO
& CONSERVATION BIOLOGY INSTITUTE

KENYA
WILDLIFE
SERVICE

University of Nairobi

icipe
African Insect Science for Food and Health

INTERNATIONAL CENTRE OF
INSECT PHYSIOLOGY AND ECOLOGY

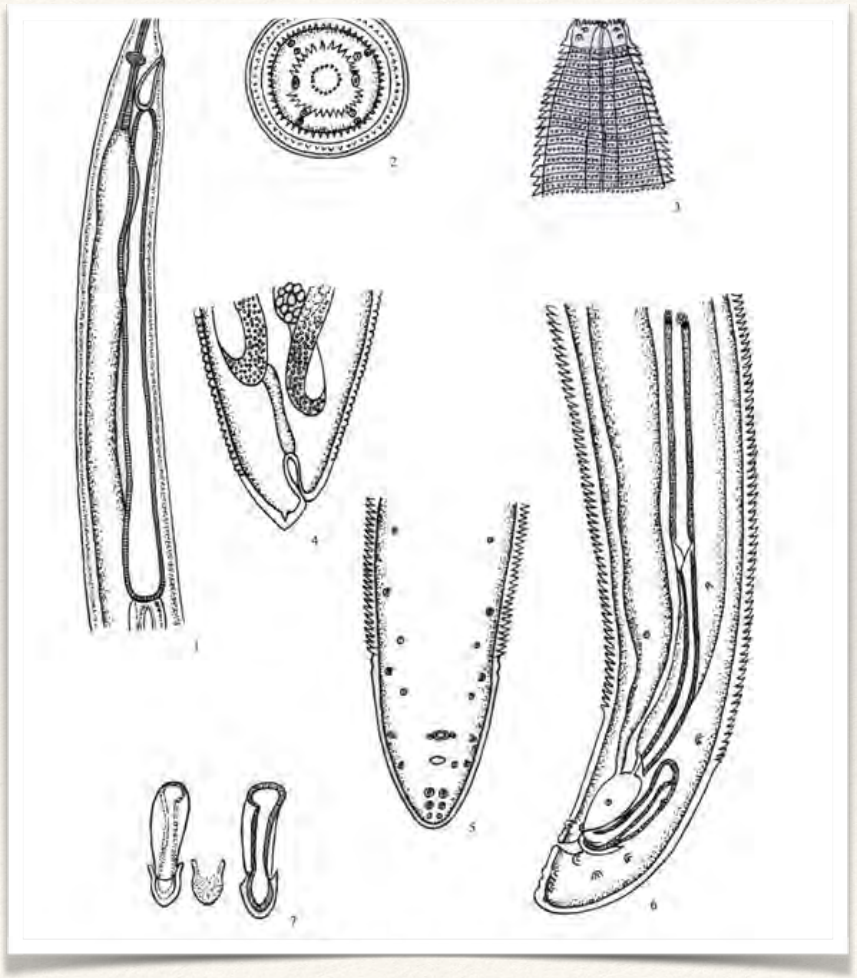
Education

- International Research Fellowship
  - Smithsonian Global Health
  - Kenya Wildlife Service
  - Training in advanced diagnostic techniques
  - Capacity building



Identification

- *Stephanofilaria dinnicki*
  - Suspect ONLY
  - First ID in 1960's
  - Histopath ID in 1990's
  - Deep epidermis
  - No molecular analysis
  - Life cycle and vector unknown



Complication

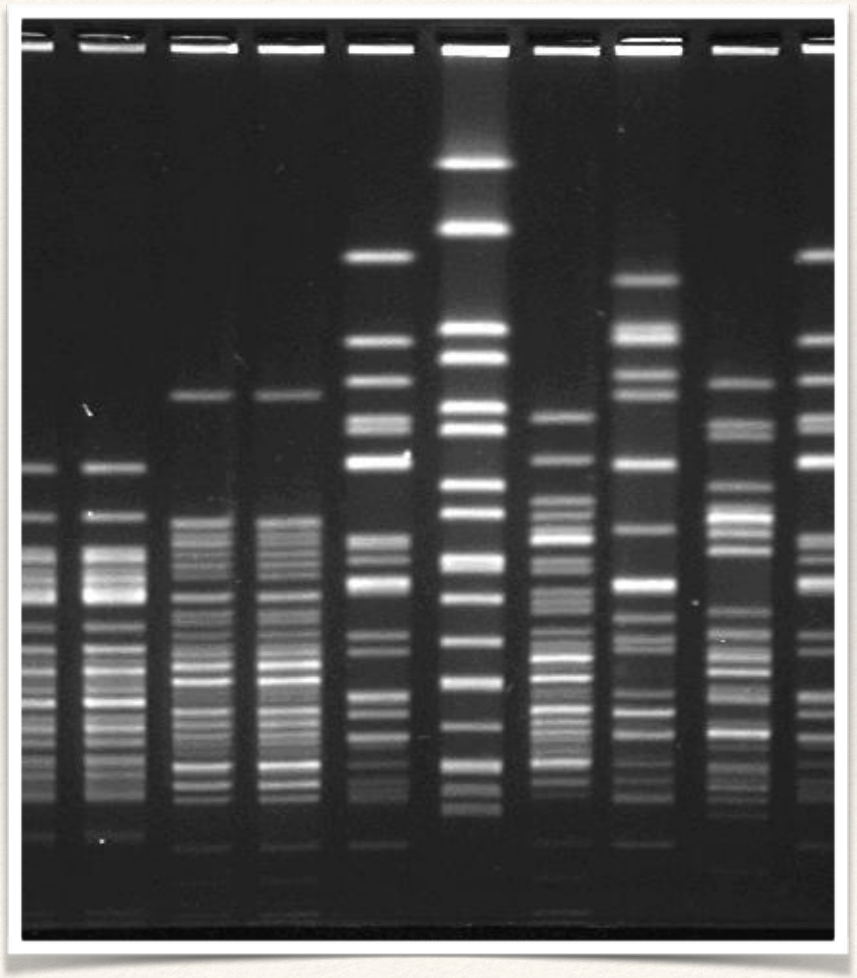


PC: African Wildlife Foundation

- Endangered species
- Anesthetic events
- Stephanofilaria - sequence information paucity
- Treatment to wild specimens
- Follow up and monitoring
- Diagnostic biopsies difficult

Molecular Evaluation

- PCR
- Broad pathogen screening
- Primer development - suspects
- Sequence 16S gene
- Metagenomics



Vector Determination

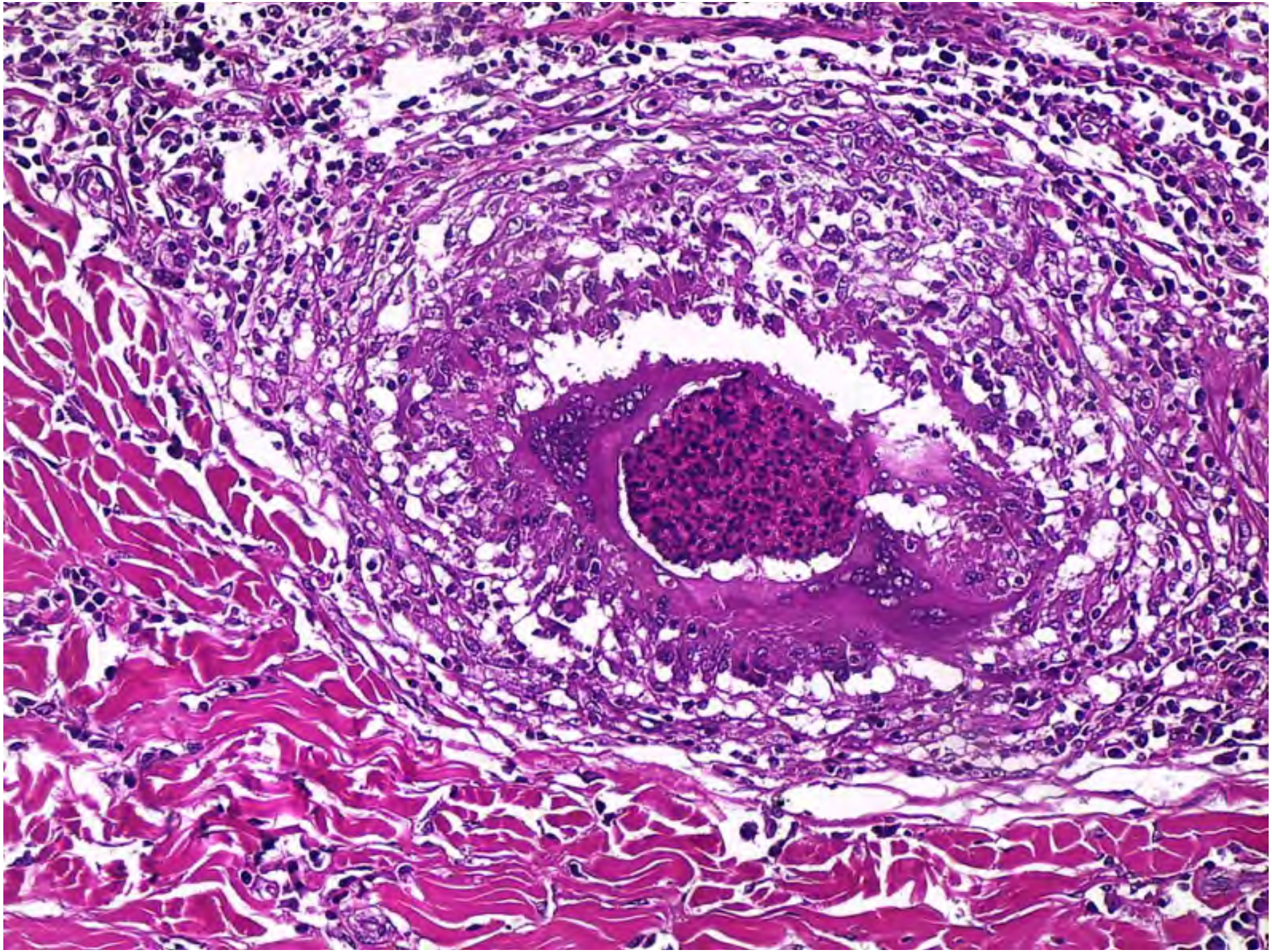


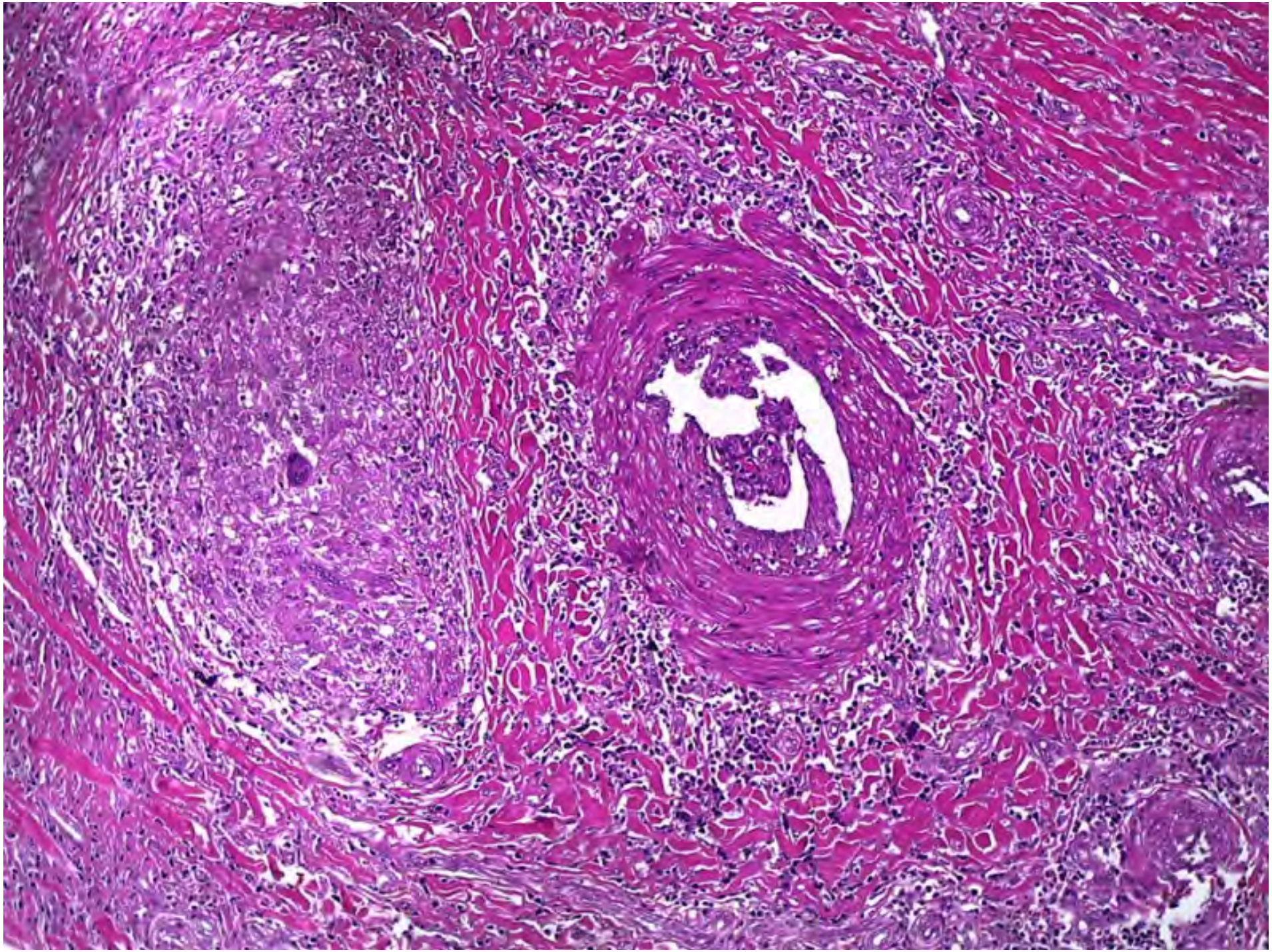
- Entomology review
  - ID potential vectors
  - Collect arthropods
  - Morphological evaluation
  - Blood meal analysis

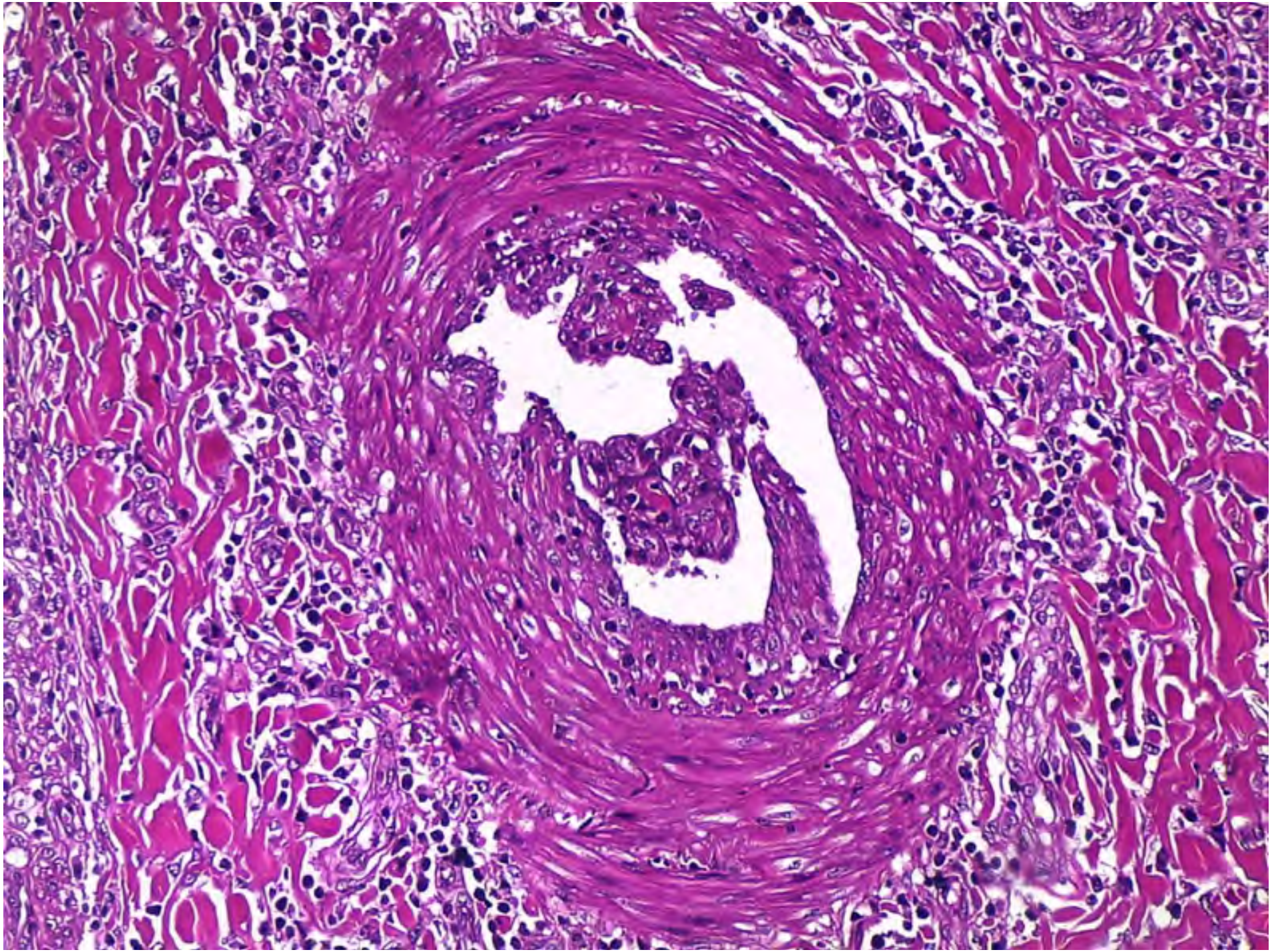
Histopathological Evaluation

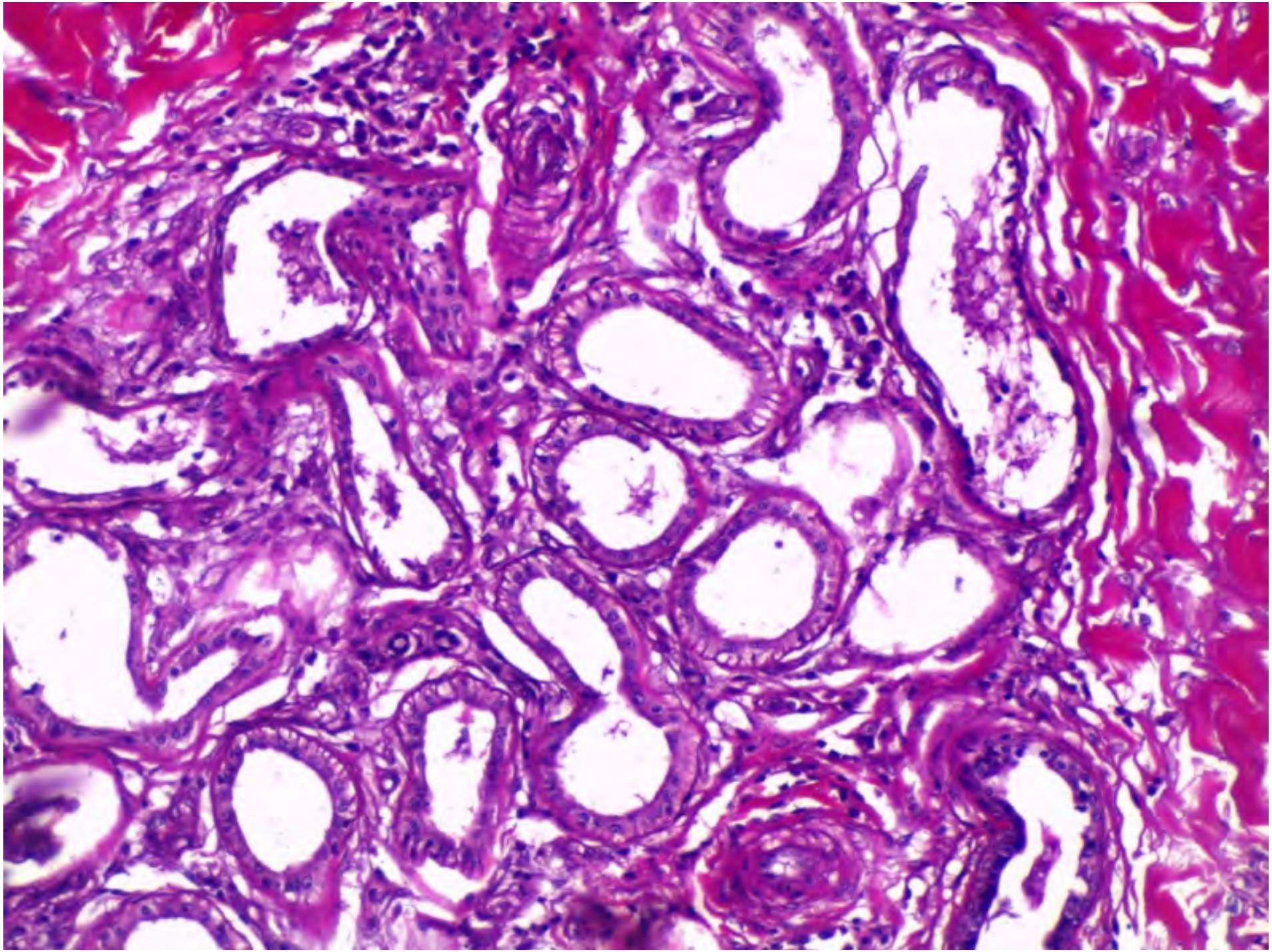
- ID pathogens
- Describe tissue change
- Evaluate extent of damage
- Characterize common features
- Compare to previous reports

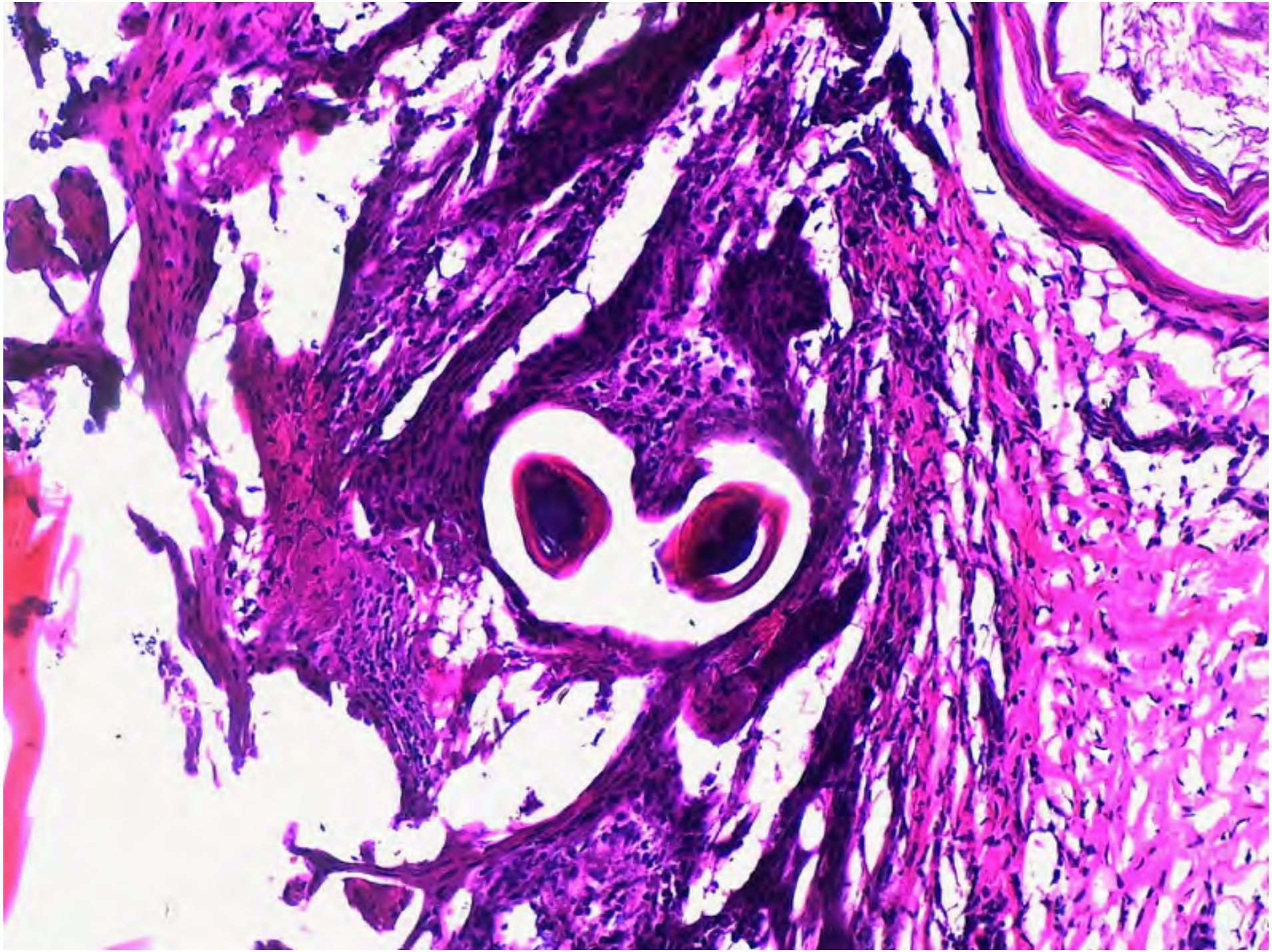


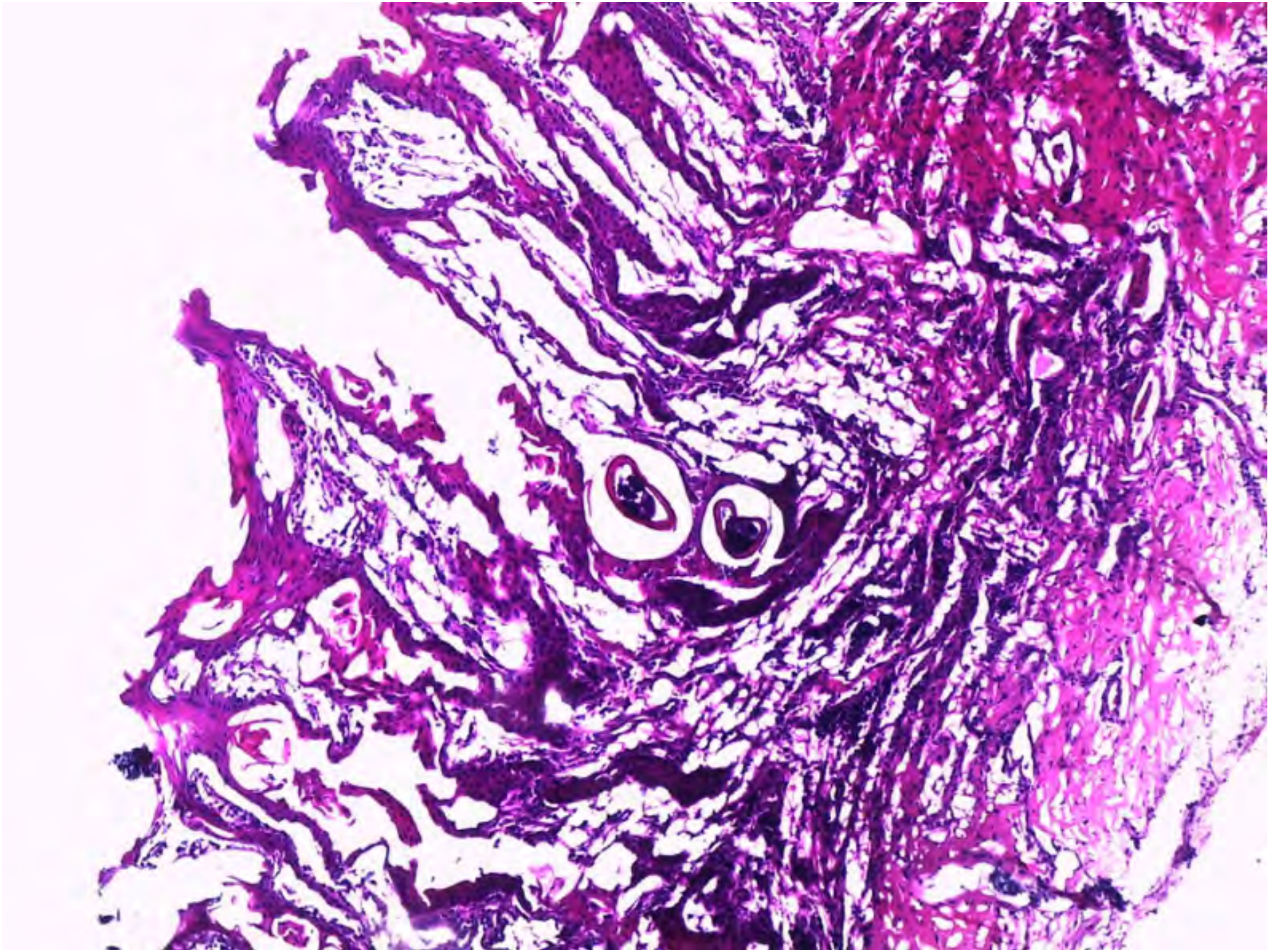


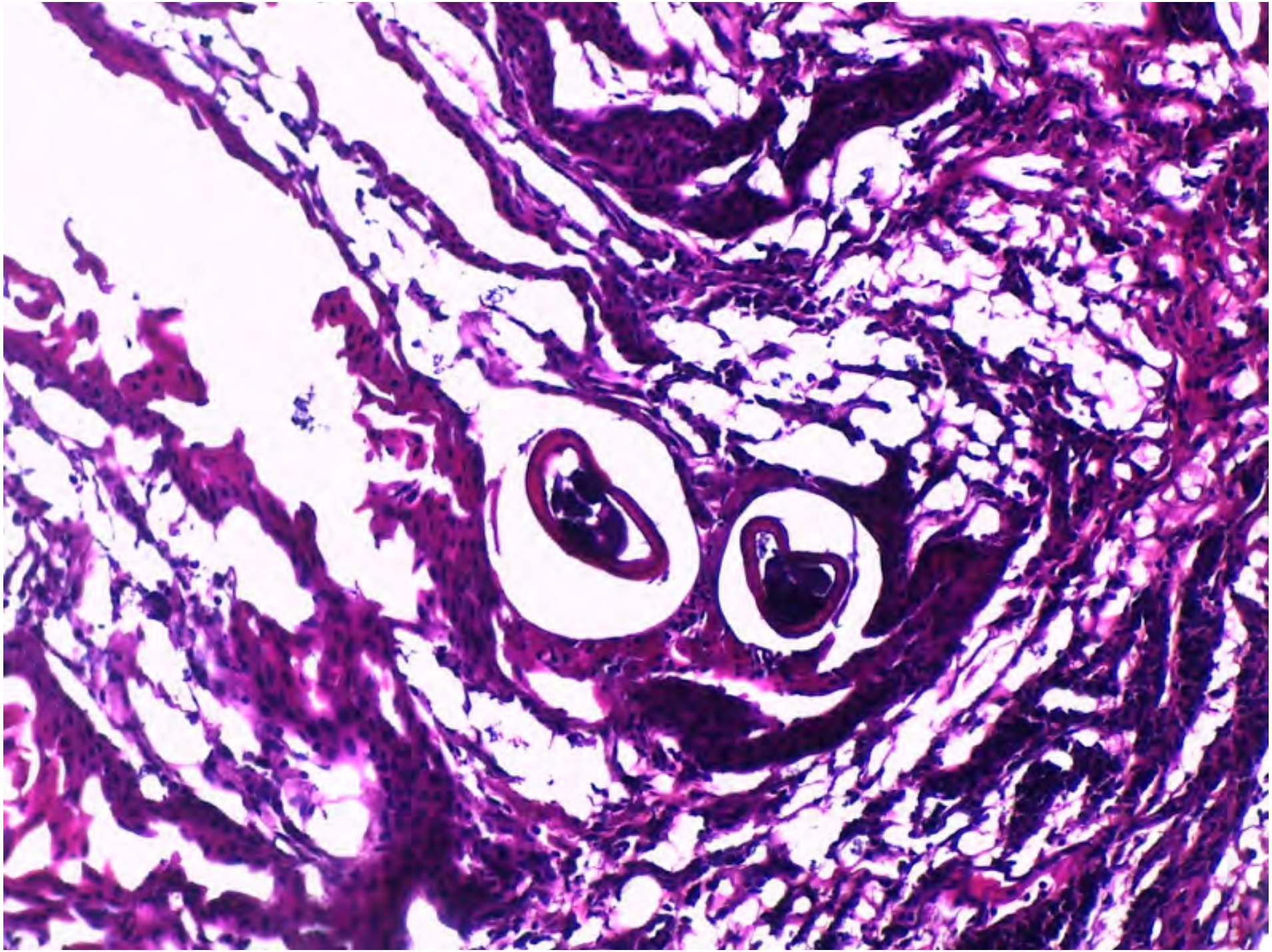


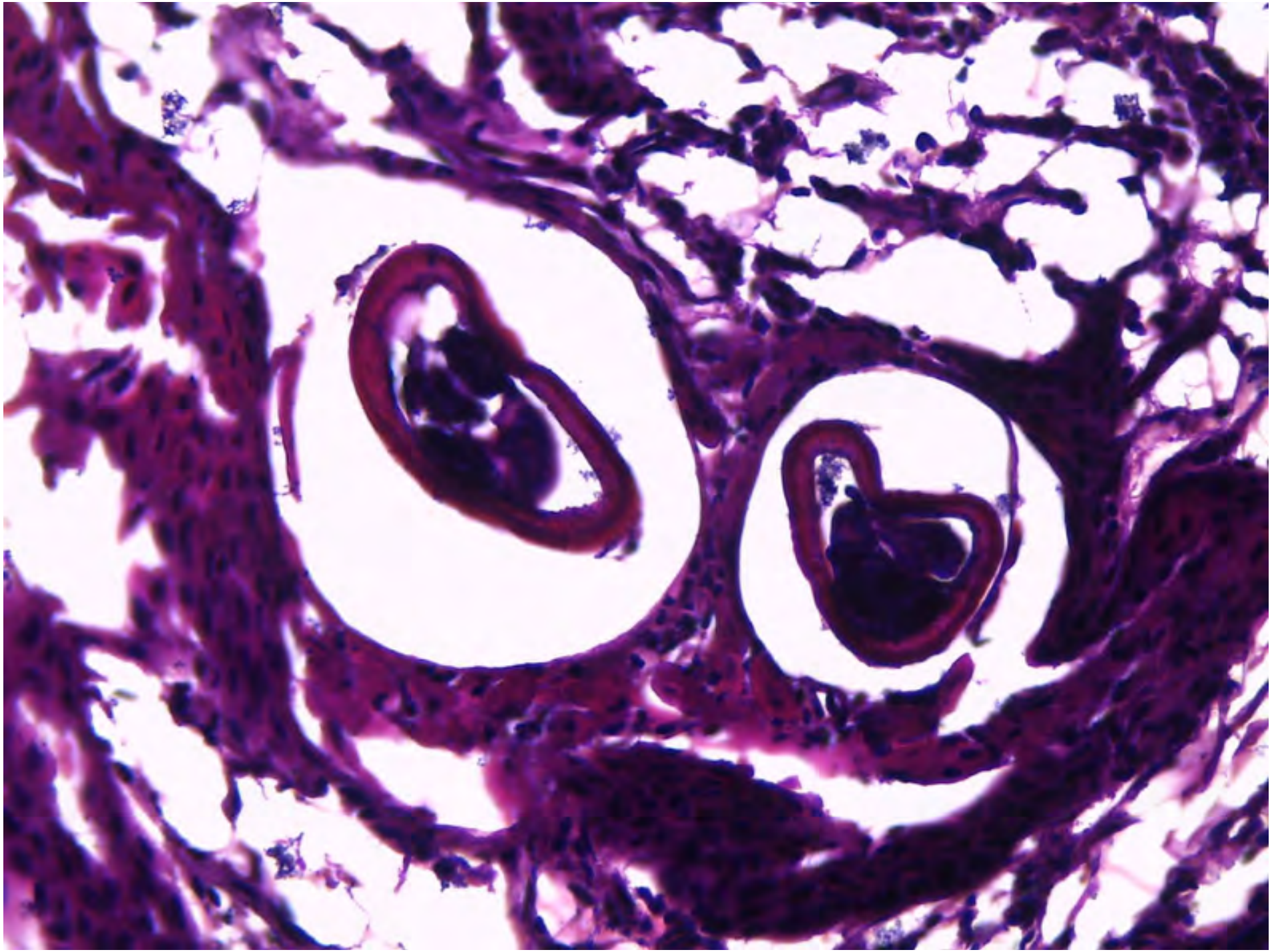












Anticipation

- Histopath slide re-preparation
- Shipment to Smithsonian
- Analyze molecular data
- Determine source of ref specimen for Stephanofilaria
  - Sequence relevant targets
- Collect more samples
- Treat and monitor



PC: flyladylori.com; Vincent Catt



PC: lewa.org; Martin Harvey

Thank You

Morris Animal Foundation

Smithsonian Women's Committee

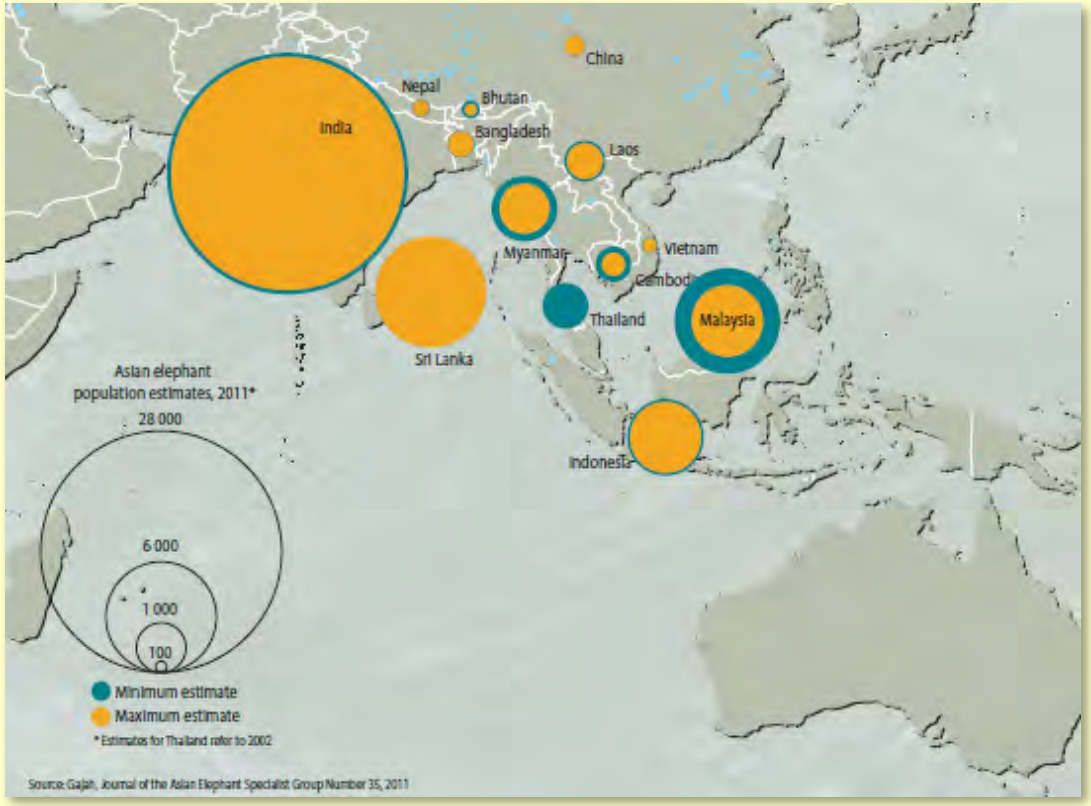
Health Policy Implications of Tuberculosis in Captive Elephants and Mahouts



David Abraham[1]& Jacob V. Cheeran[2]

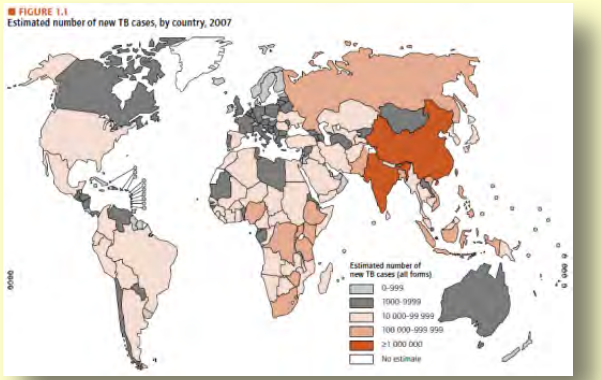
1: Veterinary Surgeon, Kerala Animal Husbandry Department
2: Professor (Rtd.), Kerala Agricultural University

Background

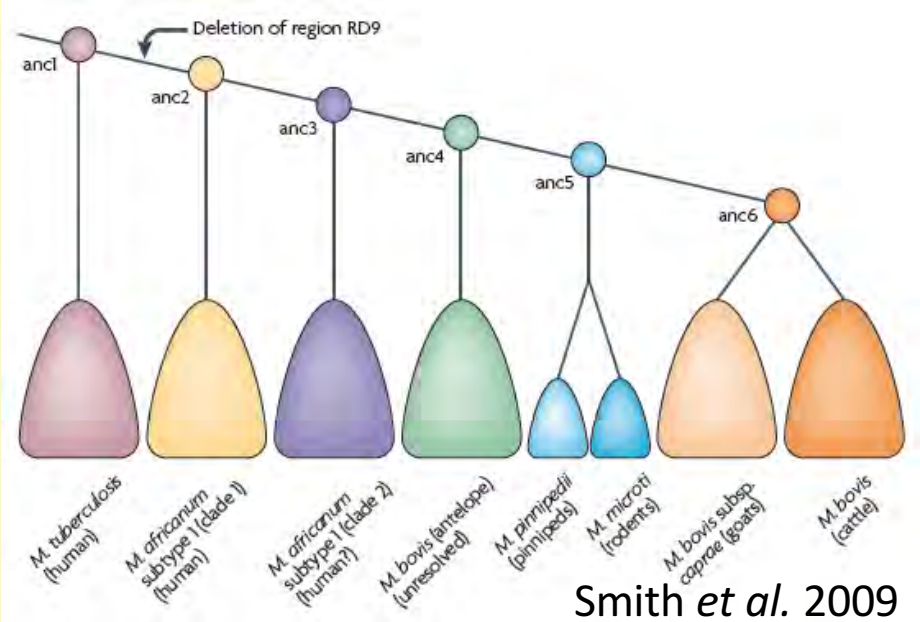


- Of the estimated global population of 45-50,000 Asian elephants, nearly 15,000 are in captivity in the range countries in South and South East Asia

Background …



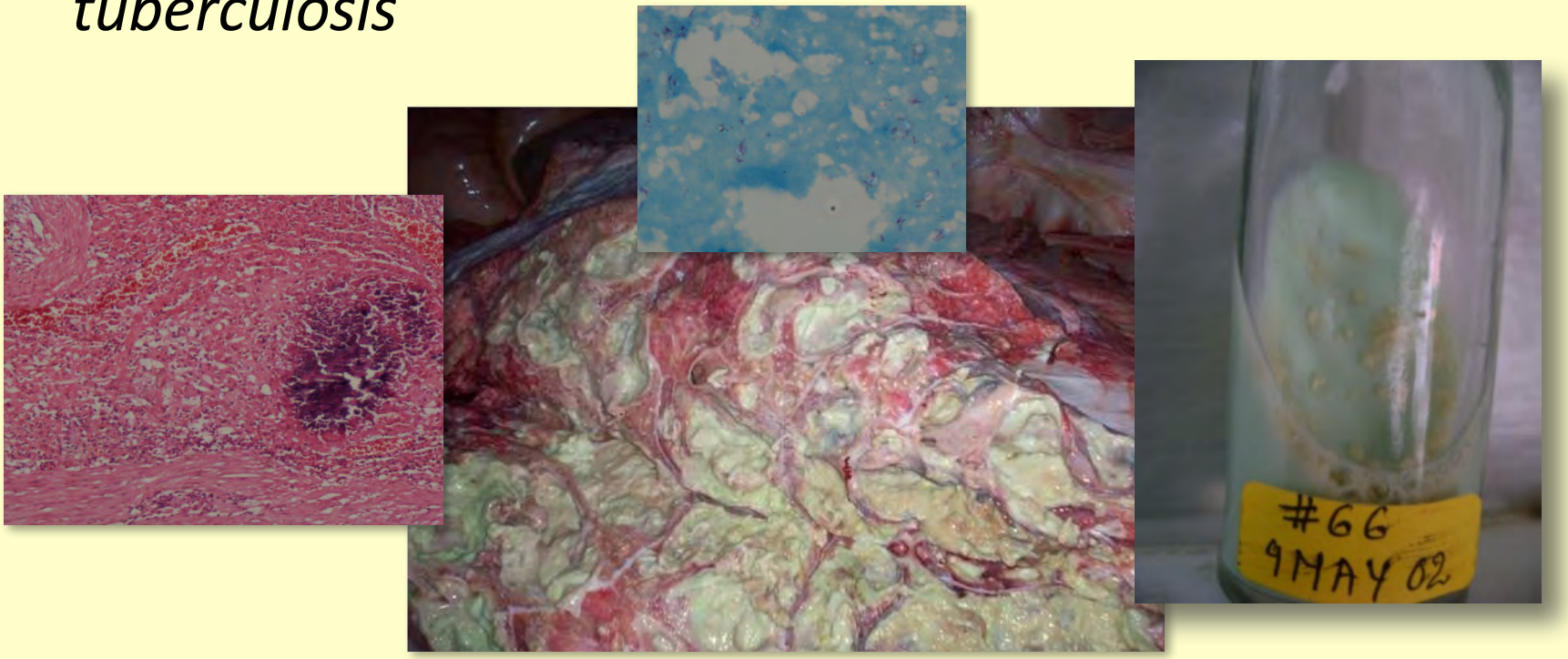
- World Health Organization defines tuberculosis as one of the most significant re-emerging human diseases
- *Mycobacterium tuberculosis* complex



Smith *et al.* 2009

Introduction

- Asian elephants (*Elephas maximus*) are susceptible to tuberculosis & most reported cases of TB infection in Asian elephants are caused by *Mycobacterium tuberculosis*



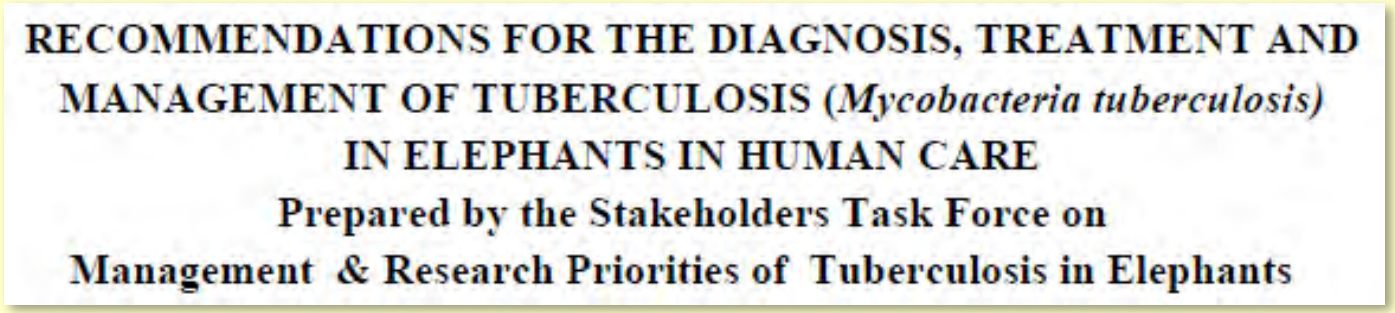
Introduction …



- According to the World Health Organisation, an explicit health policy can achieve several things: it defines a vision for the future; it outlines priorities and the expected roles of different groups; and it builds consensus and informs people.

https://en.wikipedia.org/wiki/Health_policy

Introduction ...


RECOMMENDATIONS FOR THE DIAGNOSIS, TREATMENT AND MANAGEMENT OF TUBERCULOSIS (*Mycobacteria tuberculosis*) IN ELEPHANTS IN HUMAN CARE

Prepared by the Stakeholders Task Force on Management & Research Priorities of Tuberculosis in Elephants

- At present, a policy guideline for tuberculosis control in elephants is available in the United States
- Due to the lack of country-specific guidelines, veterinarians in many elephant range countries in Asia have tried to follow the US guidelines


www.keralatourism.org
Photo: Joshy Manjummel









The dilemmas

- In many range countries, the requirement for annual testing can be difficult in the resource poor settings. Nodal agencies may not be functional for proper record keeping and maintaining serum banks
- Trunk wash collection can be difficult to perform in working elephants not used to being handled. A revised protocol for trunk wash collection in captive elephants in range countries has been published

The dilemmas ...

- The rapid serum tests are expensive and not easily available to field veterinarians. Specialist laboratories required for culture facilities to isolate mycobacteria are not readily accessible to field veterinarians in many range countries
- In many range countries, TB is endemic in the human population and captive elephants are exposed to humans extensively. Management strategies that try to regulate exposure in captive elephants are not feasible

The dilemmas ...

- The IUCN Red List classifies the Asian elephant as endangered. Priority for species conservation as well as the cultural and religious status of this species in Asian societies often challenges euthanasia of infected animals as an intervention option
- Adequate post-mortem procedures are usually not followed and follow-up monitoring and sample collection is difficult due to the lack of government policy and regulatory instruments in place to enforce the guidelines

The major dilemmas ...

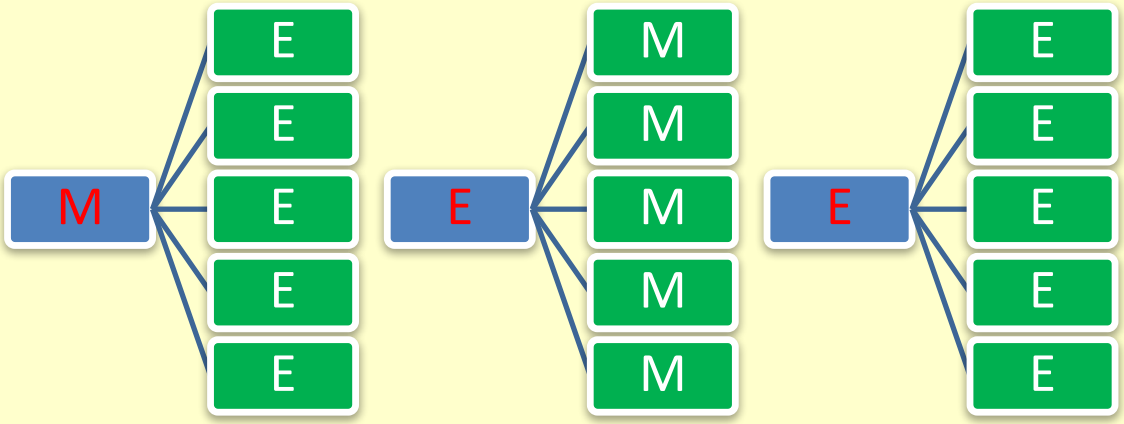
- There may be reduced compliance with full-course treatment and lesser concern for employee safety and health



What do we know?



http://en.wikipedia.org/wiki/Mahout

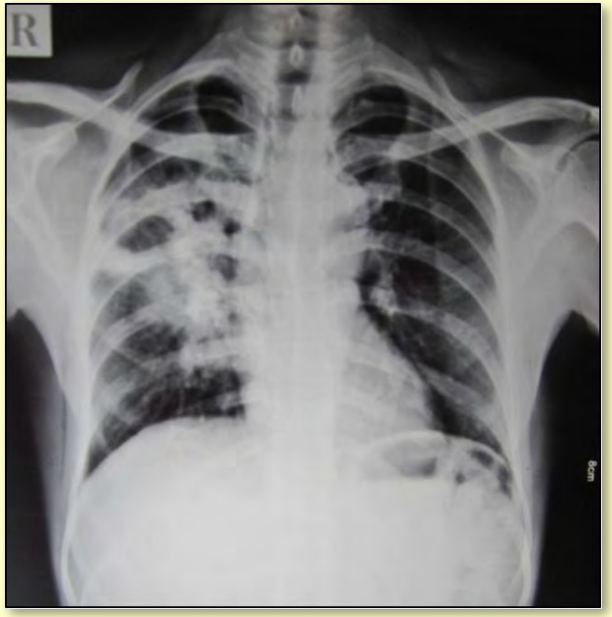


In the field

- One time screening of nearly 800 captive elephants and their mahouts completed in southern India
- Screening of elephants was done using serological tests and mycobacterial isolation on Lowenstein Jensen medium by culture of trunk wash from live animals and lung nodules from dead animals, by a team of veterinarians
- A team of medical physicians completed the tuberculosis screening of mahouts by clinical examination, chest X-ray evaluation, sputum culture and tuberculin skin testing




cm
inches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Preliminary results

- There is evidence to suggest inter-species tuberculosis transmission. *However, the risk of infection to a captive elephant from a diseased mahout seems to far outweigh the risks of infection to a mahout from a diseased elephant*
- *Under the tropical climatic conditions in southern India*, evidence seem to be lacking at present to suggest elephant-to-elephant transmission of human tuberculosis

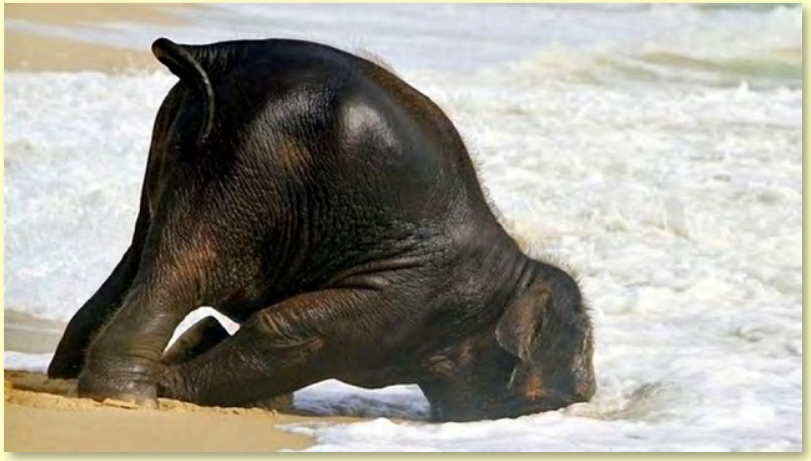
Conclusion

- Asian elephant range countries, require country and context-specific policy guidelines for control of TB infection in elephants. Interventions should take into consideration the prevailing infrastructure, as well as the cultural and socioeconomic factors
- For effective risk management, policy for tuberculosis control and prevention in wild and captive elephants require both a clear understanding of the disease burden and the feasibility of proposed interventions in the local context

So what did we learn?

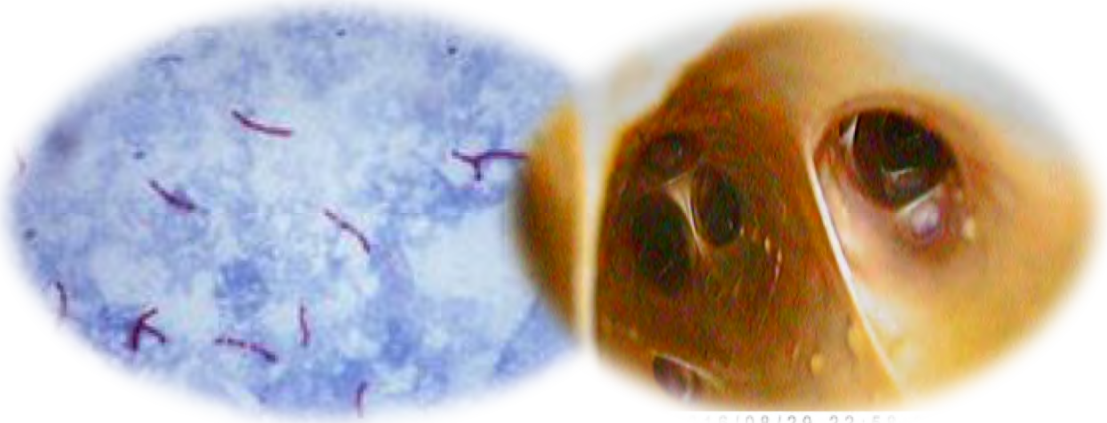
- Ethical as well as political consequences of the outcomes in each of the three scenarios are highly complex and diverse

Thank You!



Bronchoscopy, bronchial lavage and gastric fluid sampling for Mycobacterium tuberculosis screening during standing sedation in Asian elephants

Imke Lüders, Florence Ollivet Courtois, Muhammad Wahyu, Katharina Kranzer, Christopher Stremme





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Animal Fertility and Reproductive Research

Universitas Syiah Kuala

Veterinary Society for Sumatran Wildlife Conservation
Vesswic

Forschungszentrum Borstel
Leibniz-Zentrum für Medizin und Biowissenschaften

Construction of a mouth gate for elephants







- Heavy duty steel construction
- For the treatment of tetanus elephants („lock jaws“)
- Application of fluid and nutrients

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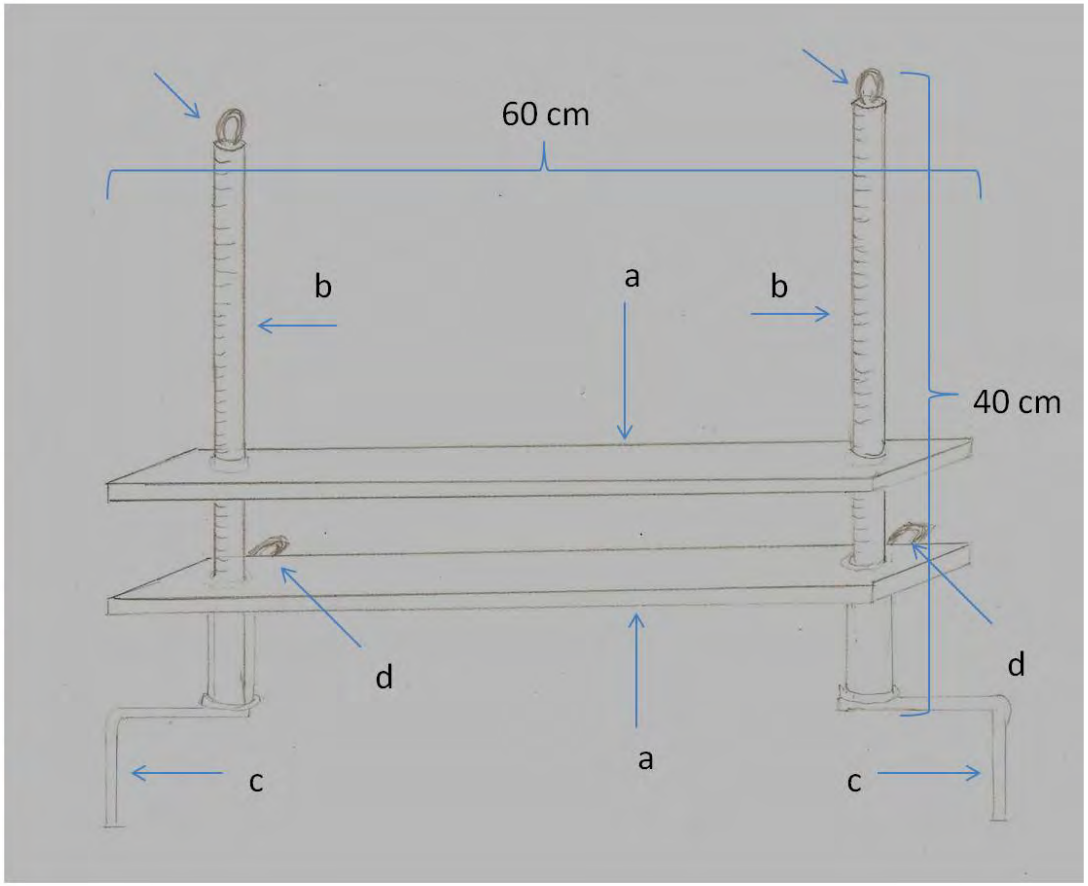
The elephant full mouth speculum





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Applications

- Inspection of oral cavity
- Bronchoscopy
- Gastroscopy
- Stomach tubing
- Tracheal and Bronchial lavage





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Sedation of the elephant

Xylazine & Ketamine –Sumatran elephants

Detomidine & Butorphanol- for elephnats in Europe





Adaequate sedation:

- Trunk permanently rested on the ground
- Ears not moving
- Drewling
- Jaws relaxed

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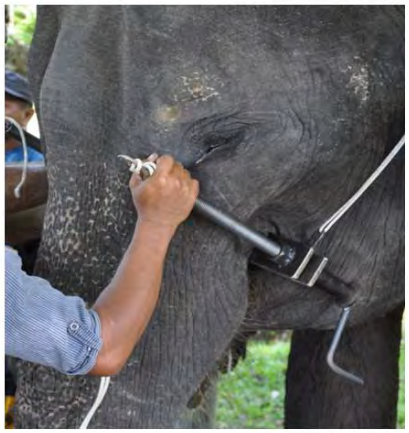
Fitting the mouth opener









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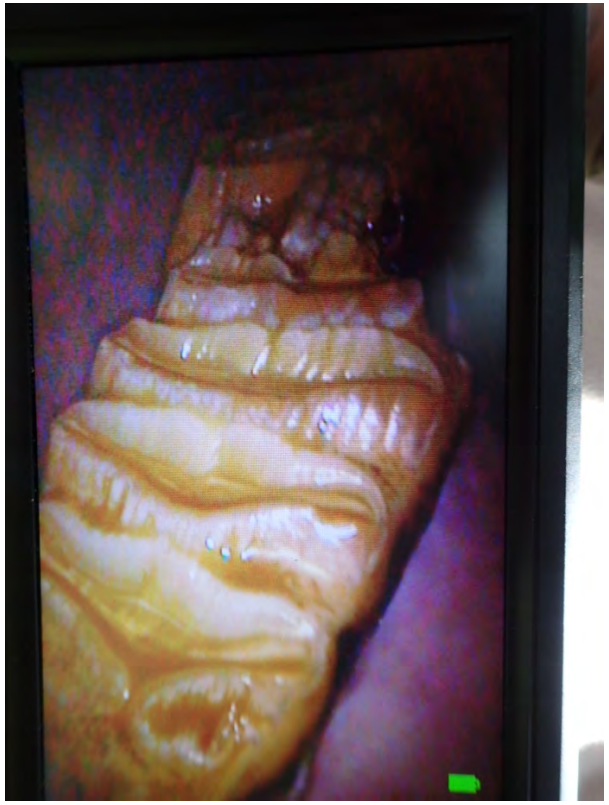
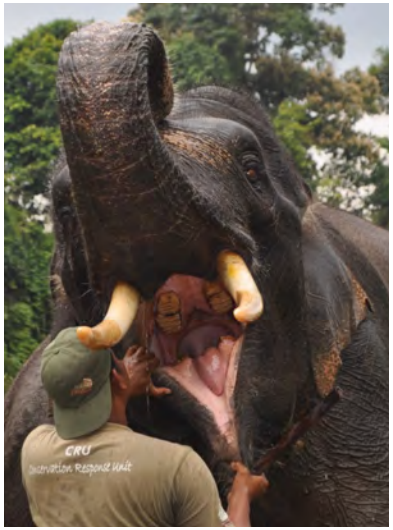
Inspecting the oral cavity











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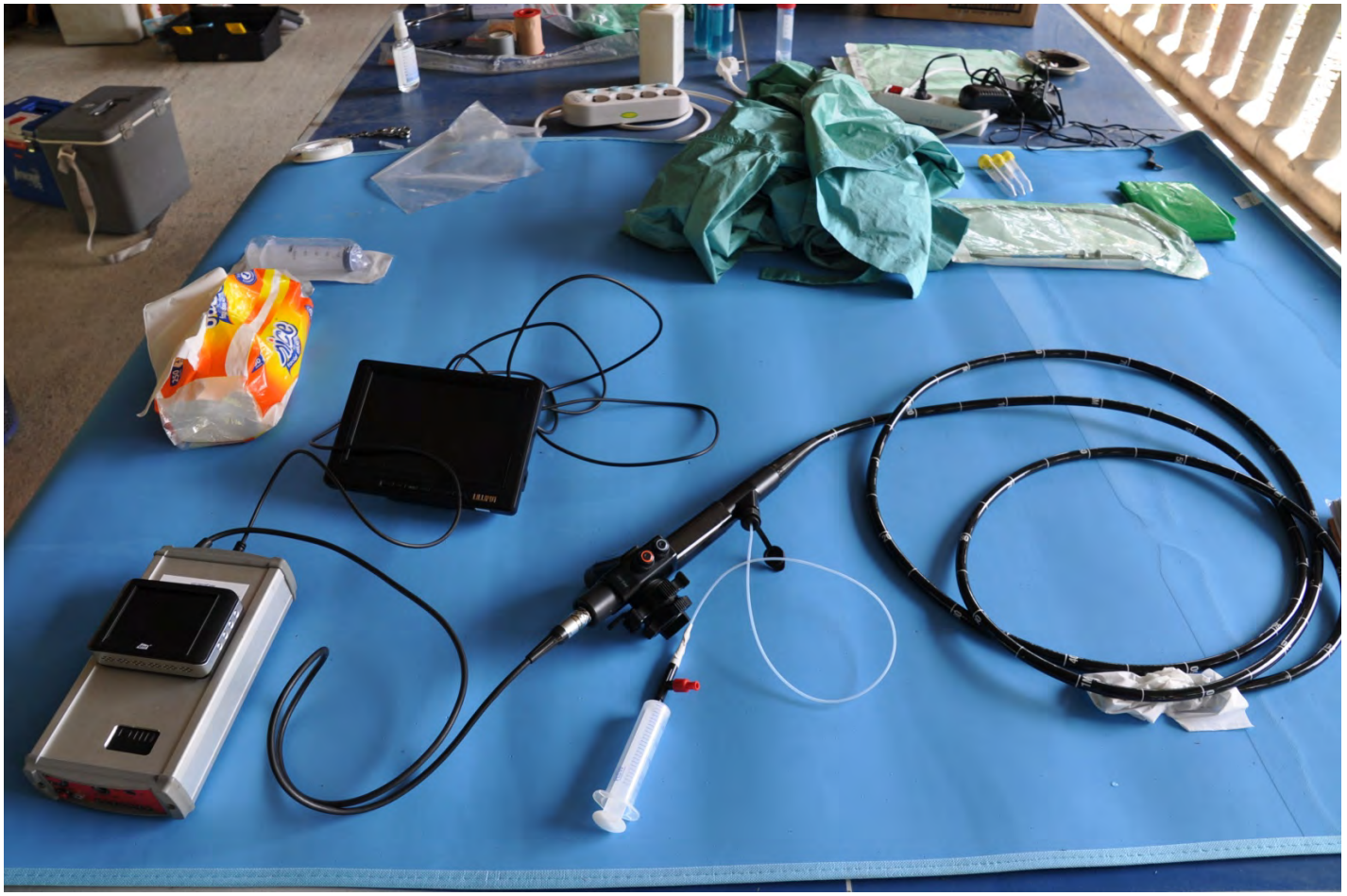
Fully portable/battery driven video endoscopy (3.3 m)



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Passing the scope directly into the trachea







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Bronchoscopy und Bronchial Lavage



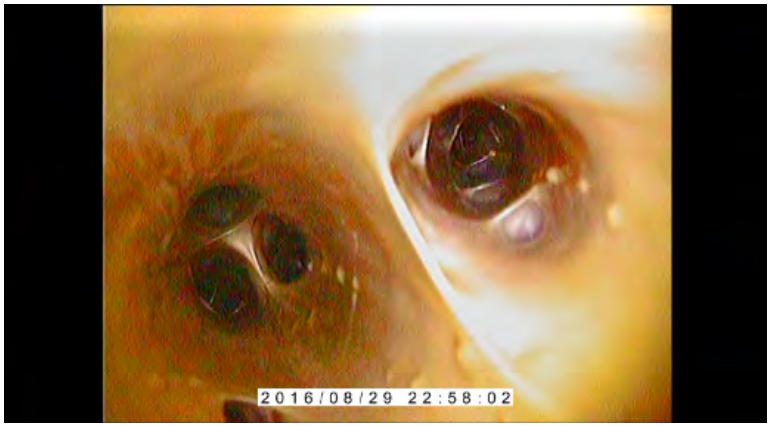


Photo: © Whipsnade zoo





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Stomach fluid collection





Reason:

- Mycobacteria are acid fast- accumulation in stomach at low pH
- Paired sampling by bronchial and stomach lavage in human medicine in patients unable to produce a sputum

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Video



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Sampled Asian elephants

Elephant	Gender	Age	Serology (STAT-PAK/DPP)	Trunk Wash	Bronchial lavage	Stomach fluid
Sumatra 1	f	>20	--	neg.	neg.	neg.
Sumatra 2	f	>20	--	neg.	neg.	neg.
Sumatra 3	f	>35	--	neg.	neg.	neg.
Sumatra 4	f	>35	--	neg.	neg.	neg.
Sumatra 5	f	>35	reactive	neg.	neg.	neg.
Sumatra 6	m	>30	--	neg.	neg.	neg.
Europe 1	f	~49	reactive	neg.	To be done	To be done
Europe 2	f	~49	reactive	neg.	To be done	--
Europe 3	f	~55	--	unknown	neg. PCR	neg. PCR
Europe 4	f	~52	reactive	neg.	MOTT	MOTT
Europe 5	f	~53	reactive	neg.	MOTT	MOTT
Europe 6	m	7	+ IFN-ϑ	neg.	neg.	--

-- =not performed; MOTT=mycobacteria other than tuberculosis

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Conclusion



- Simple approach during standing sedation
- Procedure time: 40-90 minutes
- Acces to teeth, tongue, palate, larynx, pharynx, trachea, stomach, oesophagus, bronchi

Value for TB diagnostics?

- Paired samples for PCR/culture from Stomach and Lungs
- Sampling from deeper regions, cleaner samples?
- Greater sensitivity still questionable, more research warranted!

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Special thanks to:

Department of Infectious Disease Epidemiology/ National Reference Center (NRC) for Mycobacteria, Leibniz -Center for Medicine and Biosciences, Borstel, Germany

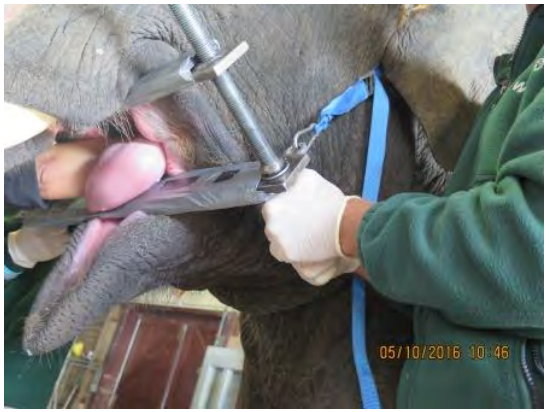
Veterinary Faculty Syiah Kuala University, Banda Aceh, Banda Aceh, Indonesia

Veterinary Society for Sumatran Wildlife Conservation, Medan 20132; North Sumatra; Indonesia

Zoo-and Wildlife Veterinary Practice F. Ollivet Courtois, 91640 Janvry, France



Photo: © ZSL Whipsnade zoo



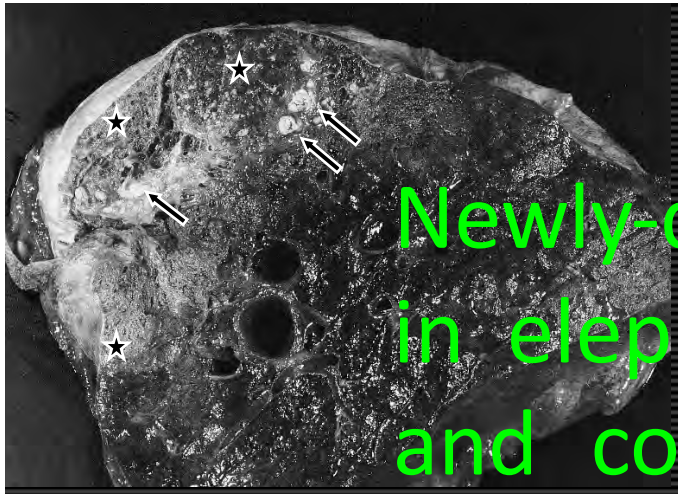
GE lifes
Animal Fertility and Reproductive Research

www.geolifes.com

UNIVERSITAS SYIAH KUALA

Veterinary Society for Sumatran Wildlife Conservation
Vesswic

Forschungszentrum Borstel
Leibniz-Zentrum für Medizin und Biowissenschaften



Newly-developed lung lavage system in elephants using a closed flushing and collection system for safe and sterile sample collection

- Thomas B Hildebrandt — IZW, Berlin, Germany
- Joseph Saragusty — IZW, Berlin, Germany
- Irmgard Moser — National TB Lab, Jena, Germany
- Susanne Holtze — IZW, Berlin, Germany
- Thomas Voracek — Vienna Zoo, Austria
- Andreas Bernhard — Leipzig Zoo, Germany
- Tim Bouts — Parc Pairi Daiza, Brugelette, Belgium
- Frank Goeritz — IZW, Berlin, Germany
- Robert Hermes — IZW, Berlin, Germany


Office of a zoo veterinarian
punished by M. tuberculosis (Mtb)
TB
TB
TB
2001-200
TB
TB
TB
TB
TB
TB
TB
TB
TB
AKTUELLT OM TBC
Zoo's
Europa-Atlas
FORSKNING
TILLS M
VET KLINIKEN
REHAB.
IN SITU
Forskning
K.D.
Projekt
K.D.
ELEFANT
GORILLA
ZOO VET
NEWS
SDF
FAZA

Mtb indirect tests in elephants



Mtb direct tests in elephants




FEB 13 2004
FEB 13 2004
FEB 13 2004


FEB 13 20

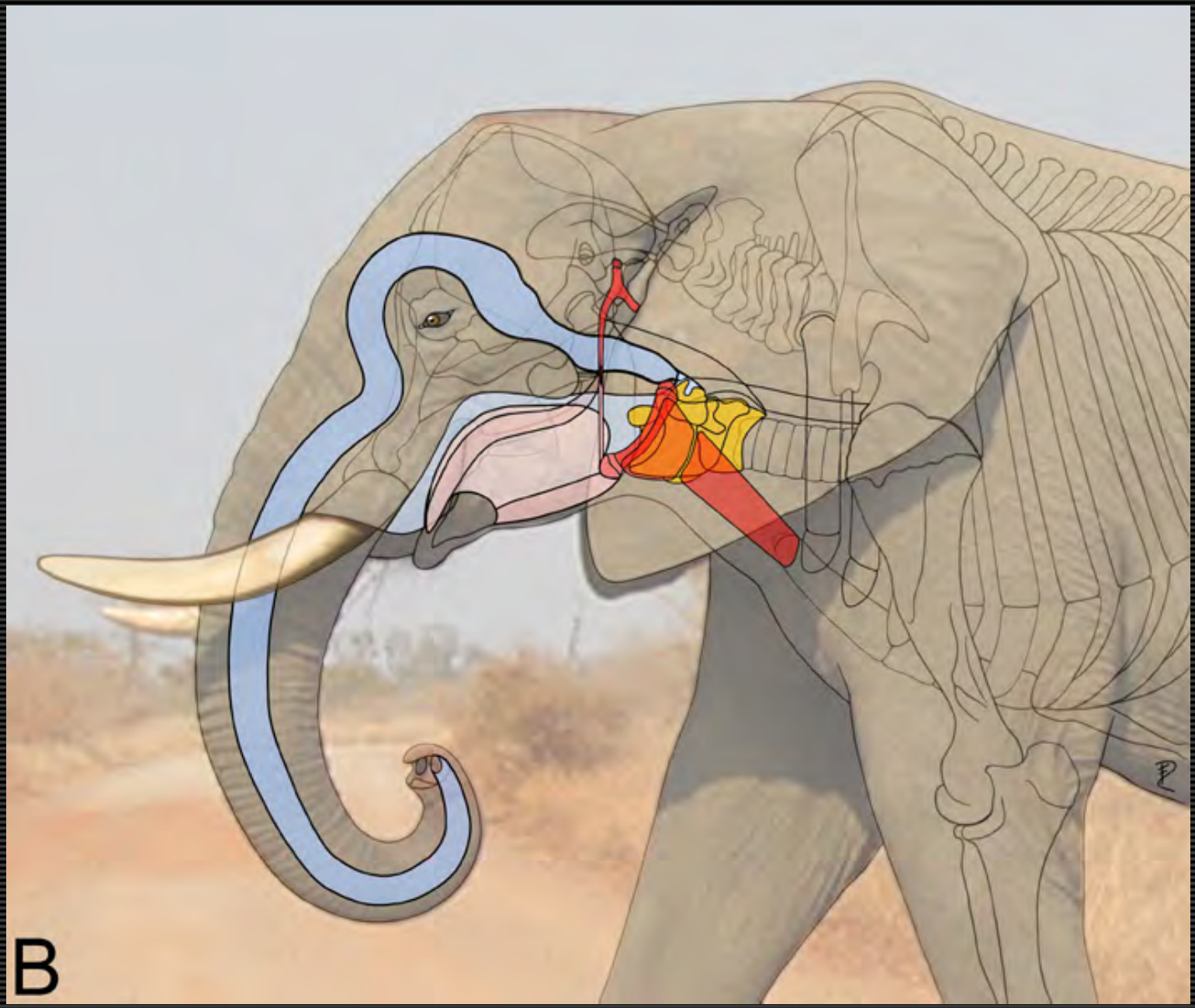

FEB 13 2004

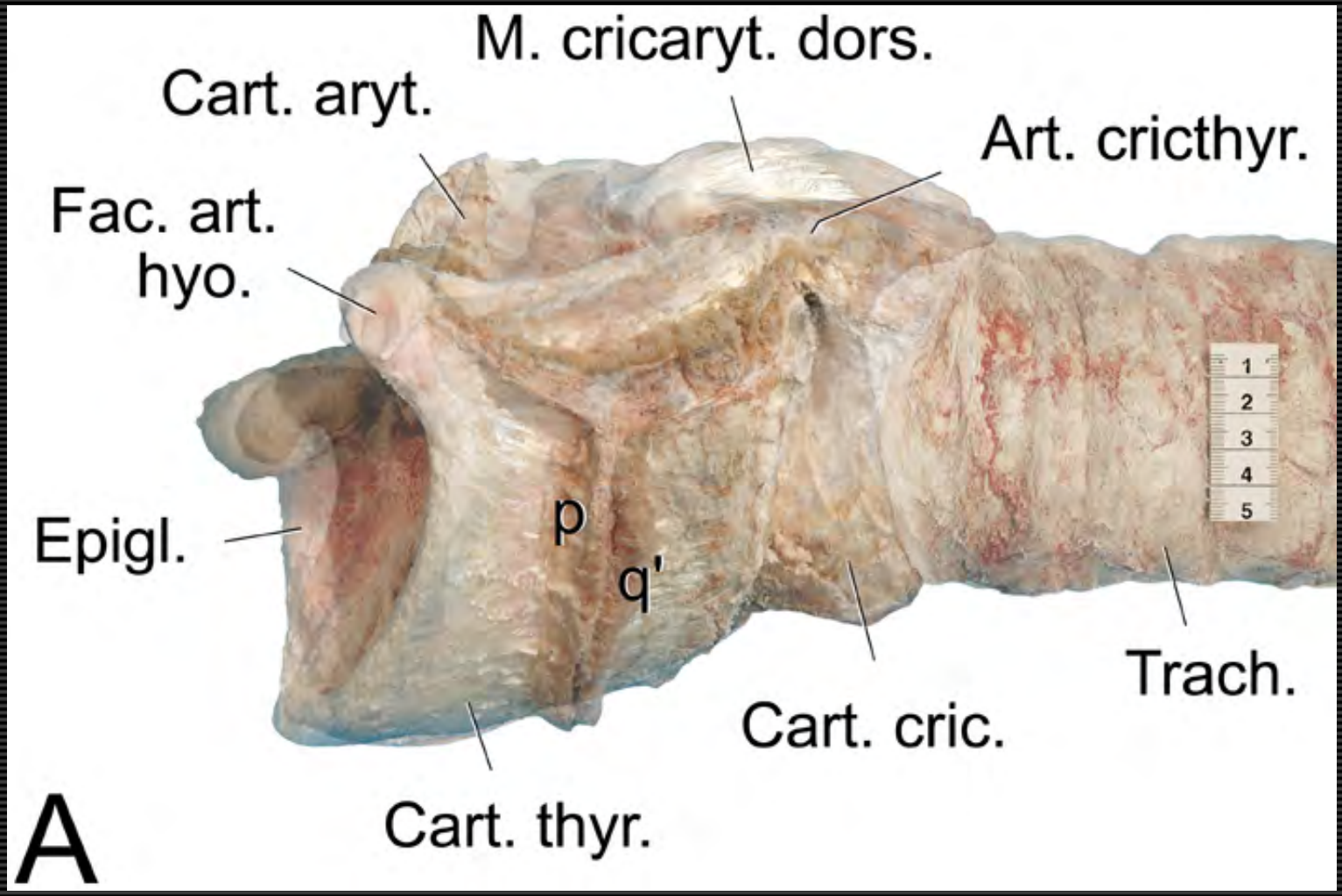

FEB 13 2004

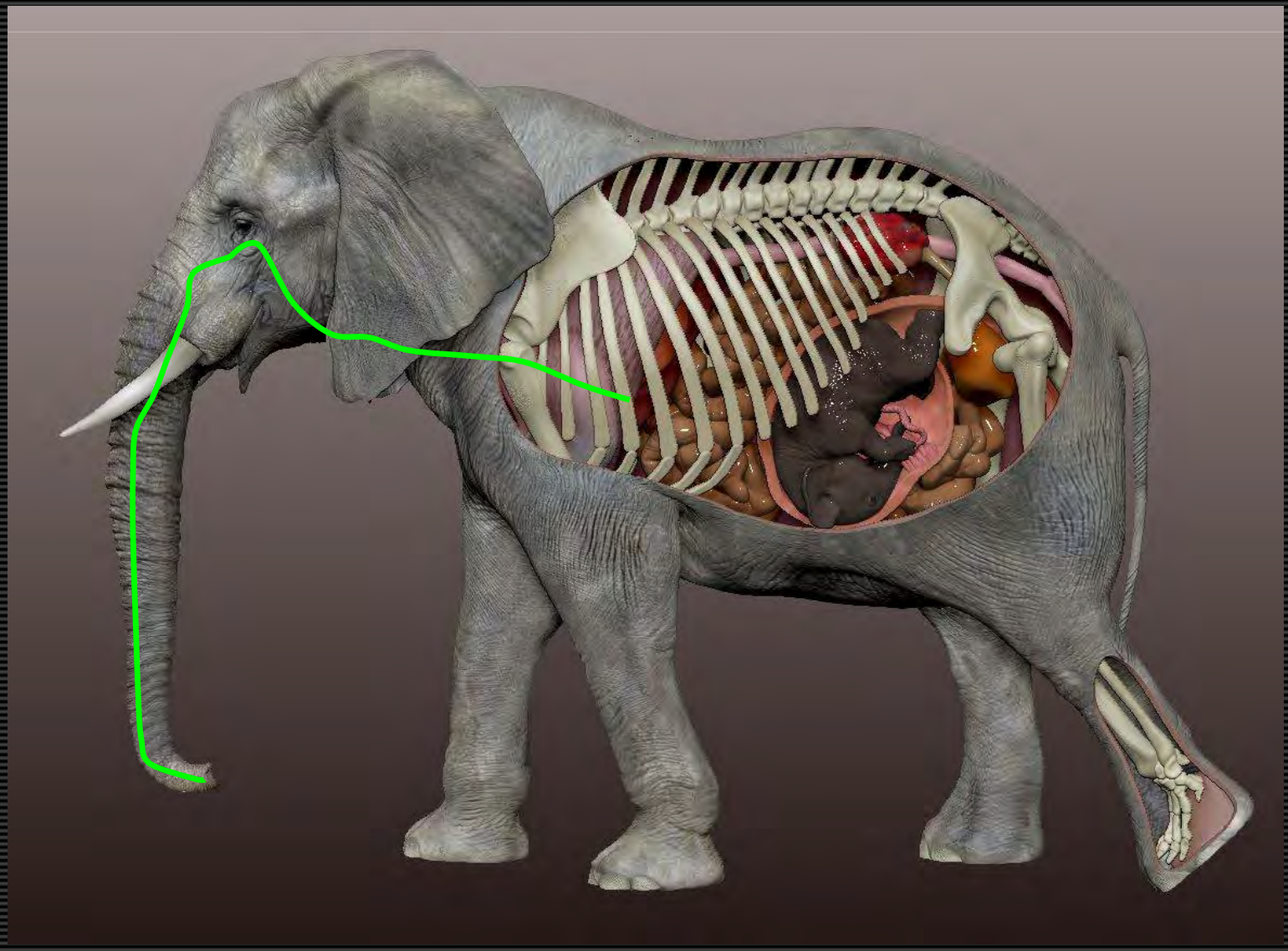


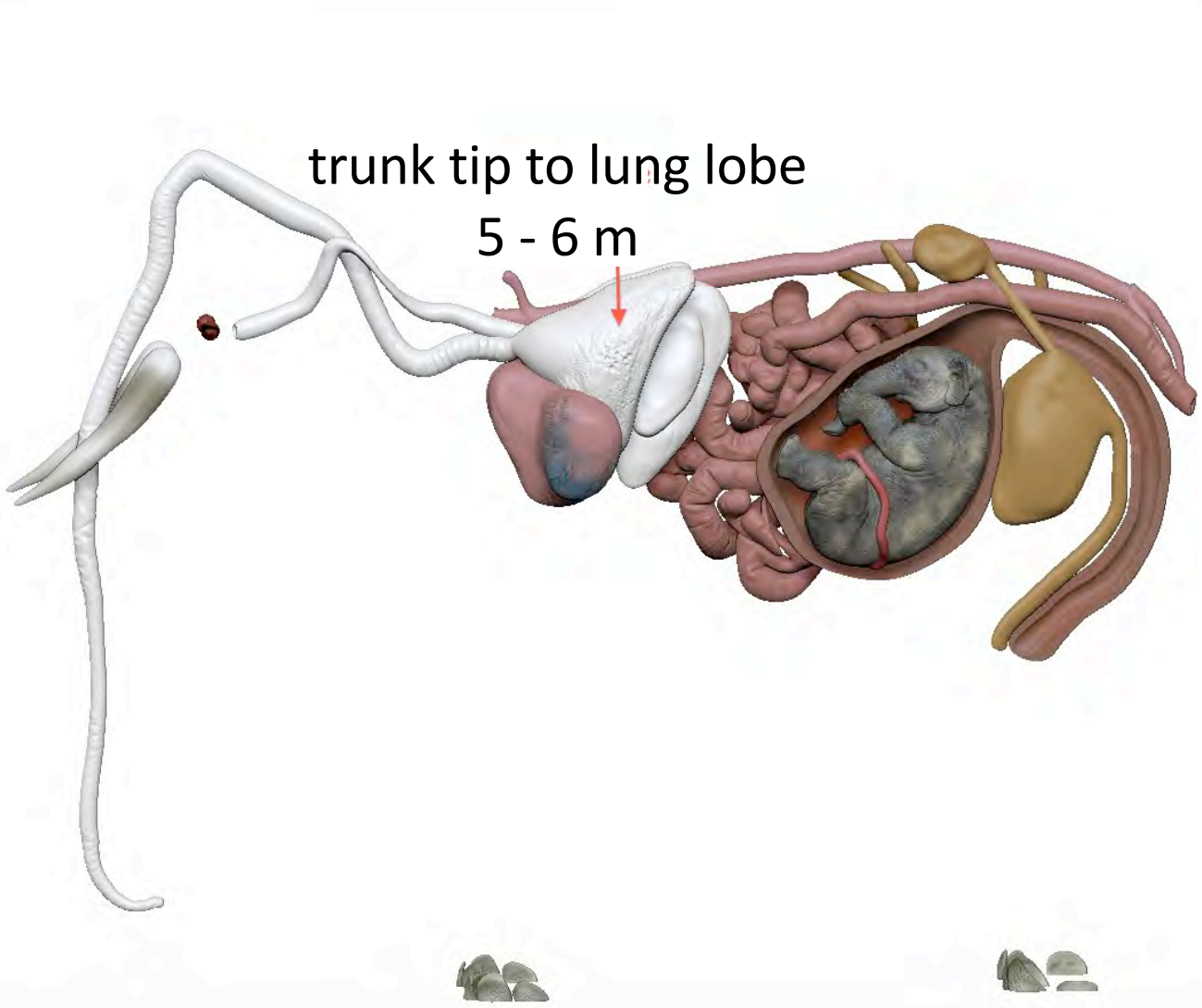
Mtb direct test in elephants




B


M. cricaryt. dors.
Cart. aryt.
Art. cricthyr.
Fac. art. hyo.
Epigl.
p
q'
Trach.
Cart. cric.
Cart. thyr.
A



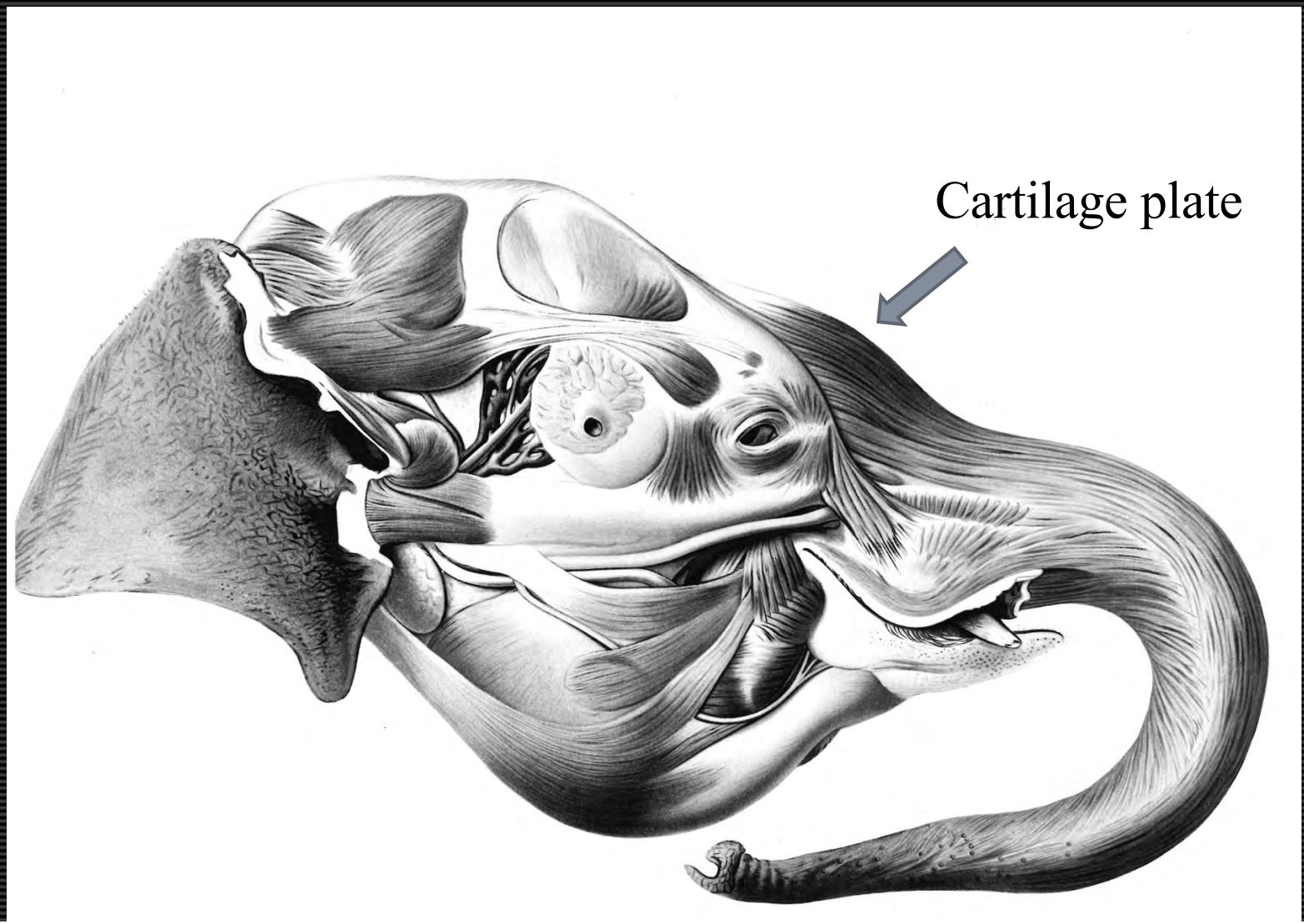

trunk tip to lung lobe
5 - 6 m

Diagnostic Mtb sampling in elephants endoscopy

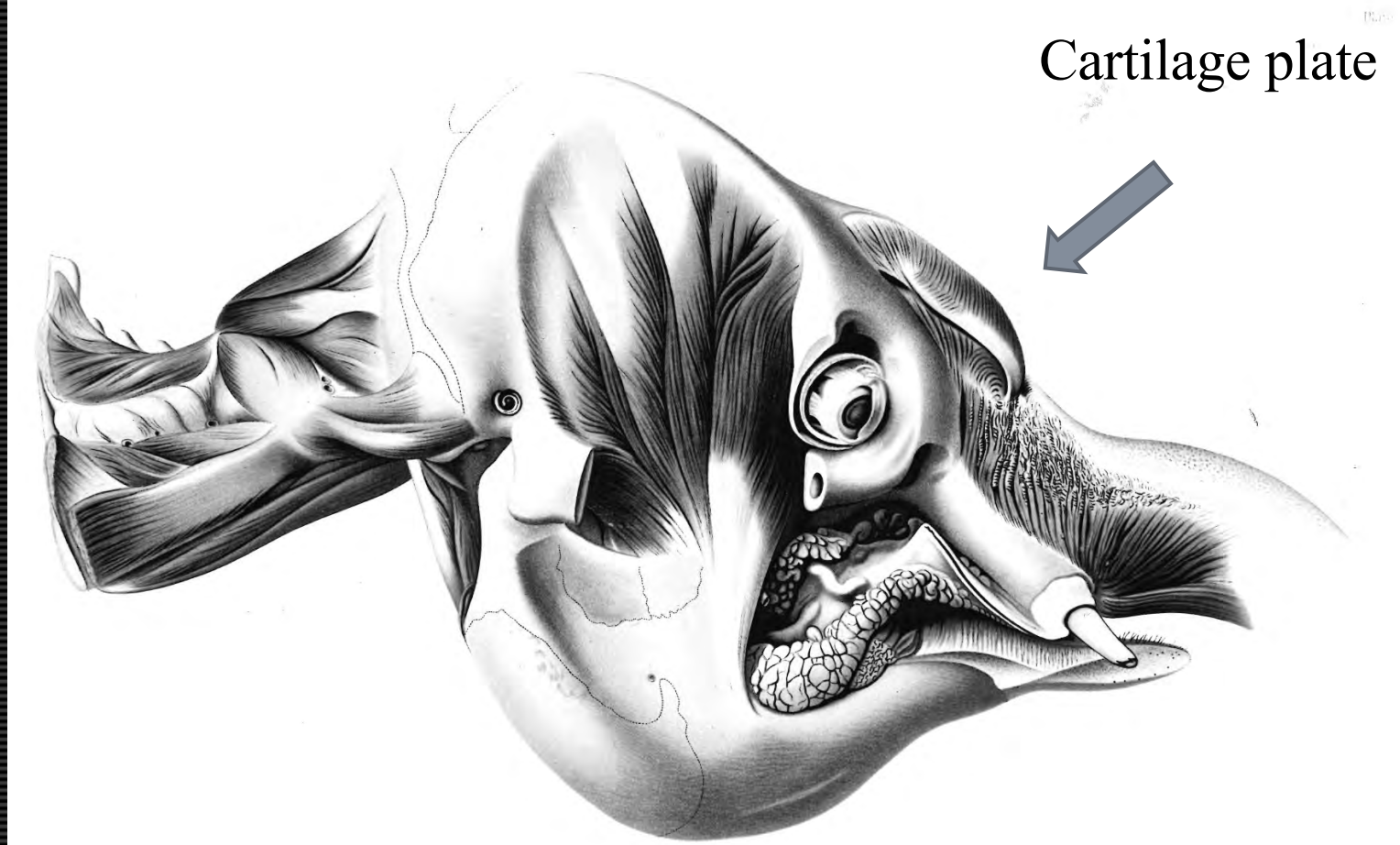




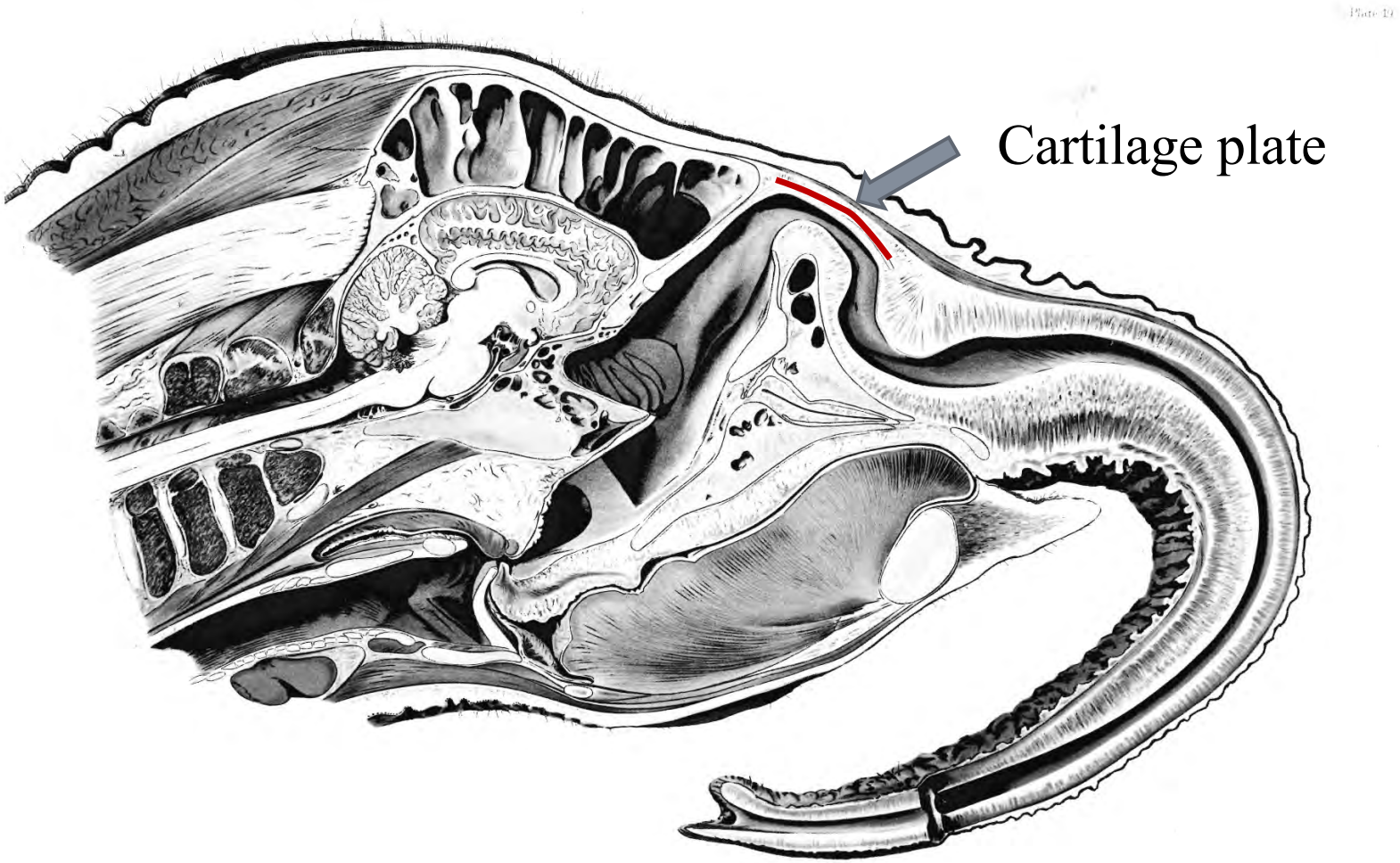
Lung lavage



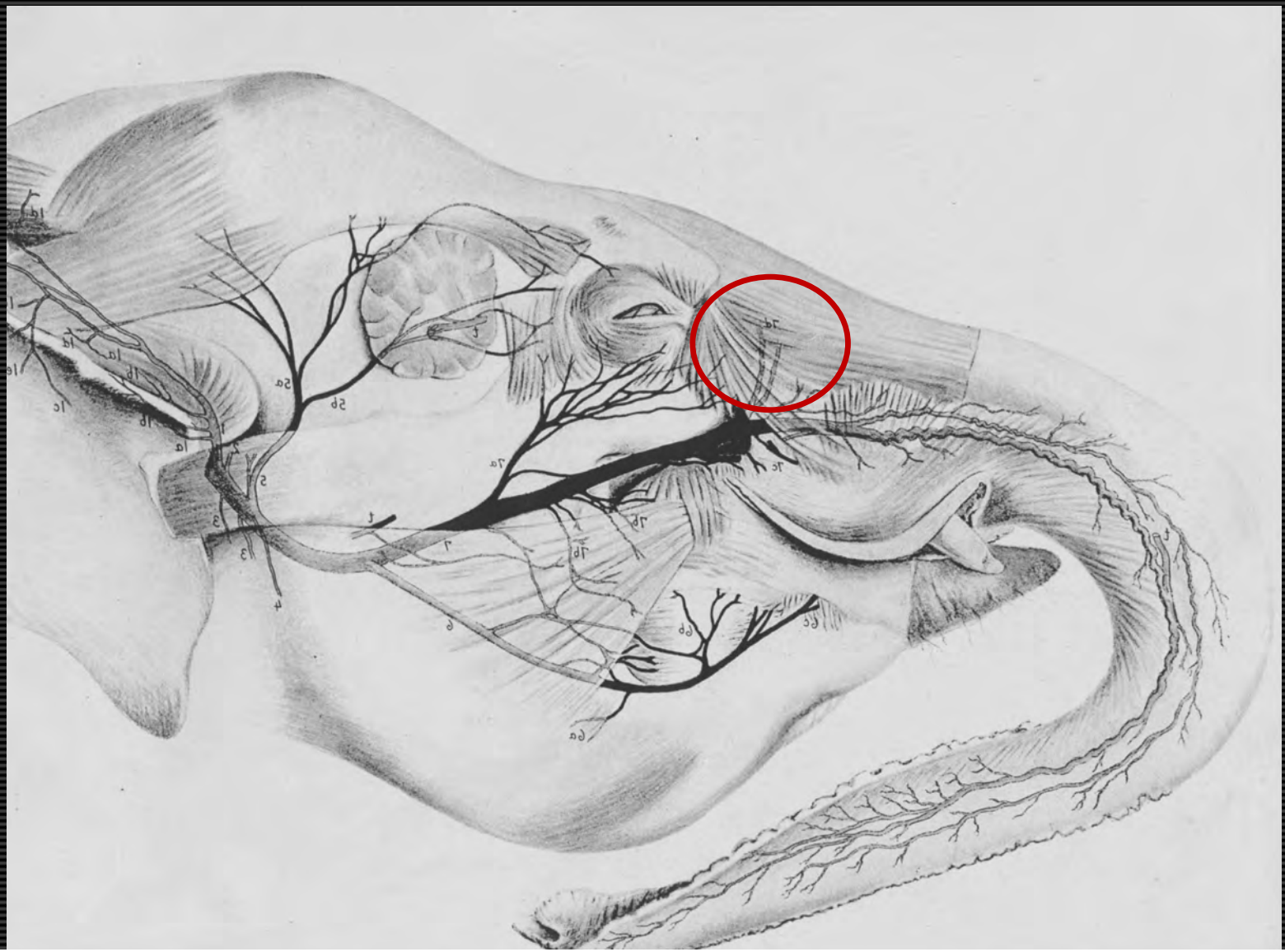
Lung lavage

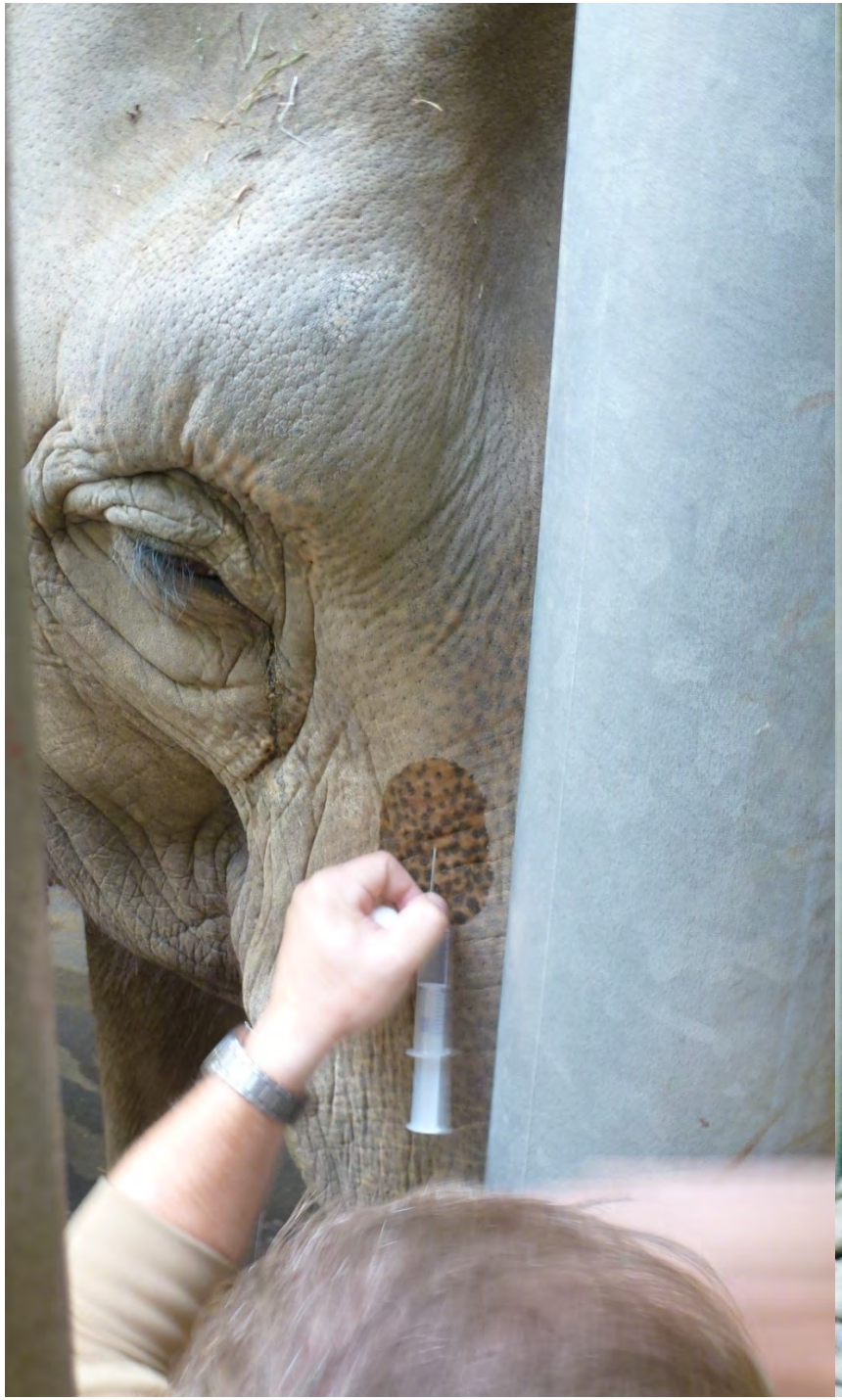


Lung lavage



Lung lavage










50

Material and Method

Animals

- performed on 12 elephants
  - 6 African (*Loxodonta africana*)*
  - 6 Asian (*Elephas maximus*)
  - 8 European institutions (zoos @ circuses)
  - 9 females / 3 males
  - age range 9 to 42 years

* in two African elephants procedure was repeated with eight months elapsing between examinations

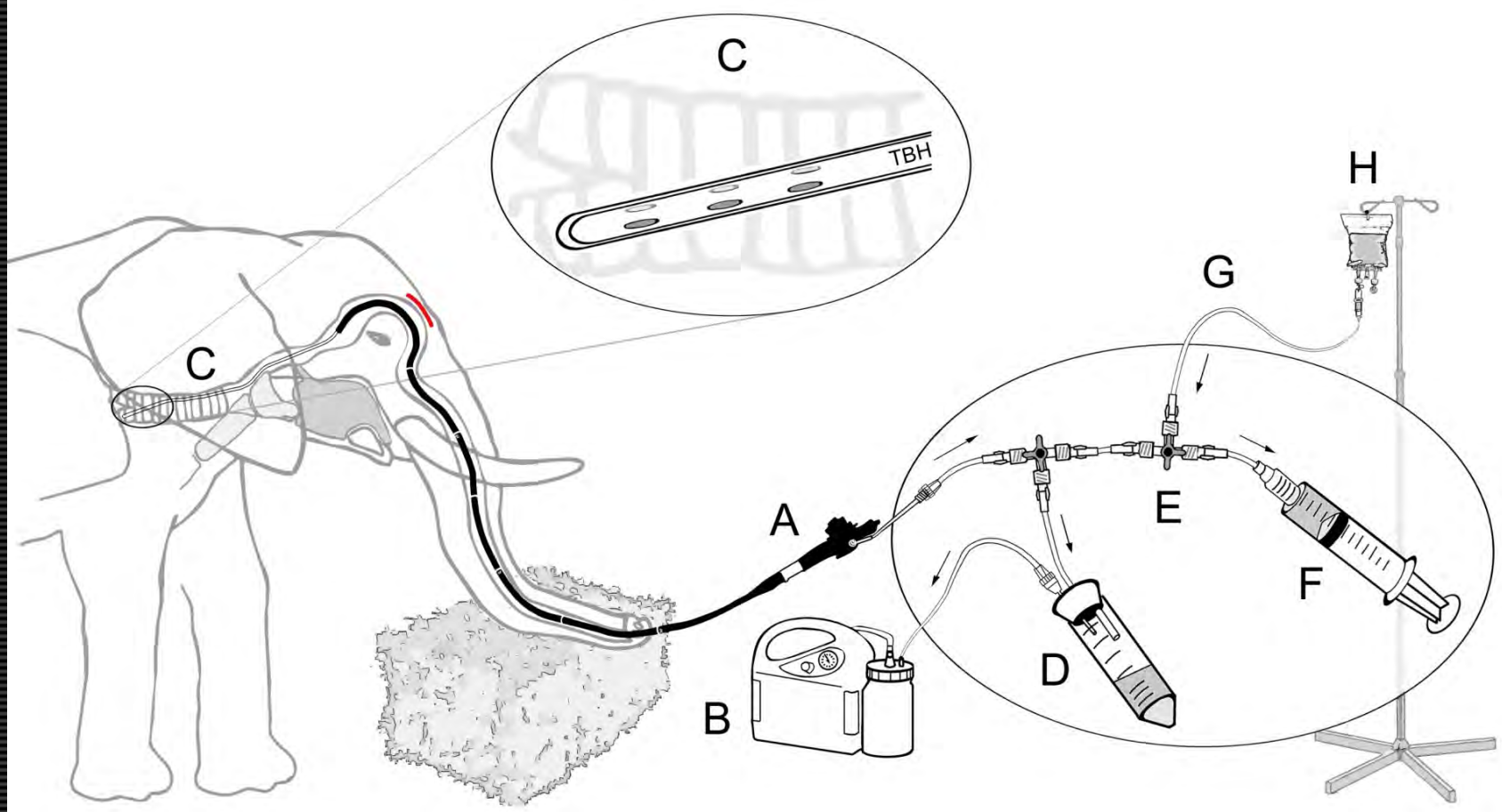
Material and Method

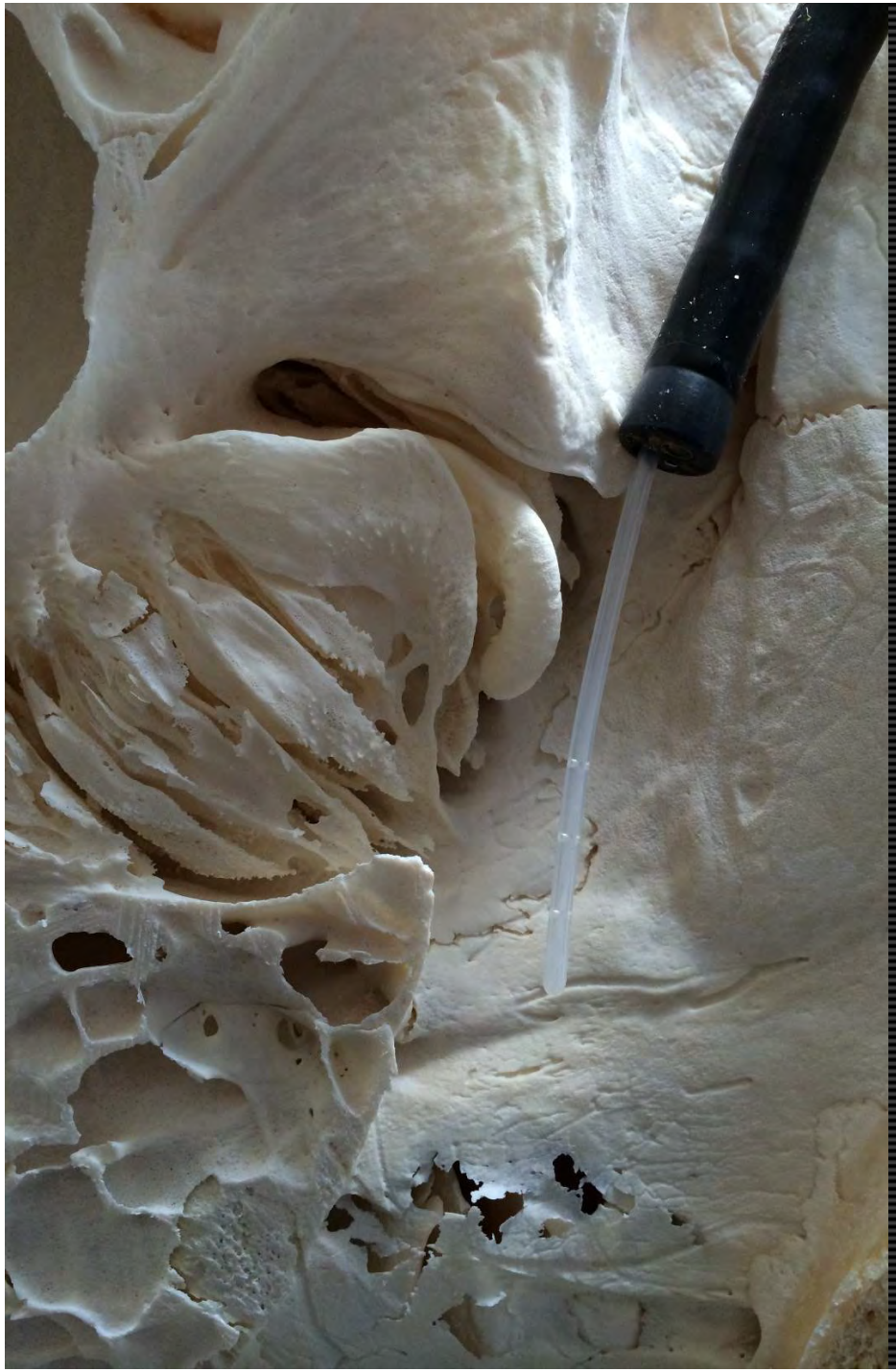
Standing Sedation

- combination of
  - 0.02 mg/kg detomidine i.m.
  - 0.02 mg/kg butorfanol i.m.
  - estimated body weight 2.0 to 6.0 tons

  - 15 min later 4x 10 ml 2% lidocaine depots to nerve rami innervating the base of the trunk

Closed flushing and collection system





Technique

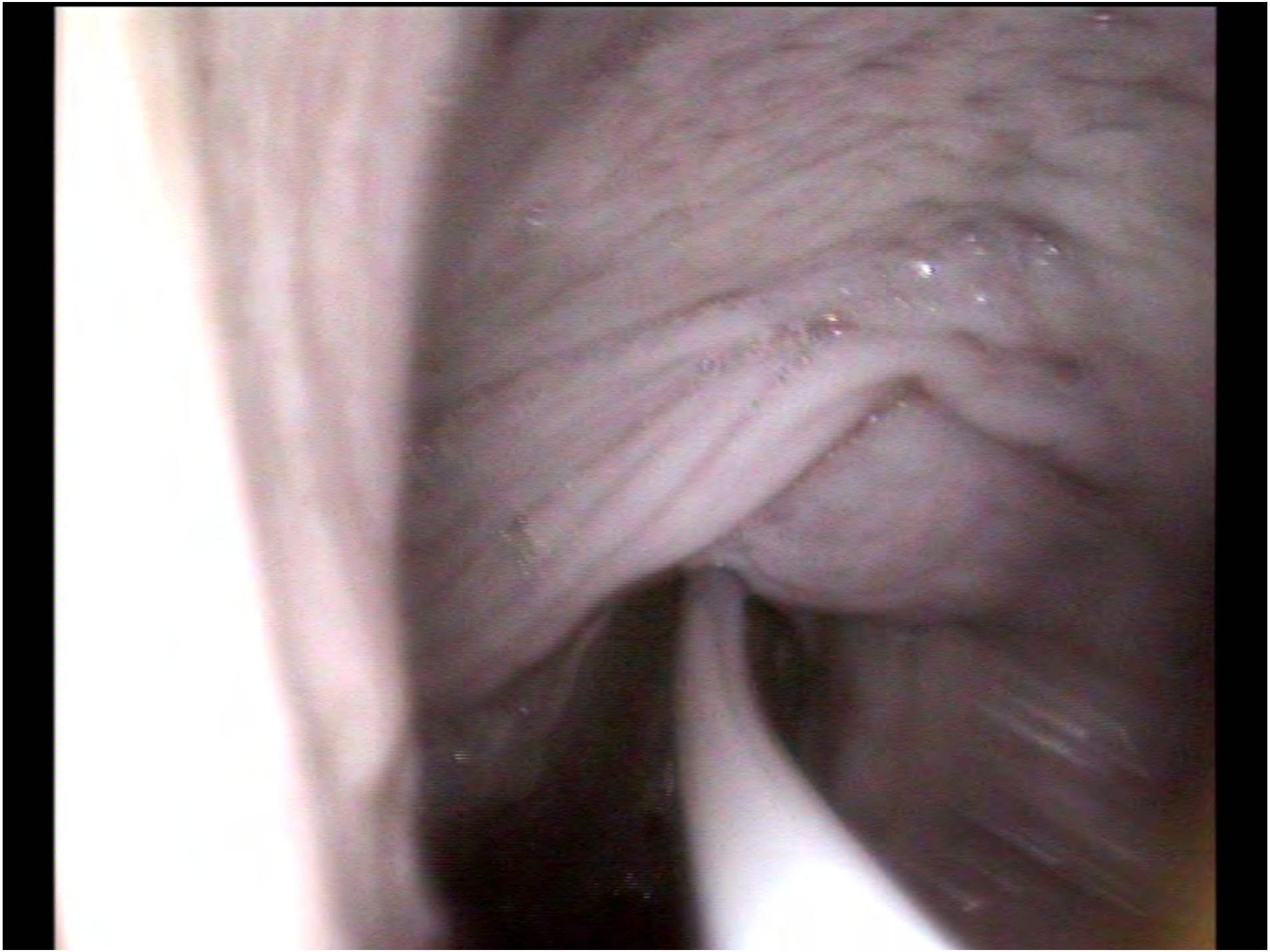
normal sized elephant (2.0 to 4.0 tons)

- 3.5 m flexible video endoscope
- 6.0 m TBH catheter

large sized elephants (5.0 tons +)

- 5.0 m flexible endoscope
- 8.0 m TBH catheter

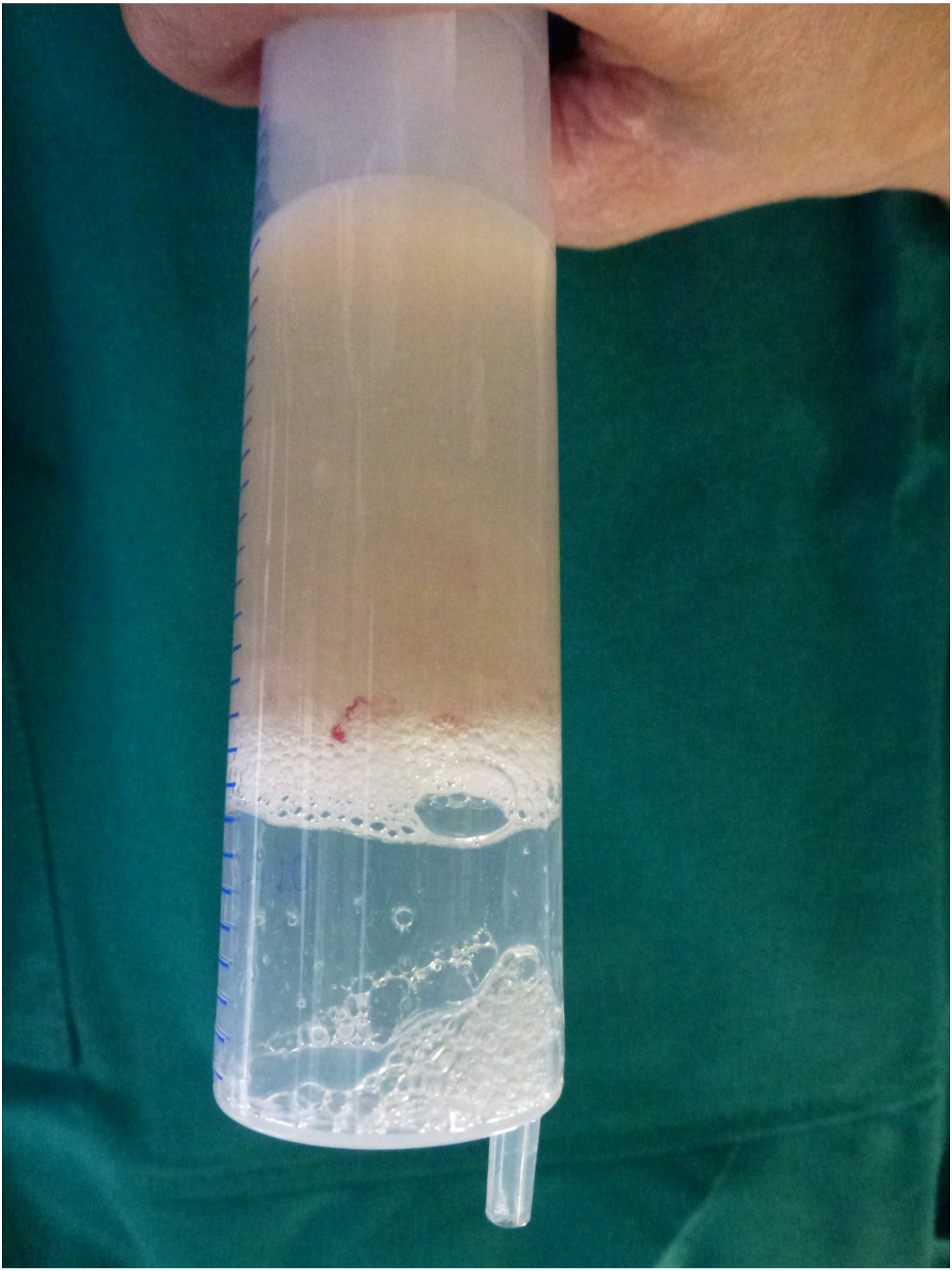




Adspection of the upper respiratory tract










HORSE



Results

Species	#	STAT-PAK / DPP	PCR	Culture	Remarks
EM	1	+	-	-	interupted procedure only trunk wash
EM	1	+	-	-	
EM	4	-	-	-	
LA	3	+	+	+	1x M. avium ssp. hominissuis 2x M. novocastrense
LA	3	-	-	-	

Results

Species	#	STAT-PAK / DPP	PCR	Culture	Remarks
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LA	3	+	+	+	1x M. avium ssp. hominissuis 2x M. novocastrense
LA	3	-	-	-	

Conclusion

Trunk wash	Bronchoalveolar lavage
Risk for staff	
moderate	zero
Cross contamination risk	
high	zero
Animal training effort	
high	zero

Conclusion II

Trunk wash	Bronchoalveolar lavage
additional information / biopsy	
no	yes
equipment cost	
low	high
specialized skill	
yes (elephant training)	yes (veterinary profession)



Conclusion III

Bronchoalveolar lavage in elephants provides a new and effective opportunity for direct testing of active respiratory infections

thanks



Thirty years in Elephant Healthcare in NE India

Dr Kushal Konwar Sarma, Prof.
College of Veterinary Science,
Guwahati, Assam, India

Elephant population status, NE India (wild)

	1986	2002	2007	2012
Arunachal Pradesh	2000-4300	1607	1690	890
Assam	3700	5246	5281	5620
Meghalaya	2870-3875	1868	1811	NA
Nagaland	NA	145	152	212
Mizoram	NA	33	12	0
Manipur	NA	12	0	0
Tripura	120-150	40	59	59

Elephant population, NE India(captive)

	1996	2015
Arunachal Pradesh	700-800	350
Assam	2000	1260
Meghalaya	120	30
Nagaland	5	5
Tripura	40	40
West Bengal	100	125

Disease/disorders incidence in order of frequency of occurrences

- Parasitic
- Foot affections
- Abscess, bursitis, gall
- Fractures
- Gunshot wounds
- Musth
- Tetanus, TB, Rabies, FMD, Herpes
- Misc (colonic impaction, Tusk injuries etc.)


Sub- Mandibular Oedema


Ventral Odeama



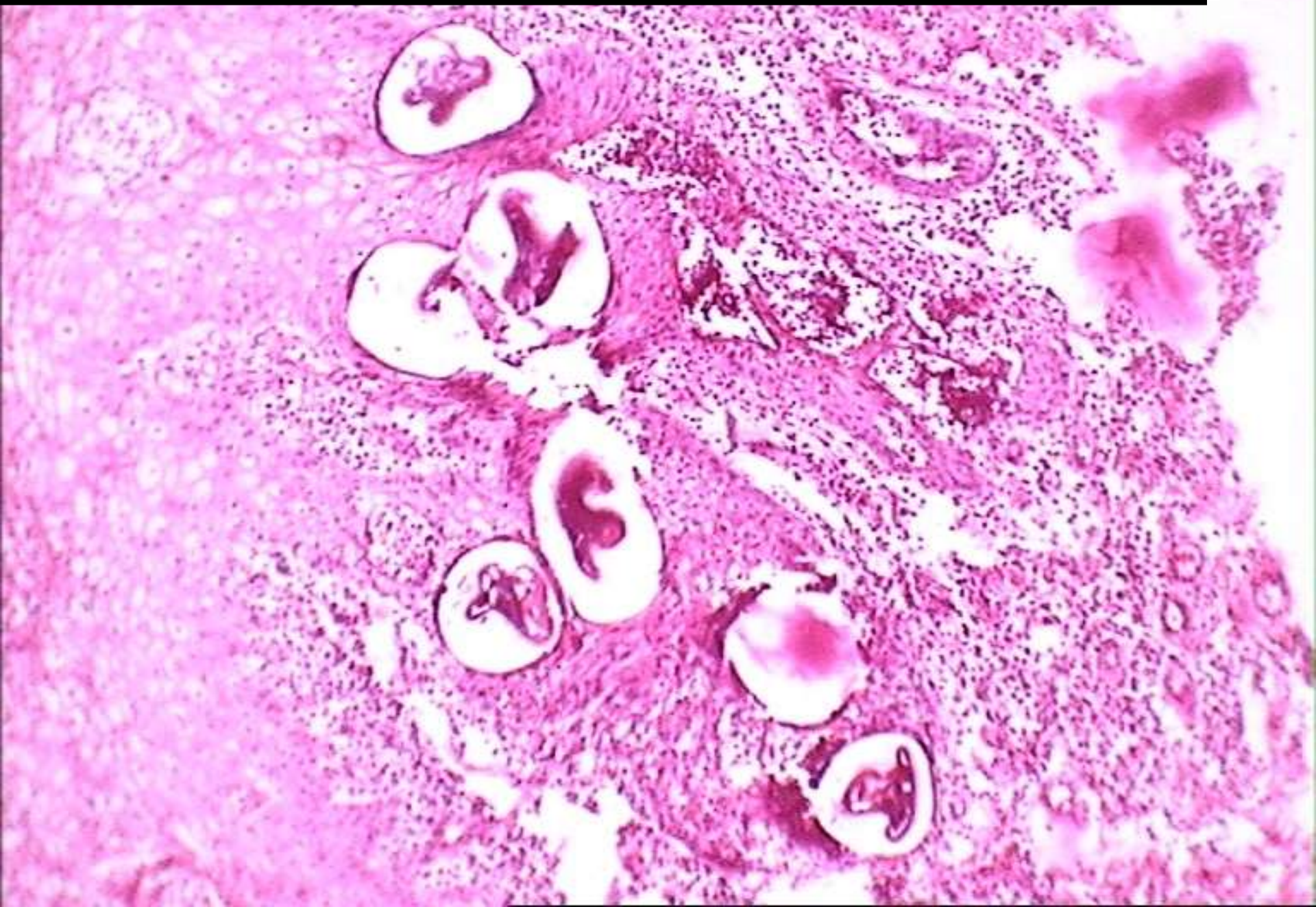


Cutanaeous filariasis

Seneviretena *et. al.* 1996

Chandrasekharan *et al. 1996*

Cross sections of filarial parasite in tissues




Coboldia elephantis


Overgrown nail


Split nails


Kari

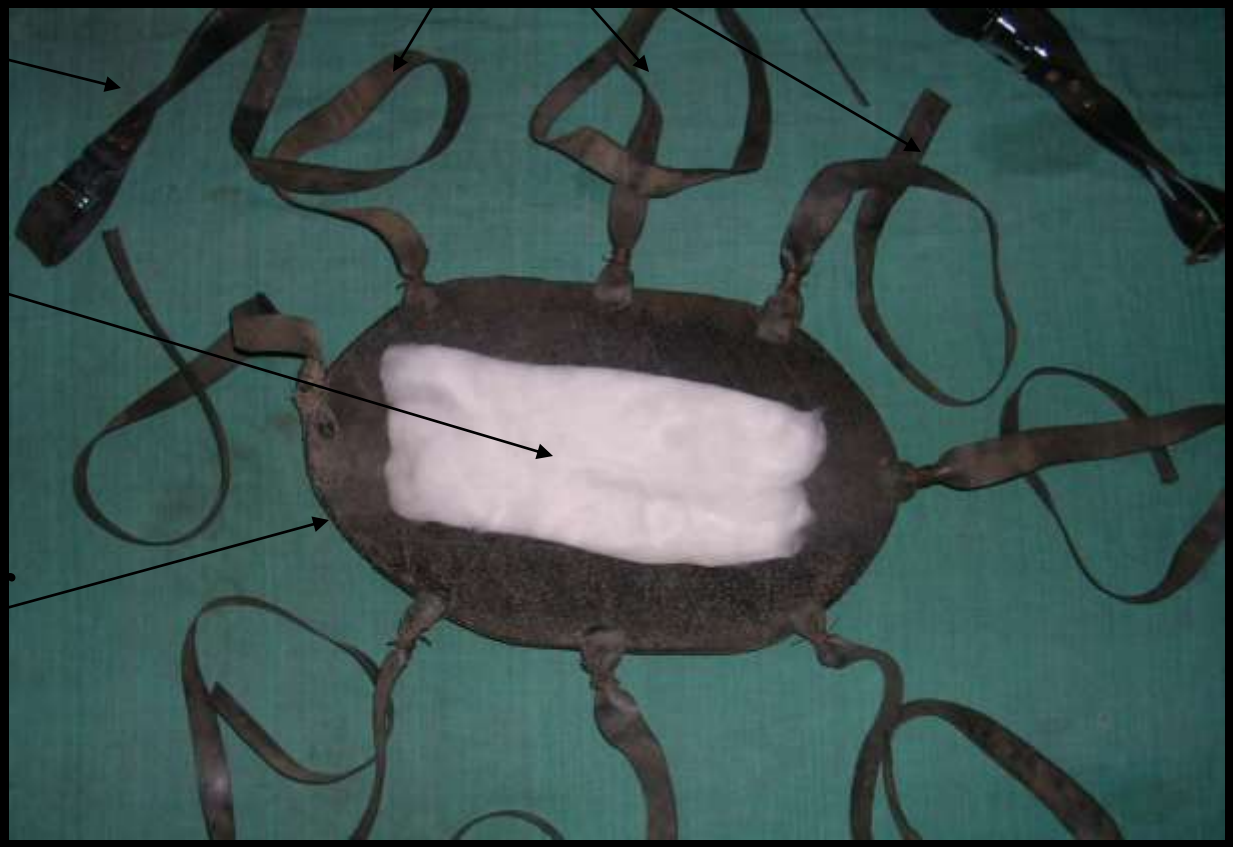

Very chronic *Kari* with sole erosions







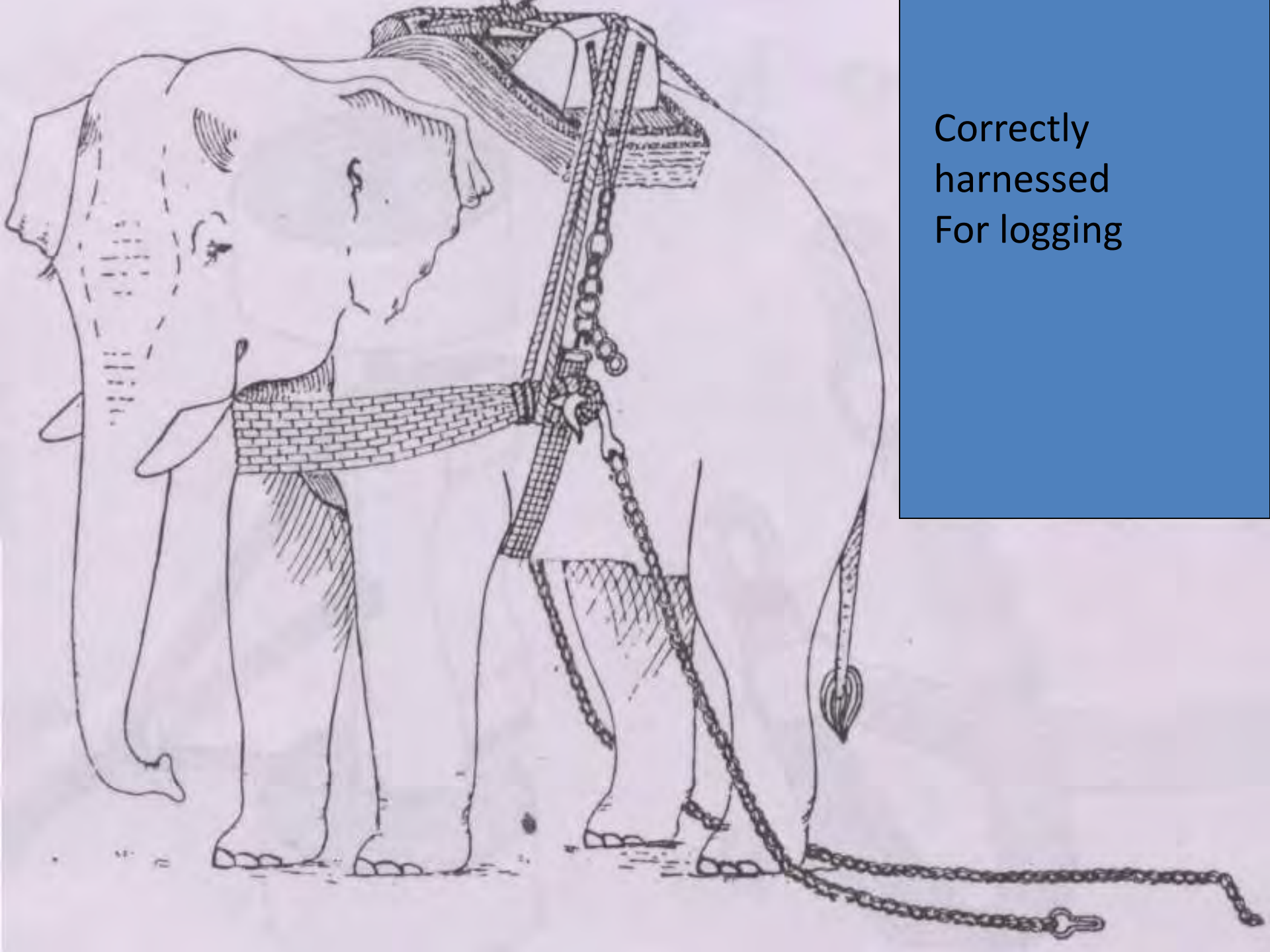




Elephant sandal



- Shoe in use



Correctly
harnessed
For logging



An overwhelming 50% of captive elephants engaged in logging



Farra gall



Opening of abscess caused by farra gall





A ruptured *farra* gall



Injury caused by neck rope



Extensive sloughing from a neglected saddle gall



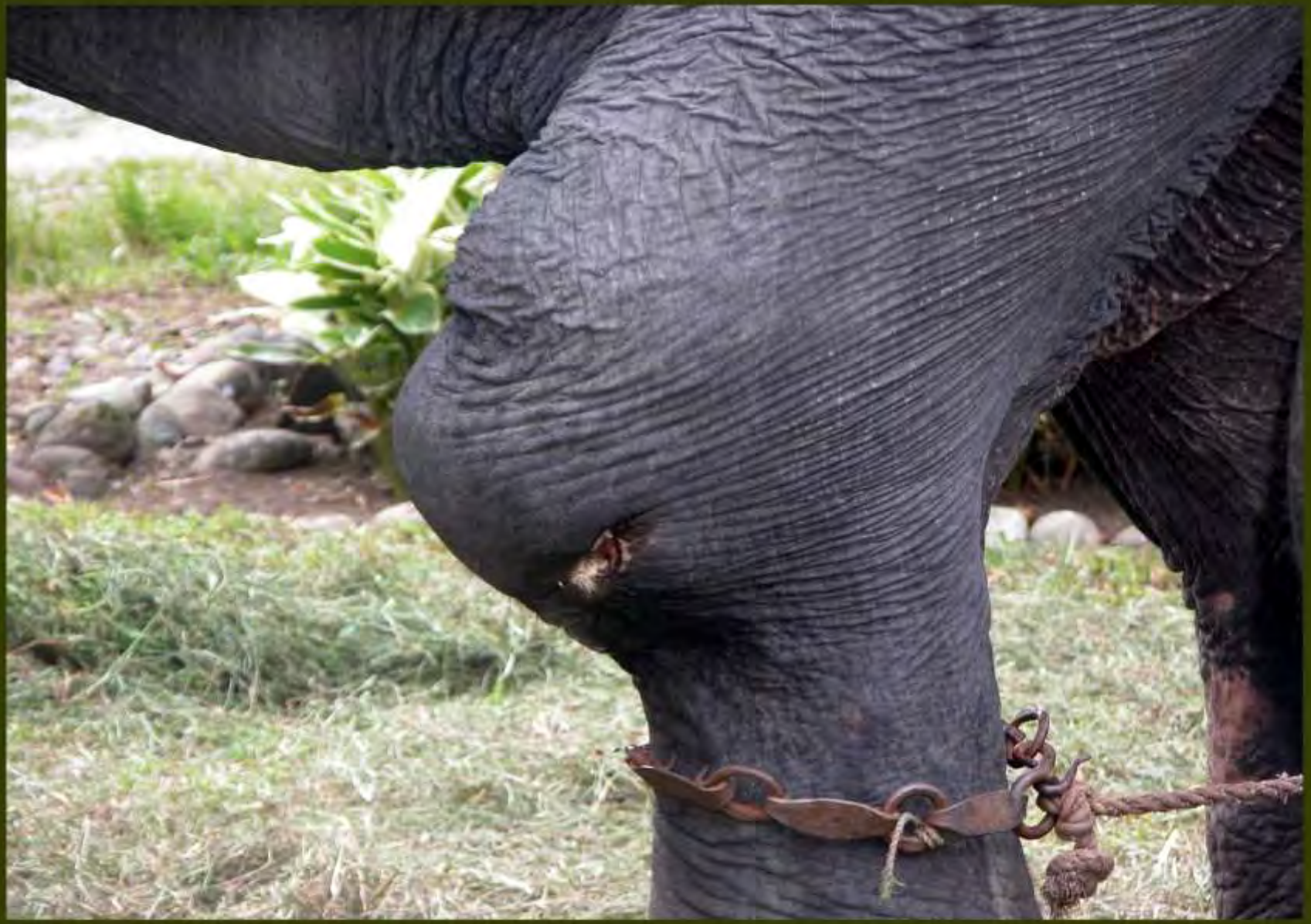
An improperly designed howdah or saddle



Making elephants kneel on hard or uneven surfaces may cause injuries to the elbow, stifle and sternum

Peribursal haematoma





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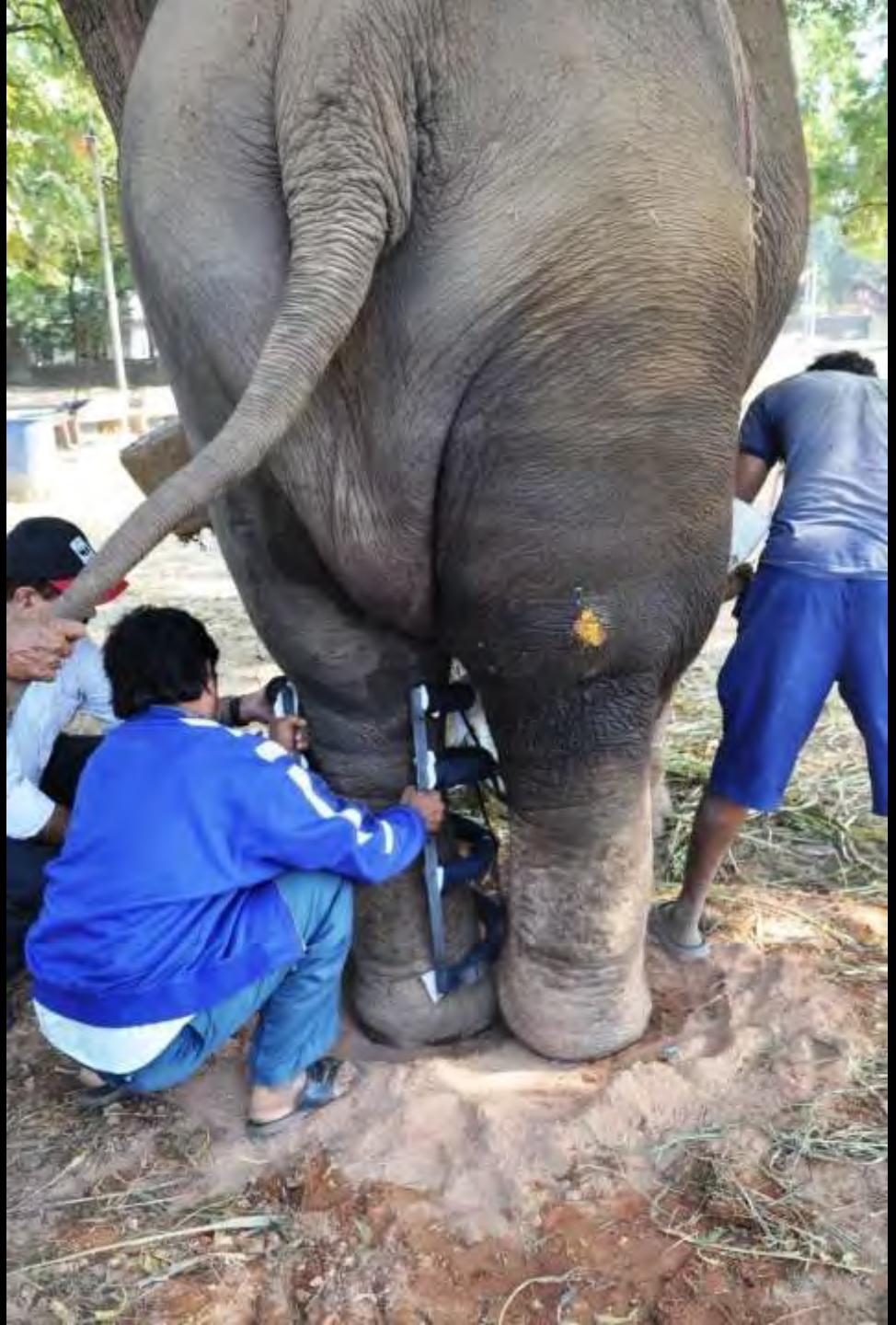
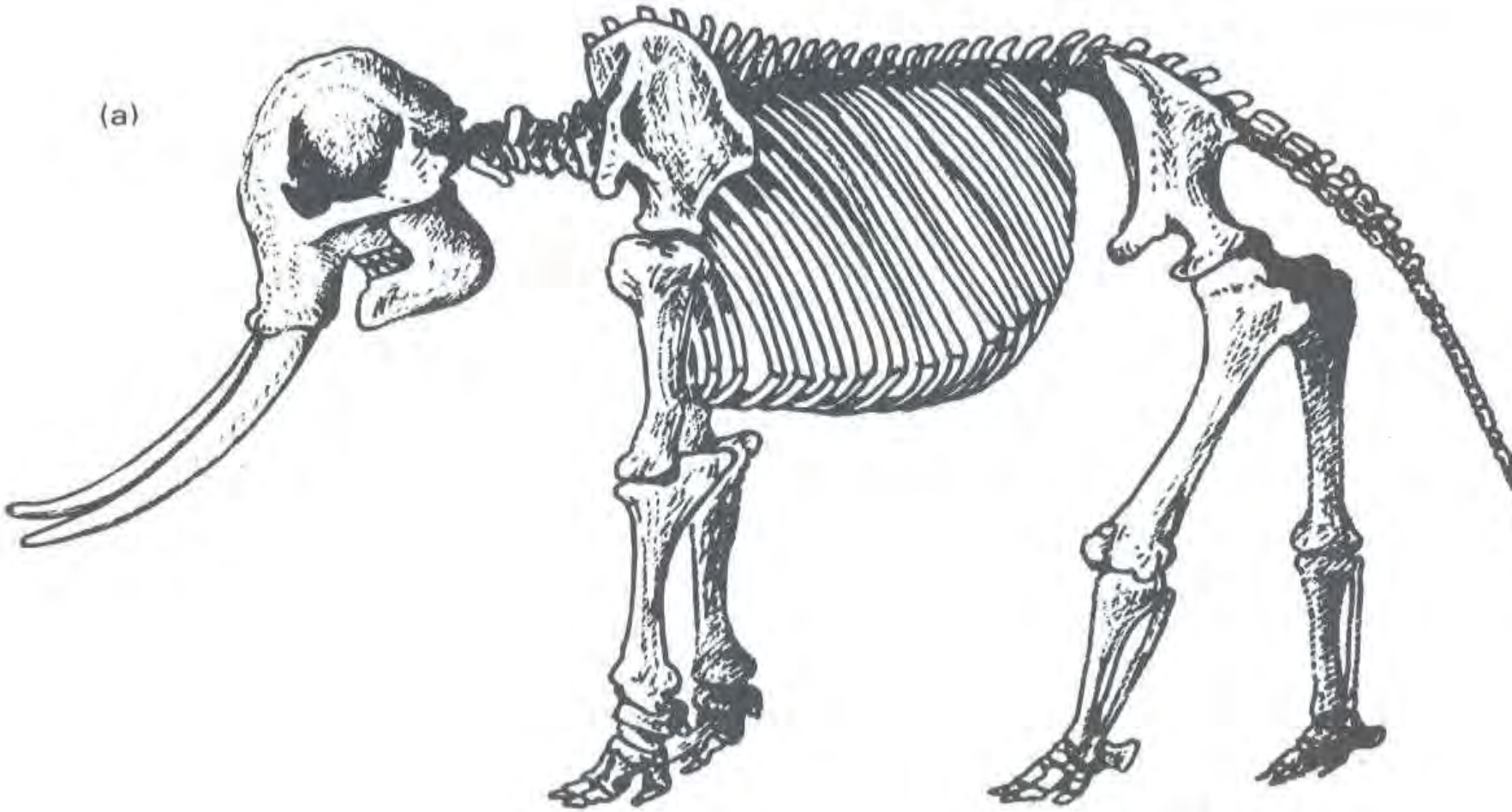











(a)


















Rx
10 x 10 Tablets
Flutamide Tablets IP 250 mg
Cytomid-250
Cipla



Flushing of saline in lateral position


Elephant exhales saline and
sample into the bag


Sample is sealed and
prepared for examination



Centrifugation of the sample



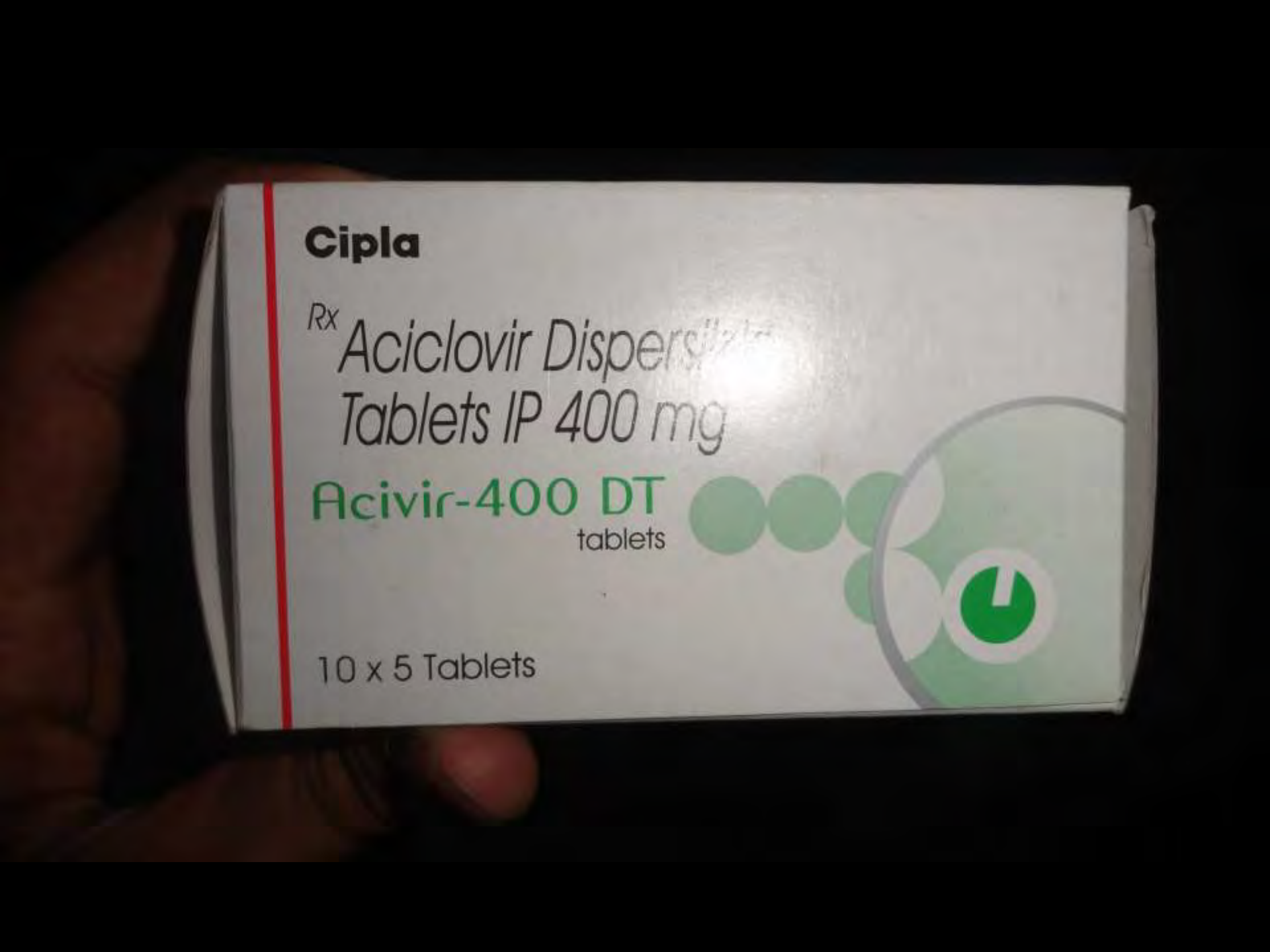
Rescue of a wild bull with fracture

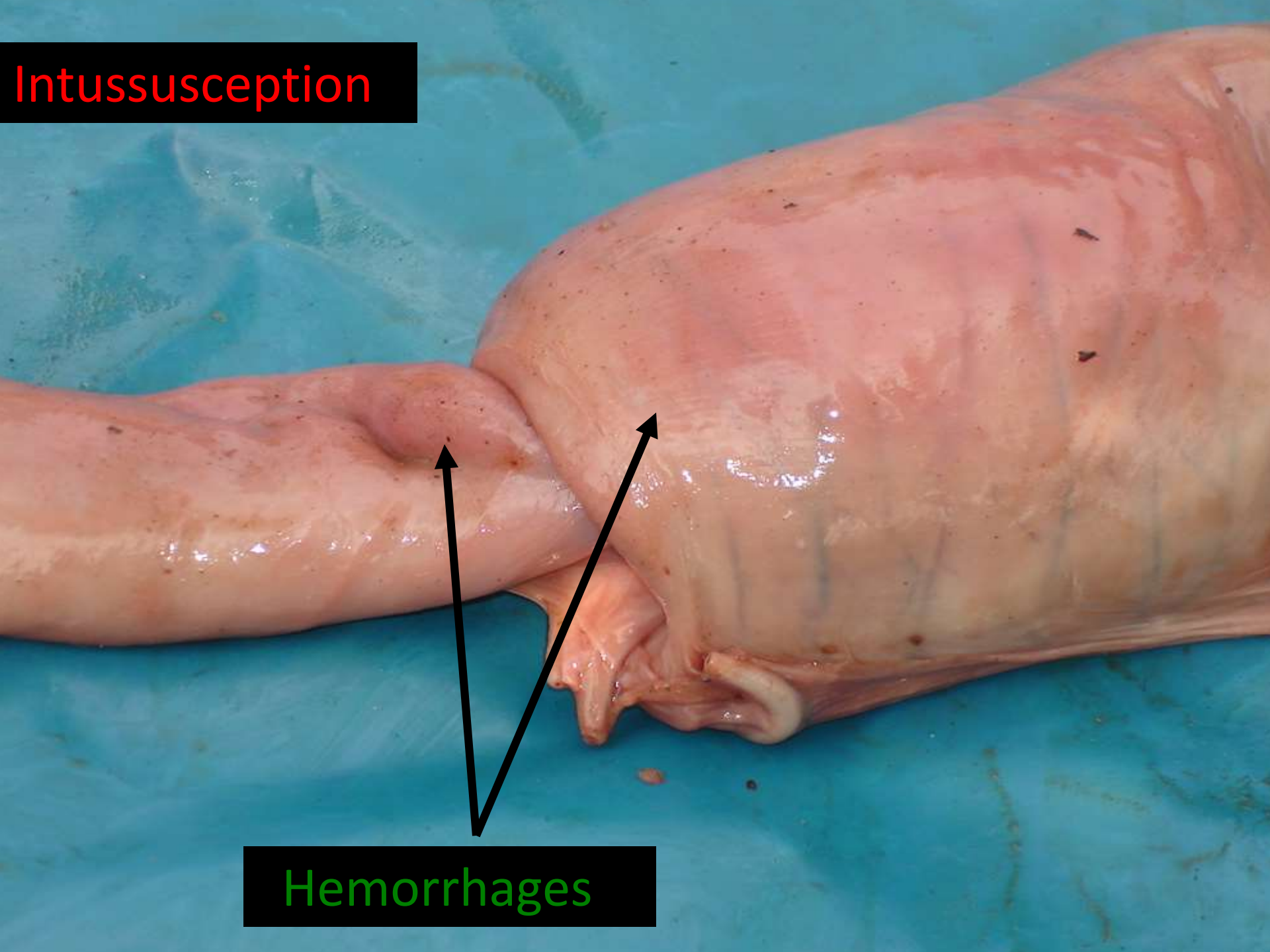



Thailand



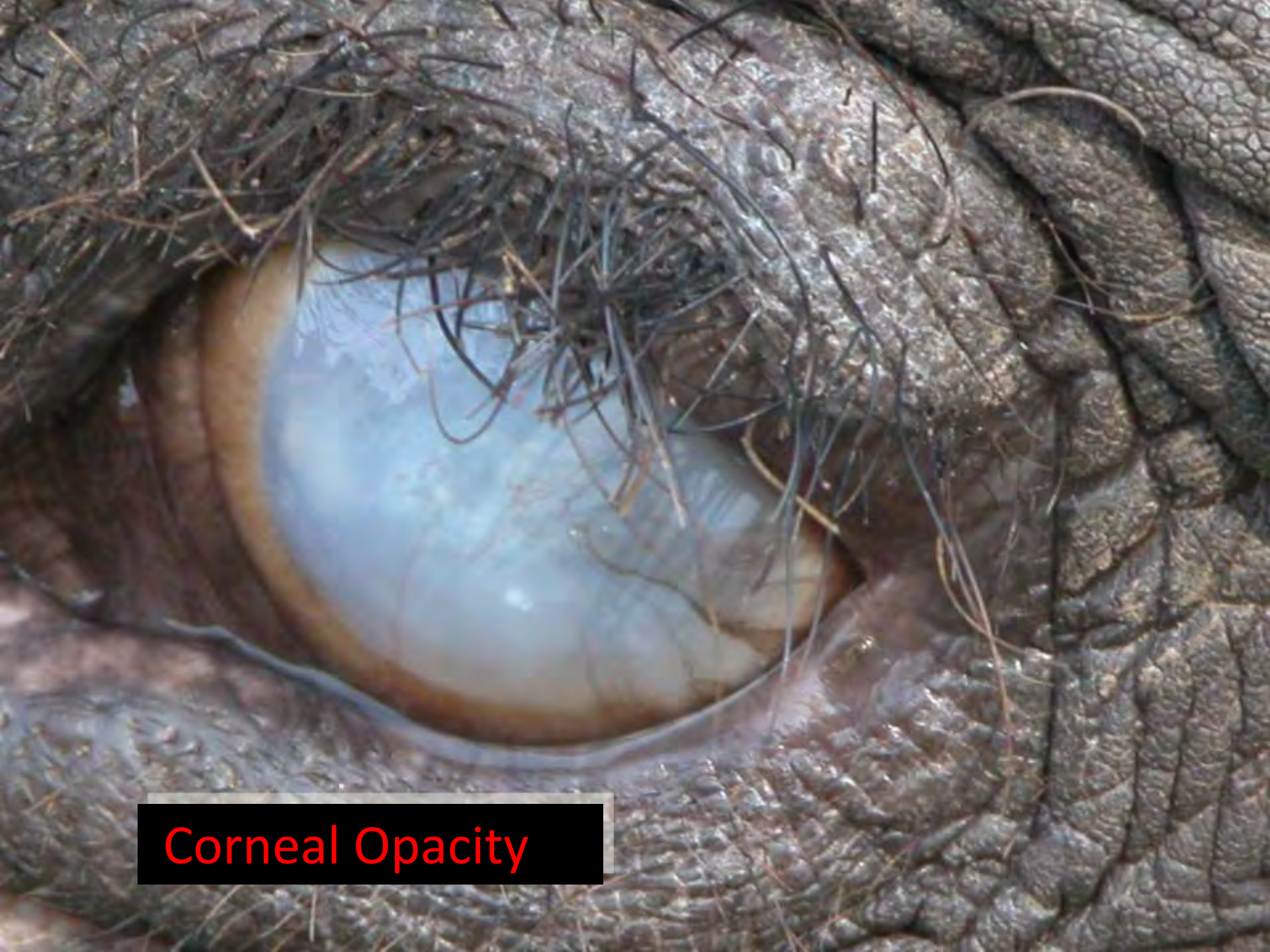



Cipla
Rx Aciclovir Dispersible
Tablets IP 400 mg
Acivir-400 DT
tablets
10 x 5 Tablets


Intussusception
Hemorrhages






Corneal Opacity




Preemptive healthcare: Deworming, vaccination, footcare,
tuskcare general examinations plus Remedial measures

Observations

- **Cleanliness of stable in general and the floor in particular and avoiding overcrowding**
- **Housing elephants for minimum period and allowing natural grazing and scope for expression of species specific behaviour**
- **Routine fecal examination (at least thrice a year) and appropriate deworming**
- **Vaccination against prevailing infectious diseases**
- **Training of elephants to receive foot care and administration of regular foot care together with substrate management**
- **Management of prospective *musth* bulls**


DEPARTMENT OF SURGERY &
ELEPHANT DAY CELEBRATION
DEPARTMENT OF SURGERY & RADIOLOGY
COLLEGE OF VETERINARY SCIENCE,
A.A.U., KHANAPARA, GUWAHATI-781 022
INTAS



Acknowledgement



- U S Fish & Wildlife Services
- Asian elephant support
- Elephant sanctuary
- WWF
- Wildlife Area Welfare Trust
- State Wildlife Departments, India
- College of Veterinary Science, Guwahati

Thank you



SAN DIEGO ZOO GLOBAL

EEHV: A Global Perspective

Lauren L. Howard, DVM, Dipl. ACZM
San Diego Zoo Global
(formerly of Houston Zoo, Inc.)

EEHV Advisory Group

Your best resource on EEHV

- Website updated regularly
- Background information on EEHV
- Professional content includes
  - sample protocols
  - recommendations on
    - anesthesia/sedation
    - diagnostics and testing labs
    - treatment for EEHV
  - *Must sign up for password to access it*

EEHV Advisory Group

eehvinfo.org

Elephant Endotheliotropic Herpesvirus

- Endemic to **Asian** and **African** elephants
  - Asian elephants: EEHV1, EEHV4, EEHV5
  - African elephants: EEHV2, EEHV3, EEHV6, EEHV7
- Often shed in trunk secretions by healthy animals
- Found in wild and captive elephants

Can also cause severe, often fatal hemorrhagic disease in young elephants = EEHV Hemorrhagic Disease

Elephant Endotheliotropic Herpesvirus

Impact on **Individuals** and **Populations**

Individuals

- Asian elephants 1-8 years old
  Severe hemorrhagic disease
  Acute onset, often fatal
- African elephants:
  Lung and trunk nodules
  Sporadic, rare hemorrhagic disease in young elephants

Populations

- Captive populations: decreased fecundity overall
- Wild populations:
  Unknown impact***

NEED TO LEARN MORE

Elephant Endotheliotropic Herpesvirus

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Populations

- Captive populations: decreased fecundity overall
- Wild populations:
  Unknown impact***

NEED TO LEARN MORE

EEHV in Asian Elephants

Impact on North American and European Herds

North America

- 32 Cases of EEHV HD
- 9 survivors, 23 fatalities
- 72% fatality rate
- 40% of all deaths
- **Largest single cause of death** in elephants born in North America since 1980

Europe

- 26 EEHV HD deaths
- 43 total elephant deaths
- 60% of all deaths
- **Largest single cause of death** of elephants born in Europe since 1995

EEHV in Asian Elephants

Asian Range Countries

- 56 cases of EEHV HD in captive elephants
  - Reported from 8 Asian elephant Range countries
  - During 1st Asian EEHV Strategy Meeting, Singapore
- 3 survivors, 53 fatalities = 95% fatality rate

- 12 EEHV HD Deaths documented in **wild elephants**
  - India, shared by Dr. Arun Zachariah

- **Need for *education, awareness, laboratories***

EEHV in Asian Elephants

Asian Range Countries

Need for

- *Education*
- *Awareness*
- *EEHV PCR laboratories*









EEHV in African Elephants

- Free ranging and captive
- Multiple EEHVs from lung and skin nodules (V Pearson, coming up!)
- EEHV2: 2 fatalities
  - 11 months, 13 years old
- EEHV6: 1 fatality (10 yo, in Thai Zoo)
- EEHV6, EEHV3
  - 2 cases of clinical disease, survived



EEHV Hemorrhagic Disease

- Virus found in blood BEFORE clinical signs occur
- Virus damages blood vessels

- Findings in EARLY clinical viremia:
  - Decreased white blood cells
  - Decreased % of monocytes
  - Decreased platelets



EEHV Hemorrhagic Disease

- Virus found in blood BEFORE clinical signs occur
- Virus damages blood vessels

- Signs seen DURING clinical viremia:
  - Lethargy, decreased appetite
  - Colic, diarrhea, or decreased feces
  - Lameness or stiffness
  - Changes in sleep patterns



EEHV Hemorrhagic Disease

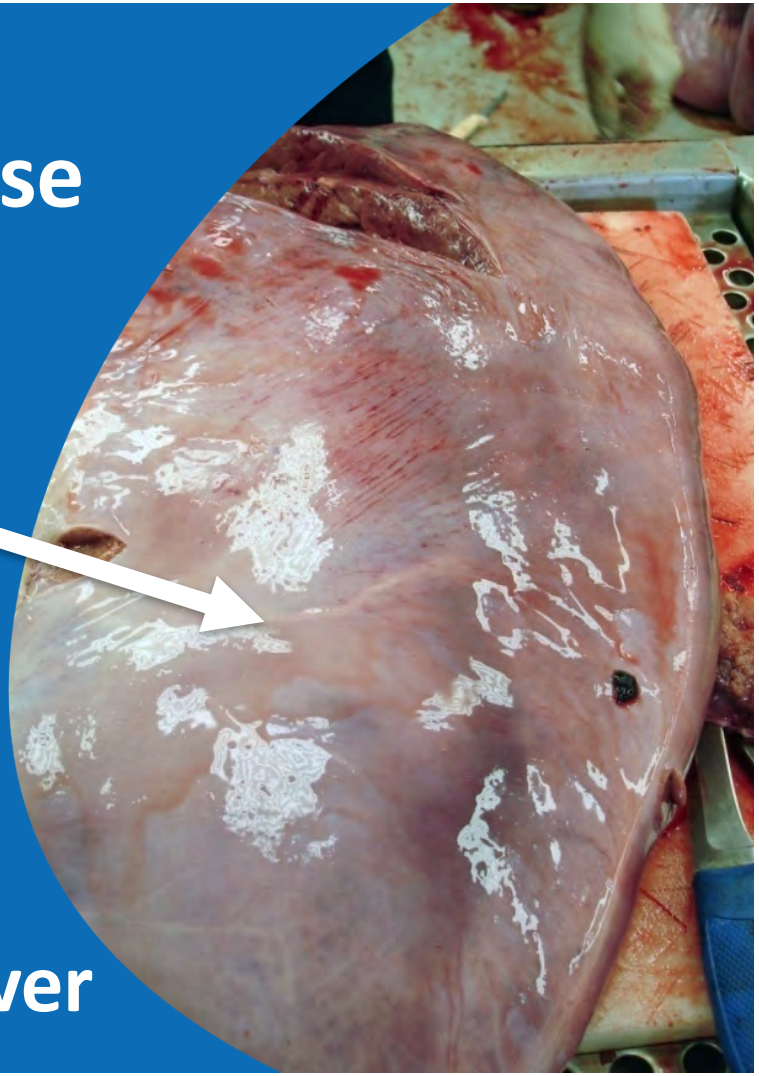
Virus damages blood vessels

- External Findings LATE Viremia:
  - Edema (mostly of head)
  - Cyanosis (tongue)

EEHV Hemorrhagic Disease

Virus damages blood vessels

- Internal Findings Post Mortem:
  - Organ hemorrhage & edema
  - Intestinal hemorrhage
  - Cardiac hemorrhage

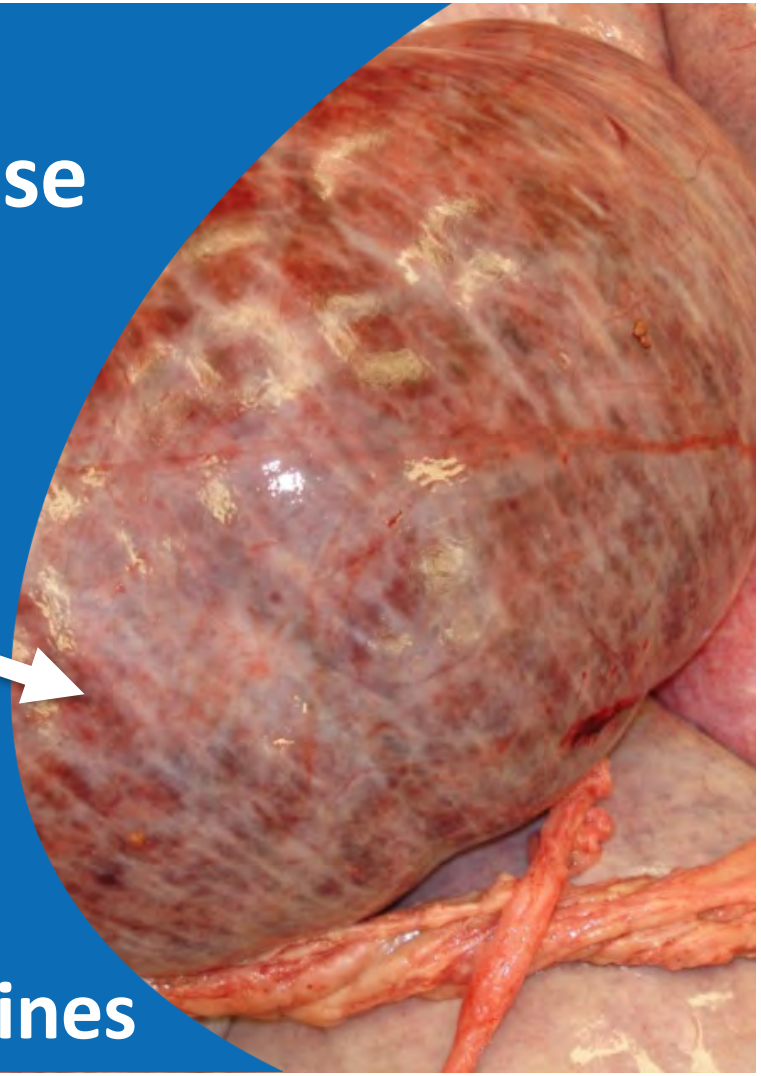


Liver

EEHV Hemorrhagic Disease

Virus damages blood vessels

- Internal Findings Post Mortem:
  - Organ hemorrhage & edema
  - Intestinal hemorrhage
  - Cardiac hemorrhage



Intestines

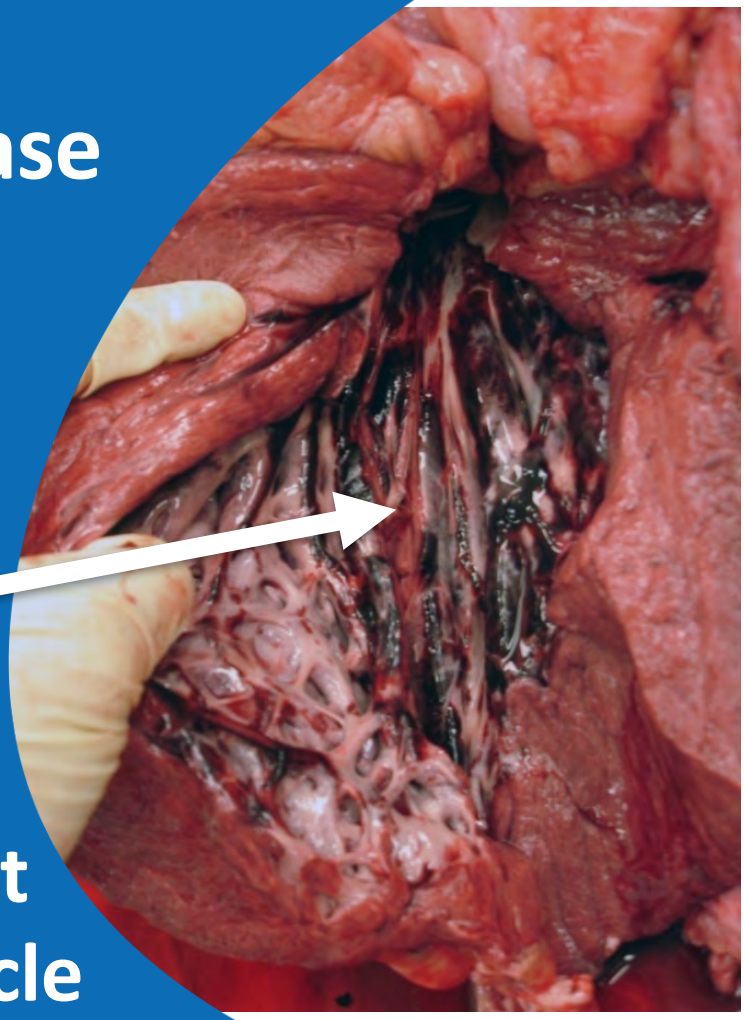
EEHV Hemorrhagic Disease

Virus damages blood vessels

- Internal Findings Post Mortem:
  - Organ hemorrhage & edema
  - Intestinal hemorrhage
  - Cardiac hemorrhage



Pericardial effusion and hemorrhage are common



Heart Muscle

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

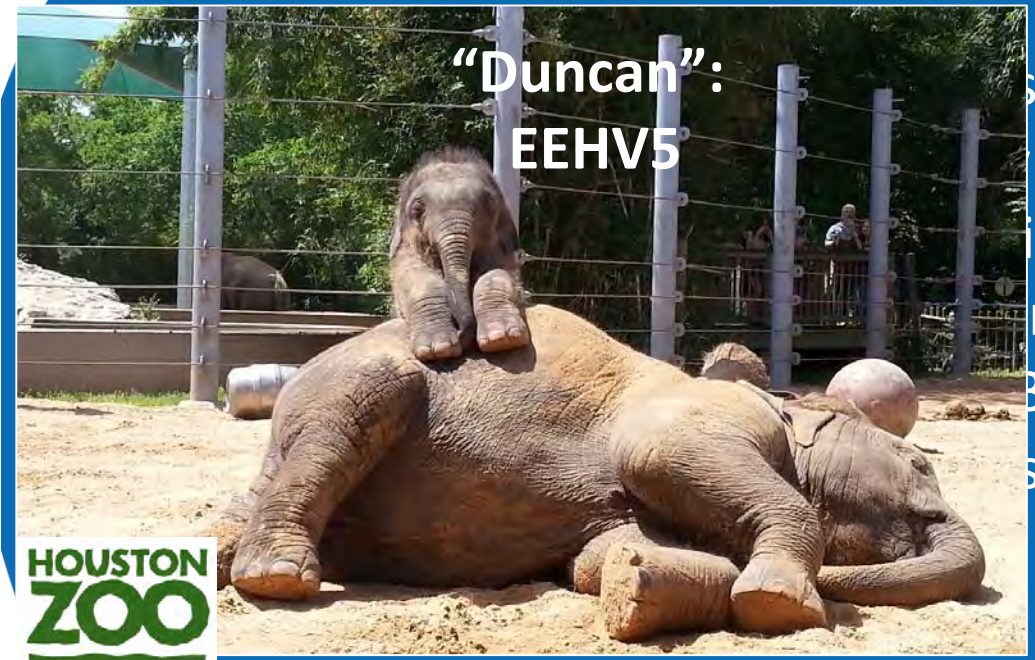
Managing EEHV HD

Preparedness, Vigilance, Early Treatment

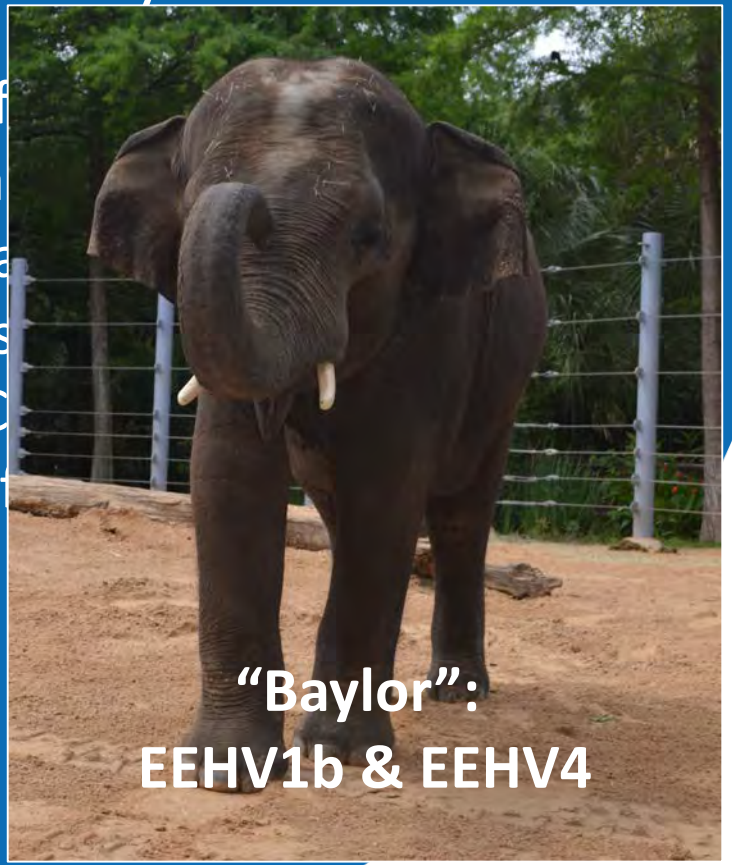
- Early diagnosis is critical to successful treatment.
- At risk calves monitored **weekly** via qPCR and CBC
- Identify virus in blood **before** clinical signs develop
- Start treatment **before** clinical signs develop
- Monitor treatment success by WBC and viral qPCR results
- Sedate if necessary, IV treatments if necessary, *even if elephant doesn't appear sick!*

Managing EEHV HD

Preparedness, Vigilance, Early Treatment



“Tupelo”:
EEHV1b & EEHV4



HOUSTON ZOO



Treating EEHV HD

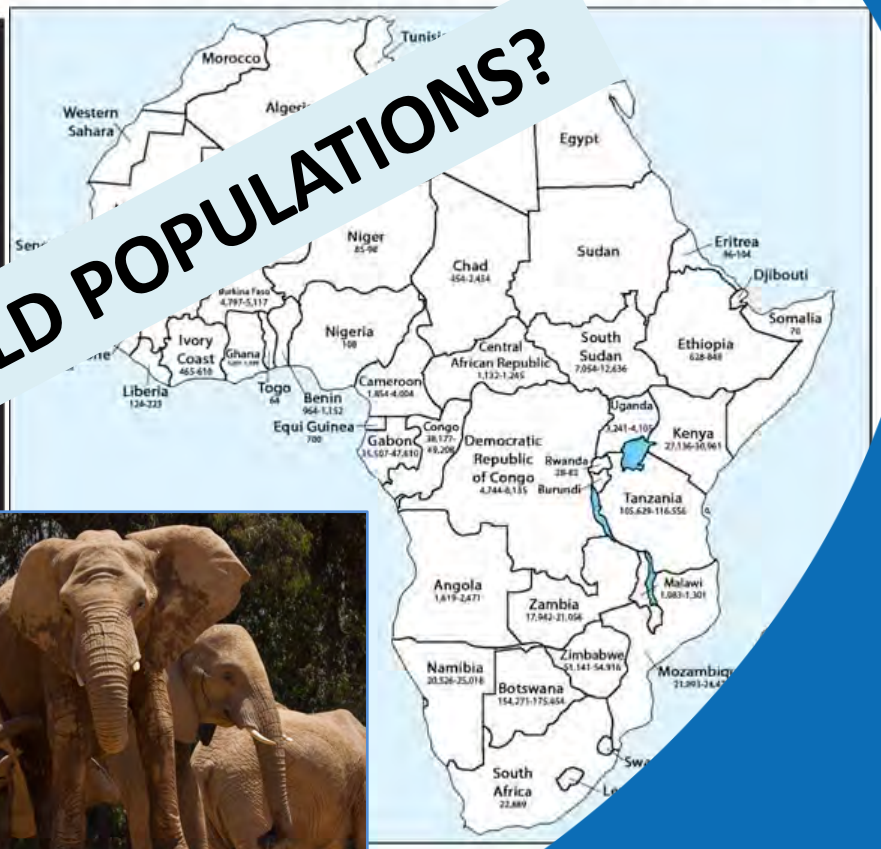
- Rectal fluid therapy: FIRST STEP
- Antiviral therapy:
  - Acyclovir
  - Famciclovir
- Intravenous Therapy:
  - Elephant plasma
  - Electrolyte fluids
- Antibiotics, nutritional support, etc.

Visit www.eehvinfo.org for updated treatment information

Asian Elephant Population Distribution Map



African Elephant Population Distribution Map



IMPACT ON WILD POPULATIONS?

Diagnosing EEHV

Identifying EEHV Presence in Healthy Elephants

- Live animals:
  - Identify virus *shed in secretions* from elephant
    - **Trunk wash**: spin down and submit for PCR
    - **Swabs** of hard palate, saliva: submit for PCR
  - Serology: save **serum** samples for future antibody testing
- Post Mortem:
  - Identification of lung nodules, submit for PCR
  - PCR of other tissues: lymph nodes, spleen, etc.
  - Post mortem serum sample for future antibody testing



Understanding EEHV

It starts with you!

- Need more information about range country elephants
- COLLECT SAMPLES!!
- SAVE SAMPLES!!
- Surveillance along with existing projects
- Communicate with colleagues



Thank you!

Questions? Contact me!

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High Levels of Novel Hypervariability and Subtyping Amongst Membrane Glycoproteins of EEHV1 Strains

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EEHV Acute Hemorrhagic Disease (HD)

Total Lethal DNA-Positive Cases Analysed at NEHL = 56x
USA = 21x, Europe = 9x, Canada = 2x, India = 18x (ten in wild free-ranging calves), Myanmar = 3x, Sumatra = 2x, Nepal = 1x.
Plus 12x survivors of acute viremia. (Vast majority = EEHV1A in E. maximus calves 1 year to 8 years old. Just six = EEHV2 to 6).

Note 1: No lethal cases yet seen in calves known to have had a previous viremic episode, and in all seven cases of calves undergoing a second episode (1A after 1B or 1B after 1A) it was mild. No known examples of two viremic episodes with the same subtype. Strongly suggests that previous mild infections (esp. in the presence of maternal antibodies) are protective (i.e. may act as vaccines).

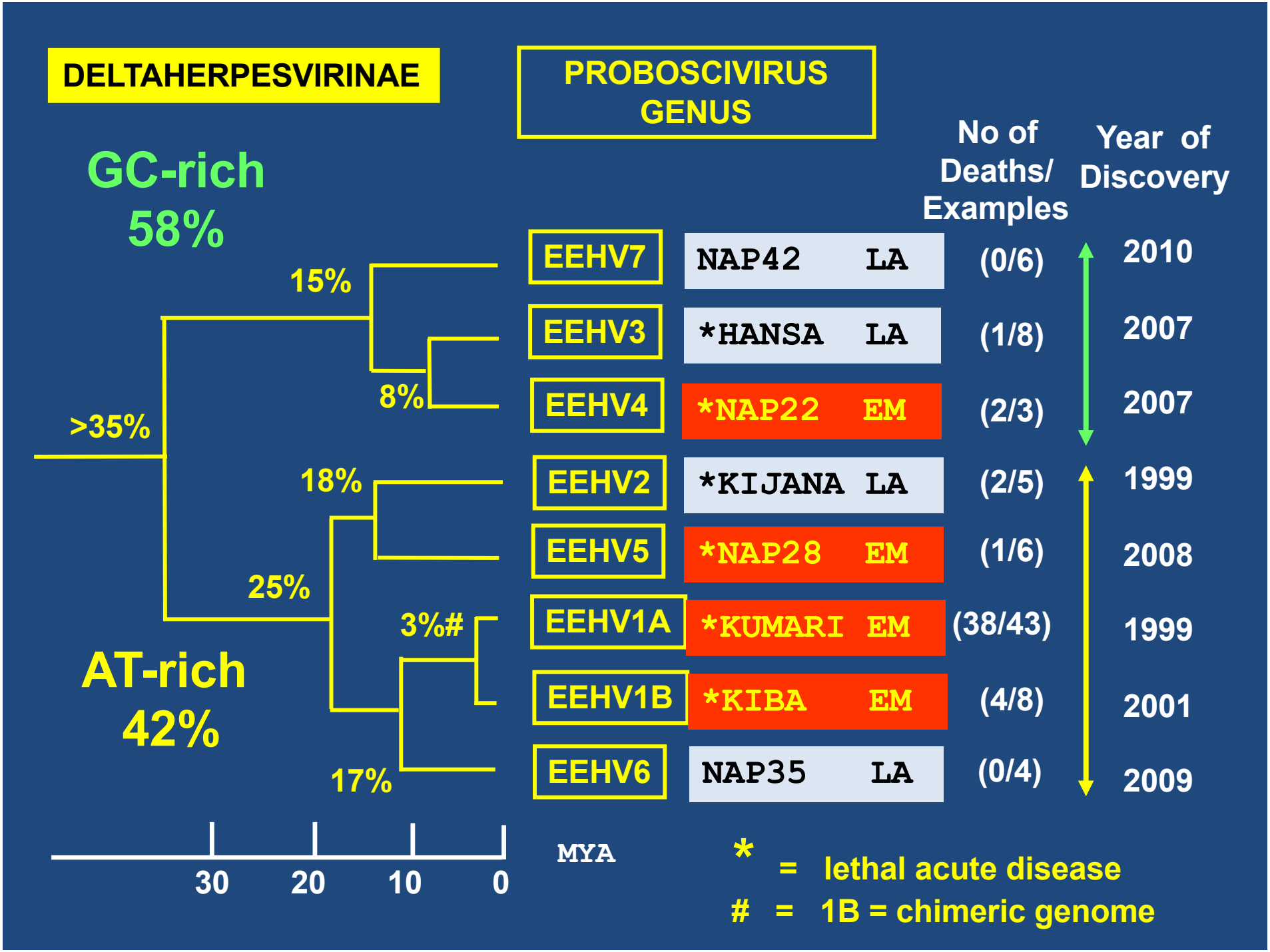
Note 2: Symptomatic disease is only associated with high level viremia, but not with viral DNA shedding in trunkwash or saliva,

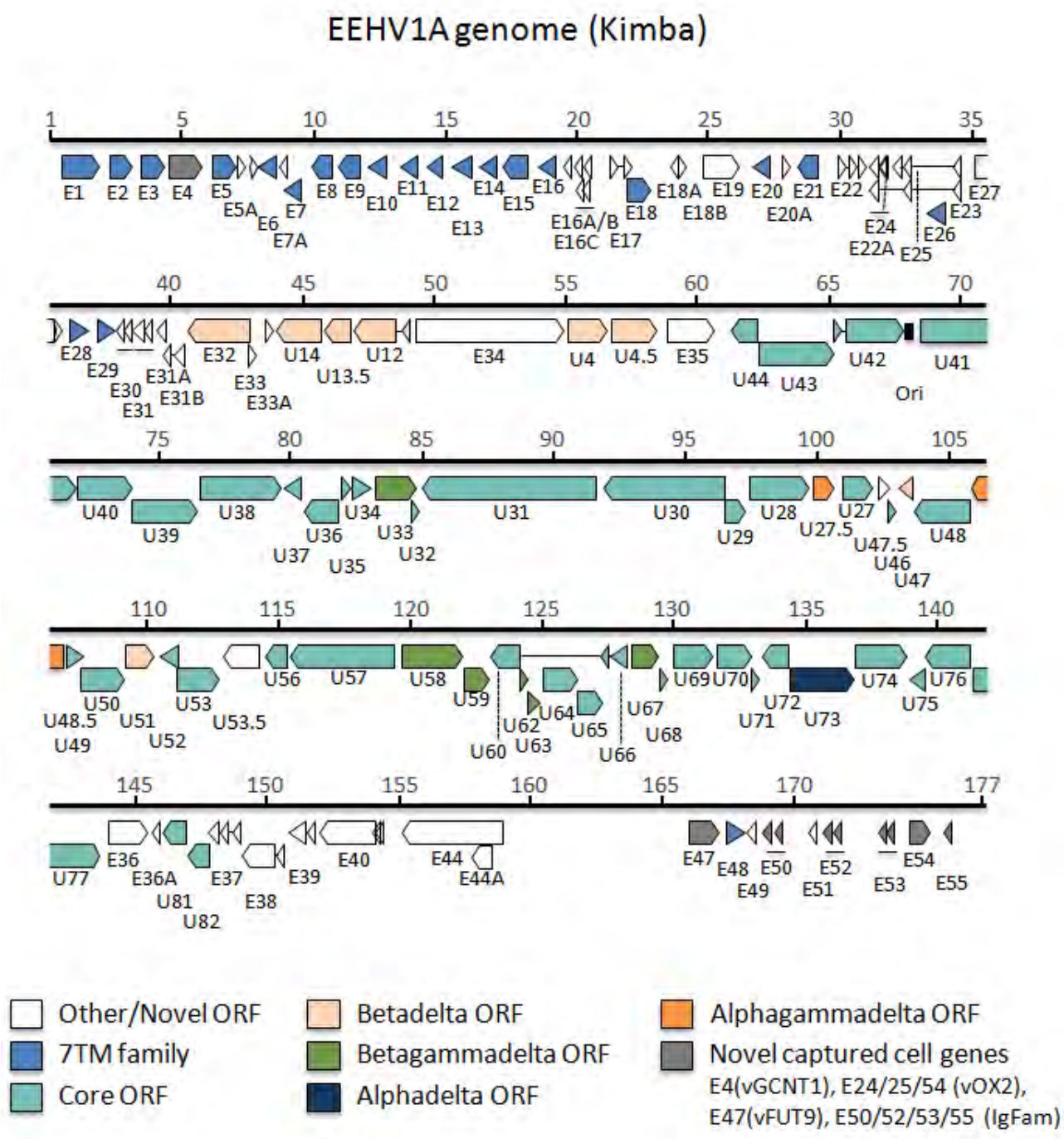
Note 3: Prognostic value of serum versus whole blood levels during acute disease.

Five Conserved Envelope Glycoproteins are Encoded in Common across All Mammalian Herpesviruses: gB (fusion), gH-gL, gM and gN

But in Addition there are also Many Other Herpesvirus Subfamily-Specific Membrane Glycoproteins that Act as Novel Receptors, Signalling Proteins and/or Neutralizing Antibody Targets:

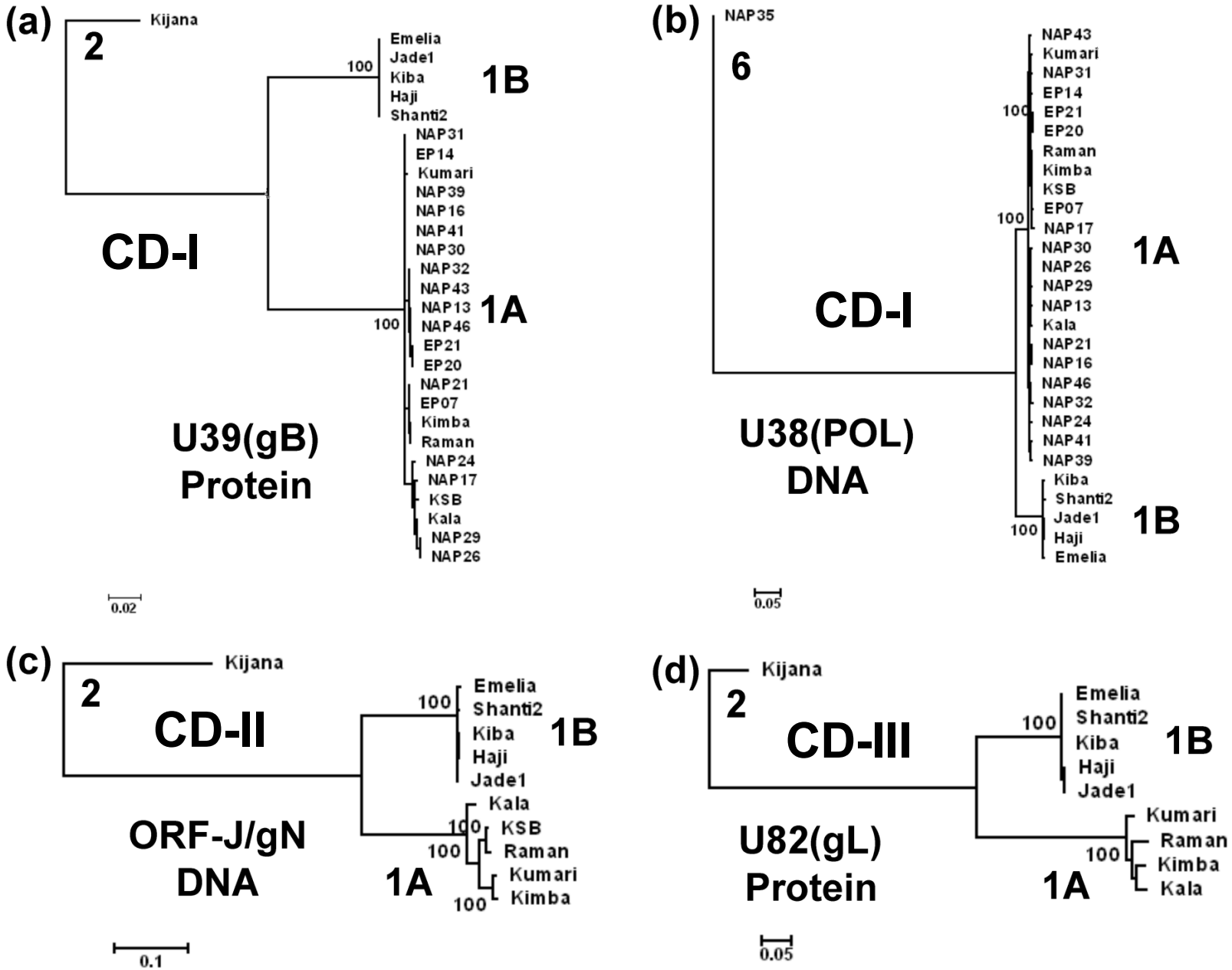
Delta: EEHV	**ORF-O,P,Q, vGPCRs, gO, vOX2, vIgFam, (plus?). Endo/MC/Mϕ**
Alpha: HSV	**gC, gD, gE, gG, gI (Neuro)**
	HVEM, Nectin, Hep-S, C3d
Beta: HCMV	**UL128,130,131A, gO (plus?)**
	Epith/Endo. Fibro. (MC/Mϕ?)
Gamma: EBV	**gp350, gp110, gp42 (Ep)**
	B-cells (CD21-BCR)


DELTAHERPESVIRINAE
PROBOSCIVIRUS GENUS
No of Deaths/ Examples
Year of Discovery
GC-rich 58%
AT-rich 42%
15%
8%
>35%
18%
25%
3%#
17%
EEHV7
NAP42 LA
(0/6)
2010
EEHV3
*HANSA LA
(1/8)
2007
EEHV4
*NAP22 EM
(2/3)
2007
EEHV2
*KIJANA LA
(2/5)
1999
EEHV5
*NAP28 EM
(1/6)
2008
EEHV1A
*KUMARI EM
(38/43)
1999
EEHV1B
*KIBA EM
(4/8)
2001
EEHV6
NAP35 LA
(0/4)
2009
30
20
10
0
MYA
* = lethal acute disease
# = 1B = chimeric genome

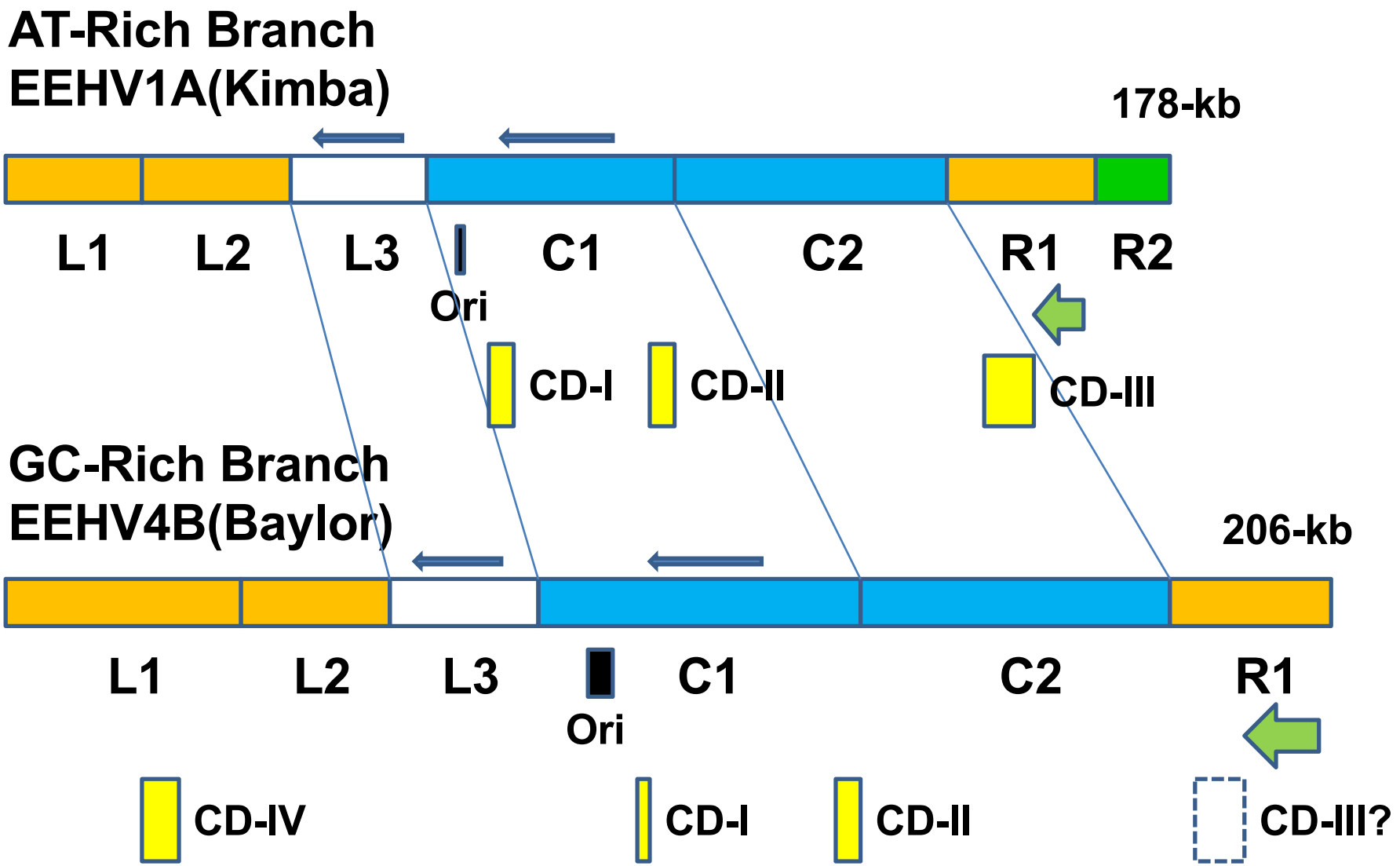


EEHV1A, 1B
EEHV4 & 5
Completely Sequenced

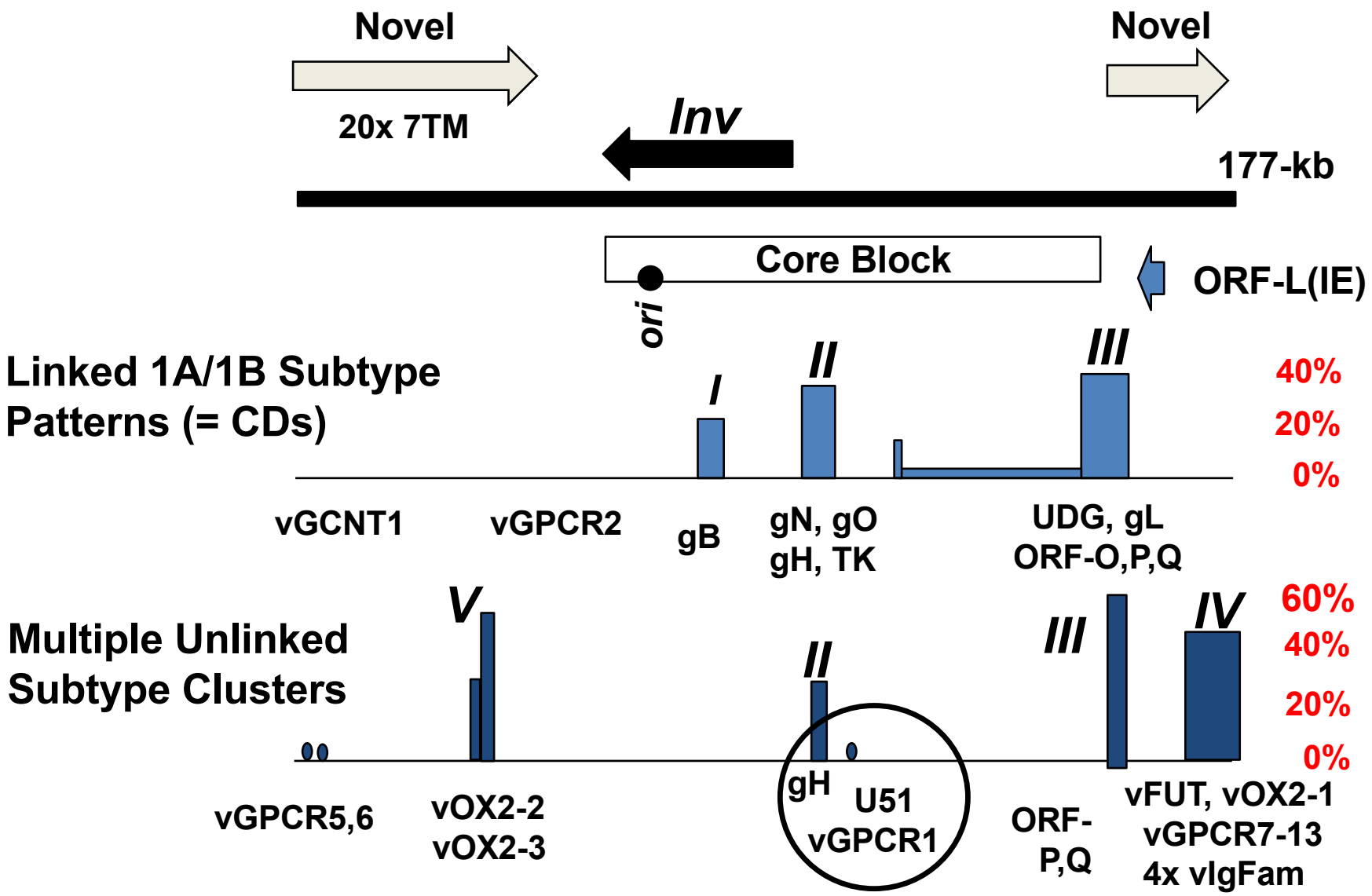
Each has about 118 total genes
= 178-206 kb with 50 novel viral genes


(a)
Kijana
2
Emelia
Jade1
Kiba
Haji
Shanti2
100
1B
NAP31
EP14
Kumari
NAP39
NAP16
NAP41
NAP30
NAP32
NAP43
NAP13
NAP46
EP21
EP20
NAP21
EP07
Kimba
Raman
NAP24
NAP17
KSB
Kala
NAP29
NAP26
100
1A
CD-I
U39(gB)
Protein
0.02
(b)
NAP35
6
NAP43
Kumari
NAP31
EP14
EP21
EP20
Raman
Kimba
KSB
EP07
NAP17
NAP30
NAP26
NAP29
NAP13
Kala
NAP21
NAP16
NAP46
NAP32
NAP24
NAP41
NAP39
Kiba
Shanti2
Jade1
Haji
Emelia
100
100
1A
1B
CD-I
U38(POL)
DNA
0.05
(c)
Kijana
2
CD-II
Emelia
Shanti2
Kiba
Haji
Jade1
100
1B
Kala
KSB
Raman
Kumari
Kimba
100
100
100
1A
ORF-J/gN
DNA
0.1
(d)
Kijana
2
CD-III
Emelia
Shanti2
Kiba
Haji
Jade1
100
1B
Kumari
Raman
Kimba
Kala
100
1A
U82(gL)
Protein
0.05

Location of A/B Subtype Chimeric Domains:



EEHV1A/B Genome Hypervariability



Protein Subtype Variations within the EEHV1 vGPCR (U51) Gene:

Total Polymorphisms (73 of 1170 nucl = 6%; 15 of 390 aa = 4.4%)

Case No	Subtype	Codon Position								Nucl Diffs$		
		165	166	168	178	181	249	252	256-262			
NAP#18	A1	V	D	K	L	I	E	A	HKLT	11	-	
NAP#23*	A1	V	D	K	L	I	E	A	HKLT	10	(20)	
NAP#20	A2	V	D	K	L	I	E	T	HKLT	6		
NAP#25	A2	V	D	K	L	I	E	T	HKLT	6	(0)	A
NAP#21	A2	V	D	K	L	I	E	T	HKLT	6	(0)	
NAP#30	A2	V	D	K	L	I	E	T	HKLT	8	(2)	
NAP#26	A3	I	N	R	I	I	E	T	HKLT	20		
NAP#14*	B1	V	D	K	L	V	E	M	HSNKVTAS	21	-	
NAP#19	B1	V	D	K	L	V	E	M	HSNKVTAS	20	(3)	B
NAP#33	B2	I	N	K	I	V	E	M	HSNKVTAS	16		
NAP#11	C	V	D	K	L	I	E	T	HLVKSTS	12	-	
NAP#15	C	V	D	K	L	I	E	T	HLVKSTS	11	(2)	C
NAP#29	C	V	D	K	L	I	E	T	HLVKSTS	11	(8)	
NAP#24	D1	I	N	R	I	I	G	T	LVKS	22	-	
NAP#16	D1	I	N	R	I	I	E	T	LVKS	23	(6)	
NAP#31	D1	I	N	R	I	I	E	T	LVKS	23	(3)	D
EP#06	D1	I	N	R	I	I	E	T	LVKS	23	(3)	
NAP#17*	D2	I	N	K	I	I	E	T	LVKS	15	(17)	
NAP#32*	D2	I	N	K	I	I	E	T	LVKS	14	(16)	
NAP#13	E	I	D	R	I	I	E	T	QKSTS	18	-	
EP#14	E	I	D	R	I	I	E	T	QKSTS	18	(2)	E
NAP#41	A/E	V	D	K	L	I	E	T	QKSTS	19	(6)	

$ Relative to Consensus from all EEHV1 Sequences

EEHV1 U51/vGPCR1 Subtype Distribution (66x)

India (18x) 2x A2, A2', B1, C1, D1, D2/A, 4x E/A, 3x E, 2x E*, E**
Sumatra (2x) 2x D2/A' Myanmar (3x), E, 2x? [Thailand 11/15 = A or D]

Europe(8x) London 2x A2(Donald, LeeLee), B1'(Emelia)
Deaths Berlin 3x D1(Kiri,K-R,Sh-P), B1(Kiba); Zurich E/A(Xian)

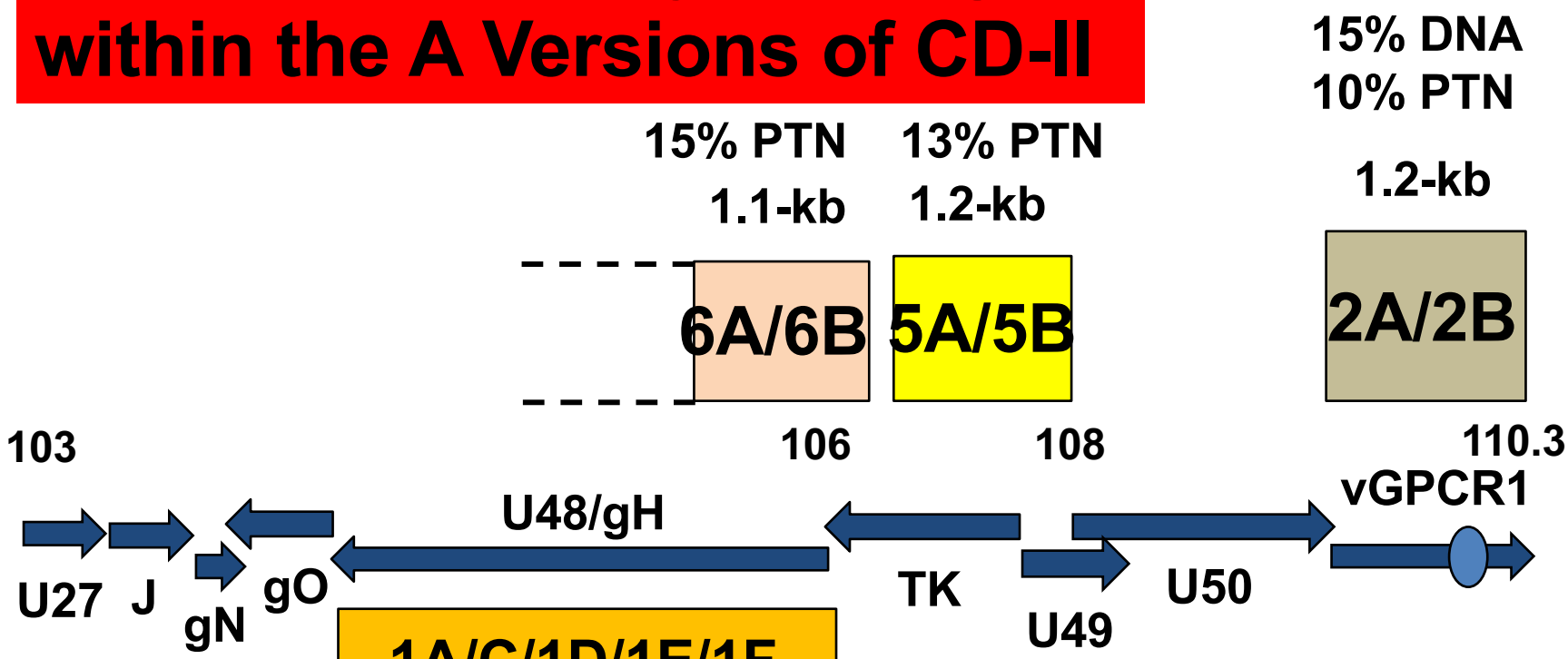
Canada(2x) A2(Logan), D1(Malti)
USA (17x) 2x A1(Kimba, Kala), 4x A2 (Preya, KSB, Daizy, Malee),
Deaths 2x C1(Kumari, JP), C2(Nisha), 2x D1(Mike, Belle), D2'(P),
2x D2(Mac, Singgah), D1/A(Ganesh), B1(Haji), ?(Nate).

Houston D2(Mac), A3(Kimba), D2 /A(Singgah), D2'(Pearl)
HTWLT D1(Belle), C1(JP)
DPM A1(Kala), B1(Haji), (plus others, but no samples kept)

USA (7x) A1+B2(Jade1/2), A2(Mali), B3+E/A(Barack1/2), C1(Doc)
Survivors D1(Obert), E(Chandra), D2(Achara).

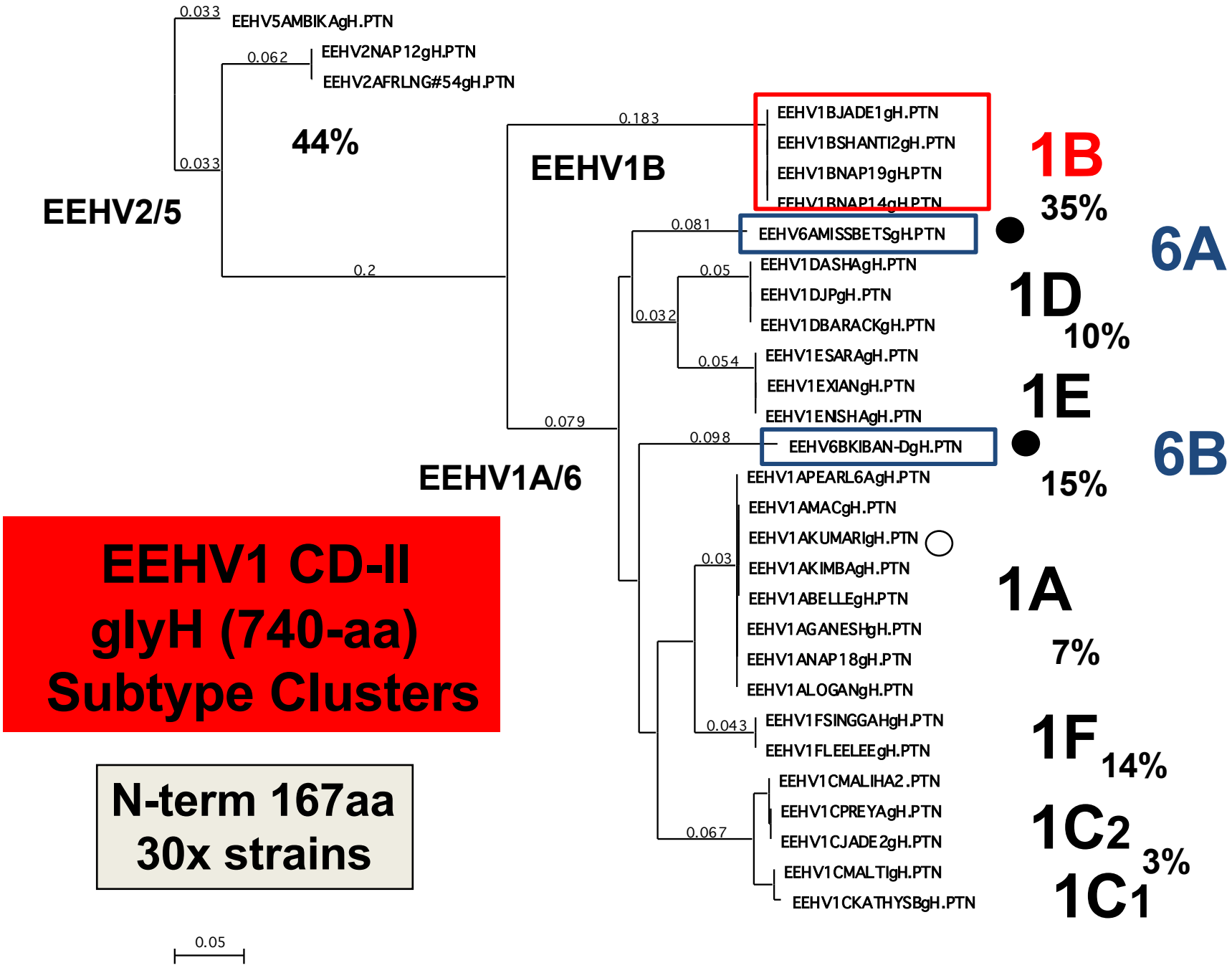
Asymptom. D2+ B3(S/T/M/B), C2(Sara), A1+B2(Maliha), E/A, D2.

Five Further Subtypes of gH within the A Versions of CD-II

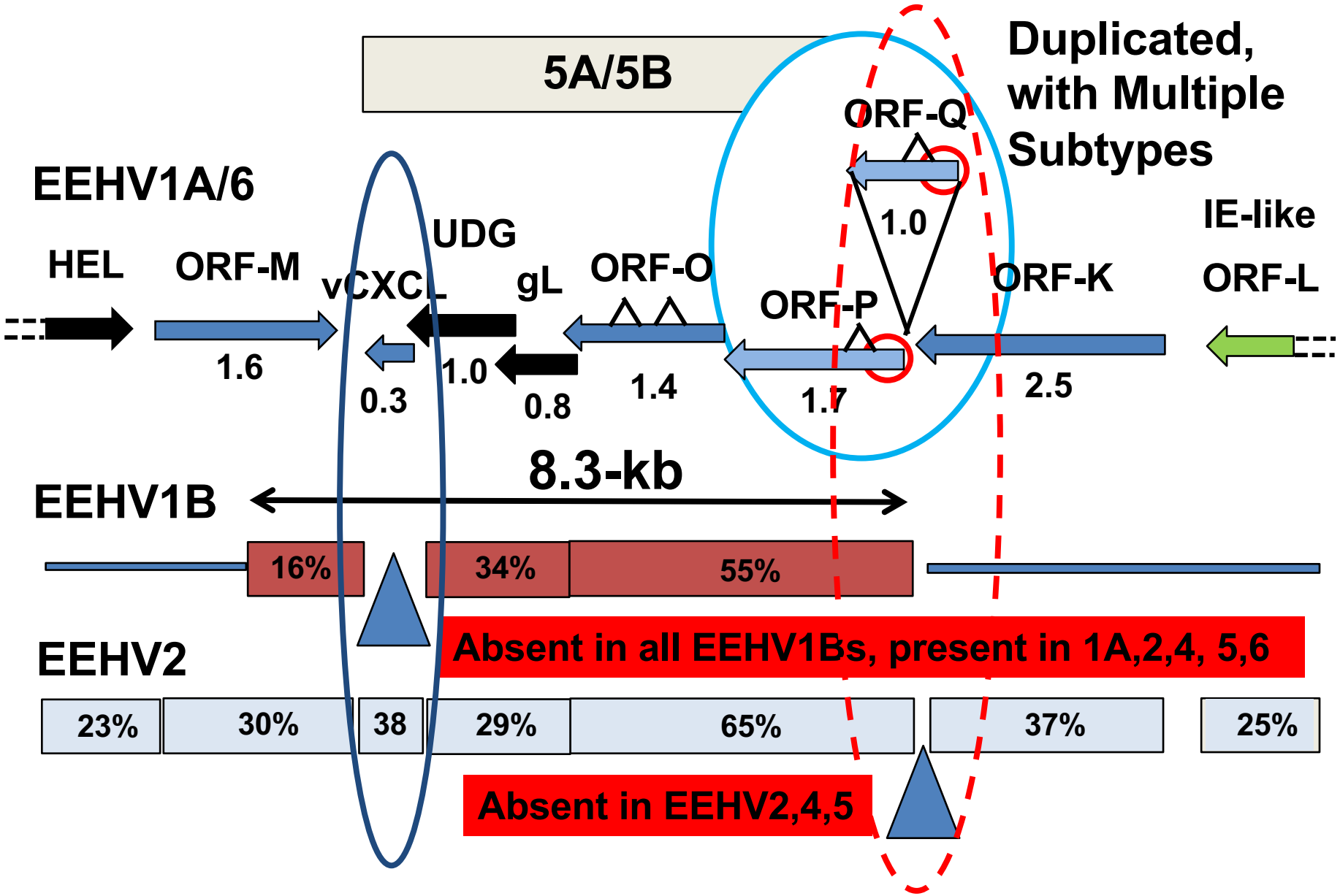


1A vs 6 = 21% PTN
1A vs 2 = 40% PTN

gO 1A/1B = 37% PTN
gO 1A/ 6 = 11% PTN
gO 1A/ 2 = 52% PTN
gH 1A/1B = 38% PTN
gH 1A/ 6 = 21% PTN
gH 1A/ 2 = 45% PTN
TK 1A /1B = 16% PTN
TK 1A/ 6 = 21% PTN
TK 1A/ 2 = 26% PTN

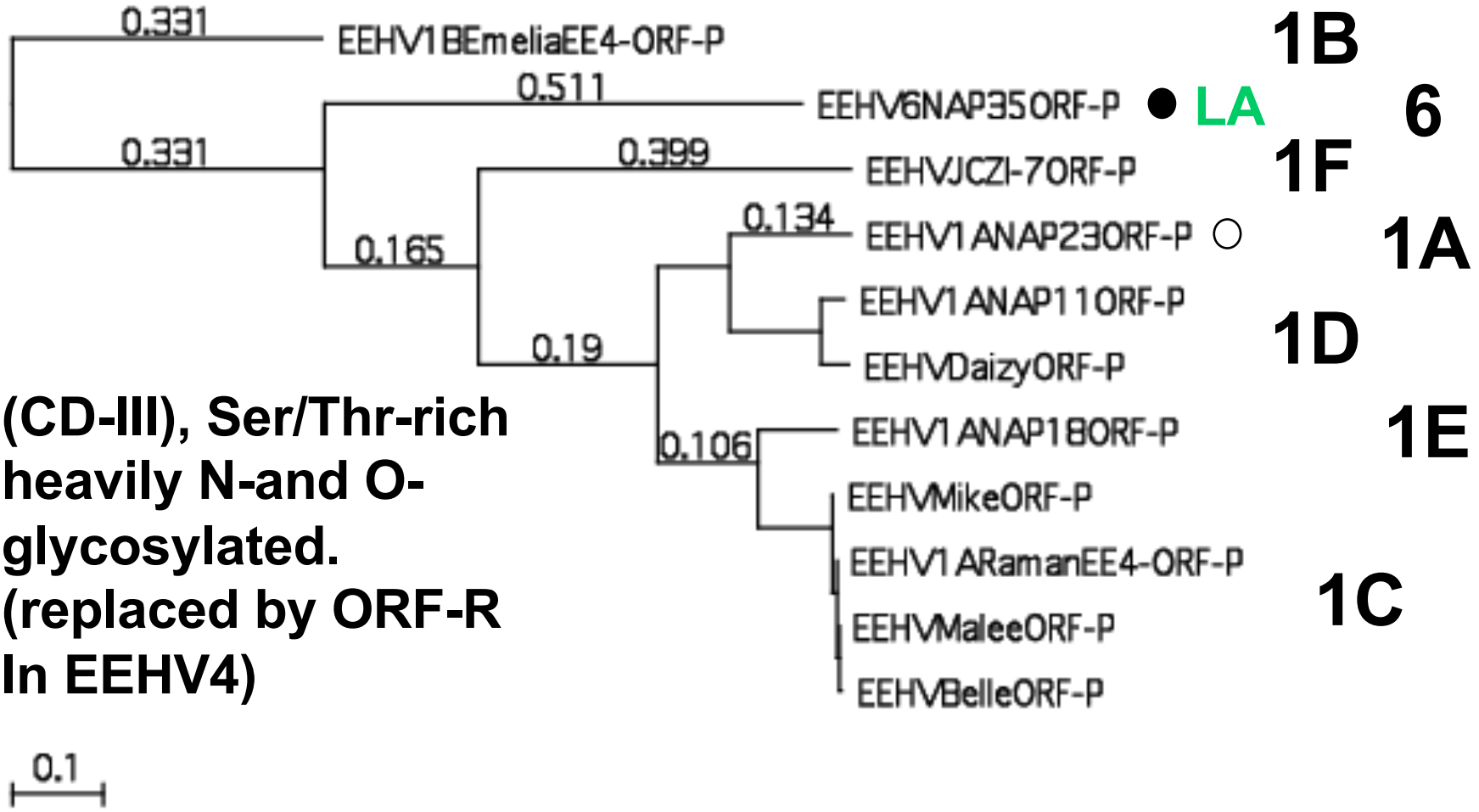

0.033
EEHV5AMBIKAgH.PTN
0.062
EEHV2NAP12gH.PTN
EEHV2AFRLNG#54gH.PTN
44%
0.033
EEHV2/5
0.183
EEHV1BJADE1gH.PTN
EEHV1BSHANTI2gH.PTN
EEHV1BNAP19gH.PTN
EEHV1BNAP14gH.PTN
EEHV1B
1B
35%
0.081
EEHV6AMISSBETSgH.PTN
6A
0.2
0.05
EEHV1DASHAgH.PTN
EEHV1DJPgH.PTN
1D
0.032
EEHV1DBARACKgH.PTN
10%
0.054
EEHV1ESARAgH.PTN
EEHV1EXIANgH.PTN
1E
EEHV1ENISHAgH.PTN
0.079
0.098
EEHV6BKIBAN-DgH.PTN
6B
EEHV1A/6
EEHV1APEARL6AgH.PTN
15%
EEHV1AMACgH.PTN
EEHV1AKUMARIgH.PTN
0.03
EEHV1AKIMBAgH.PTN
1A
EEHV1ABELLEgH.PTN
EEHV1AGANESHgH.PTN
7%
EEHV1ANAP18gH.PTN
EEHV1ALOGANgH.PTN
0.043
EEHV1FSINGGAHgH.PTN
1F
EEHV1FLEELEEgH.PTN
14%
EEHV1CMALIHA2.PTN
EEHV1CPREYAgH.PTN
1C2
0.067
EEHV1CJADE2gH.PTN
3%
EEHV1CMALTIgH.PTN
1C1
EEHV1CKATHYSBgH.PTN
EEHV1 CD-II
glyH (740-aa)
Subtype Clusters
N-term 167aa
30x strains
0.05

Additional Subtype Divergence in CD-III



EEHV1 Env GlyP ORF-P

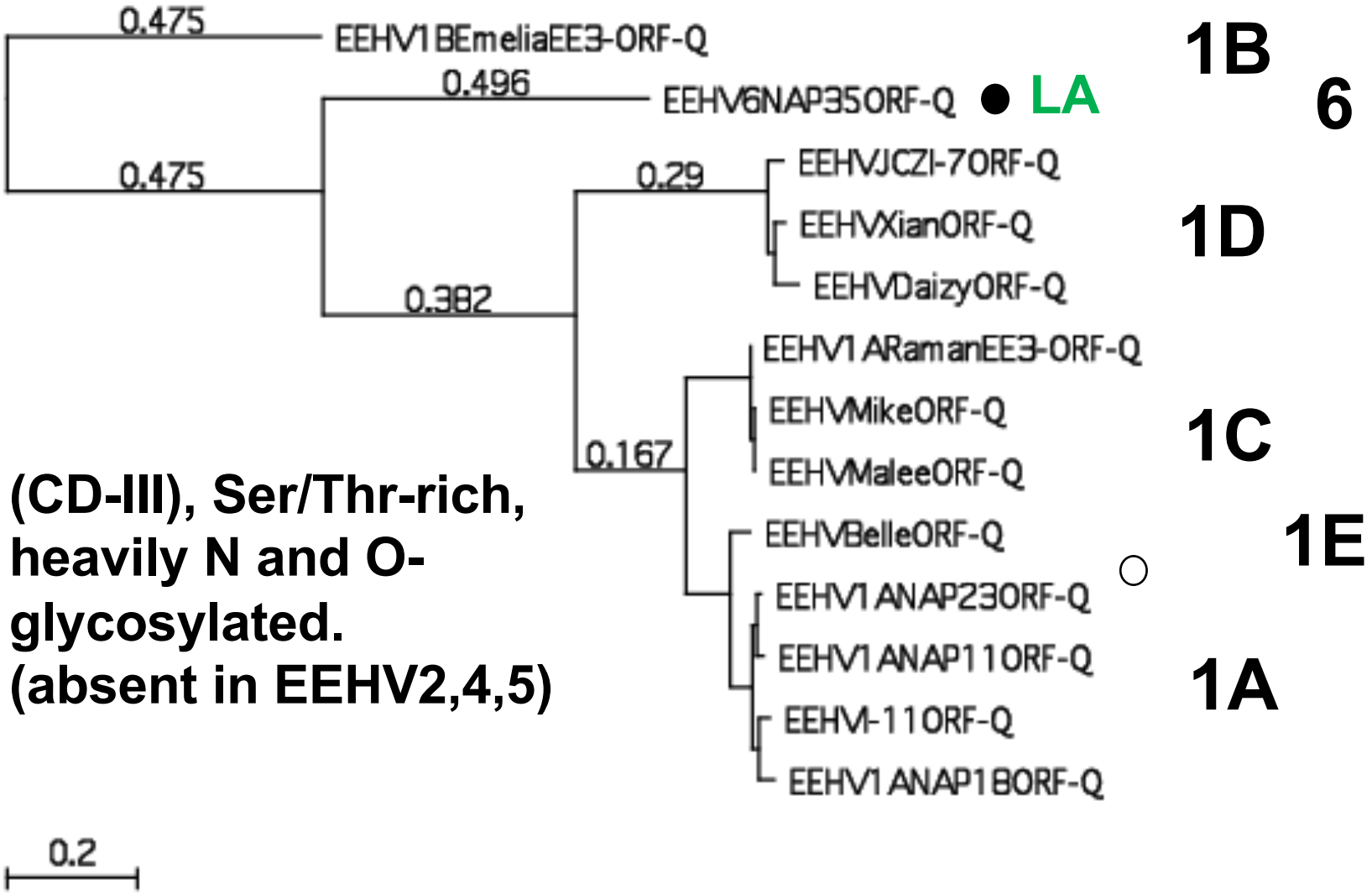
(six subtypes, up to 45% aa diverged)



(CD-III), Ser/Thr-rich heavily N-and O-glycosylated. (replaced by ORF-R In EEHV4)

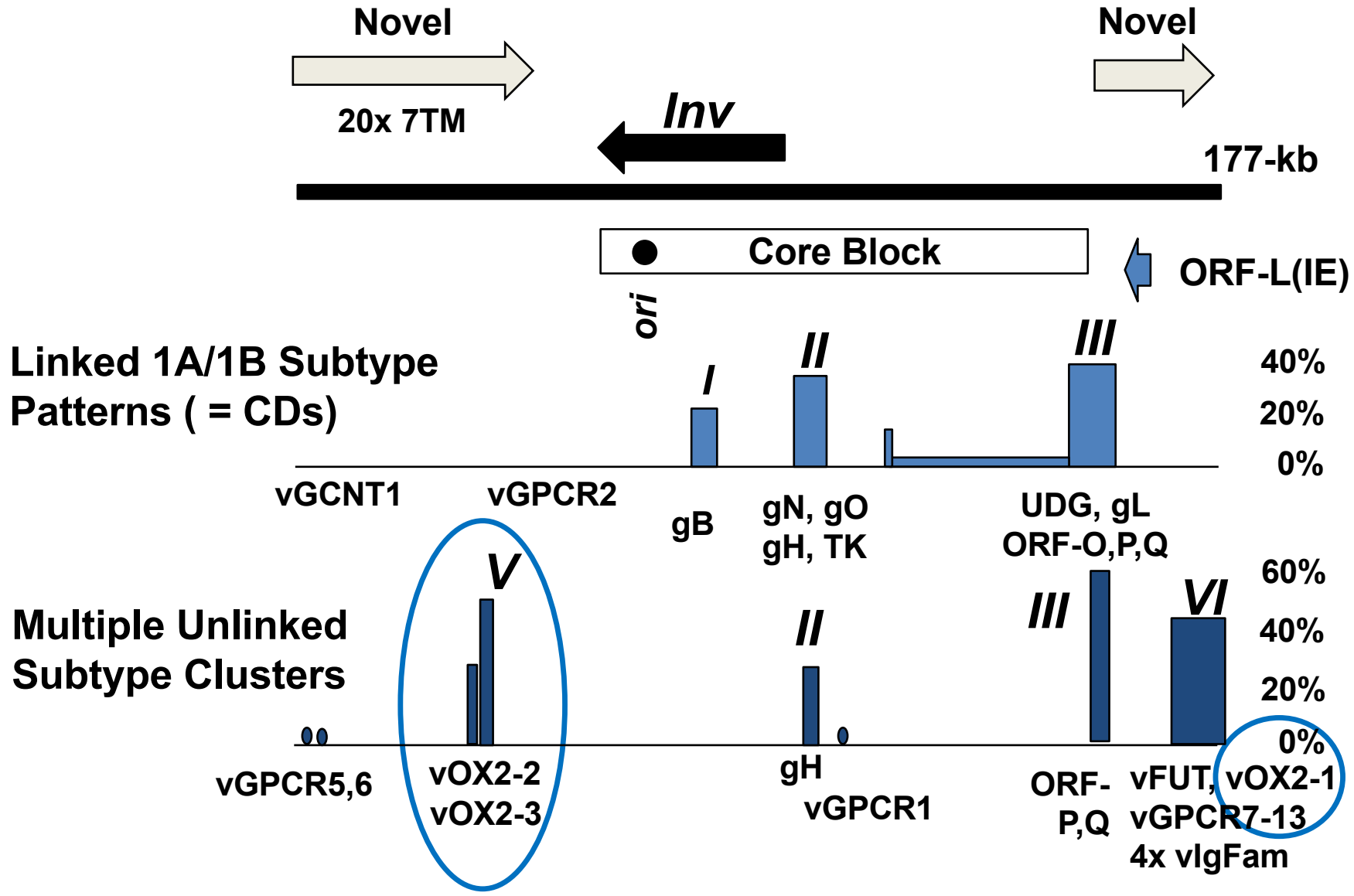
EEHV1 Env GlyP ORF-Q

(five subtypes up to 60% aa diverged)



(CD-III), Ser/Thr-rich, heavily N and O-glycosylated. (absent in EEHV2,4,5)

EEHV1Genome Hypervariable Region V, VI



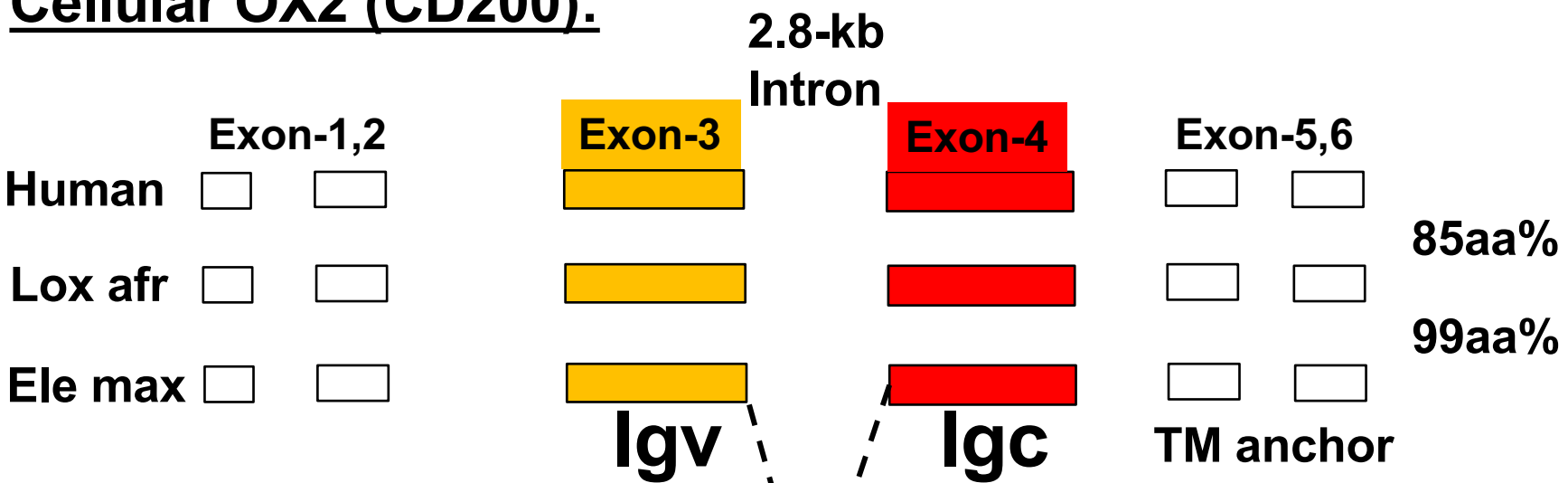
EEHV1 Encodes Three vOX2 (CD200) Ligands

Sixth known herpesvirus lineage with captured cellular OX2 genes. Acquired twice in EEHVs. Roles in monocytes / macrophages during cell-to-cell signaling via surface OX2-receptors. Act to limit host inflammatory responses to infections by pathogens.

"New" vOX2-1 (TM anchor, no intron, conserved in EEHV2, 5, 6 but not 4). Retains up to 98% amino acid identity to host ex3, but DNA is diverged by 20% from host and therefore captured more than 20 million years ago. Most useful gene for EEHV1 strain Identification (vary by 15% with scrambled mixed-up subtypes).

"Old" vOX2-2/3 highly diverged (25% aa), tandemly duplicated, retains ex3/4 splice signals. Creates several alternatively spliced versions ex3A/4A (TM anchor) and ex3A/4B (acidic, soluble decoy). Both vOX2-2/3 proteins hypervariable with multiple (4-5x) subtype clusters and 30 to 55% protein divergence. Triplicated in EEHV5.

Cellular OX2 (CD200):



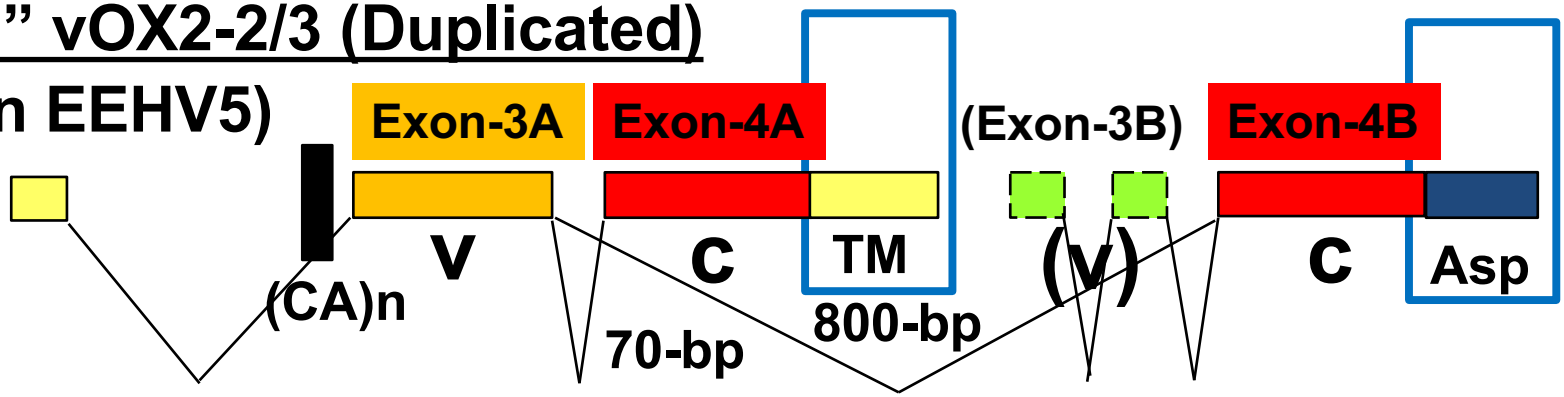
"New" vOX2-1
EEHV1,2,5,6

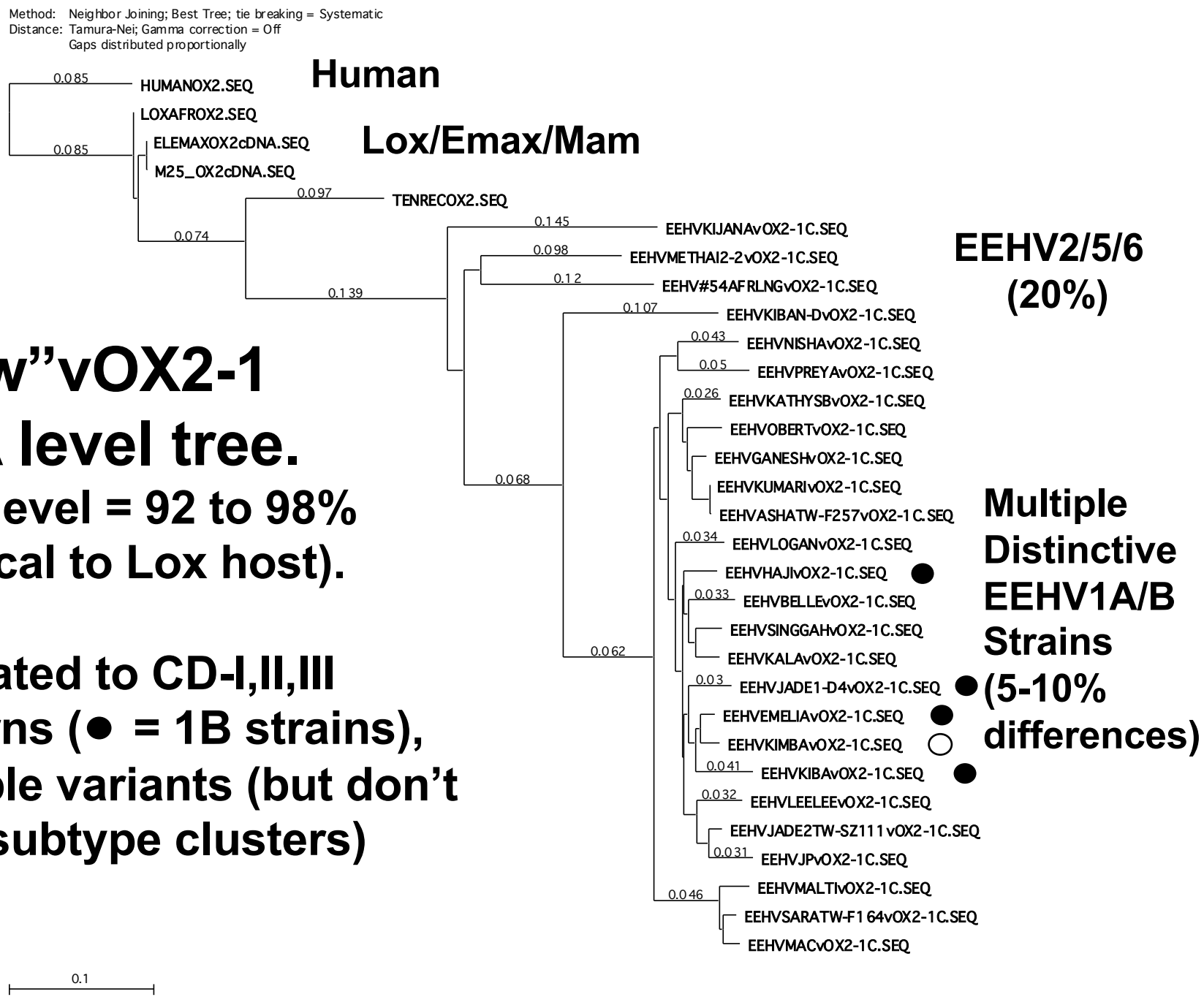


90- 98aa%
to E.max

25aa%

"Old" vOX2-2/3 (Duplicated)
(3x in EEHV5)





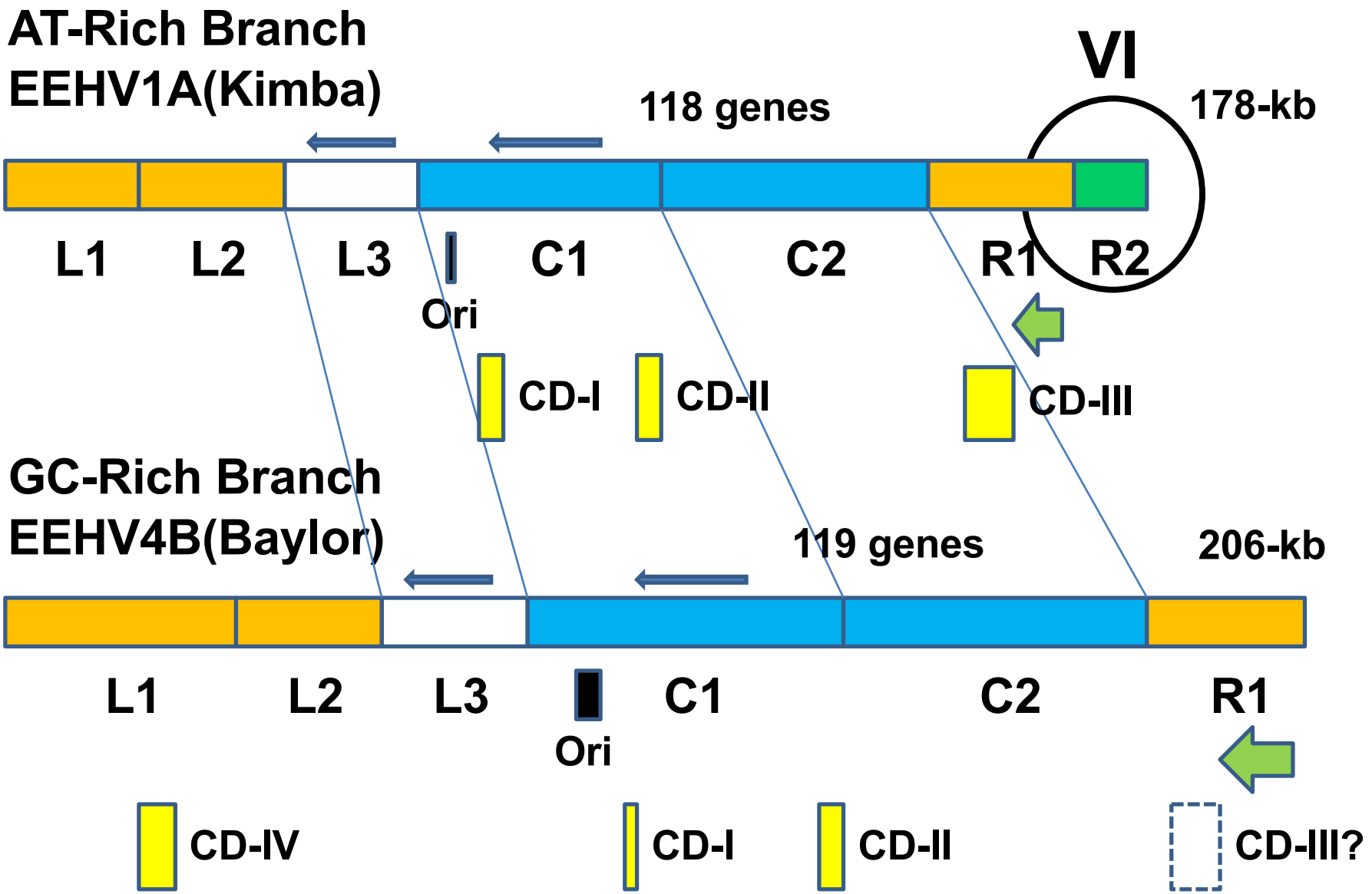
"New"vOX2-1 DNA level tree.

(PTN level = 92 to 98% identical to Lox host).

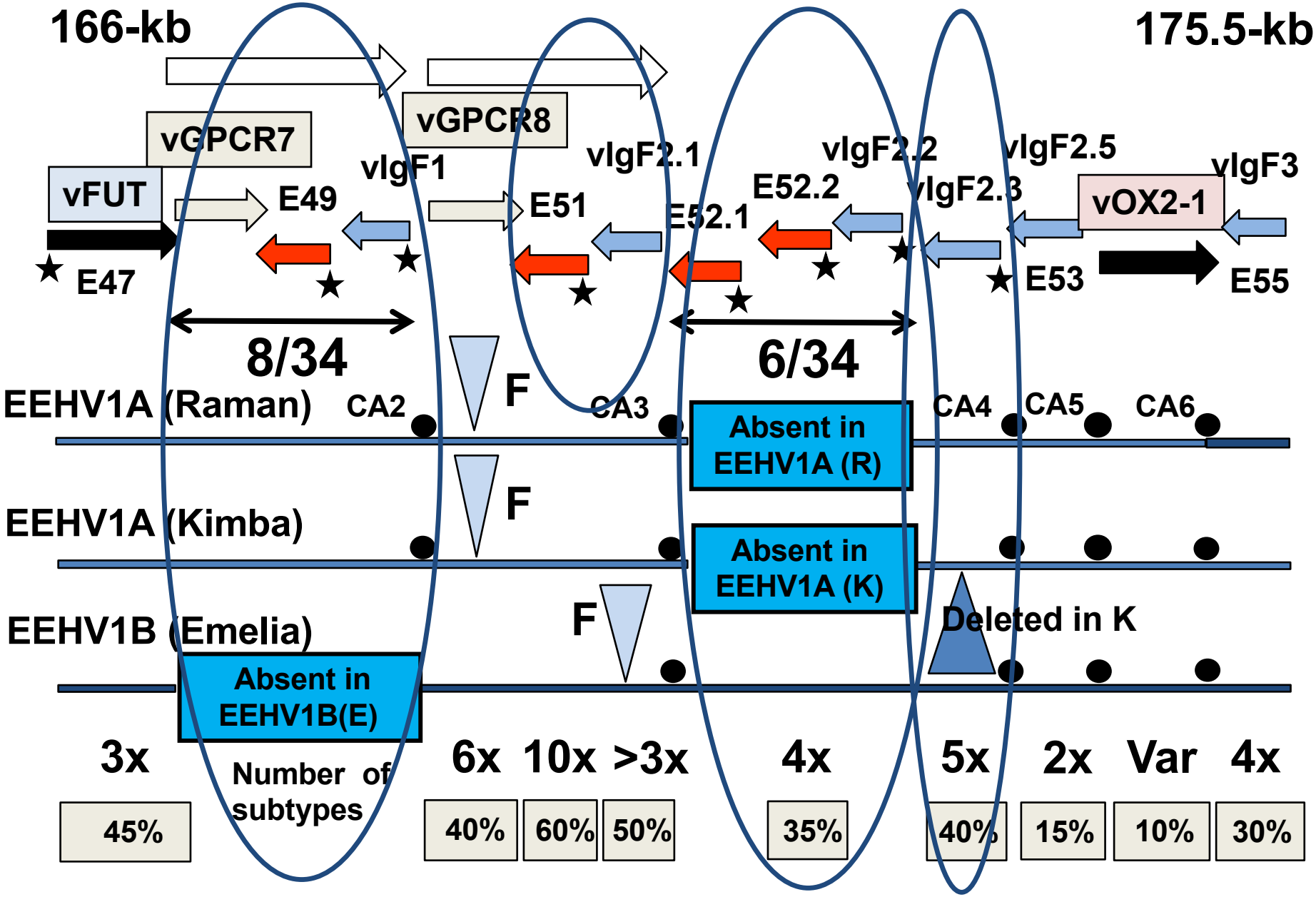
Unrelated to CD-I,II,III Patterns (● = 1B strains), Multiple variants (but don't form subtype clusters)

EEHV2/5/6 (20%)

Multiple Distinctive EEHV1A/B Strains (5-10% differences)


AT-Rich Branch
EEHV1A(Kimba)
VI
118 genes
178-kb
L1
L2
L3
Ori
C1
C2
R1
R2
CD-I
CD-II
CD-III
GC-Rich Branch
EEHV4B(Baylor)
119 genes
206-kb
L1
L2
L3
Ori
C1
C2
R1
CD-IV
CD-I
CD-II
CD-III?

EEHV1 Subtype Divergence – Region VI



Features of Variable Region VI (10-kb):

Encodes a total of 30 paralogous genes in three Interspersed Gene Families, 8x vGPCR, 18x E52/vIgFam, 4x E51 (plus vFUT9, vOX2-1), with Complex Multi-Gene Insertion/Deletion Casettes. Different strains have an alternative subsets of just 10-12 of these genes. [= Totally unprecedented feature]

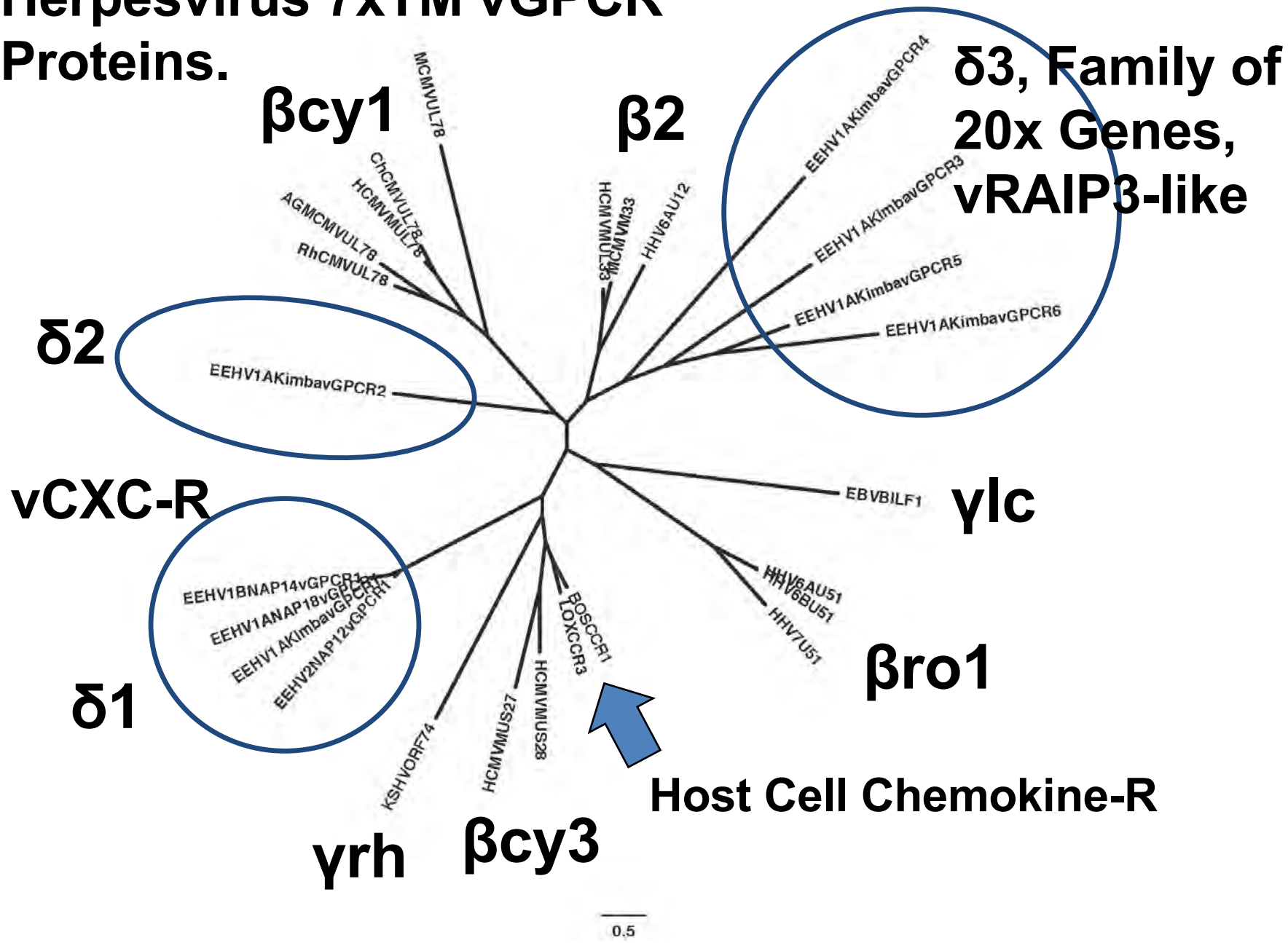
Met initiator motifs (often frame shifted)

7 - 10x ★ **ATGGGGGGGGGG- (9,10,11 or 12x G-runs)**

3 - 5x ● **-CACACACACACACA- 15 to 65-bp (in non-coding regions only)**

3 - 5x ▲ **Partially Deleted or Fragmented Genes**

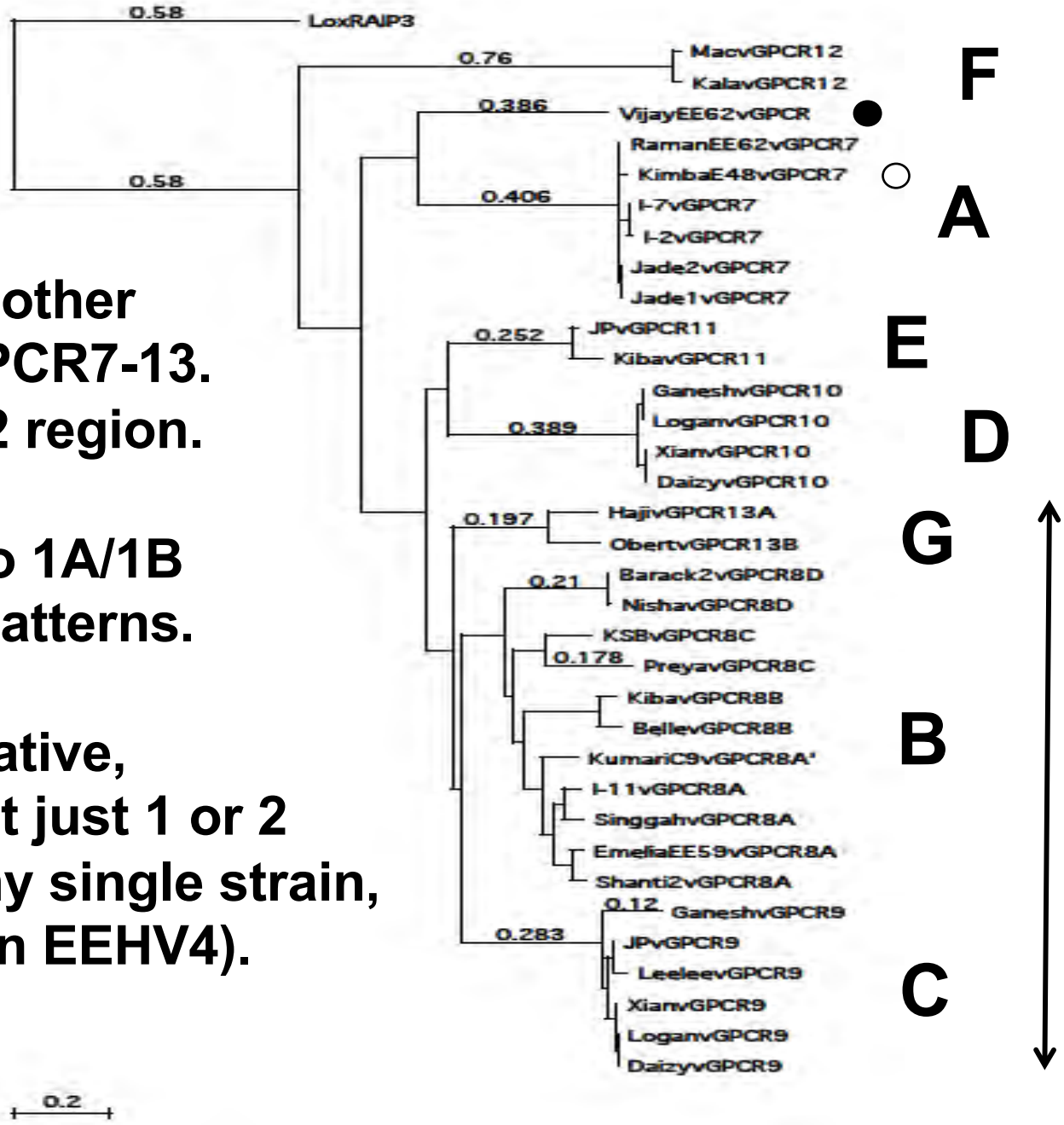
Herpesvirus 7xTM vGPCR Proteins.



EEHV1 δ3 another subset = vGPCR7-13. All map in R2 region.

Not related to 1A/1B or CD-I,II,III patterns.

Seven alternative, subtypes, but just 1 or 2 present in any single strain, (all missing in EEHV4).



Summary

- EEHV1 genomes contain five major hypervariable gene segments, e.g. I, II, III, V and VI that total 26 / 180-kb and encompassing 27 / 118 genes (mostly membrane signalling and envelope glycoproteins).

- Domains I, II and III represent central linked chimeric domains that define A / B subtyping. The protein level divergence between 1A / 1B strains can be between 30 to 60% and is often greater than that between the EEHV1 and EEHV6 species (= EM and LA versions).

- All EEHV1 strains display additional clustering into multiple (up to 7) subtypes that again differ by between 20 to 50% within parts of all five variable domains for A subtypes, but only within V and VI for B subtypes.

-Within region VI individual strains contain a selection of just 10 out of 30 alternative paralogous proteins from three gene families, as well as show extensive gene deletions, fragmentation and translational slippage.

- Overall, the different chimeric domains and subtype clusters have been evolving separately for millions of years. Therefore, different strains could have very different biological properties and their antibody / T-cell response repertoires would only partially cross-react. For vGPCR1, all subtypes are found worldwide but India (E) vs Thailand (A/D) differ.

Likely Relevant Observations for HD (GSH)

1. Multiple Highly Diverged EEHV1 Strains all cause Disease. Therefore, unlikely that a Single Mutation or Dominant Highly Pathogenic Strain is Involved.

2. Few Examples of Transfer between Facilities, instead each Facility has its own Strains and the same Strain can be Fatal or Asymptomatic in different Elephants.

3. Five Examples of Sequential Infections with First 1A then 1B or vice versa or with first 1 then 5 then 4 (Tucker) or first 4 then 1B (Baylor and Tupelo). Suggests that Infection with One Virus Type does not protect against infection by another, but maybe it does provide enough Immune Response to protect against Disease.

Likely Relevant Observations for HD (contd-2)

4. Lack of Cases in Calves less than One-Year-Old also Suggests Protection by Maternal Antibodies. (Infection before weaning = equivalent of vaccination?)

5. Multiple Examples of Simultaneous Infections of Pairs of Calves at the Same Facility with Identical Strains.

6. Consistent Pattern of First Symptomatic Viremia then Trunk Wash or Saliva Shedding several months later. (Reactivated Shedding may not include the Viremia?).

Both 5 and 6 suggest that Serious Disease may always represent Primary Infection – again indicating that Prior Immune Response Status is a Critical Factor.

Likely Relevant Observations for HD (contd-3)

7. No Evidence Yet for Serious Disease or Even for Reinfection by the Same or a Different Strain of the Same Subtype in any Calf that had Already Survived Prior Infection by Either EEHV1 Subtype-1A or Subtype-1B.

8. Strongly Recommend Continuous Routine Monitoring (Blood and TW) of all Calves and Herdmates in Breeding Facilities.

9. Should also carry out Prior Screening of all Elephants at both Donor and Recipient Facilities when Transfers Involving Breeding Facilities are Planned.

10. Include Long-Term Storage of Samples (or DNA) for Retrospective Analysis, plus Multi-Locus PCR Strain DNA Sequence Analysis on all Positive Samples.

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Virginia Riddle Pearson

Visiting Scientist, Fox Chase Cancer Center, Philadelphia
Collaborator, Molecular Virology Group, Johns Hopkins University School of Medicine



Genetic Characterization of EEHV and Gammaherpesviruses In Lung or Skin Nodules and Saliva from Zoo and Wild African Elephants

***Pearson VR, Zong JC, Heaggans SY, Long SY & Hayward GS**

12 SPECIES, 20 SUB-TYPES of ELEPHANT HERPESVIRUS

Species	Case#	Source	Host	Discovery/Report
Proboscivirus Genus (Deltaherpesvirus Sub-Family):				
*EEHV1A	NAP#11,19	Bl/Nec, TW	EM	Richman1999; Stanton2009
*EEHV1B	NAP#14,18	Bl/Nec, TW	EM	Ehlers2001; Fickel2001
*EEHV2	NAP#12,#42	Nec,LungN,SkinN	LA	Richman1999; Zong2010;Pearson2011
*EEHV3A	NAP#27,#42	Bl/Nec,LN,SkinN	EM,LA	Garner2007; Zong2010;Pearson2011
EEHV3B	NAP#63	Skin Nod, Bl, TW	LA	Pearson2012;Bronson,2013
*EEHV4A	NAP#22	Bl/Nec	EM	Garner2007
EEHV4B	NAP#69	Bl, TW	EM	Feury2014
*EEHV5A	NAP#29	Bl, TW	EM	Latimer2008;Atkins2011
EEHV5B	NAP#58	Bl, TW	EM	Atkins2011
EEHV6	NAP#35,#42	Bl, Lung Nod	LA	Latimer2009;Zong2010;Pearson2011
EEHV7A	NAP#42	LungN,Skin Nod	LA	Zong2010;Pearson2011
EEHV7B		Skin Nod	LA	Pearson2012
Gammaherpesvirus Sub-Family:				
EGHV1A		Con/Swab, Saliva	EM	Wellehan2007; Ehlers 2007
EGHV1B	NAG#11,12	Saliva	LA	Pearson2012
EGHV2	NAG#1,13,14	Con/Swab,Bl	EM,LA	Wellehan; Latimer; Pearson2012
EGHV3A	NAG#2,7	Con/Swab,Bl	EM	Wellehan2007; Latimer2008
EGHV3B	NAG#5,15,16	Bl, Saliva	LA	Latimer2008, Pearson2012
EGHV4	NAG#17	Con/Swab, Saliva	LA	Wellehan2007; Pearson2012
EGHV5A	NAG#6	Trk Papilloma	EM	Latimer2008; Masters2011
EGHV5B	NAG#8	Trk Papilloma	LA	Long2011

• = Lethal Acute Hemorrhagic Disease.
EM = Elephas maximus; LA = Loxodonta africana
NAP/NAG# = North American Proboscivirus/Gammavirus case/sample ID No.

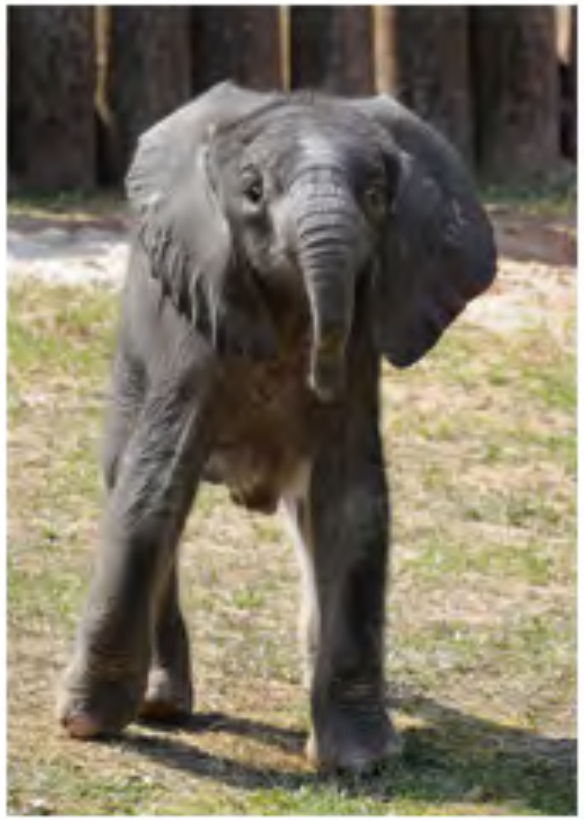
In contrast to more than 100 confirmed cases of EEHV hemorrhagic disease in Asian elephants (Elephas maximus, EM) worldwide, there have only been four documented cases of EEHV disease in African elephants (Loxodonta africana, LA). It was thought when EEHV was first identified that herpesviruses endogenous to African elephant hosts might be infecting non-natural host Asian elephants, resulting in unusually severe pathogenesis and death from hemorrhagic disease [Hayward, 2012, Richman et al 1999; Richman et al, 2000].

(1) death of an 11-month old LA calf in a California zoo in 1996 (the prototype example of EEHV2);

(2) surviving case of viremia in a one-year old USA zoo LA calf in 2009 (the prototype example of EEHV6);

(3) surviving case of EEHV3B viremia in a USA LA calf in 2013

(4) lethal case in a young LA living in a Thailand zoo in 2013 (first known death associated with EEHV6).



Samson, credit Maryland Zoo, 2013

McCully et al (1971) first described lymphoid lung nodules containing viral inclusion bodies morphologically consistent with herpesviruses from among a group of 50 culled LA in South Africa. Jacobson et al (1987) reported herpes-like viral inclusion bodies in trunk nodule biopsies from a group of 99 African elephants imported from Zimbabwe to Florida in 1983-1984 known as Nautilus 99. Wellehan et al (2008) reported that healthy asymptomatic African zoo elephants in the USA shed several types of EGHV from the Gammaherpesvirus sub-family in a pioneering study of primarily conjunctival swabs.



Photo courtesy of Elliot Jacobson, DVM



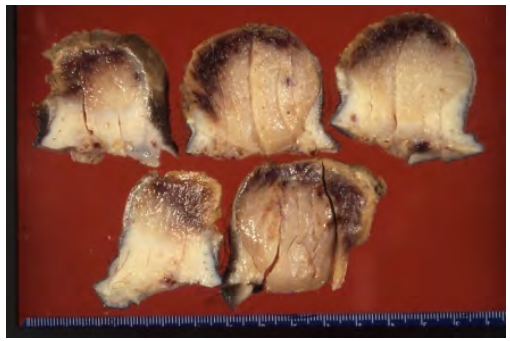
Nautilus 99

courtesy Elliott Jacobson, DVM, PhD
University of Florida
College of Veterinary Medicine

Jacobson et al 1987







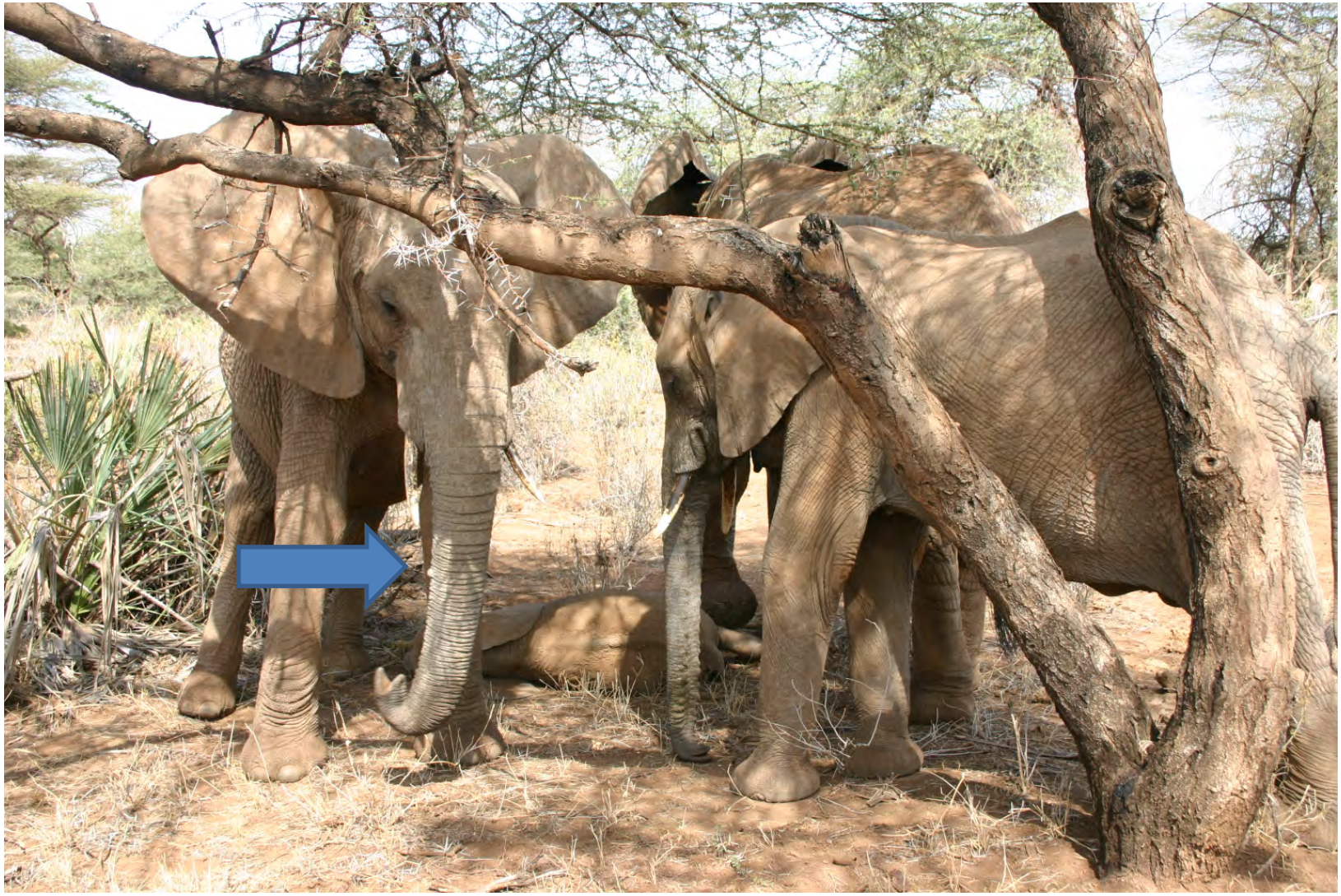
Over the past several years, we have undertaken to search for and genetically evaluate EEHVs and EGHVs in numerous clinical samples, including skin nodule, warts and lesions, lung biopsies and saliva from wild African elephants in Kenya, Botswana, South Africa and Zimbabwe, in saliva and tissues from adult and juvenile African and Asian elephants at multiple facilities in the USA, and in archived FFPE skin biopsies from elephants imported from Zimbabwe to America in 1983-84.



"Babylon"
Samburu National Reserve.
Kenya

Credit:VR Pearson, 2009

A surprising discovery July 2009 of nodules on wild African elephants similar to Jacobson's Nautilus 99



Credit: Eric Pearson, 2009

KENYA 2011





www.SaveTheElephants.org



Kenya Wildlife Service Veterinary and Capture Services Department

EEHV3

Calf of Graca Michelle

"First Ladies" Family, Samburu, Kenya 2011



credit VR Pearson 2011

EEHV2,3,6,7

Nodule Calf of MaryTodd Lincoln

“First Ladies” Family, Samburu, Kenya 2011



credit VR Pearson 2011

Kenya 2011



credit VR Pearson 2011

Kenya 2011



credit VR Pearson 2011

We recently published a study Zong et al, 2015of necropsy lung and spleen samples from five otherwise healthy adult LA elephants, including lung biopsy from Kenya, in which we detected 16 distinct examples of quiescent EEHV strains from amongst four highly diverged species of *Probosciviruses* (namely EEHV2, EEHV3, EEHV6 and EEHV7) that were especially highly abundant in lymphoid lung nodules similar to those that were first described by McCully et al, (1971).







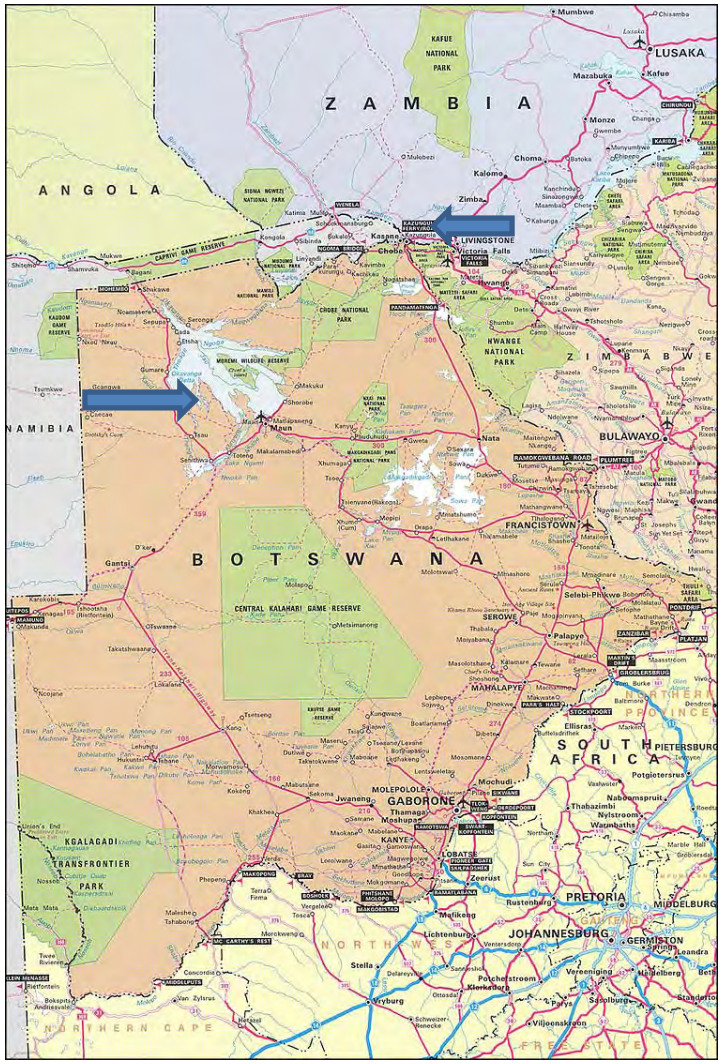
VR Pearson, Kenya 2011

Botswana 2013

with Dr. Michael Chase and Kelly Landen

Elephants Without Borders





KALWESI WATER HOLE
Chobe National Park, Botswana 2013



credit VR Pearson 2013

Botswana 2013





Trunk nodules, Botswana 2013

Credit VR Pearson 2013

South Africa 2010 and 2013

with Dr. Michelle Henley

Elephants Alive and Save the Elephants



Wild Spirit Ear Lesion: positive EEHV3/7,EGHV3B
Balule Reserve, South Africa 2013







credit VR Pearson 2013

Nautilus Ear Warts #88



credit Elliott Jacobson 1986

Summary of EEHV Kenya Loxodonta africana Skin Nodules (N=5) and Lung Biopsy (N=1) at Five Core PCR Loci

NAME	POL2	POL3/4	POL6	TERC	TER3/4	TER2/6	gMC	gM3	gM7	gM-B	OBP	OBP3/7	HELC	HEL3	HEL7	HELB
Primer set	**8**	**9**	**x**	**2**	**7,7A**	**2A**	**4**	**16**	**16AB**	**16N**	**17**	**18/18A**	**6**	**6A**	**6B**	**6N**
All = second or third round PCR																
GM1-20		3A(7x)		3A(4x)	3A(4x)		3A(1x)	3A(1x)	3A(4x)	3A(1x)			3A(4x)	3A(4x)	NT?	NT?
HIM-S3		3A+3B			3B+7				7A			3B				
HIM-S11									3B							
HIM-S13					3A				3B							
HIM-S19		3B								7A						3B
HIM-S28									7A							
MM-M-S4					2	2						(3B)				
MM-M-S23			3B						7A							3B
MM-M-S25	2				(7B)	2			(7A)						7A	3B
MM-M-S26					(3A)											
MM-F-S5		3B	3B		3A+3B*				3A+3B	3A+3B		3A+3B	3B	3A+3B	3A	3A+3B
MM-F-S22																3B
MM-F-S26					(3A)											
MM-F-S40												3B				
MM-F-S41												3B				
MT-S2		3A+3B	3B	3A+3B*			2	7A								3B
MT-S8		7A		3A+7	3A+7	2		7B	7B			2+7A+7B		3A+3B+7A		7A+7B
MT-S9	2	7A		7A	7A				2x7A	7A+7B					7A	3B
MT-S10			3B	7A												7A
EnthLung#1-S6		3A	6		6	6			3A	3A	6	3A	6	3A	3A	3A
EnthLung#2-S7		3A		6	6	6	3A		3A		6	2	6		3A+7A	

Detection of GC-Rich EEHVs in Elephant Skin Nodules (N=10) and Lung Biopsy (N=1) from Kenya, Botswana and South Africa

Name Code	Source	Host Species	Extended PCR Loci				Overall
			OBP	TK	vGCNT1	UDG	
NAP27 Hansa	WB	EM	3A	3A	3A	3A	3A
NAP62 Samson	WB	LA	3B	3B	3B	3B	3B
SAM6 Enthus	Lung	LA	3A,7A	3A	3A	3A, 7A	3A,7A
SAM2MT	Skin Nod	LA	3A	3A,7A	3C	3A,3C,7A	3A,3C,7A
SAM3 HIM	Skin Nod	LA				3A	3A
SAM4 MMM	S. Nod	LA	3B				3B
SAM5 MMF	Skin Nod	LA	3A,3B	3C	3C	3A,3C	3A,3C
SAM8 MT	Skin Nod	LA	7B			7A	7A,7B
SAM9 MT	Skin Nod	LA	7A				7A
SAM20 MMM	S.Nod	LA				3A	3A
SAM35 MT	Eye Nod	LA	3A				3A
SAM40 TMF	S. Nod	LA	3B				3B
SAM41 TMF	S. Nod	LA	3B				3B
SAM44 HIM	Skin Nod	LA				3D,7A,7B	7A,7A,7B
SAM55 Enth	Lung#3	LA	3A				3A
GM7,17,20	Skin Nod	LA	3A				3A
BW1M-2	Skin Nod	LA	3A			3A	3A
BW1M-3	Skin Nod	LA	3B	3D			3B,3D
BW2F	Skin Nod	LA	3A		3A	3A	3A
BWWildSpirit	Ear Nod	LA	3B				3B
RSABuss-A	Skin Nod	LA					-
RSABuss-B	Skin Nod	LA			3C		3C
RSABuss3	Skin Nod	LA	3A				3A

Herpesviruses Detected in Elephant Skin Nodules,Lung and Tissue Biopsy

	EEHVs							EGHVs						
	1AB	2	3A	3B	6	7A	7B	1A	1B	2	3B	4	5A	5B
Kenya MT		2	3A	3B		7A	7B		1B/*					
Kenya HL			3A			7A	7B		1B					
Kenya MM-M		2		3B		7A			1B	2				
Kenya MM-F			3A	3B					1B/*					
Kenya GM			3A											
Kenya Lung-E (LA)		2	3A		6	7A			1B			4		
Botswana M			3A			7A			1B					
Botswana F						7A			1B	2				
RSA WildSpirit				3B							3B			
RSA Matumbu									1B		3B			
RSA Proud									1B					
RSA Buss-A		2		3B		7A				2				5B
RSA Buss-B				3B						2				5B
Binti CLDB LA,USA Skin,heart,spleen, thymus											3B			
Coco (EM, USA)		←----------NT----------→											5A	
Spain Spleen (LA)		2		3B	6				<----------NT----------→					
Connie Sal Gland (EM,USA)	1A		3A					1A						
Ali Semen (LA USA)			3A			7A								
Jo CLJ (LA ,USA Oral Papilloma														5B

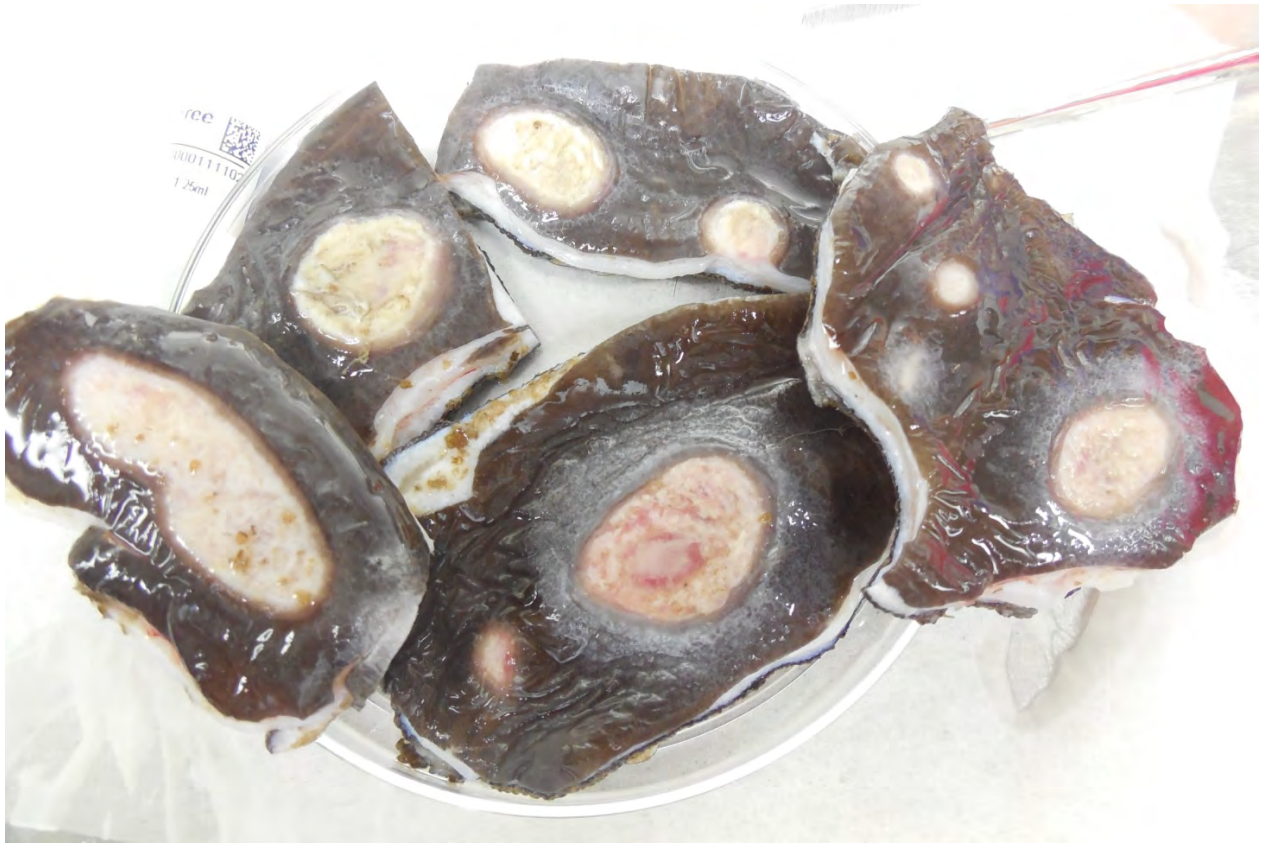
* = Also sometimes detected EEHV3B with 2cd round Pan EGHV primers

EGHV Distribution

	Conjunct Swabs	Blood	Vulval Lesion	Oral Lesion	Saliva Swabs	Skin Nodules, Lesions, Warts	Lung, Heart, Salivary Gland Spleen,Thymus
EGHV1A	EM				EM		
EGHV1B		LA			LA	LA	
EGHV2*	EM	EM	EM		EM		
EGHV2*			LA		LA	LA	
EGHV3A		EM	EM		EM		
EGHV3B		LA	LA		LA	LA	LA
EGHV4A					EM		
EGHV4B	LA				LA	LA	
EGHV5A						EM	
EGHV5B				LA	LA	LA	

“Binti”, Caldwell Zoo, TX
EGHV3B

like South Africa “Wild Spirit” Ear Wart



credit VR Pearson

Detection of Herpesviruses in Saliva USA 2012

Non-invasive buccal swabs for first MHC gene characterization

Elephant herpesviruses detected in saliva by VPearson



Six Flags Safari Park, NJ, USA



Samson (LA, 5-yo) Maryland Zoo Episode (Feb to Oct 2013)
Summary of EEHV and EGHV Types Detected in Herdmates

	WB	WB	Saliva Swab Collections																	
	-1 y	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	+1y
EEHVs (U71/gM)																					
Samson	0	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	3B	0	3B	0	3B	0	0
Anna	-	0	0	0	0	0	0	0	(0)	0	0	0	0	0	(0)	0	0	0	0	0	0
Lil Felix	-	0	0	0	0	0	0	(0)	0	0	0	0	0	0	0	0	0	0	0	0	0
Dolly	-	0	0	0	0	0	0	0	0	0	3B	3B	0	3B	3B	3B	0	0	0	0	0
EGHVs (POL)																					
Samson	1B	*							1B	1B								1B			1B
																			2		2
																					3B
																		4			4
Anna	-		1B	1B	1B		1B								1B			1B	1B	1B	
			3B	3B											3B						3B
															4						
Lil Felix	-		1B				1B										1B		1B		
		2		2													2		2		2
			3B														3		3		
Dolly	-											1B			*	*					-
																				2	-
																				3B	-

Detection of Elephant Herpesviruses in USA Saliva Swabs:

N=28 Loxodonta africana and 46 Elephas maximus

Name	Case	Host	Loc	EGHV1			Other EGHVs						EEHVs						
	(Facility)			TTTT	CCGC	1A	2	3A	3B	4	5A	5B	1A/1B	2	3A	3B	6	7A	7B
Joyce	SFJ97	LA	USA	1B			2							2	3A		6		
Lucy	SFL	LA	USA	1B										2	3A	3B	6		
Tanya	SFTn	LA	USA		1B'		2									3B	6		
Gloria	SFG	LA	USA		1B'												6		
Shiela	SFS	LA	USA		(1B')					4				2		3B		7A	
Debbie	SFD	LA	USA		1B'									2		3B	6		
Barbara	SFB	LA	USA	1B													6		
Tava	SFTv	LA	USA	1B															
Valerie	SFV	LA	USA	1B															
Bertie Mae	SFBM	EM	USA			1A									pending				
Liz	SFL	EM	USA			1A									pending				
Kalli	CZK	LA	USA		-		2												
Willy	CZW	LA	USA	1B			-			-									
Martika	CZMr	LA	USA		1B'		-			-									
Moshi	CZMs	LA	USA		1B'		2			-									
Shenga	CZS	LA	USA		1B '		-			-									
Indy	DPI	EM	USA			1A	-		-	-		-			pending				
Patience	DPP	EM	USA			1A	-		-	-		-			pending				
Connie	DPC	EM	USA			1A	2			-			1A (Salivary gland)						
Moola	DPM	EM	USA			1A									pending				
Kuhnshorn	DPK	EM	USA			1A	-		-	-		-			pending				
Boo2	SAZ	EM	USA	1A			2								pending				
Lucky	SAZ	EM	USA	-											pending				
Kate	RWZ	LA	USA									5B							
Ginny	RWZ	LA	USA	1B					3B	4									
Samson	MZS	LA	USA	1B			2		3B	4		-				3B			
Dolly	MZD	LA	USA		-*		2		3B	-		-				3B			
LilFelix	MZLF	LA	USA	1B			2		3B	-		-							
Anna	MZA	LA	USA	1B			-		3B	-		-							

Detection of Elephant Herpesviruses in USA Saliva Swabs: cont'd

Name	Case	Host	Loc	EGHV1			Other EGHVs						EEHVs						
	(Facility)			TTTT	CCGC	1A	2	3A	3B	4	5A	5B	1A/1B	2	3A	3B	6	7A	7B
Lois	KCL	LA	USA	1B			-		-	-		-							
Lady	KCLY	LA	USA	1B			-		-	-		-							
Tattoo	KCT	LA	USA	1B			-		-	-		-							
Megan	KCM	LA	USA	1B			-		-	-		-							
Binti	CLDB	LA	USA						3B (skin lesions, heart, salivary gland, thymus)										
Nautilus	FFPE	LA	USA							4									
Oklahoma	6 x EM 6 month saliva study		USA						pending							pending			
	Chai	Saliva											1A						
	Malee	Saliva at birth					2		3B				1A (lung at necropsy one year +)						
	Asha	Saliva at Malee birth					2		3B										
Oregon	7 x EM		USA						pending							pending			
	SungSurin												1A						
Houston	8 x EM		USA						pending							pending			
Albequerque	6 x EM		USA						pending							pending			
Fort Worth	5 x EM		USA						pending							pending			
	Blue Bonnet												1A						
Ring	3 x EM		USA						pending							pending			
	Baby												1A						

Detection of EEHVs in Elephant Saliva Swabs from South Africa, Botswana and Zimbabwe

N= 40 wild Loxodonta africana including Kenya

Location Code	Name	Host Species	Core PCR Loci				EEHV Overall
			2A/POL	6B/HEL	16A/U71/gM	18A/OBP	
RSA-M	Proud	LA					-
RSA	Buss 3	LA	3A	3A + 3B	3A	3A	3A, 3B
BW ABU1	Sirini	LA	3A	3A		3A	3A
BW ABU1	Kitti	LA	2	3A	7A		2, 3A, 7A
BW ABU3	Paseka	LA	2	3A		3A	2, 3A
BW ABU4	Lerato	LA		3A	7A	3B	3A, 3B, 7A
BW La#1	M-La#1	LA		3A	3A	3B	3A
BW La#2	F-La#2	LA		3A’			3A’
BW WH7	Chobe3	LA		3A			3A
BW WH8	Chobe4	LA		7A			7A
ZIM WH1	Doji	LA	2	3A	3A + 3B	3B	2, 3A, 3B
ZIM WH2	Tembe	LA	3A	3A	3A	3A	3A
ZIM WH3	Pfumo	LA	3A	3A	3B	3B	3B
ZIM WH4	Jumbo	LA		3A		3B	3A, 3B
ZIM WH5	Tendai	LA			3A		3A
ZIM WH6	Ntombi	LA		3A			3A

Detection of GC-Rich EEHVs in Elephant Saliva Swabs in Africa

		Extended PCR Loci				EEHV	EGHV
Code / Name	Species	OBP	TK	vGCNT1	UDG	Overall	Overall
Samson (MD) Sal	LA	3B	3B	3B	3B	3B	1B
SAM32 MT calf	LA	3A,3B	3B,7A		3B,3D,7A	3A,3B,7A	3B
SAM32 MT mother	LA				7A	7A	3B
SAM42 MMF	LA	3B	3C		3A,3C,7A,7B	2x3A,7A,7B	3B
GM26 calf	LA			7	3A,7A,7B	3A,&A,7B	
GM23 mother	LA		3B	3A	3A,3D	2x3A,3B	
SAM62 MM mother	LA		3B		7B	3B,7B	
KENYAHonesty	LA				7A	7A	
KENYATaurus	LA				7A		
KENYAMercury	LA						5B
KENYAResilience	LA						3B
BW1 M	LA	3B	3A	3A		3B	1B,2
BW2 F	LA						1B
BWSirini	LA			3A		3A	
BWLerato	LA	3B				3B	
BWPaseka	LA			3B			
BWKitti	LA		3A				
BW Chobe3	LA						1B
RSA Wild Spirit	LA						1B
RSA Matumbu	LA						1B,3B
RSAProud	LA						1B
ZIMDoji	LA	3B	3A	3C		3B	
ZIMJumbo	LA	3B				3B	
ZIMPfumo	LA	3B				3B	
ZIMTembe	LA			3A		3A	

NB: Many Others Gave Unresolvable Mixtures of Multiple EEHV3 and EEHV7 Strains

This research has all involved Sanger PCR sequencing of purified DNA products amplified directly from clinical DNA samples using a series of specific primers designed for diagnostic detection of individual EEHV species or both generic and individual primers for each EGHV species. We conclude that quiescent infections by a total of at least eleven species and subtypes of EEHV or EGHV herpesviruses are endemic in asymptomatic African elephants.

Qiagen DNAeasy Blood and Tissue Kit
Qiagen RNALater
Qiagen RNAprotect Cell Reagent
Promega G2 Hot Start Master Mix
GE Life Sciences FTA indicatingCards
Integenx GenTegra DNA tubes
Integenx GENSOLVE
Puritan Medical Products 16" swabs



credit VR Pearson 2013

Twenty Known Types of Elephant Herpesviruses

Asian (E. maximus)	African (L. africana)
Deltaherpesvirus-Proboscivirus genus	
EEHV1A, 1B	EEHV2
EEHV4A, 4B	EEHV3A, 3B
EEHV5A, 5B	EEHV6
	EEHV7A, 7B
Gammaherpesviruses	
EGHV1A	EGHV1B
EGHV3A	EGHV3B
EGHV5A	EGHV4
	EGHV5B
EGHV2	

Important next steps



credit Oregon Zoo, USA

Elephas maximus borneensis

1) Obtain saliva samples from wild Borneo elephants currently believed to have been isolated from mainland Asian elephants for 200,000 years.

2) and from African forest elephants in Western Africa, speciation more than 4M years from savannah elephants.

ACKNOWLEDGEMENTS

Dr. Glenn Rall, Professor, Fox Chase Cancer Center, Philadelphia, PA



Dr. Gary S. Hayward, Professor, Viral Oncology Program, The Sidney Kimmel Comprehensive Cancer Center, Johns Hopkins School of Medicine



Dr. Lynn Enquist, Chairman Emeritus, Department of Molecular Biology, Princeton University



Dr. Edward Daeschler, Associate Curator, Department of Vertebrate Biology, The Academy of Natural Sciences of Drexel University



Colleagues: KENYA and USA 2011-2013

Virginia R. Pearson[1,2*], Heidi Robbins[1], David Daballen[3], Chris Leadismo[3], Jerenimo Lepirei[3], Gilbert Sabinga[3], Lucy King[3], Iain Douglas-Hamilton[3], Francis Gakuya[4], Domnic Mijele[4], Mathews Mutinda[4], Jeremiah Poghon[4], Moses Otiende[4], John Kariuki[4], Isaac Lekolool[4], William Rives[5], Kenneth Keiffer[5], Jason Holloway[5], Nicholas Way[6], Oliver A. Ryder[7], Gary S Hayward[8]

[1]Enquist Laboratory, Department of Molecular Biology, Princeton University, Princeton, NJ, USA; [2]Academy of Natural Sciences of Philadelphia, Philadelphia, PA, USA; [3]Save The Elephants, Nairobi, KENYA; [4]Kenya Wildlife Service Veterinary and Capture Services Department, Nairobi, KENYA; [5]Six Flags Wild Safari, Jackson, NJ, USA; [6]Six Flags Discovery Kingdom, Vallejo, CA, USA; [7]San Diego Zoo Institute for Conservation Research, Escondido, CA,USA; [8]Viral Oncology Program, The Sidney Kimmel Comprehensive Cancer Center, The Johns Hopkins School of Medicine, Baltimore, MD, USA[8]













EWB
Elephants Without Borders



Colleagues: BOTSWANA/SOUTH AFRICA 2013

Elephants Without Borders/Botswana: **Dr. Michael Chase, Kelly Landen, Larry Patterson, DVM**

Elephants Alive/Save The Elephants South Africa: **Dr. Michelle Henley, Cobus Raath, DVM**

WESSA South Africa: **Chris Galliers**

SANPARKS South Africa: **Peter Buss, DVM**

University of Pretoria Veterinary Genetics Laboratory, South Africa: **Dr. Cindy Harper, Susan Miller**

Princeton University, USA: **Matthew Aardema**

University of Washington, USA: **Dr. Samuel Wasser**

Thank you



FOX CHASE
CANCER CENTER
TEMPLE HEALTH

Identification of candidate proteins for an EEHV vaccine

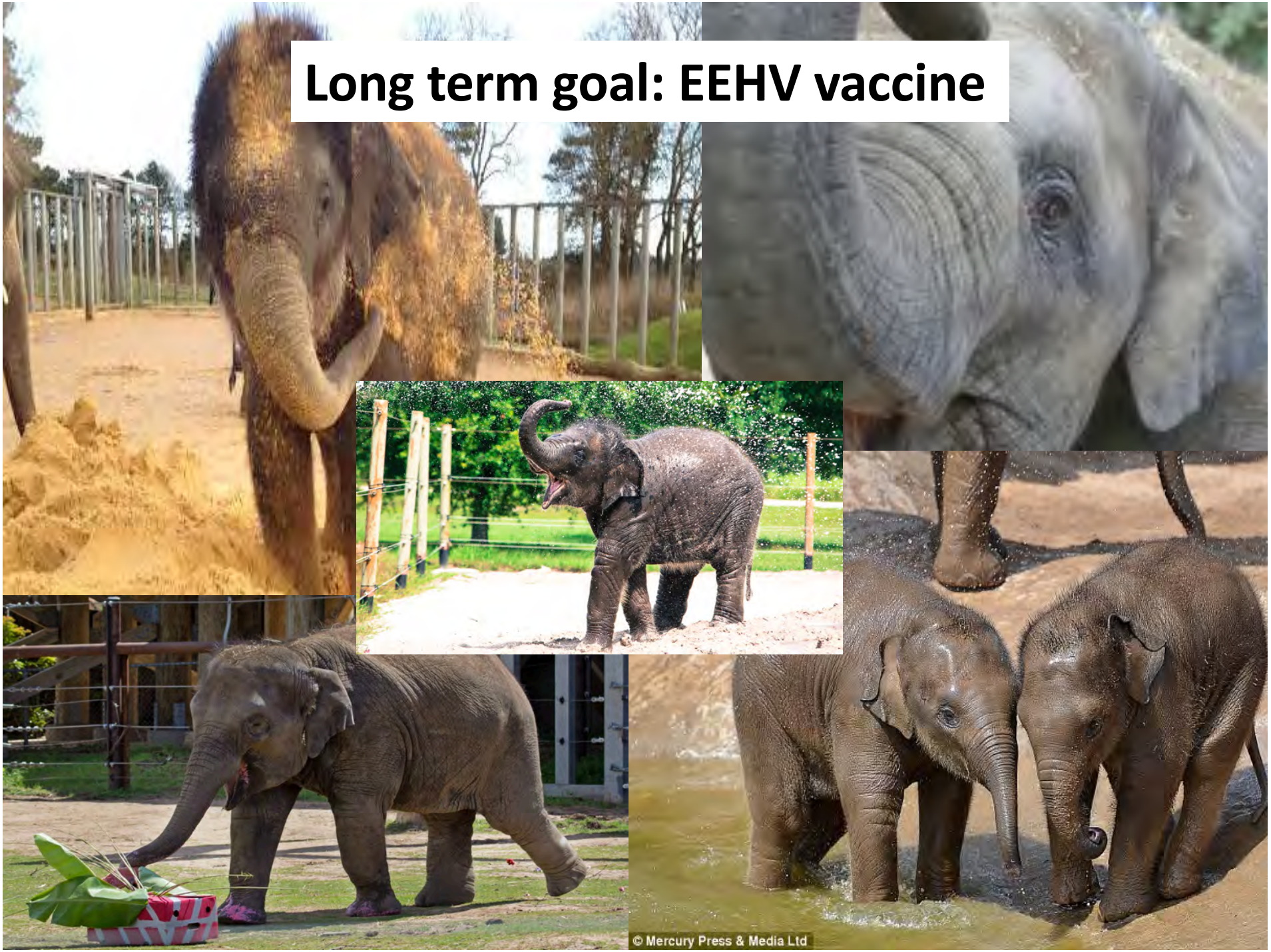
Angela Fuery, RongSheng Peng, Jie Tan, Lauren L Howard and Paul D Ling



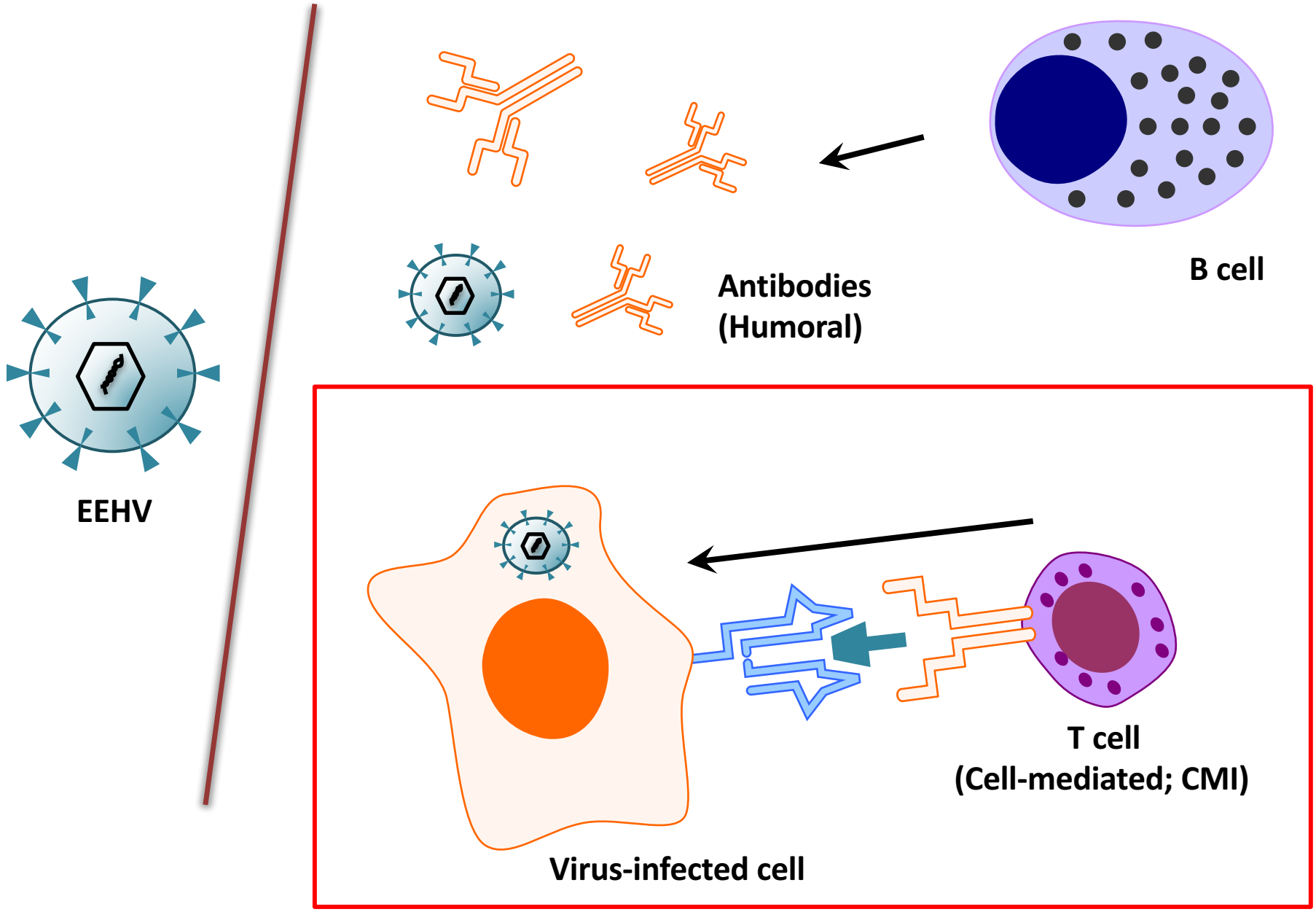
HOUSTON ZOO

Baylor College of Medicine

Long term goal: EEHV vaccine



A vaccine will require……Adaptive immune responses



Types of Vaccines

~~Live attenuated~~

~~Inactivated~~

DNA ?

Subunit ✔

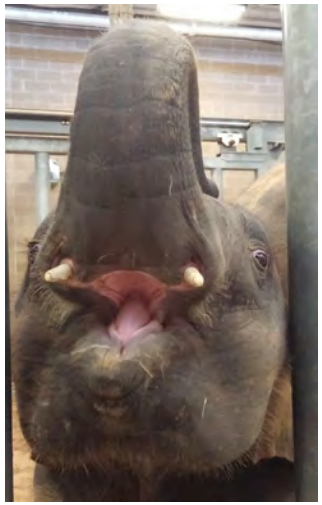
Recombinant Vector ✔

T cells are likely to be an important mechanism of protection against EEHV

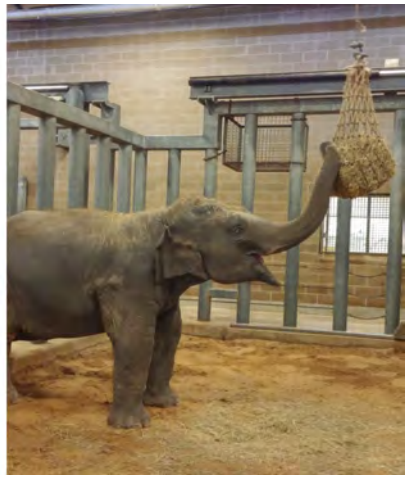
- Young elephants potentially vulnerable to severe EEHV infection do not possess EEHV-primed T cells

- Latently infected adults (healthy survivors/EEHV experienced) are likely to have EEHV-primed memory T cells

Identifying the EEHV proteins that stimulate the most robust EEHV-specific T cell responses in adult elephants will help to identify vaccine candidates







How does one go about doing this?

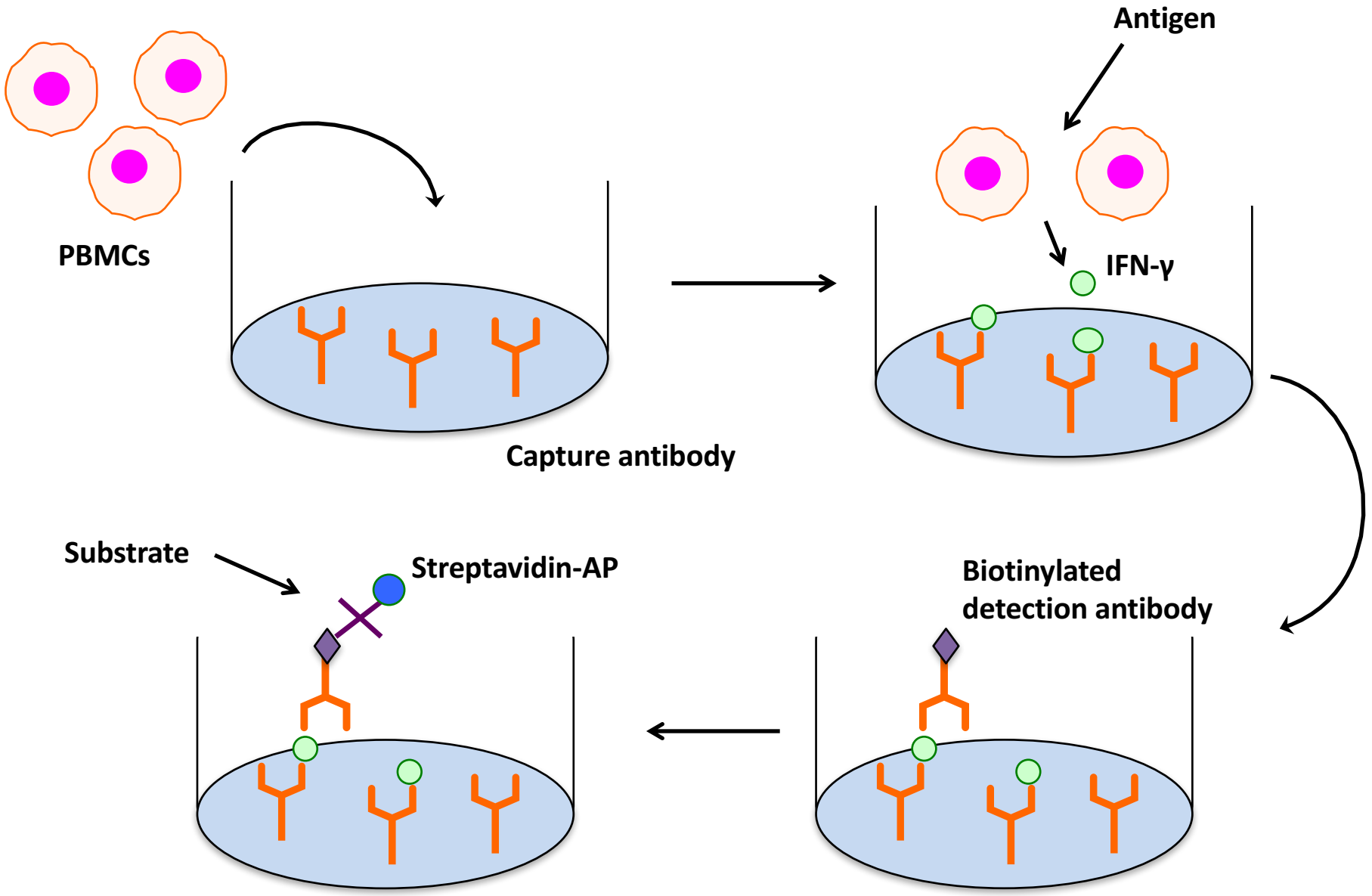
- **Interferon Gamma (IFN-γ) Enzyme-Linked ImmunoSpot (EliSpot):**
  --PBMCs
  --Abys to IFN-γ (and/or TNF)
  Angkawanish…Rutten, Transbound Emerg Dis 2013)

- **Fluorescence Activated Cell Sorting (FACS):**
  --PBMCs
  --Abys to IFN-γ, cell surface markers (e.g., CD3, CD4, CD8 etc)
  --CD3: ab11089, CD8 (Ling lab, unpubl)

- **Antigen: T cell epitopes are linear, peptide libraries of**
  15aa overlapping by 11
  --all major subtypes of EEHVs known to be endemic for Asian elephants have been sequenced (EEHVs 1A, 1B, 4, and 5);
  most predicted EEHV gene products are now known

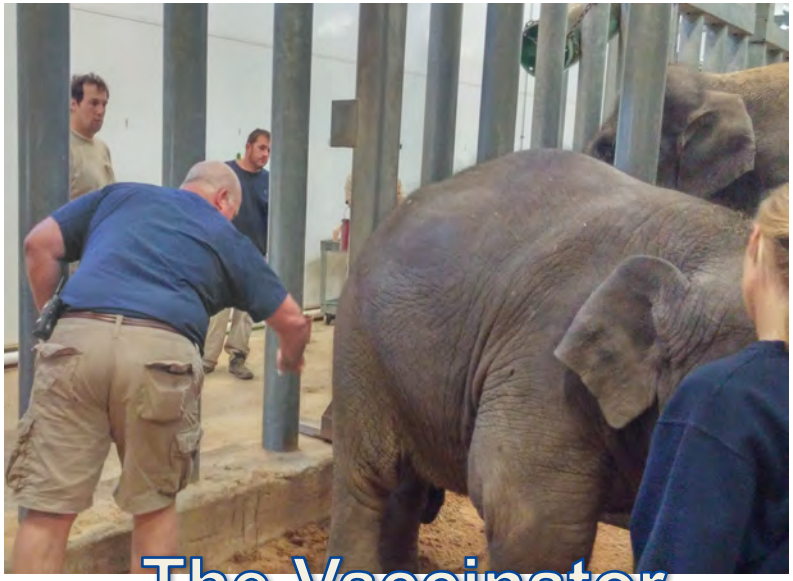
  ***EEHV4; Ling….Hayward, mSphere 2016**

IFN-γ ELISpot



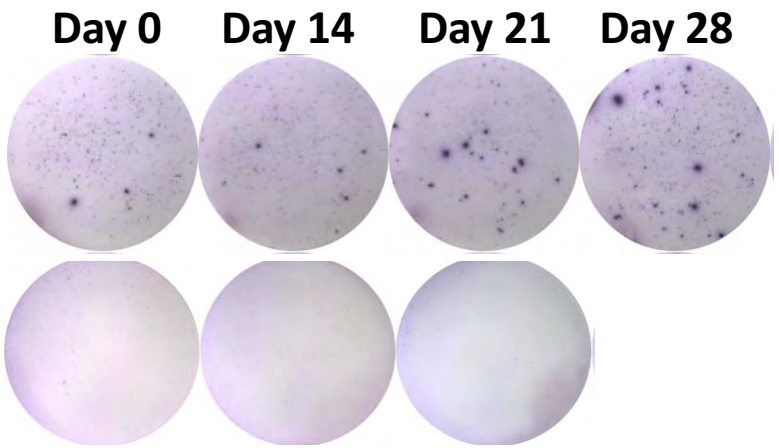
Establishing assays using a known antigen/vaccine: Rabies

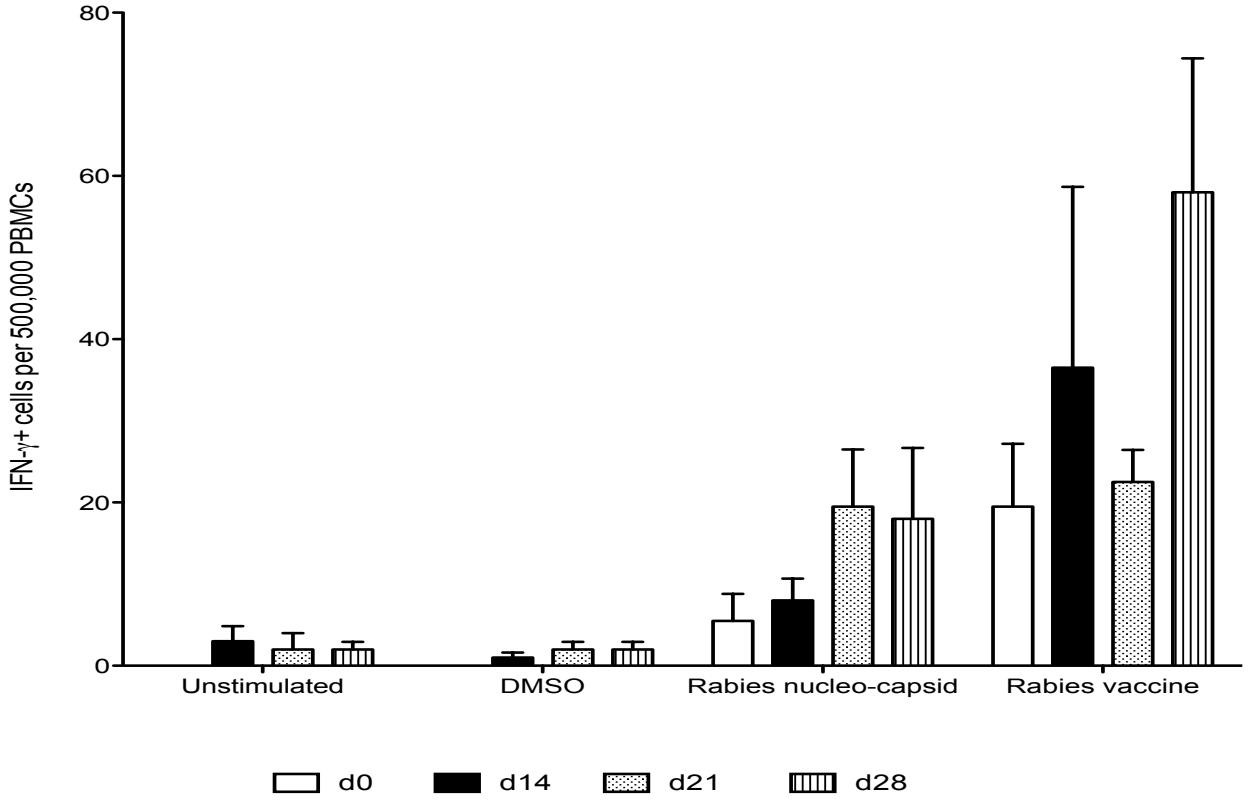
- Rabies vaccine given every 1-2 years
- Following vaccination, antigen-specific T cells circulate in the peripheral blood
  - Vaccine at day 0
  - Blood taken at days 0, 14, 21 and 28



The Vaccinator

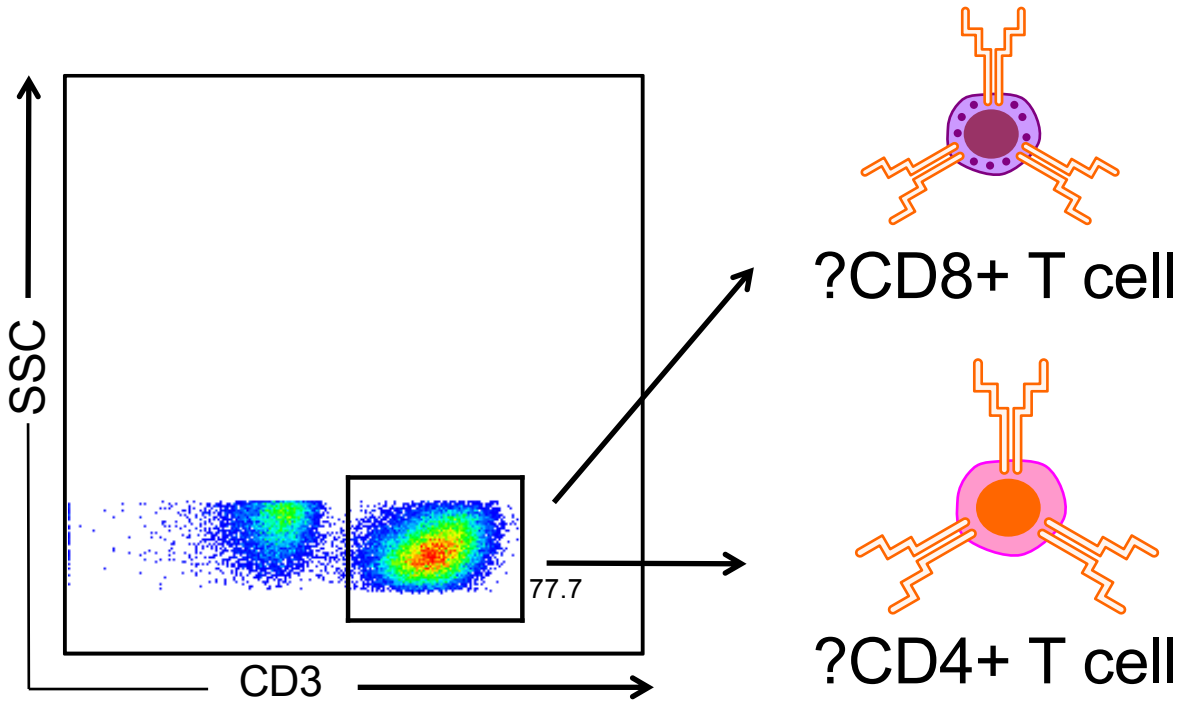
IFN-γ ELISpot following Rabies vaccination



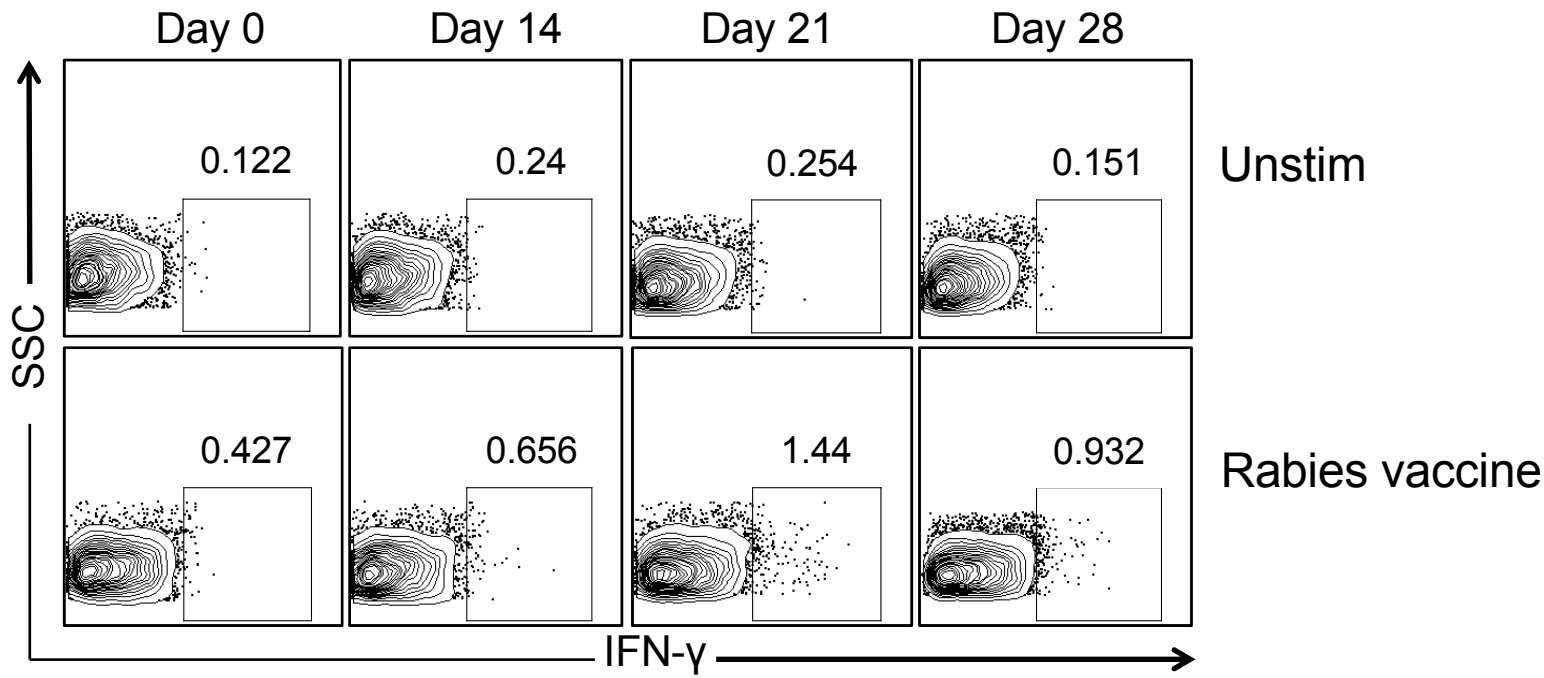


Characterizing the T cell response: Identifying cell types by flow cytometry

- PBMCs consist of a number of different cell types
- We have 3 monoclonal antibodies to assess Asian elephant T cell responses
  - CD3-all T-cells
  - CD8-"killer T-cells
  - IFN-γ

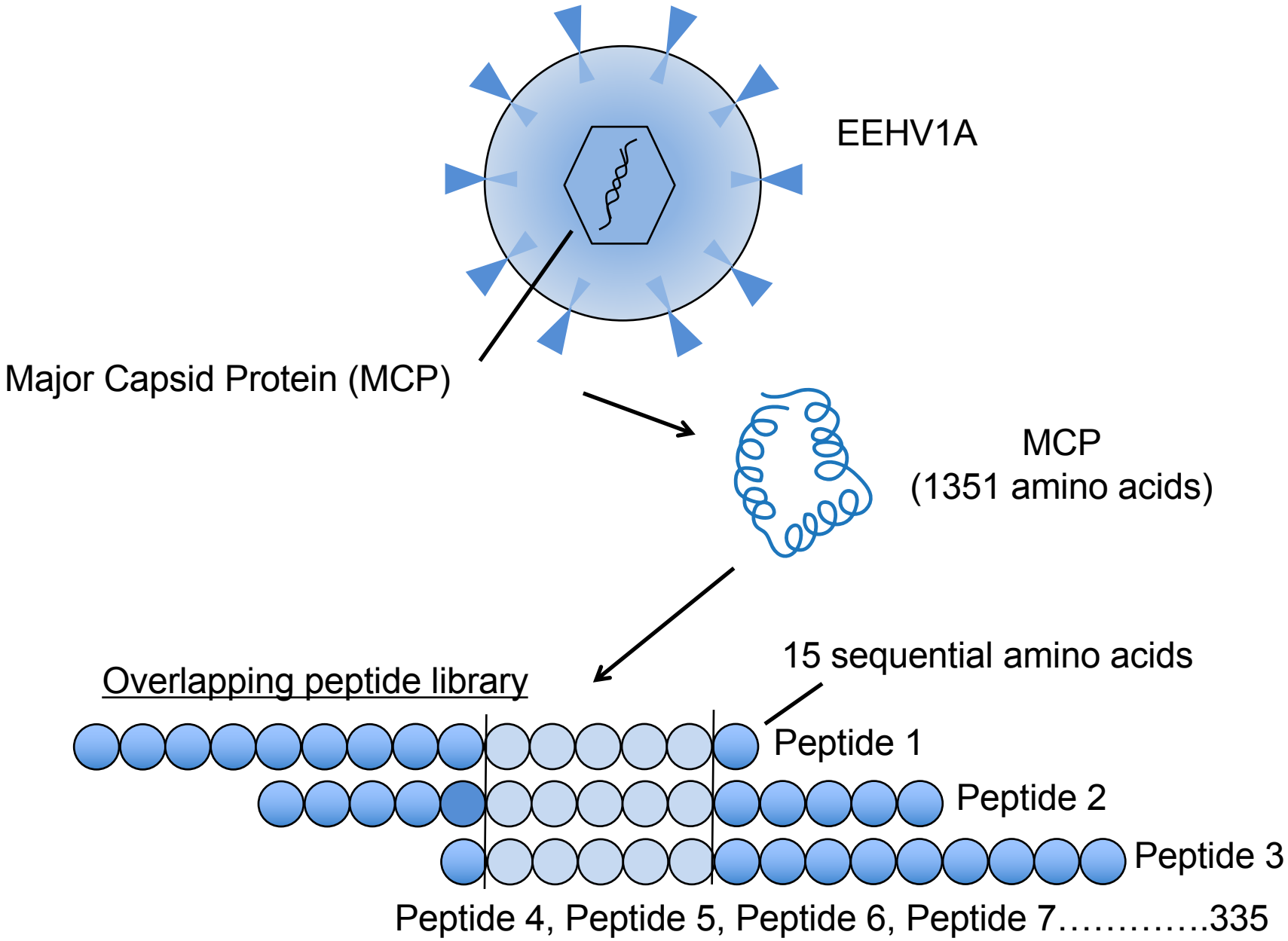


Characterizing the T cell response: Rabies-specific CD8+ responses



**Cells pre-gated on CD3 and CD8*

EEHV1A proteins are studied as peptide libraries



T cells recognize proteins encoded by Open Reading Frames (ORFs)

- EEHV1A genome has been sequenced (Ling *et al*, 2013)



Complete Genome Sequence of Elephant Endotheliotropic Herpesvirus 1A

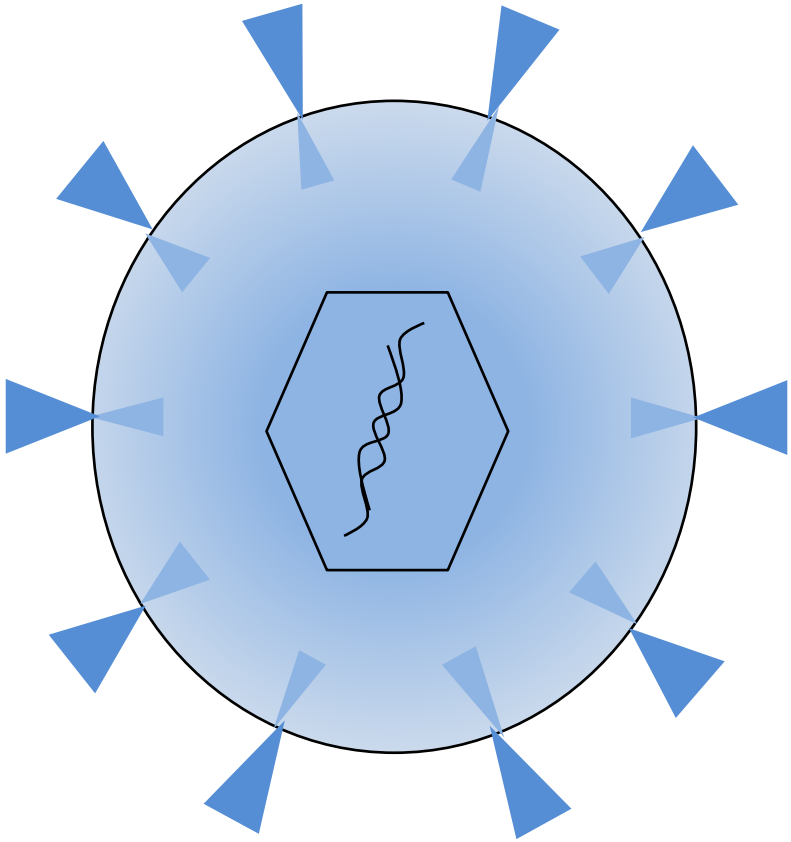
Paul D. Ling,[a] Jeffrey G. Reid,[b] Xiang Qin,[b] Donna M. Muzny,[b] Richard Gibbs,[b] Joseph Petrosino,[a,b] RongSheng Peng,[a] Jian-Chao Zong,[c] Sarah Y. Heaggans,[c] Gary S. Hayward[c]

Department of Molecular Virology and Microbiology, Baylor College of Medicine, Houston, Texas, USA[a]; Human Genome Sequencing Center, Baylor College of Medicine, Houston, Texas, USA[b]; Viral Oncology Program, Johns Hopkins School of Medicine, Baltimore, Maryland, USA[c]

  - 115 ORFs
    - 37 conserved core genes
    - 15 genes conserved within selected sub-families
    - 60 novel ORFs not seen in any other herpesvirus

EEHV1A candidate proteins

- Major Capsid Protein (Structural)
- U71 (Tegument/structural protein)
- E34 (pp150, tegument/structural protein)
- Major Immediate Early Protein (Regulatory)
- U42 (Virus regulatory protein)
- Glycoprotein B
- Glycoprotein H



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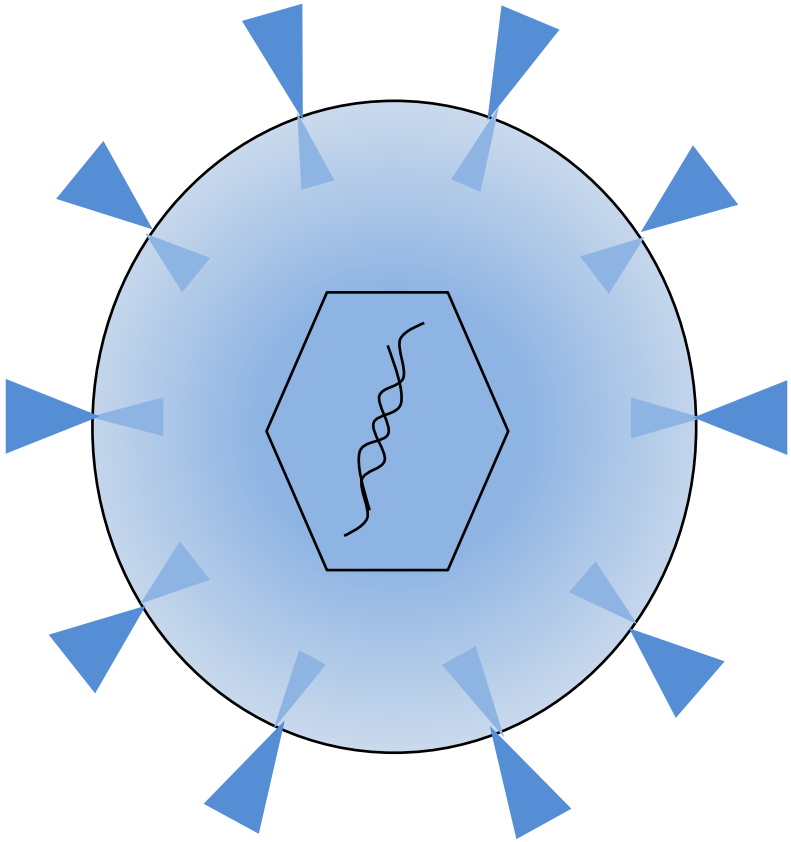
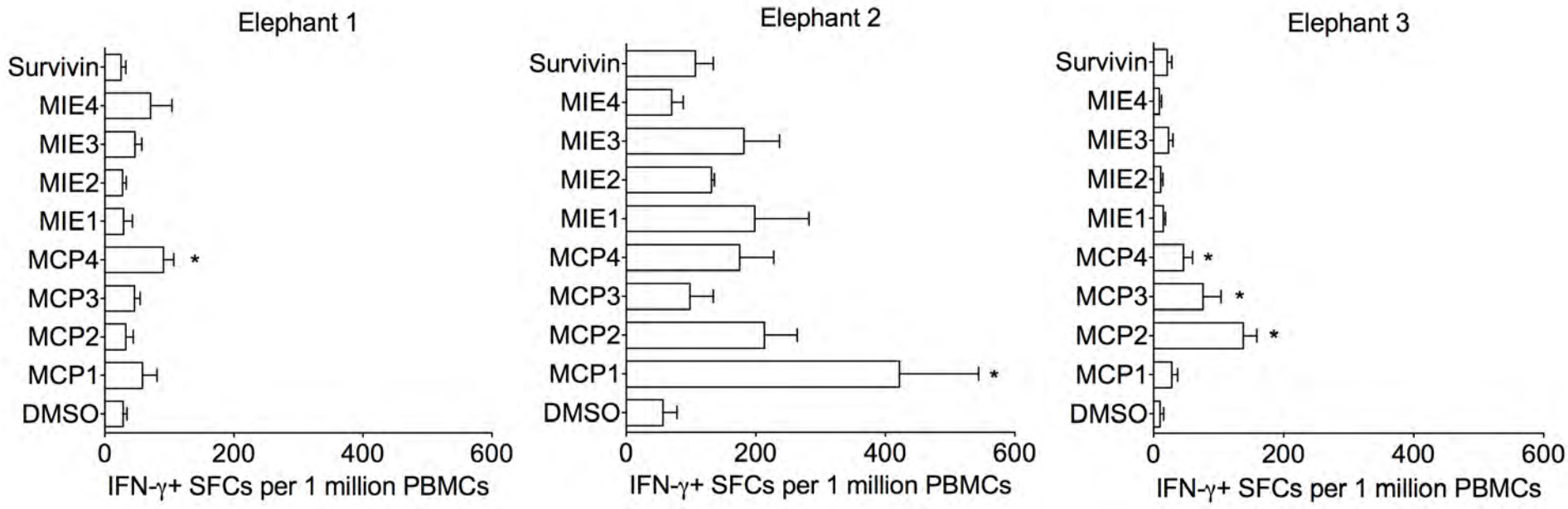


Peptide libraries are divided into peptide mixes (pep-mixes) for stimulation

- MCP (335 total peptides) divided into 4 pep-mixes of 83-86 peptides
  - MCP1, MCP2, MCP3 and MCP4

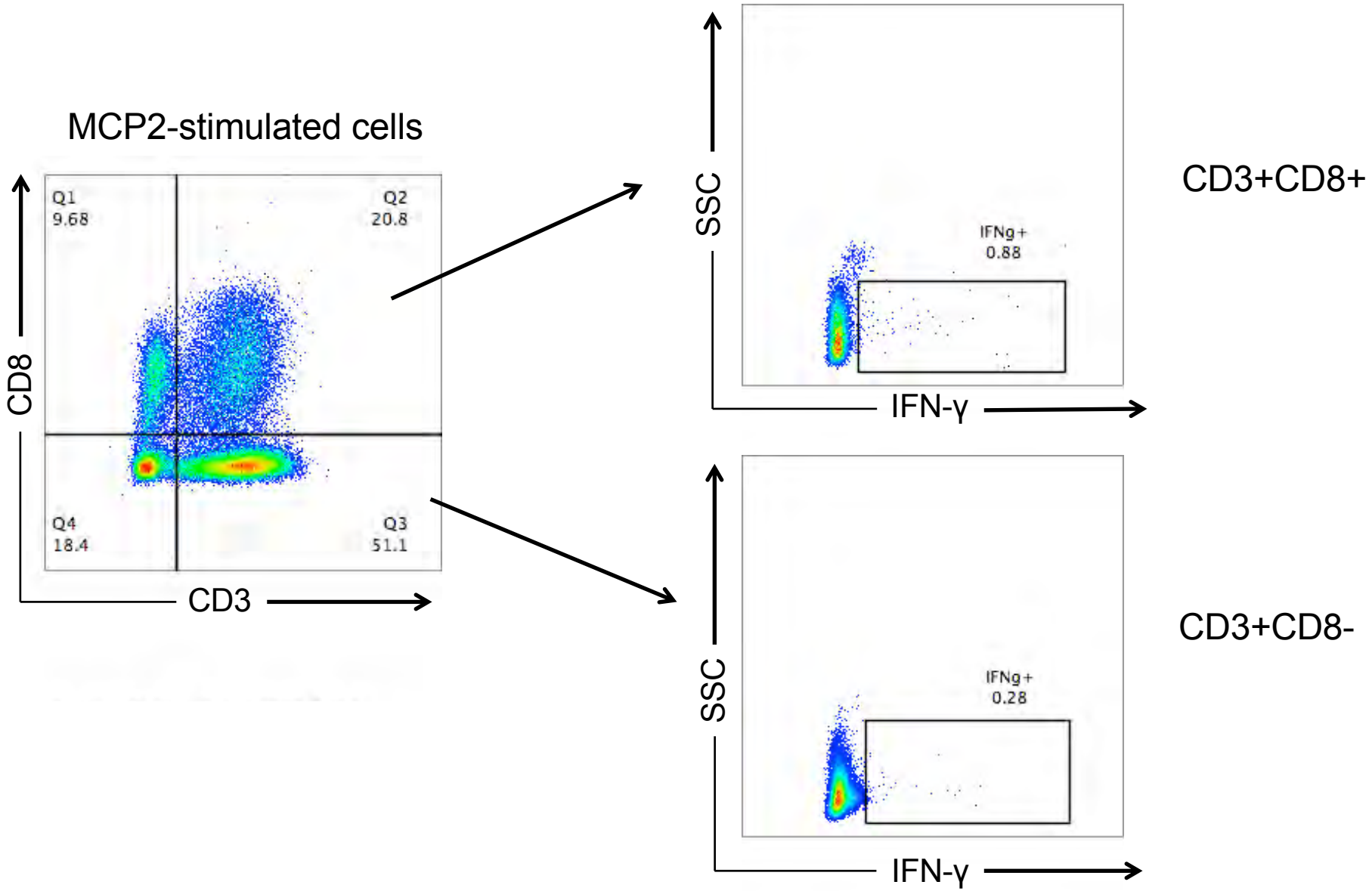
- MIE (324 total peptides) divided into 4 pep-mixes of 81 peptides
  - MIE1, MIE2, MIE3 and MIE4

Individual elephant responses to MCP and MIE



**p≤0.05 according to ELISpot Distribution Free Resampling (DFR) statistical methods (Moodie et al., 2012)*

CD8+ and CD8- T cells produce IFN-γ following MCP2 stimulation



Summary and Conclusions

- Three out of seven elephants responded to at least one pep-mix of MCP
- No elephants responded to MIE, to a significant level, illustrating the need to screen several EEHV proteins for every elephant
- MCP generates responses within the realm of what are acceptable positive responses in human vaccine studies
- In human studies, some proteins induce far greater responses
  ----Perhaps the best protein is still out there
- CD8+ and CD8- T cells account for the IFN-γ response



Identification of vaccine candidates is within reach

- Focusing in on MCP and MIE responses to identify individual epitopes
- Screening of more proteins
- Completing the generation of an Asian elephant specific CD4 monoclonal antibody
- Studying more elephants in other herds



Thanks to:



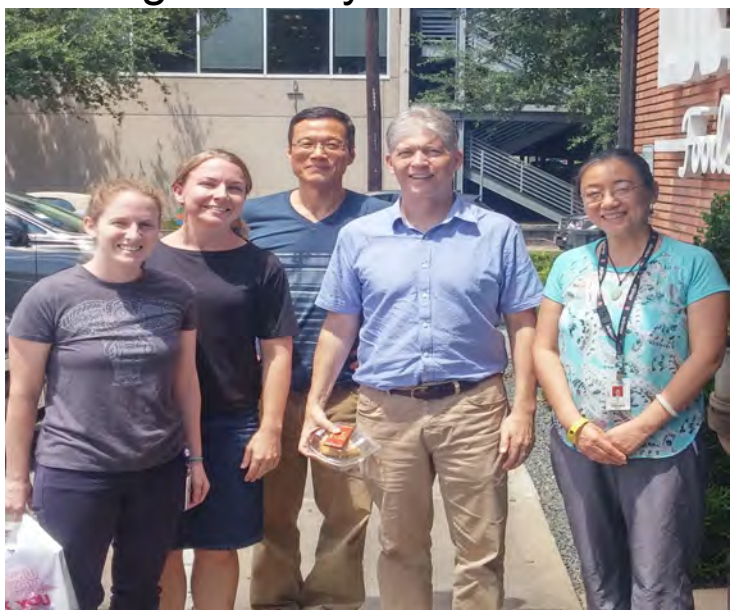
Houston Zoo

- The elephants:
  Thai, Methai, Tess, Shanti,
  Tucker, Baylor, Tupelo & Duncan
- Elephant Management Team
- Lauren Howard
- Veterinarians and clinic staff

BCM Cytometry and Cell Sorting Core

Ling Lab elephant team

- Paul Ling
- Jie Tan
- Rongsheng Peng
- Angela Fuery



BCM

- Cliona Rooney
- Lisa Rollins
- Natalia Lapteva
- George Makedonas
- Matthew Wong

Methodist Hospital Research Institute

- Ed Gravis
- Justin Lew

MD Anderson Cancer Center

- Laura Bover
- Long Vien

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- Houston Zoo
- Institute of Museum and Library Services
- American Association of Zoo Veterinarians
- BCM crowd-funding initiative
- Morris Animal Foundation (Postdoctoral fellowship)

Elephant endotheliotropic herpes virus (EEHV) associated with *Clostridium perfringens* infection

Kittikorn Boonsri, Chaleamchat Somgird, Pheudphol Noinafai, Kidsadagon Pringproa, ThittayaJanyamethakul, Taweepoke Angkawanish, Janine L. Brown, Pallop Tankaew,

Chatchote Thitaram

Introduction: Thailand EEHV status

- EEHV1A and EEHV4 with hemorrhage of the gastrointestinal, respiratory, and cardiovascular systems (Sripiboon et al., 2013)
- Report of EEHV1A, EEHV1B and EEHV4 in 8 elephants during 2007-2013 (Lertwacharasarakul et al., 2015)
- Occurrence and genetic variation of EEHV1A, EEHV1B and EEHV4 in 24 Thai elephants (Sripiboon et al., 2016)

- Todate: 33 EEHV-HD case molecularly confirmed



Introduction:

- *Clostridium perfringens*: common cause of disease in many species; particularly in herbivores
- Mild to severe forms of enteritis depending on the toxins produced by the bacteria
- *C. perfringens* producing enterotoxin (CPE) and/or beta2 toxin (CPB2)
- Occurrence of diarrhea due to beta2 toxin in Asian (Das et al., 2008) and African elephants (Bacciarini et al., 2001)
- Both EEHV and *C. perfringens* toxins can produce similar intestinal lesions with fatal outcomes in elephants

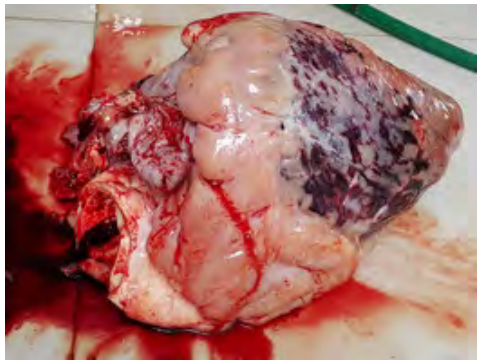
Case 1: history

- A 7-month-old male, captive-born Asian elephant calf transported 250 km (4 hrs) with mother (50-years-old)
- Two months later, calf showed clinical signs of abdominal discomfort, lethargy, partial anorexia, and watery diarrhea
- Calf died within 2 days after onset of clinical signs
- Necropsy performed in the field,
- Internal organs submitted to the Faculty of Veterinary Medicine, Chiang Mai University, within 24 hours for analysis.

Case 1: laboratory analysis

- Genomic DNA was extracted from the heart, lungs, liver, spleen and intestines using NucleoSpin®Blood
- EEHV screening using DNA polymerase (DPOL) PCR primers,
- Terminase (TER) primers were used for EEHV1a/EEHV1b and EEHV3/EEHV4 screening (Richman et al., 2000)
- Intestinal DNA extracted for detection of *C. perfringens* alpha toxin (*cpa*), beta toxin (*cpb*), epsilon toxin (*etx*), iota toxin (*iA*), enterotoxin (*cpe*), and beta2 toxin (*cpb2*) genes by multiplex PCR (Yuzal et al., 2010)

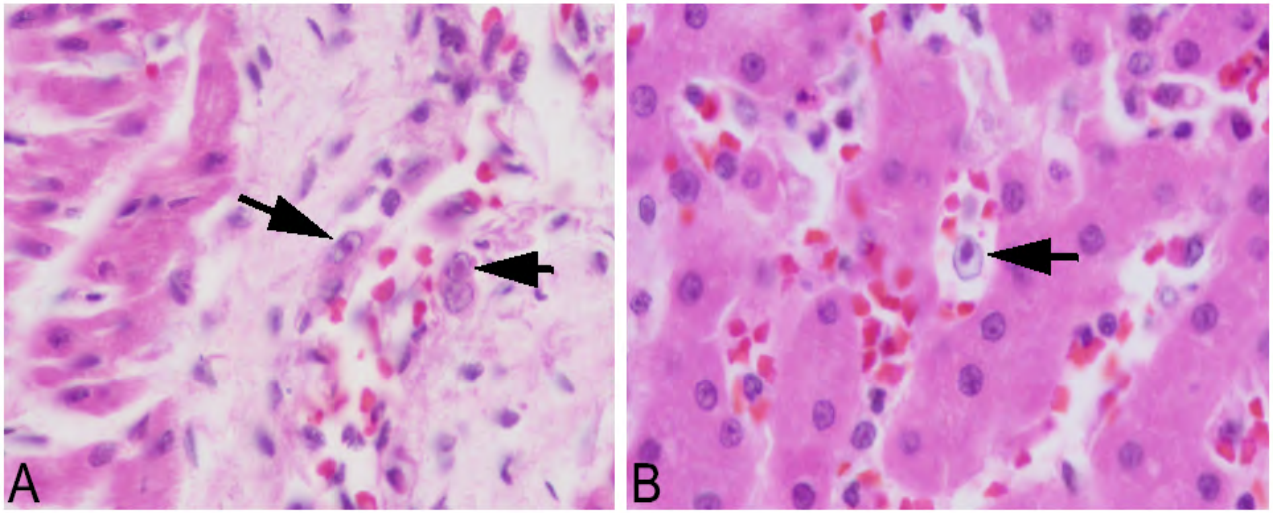
Case 1: Results



- Heart: - Petechiae and ecchymotic hemorrhage on epicardium & endocardium
- Lungs: multifocal, moderately reddened, and edematous
- Cecum and colon: congestion with watery dark brown content
- Small intestine: necrosis of the surface and crypt epithelium with intralesional bacilli bacteria attachment

Case 1: Results

- Eosinophilic intranuclear inclusion bodies: capillaries in the heart, lungs and the liver
- Lungs, liver and spleen showed positive results for EEHV4
- Intestine samples tested positive for several *C. perfringens* toxin primers: alpha, beta and epsilon toxins



Case 2: history

- A 3-month-old female, wild-born Asian elephant calf at the Queen's Elephant Reintroduction Project in the Doi Phamuang Wildlife Sanctuary
- Signs of lethargy, anorexia, and died 6 hours later

Laboratory analysis

- The same as case 1

Case 2: results

- Necropsy: emaciated body, and no stomach contents
- Multifocal necrotic ulcers in the gastric mucosa
- Hemorrhages heart, liver, kidney, spleen, lymph node and small intestine tissues

- Heart, liver, spleen and lymph node tested positive for EEHV1A.
- Liver and spleen showed positive for *C. perfringens* type B alpha, beta and epsilon toxins

Discussion

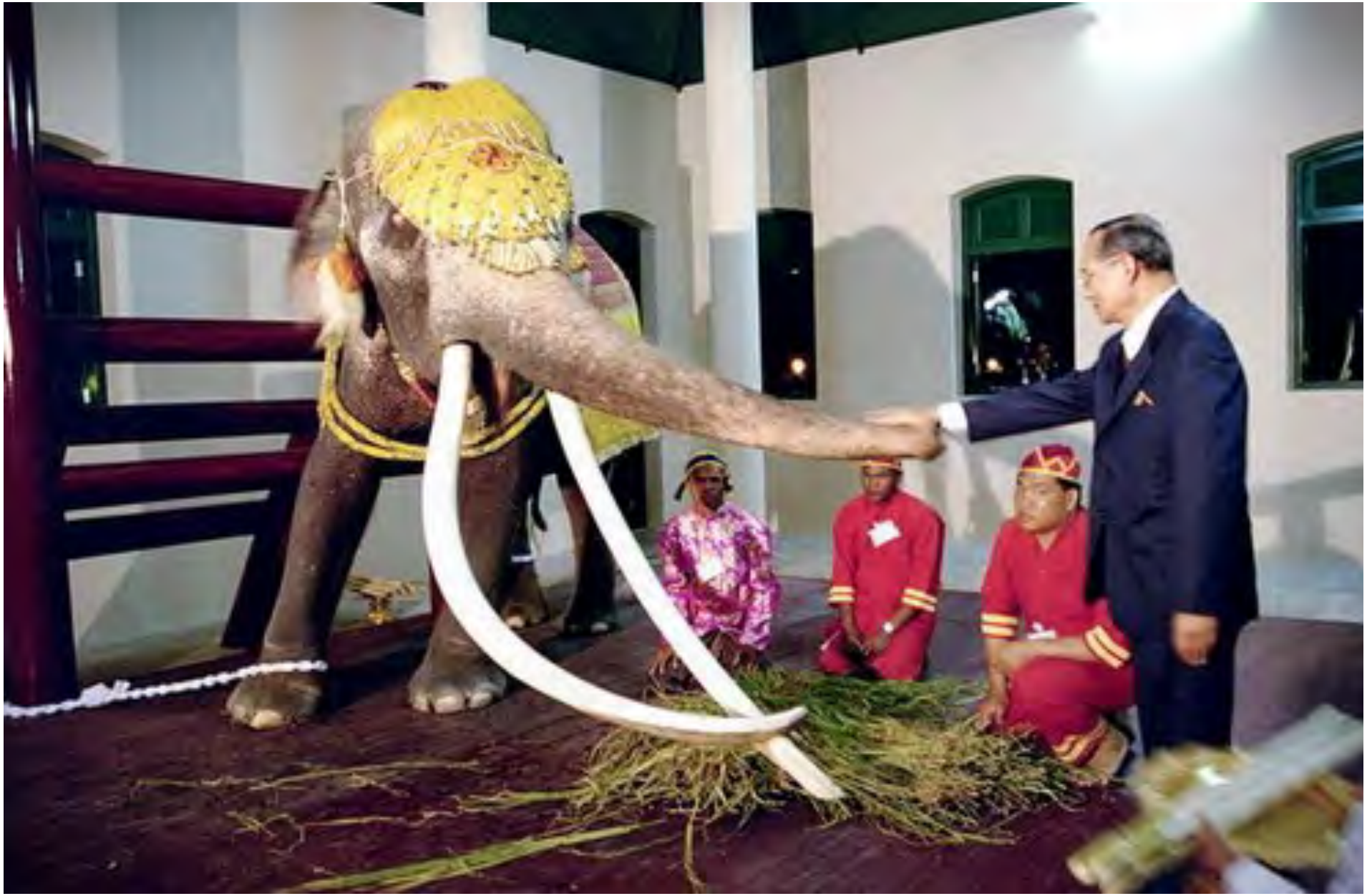
- First report of EEHV and *C. perfringens* co-infection in elephants
- Both calves were under 1 year of age
- Not often occur due to the maternal immunity (Long et al., 2016)
- Associated with poor condition, physiological stress, unfamiliar environment and transportation
- Case no 1: transportation stress
- Case no 2: empty stomach → illness of calf / agalactia of cow

Discussion

- EEHV4 was positive from cow blood of Case 1
- Samples not collected from cow of case 2
- Two calves picked up organism from coprophagic behavior
- Diarrhea associated with *C. perfringens* toxin
- EEHV4 systemic lesions especially gastrointestinal system
- Subclinical EEHV in cow, easily transmit the virus to calves, resulting in hemorrhagic disease.

Conclusion

- Fatal hemorrhagic diarrhea association with co-infection of EEHV and *C. perfrinens*
- Treatment of both viral and bacterial infection should be considered, if signs of diarrhea
- Pathogenesis of EEHV infection young calves (< 1 yrs)
- Evidence for a combined negative effect of bacterial and viral infection in low immunity animals
- Critical monitoring before and after transportation with standard protocol



FREEZE-DRIED PLATELETS: A NOVEL TREATMENT FOR ELEPHANT ENDOTHELIOTROPHIC HERPES VIRUS HEMORRHAGIC DISEASE

Smithsonian Global Health Program
Smithsonian Conservation Biology Institute
National Zoological Park

Sabrina McGraw, DVM, PhD, DACVP

Presented by: Marc T. Valitutto, VMD

THE DISEASE



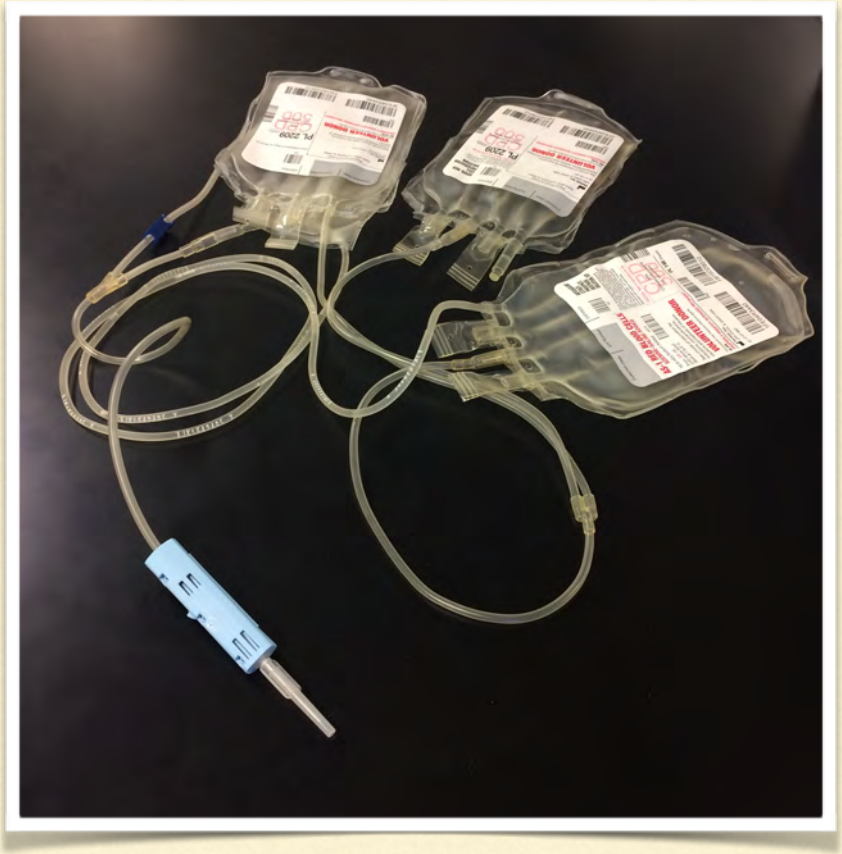
PC: Bradley Ryan

- Elephant Endotheliotrophic Herpesvirus (EEHV)
  - Leading cause of death among Asian elephants < 15 yo
- Hemorrhagic disease
  - Fulminant consumptive coagulopathy and hemorrhage


PC: Jon Cracknell
(f) Swollen head

THE PROBLEM

- Current treatment options:
  - Supportive care
  - Cost prohibitive
- Coagulopathy unaddressed
  - Transfusions - low feasibility
  - Platelet products unavailable

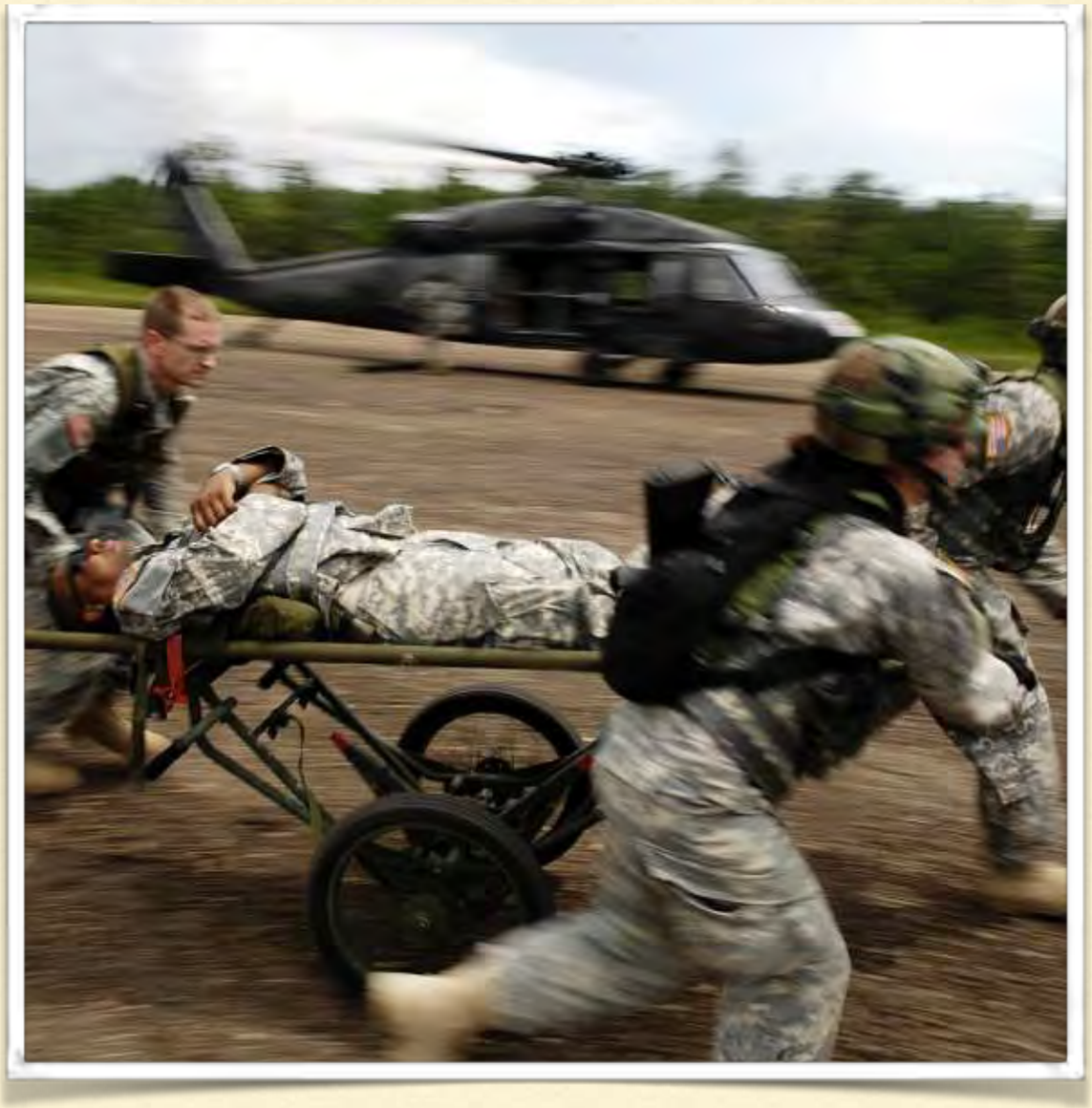



RED CELLS IN ADDITIVE SOLUTION
LEUCOCYTE DEPLETED
FOR NEONATAL USE
STORE AT 4 °C ± 2°C
Always check patient/component compatibility/identity
inspect pack for signs of deterioration or damage
Risk of adverse reaction/infection including vCJD
This component was collected in CPD anticoagulant and
suspended in 100 millilitres of additive solution
following composition
Sodium Chloride
Adenine
Anhydrous Glucose
Mannitol
LOT
Pack Type
REF


A
AB
A



THE IDEA



- Readily accessible product
- Species appropriate
- Hemorrhage addressed

THE PARTNERS

Smithsonian
Conservation Biology Institute

Ringling Bros. and Barnum & Bailey
Center for Elephant Conservation

International Elephant Foundation.org

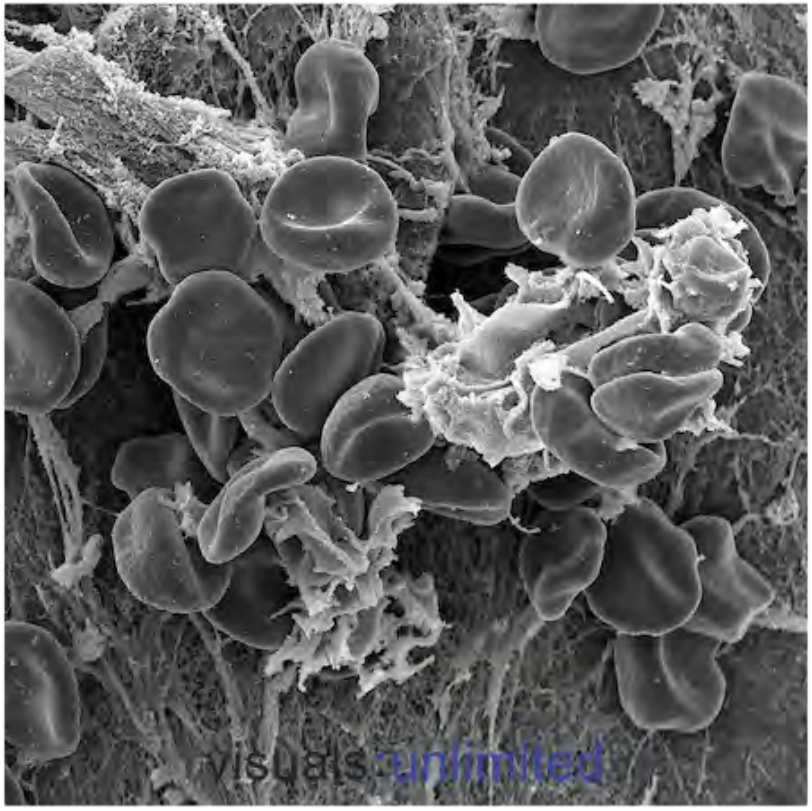
Houston Zoo

Cellphire

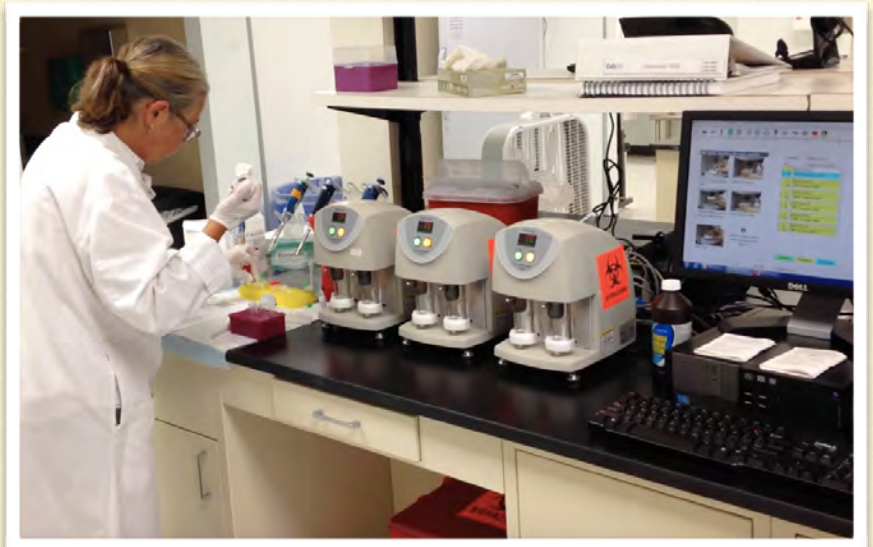
fort worth zoo

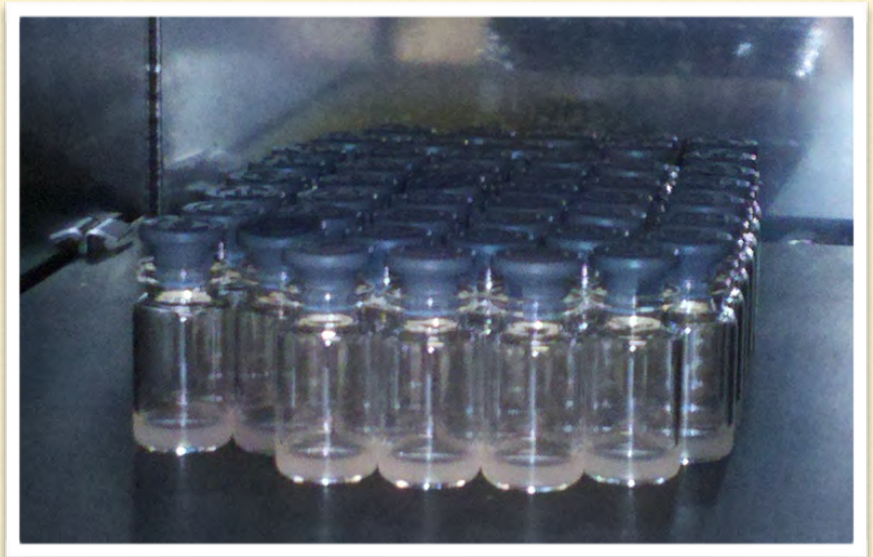
THE INNOVATION

- Freeze-dried platelet product
- Shelf Stable - 24 to 36 months
- Room temperature
- Portable
- Other applications









THE QUALITY



- Quantitative analysis
  - Size, particle count, etc…
- Infectious agent screening
  - Cx, endotoxin evaluation
- Antigen identity expression
- In vitro activity

THE PROGRESS

- First blood collected
- Platelet rich plasma separated
- Lyophilization successful
- Sterile and endotoxin negative
- In vitro testing - underway
- Flow cytometry progress



THE FUTURE



- In vivo - safety testing
- Experimental use - clinical context
- Large scale production
- Distribution

THE POTENTIAL



PC: Palm Beach Clinic

- Other applications
  - Chronic skin wounds
  - Arthritic conditions
  - Tendon repair
  - Immunomodulation







PC: ARKive, Vladimir Motycka



PC: Public Domain: Cheetah News

SUMMARY

- Freeze-dried platelets have the potential to be an effective hemostatic agent that is readily accessible with low storage requirements and a long shelf-life
- Direct application for use in treatment of Elephant Endotheliotrophic Herpesvirus Hemorrhagic Disease - Further analysis in progress
- Other applications likely, beyond hemorrhagic disease and consideration for studies in other species is essential

Thank You

THE SPINALL FOUNDATION

REGISTERED CHARITY NO. 326567

Berry White

Introduction to Howletts & Port Lympne rhino collection





Back to the Wild





Port Lympne Reserve
African Experience 90 acres
Mixed exhibit



Translocation of Black Rhino back to Africa – crate training







2 months prior to departure, 2 hours per day crate training.

Rhino horns trimmed prior to departure.





1 hour in UK by road and 10 hours by air to Kilimanjaro airport, Tanzania.











After the rhinos were unloaded there was a 5 hours road trip to Mkomazi rhino sanctuary.







The rhinos were checked hourly along the journey.

Rhino bomas



Within an hour of arrival all three rhinos were successfully unloaded and given two bomas each.















The fence







Making the fence visual to the rhinos and introducing them to various browse species whilst in the boma.

Upon mixing the three rhinos, the bomas and camp 1 are now fenced off.









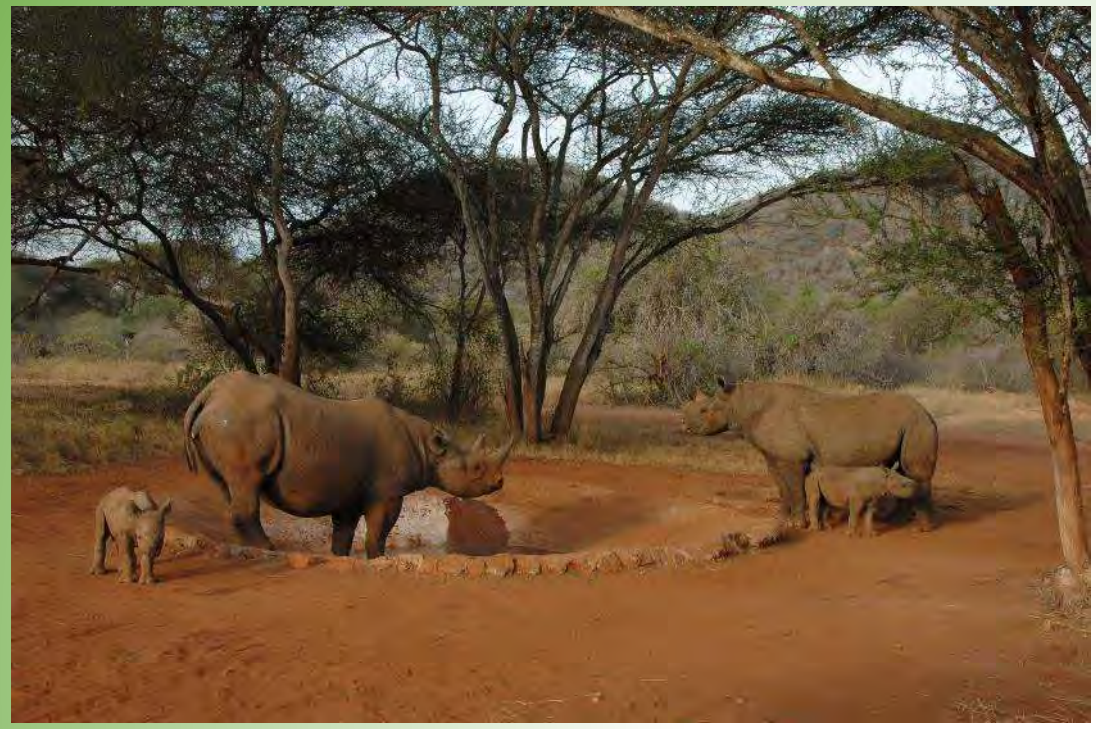
By the second day the rhinos had settled together



Success!
Grumeti and Zawadi give birth to their first calves in Africa at the Mkomanzi rhino sanctuary, Tanzania. Summer 2016









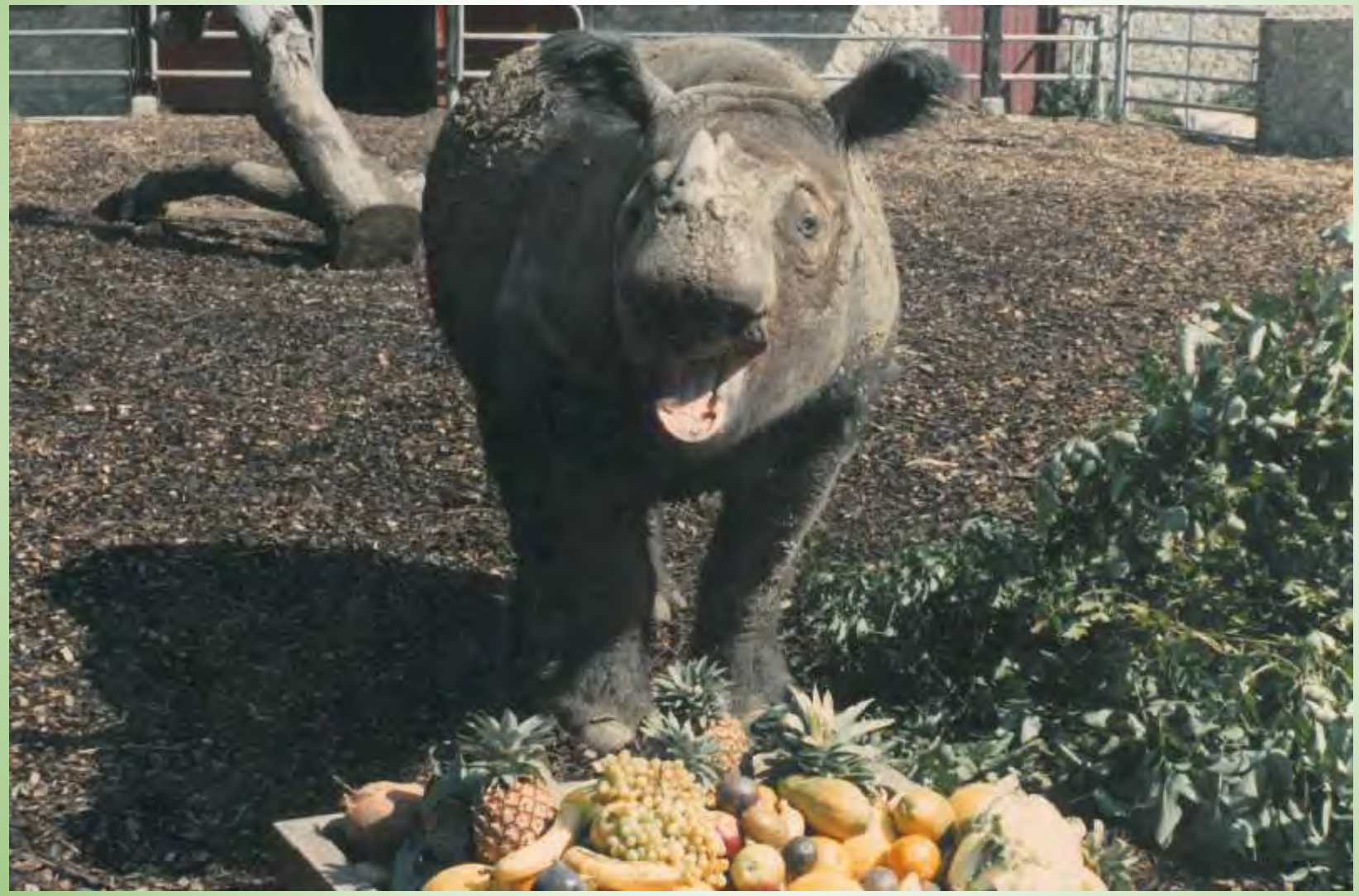
Mums and babies – 35 successful births to date







Sumantran rhinos at Port Lympne 1985-1998.



1986 – rhinos moved to their new facility at Port Lympne.















Thank you.





Benefits of long-term hormone monitoring for reproductive and welfare management of elephants

Sharon S. Glaeser

Oregon Zoo

Janine L Brown and Katie L. Edwards

Smithsonian Conservation Biology Institute, Center for Species Survival

Why monitor hormones?

Hormones:

- coordinate physiology and behavior
- are produced by endocrine glands and released into the blood (or tissue fluid)
- are measures of internal physiology (e.g. gonadal or adrenal activity)

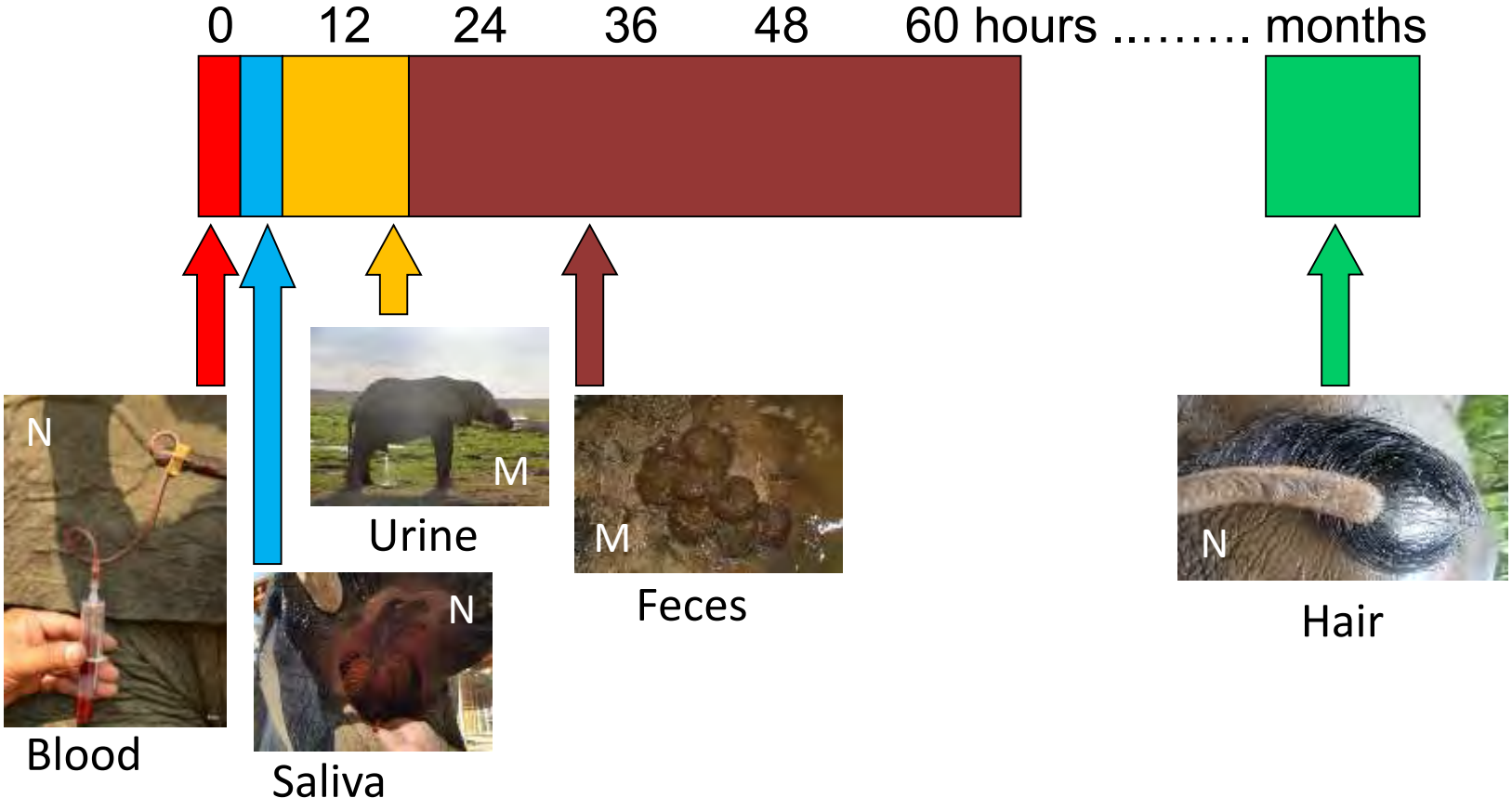
Hormone measurements can provide information on:

- Response to a perceived stressor (e.g. glucocorticoids-GCs)
- Reproductive state (e.g. progestogens, androgens)
- Overall health and well-being

We can use this information to improve management of these animals under varying levels of human care and management.

Samples for monitoring hormones

- Different samples allow us to ask different questions, and collect in different situations
- We measure native hormone (N) or excreted metabolites (M)
- Temporal differences across sample types



Benefits of long-term monitoring

- Investigate individual and group variability to understand what is “normal” for the individual and the species
- See hormone patterns and changes over time
- Evaluate hormone patterns with respect to:
  - Age
  - Life events (births, deaths, transfers/translocations)
  - Social factors
  - Management factors
  - Overall health, illness and injury
  - Human impact/conflict
  - Environmental factors

Long-term hormone studies of elephants under human care & free ranging

African elephants

Under human care:

- Reproductive physiology
- Management & welfare

Free ranging:

- Reproductive physiology
- Adrenal response to:
  - Translocation
  - Human impact/conflict
  - Ecology

Asian elephants

Under varying levels of human care:

- Reproductive physiology
- Management & welfare
- Adrenal response to:
  - Translocation
  - Ecology

Free ranging:

- Reproductive physiology

Long-term hormone studies of elephants under human care & free ranging

African elephants

Under human care:

- Reproductive physiology
- Management & welfare

Free ranging:

- Reproductive physiology
- Adrenal response to:
  - Translocation
  - Human impact/conflict
  - Ecology

Asian elephants

Under varying levels of human care:

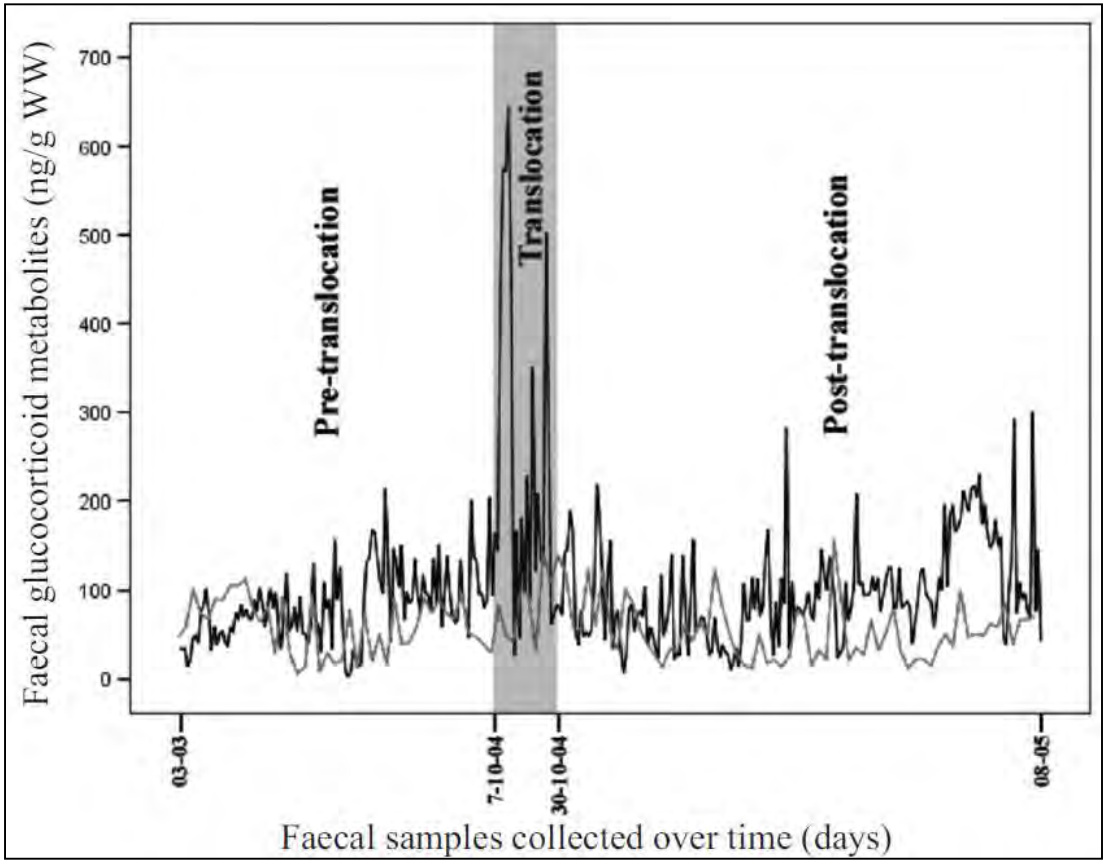
- Reproductive physiology
- Management & welfare
- Adrenal response to:
  - Translocation
  - Ecology

Free ranging:

- Reproductive physiology

1. Adrenal response to translocation

Fecal glucocorticoid metabolites (FGMs) were measured in African elephants to assess the effect of translocation.



FGMs were significantly higher during translocation compared to:

- Pre-translocation
- Post-translocation
- Resident elephants

(Viljorn *et al.* 2008)

Elephants returned to previous home range (300 km in 23 days) and FGMs returned to pre-translocation levels.

1. Adrenal response to translocation

Other *in situ* studies show a relatively quick recovery to baseline after a measured adrenal response.

(Burke *et al.* 2008; Millspaugh *et al.* 2007)

- Evaluating the physiological response to translocation is important for managing stress with future actions.
- Long-term monitoring establishes a baseline against which to assess the response to translocation.
- Comparing behavior and physiology of translocated animals to local residents can be used to assess the more immediate response to translocation.

2. Gonadal function

Hormone monitoring has improved reproduction in elephants under human care in western facilities and range countries.

We can reliably:

- Assess estrous cyclicity status (cycling, not cycling)
- Assess musth status
- Predict ovulation to time breeding and AI
- Diagnose pregnancy
- Predict parturition
- Assess changes with age, season, resources, and stress

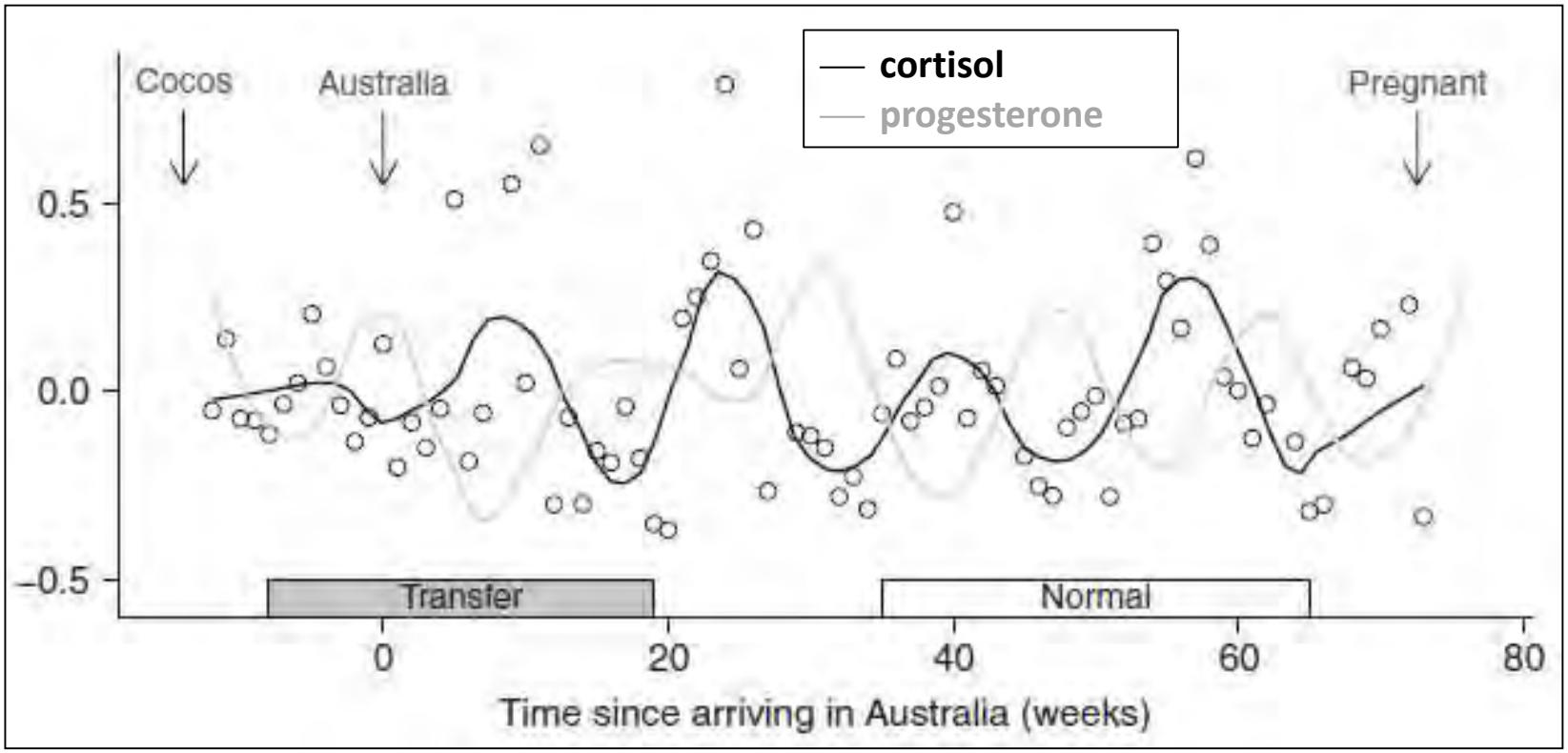
Still need to determine the role of stress on gonadal function and causes of ovarian dysfunction in *ex-situ* populations for both African and Asian elephants.

3. Glucocorticoids and ovarian function

In females that had normal estrous cycles:

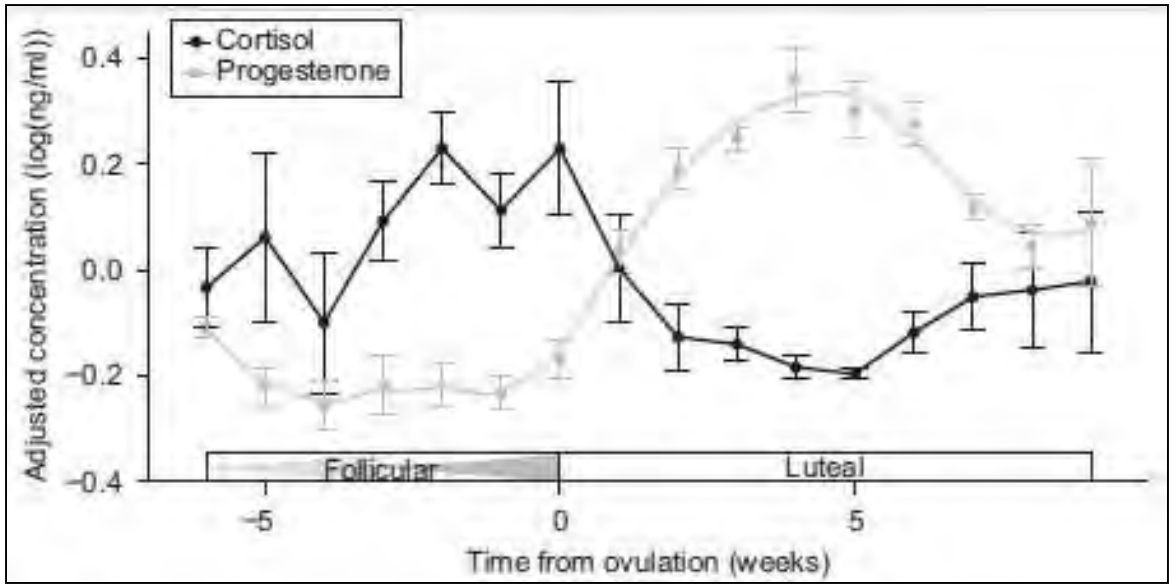
Serum cortisol fluctuated in a distinct cycle across the estrous cycle

(Fanson et al. 2014; Glaeser et al. in prep)



3. Glucocorticoids and ovarian function

Parous females: serum cortisol peaked in the second half of the follicular phase, then declined during the luteal phase.



Nulliparous females who did not conceive with mating or AI: serum cortisol peaked at the second half of the follicular phase but did not decline during the luteal phase.

- Glucocorticoid variation may play a role in normal function.

(Fanson et al. 2014)

3. Glucocorticoids and ovarian function

Study investigating the effect of major life events on gonadal and adrenal function in Asian elephants, we discovered that serum cortisol patterns in relation to the estrous cycle explained more variation in cortisol than the response to major events.

Glaeser et al. in prep

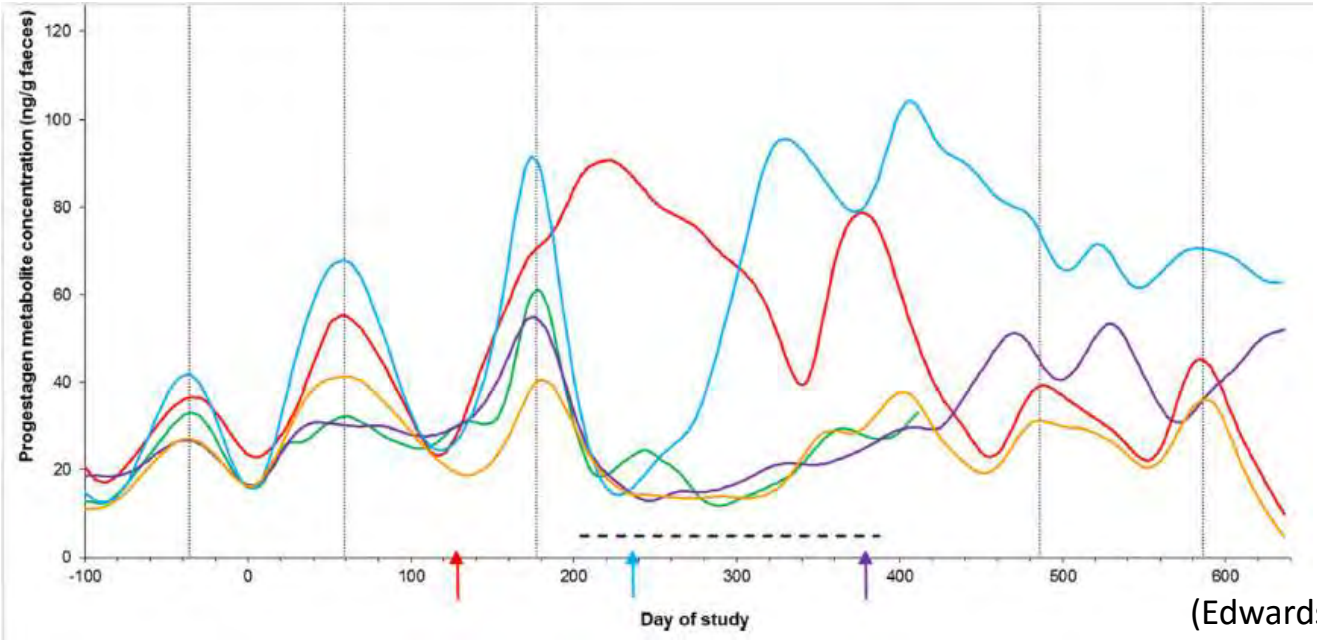
- GC patterns may be important in relation to reproductive cyclicity.
- These patterns must be taken into account when planning sample collection, designing analyses, and interpreting results.



4. Glucocorticoids and cycle disruption

We can use hormone data in relation to behavior, keeper records, and medical records to assess physiological state.

- Estrous cycles were synchronized among 5 Asian females.
- 3 females stop cycling following management and social changes and early pregnancy of a herd mate
- Could GCs help identify the cause?



(Edwards et al. 2016)

4. Glucocorticoids and cycle disruption

FGMs were evaluated in relation to reproductive status (pregnant, cycling, acyclic), husbandry (training, foot-care), and matriarch presence. (Edwards et al. 2016)

- FGMs were significantly different across reproductive states, but the pattern was individual.
- FGMs were influenced by temporary separation of the matriarch and to treatment of a foot abscess.
- In females that stopped cycling, mean FGM did not differ between the cyclic and acyclic period, so cycle disruption was not due to altered adrenal activity associated with husbandry changes or matriarch presence. (Edwards et al. 2016)

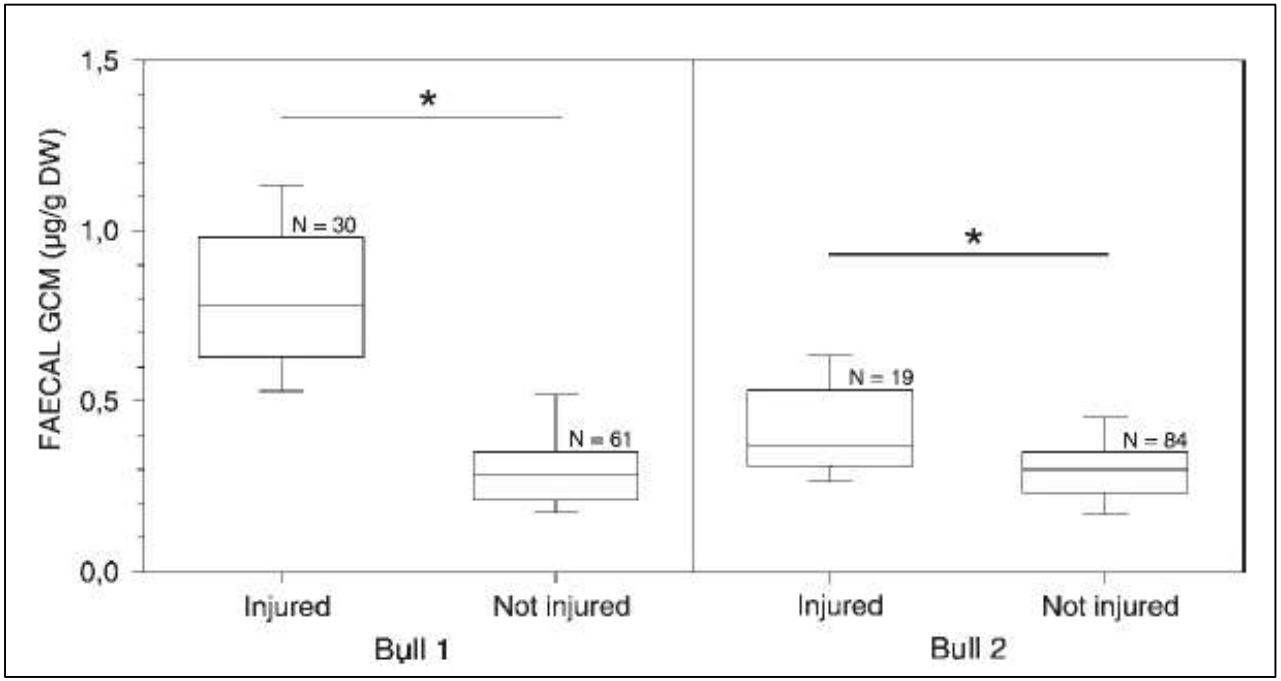
➢ No studies to date have associated chronically elevated GCs with reproductive abnormalities in elephants - GC pattern?

5. Glucocorticoids and detection of injury

In situ African bulls with apparent foot injuries:

- Both bulls showed a significant increase in FGMs during injury. Bull 1 had higher FGMs and greater loss in body condition, and failed to come into his typical musth.
- Following recovery, FGMs returned to baseline and body condition improved.

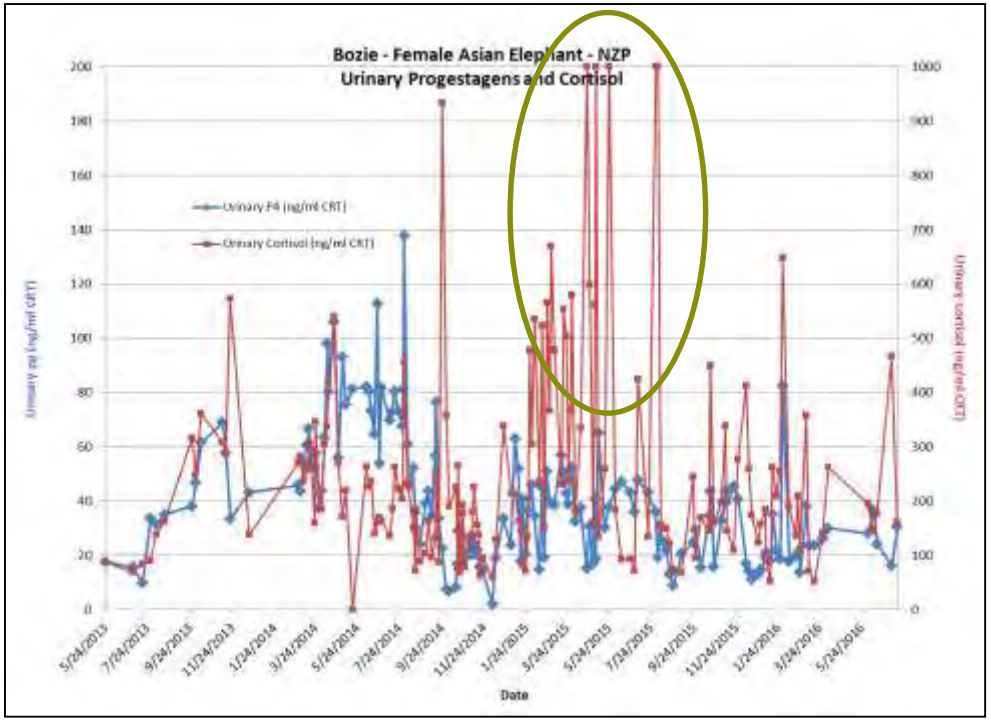
(Ganswindt *et al.* 2010)



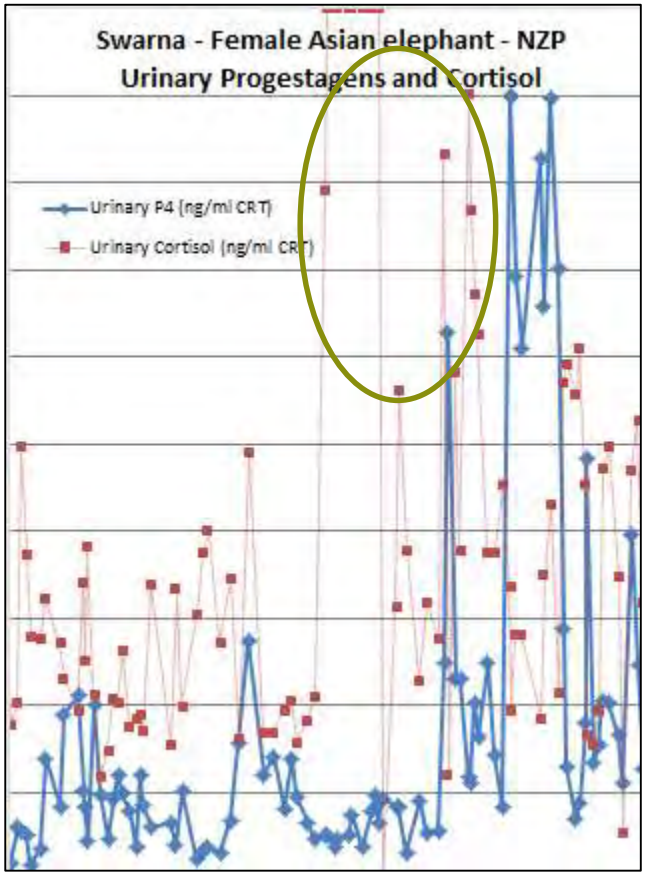
6. Glucocorticoids and detection of illness

Glucocorticoids can be a valuable tool in animal care

An undiagnosed illness was associated with elevated glucocorticoids and elevated inflammatory markers



Illness associated with elevated glucocorticoids



Hormone monitoring is a valuable tool

- We can use hormone data along with behavior and management records to assess welfare, health and reproductive outcomes.
- Long-term monitoring allows us to evaluate hormone patterns in relation to many factors.
- Glucocorticoid patterns in relation to reproductive cyclicity need to be taken into account in designing studies and assessing impact of any perceived stressor.
- Hormone monitoring is being used to improve animal management on an individual and population basis.


Thank You

Captive Elephant Working Group (SE Asia)

Janine L. Brown, Ph.D.
Smithsonian Conservation Biology Institute

Chatchote Thitaram, D.V.M., Ph.D.
Chiang Mai University

Sonja Luz, Ph.D.
Wildlife Reserves Singapore

Who are We?

- Steering Committee

  Chatchote Thitaram (Chair)
  Sonja Luz (Vice-Chair)
  Janine Brown (Vice-Chair)
  Carmen Rademaker (Secretary)

  Joanna MacLean
  Khyne U Mar
  John Roberts
  Khajohnpat Boonprasert
  Annabel Lopez Perez
  Josh Plotnik

- Advisors

  Richard Lair
  Susan Mikota
  Preecha Phoungkham
  Parntep Ratanakorn
  Christopher Stremme

A group of elephant specialists, managers, veterinarians and researchers interested in developing science-based standards for better management of captive elephants in SE Asia, focusing initially on Thailand

Welfare of Captive Elephants

- Inconsistent management of captive elephants in Asia
- Intense criticism of elephant management in tourism in particular
- Need for practical guidelines and standards to effectively manage elephants under varying conditions
- In Thailand, the tourism industry and tourist camps are seeking help in identifying best practices and setting standards
- If we don't do something, international opinion will, and it will be based on emotion, not science

WORLD ANIMAL PROTECTION

PETA

TripAdvisor halts sales for animal tourism including elephant ri...
www.cbsnews.com › MoneyWatch › Trending
Oct 12, 2016 - **TripAdvisor** halts sales for animal tourism including **elephant rides** ... animal welfare standards in its booking policies, including a **ban** on travel ...

TripAdvisor bans elephant rides - news - travel | Stuff.co.nz
ssl-www.stuff.co.nz/.../**TripAdvisor**-agrees-to-stop-selling-tickets-to-cruel-w...
Oct 13, 2016 - **TripAdvisor** agrees to stop selling tickets to cruel wildlife tourist attractions ... no longer sell tickets for activities like **elephant rides**, tiger petting, ...

TripAdvisor Stops Selling Tickets That Involve Cruel Elephant...
nextshark.com/tripadvisor-stops-selling-tickets-involve-cruel-elephant-ri...
Oct 21, 2016 - **Elephant rides**, tiger-petting and swimming with dolphins are just some ... On top of the **ban**, **TripAdvisor** will introduce an education portal that ...

Vision and Mission

- Vision Statement:

  To ensure a sustainable, high quality of life for captive elephants in SE Asia.

- Mission Statement:

  We will ensure a good life for elephants and create sustainable captive populations through the development of best management and welfare standards, and the formation of partnerships that focus on education, veterinary health, cultural traditions, capacity building, good mahoutship and conservation needs.

One Size Does Not Fit All







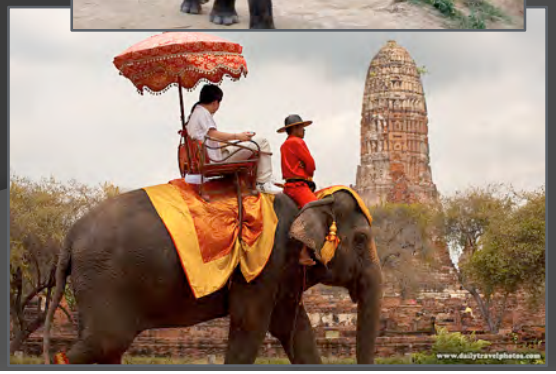




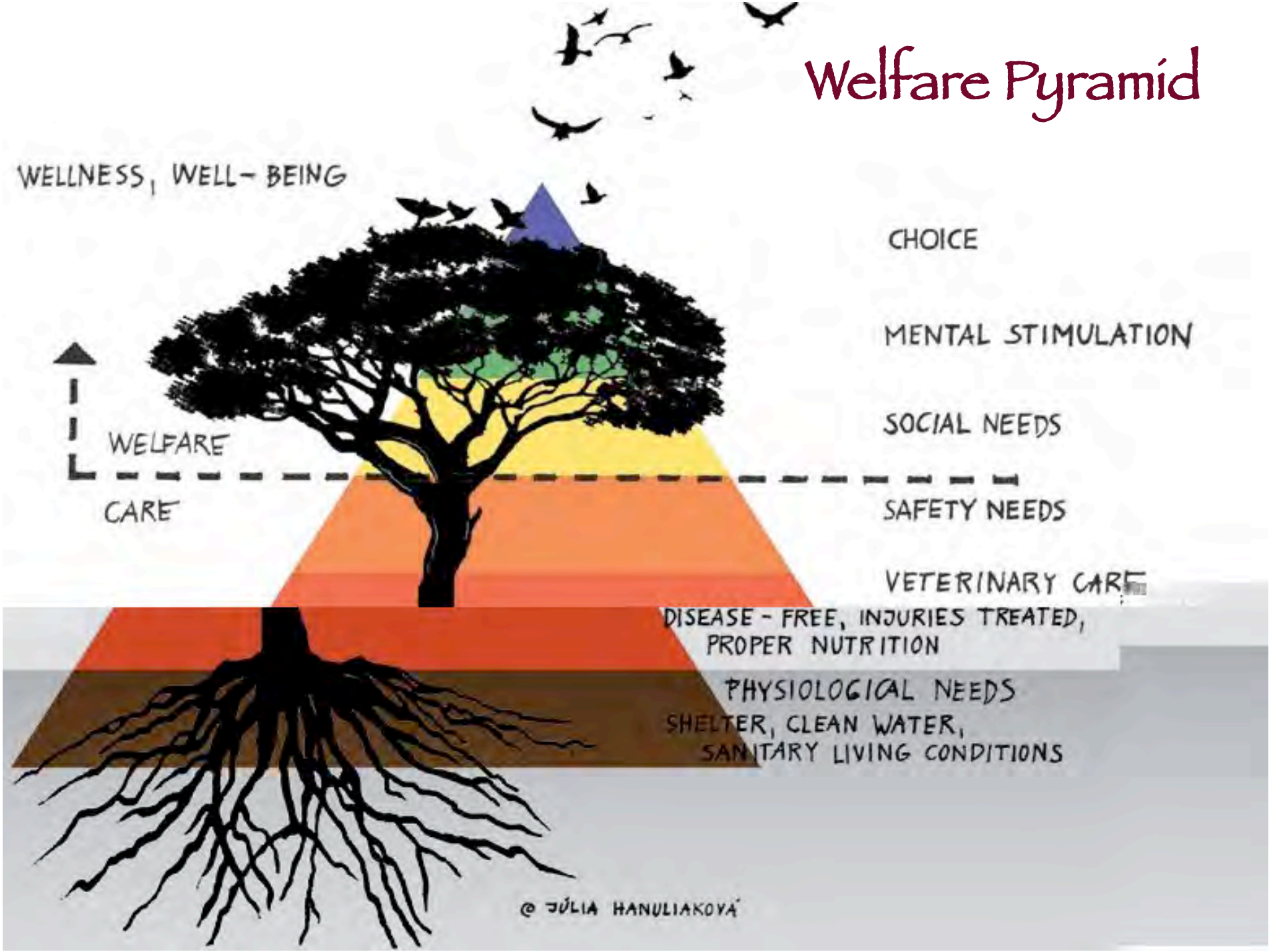








Welfare Pyramid



Group Meetings

Singapore – November 2015





Thailand – June 2015



Thailand – June 2016


90°E
India
China
Bangladesh
Myanmar
Vietnam
Ha Noi
Laos
Vientiane
Rangoon
Thailand
Bangkok
Cambodia
Phnum Pénh
Taipei
Taiwan
Manila
Philippines
Bandar Seri Begawan
Brunei
Malaysia
Kuala Lumpur
Singapore
Singapore
Indonesia
Jakarta
Dili
East Timor
New Guinea
120°E

Goals (1-3 of 9)

1. Bring together knowledgeable/experienced parties to address matters related to ensuring a sustainable quality of life for captive elephants in Asian elephant range countries.
2. Support positive elephant welfare practices, ensuring that the physical and mental needs of elephants are met, while promoting proper environmental stimulation, enrichment and social groups.
3. Ensure sustainable populations are only created from already existing captive elephant groups, and not supplemented by wild capture.

Goals (4-6 of 9)

4. Support the creation of Elephant Welfare Standards for captive elephants in SE Asian countries providing camp managers and the public with a baseline for elephant care.
5. Improve captive elephant welfare by supporting quality mahouts and protecting elephants from abuse and misuse by humans.
6. Develop effective and humane elephant management strategies while respecting mahout tradition and its cultural history and significance.

Goals (7-9 of 9)

7. Encourage good business practices, and strengthen business models for captive elephant management based on high welfare standards.

8. Enhance education and awareness of issues related to wild and captive elephants, and recognize the opportunities the captive populations present for species conservation.

9. Encourage tourism facilities to use accurately researched and conveyed science and education to promote wild elephant and habitat conservation and good captive elephant welfare practice to the public.

- Statement on elephants in tourism
- Developing guidelines for:
  - Elephant identification/legal requirements
  - Camp management
  - Mahout management
    - training & certification
    - compensation & salaries
  - Education/conservation messages
  - Elephant welfare
    - living conditions
    - work load
    - socialization
    - nutrition
    - medical
    - musth management



	Elephant welfare	
	Elephant living conditions	
F1	The elephants' daytime living area include shaded, forested or roofed parts that provide sufficient protection from the elements.	
F2	Night-time rest area chaining is done in such a way that elephants can enjoy physical contact with at least one other elephant and can also choose to be alone, if chain free roaming is practiced in a confined area the ACEWG protocol is followed.	
F3	Any shelters and facilities are constructed in such a way as to not be injurious to elephants.	Shelter roof high enough that an elephar shelter, no exposed hazards such as nails
F4	Elephants have time to rest in peace and in the company of other elephants without human interference.	
F5	Daytime living area elephants have space of at least 56 sqm./elephant. Night time rest chains must be at least 25m long. If free roaming the ACEWG Protocol is followed.	
F6	Night-time resting area must be a forested or other shaded natural environment.	
F7	Elephants are in their resting area for at least 15 hours per 24.	
F8	When chained elephants have ability to lay down, touch other elephants and socialise.	
F9	Free roaming is encouraged and allowed following the ACEWG protocol.	
F10	Daytime living area must have sufficient drainage keeping it dry at all times.	

Protocols to Supplement Guidelines

Written Protocols
Safe Transportation of Elephants.
Recapture of Escaped or Dangerous Elephants.
Provision of Scientifically Accurate Educational Material.
Use of Tools to Control Elephants (specifically in Emergency Situations)
Outlawing of Abusive Behaviour by Mahouts & Owners on Elephants.
Integrations of Social Groups without Human Interference (Free Roaming).
Provision of Behavioural Enrichment (including Identifying Priority Cases).
Initial Training of Calves (including Initial Separation from Mother)
Management of Bulls in Musth (& other Aggressive Elephants).
Performing of a Post Mortem Examination.
Provision of Recommended General Nutrition and Supplemental Feeding.
Minimum Stock to be Carried in Camp Medicine & Medical Stores.
Provision of Care to Geriatric Elephants.
Training of Mahouts to Provide Basic First Aid to Elephants.
Use of Traditional and Herbal Medicine.
Training of Mahouts in Preventative Health Care Techniques.
Safe Provision of Foot and Nail Care to Elephants.
Keeping of Elephant Medical Records and Logbook.
Elephant & Human Safe Provision of Elephant Rides (Mahout Style).
Elephant & Human Safe Provision of Elephant Trekking (in the Saddle).
Elephant & Human Safe Provision of Elephant Shows.
Elephant & Human Safe Provision of Observing Elephant Free Roaming.
Elephant & Human Safe Provision of Walking Alongside Elephants.
Elephant & Human Safe Provision of Elephant Feeding by Guest Activities.
Elephant & Human Safe Provision of Elephant Bathing by Guest Activities.
Elephant & Human Safe Provision of Calf Interaction with Guests.

Subgroups	Partners	Group Participants
Camp management (staff & mahout training, business plan, camp standards, marketing, logistics, facilities, conservation activities)	Golden Triangle Asian Elephant Foundation, National Elephant Institute Elephant Conservation Center	**John Roberts**, Prasop Thipprasert, Preecha Phoungkham, Chaleamchat Somgird, Sonja Luz, , Annabel Perez Lopez
Animal management (health care, elephant welfare standards, elephant training)	National Elephant Institute Elephant Conservation Center, Chiang Mai University, Wildlife Reserve Singapore, Smithsonian Conservation Biology Institute	**Sonja Luz,** Janine Brown, Khyne U Mar, Christopher Stremme, Prasop Thipprasert, Khajohnpat Boonprasert, Taweepoke Angkawanish, Annabel Perez Lopez
Education, Communication, Outreach (volunteer opportunities, public relations, cultural traditions, conservation education)	NAKA Foundation, Maesa Elephant Camp, Patara Elephant Camp Think Elephants International, Wildlife Reserve Singapore, Chiang Mai University	**Josh Plotnik**, Joanna MacLean, Carmen Rademaker, Annabel Lopez Perez, Sophie Bergun**,** Thitiporn K. Plotnik
Research (peer-reviewed, scientific)	Chiang Mai University, Sheffield University, Smithsonian Conservation Biology Institute, Zoological Park Organization, Think Elephants International	**Chatchote Thitaram, Janine Brown**, Boripat Siriaroonrat, Khyne U Mar, Josh Plotnik, Thitiporn K. Plotnik

Thailand Tourist Camp Welfare Study

- Survey of camps near Chiang Mai University
  - Camp management & facility surveys
  - Tourist activities
  - Diet & body condition scores
  - Wound & foot scores
  - Blood samples for reproductive & health status
  - Fecal samples for glucocorticoid analyses
  - Mahout training & attitudes



- What factors are important good reproduction, health & welfare?





Center of Excellence in Elephant Research and Education

Myth vs. Reality



- Human encounters (bathing, feeding)
- Trekking/riding
- Elephant shows
- Painting
- Proper use of management tools (e.g., ankus, chains)





Final Points

- Animal welfare is a complex concept (rights vs. welfare)
- Management decisions should be based on objective criteria (i.e., science), not emotion
- Deciding how to apply scientific findings involves ethics (how we should treat animals)
- Enforcing those decisions involves the law (how we must treat animals)

Journal of Sustainable Tourism
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/rsus20

Global regulations and local practices: the politics and governance of animal welfare in elephant tourism

Rosaleen Duffy [a] & Lorraine Moore [a]
[a] Department of Politics, Manchester University, Arthur Lewis Building, Oxford Road, Manchester, M13 9PL, UK

Available online: 05 May 2011





- We intend to produce science-based welfare outcomes and objective criteria that agencies can use to identify camps that adhere to high welfare standards.

- Given dwindling wild Asian elephant populations, and the accepted impossibility of releasing large numbers of captive elephants back into the wild, it is increasingly important to work with and support responsible camps that are committed to the welfare of elephants and their mahouts.



Thank You!

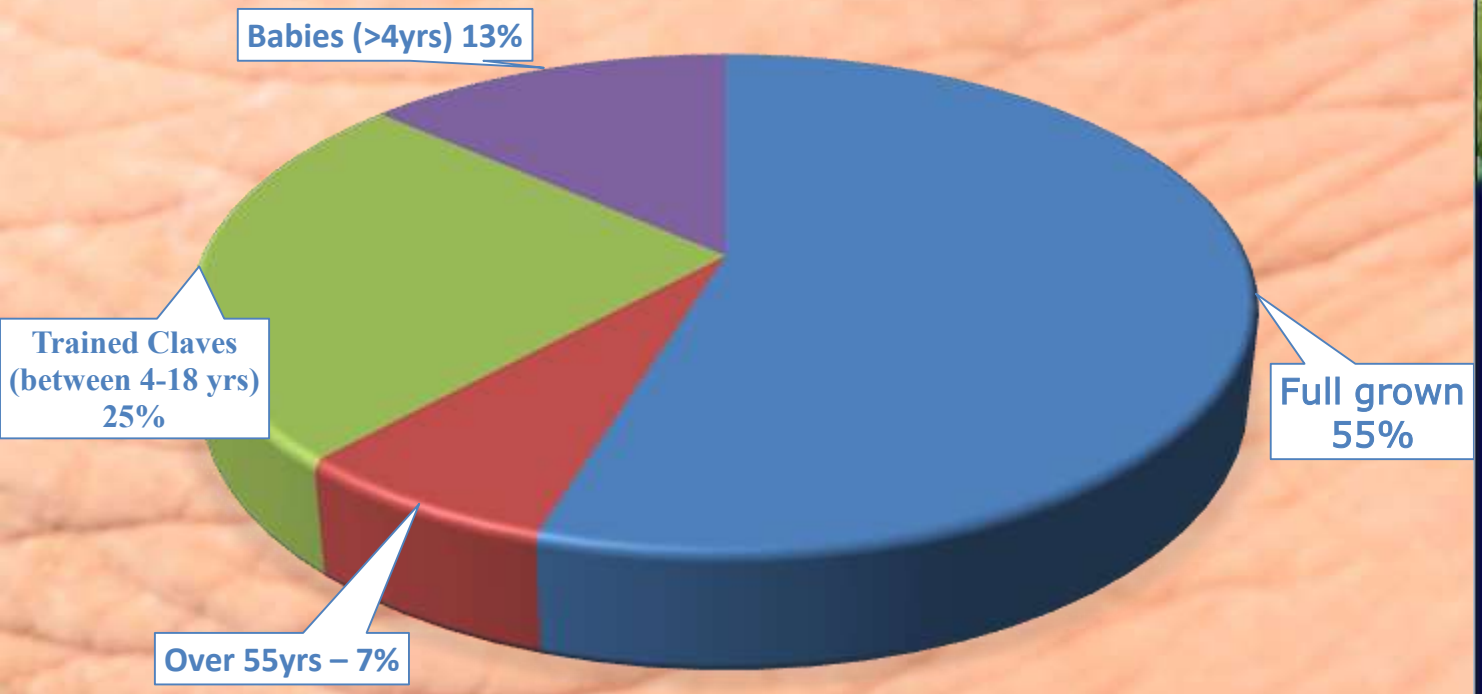


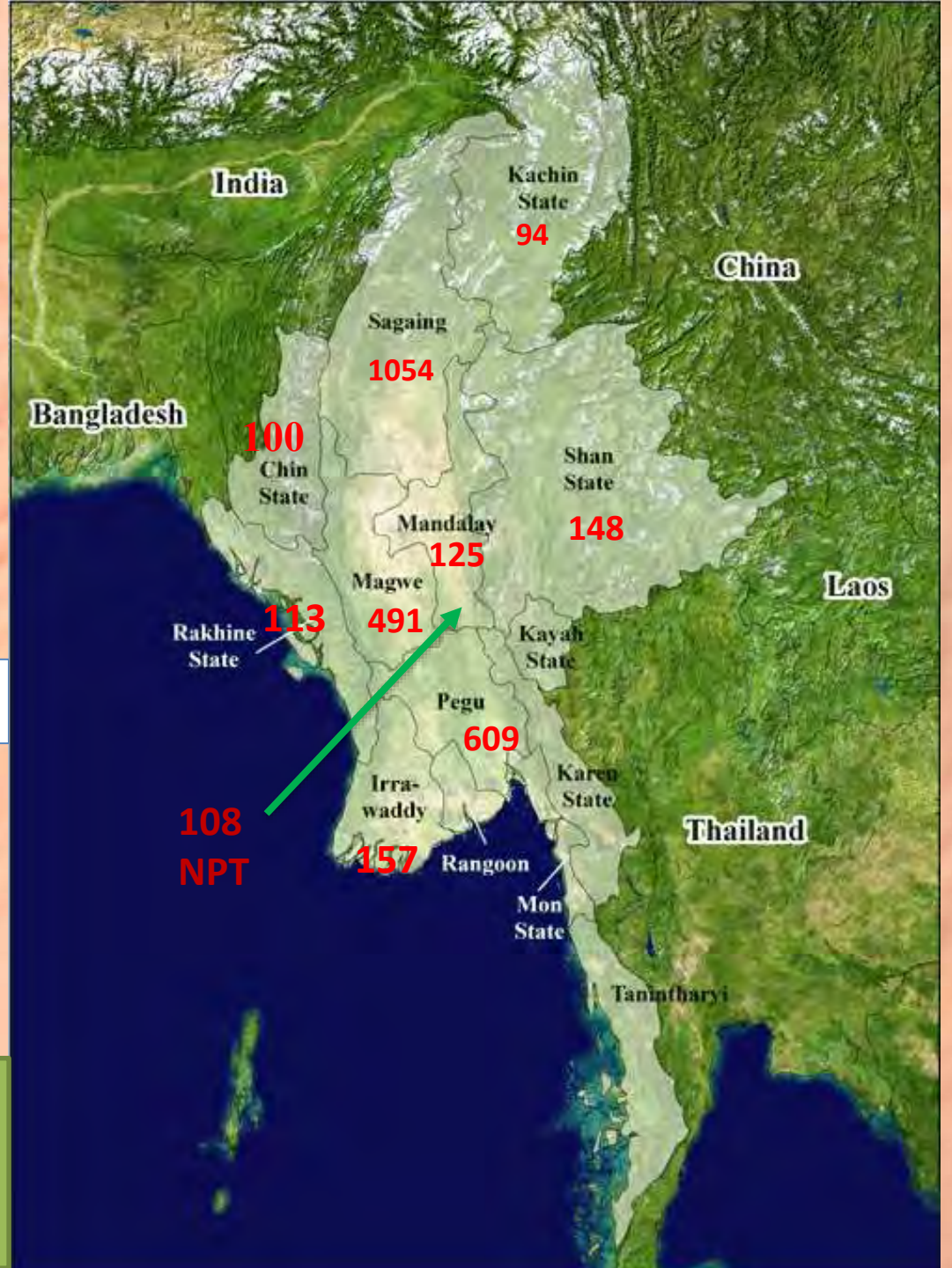
Elephant Situation and Activities for elephants in Myanmar

Dr. Zaw Min Oo, Manager (Vet)
zawminoomte@gmail.com
Department of extraction, Myanma Timber Enterprise, Yangon
Ministry of Natural Resources and Environmental Conservation

MTEElephants' Situation and Distribution in Myanmar

SITUATION OF MTE'S ELEPHANTS

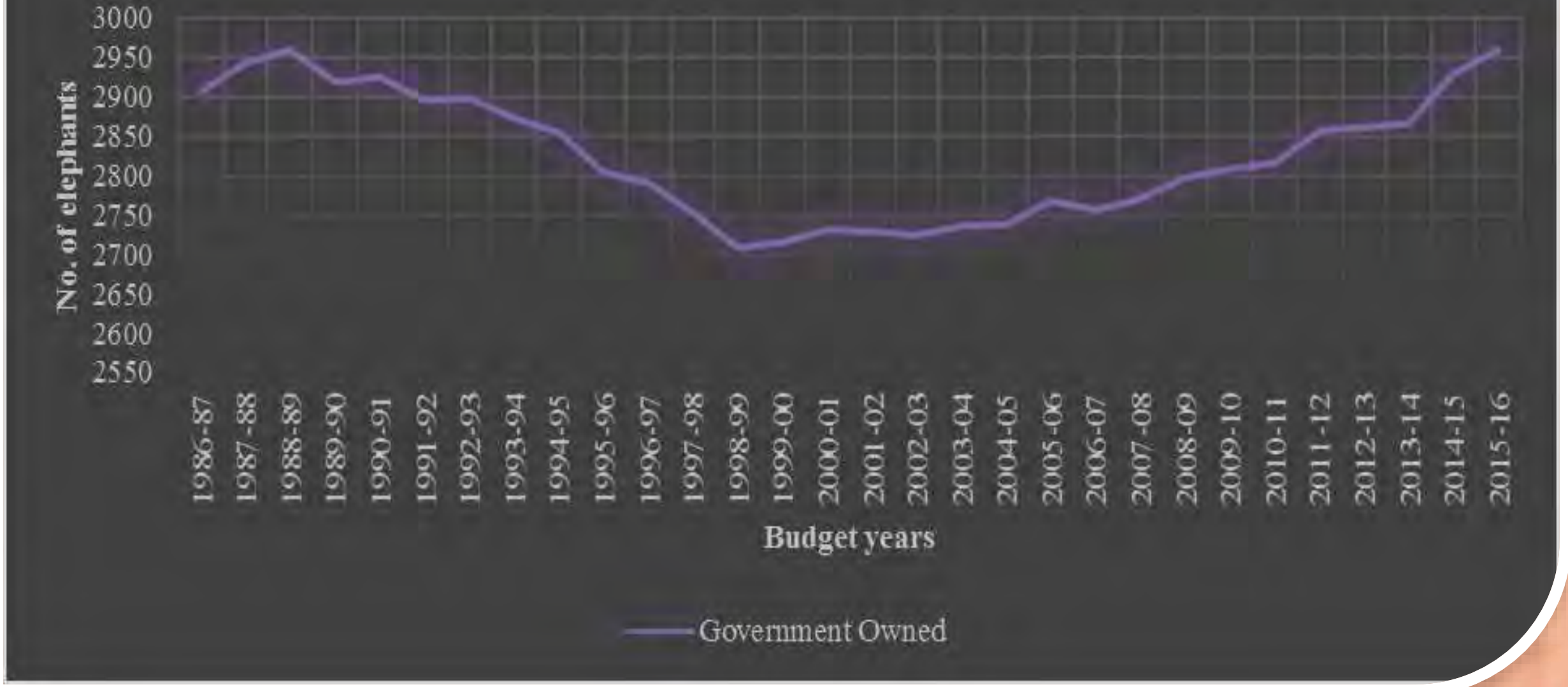


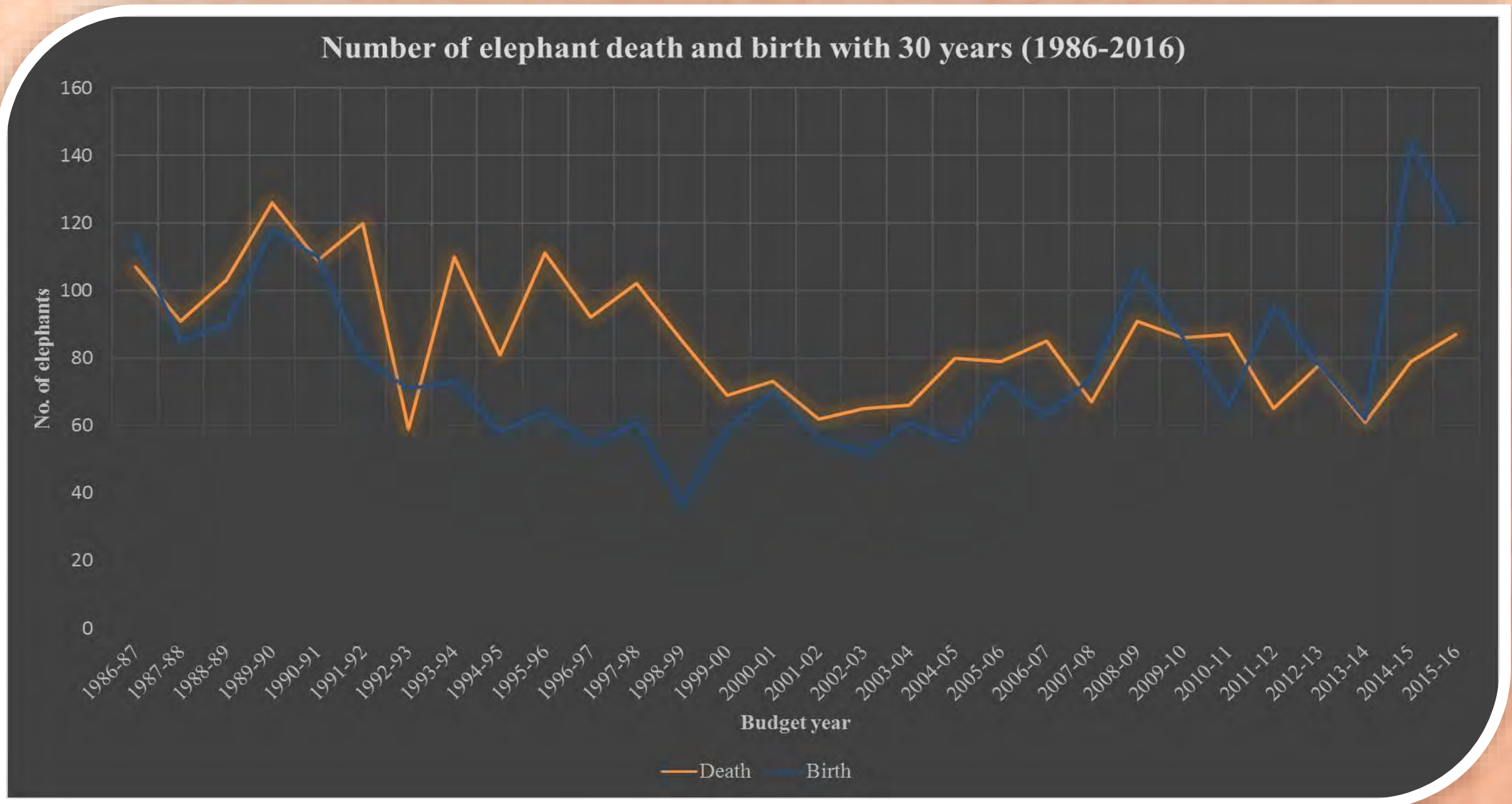


At the present,

- Government owned elephants- 2999
- Privately owned elephants-2500 (esti;) totally ~ 5500

Government owned elephants population within 30 years (1986-2016)




Number of elephant death and birth with 30 years (1986-2016)
No. of elephants
160
140
120
100
80
60
40
20
0
1986-87
1987-88
1988-89
1989-90
1990-91
1991-92
1992-93
1993-94
1994-95
1995-96
1996-97
1997-98
1998-99
1999-00
2000-01
2001-02
2002-03
2003-04
2004-05
2005-06
2006-07
2007-08
2008-09
2009-10
2010-11
2011-12
2012-13
2013-14
2014-15
2015-16
Budget year
Death
Birth

Causes of elephant death with 30 years (1986-2016)









Elephant health care programme in Myanmar

- Two Mobile Clinic Unit (At the north and south)
- Elephant Veterinarians- 40 + 17







One new Mobile Clinic project in Myanmar with SPANA, UK


2014/12/03 03:36 PM













Communication Road



Elephant Hospital and Elephant conservation center in Myanmar by collaboration with AES



plantation



Water resources



Treating elephant in hospital



Shelter for elephants



Current and planned elephant conservation/ HEC management activities in MTE collaboration with IEF

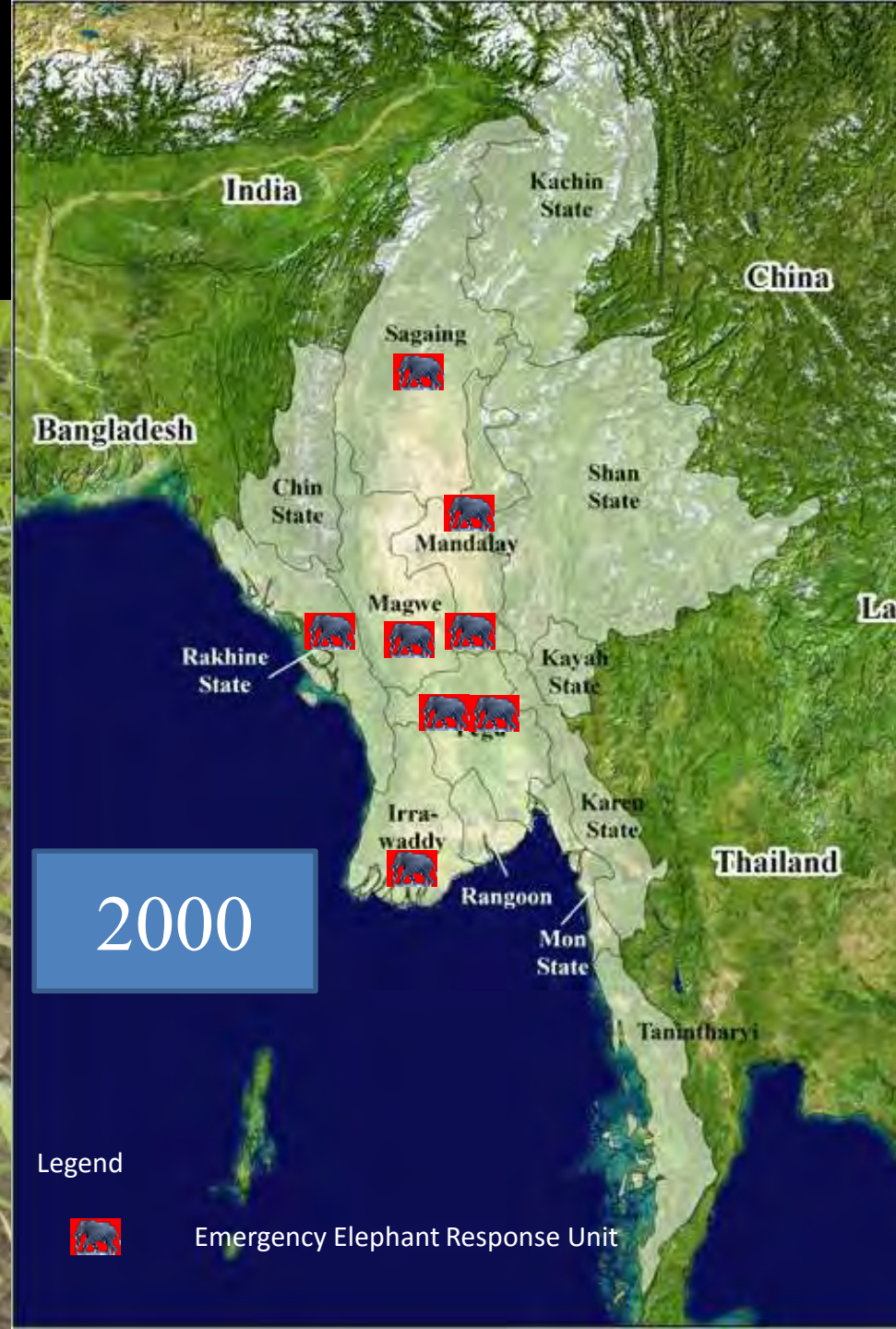
- MTE have 8 EERU units

for HEC management.

1. Sagaing Region
2. Mandalay Region
3. Magway Region
4. Nay Pyi Taw
5. Bago (East) Region
6. Bago (West) Region
7. Ayeyarwaddy Region
8. Rakhine State







Why?











Why?







HEC Mitigation













Why HEC increase?

- Habitat lost
- Poaching
- improper land use
- Excessive dams
- Plantation





Driving

Activities of MTE for HEC mitigation



Education and awareness, local community building





Translocation to Protected area



Patrolling only mahouts



Patrolling with elephants



Thank very much for your attention!

CRU SEBLAT
PATROL & MONITORING AROUND AND WITHIN SEBLAT NATURE TOURISM PARK (TWA SEBLAT)

The 15th International Elephant & Rhino Conservation and Research Symposium,
14 -18 November 2016,Singapore

By Slamet Riyanto
Conservation Response Unit Seblat,
Balai KSDA Bengkulu, Indonesia

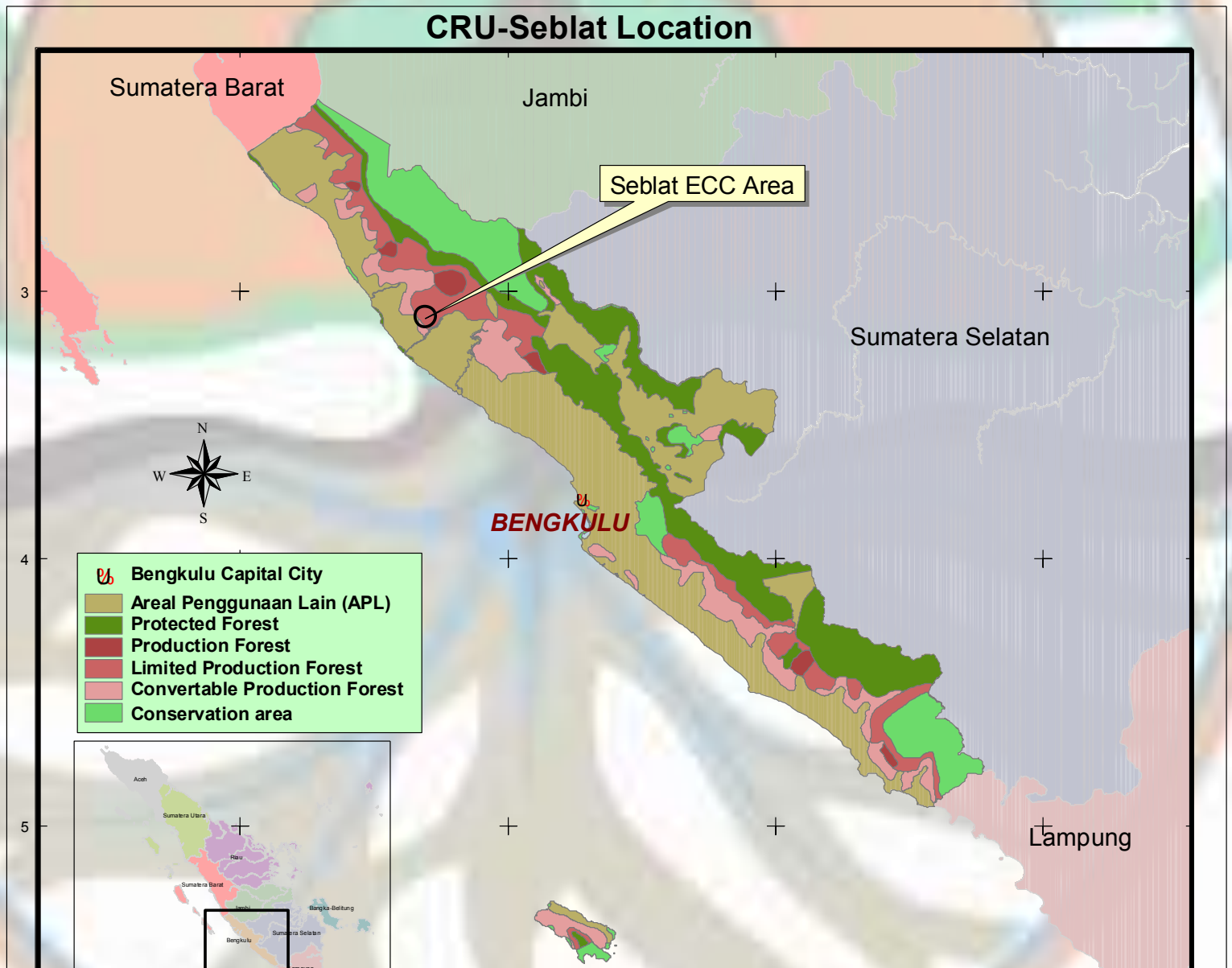


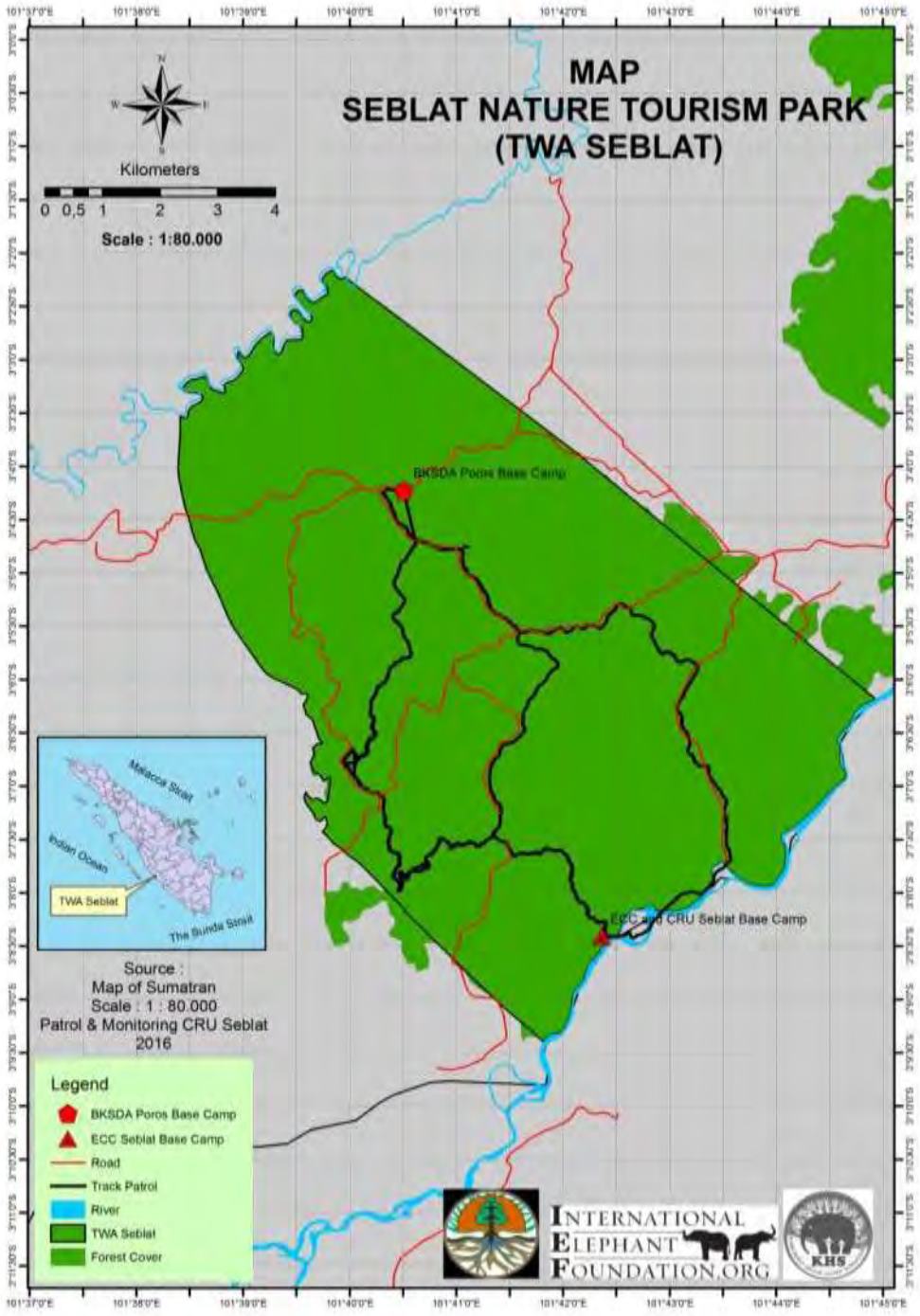
INTERNATIONAL ELEPHANT FOUNDATION.ORG

KHS
KOMUNITAS UNTUK HUTAN SUMATERA

MAP


Malaysia
Singapore
Bengkulu
Brunei D
Indo
N
© 2007 Europa Technologies
Image NASA
Image © 2007 TerraMetrics
703 km
Google
Pointer 1°41'30.03" S 101°06'43.78" E
Streaming 100%
Eye alt 2206.10 km


CRU-Seblat Location
Sumatera Barat
Jambi
Seblat ECC Area
Sumatera Selatan
N
W
E
S
BENGKULU
Bengkulu Capital City
Areal Penggunaan Lain (APL)
Protected Forest
Production Forest
Limited Production Forest
Convertable Production Forest
Conservation area
Lampung
3
4
5



SK. 643/Menhut-II/2011 tanggal 11 November 2011, Luas ± 7.737 ha.

CRU SEBLAT TEAM



TUJUAN (Goal)

- Melakukan perlindungan dan pengamanan kawasan TWA Seblat terhadap Aktivitas Illegal Kehutanan
- Melakukan survey jalur gajah liar yang keluar dari Kawasan Hutan Konservasi PLG Seblat dan mengidentifikasi berbagai penyebab lain yang memicu kejadian konflik
- Membangun jaringan dan keterlibatan masyarakat dalam penyampaian informasi langsung kepada CRU Seblat dalam penangganan konflik satwa liar yang dilindungi di sekitar Kawasan TWA Seblat
- Memberikan respon langsung terhadap konflik satwa liar khususnya gajah yang keluar dari Kawasan Hutan TWA Seblat yang akan menganggu lahan pertanian masyarakat setempat

(Utilization of Sumatran elephants for Patrol)











Canal sebagai bataasan TWA Seblat dengan Areal Perusahaan Sawit



Patroli Jalan Kaki (Patrol Walking)







HASIL

- Hampir keseluruhan kawasan yang dilakukan monitoring oleh tim merupakan habitat gajah liar



Jejak Tapir/Footprints findings Tapir (*Tapirus indicus*)



Temuan Jejak Kucing Emas /Golden Cat(*Paradoxurus hermaphroditus*)





Direct encounter with a wild Sumatran elephants (perjumpaan langsung Gajah liar)












24/03/2014 23:29













Temuan Jerat Satwa Liar (Snares Wildlife)









Pemakuan





Konflik Beruang Madu

















PENDIDIKAN LINGKUNGAN

- Memberikan penyuluhan & pendidikan pentingnya menjaga dan menyelamatkan lingkungan hidup kepada siswa Sekolah Menengah Atas Negeri 1 Putri Hijau, Lokasi PKG Seblat
- Bersama Polsek Putri Hijau dan tim Kecamatan Putri Hijau bekerjasama dengan Aparat Desa SP I Suka Makmur melakukan penyuluhan pendidikan tentang arti pentingnya hidup dilingkungan sekitar hutan







Kebersamaan











THANK YOU







ERU TN. WAY KAMBAS

3 TIM ERU TN.WAY KAMBAS

ERU BUNGUR







ERU TEGAL YOSO





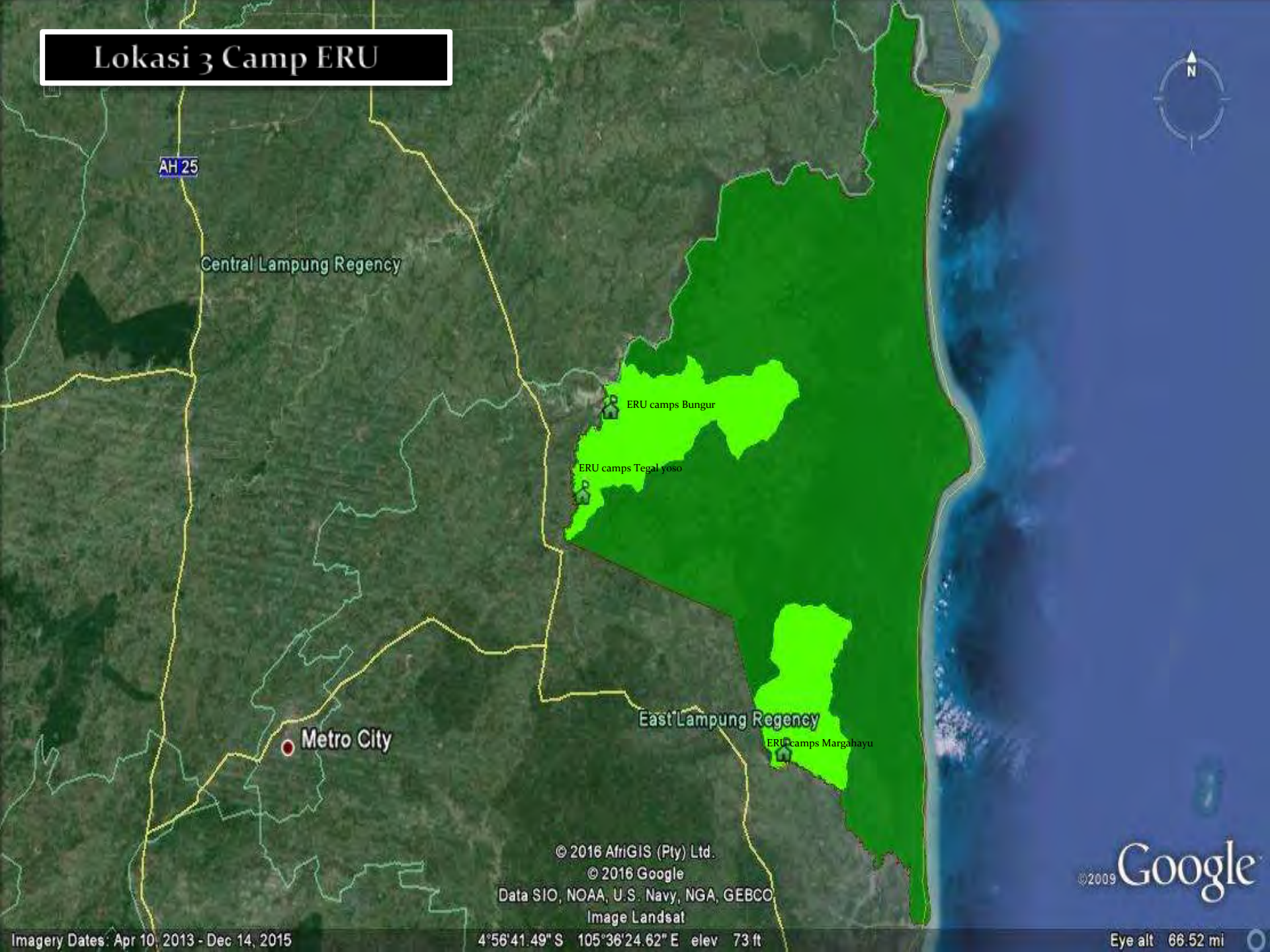


ERU MARGAHAYU

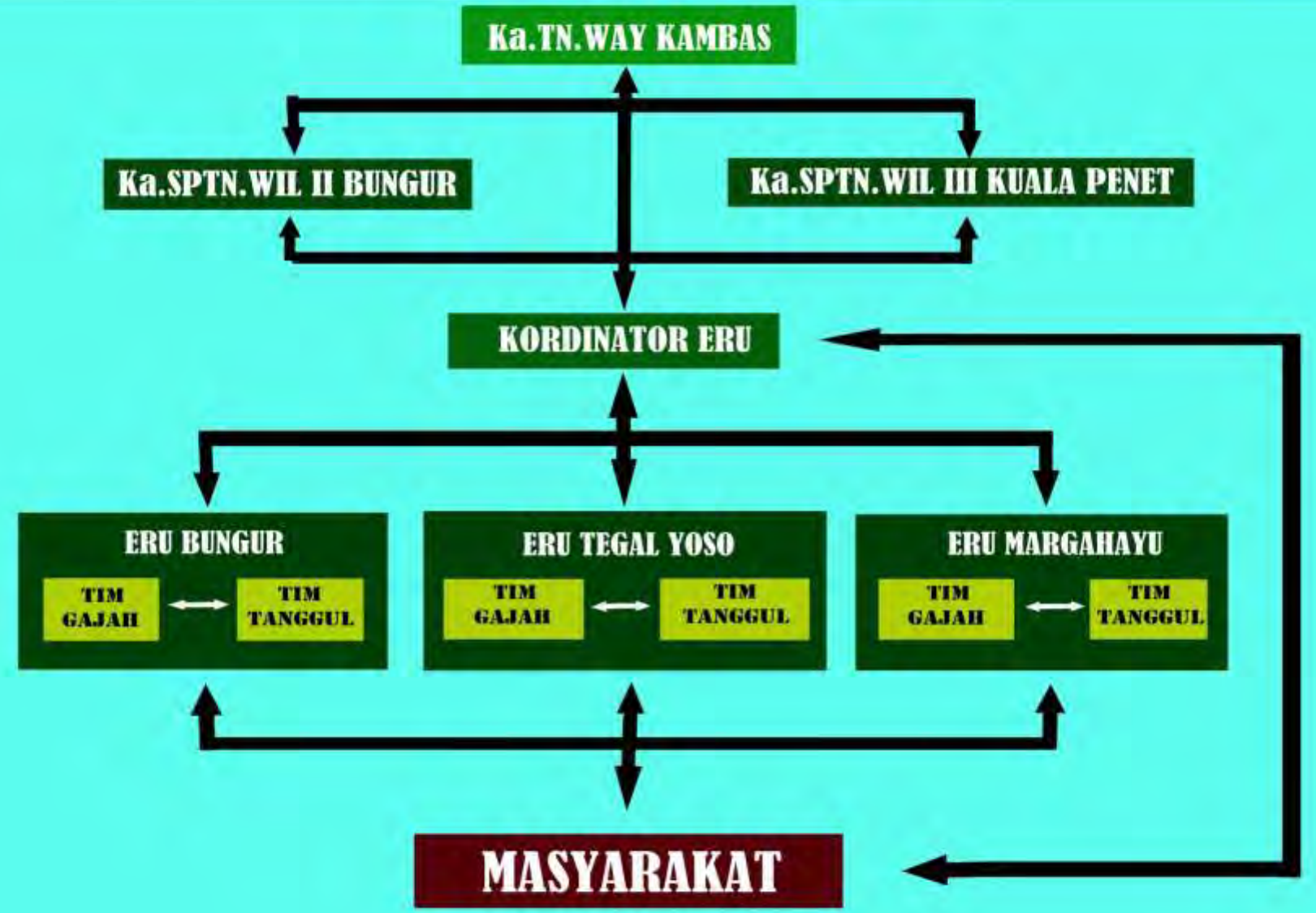







Lokasi 3 Camp ERU
AH 25
Central Lampung Regency
ERU camps Bungur
ERU camps Tegal yoso
East Lampung Regency
ERU camps Margahayu
Metro City
© 2016 AfriGIS (Pty) Ltd.
© 2016 Google
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat
©2009 Google
Imagery Dates: Apr 10, 2013 - Dec 14, 2015
4°56'41.49" S 105°36'24.62" E elev 73 ft
Eye alt 66.52 mi

STRUKTUR ERU



AKTIVITAS MASYARAKAT DESA PENYANGGA

Presentasi Team ERU

TANAMAN YANG RUSAK AKIBAT GAJAH



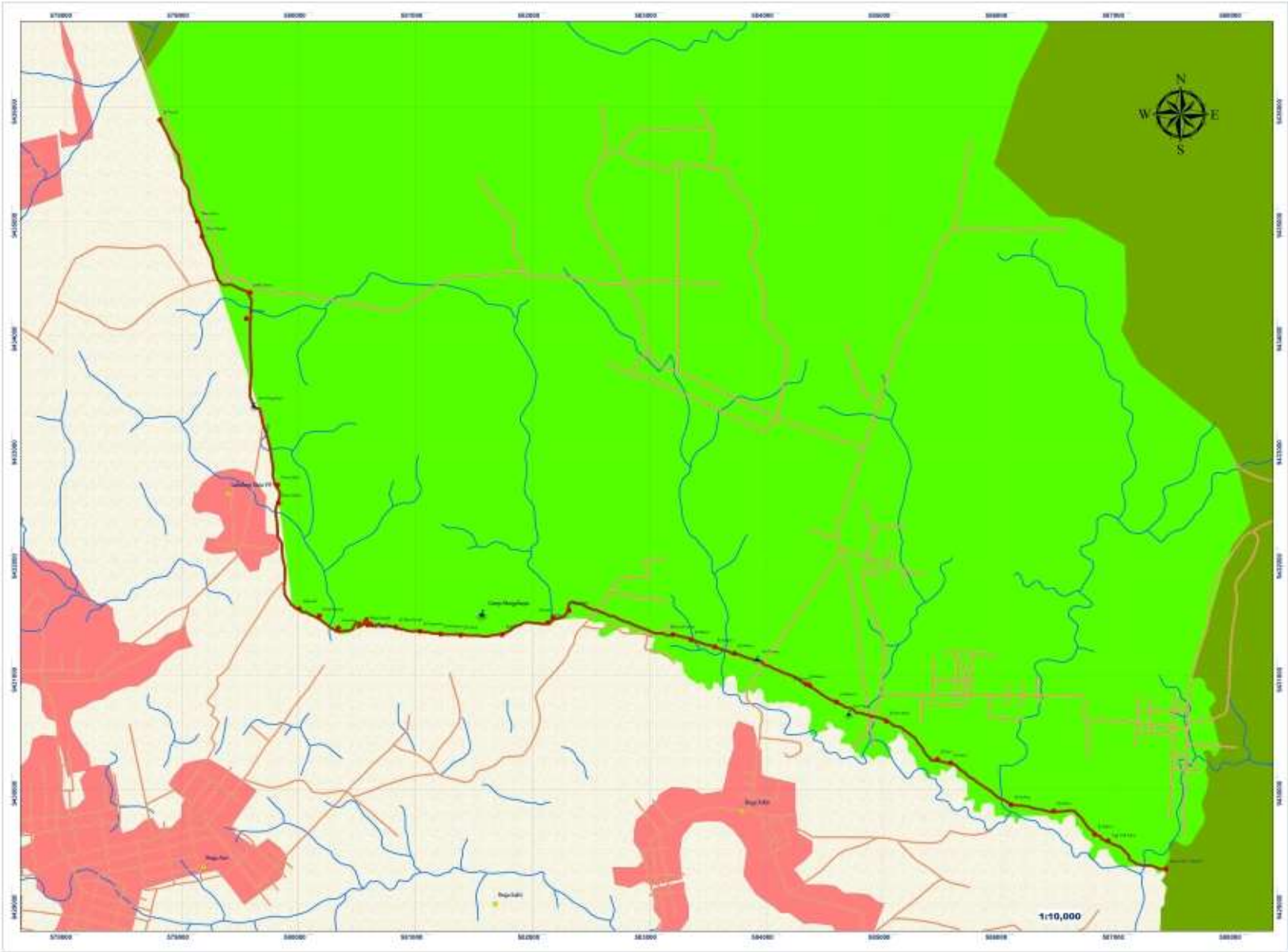






JALUR RAWAN GAJAH SPTN.II BUNGUR





Legend

- Jlr.Proyek
- Tbm 6 Atas
- Tbm 6 Bawah
- Jmbt.Darmo
- Jlr.Cipluk
- Rest.Margahayu
- Waru Udin 1
- Waru Udin 2
- Ssk.Jeruk
- Preng Kuning
- Dam Atas
- Bbkn.Pondok
- Jlr.Mian Atas
- Jlr.Mian Bawah
- Jlr.Sengonan
- Jlr.Kolonjono
- Jlr.Panut
- Gbk.Cor
- Br.Darli
- Jlr.Pedotan
- Knl .Putul.
- Bbkn.Pak Gimin
- Jlr.Balian 1
- Jlr.Balian 2
- Jlr.Balian 3
- Pos Y Lama
- Jlr.Balian 4
- Jlr.Balian 5
- Jlr.Balian 6
- Pos Y Baru
- Jlr.Boro Muh
- Jlr.Bari
- Jlr.Surat
- Jlr.Sadeng
- Jlr.Rabin 1
- Jlr.Rabin 2
- Tngl .Gbk.Rabin
- Rawa Lebar Y (Sapon)
- Camp ERU Marahayu



JALUR RAWAN GAJAH

SPTN WIL III KUALA PENET

Legend

Hutn Margahayu
TN Way Kambas
Prop Lampung
Jalan
Sungai
Pemukiman
Desa
Tanggul Kanal

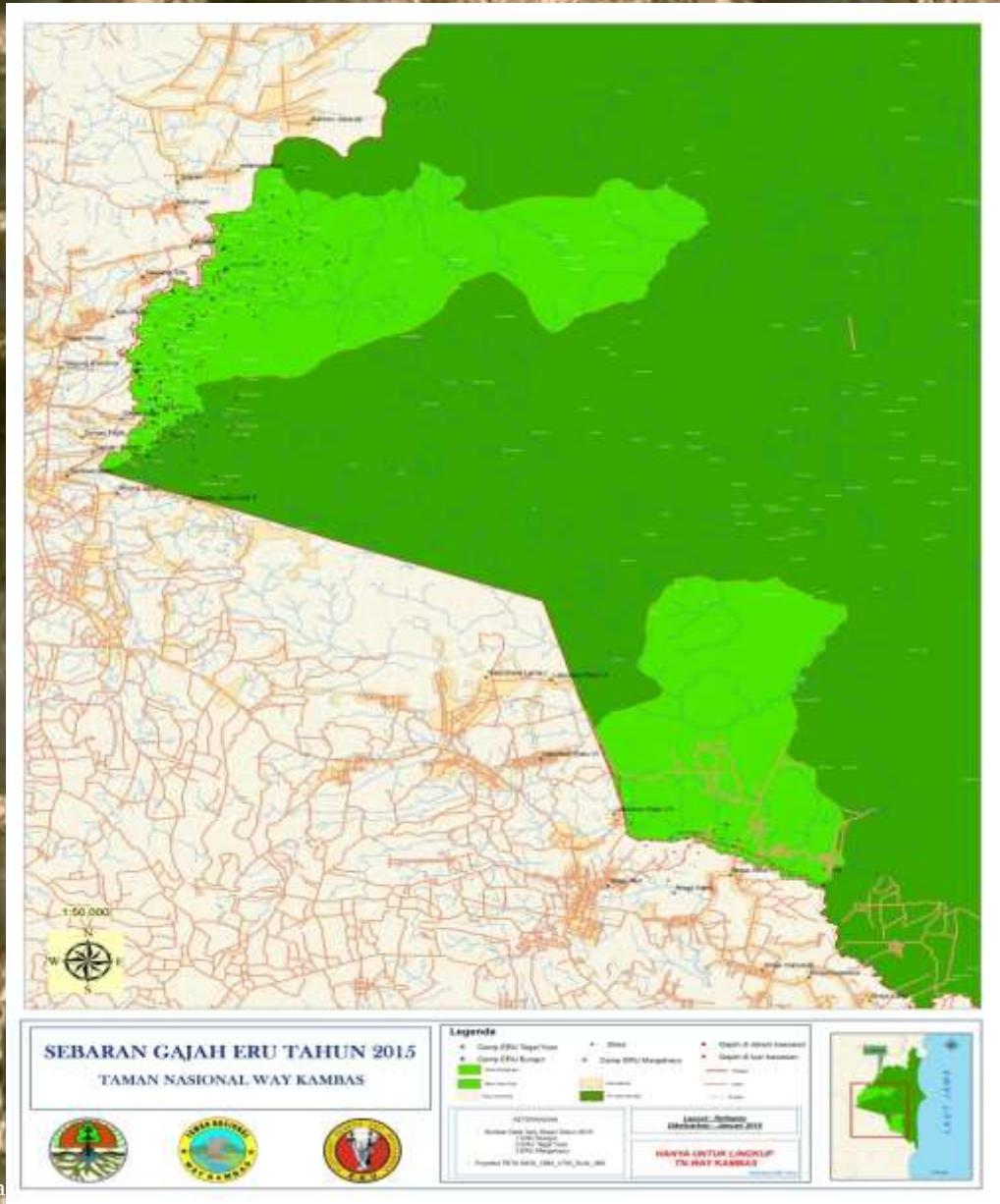
LAYOUT REFLIANTO

PENGAMBIL DATA
- Tri Sulistiyono
- Eko Ariyanto
- Agus Riyadi

KETERANGAN
- Data Dasar Peta Bbakosurtanal 2003
- Proyeksi Peta UTM DATUM WGS 84
- Dibuat tahun 2015

HANYA UNTUK BALAI TAMAN NASIONAL WAY KAMBAS

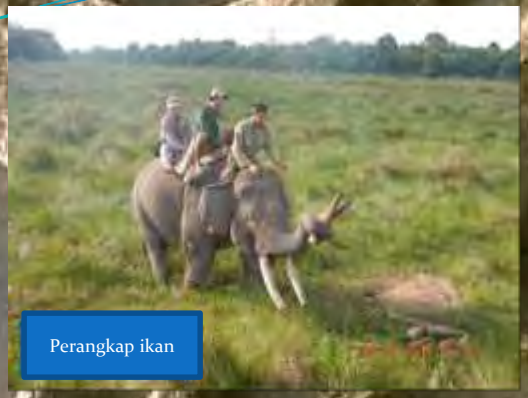
PETA SEBARAN GAJAH DALAM KAWASAN TN.WK



Patroli

- 1 . Patroli Kawasan Hutan
- 2 . Deteksi Dini Keberadaan Gajah Liar
- 3 . Deteksi Dini Kebakaran hutan
- 4 . Patroli Gabungan Tim ERU Bersama Personil SPTN,RPTN, NGO lain (RPU,PKHS)

Temuan


Perangkap ikan


Jerat Tambang

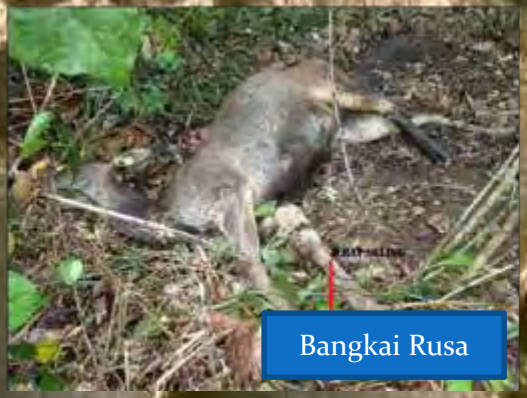

Jerat Seling


Kebakaran Hutan


Jerat Burung


Ilegal loging


Besi Runcing


Bangkai Rusa


Kerangka Gajah

KEBAKARAN HUTAN



TITIK API 1



TITIK API 2



PEMADAMAN API 1



PEMADAMAN API 2

Penghitungan Populasi Secara Manual dan Identifikasi Kelompok



Penghitungan Populasi 1



Penghitungan Populasi 2

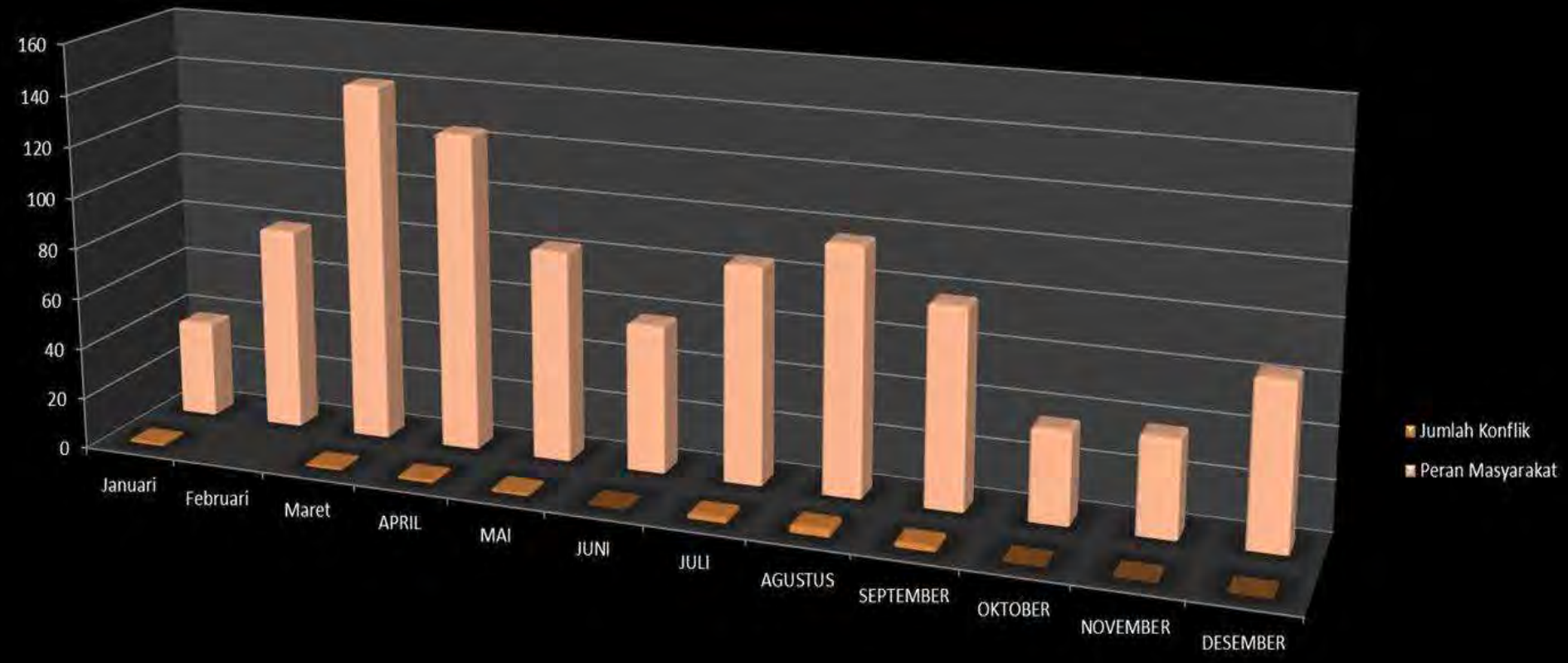


Identifikasi kelompok 1



Identifikasi kelompok 2

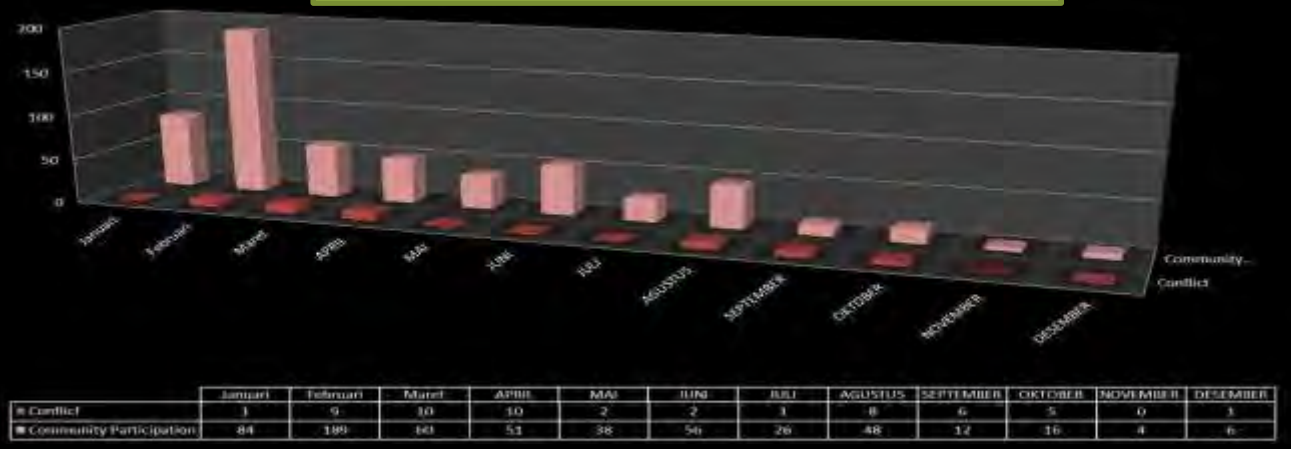
Grafik Konflik Antara Gajah Dan Masusia 2015
Bungur



	Januari	Februari	Maret	APRIL	MAI	JUNI	JULI	AGUSTUS	SEPTEMBER	OKTOBER	NOVEMBER	DESEMBER
Jumlah Konflik	1		1	1	1	0	2	3	2	0	0	0
Peran Masyarakat	38	80	141	125	83	58	85	97	78	36	38	64

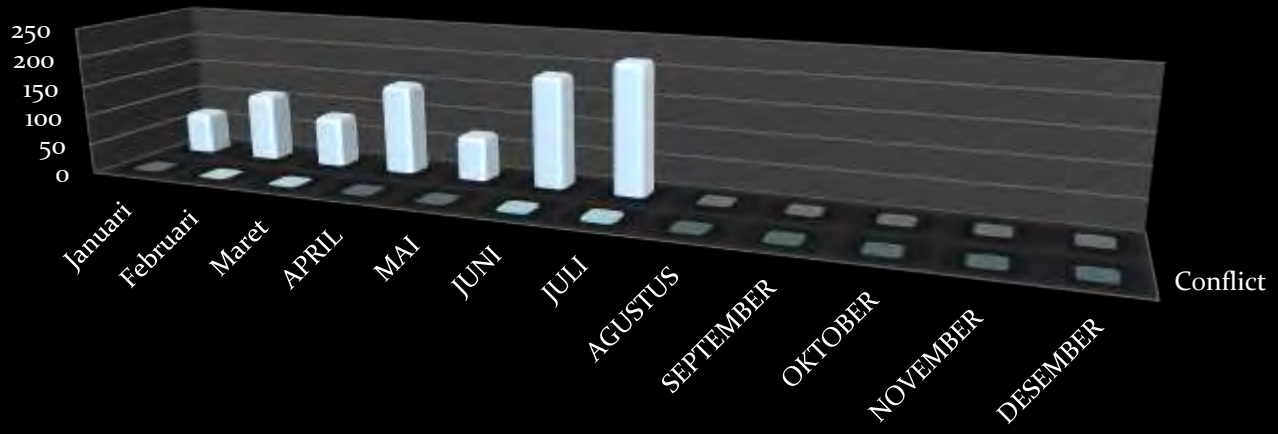
GRAFIK PERBANDINGAN KONFLIK GAJAH DAN MANUSIA THN 2015 - THN 2016

Grafik Konflik Gajah dan Manusia THN 2015 TEGAL YOSO



	Januari	Februari	Maret	APRIL	MAI	JUNI	JULI	AGUSTUS	SEPTEMBER	OKTOBER	NOVEMBER	DESEMBER
Conflict	1	9	10	10	2	2	1	8	6	5	0	1
Community Participation	84	189	60	51	38	56	26	48	12	16	4	6

Grafik Konflik Antara Gajah Dan Manusia 2016 TEGAL YOSO



	Januari	Februari	Maret	APRIL	MAI	JUNI	JULI	AGUSTUS	SEPTEMBER	OKTOBER	NOVEMBER	DESEMBER
Conflict	0	1	1	0	0	3	5	0	0	0	0	0
Community Participation	69	113	84	150	74	186	217	0	0	0	0	0



Terimakasih

Rehabilitation of greater one one-horned rhinoceros calves in Assam, India



Dr. Rathin Barman, Wildlife Trust of India
rathin@wti.org.in

IFAW

Assam Forest Department

Wildlife Trust of India

Background

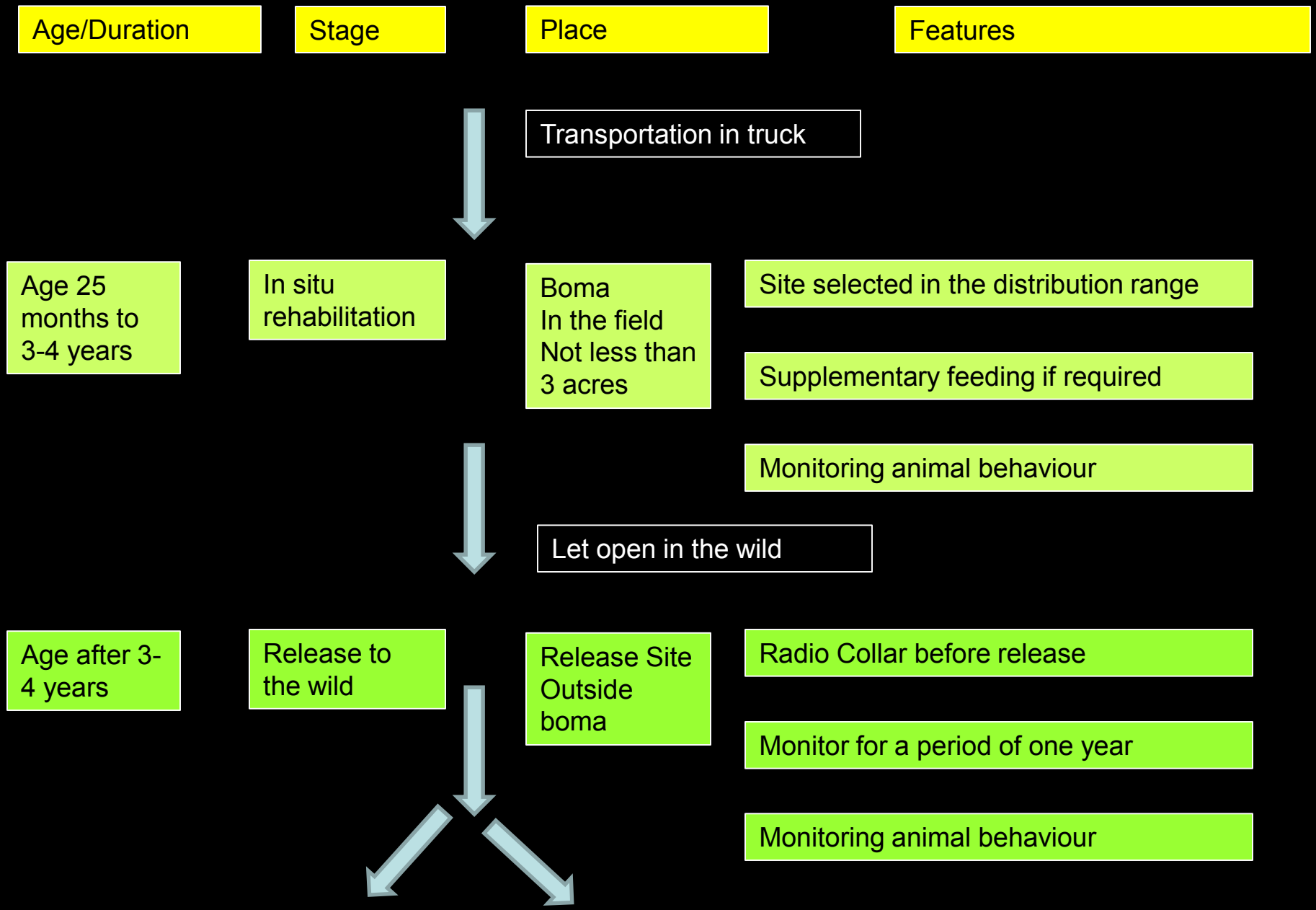
Rhino calves regularly rescued in Kaziranga , most of them die, if survive landed in life time captivity

Assam Forest Department, IFAW and WTI established CWRC at Kaziranga NP, India

Kaziranga has about 2400 rhinoceros.



Age/Duration	Stage	Place	Features
		If reunion with mother fails	
		To CWRC for hand raising	
Duration 2 months	Stabilization Stage	Stabilization nursery (100 sq metre)	Emergency relief to the calf in distress
			Choice of appropriate milk formula
			Protection from extreme of weather
		Moved on foot to paddock	
Age 5-24 months	Ex situ rehabilitation	Paddock (1000 sq meter)	Feeding of fodder and concentrate
			Mixing with calves of same age
			Weaning by 18 months


Age/Duration
Stage
Place
Features
Transportation in truck
Age 25 months to 3-4 years
In situ rehabilitation
Boma
In the field
Not less than 3 acres
Site selected in the distribution range
Supplementary feeding if required
Monitoring animal behaviour
Let open in the wild
Age after 3-4 years
Release to the wild
Release Site Outside boma
Radio Collar before release
Monitor for a period of one year
Monitoring animal behaviour

Methodology

Calves rescued in Kaziranga NP, India at the age from 1 to 6 months



Hand raised at CWRC up to 2 years feeding with human baby milk formula



Translocated to release site and placed into a *boma*



Released to the wilderness after 1-2 years from *boma*



Radio monitored for two years






IFAW
ANIMAL
RESCUE


IFAW
IFAW







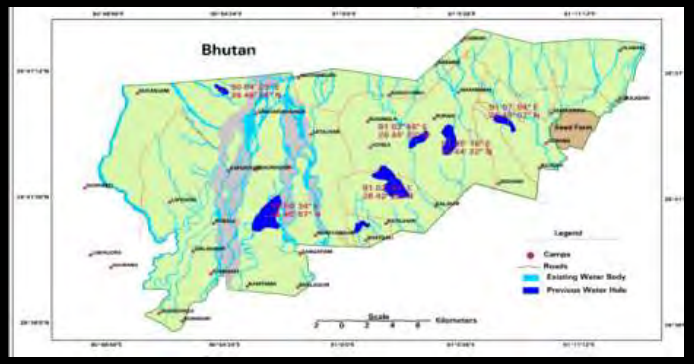




20th February 2006…created history in India



400 km







Habitat in a rhino boma









Released from the boma in 2007…

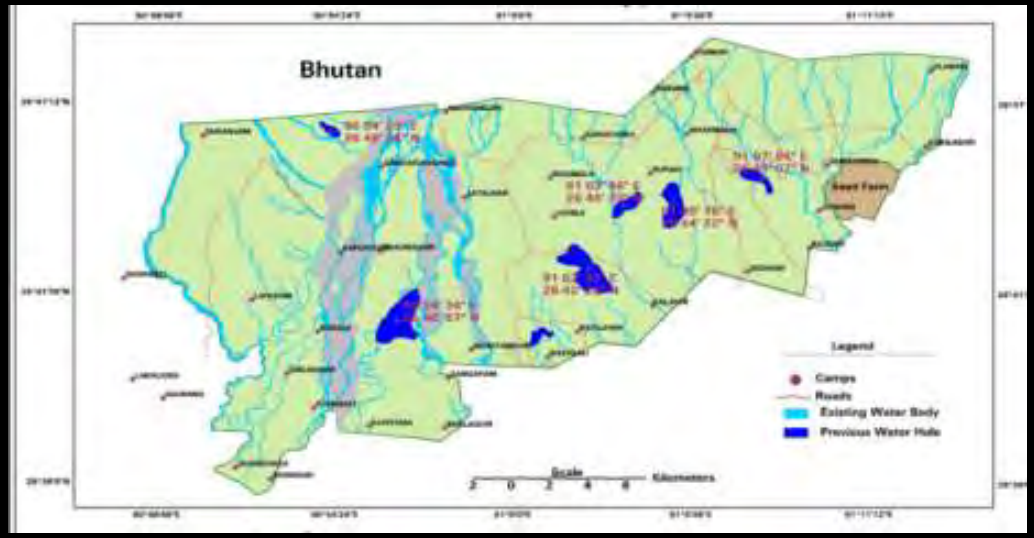






Mother	1st calf born/detected	2nd calf born/ detected	Calving interval
Ganga	04/05/2013	19/06/2015	**2 Yrs-1M-15 Days**
Mainao	02/06/2013	30/07/15	**2 Yrs-1M-28 Days**
Jamuna	31/07/13		

Home ranges established after two years in wilderness







Hard releases in Kaziranga National Park

2015 April



Sohola



Baghmari


< Sohola


< Baghmari

Conclusions

Rehabilitated rhinoceros are able to establish home range, adapted to the release habitat.

Habitat use pattern is found similar to the wild rhinoceros

Both hard release and soft release methods are possible, if protocols are followed properly.

Tolerance of human presence is higher but this is expected !!

The first translocated female rhino passed away this year after 10 years of rehabilitation. She contributed two calves.

Another male rhino died after four years of rehabilitation.

Future plans…

Rehabilitation of nine more rhinos…in next four years



Thank You..



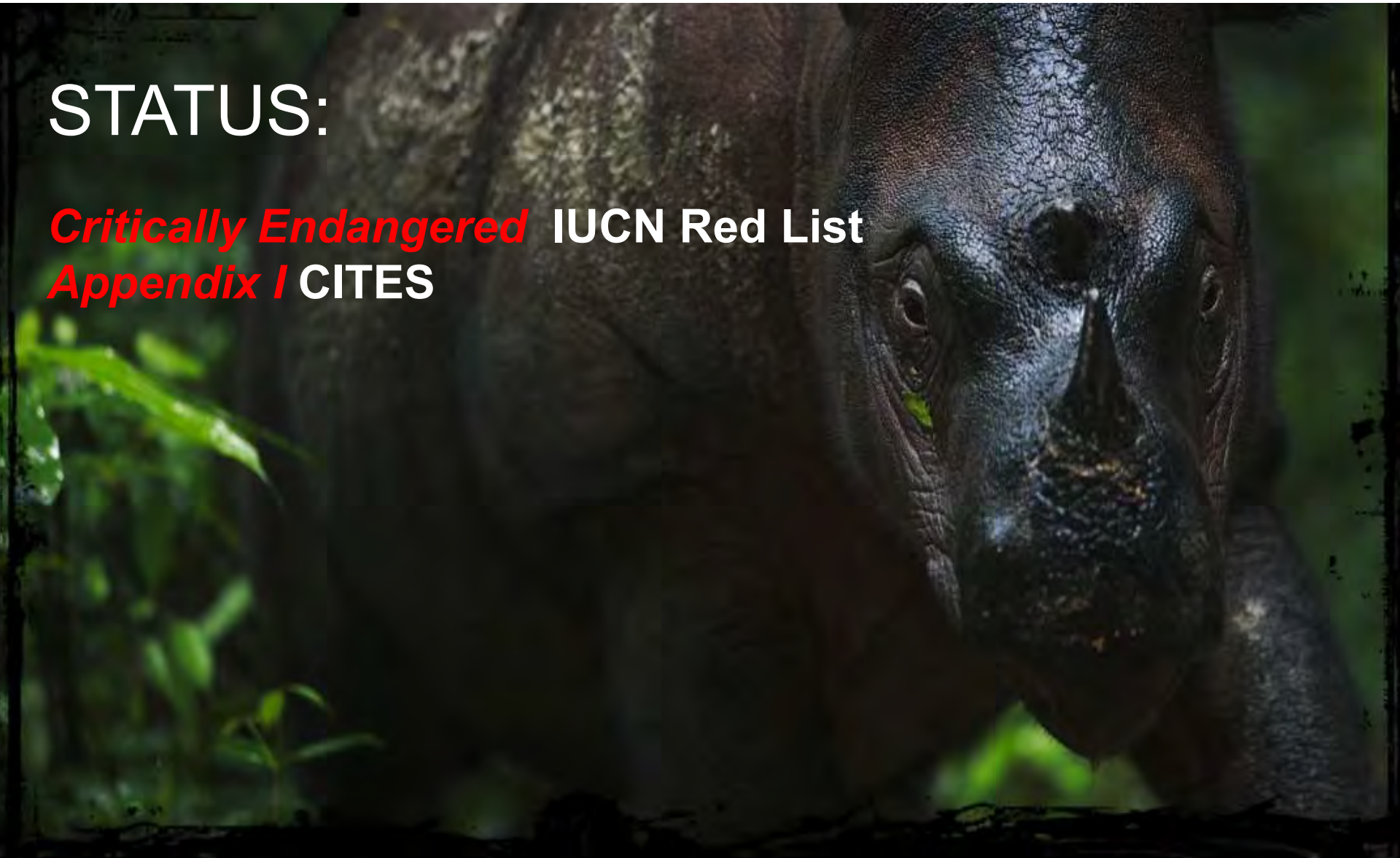
PREGNANCY AND BIRTH OF SECOND SUMATRAN RHINOCEROS CALF IN SUMATRAN RHINO SANCTUARY, WAY KAMBAS NATIONAL PARK, INDONESIA



Zulfi Arsan, DVM and Made Ferawati, DVM
zulfiarsan@gmail.com

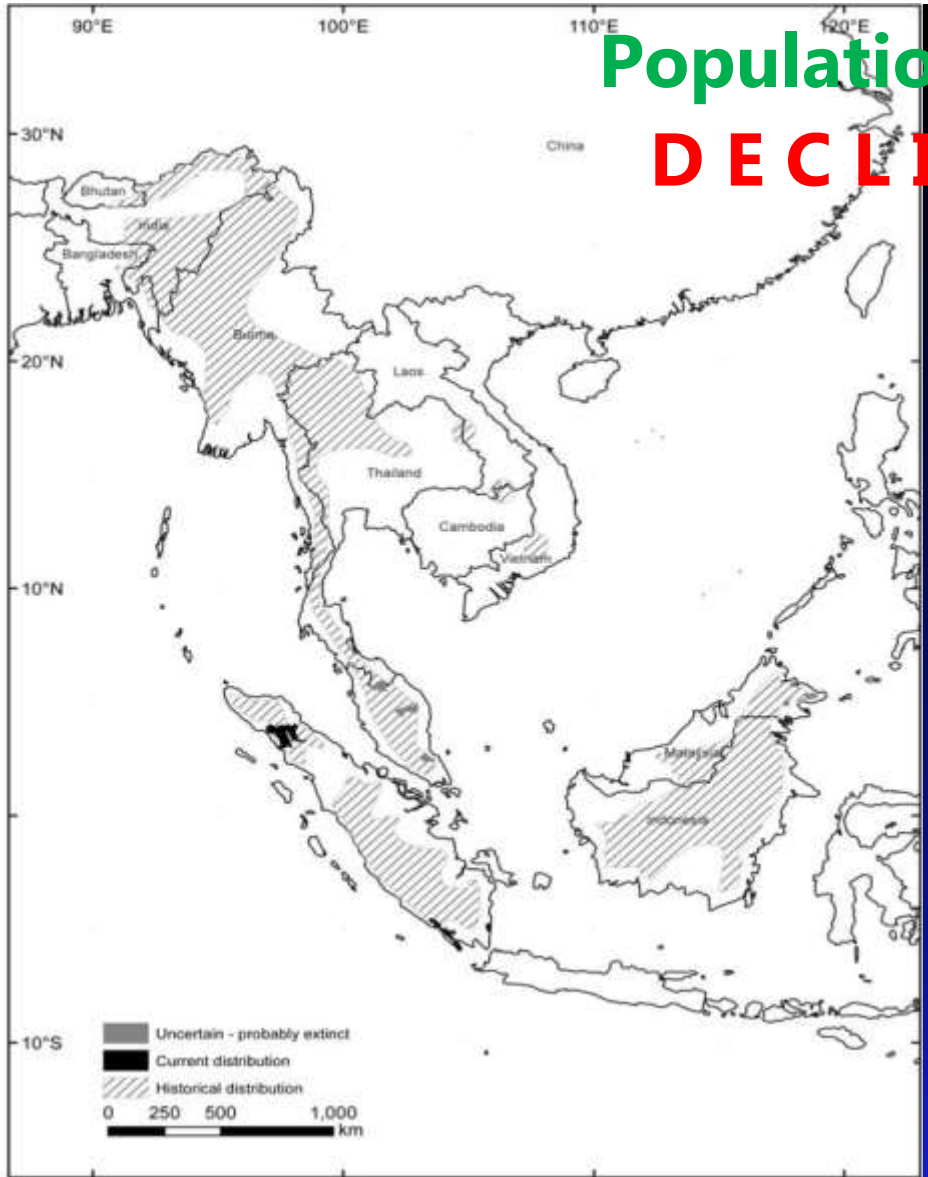
Sumatran Rhinoceros

(*Dicerorhinus sumatrensis,* Fischer 1814)



Sumatran Rhinoceros

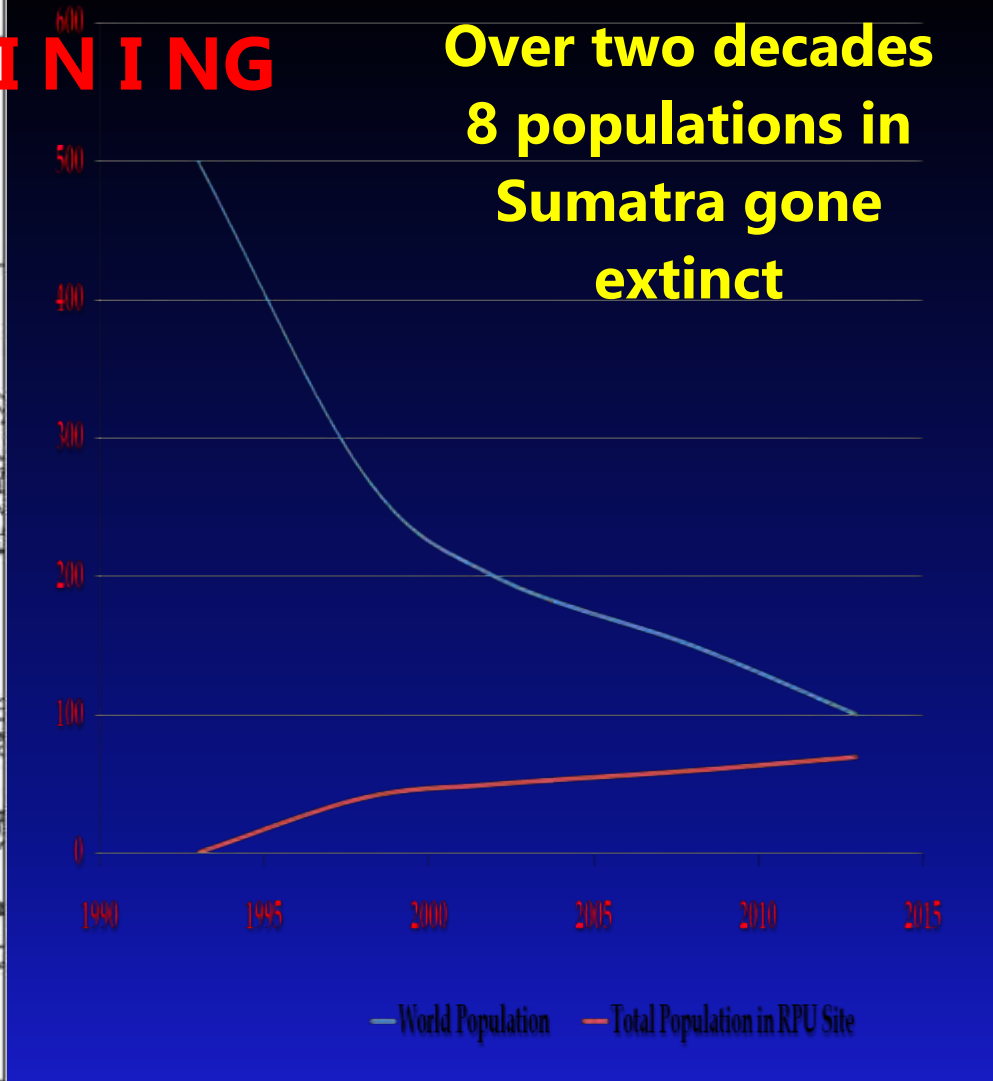
(*Dicerorhinus sumatrensis,* Fischer 1814)



Population Trends

D E C L I N I NG

Over two decades 8 populations in Sumatra gone extinct



Sumatran Rhinoceros

(*Dicerorhinus sumatrensis,* Fischer 1814)

THREATS



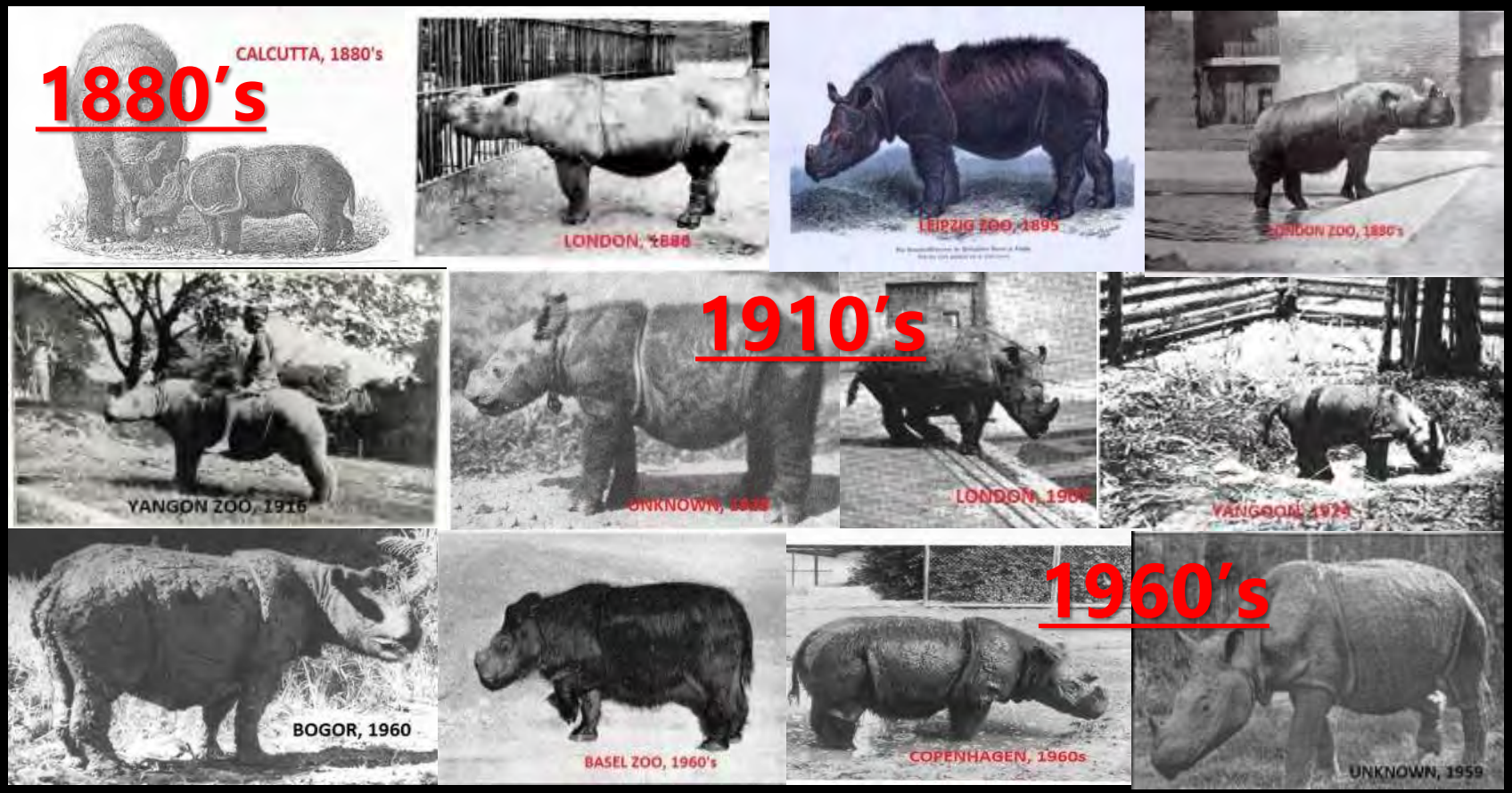




Sumatran Rhinoceros

(*Dicerorhinus sumatrensis,* Fischer 1814)

Efforts to do Captive Breeding has been conducted since over a century ago



Sumatran Rhinoceros

(*Dicerorhinus sumatrensis,* Fischer 1814)

Managed Captive Breeding Program Started in 1985



Under the right conditions could provide:

- higher survival rates
- slower rates of inbreeding accumulation
- greater disease resilience
- higher breeding rates than a wild population of the same size

Sumatran Rhinoceros

(*Dicerorhinus sumatrensis,* Fischer 1814)

7 Calves born in captivity, only 5 from Captive Breeding Program



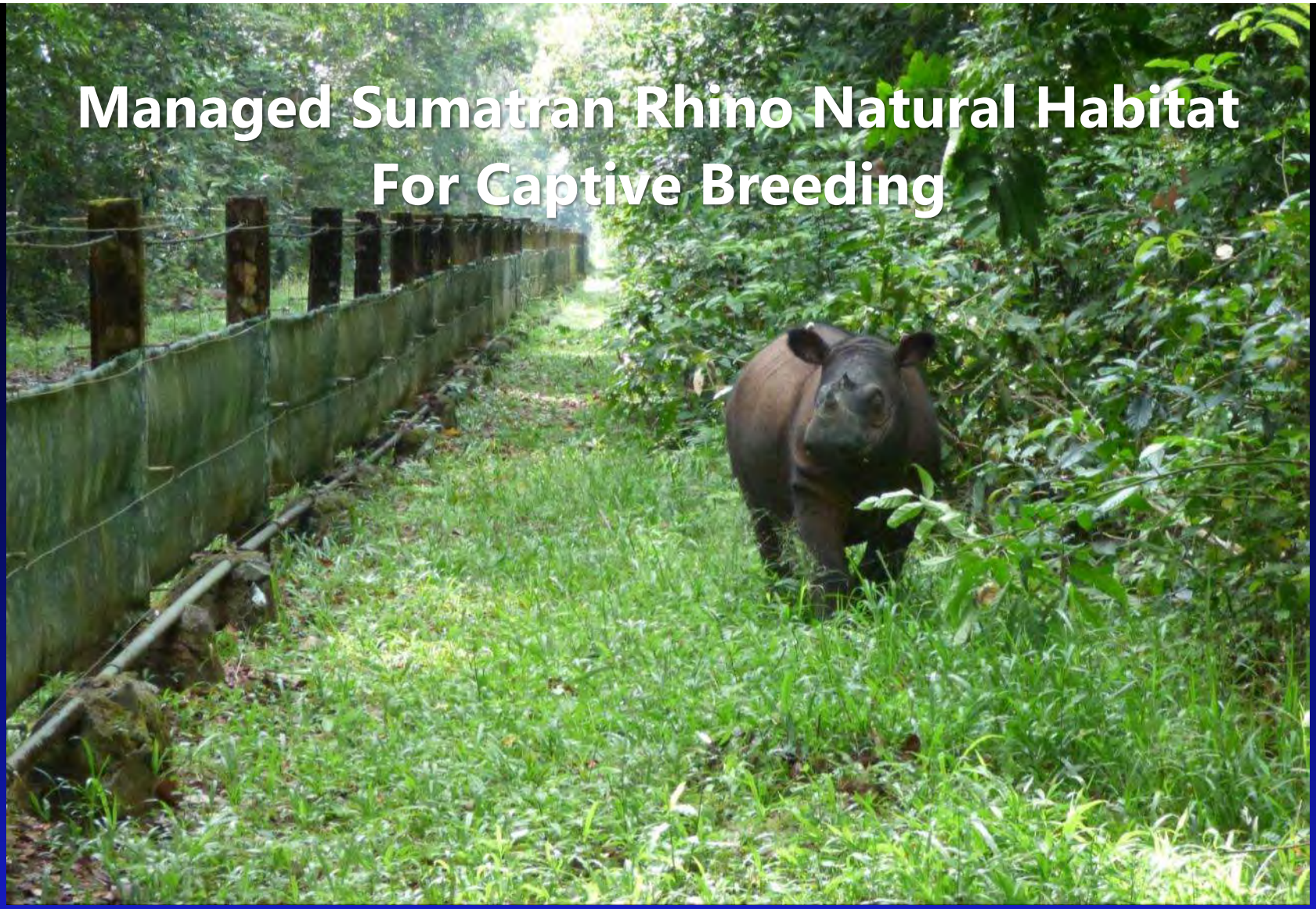




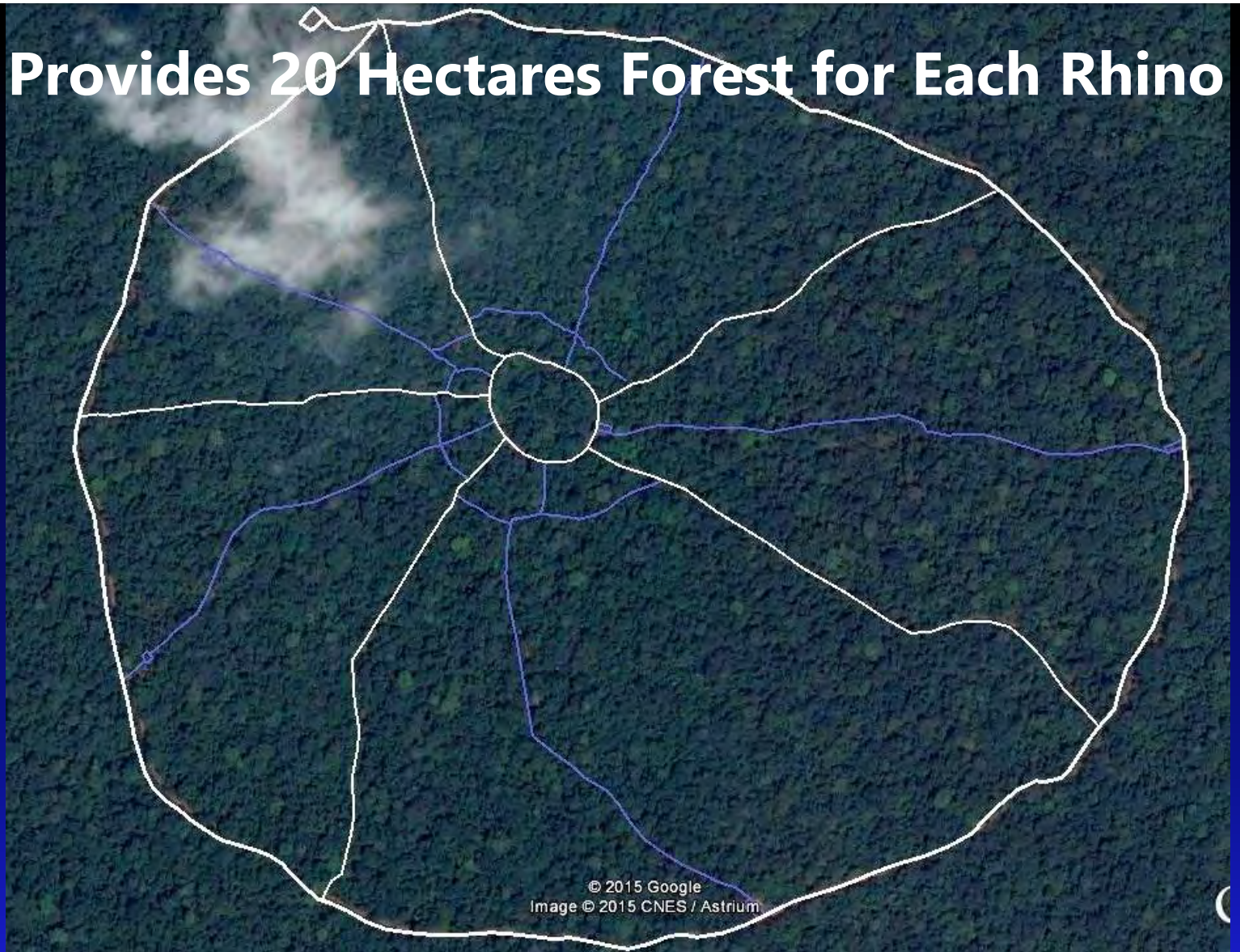




Sumatran Rhino Sanctuary



Sumatran Rhino Sanctuary



Sumatran Rhino Sanctuary

Intensive Health Care and Monitoring





Sumatran Rhino Sanctuary

Assisted Natural Breeding Program











Rhino Mating

Sire: Andalas (15)
Born in CZBG



Dam: Ratu (15)
Rescued from WKNP



Rhino Mating

18x24 mm follicle size on January 22nd 2015



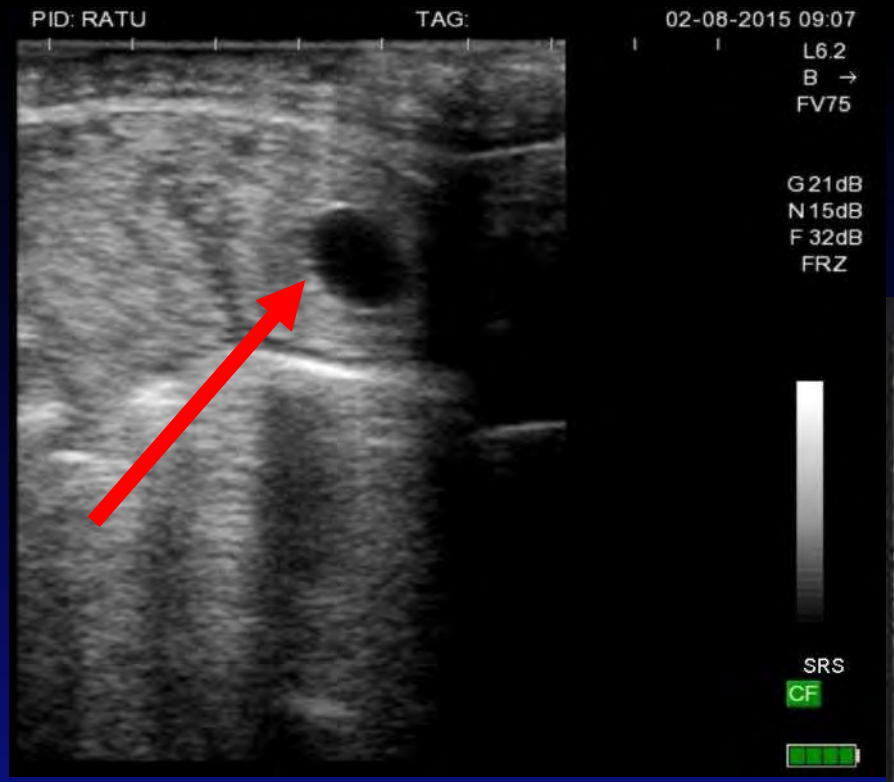
Rhino Mating

Two mating on same day



Pregnancy

Early Development



Day 16 Post Breeding

Embryonic Vesicle ⌀ : 15 mm

Started to giving Synthetic Progesteron (Altrenogest)

Day 36

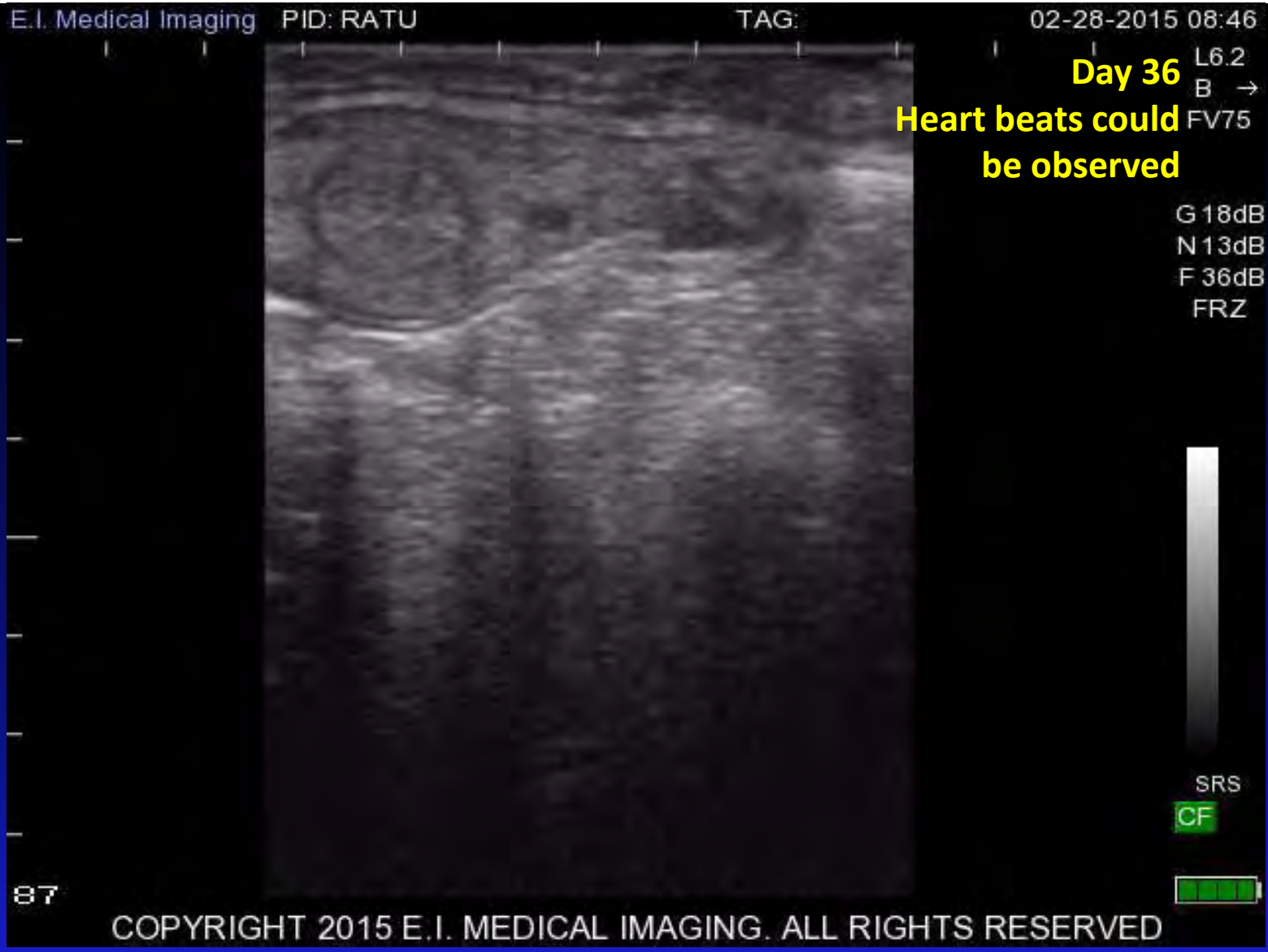
⌀ Vesicle: 62 mm

Embryo length: 16 mm



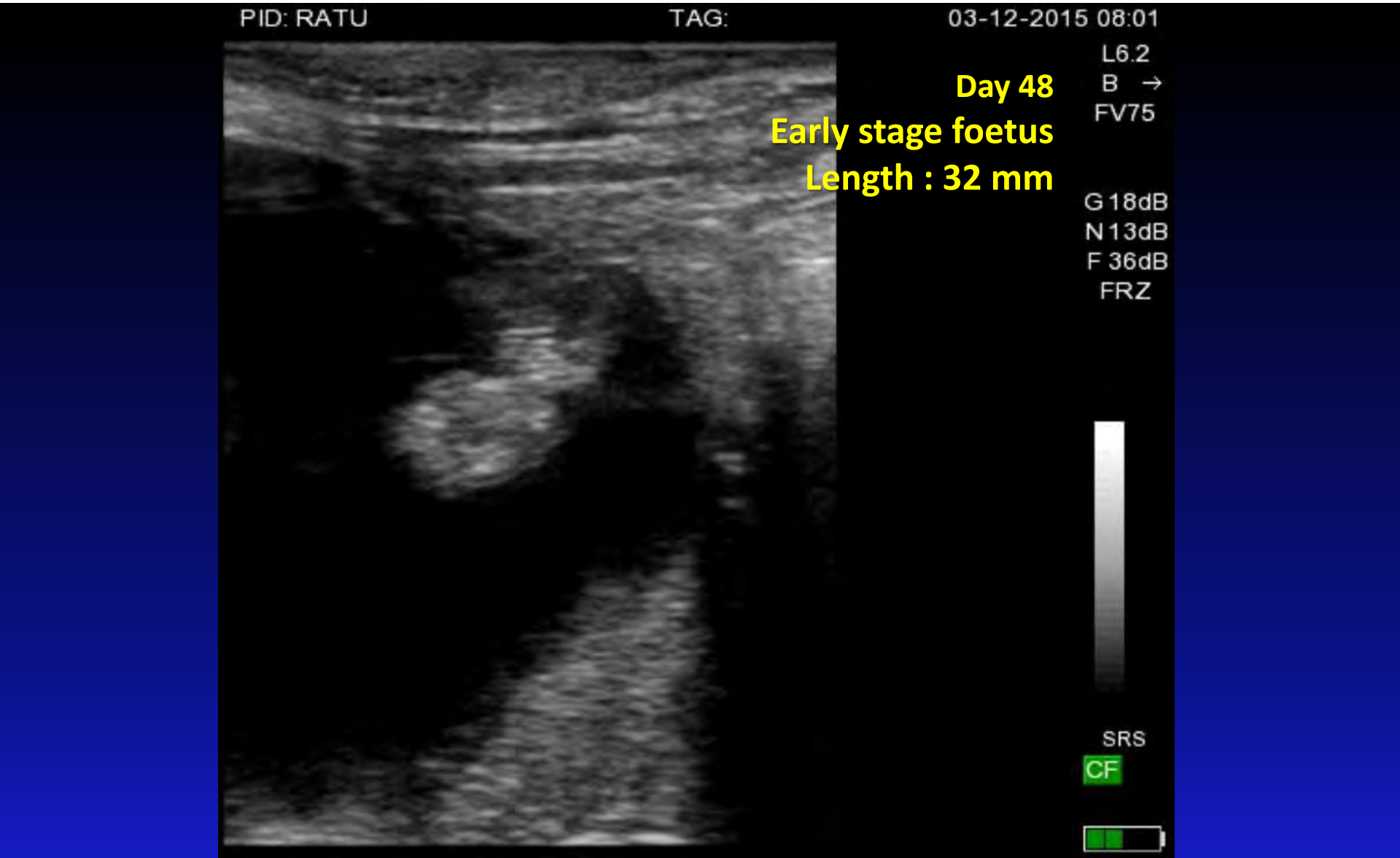
Pregnancy

Early Development



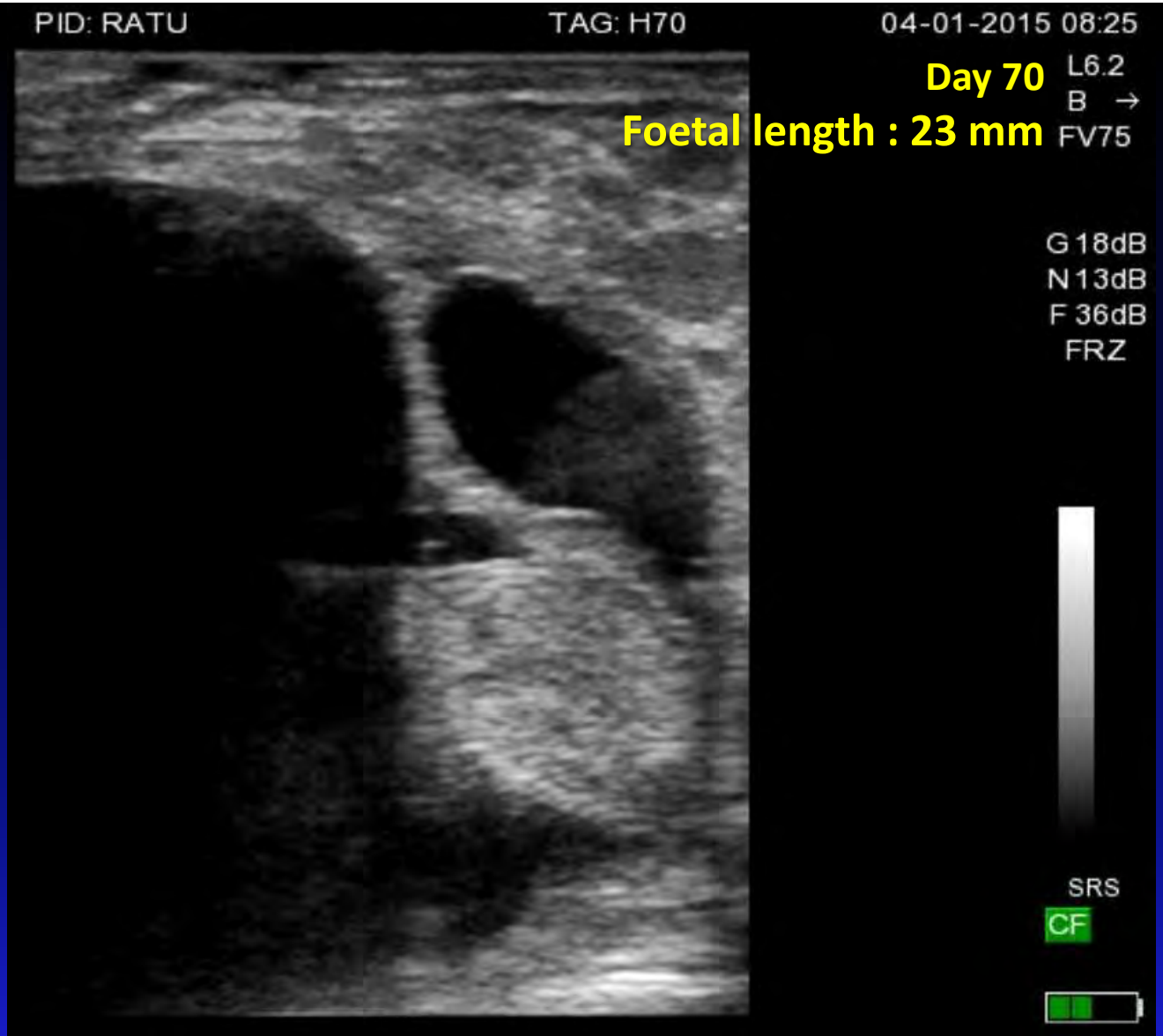
Pregnancy

Early Development

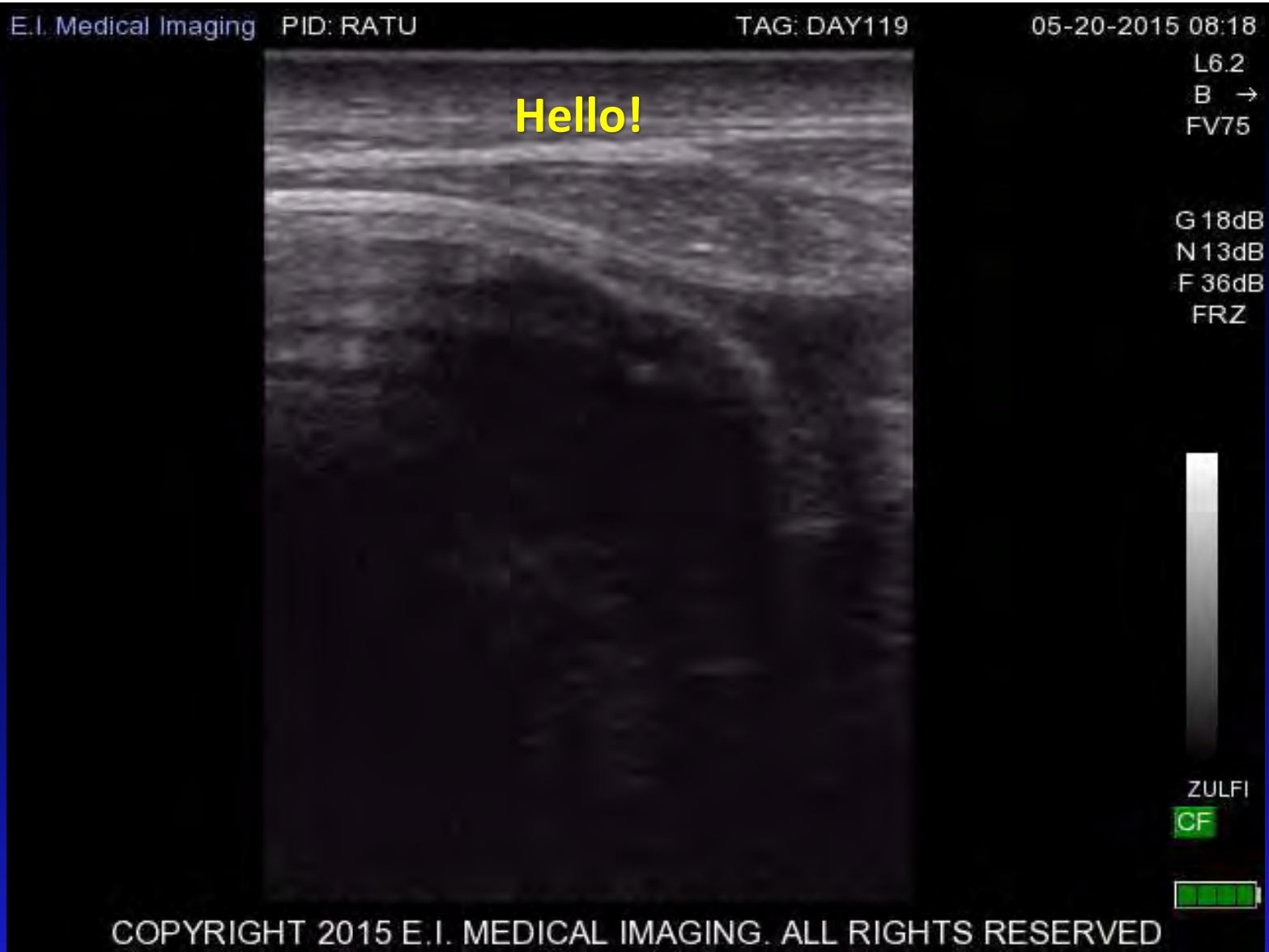


Pregnancy

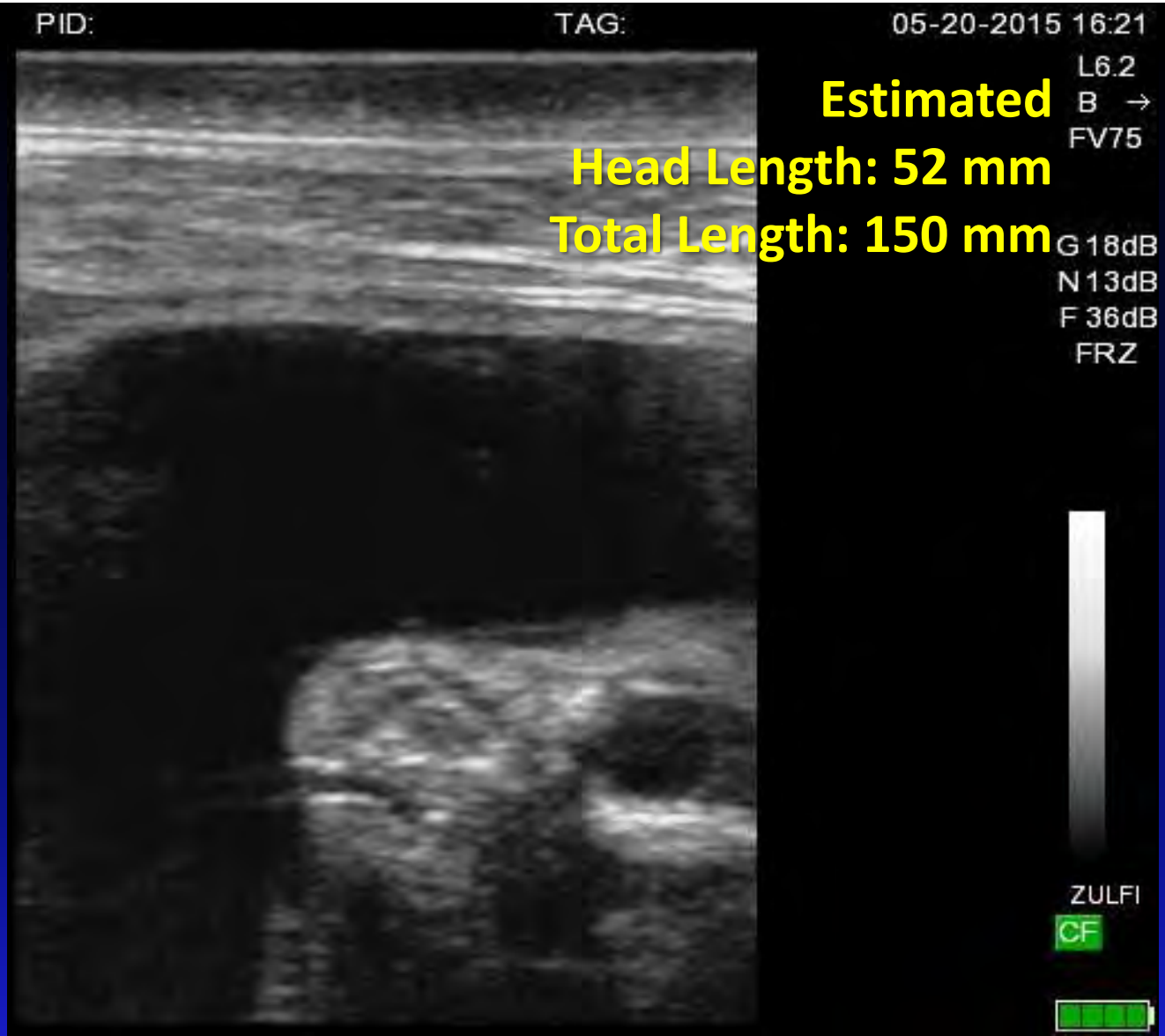
Early Development



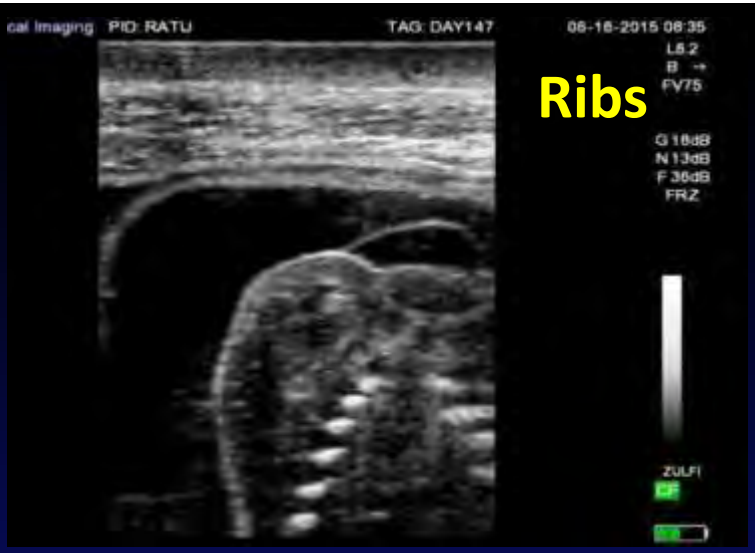
Pregnancy


E.I. Medical Imaging
PID: RATU
TAG: DAY119
05-20-2015 08:18
L6.2
B →
FV75
Hello!
G 18dB
N 13dB
F 36dB
FRZ
ZULFI
CF
COPYRIGHT 2015 E.I. MEDICAL IMAGING. ALL RIGHTS RESERVED

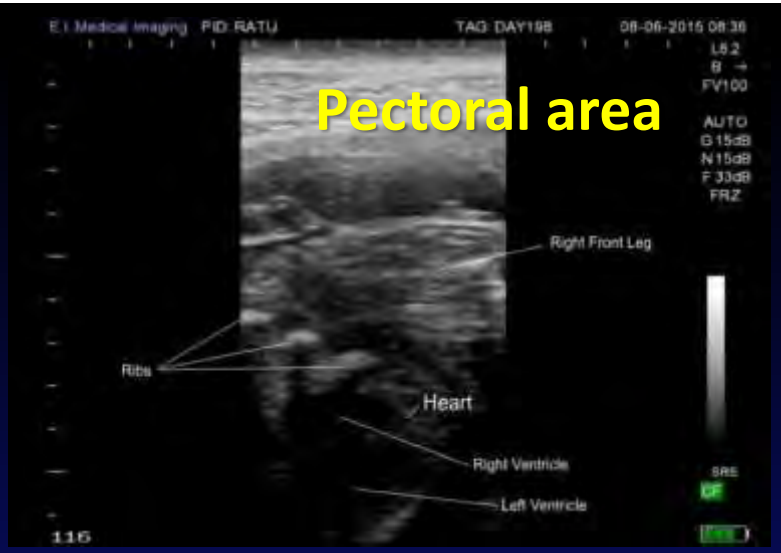
Pregnancy


PID:
TAG:
05-20-2015 16:21
L6.2
B →
FV75
Estimated
Head Length: 52 mm
Total Length: 150 mm
G 18dB
N 13dB
F 36dB
FRZ
ZULFI
CF

Pregnancy



Ribs



Pectoral area



Foot



Sole

Parturition

Pre-Parturition



Parturition

Pre-Parturition

Observation on two parameters:

Physical signs



Behavioural signs

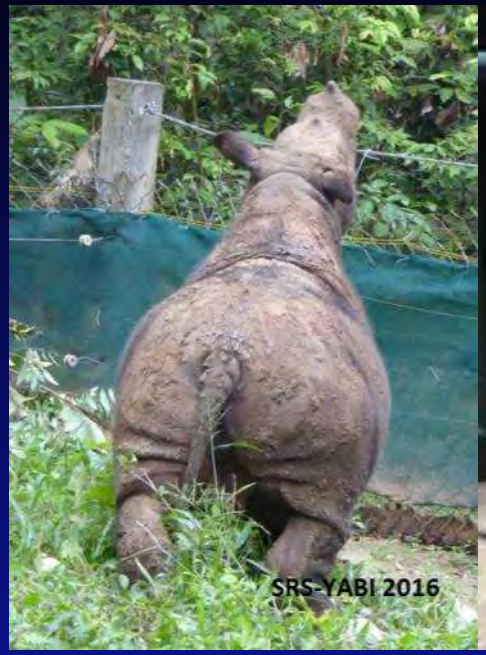


Parturition

Pre-Parturition

Behaviour

Oftenly lifting her head high









Parturition

Pre-Parturition

Behaviour
“Climbing”,
more frequent 24 hours prior to parturition







Parturition

Day 477th of Pregnancy

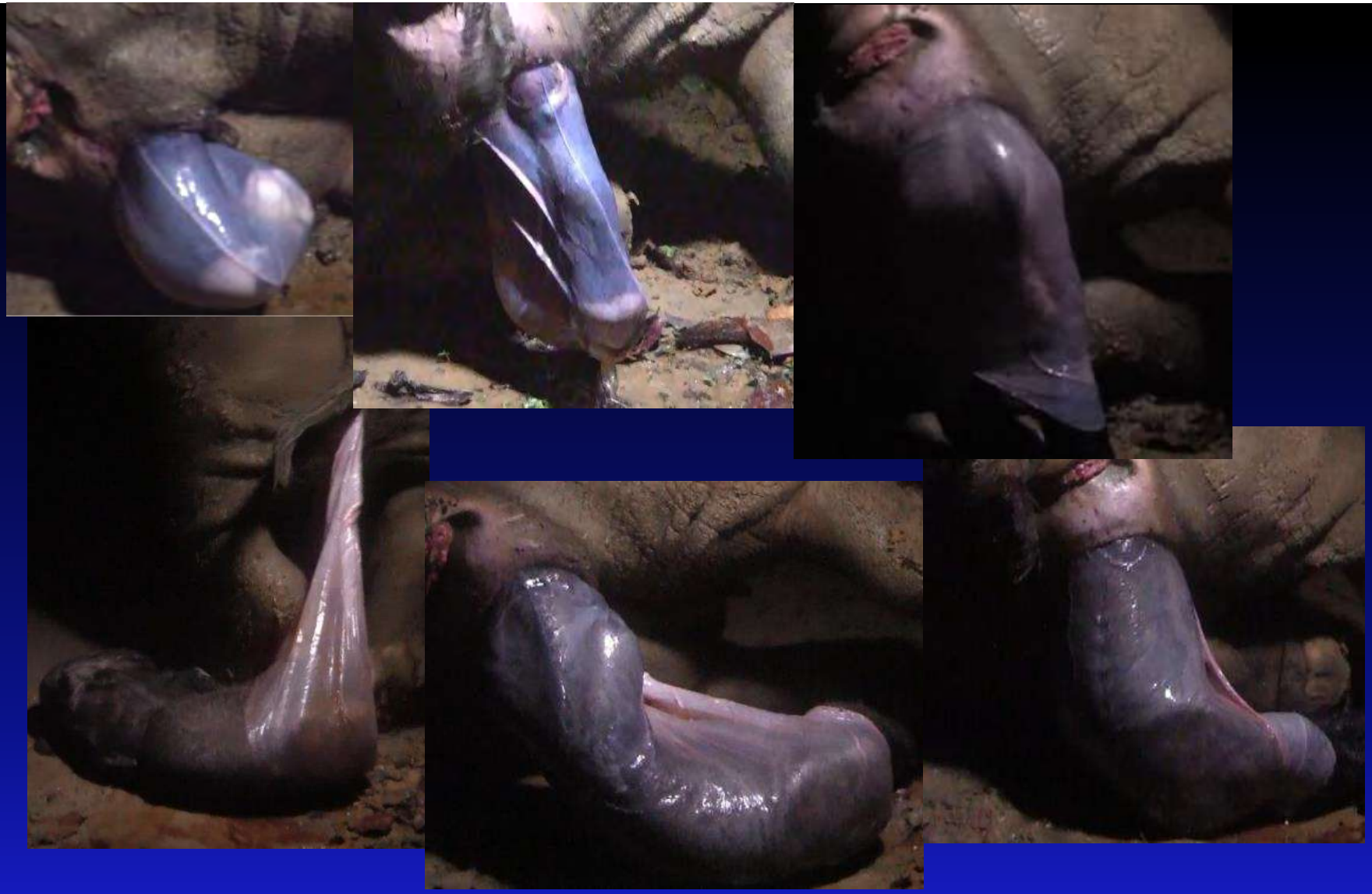
12 May 2016

- 03.00 am : wake up, vocalization, brisk walk around
- 04.48 am : amnionic sac protrude
- 05.11 am : calf hind leg protrude → Posterior presentation
- 05.40 am : Born
- 1 hour after birth started to stand and walk
- 2 hours after birth started to milk



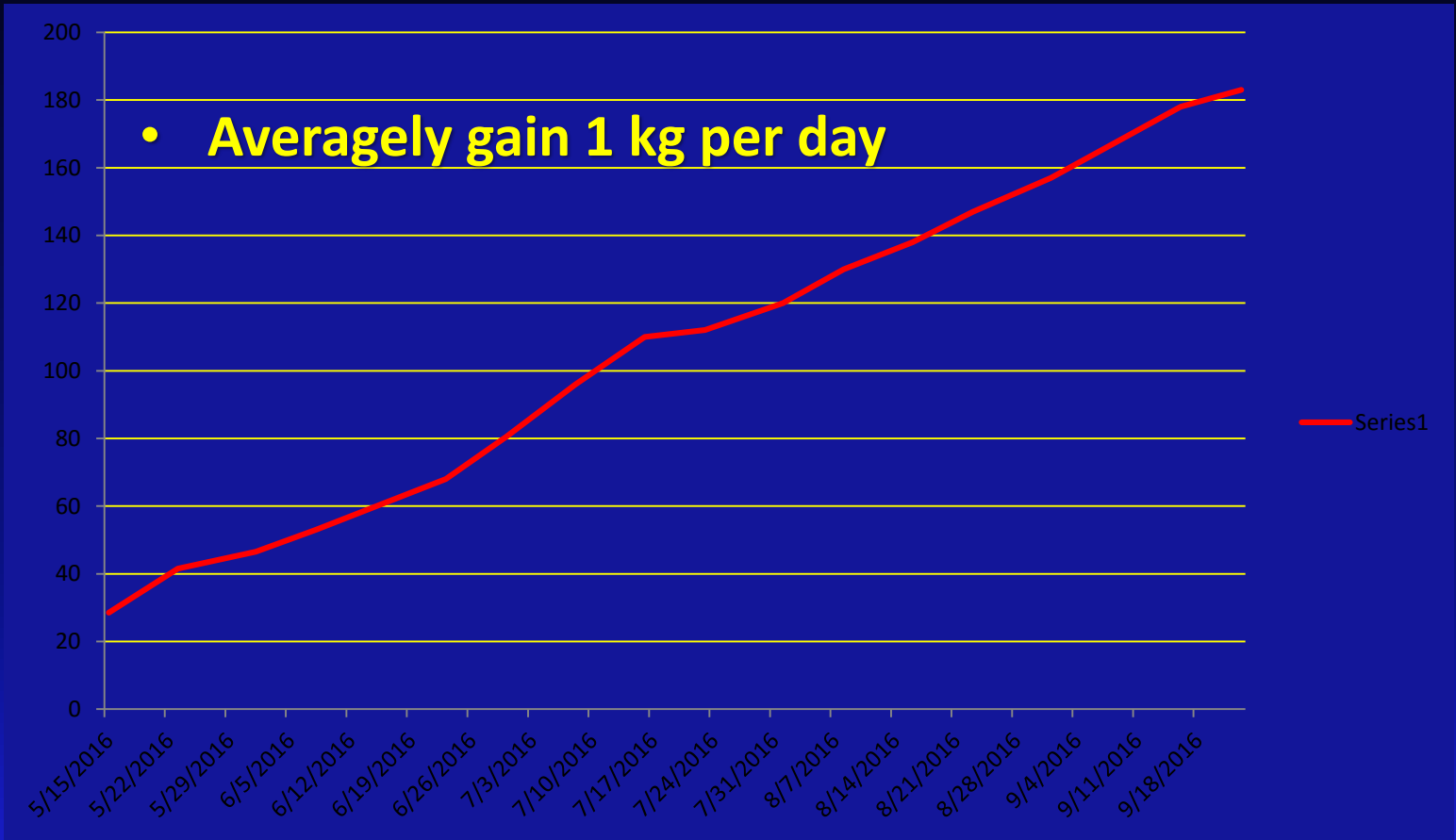
Parturition

Day 477th of Pregnancy



Calf Development

- First Urination within 24 hours after birth
- First Defecation 6 days old
- First tooth erupted 7 days old -> P1



Thank You!



Acoustic detection and monitoring as conservation tool ?

Angela S. Stoeger*

M. Zeppelzauer[+] & A. Baotic*

*Department of Cognitive Biology
University of Vienna
[+]In…

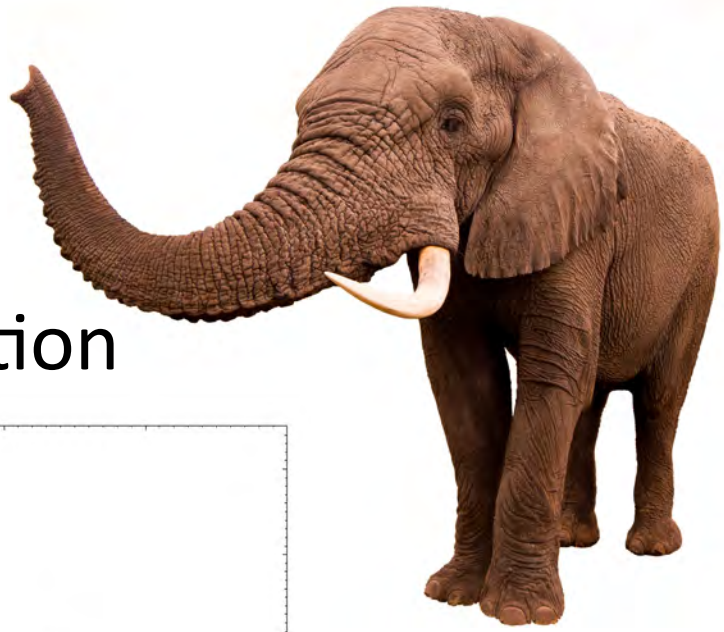


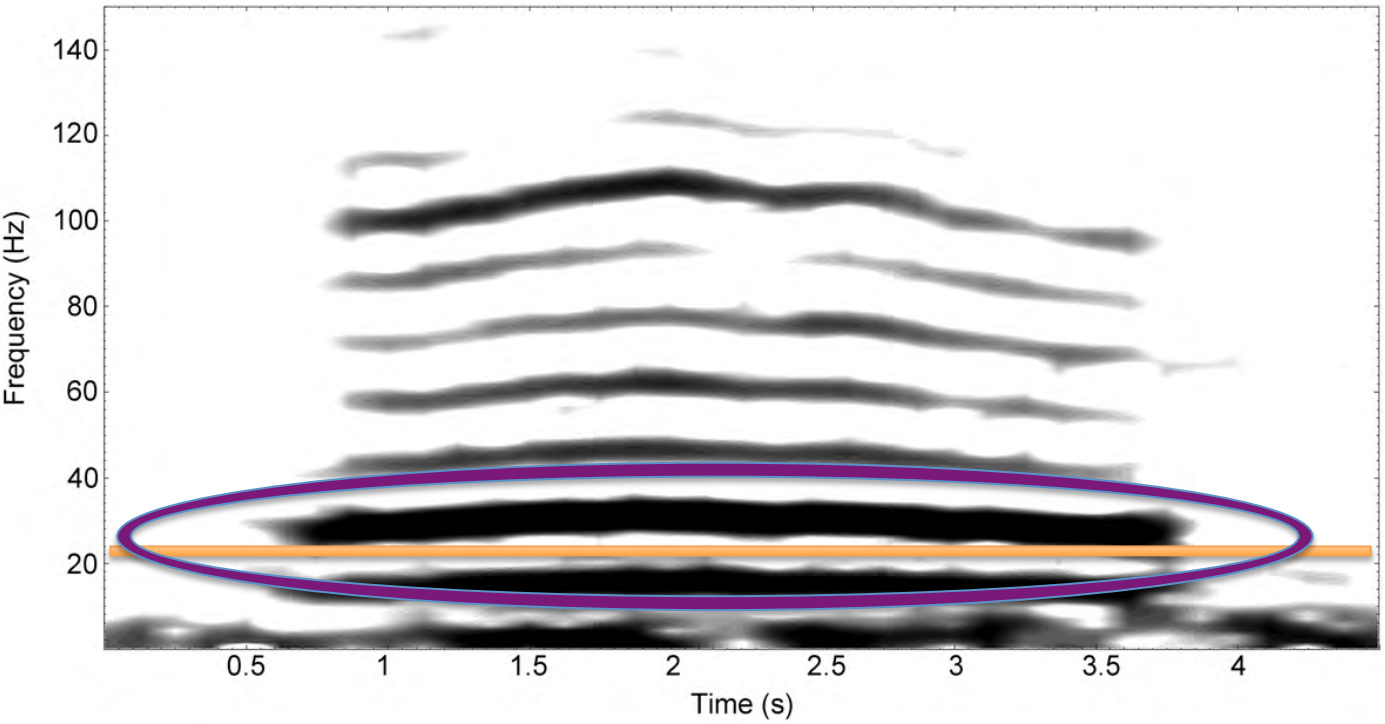
Acoustic detection and monitoring as conservation tool ?



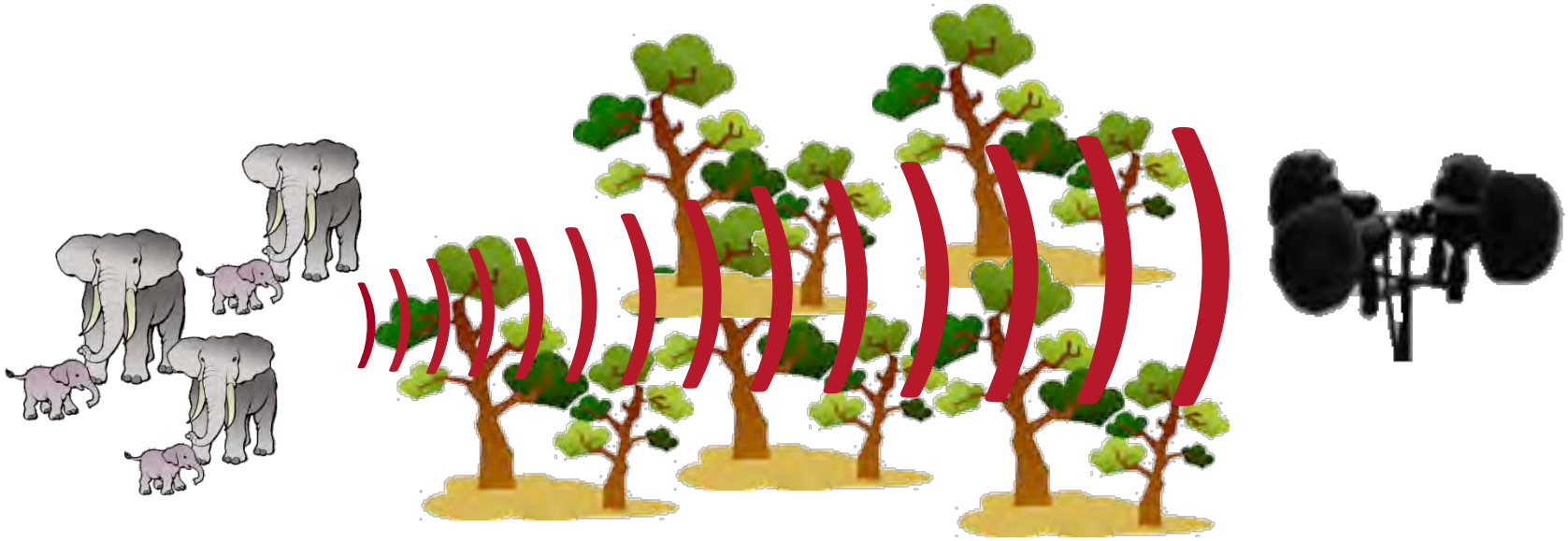
Elephant vocalizations: Overview

- Low-frequency rumbles
- Infrasonic range
- Long-distance communication





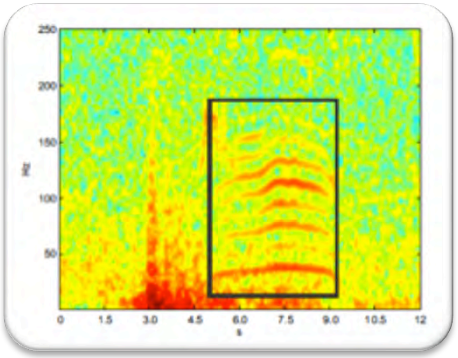
Acoustic detection and monitoring as conservation tool ?



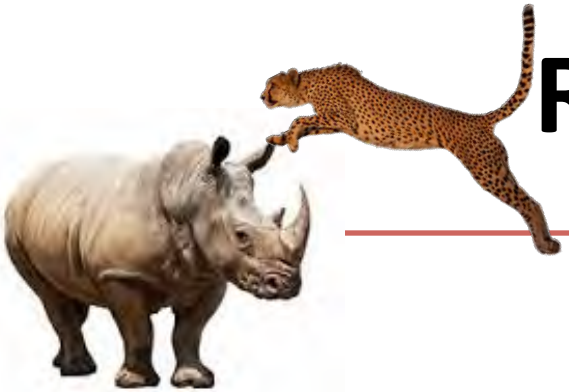
Call



Detection



Information / alarm

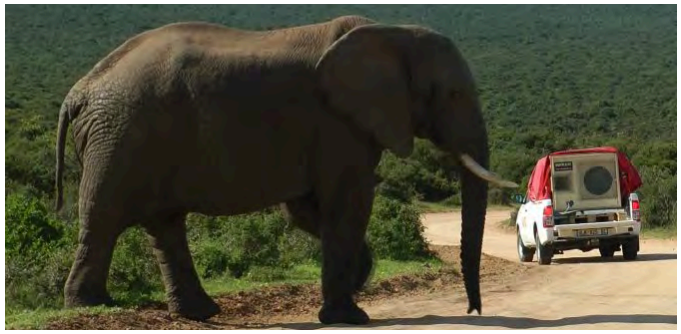


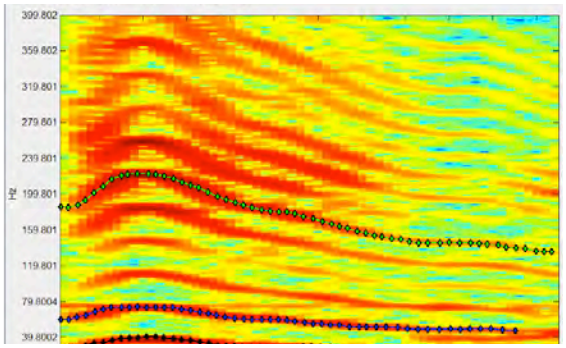
Research foci

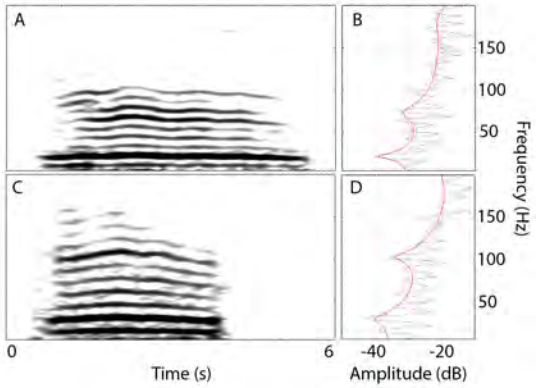




Information coding





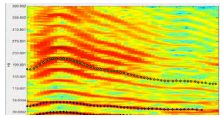
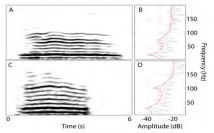




e.g. Stoeger & Baotic 2016, ***Scientific Reports***
Stoeger et al. 2014, ***Bioacoustics***

Research foci

Acoustic coding in mammal vocalizations


e.g. Stoeger & Baotic 2016, ***Scientific Reports***

Sound production

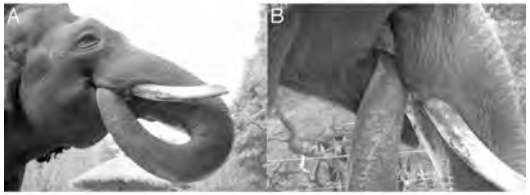
Larynx/Vocal tract
Sound structure




Stoeger et al. 2012, ***PlosOne***
Herbst & Stoeger et al. 2012, ***Science***

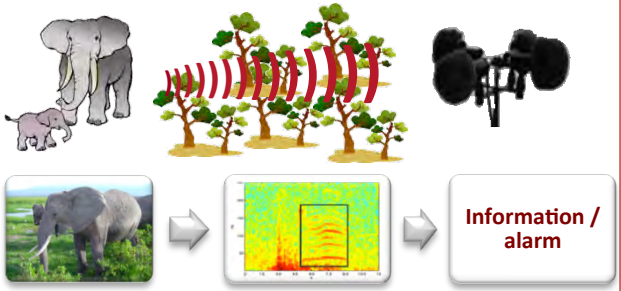
Vocal learning

Imitation and sound invention



Poole,Tyack,Stoeger et.al. 2005, ***Nature***
Stoeger et al.2012 ***Current Biology***
Stoeger & Manger *2014* ***Curr Opinon in Neurobiolology***

Conservation: automatic detection methods



Zeppelzauer & Stoeger 2015,
Bioacoustics and ***BMC Research Notes***

Using elephant acoustics for conservation

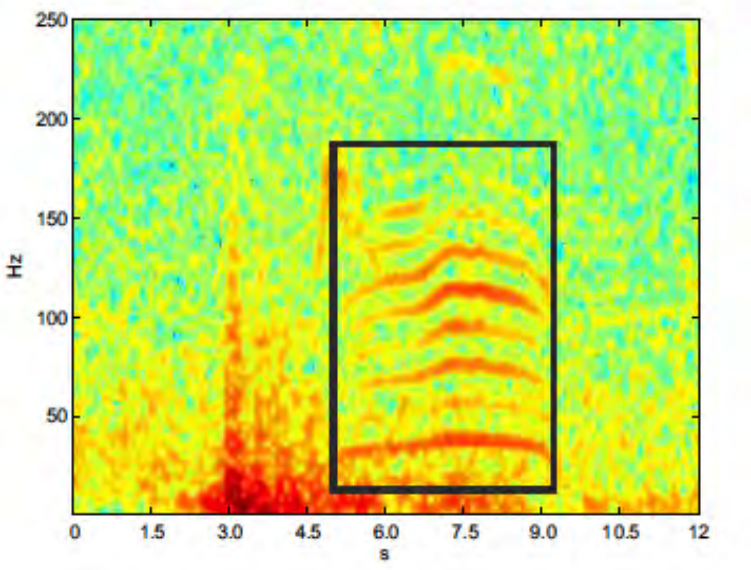
Requests:

- Call detection - acoustic early warning system
- Acoustic monitoring (e.g elephant abundance)
- Using sounds to influence spatial behavior
- Acoustic deterrents



Automatic call detection

Acoustic detection and early warning system: Requirements:



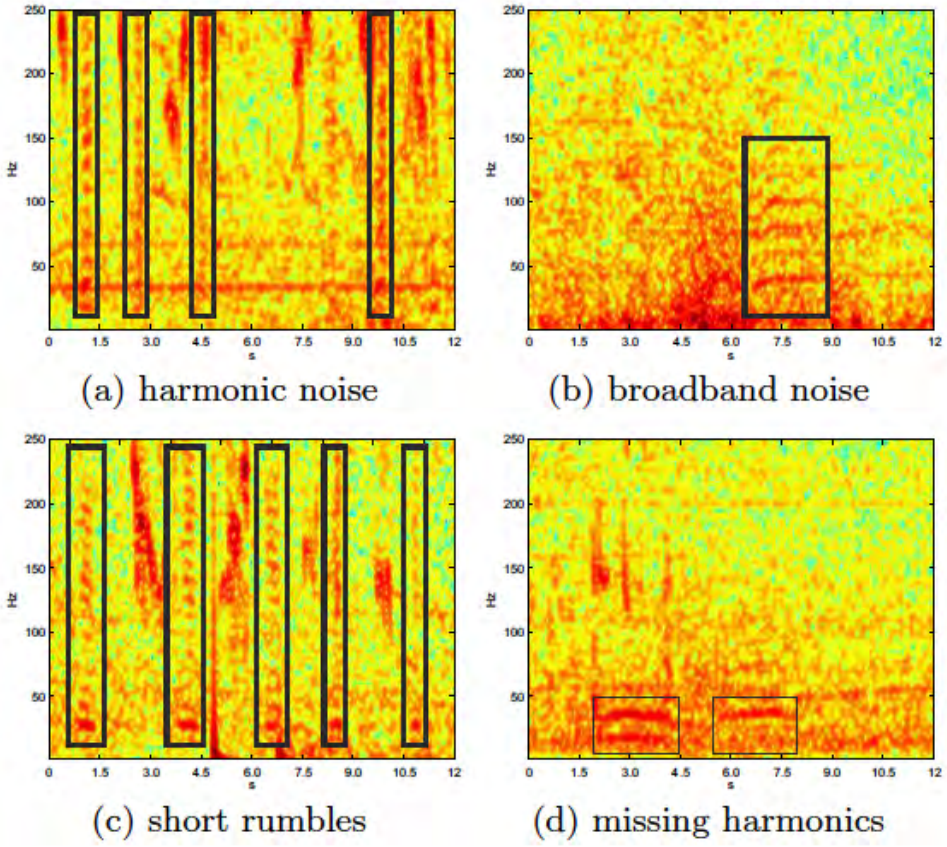
Methods to automatically detect elephant vocalizations

- Robust against natural variations
- Robust against environmental noise

Matthias Zeppelzauer, Sean Hensman & Angela S. Stoeger (2014): Towards an automated acoustic detection system for free-ranging elephants, Bioacoustics, DOI: 10.1080/09524622.2014.906321

Automatic call detection

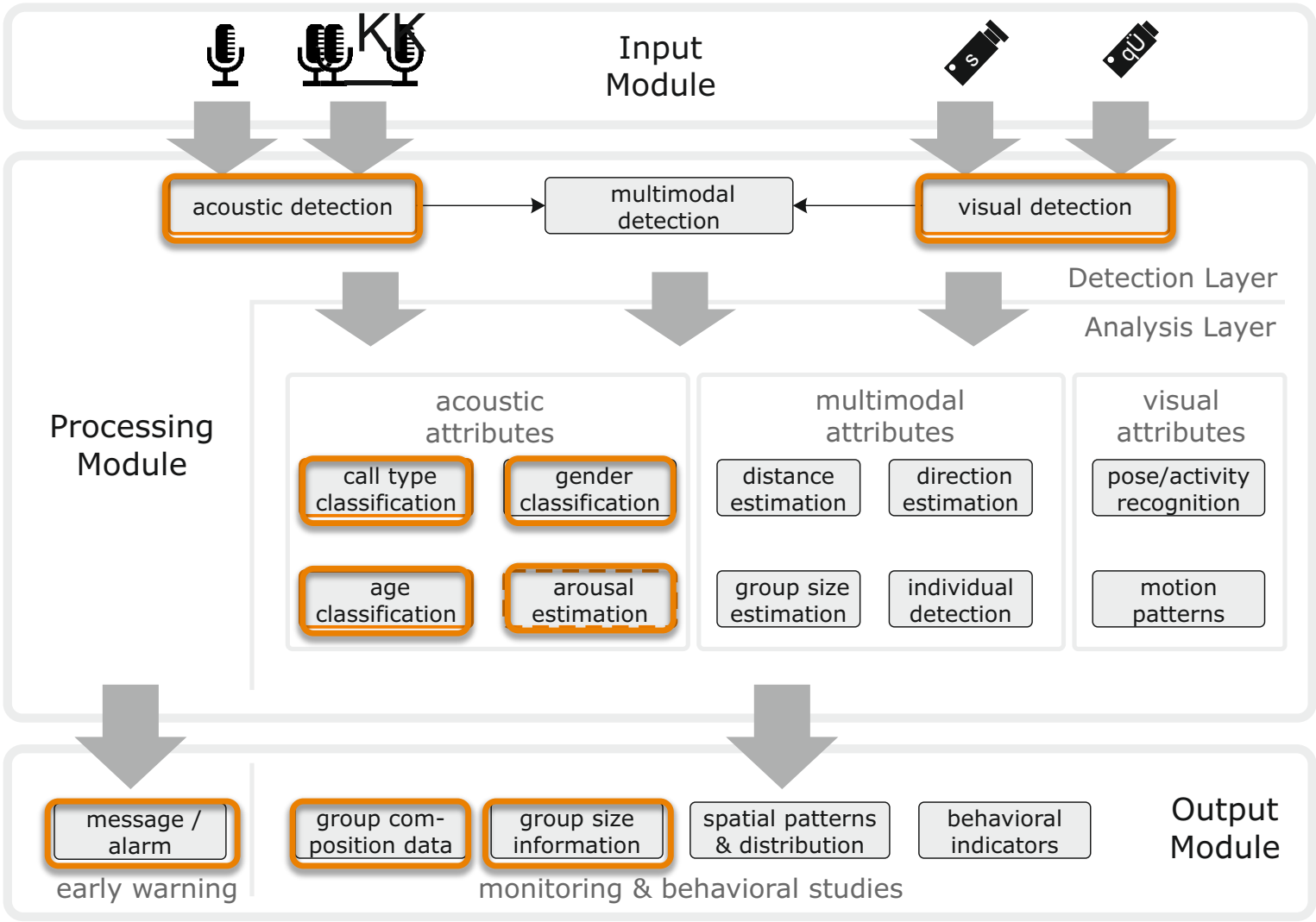
Rumble detection besides various disturbing environmental sounds





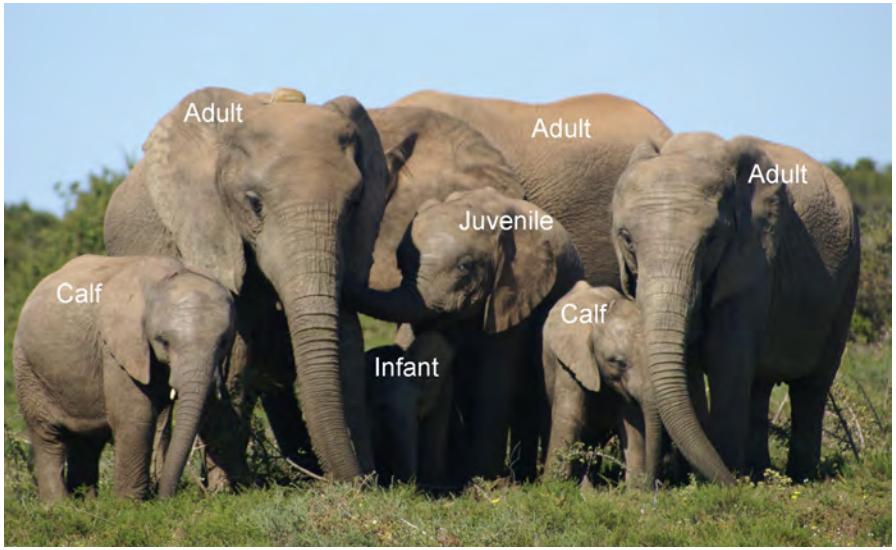
Matthias Zeppelzauer, Sean Hensman & Angela S. Stoeger (2014): Bioacoustics, DOI: 10.1080/09524622.2014.906321

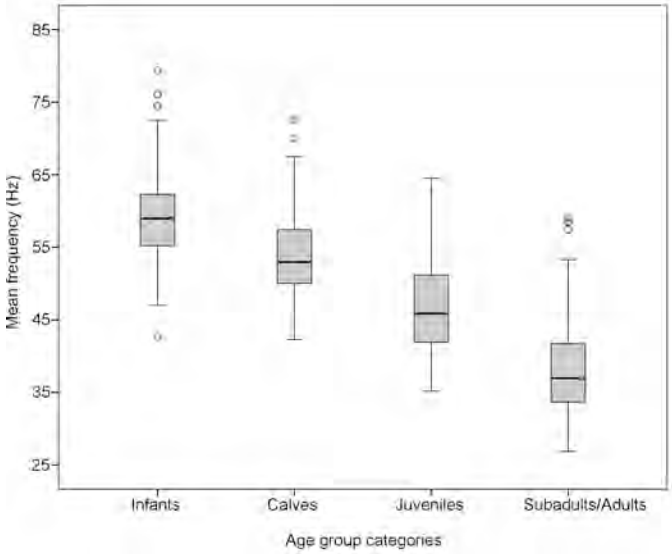
Automatic call detection

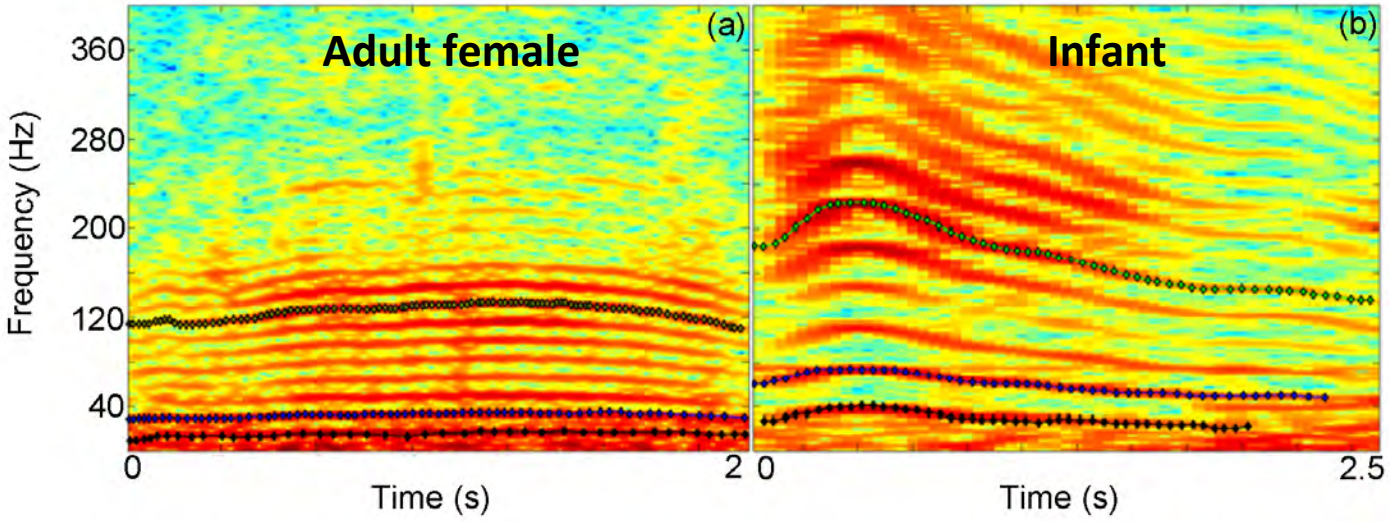


Information content

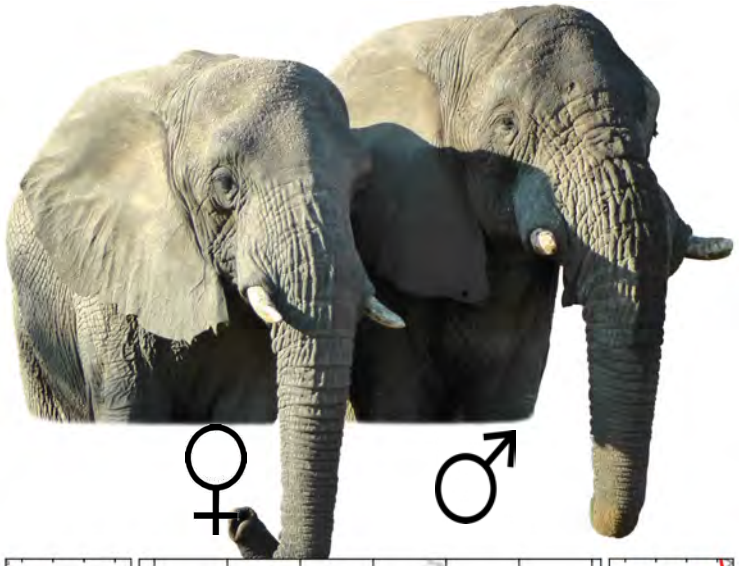
Age groups Stoeger et al. 2014 *Bioacoustics*

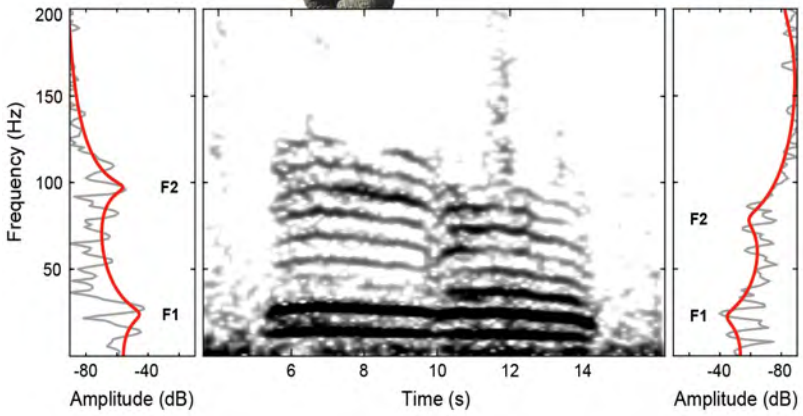


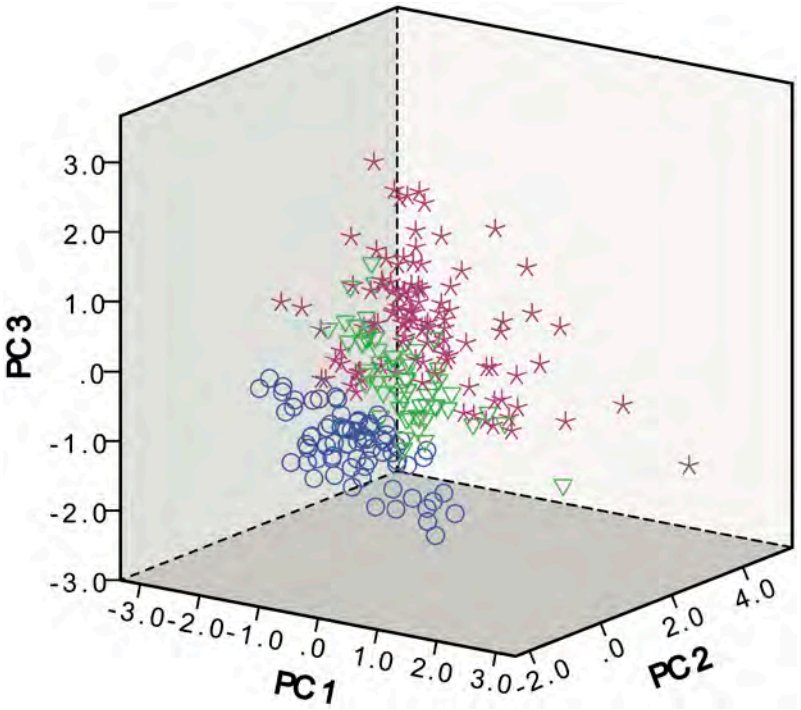




Detection of sex







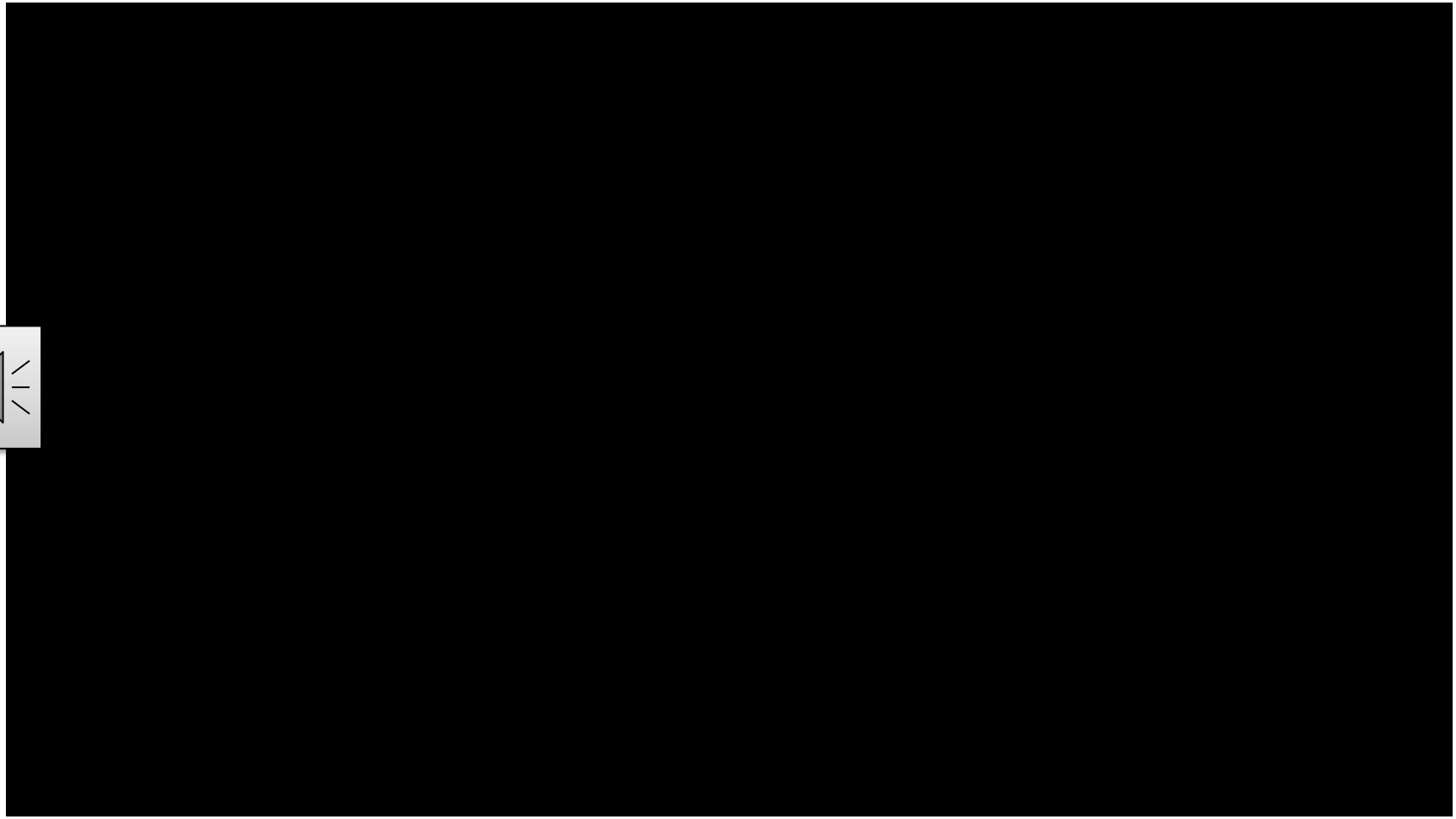
★ Females
○ Males mg2
▽ Males mg1

Acoustic deterrents: vocalization

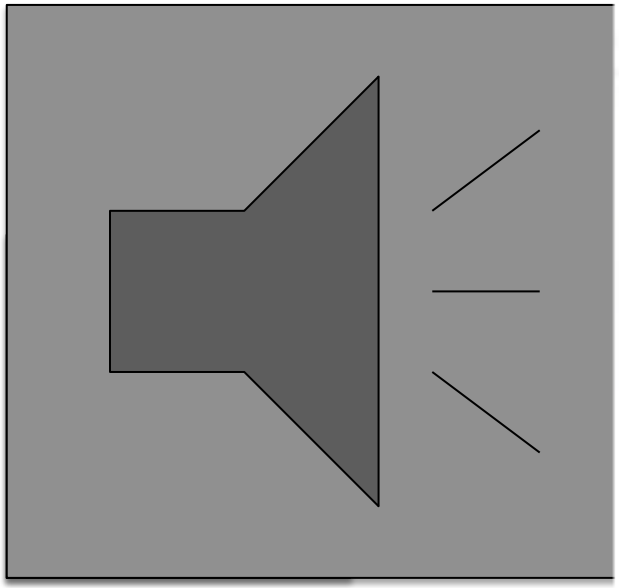


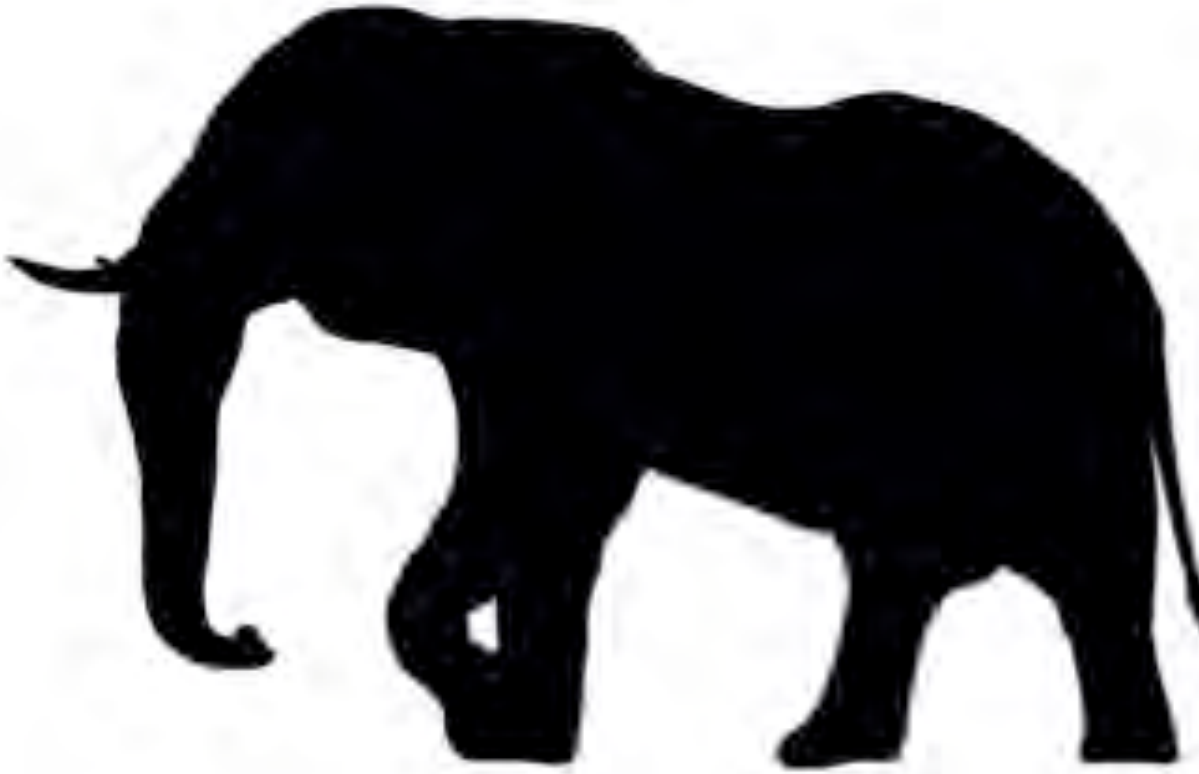
- Bee sound (King & Soltis 2010)
- Predators (? – talk tomorrow….)
- PROBLEM: **HABITUATION**

Acoustic attraction: vocalization



Acoustic deterrents: vocalization





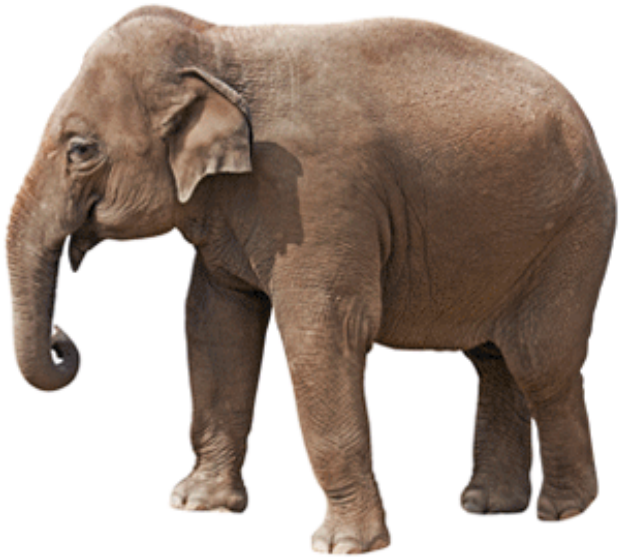
Infrasound production

Acoustic detection and monitoring as conservation tool ?

Most promising:

1. Automatic detection of elephant vocalizations
2. Detect poaching activities







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FWF
Der Wissenschaftsfonds.

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Automatic Elephant Detection

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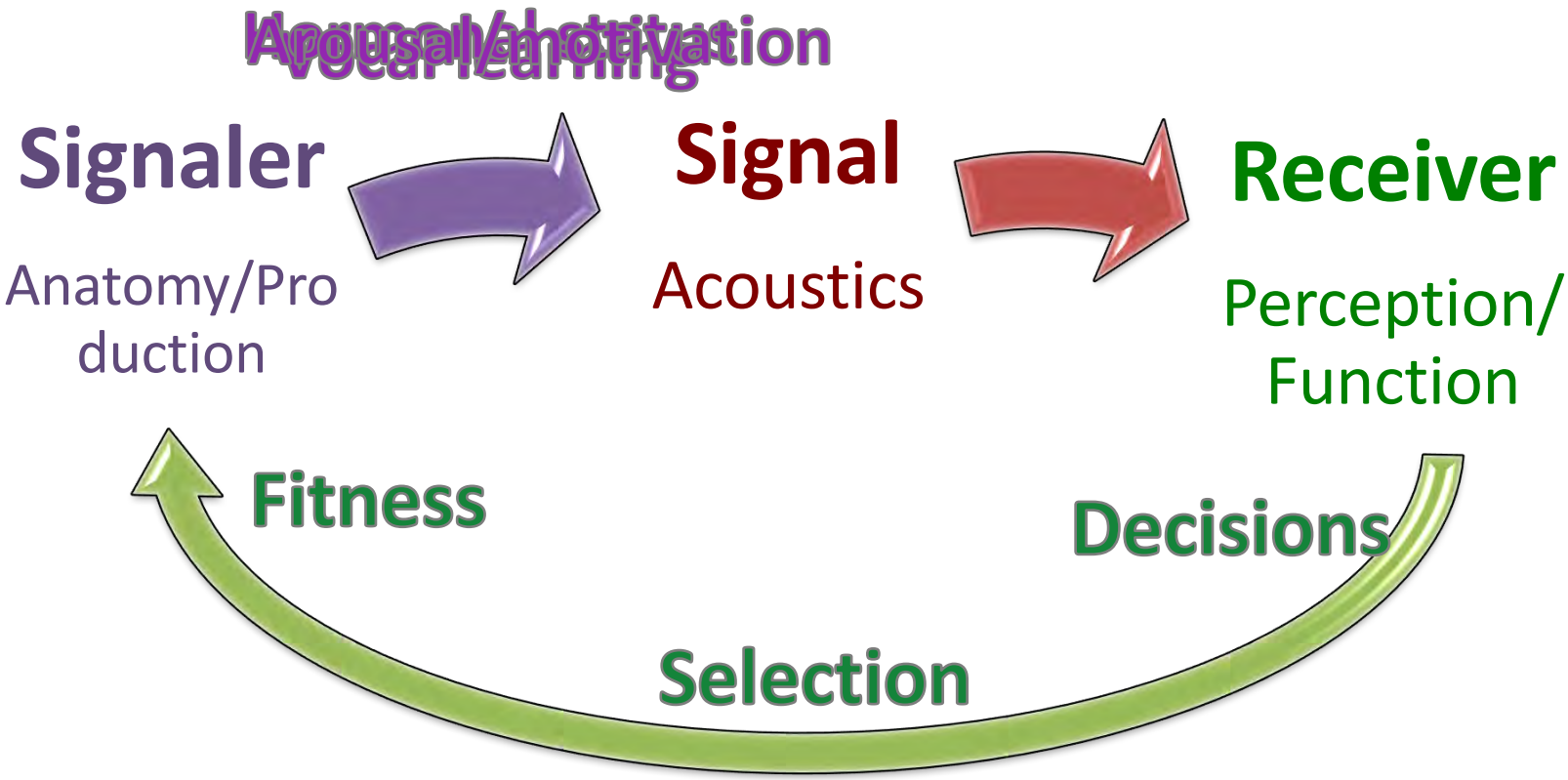
Aspects of vocal communication





WHAT ELEPHANT RUMBLES TELL US ABOUT THE SENDER?

Anton Baotic & Angela S. Stoeger

Mammal Communication Lab

CORE FACTS

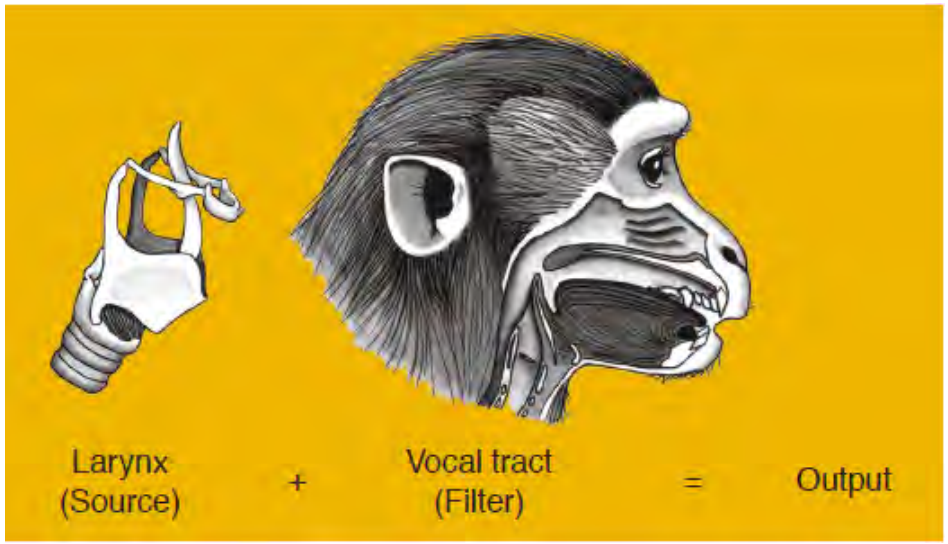
- Elephants are highly social animals
- Highly developed vocal communication system
- Variety of vocalizations
- Low-frequency rumbles
- Short- long-distance communication

How do elephants produce vocalizations?

SOUND PRODUCTION IN MAMMALS

Mechanisms for sound production determine acoustic output.

How sounds are produced: The source and filter theory



(Fitch, 2000)

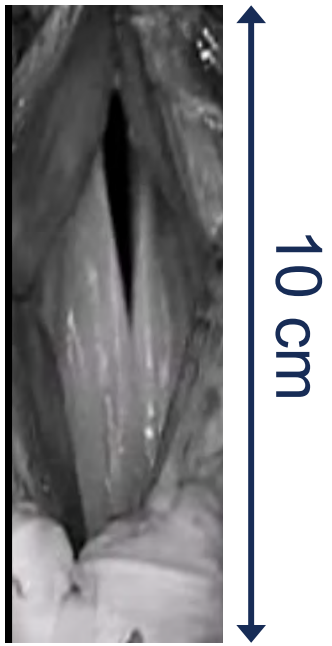
- **Sound source**: Larynx
- **Vocal tract** acts like a filter, amplifying certain frequencies = vocal tract resonance frequencies or 'formants'

Formants are determined by the anatomy/shape of the vocal tract.

SOUND PRODUCTION IN AFRICAN ELEPHANTS

Elephant vocal folds

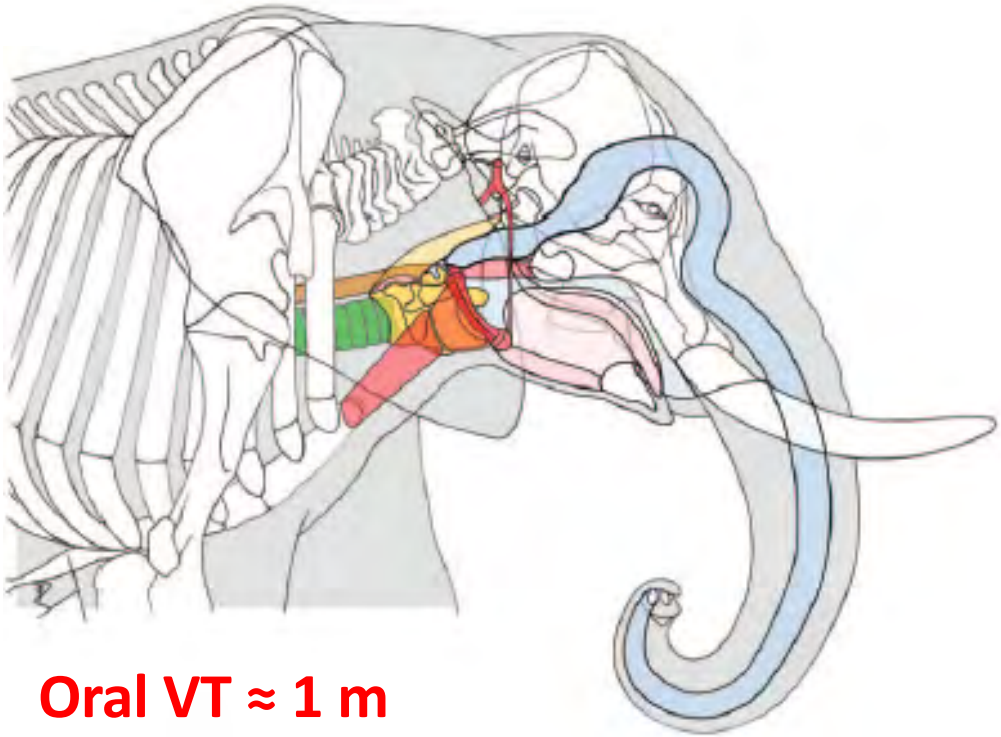
Herbst & Stoeger et al. 2012, *Science*



Pitch: 16 Hz

Vocal tract (VT)

Herbst & Stoeger et al. 2012, *Science*

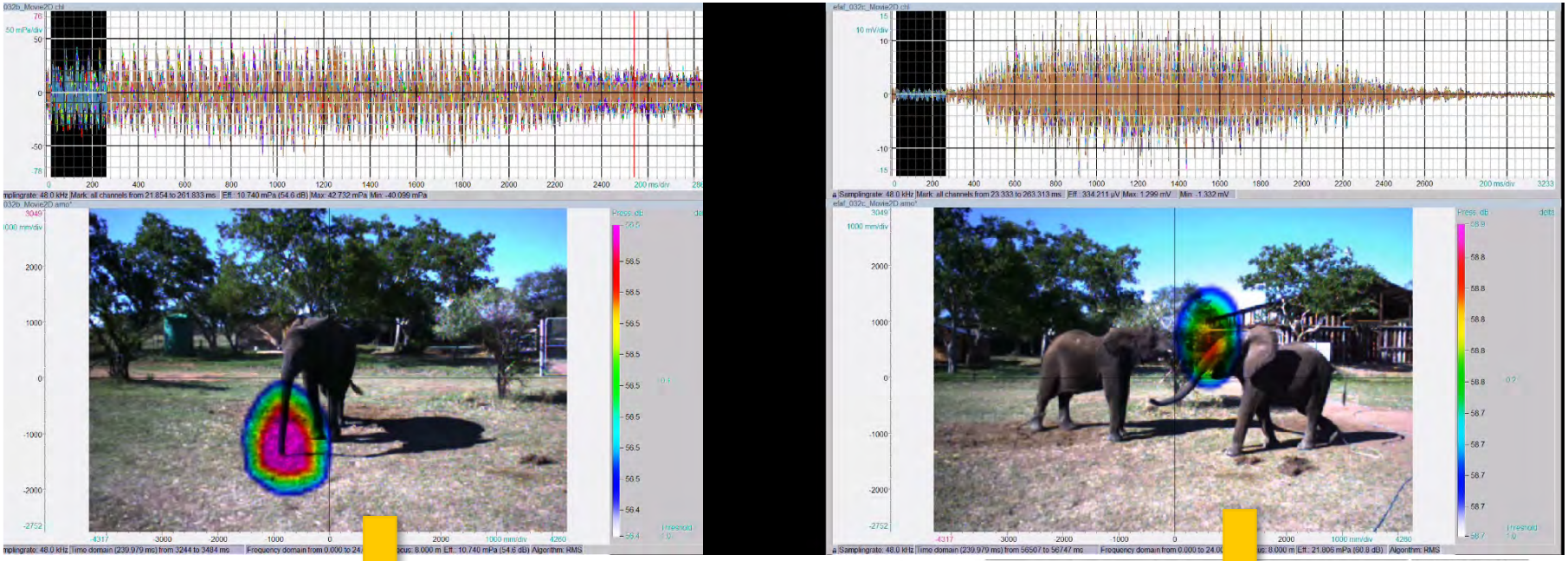


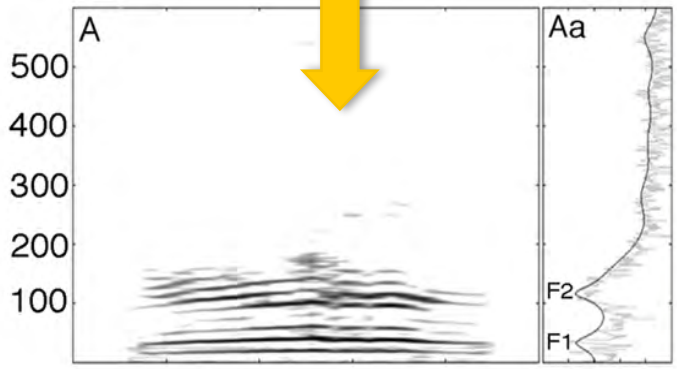
Oral VT ≈ 1 m

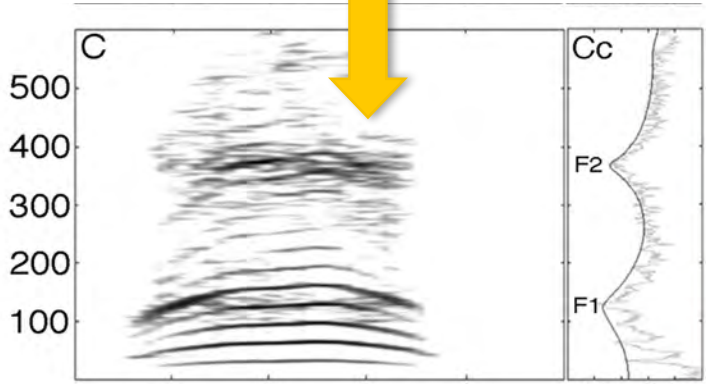
Nasal VT ≈ 2.5m

SOUND PRODUCTION IN AFRICAN ELEPHANTS

”slow motion”

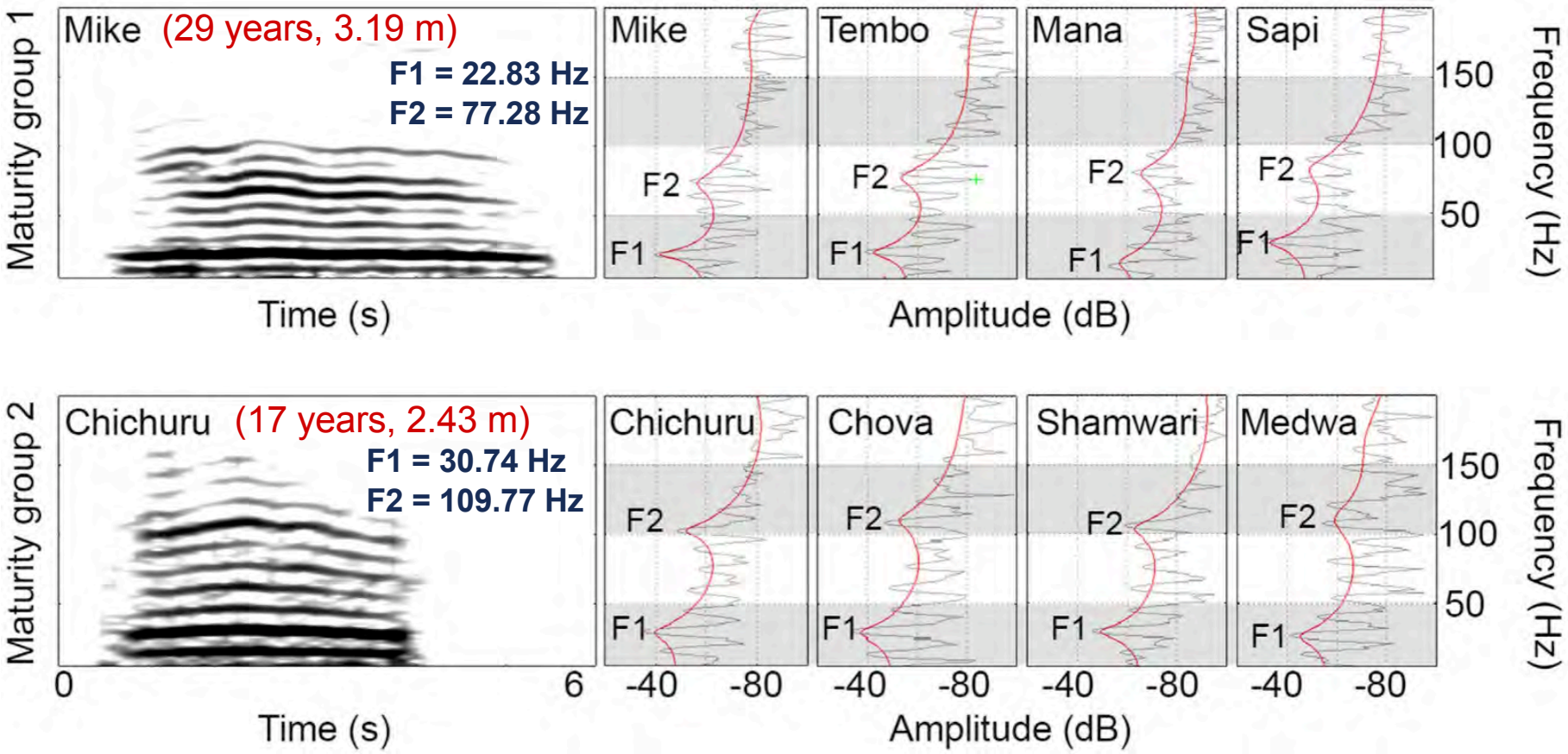






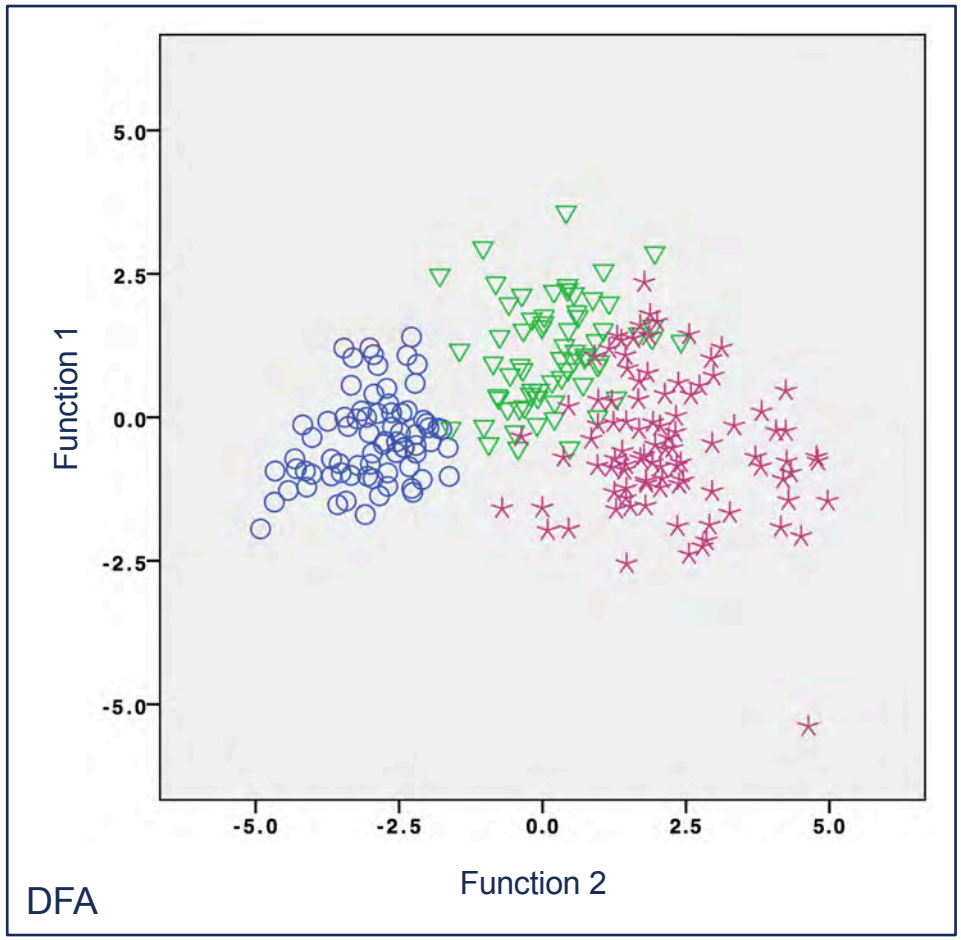
ACOUSTIC CUES TO MATURITY IN MALE AFRICAN ELEPHANTS

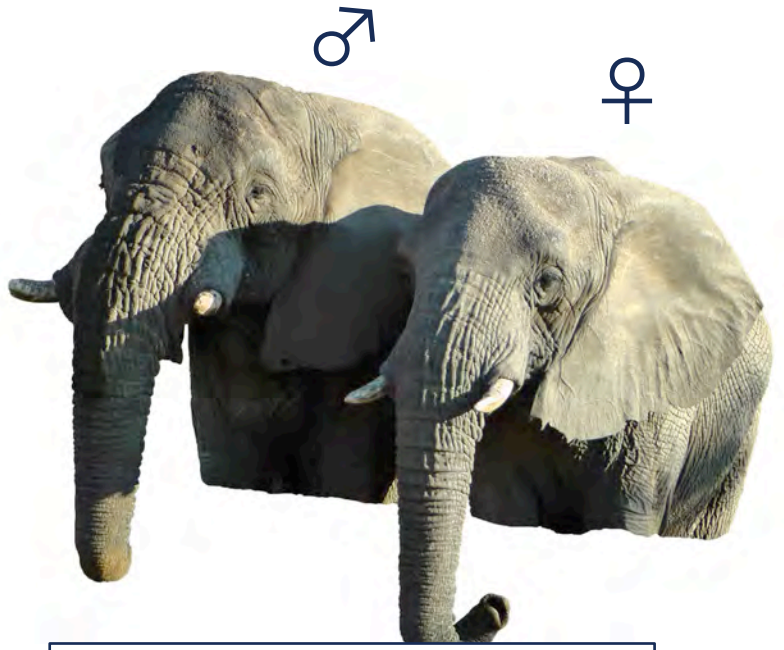
Stoeger and Baotic 2016, *Scientific reports*



ACOUSTIC CUES TO SEX IN AFRICAN ELEPHANTS

Baotic and Stoeger 2016, *submitted*





- Females
- Males (> 3 meters)
- Males (< 3 meters)

ADAPTIVE SIGNIFICANCE

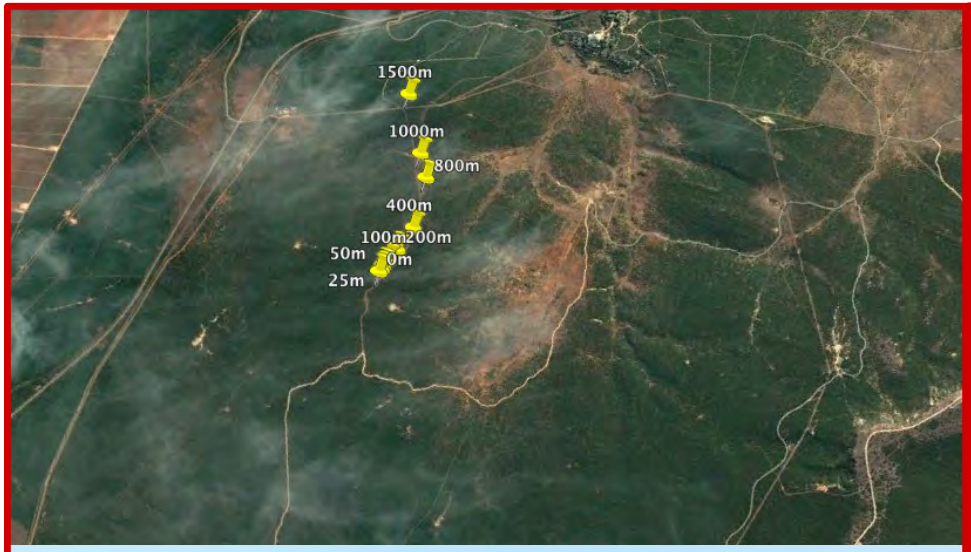
Unknown, whether low formants in nasal rumbles..

- reflect sexual (or other social) selection pressures to sound larger?
- **reflect natural selection pressures to maximize call propagation distances?**

ADDO ELEPHANT NATIONAL PARK, SA

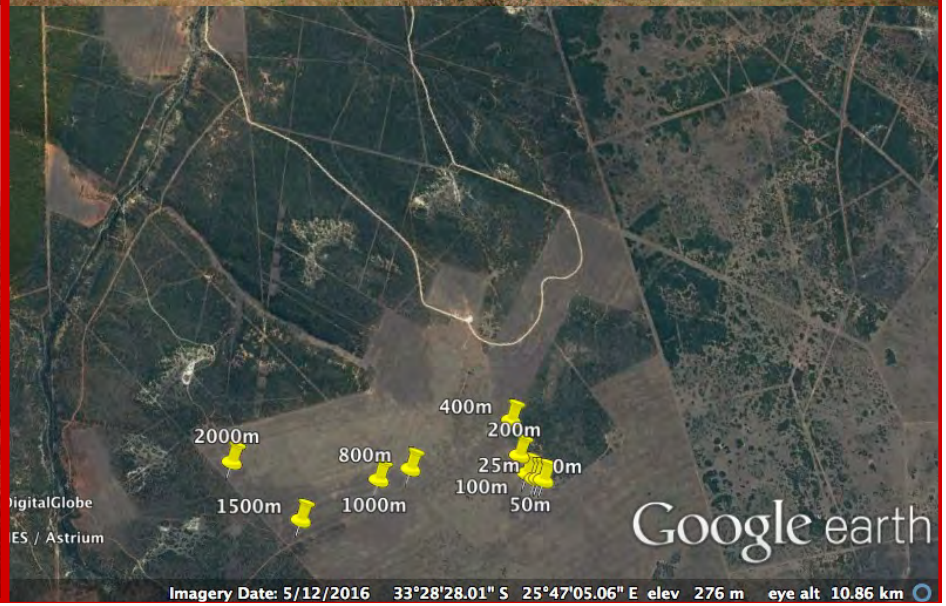


PROPAGATION EXPERIMENTS

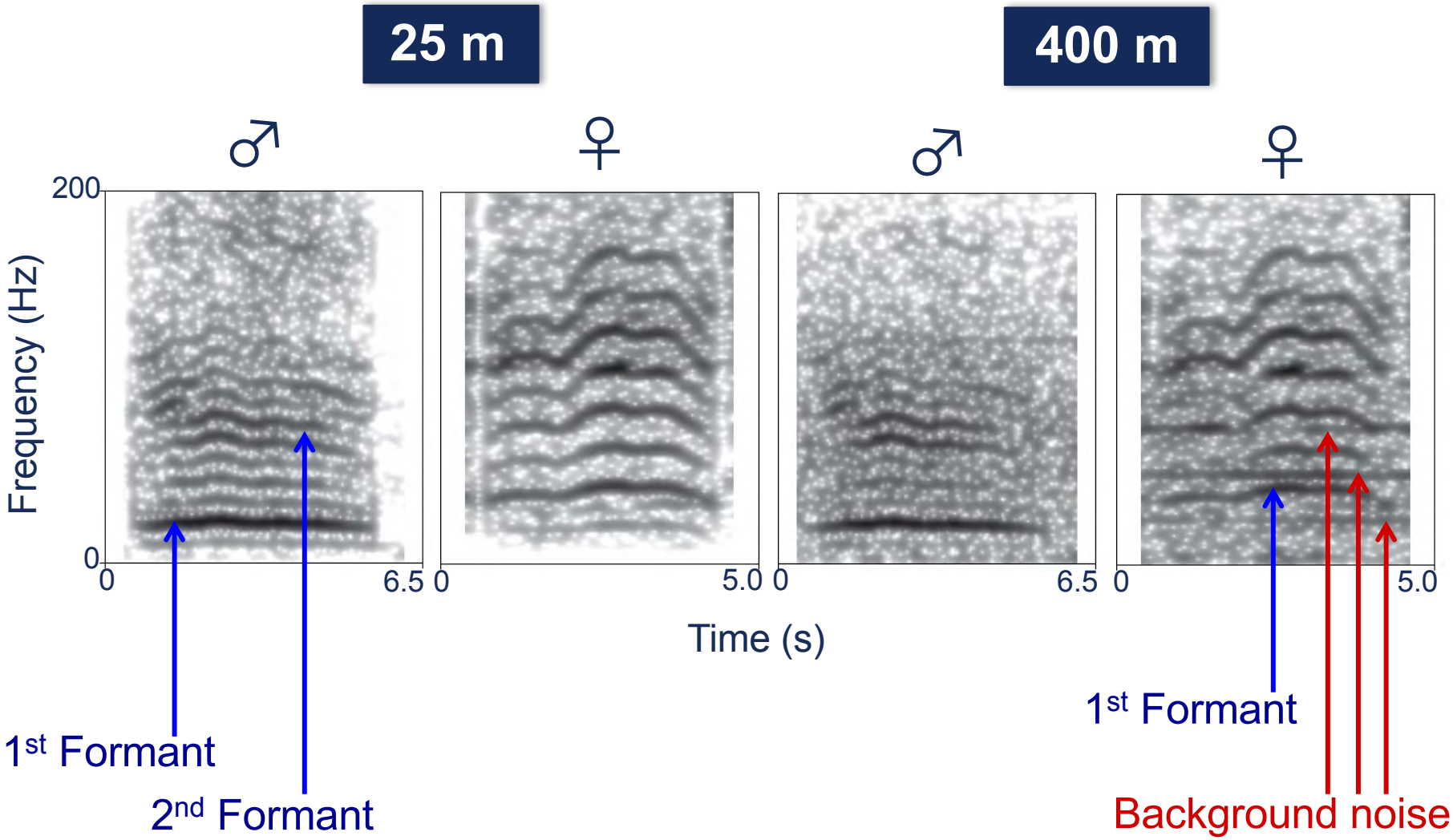




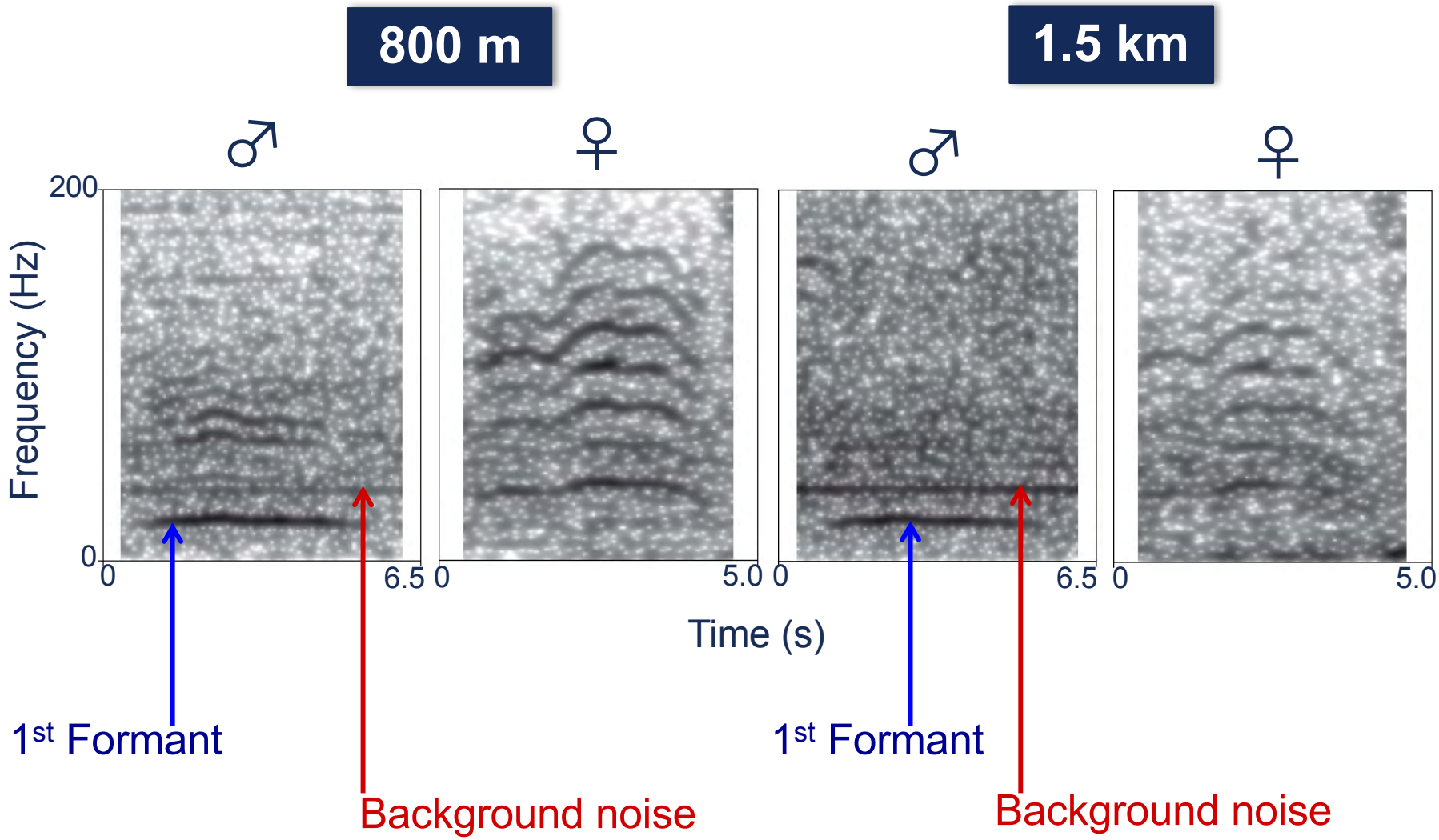




SOUND PROPAGATION

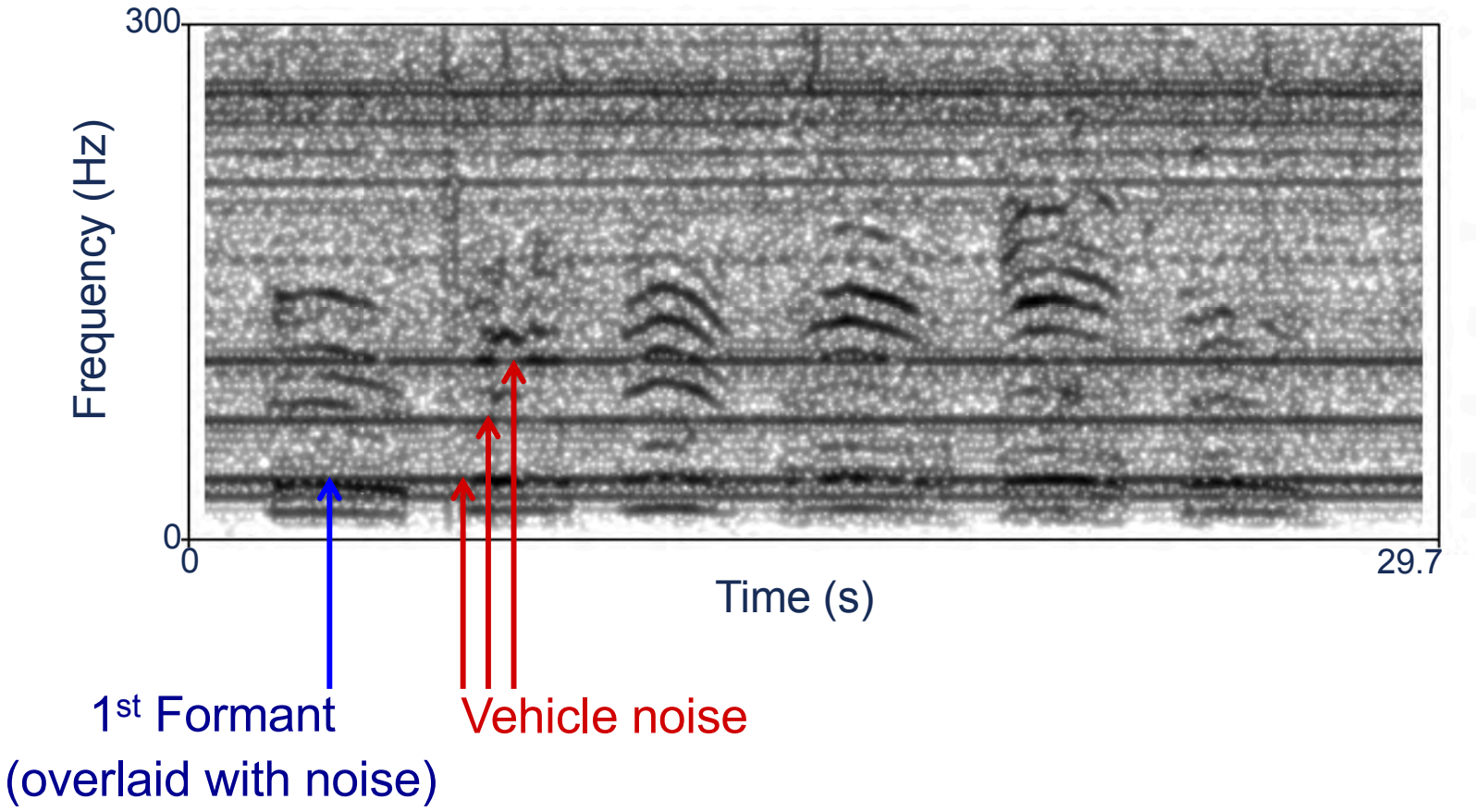


SOUND PROPAGATION



ANTHROPOGENIC NOISE POLLUTION

- Increased noise levels inhibit perception of sound.



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FWF Der Wissenschaftsfonds.

COGBIO Department of Cognitive Biology

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White rhino olfactory communication and the potential for odour manipulation

Courtney Marneweck[1], Andreas Jürgens[1,2] & Adrian M. Shrader[1]

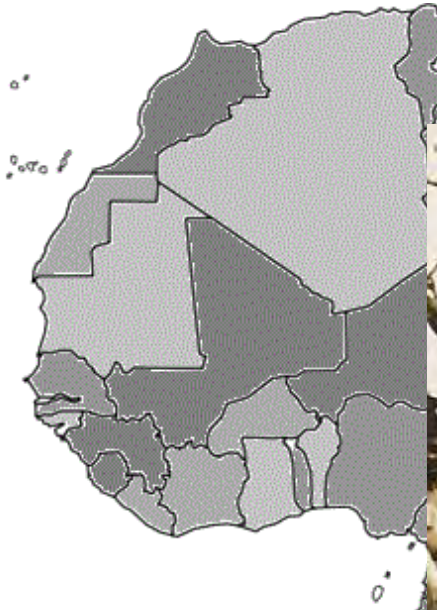
[1] University of KwaZulu-Natal, South Africa
[2] Technische Universität Darmstadt, Germany

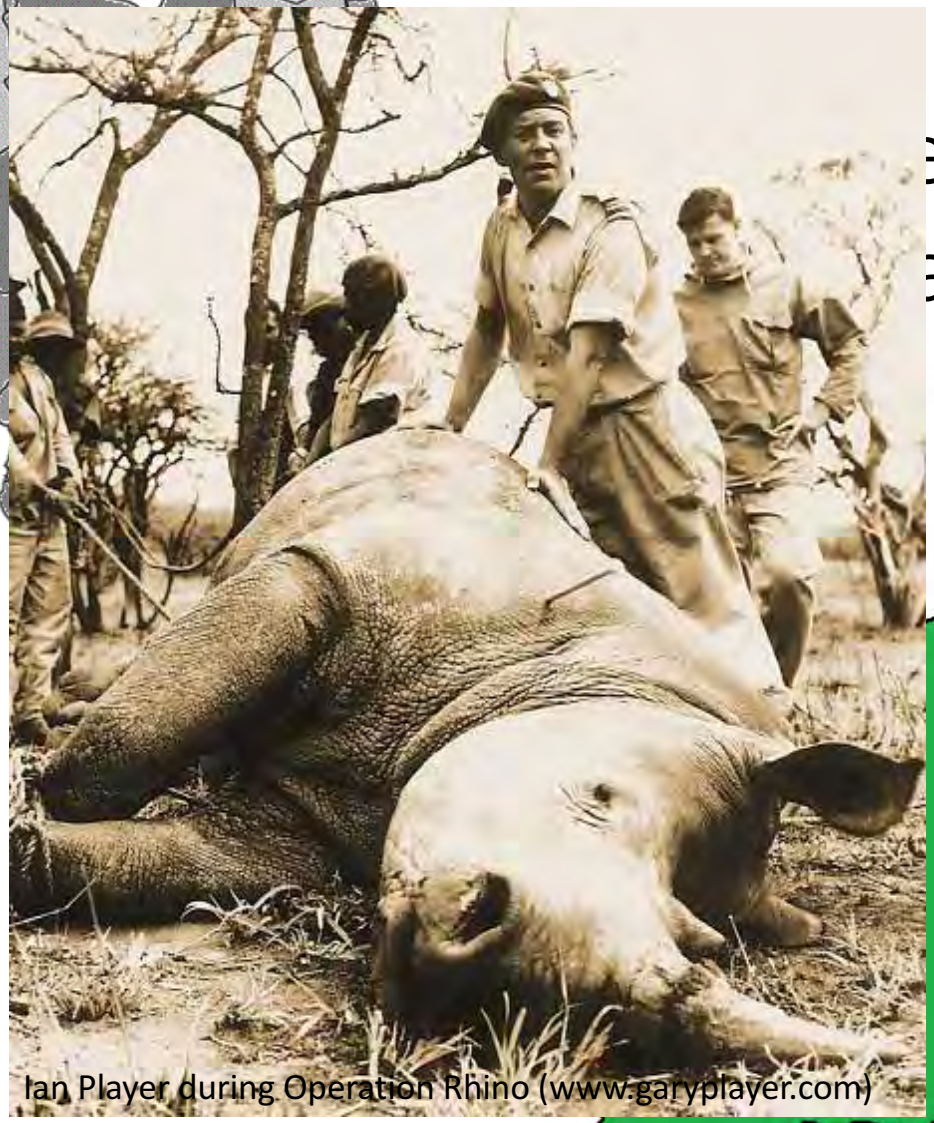


Characteristics of age, sex, territorial and oestrous state



Operation Rhino

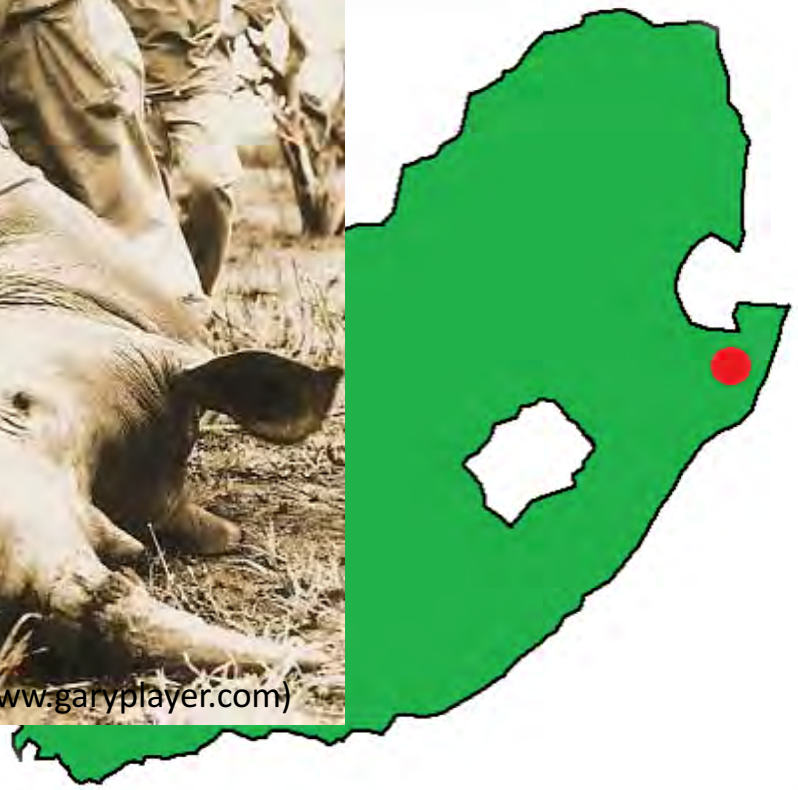




Ian Player during Operation Rhino (www.garyplayer.com)

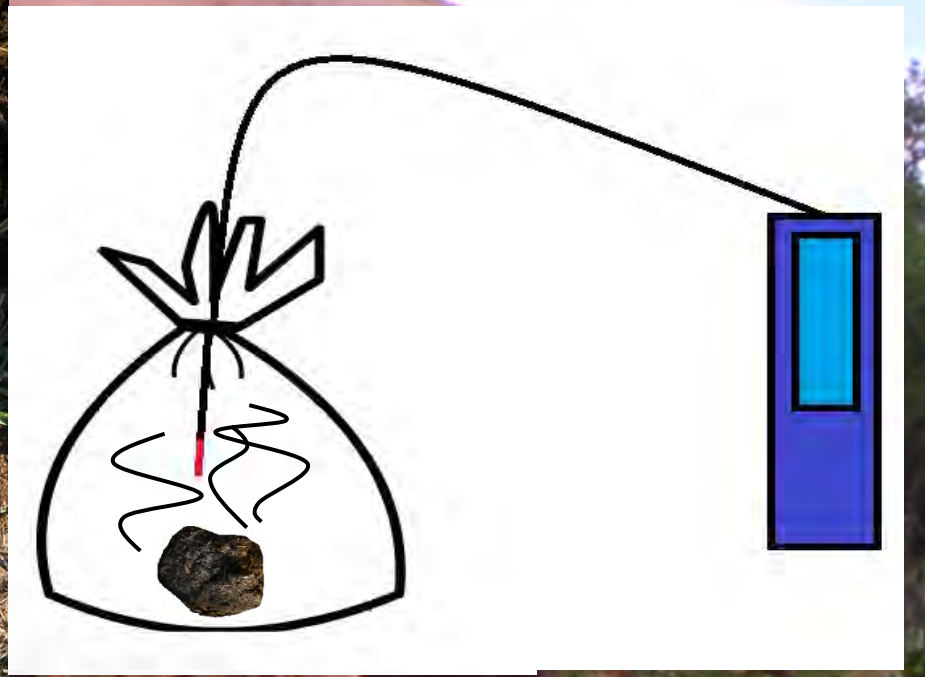
e-iMfolozi

ark



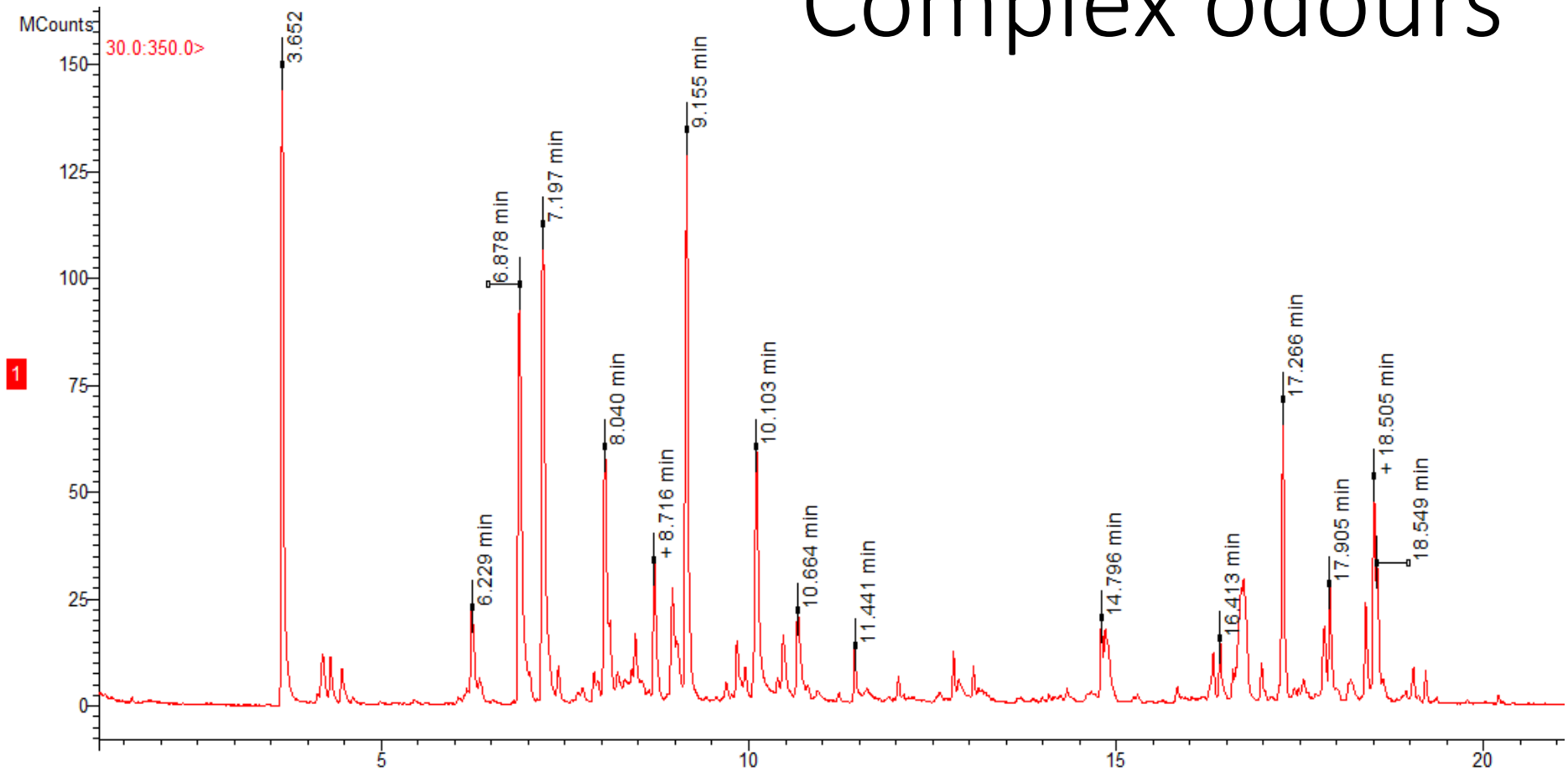




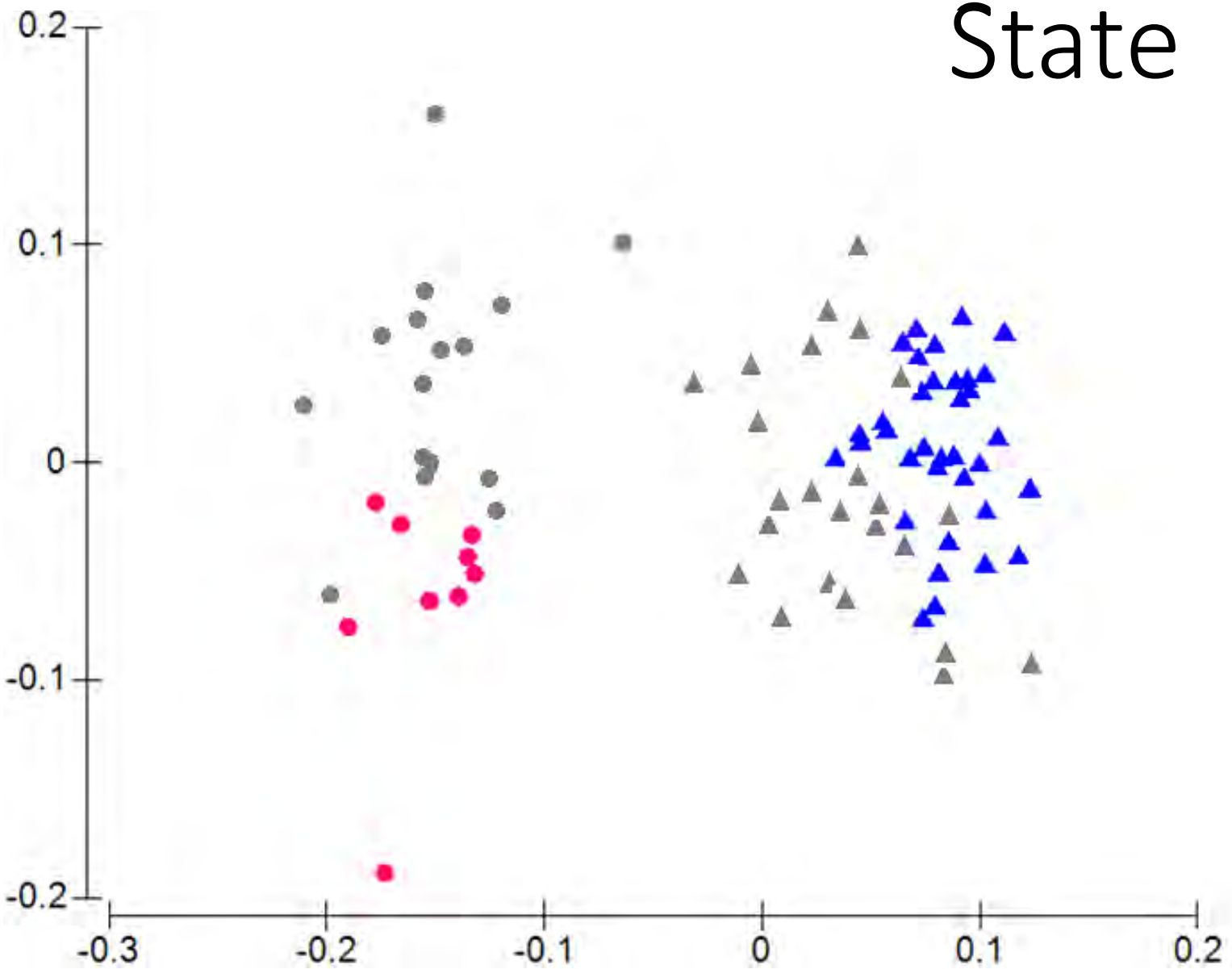


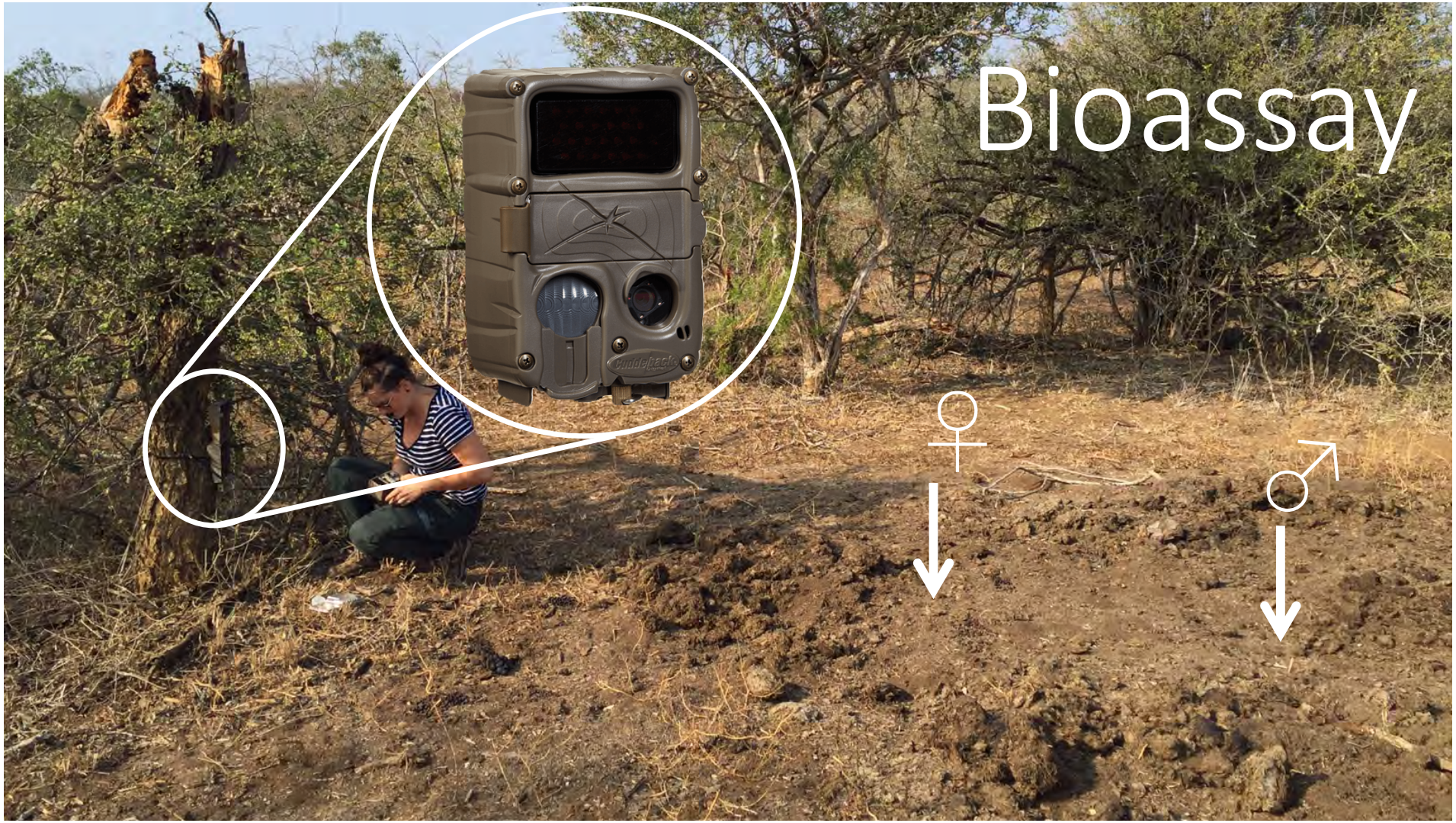


Complex odours

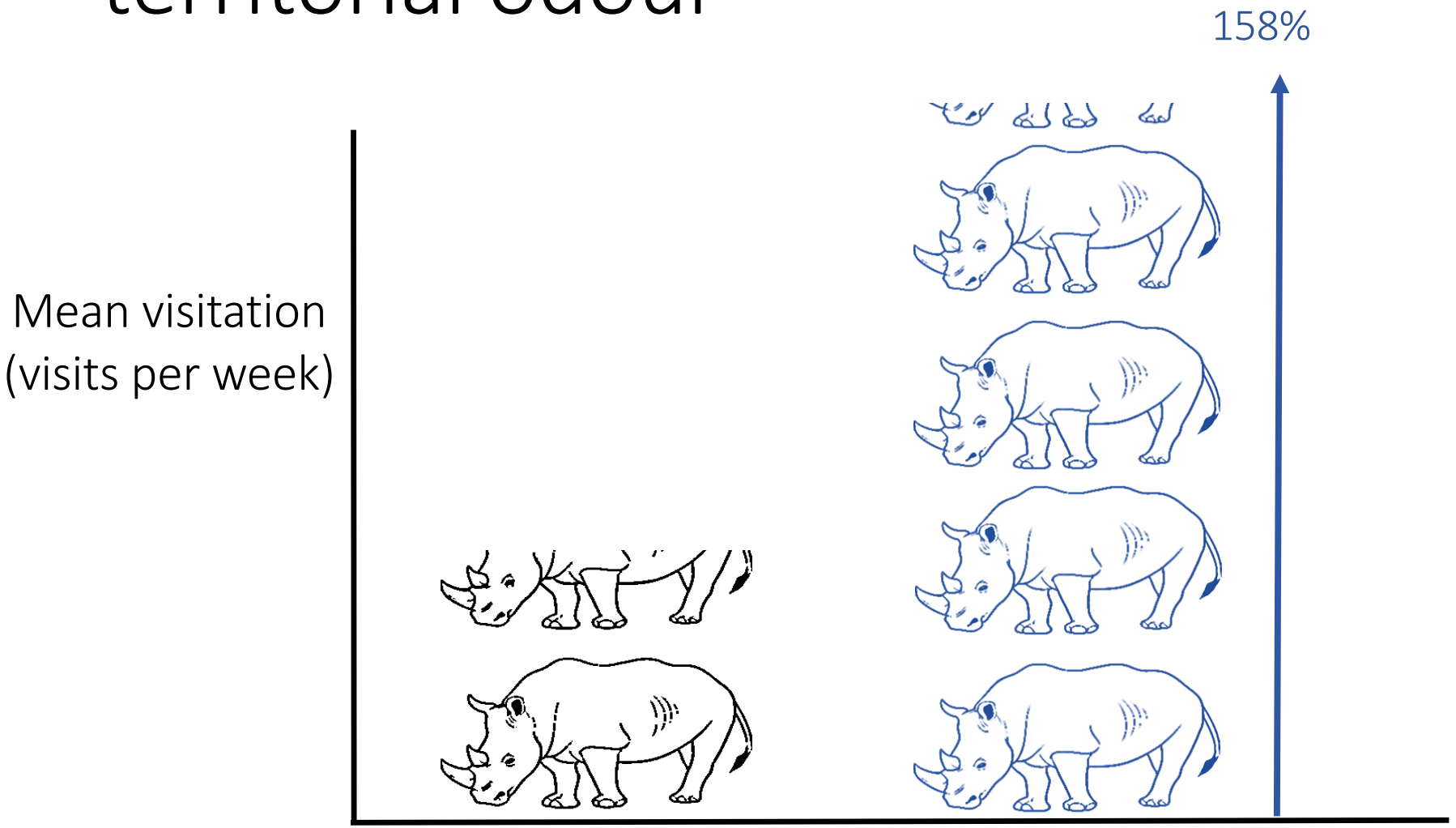


State

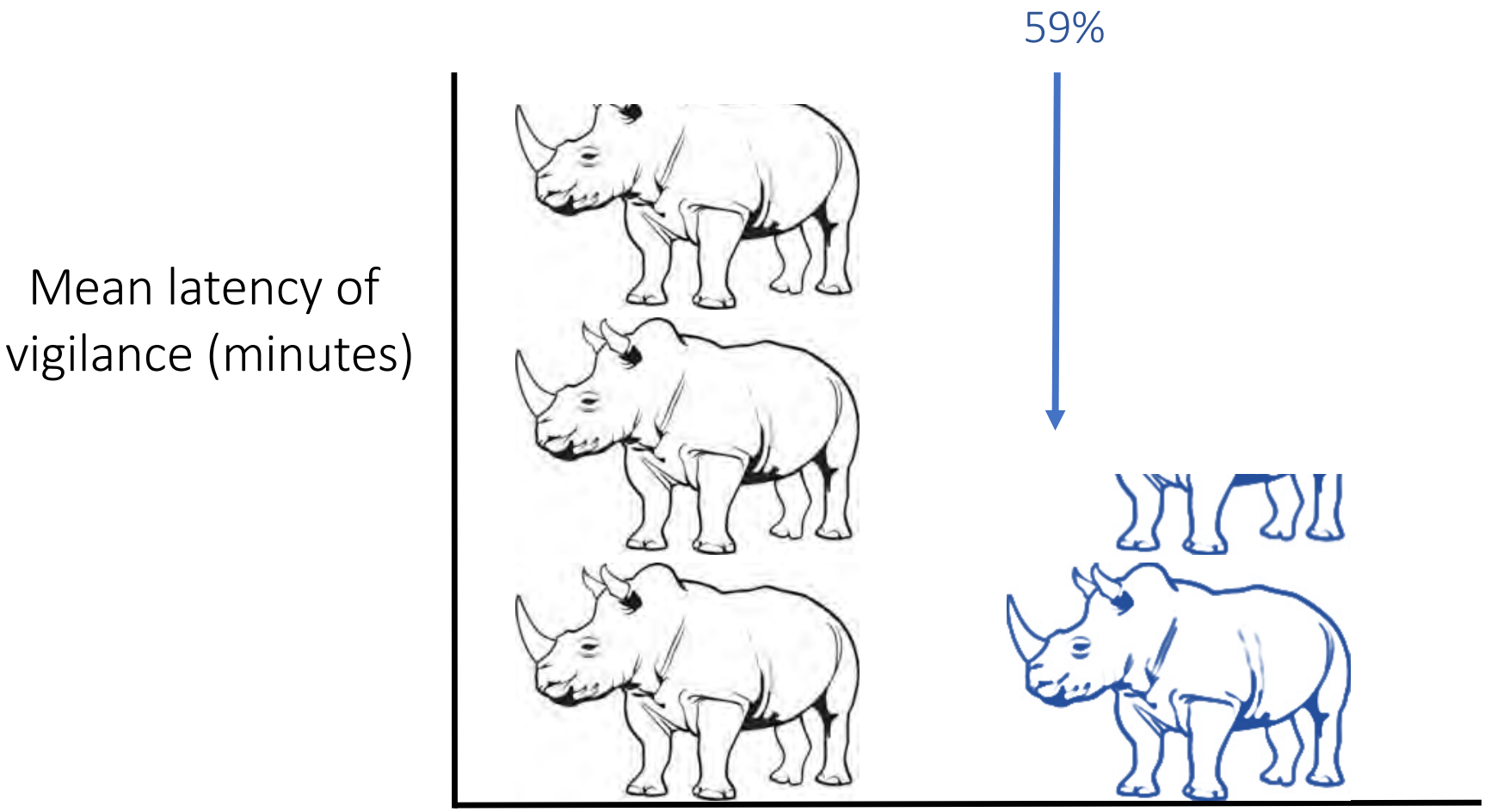



Bioassay

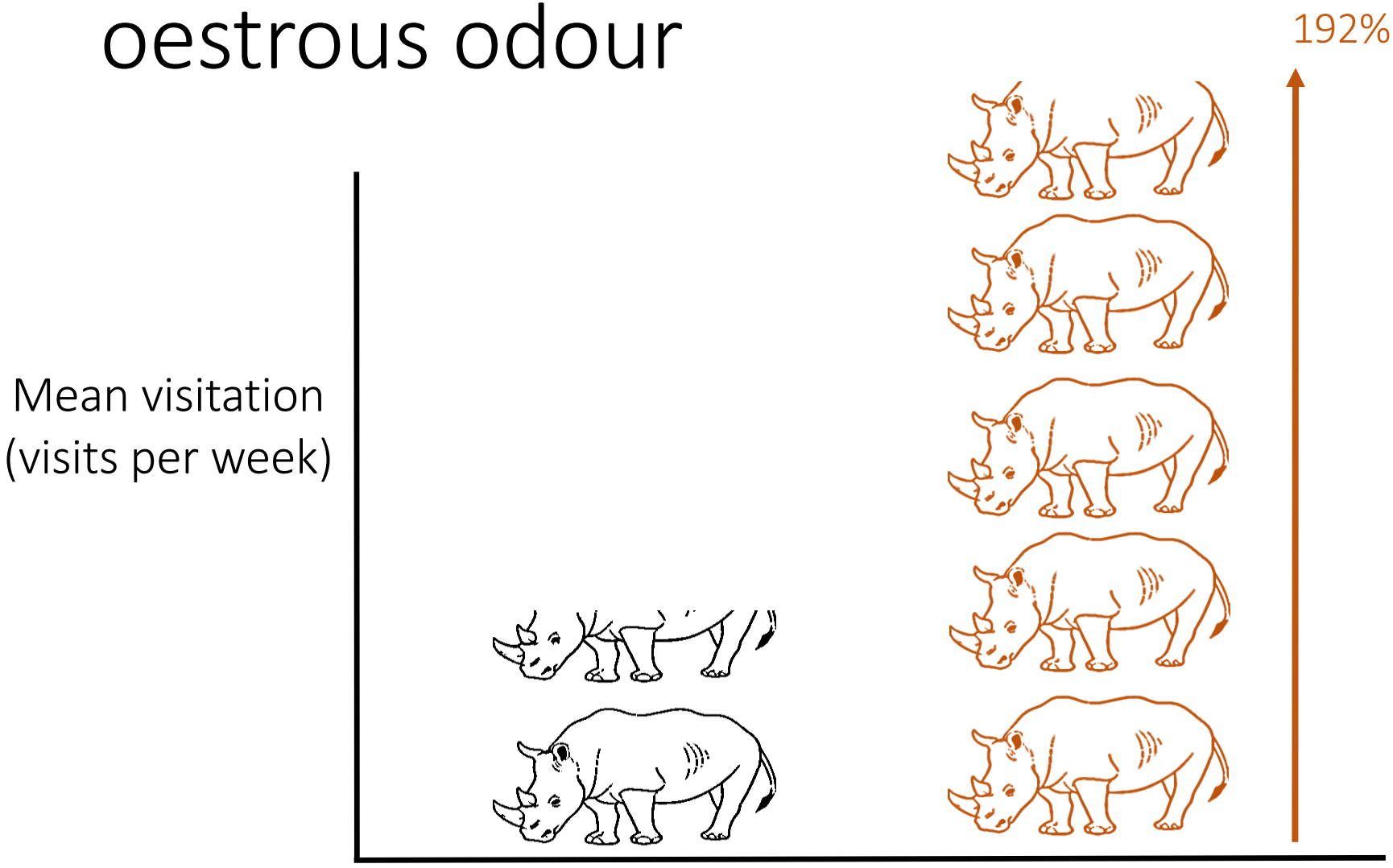
Territorial male response to territorial odour



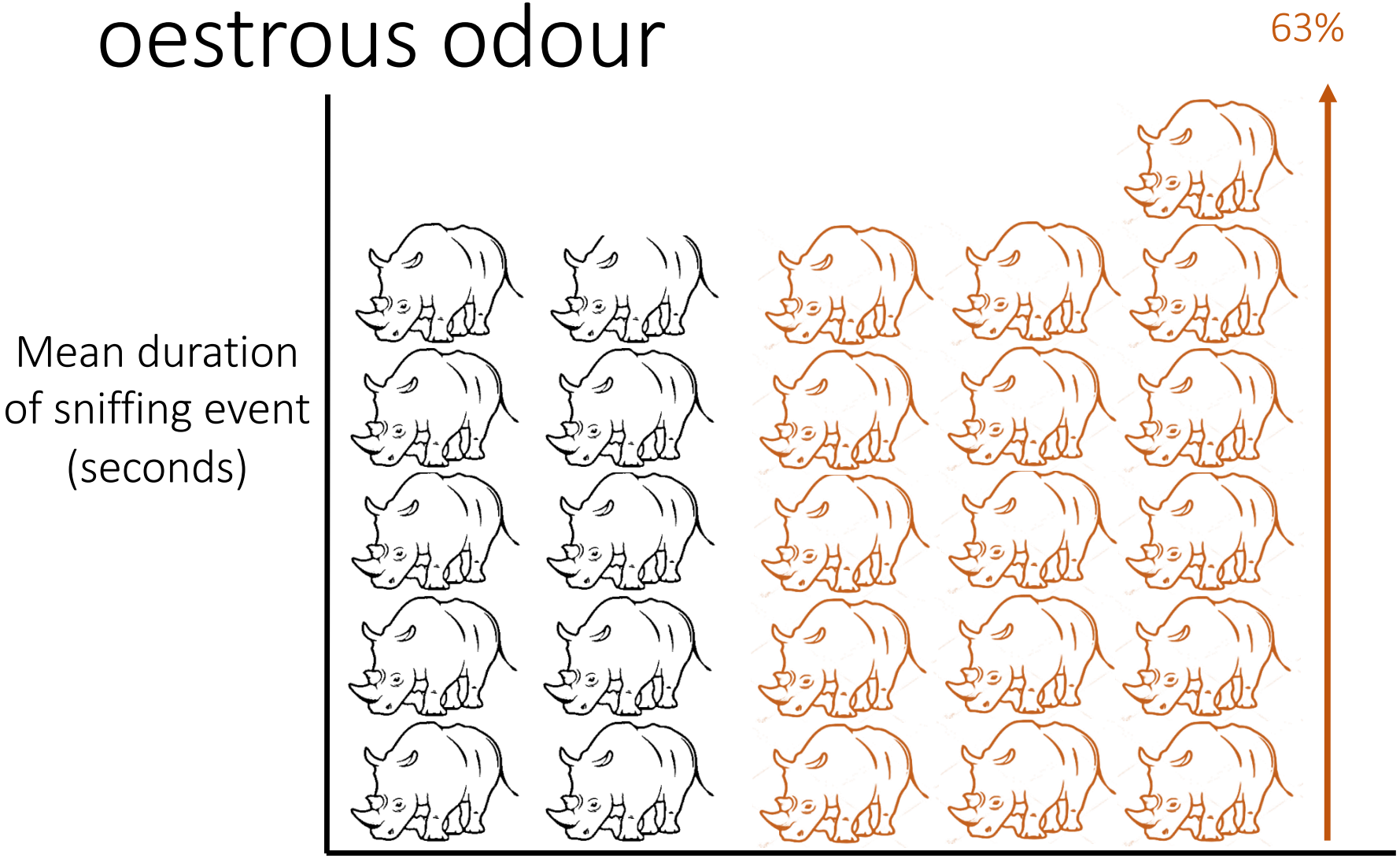
Territorial male response to territorial odour

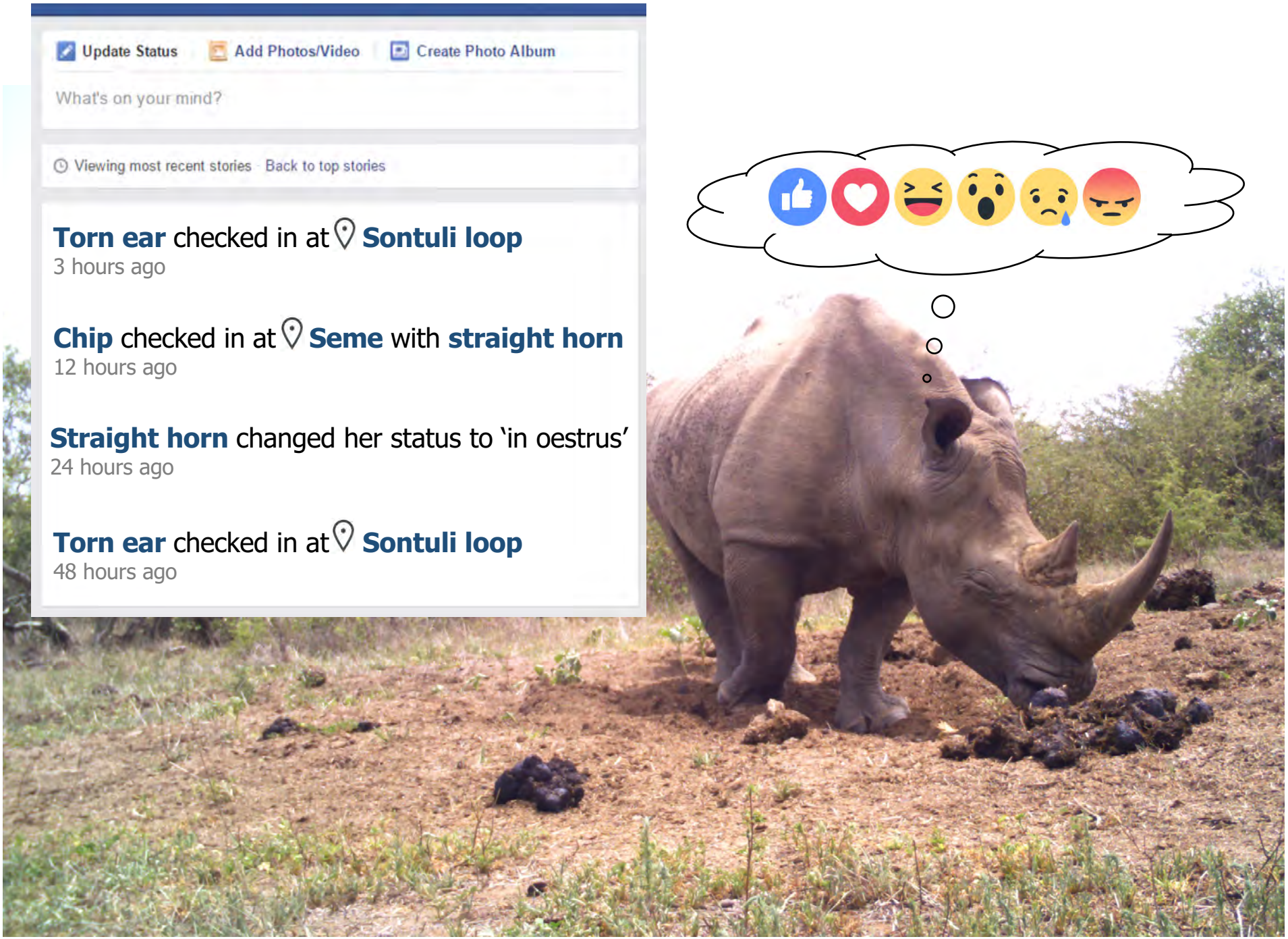


Territorial male response to oestrous odour



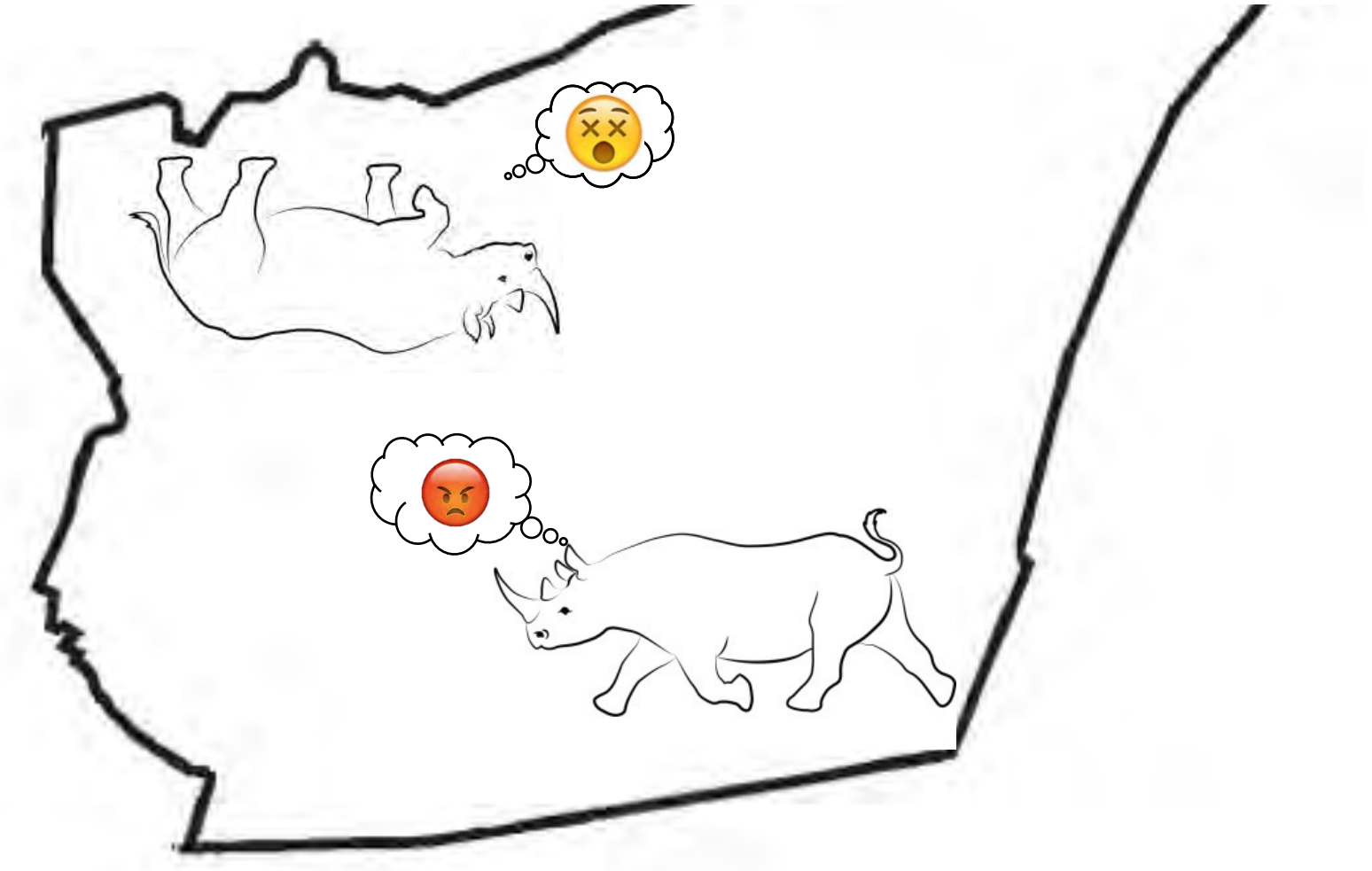
Territorial male response to oestrous odour

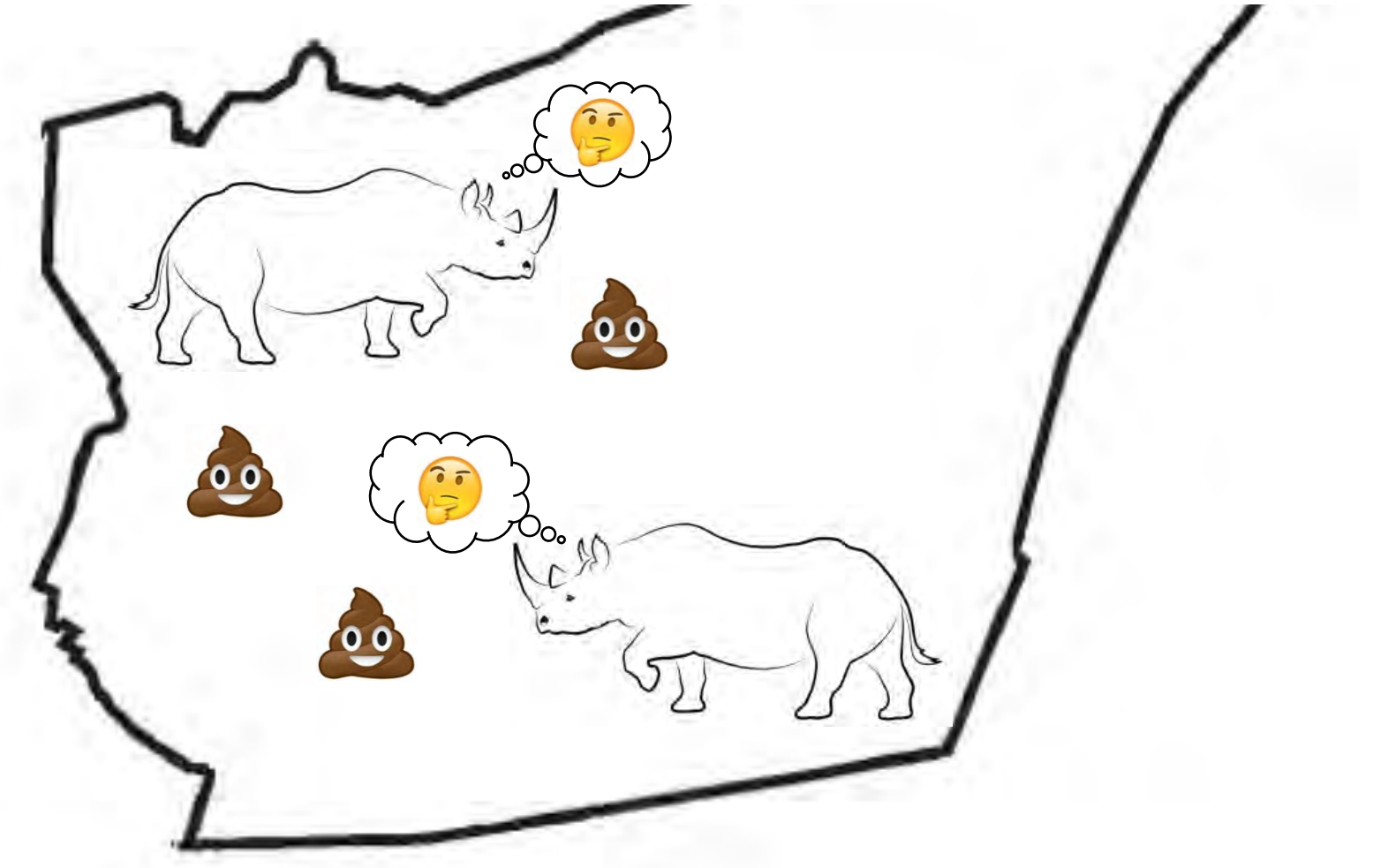



Update Status
Add Photos/Video
Create Photo Album
What's on your mind?
Viewing most recent stories
Back to top stories
Torn ear checked in at Sontuli loop
3 hours ago
Chip checked in at Seme with straight horn
12 hours ago
Straight horn changed her status to 'in oestrus'
24 hours ago
Torn ear checked in at Sontuli loop
48 hours ago

How can we use this information?

- *In-situ*

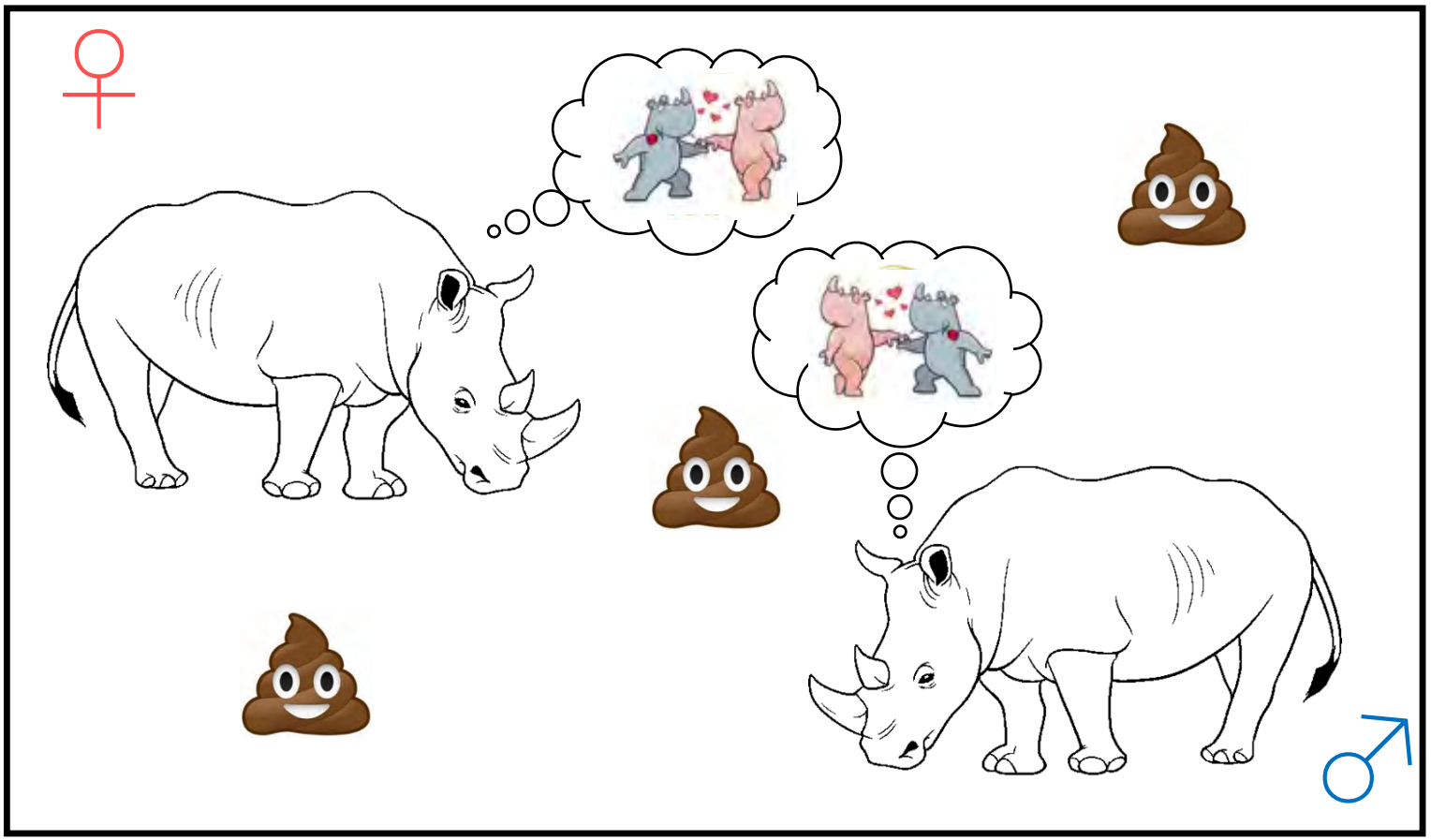


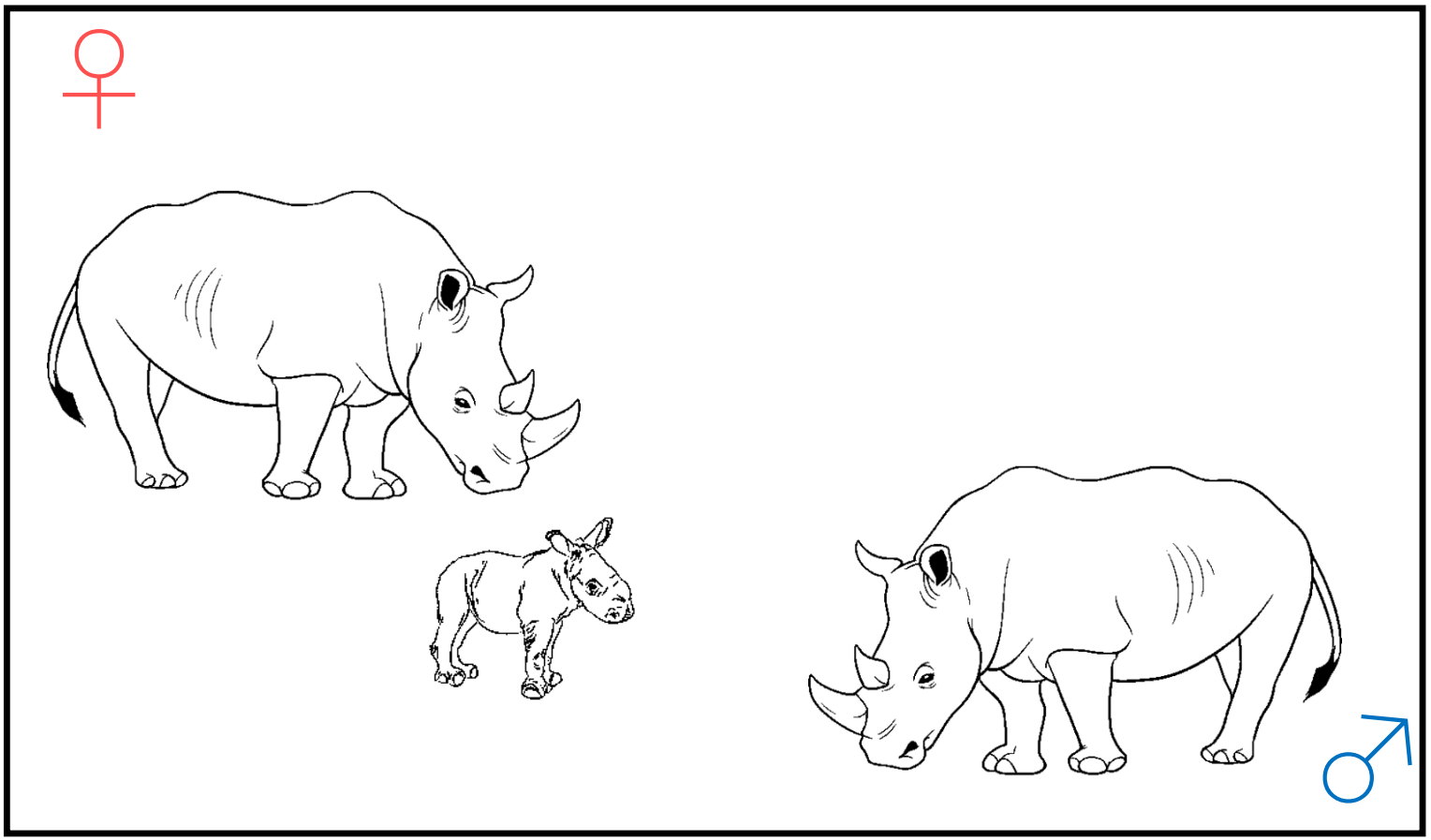


How can we use this information?

- *In-situ*

- *Ex-situ*





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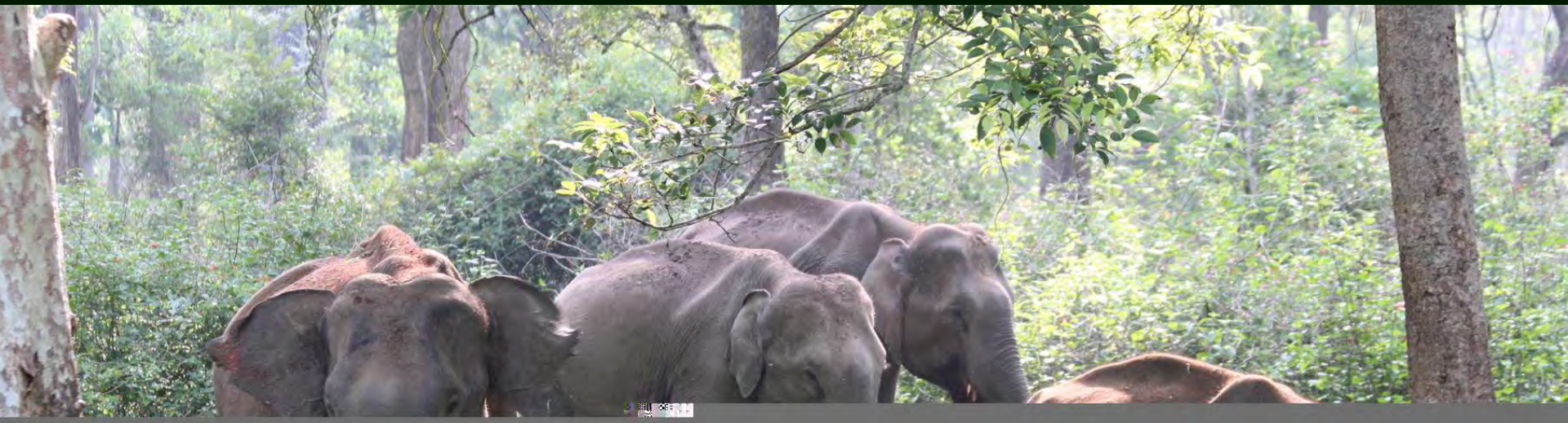
Questions?



Female Social Organization in Asian Elephants in Southern India



Nandini R. Shetty, Keerthipriya P., T.N.C. Vidya

Evolutionary and Organismal Biology Unit, Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru

Social Organization

- Describes the size, composition, and spatio-temporal cohesion of a society (Kappeler and van Schaik 2002).
- May be affected by spatio-temporally varying resource-risk distributions (Clutton-Brock and Harvey 1977, Wrangham 1980, van Schaik 1989) and individual relationships.



Why Bother?

- Social structure: information transfer, disease transfer
- Translocations
- Anthropogenic habitat modifications

Degrees of Sociality









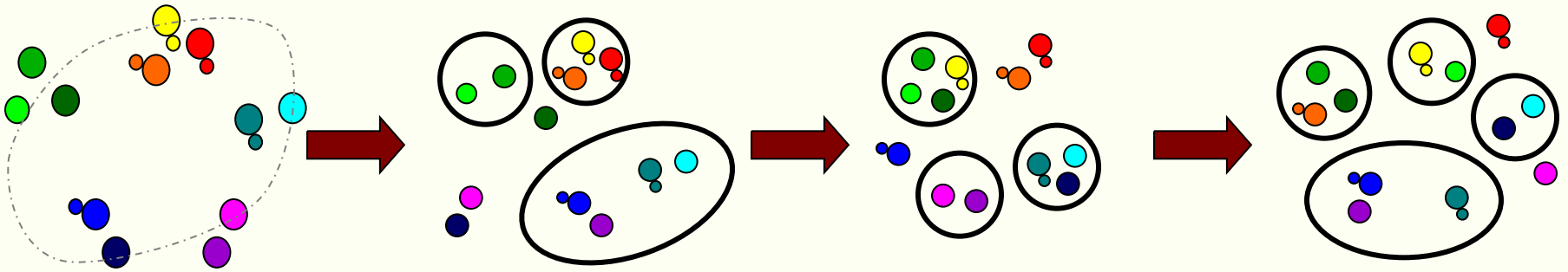


Fission-Fusion Societies

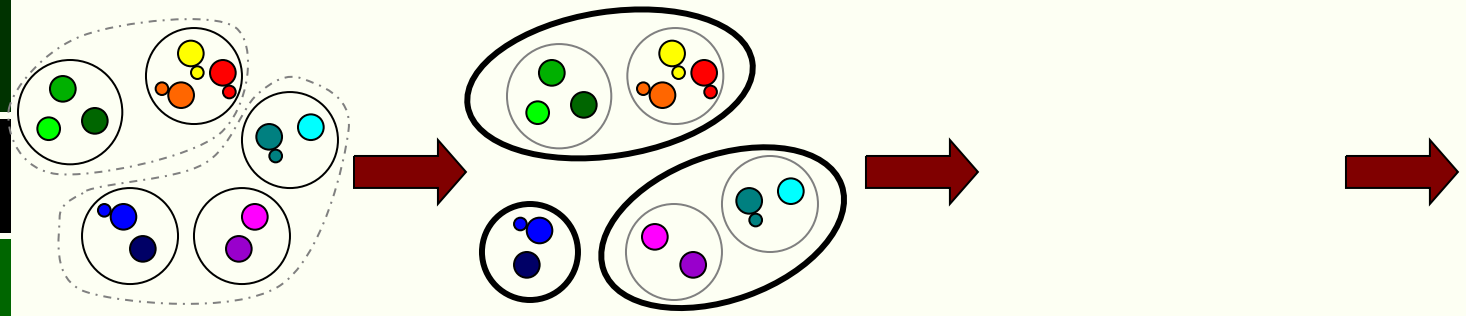
- Group sizes and compositions vary across time, but groups are not just random collections of individuals from the area.
- Changes arise from fission and fusion of sub-groups, in response to spatio-temporally varying resources.
- Modal fission-fusion societies may be individual-based or multi-level (group-based); multi-level societies may be either strictly hierarchically nested or flexibly nested.

V Chandar

Individual-based society



Flexibly nested multi-level society



Strictly nested multi-level society

Social Organization in Female Asian Elephants

- The most inclusive group of related females and their dependent offspring called a “herd”. Herds comprised sub-groups that showed fission-fusion dynamics (Mc Kay 1973).
- In southern India, hierarchical multi-level society thought to exist, with family groups, joint family groups, bond groups, clans (Sukumar 1989).
- In Sri Lanka, social groupings restricted to what was thought to be the family group (Fernando and Lande 2000).
- In the only detailed, quantitative study so far, a non-nested multi-level society found in Sri Lanka (de Silva *et al*. 2011, de Silva and Wittemyer 2012). Females showed short- and long-term associations and were connected in a population-level social network.

Kabini Elephant Project

- Nagarahole NP and TR, Bandipur NP and TR, Karnataka: ~60% of the wild elephant population in Karnataka and ~10-12% of India's wild elephant population.

Started: 2009

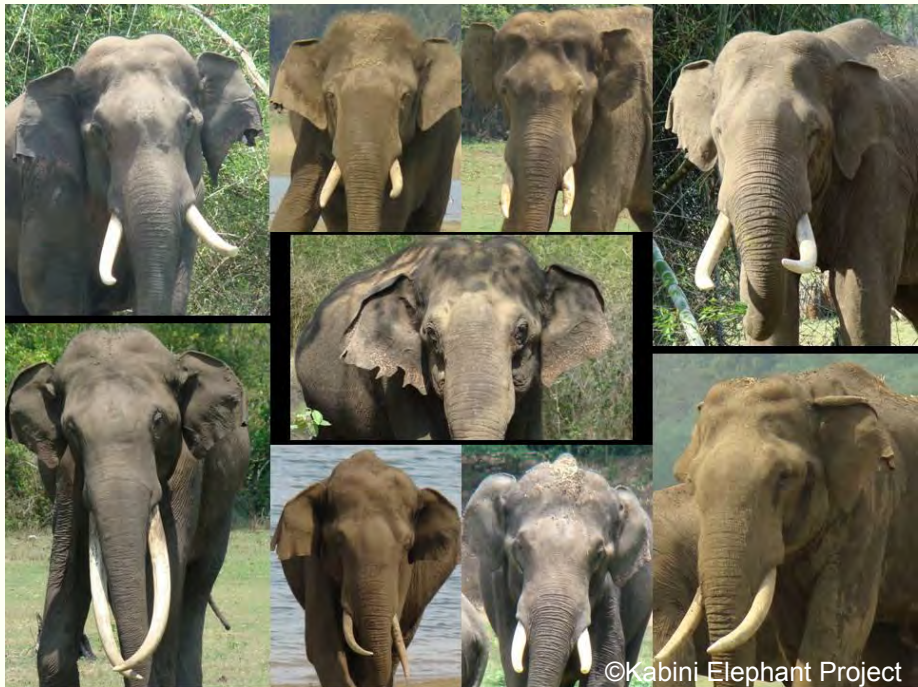




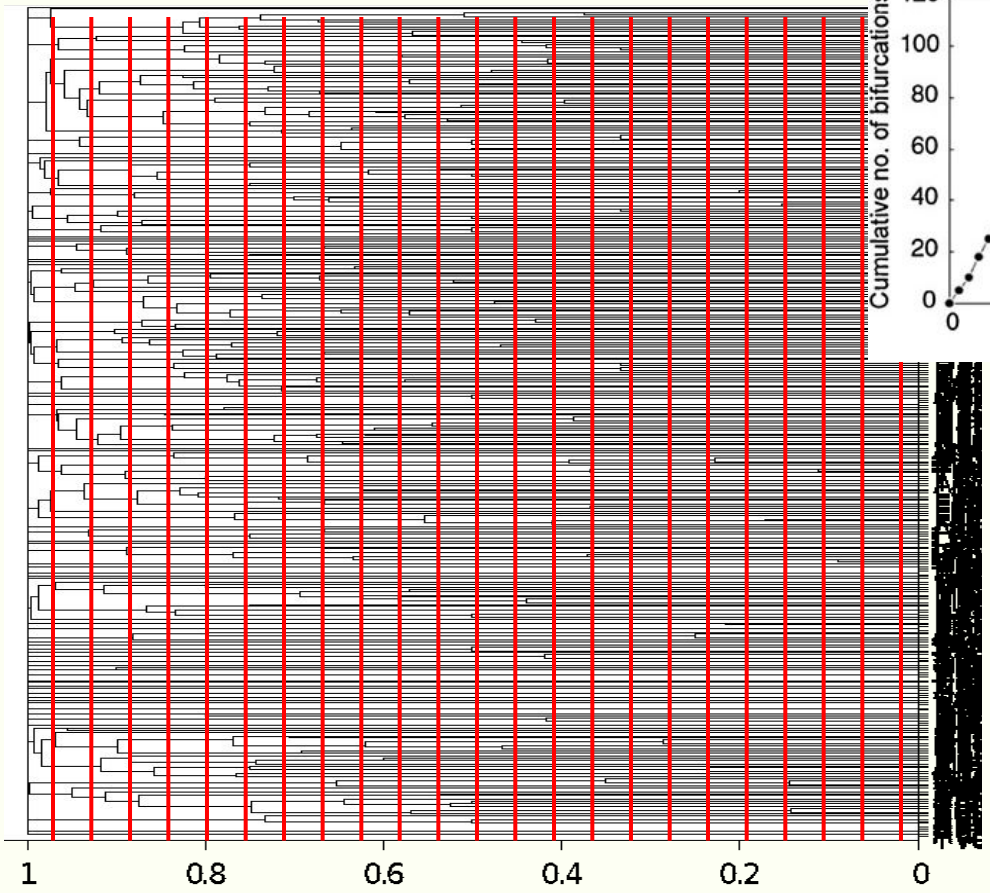
Physical ID

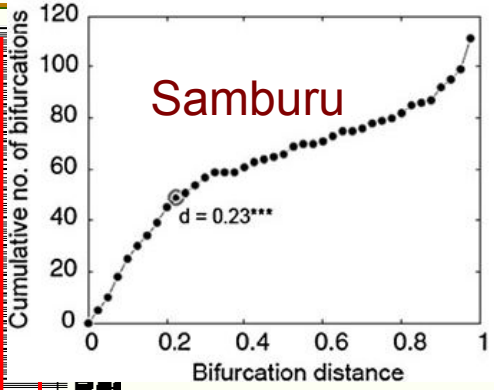
Category	Number
Adult, subadult females	417
Adult, subadult males	174
Juveniles	133
Calves	101
Total	825 (591)

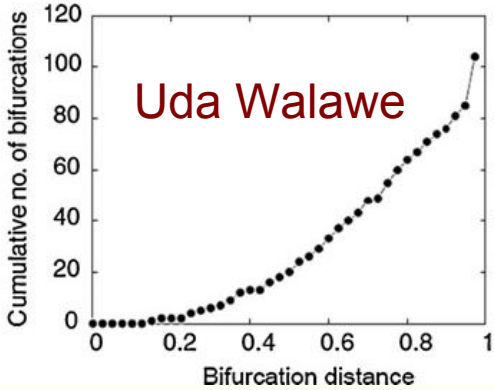
- Identification based on natural physical characteristics (Vidya *et al*. 2014).
- Calf (>0<1 yrs), Juvenile (1-<5 yrs), Subadult (5-≤10 yrs, females; 5-≤15 yrs, males), Adults (≥10 yrs, females; ≥15 yrs, males).

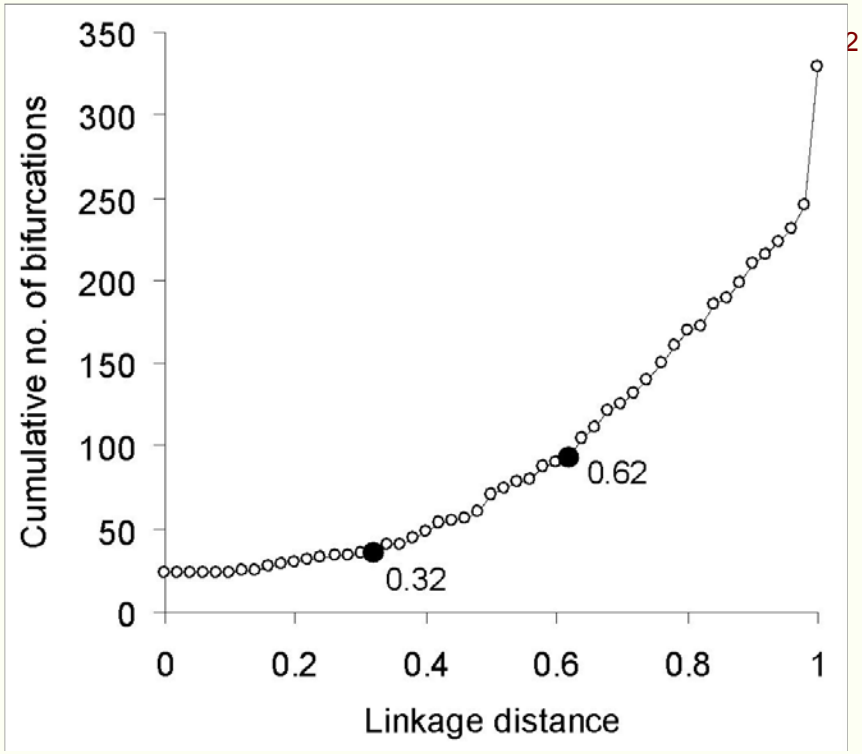


Associations Between Females



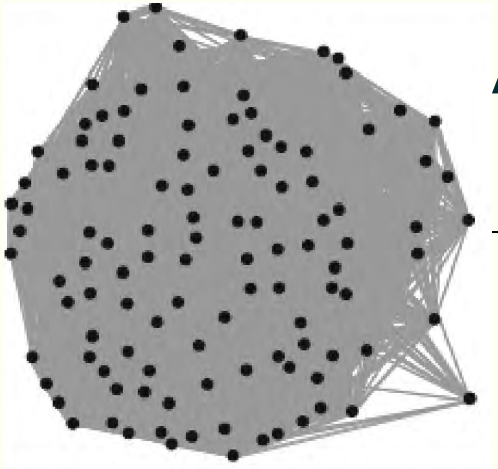






Shetty *et al.*, in prep.

Female Societies in Different Elephant Populations

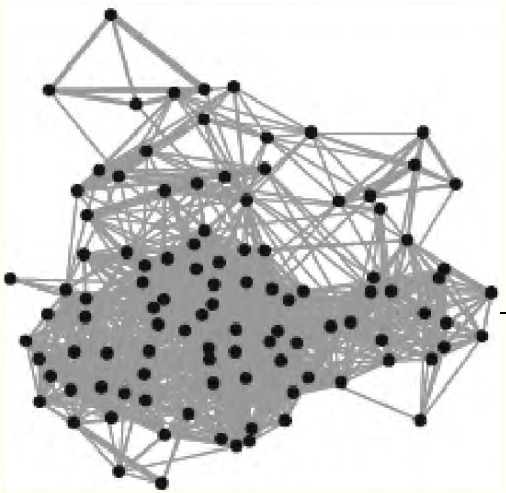


Average degree (SD)

88.87 (16.00)

Samburu

8.32 (8.15)



Kabini

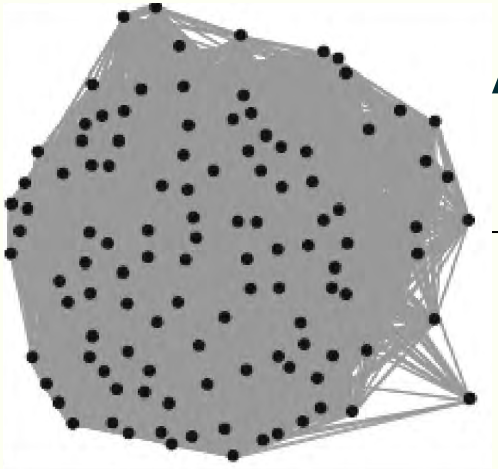
22.53 (11.85)

Uda Walawe

De Silva and Wittemyer 2012

Shetty *et al*., in prep.

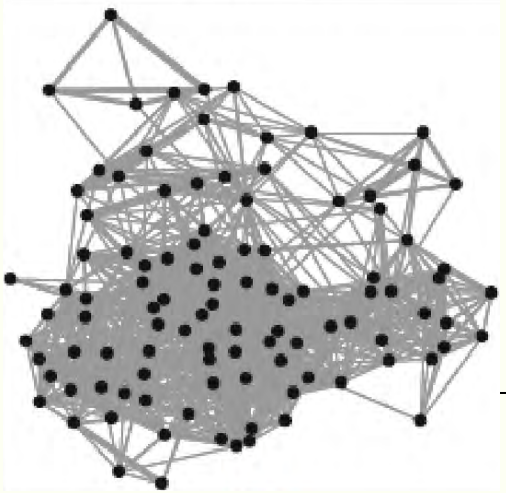
Female Societies in Different Elephant Populations



Average degree (SD)

88.87 (16.00)

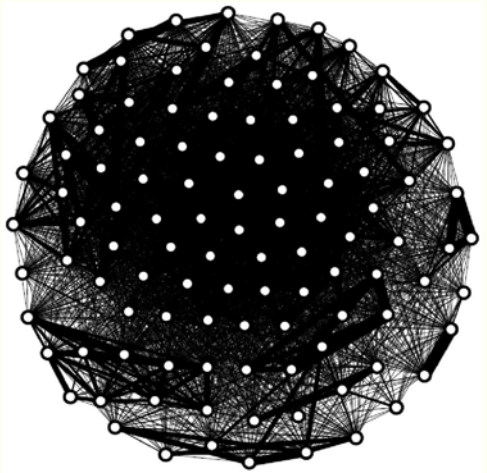
Samburu



22.53 (11.85)

Uda Walawe

74.95 (19.50)



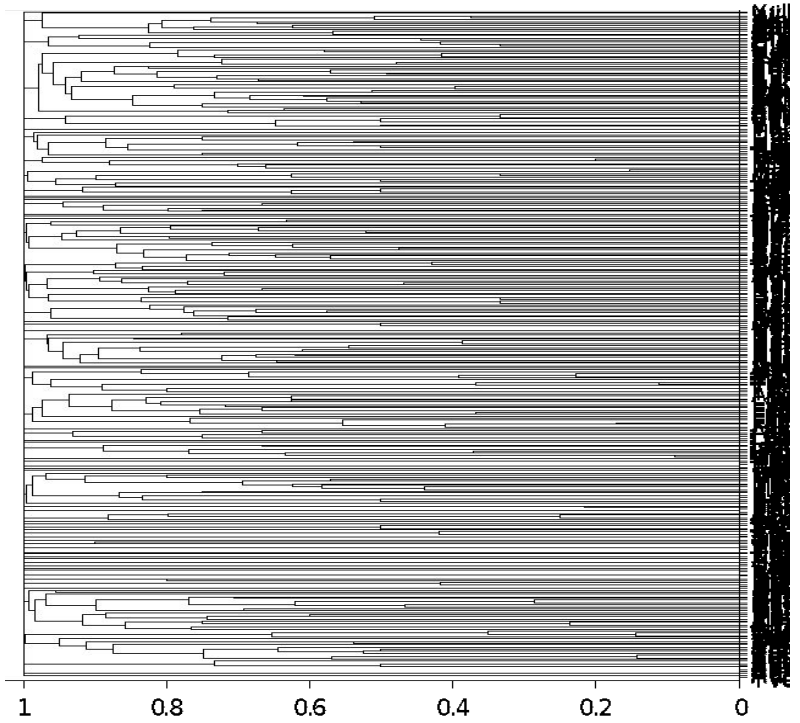
Kabini 500-m

De Silva and Wittemyer 2012

Shetty *et al*., in prep.

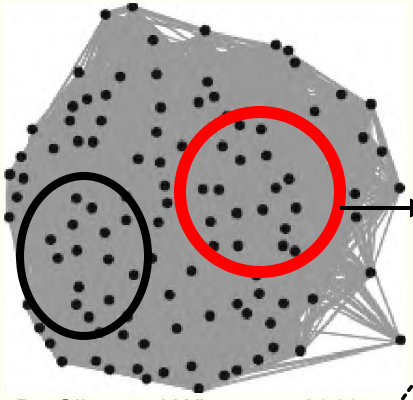
Association Network of Females

Average degree = 8.32,
Average group size = 2.4 (±0.06)



Shetty *et al.*, in prep.

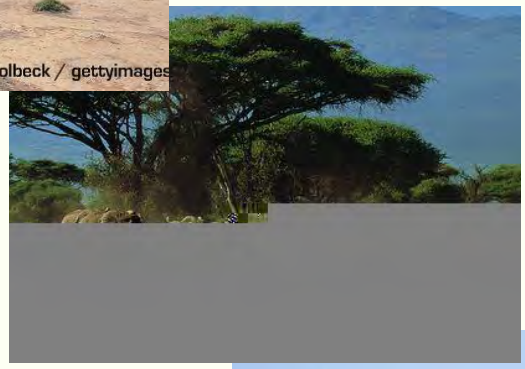
Female African Savannah Elephant Society



De Silva and Wittemyer 2012

Clan

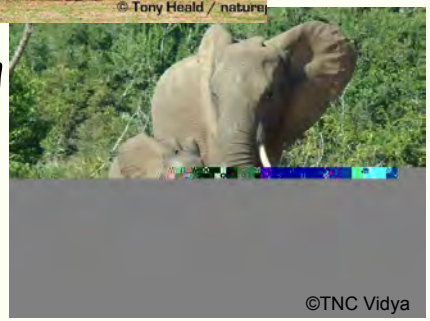




Bond group



Family group

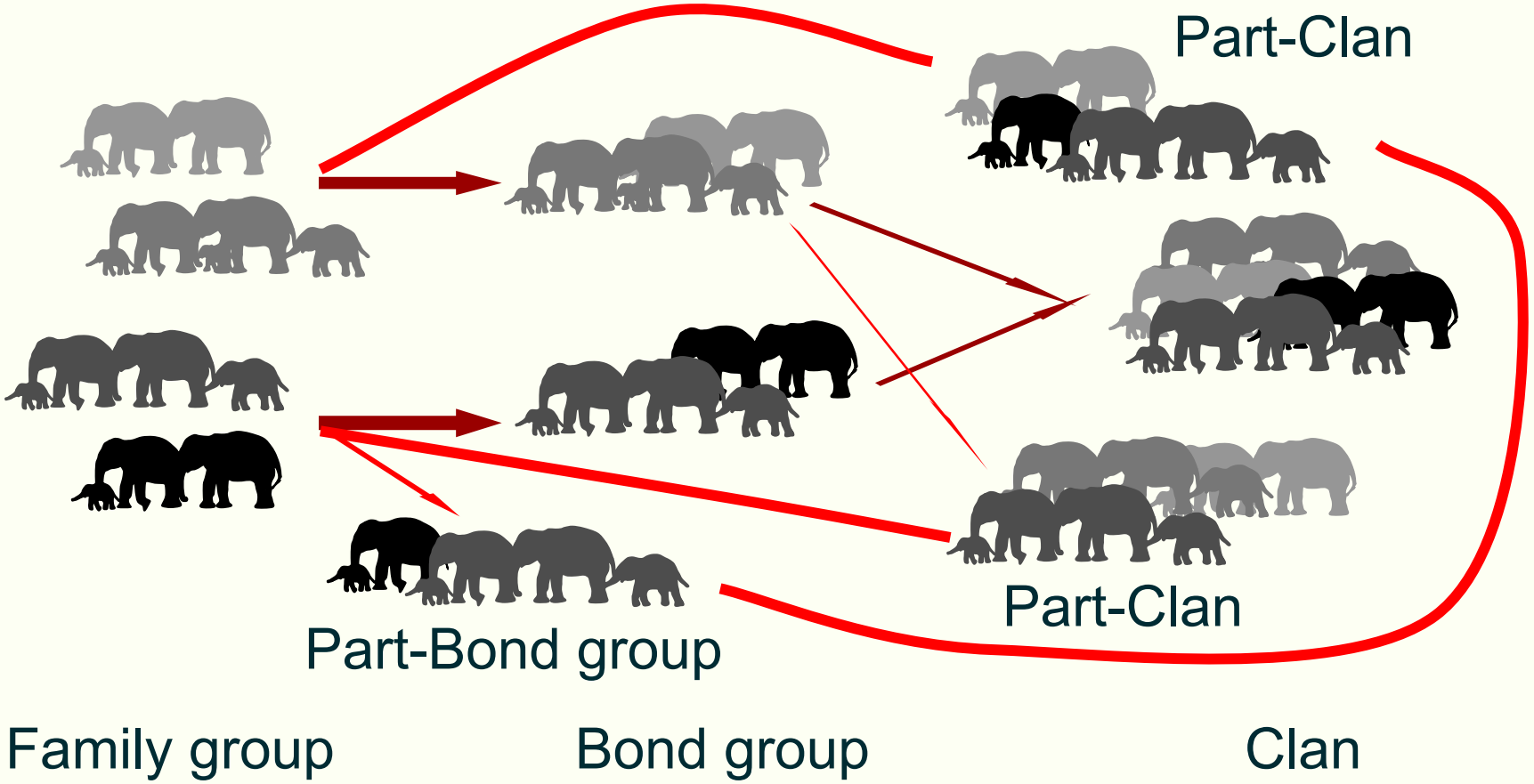


Mother-offspring unit

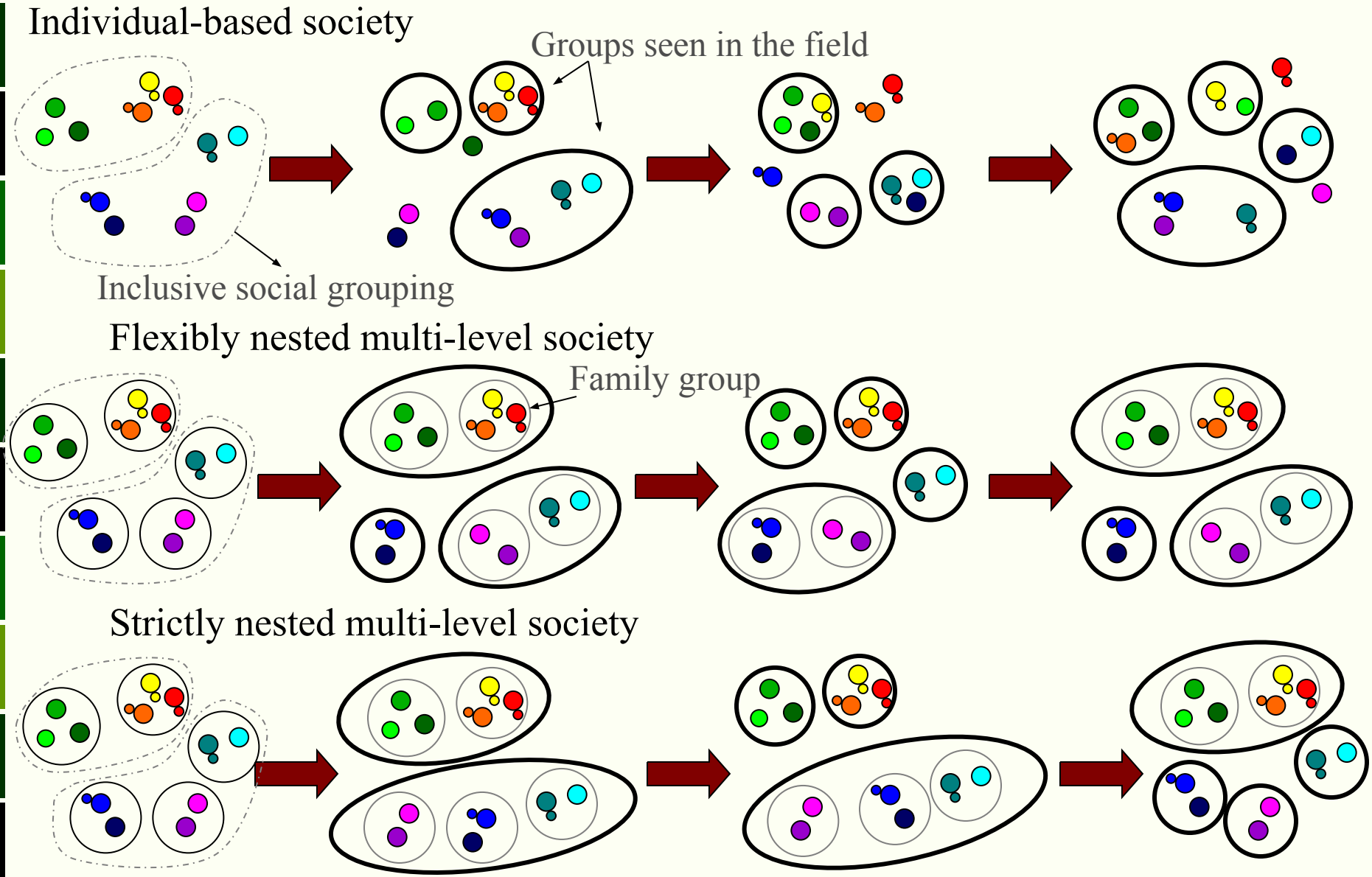
Individuals

Multi-Level Fission-Fusion Society

MULTI-LEVEL SOCIETY, MORE FLUIDITY WITHIN CLANS



Fission-Fusion Societies



Summary

- There was multi-level social organization amongst females, more fluid than in African savannah elephants.
- Non-random female associations, with clans being the most inclusive unit of female social organization.
- Clans similar to “herds” of Mc Kay (1973), possibly “family groups” of Fernando and Lande (2000), did not associate with one another.
- Ave. no. of associations intermediate in the Kabini-500m dataset.
- Historical disturbance in Sri Lanka (Sanderson 1879, Lorimer and Whatmore 2009).




Acknowledgments

• Department of Science and Technology (DST, Govt. of India)-Ramanujan Fellowship, Centre of Scientific and Industrial Research (CSIR, Govt. of India), National Geographic Society, JNCASR *for funds, support*.

• State Forest Department of Karnataka *for research permits, support*.




Deepika Prasad Krishna Gunda Hansraj Gautam Althaf

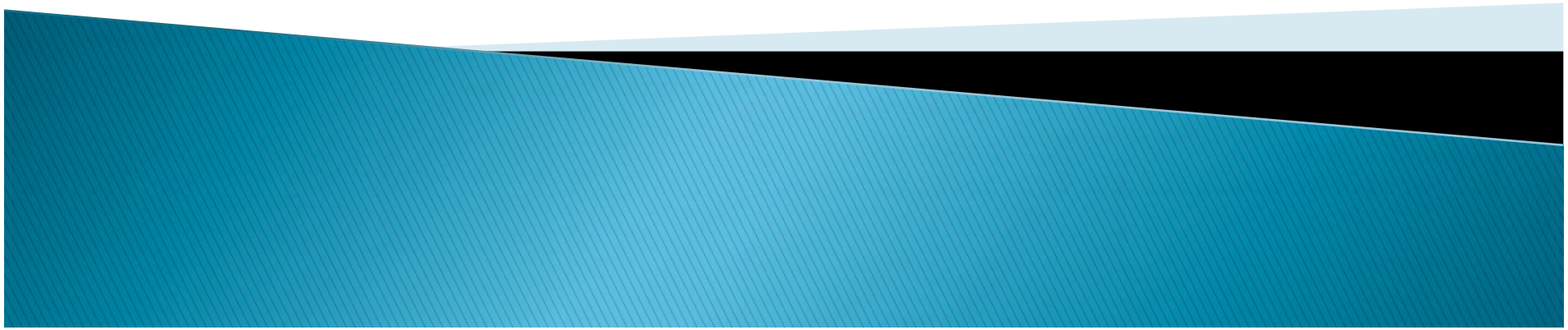
INTERNATIONAL ELEPHANT FOUNDATION.ORG

Understanding the behavior of African elephants as they move in landscapes with different protection status and habitat types in the Mahale – Katavi – Lwafi ecosystem of Tanzania.

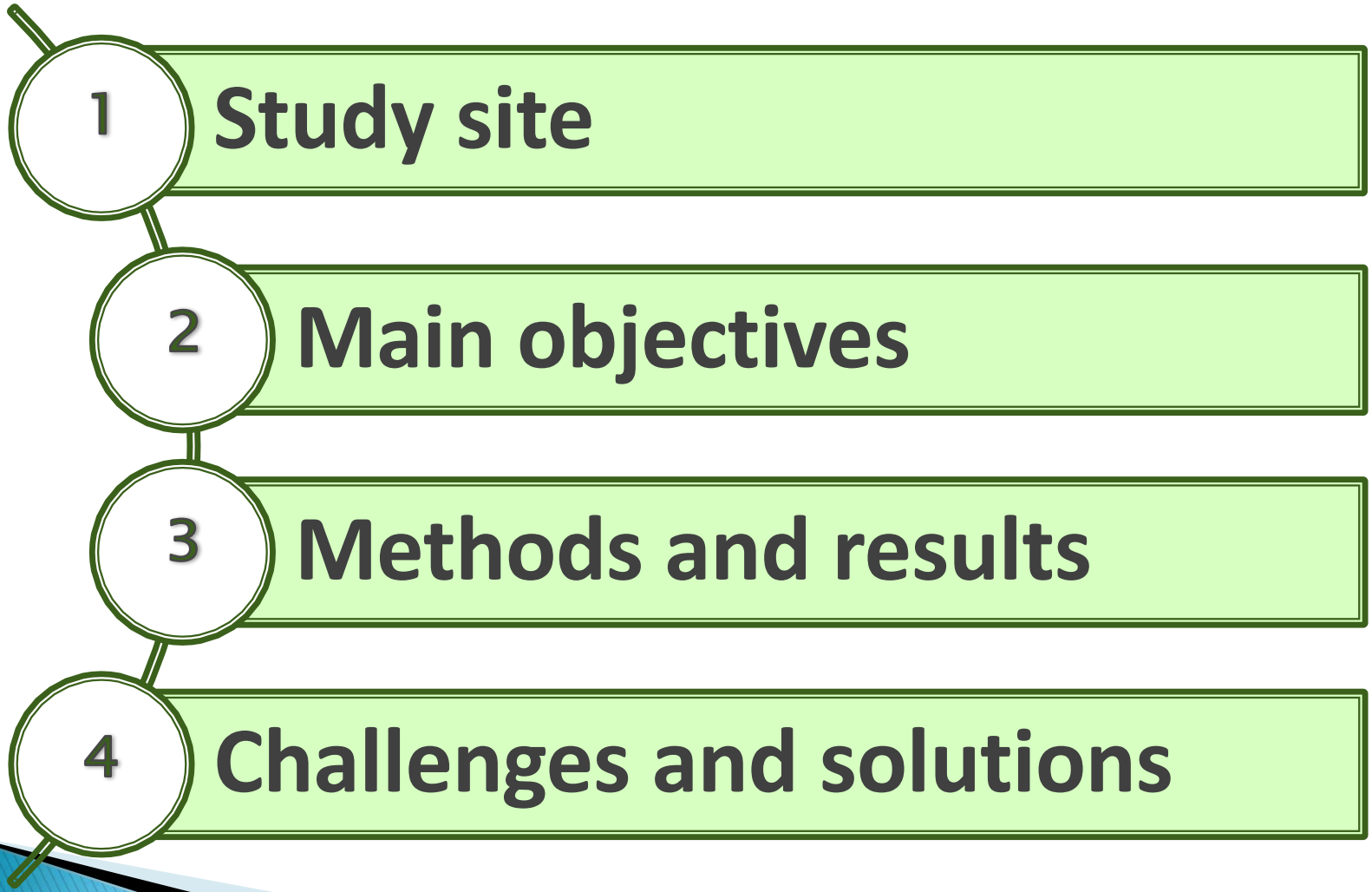
Andimile Martin, PhD
Katavi Elephant Project

Elizabeth W. Freeman, PhD
Associate Professor
George Mason University

Bruce A. Schulte, PhD
Professor and Department Head of Biology
Western Kentucky University

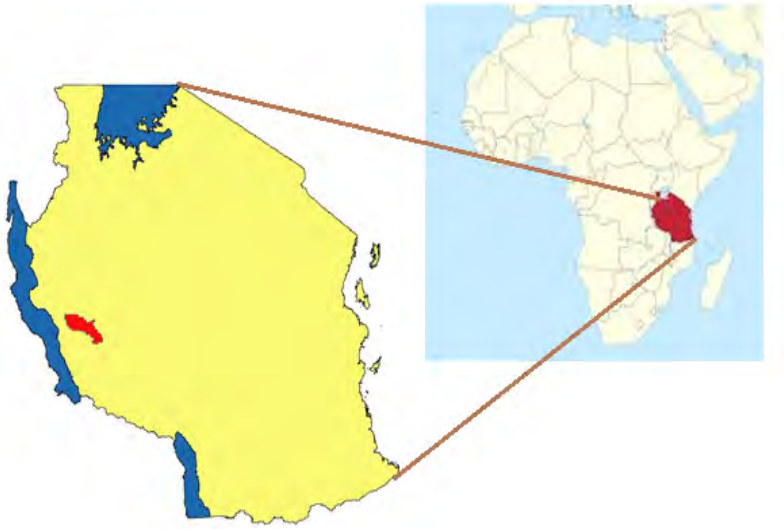


Outline


1
Study site
2
Main objectives
3
Methods and results
4
Challenges and solutions

Study Site

- Katavi National Park was created in 1974,
- Current size : 4,471 square kilometers
- Miombo woodland characterized by *Acacia*, *Combretum*, *Commifora*, *Grewia*, *Kigelia*, *Pterocarpus* and *Terminalia* trees
- Mean annual rainfall c. 1,000 mm/year
- Mean temperatures: 25°C–36°C









Main Objectives

- Determine the current geographical distribution of African elephants.
- Map the habitats and migratory routes used by African elephants.
- Monitor African elephant groups to determine activity budget behavior.

(1) Determine the current geographical distribution

- **Foot transects:**
  - Three times
    - 16th July to 30th September 2015
    - 25th January to 3rd March 2016
    - 2nd August to 30th September 2016
  - Signs of Elephants
  - Observations of Elephants

- **Park Rangers sightings**
  - Location
  - Weather
  - Vegetation types
  - General activities
  - Age estimates





Example of Results

GPS Points		Transect length (km)	Elephant (Sign or sighting)	Vegetation Types	Number of elephants			
Northings	Eastings				Adults	Sub-adult	Juvenile	Total
279436	9140401	1	Sighted	Bush land	4	1	2	7
279529	9138266	1	Sighted	Bushed shrub	5	3	-	8
279211	9138216	1	Sighted	Woodland Wooded	3	5	5	13
276623	9140296	1	Sighted	grassland	2	4	3	9
278695	9138239	1.5	Dung	Bush land				
278629	9138220	2	Sighted	Wooded grassland	2	4	2	8







(1)Determine the current geographical distribution

Results

- Average of 50 transects lines of 1km each
- Average of 82.1kms
- Elephants groups contained 5 to 15 individuals
- Mean diameter of dung piles is 45±25.9cm
- The mean number of boli in a pile is 5.7±2.1
- Mean size of tracks is 38±3.5cm length and 28±2.8cm width





(2) Map the habitats and migratory routes

- 20 interviews in local villages.
- Vegetation recorded during visits

Results

- Two migratory routes between Mahale and Katavi
  - Katavi via Mabungo to Mahale
  - Katavi via Rwega River to Mahale



- Habitat types include
  - Woodland (trees up to 18 m, canopy cover >20%)
  - Wooded grassland, (trees up to 18m, canopy cover >20% with grasses)
  - Bushed grassland (grassland with bushes and shrubs of canopy cover 2–20%)
  - Bushland (woody vegetation of shrubby habit; low stature <6 m in height; canopy cover >20%)
  - Grassland (dominated by grass; tree canopy <2%)

(3)Monitor African elephant groups to determine activity budget behaviour

- Three months (1st April to 30th June)
- State behaviours
  - Feeding, moving, resting, watering, social and alert.
  - 5 mins intervals until out of view.
- Other data
  - Weather,
  - Group size
  - Age classes
- Locations
  - Ikuu flood plain, Lake Chada, Mpunga and Lake Katavi
  - Other areas (random encounters)





Building elephant ID database
~40 individuals to date

(3)Monitor African elephant groups to determine activity budget behaviour



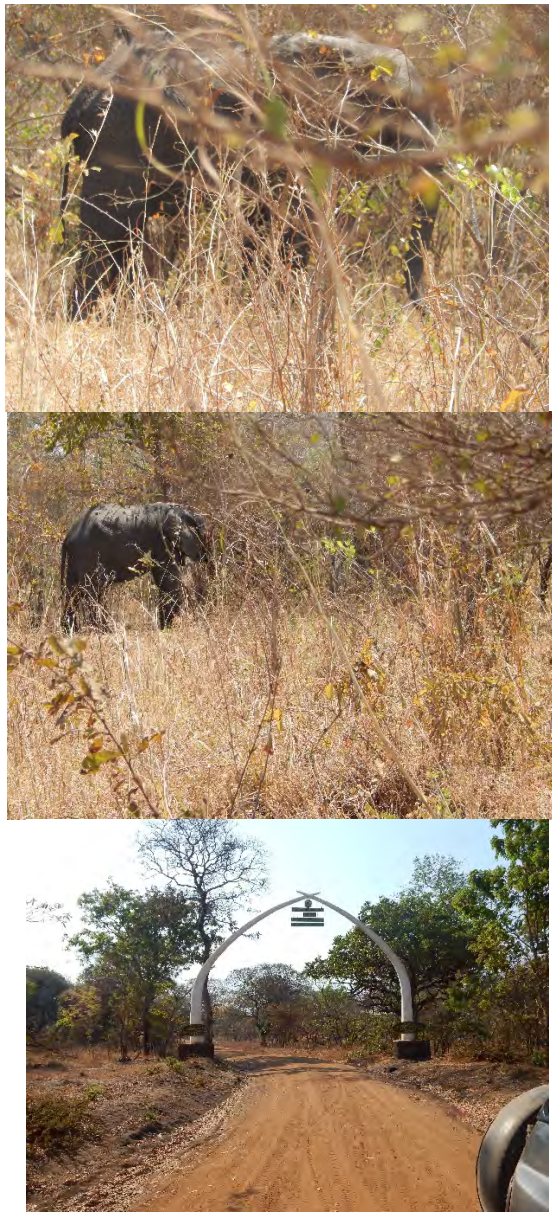
Challenges & Solutions

Challenges

- Visibility
- Absence of roads
- Variability of elephant presence
- Elephants move away quickly

Solutions

- Longer field time
- Focused observations in elephant assembly locations



Next Steps

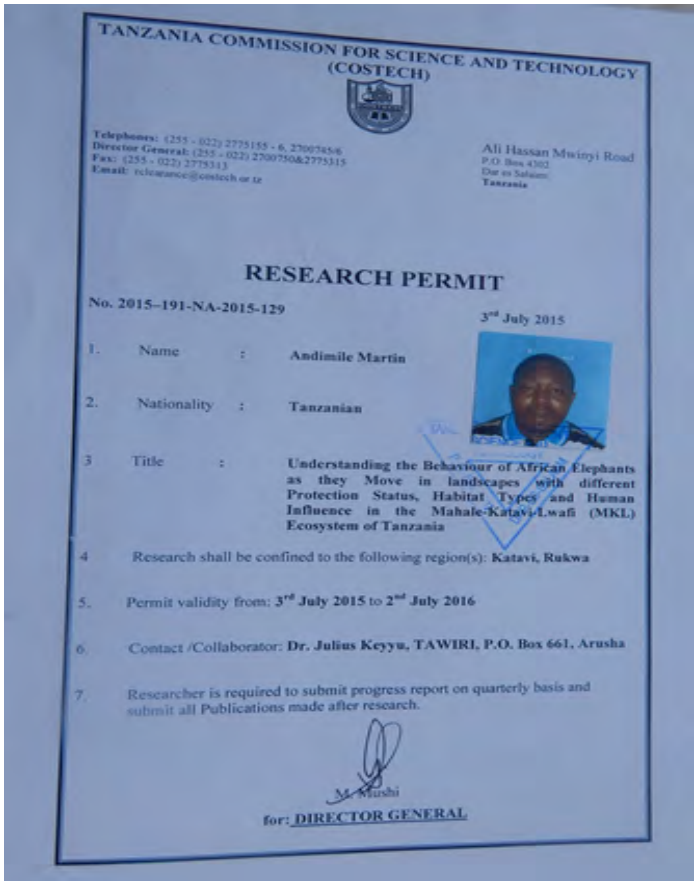
- More behavioural observations
- Manuscripts
- Continue Katavi Elephant Project
- Future funding
  - Elephant activity
  - Conservation and outreach
  - HEC





Acknowledgements

- **Sponsors:** International Elephant Foundation and Elephant Research Foundation M. Philip Kahl Postdoctoral Fellowship
- **Park officers:** Mr. John Gara, Mr. Elisa Manase and various rangers
- **Field assistants:** Mr. Christopher Mpemba and Conrad Mizengo
- **Permits:** TAWIRI and TANAPA



TANZANIA COMMISSION FOR SCIENCE AND TECHNOLOGY
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P.O. Box 4302
Dar es Salaam
Tanzania

RESEARCH PERMIT

No. 2015-191-NA-2015-129

3rd July 2015

1. Name : Andimile Martin
2. Nationality : Tanzanian
3. Title : Understanding the Behaviour of African Elephants as they Move in landscapes with different Protection Status, Habitat Types and Human Influence in the Mahale-Katavi-Lwafi (MKL) Ecosystem of Tanzania
4. Research shall be confined to the following region(s): Katavi, Rukwa
5. Permit validity from: 3rd July 2015 to 2nd July 2016
6. Contact /Collaborator: Dr. Julius Keyyu, TAWIRI, P.O. Box 661, Arusha
7. Researcher is required to submit progress report on quarterly basis and submit all Publications made after research.

for: DIRECTOR GENERAL

Questions ?



Email: andimile@gmail.com

Sleeping Behaviour in Asian Elephants

Emma Evison Bsc (Hons), MSc
Lead Keeper

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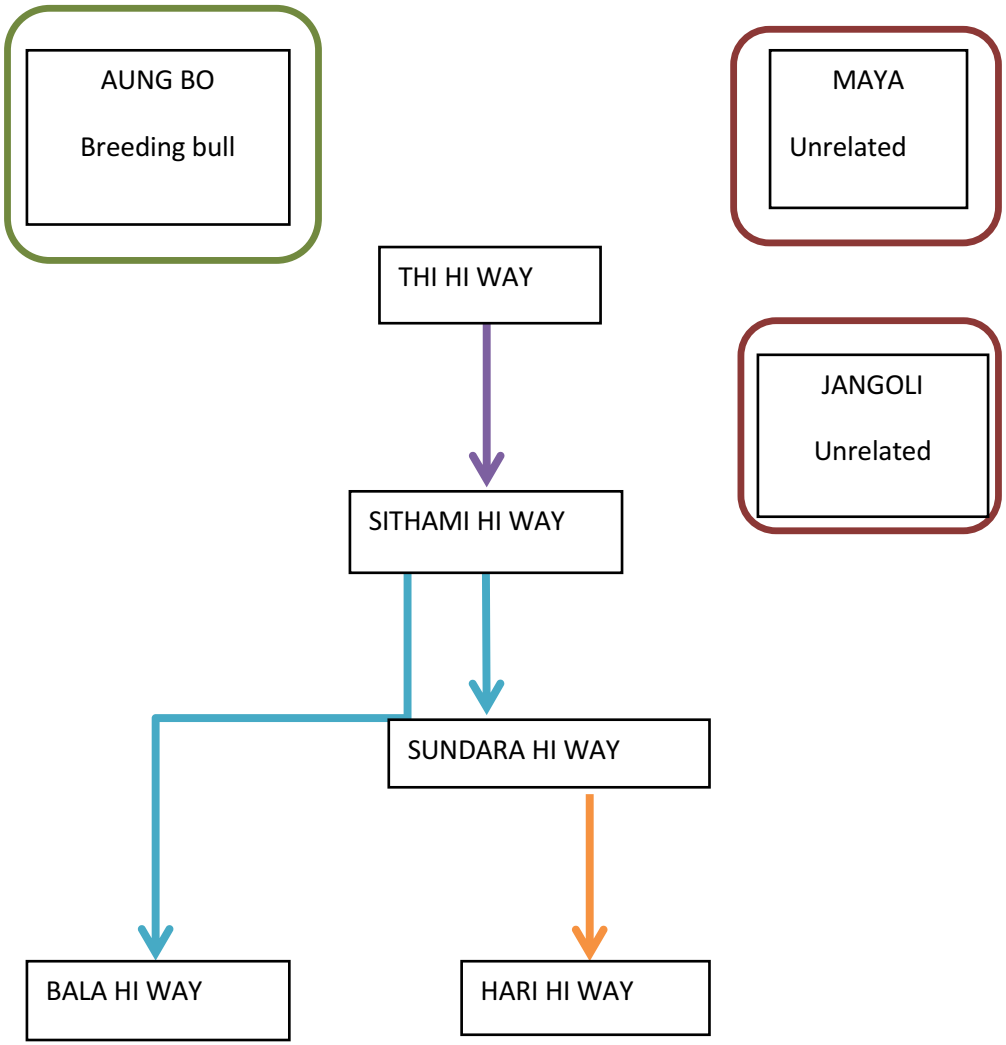
Introduction

- Elephant study group
- 8 individuals
- Related and unrelated
- Various ages
- Multigenerational group



"Evison et al (In prep) How Asian elephant sleep behaviour and proximity can be an measure for social compatibility and optimal welfare"

Why sleeping behaviour?

- Physical health indicator
- Welfare assessment tool
- Comfort and compatibility
- Gap in research



- A measure of social bonds and bond strength

Method

- CCTV cameras
- Continuous sampling
- Two to three times a week
- 7pm – 7am
- Same observer
- Start time, end time, location, if in close proximity to others and if touching another individual
- Lying rest only

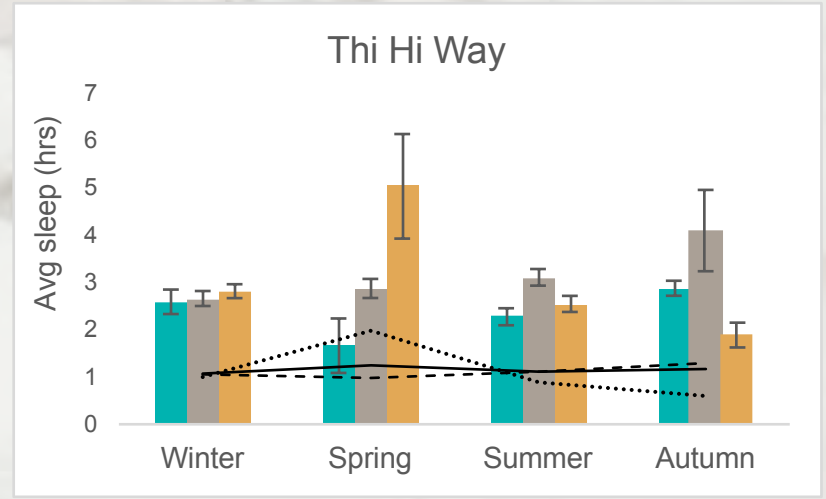


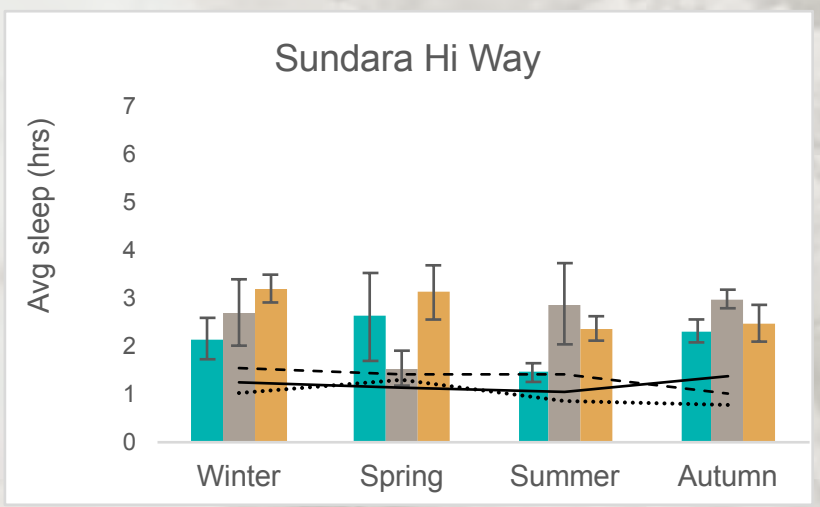


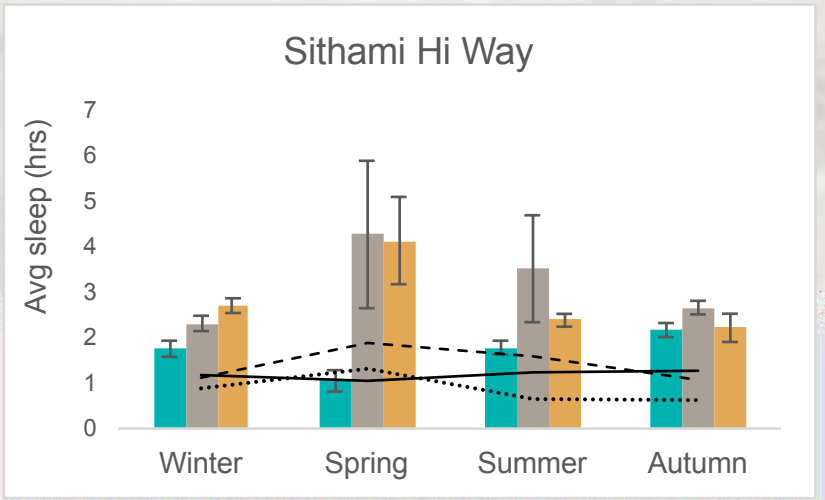
"Evison *et al* (In prep) How Asian elephant sleep behaviour and proximity can be an measure for social compatibility and optimal welfare"

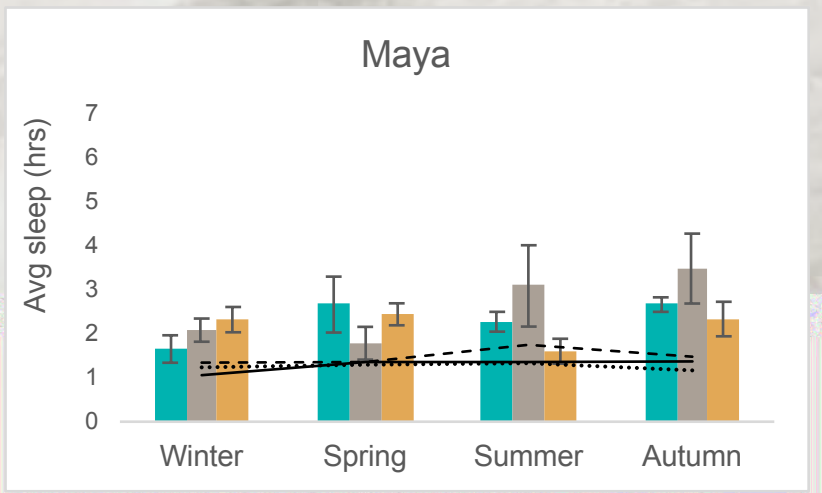
Results





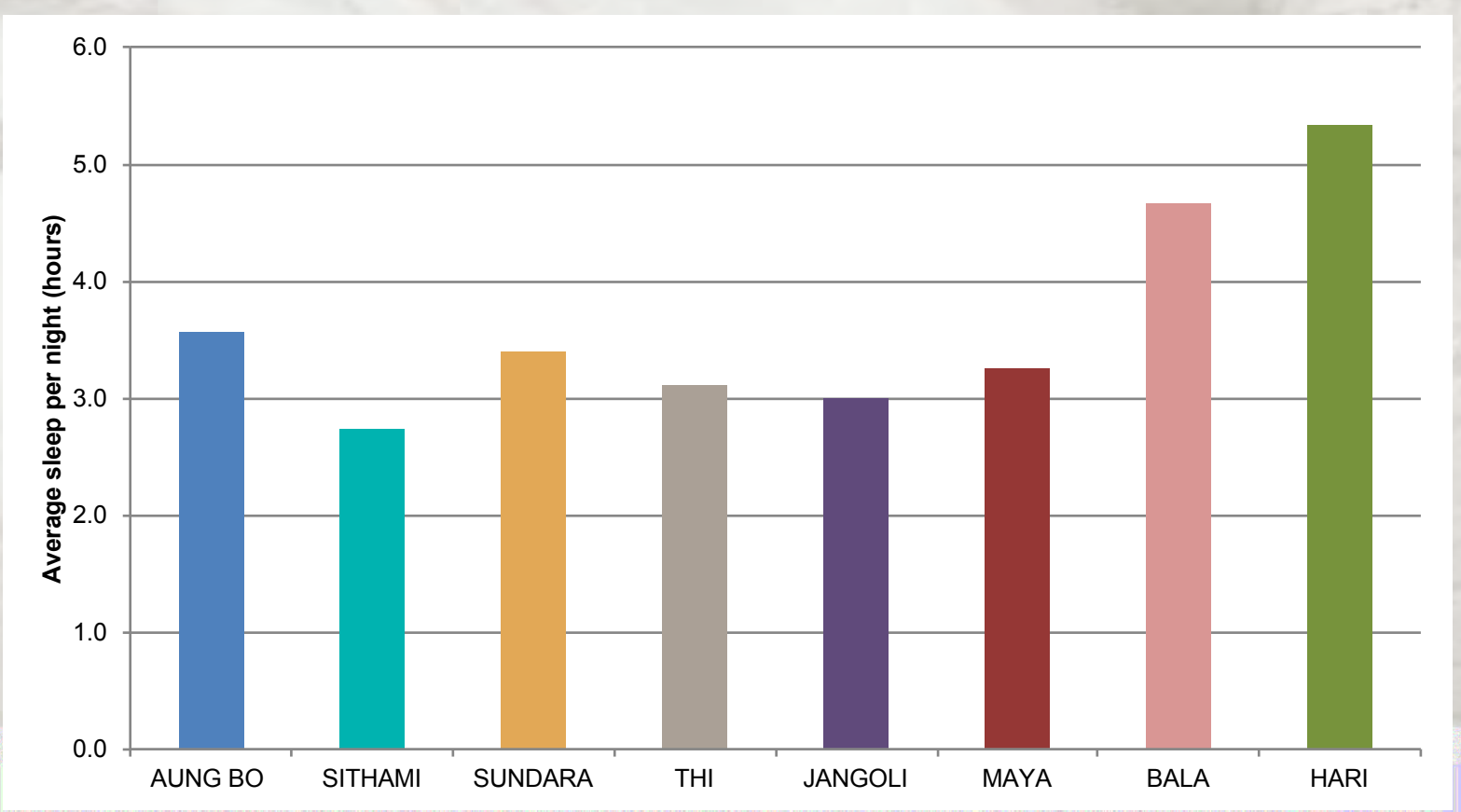






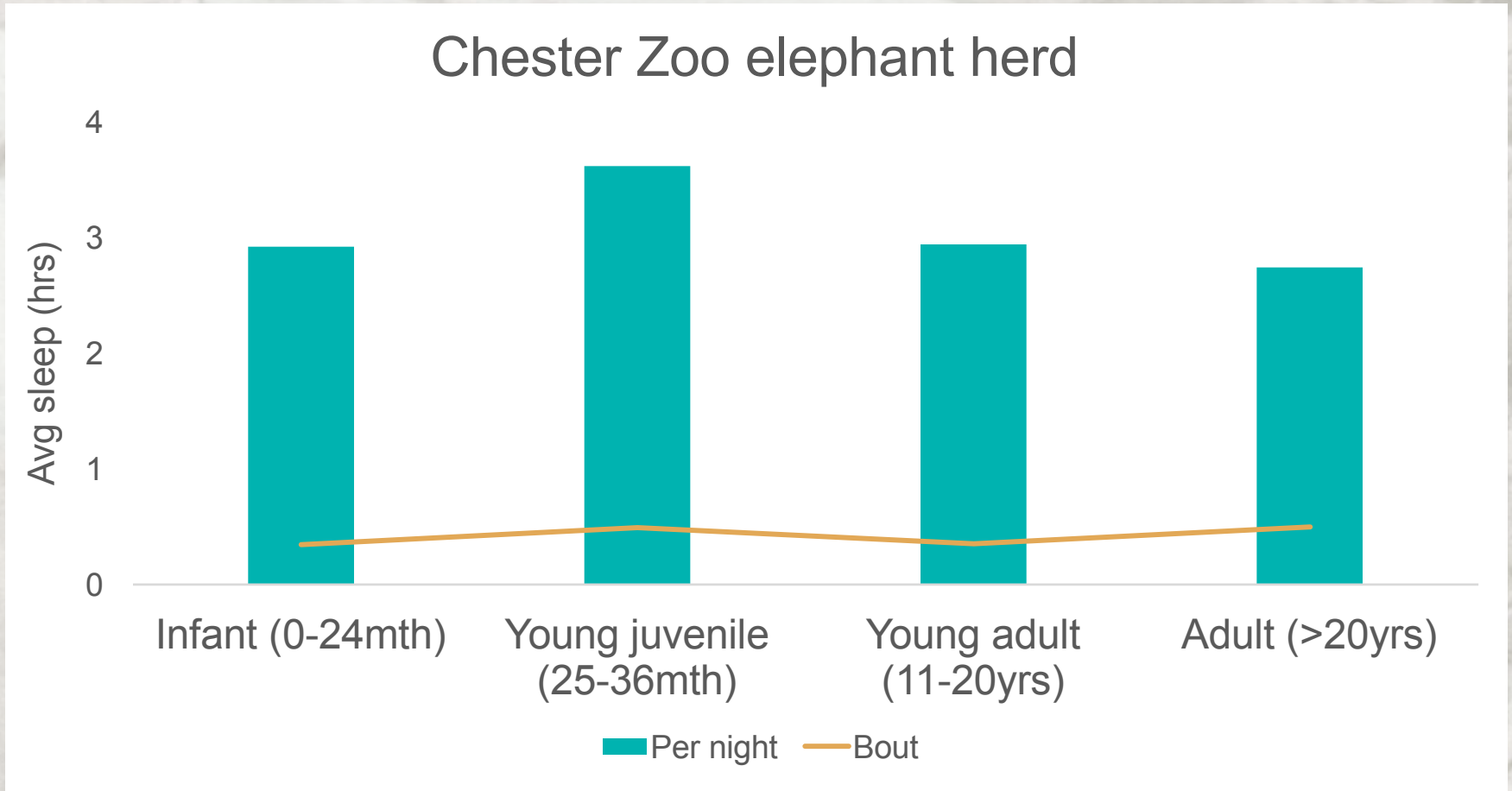
"Evison *et al* (In prep) How Asian elephant sleep behaviour and proximity can be an measure for social compatibility and optimal welfare"

Results – overall duration



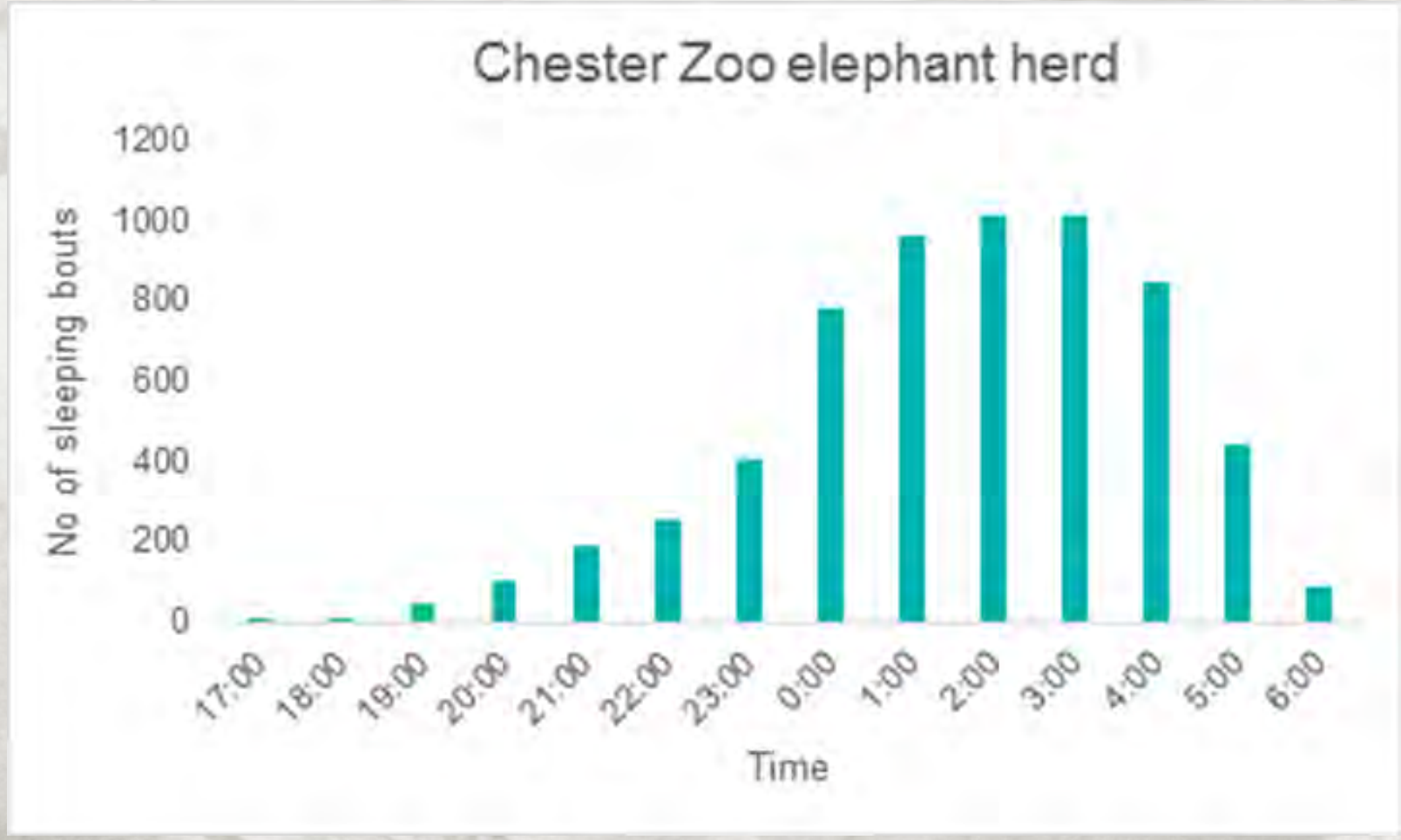
"Evison *et al* (In prep) How Asian elephant sleep behaviour and proximity can be an measure for social compatibility and optimal welfare"

Results – age groups



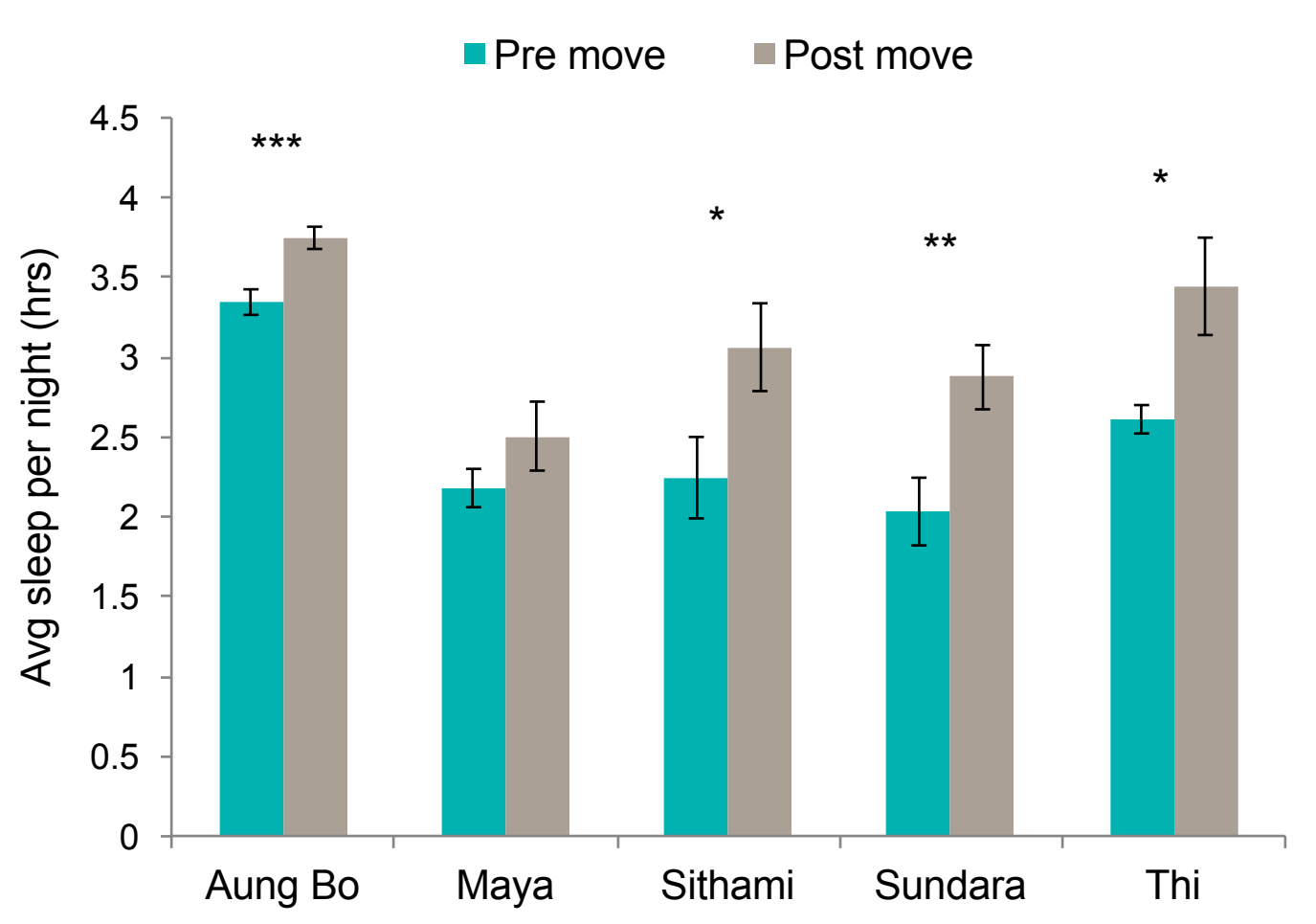
"Evison *et al* (In prep) How Asian elephant sleep behaviour and proximity can be an measure for social compatibility and optimal welfare"

Results – time of sleep



"Evison *et al* (In prep) How Asian elephant sleep behaviour and proximity can be an measure for social compatibility and optimal welfare"

Results - Compatibility



"Evison *et al* (In prep) How Asian elephant sleep behaviour and proximity can be an measure for social compatibility and optimal welfare"

Wild Comparison

- Seasonal variation seen in the wild and captivity
- Age differences – Infants and young juveniles sleep more than the adults
- Time period in which they sleep similar to the wild
- Limited wild/range data



Possible technology

- Data loggers (Stokes, 2016 MSc study)
  - 3 axis accelerometer (standing or lying)
  - Temperature
  - Humidity

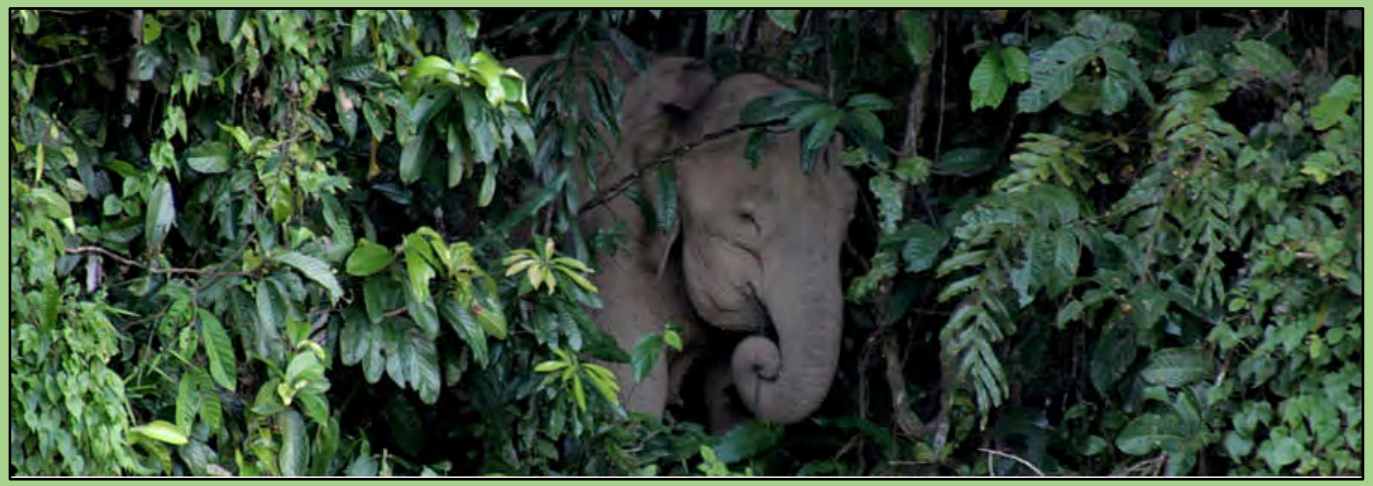
- Fitness trackers
  - Steps and distance
  - Sleeping duration

Thank you for listening



Elephant resource-use and food plant preferences in the Lower Kinabatangan Wildlife Sanctuary, Sabah

By Megan English
PhD



TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI
VICTORIA
UNIVERSITY OF WELLINGTON

ZOOS VICTORIA
WERRIBEE MELBOURNE HEALESVILLE

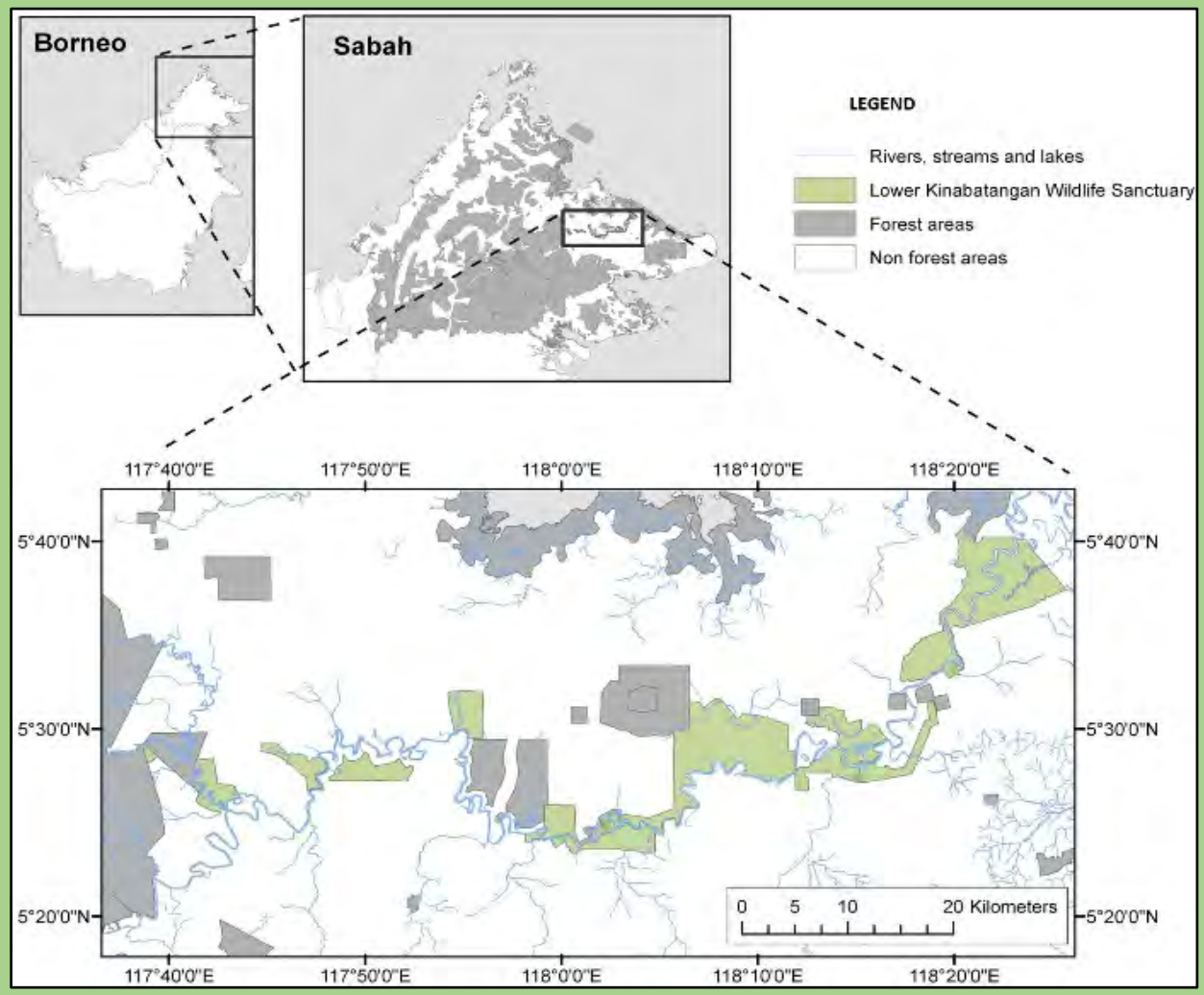
HUTAN

DANAU GIRANG • FIELD CENTRE •

Elephas maximus borneensis






Borneo
Sabah
LEGEND
Rivers, streams and lakes
Lower Kinabatangan Wildlife Sanctuary
Forest areas
Non forest areas
117°40'0"E
117°50'0"E
118°0'0"E
118°10'0"E
118°20'0"E
5°40'0"N
5°30'0"N
5°20'0"N
0 5 10 20 Kilometers



Resource-use studies and habitat conservation

- How animals utilise and navigate a landscape – essential to understanding ecological and population processes
- Feed quality & spatial distribution of resources – influences foraging strategies
- Herbivores for example may use the landscape in ways that are efficient but also in ways that enhance their resources
- May be achieved by repeated use of resources over different temporal scales –these patterns are a product of how and animal adjusts to & influences its environment
- Recognising these patterns has benefits for conservation – incorporated into management strategies and assessment

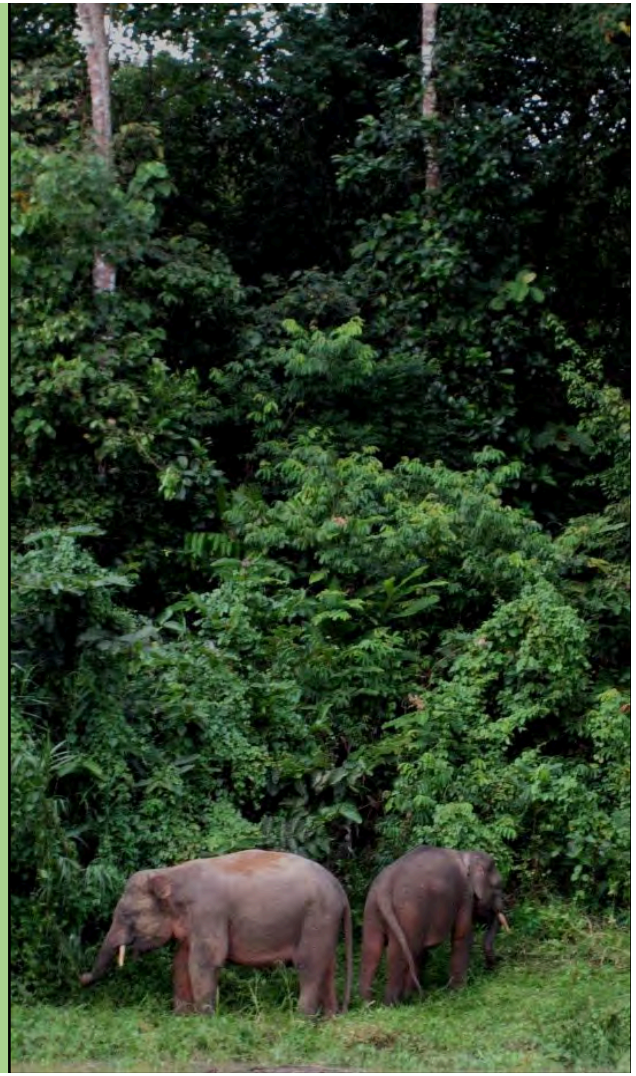
Recursion

- Occurs at varying spatial e.g. habitat, site, plant and temporal scales e.g. short-term or long-term
- Few studies on large wild herbivores
- Resource recovery
- Reflection of movement patterns

English, M., Ancrenaz, M., Gillespie, G., Goossens, B., Nathan, S., & Linklater, W (2014). Foraging site recursion by a megaherbivore (*Elephas maximus borneensis*). *Current Zoology*, 60: 551-559.

Site recursion to measure habitat quality

- Amount of time at site per visit
- How frequently they return to a site
- Previous methods may under-or over-estimate resource importance
- Repeated visits & more time per visit may identify species-specific high quality areas



Hypotheses

1. More time at recursion compared to non-recursion sites

2. Recursion at two temporal scales – long and short-term

3. Sites with specific characteristics will influence recursion

-preferred food plants (such as grasses including bamboos)

-close to fresh water source

-further from ongoing human habitation

-canopy cover allowing for increased understorey growth



Determining site location

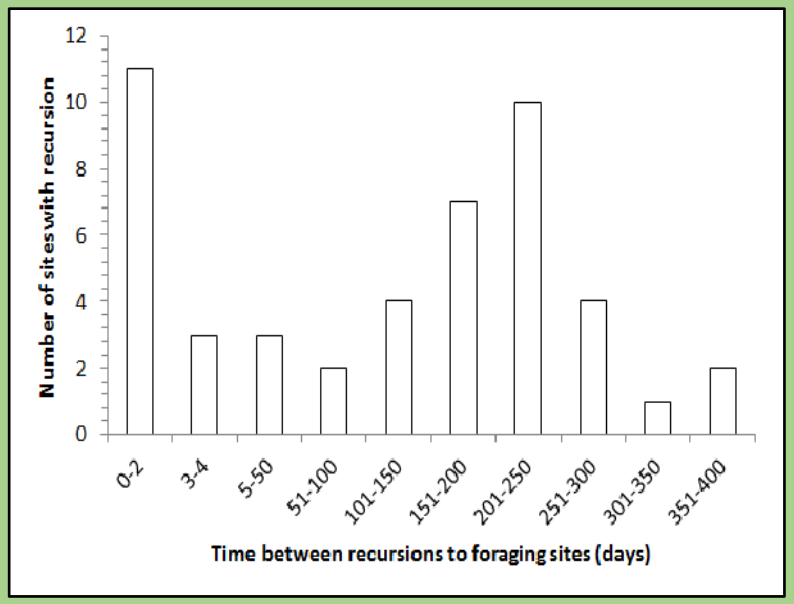
- Two adult females from separate herds collared
- Positions recorded hourly for a year
- Direct observations of site use
- Habitat characteristics at sites used throughout range

Defining and measuring site recursion

- Site defined as an area with 100m radius from centre of herd – 87 foraging sites in total
- Using GPS points from collars uploaded to Google Earth the number of returns to foraging sites was quantified over 12 months
- Density of GPS points within site as measure of time at site per visit
- Time period between recursions quantified

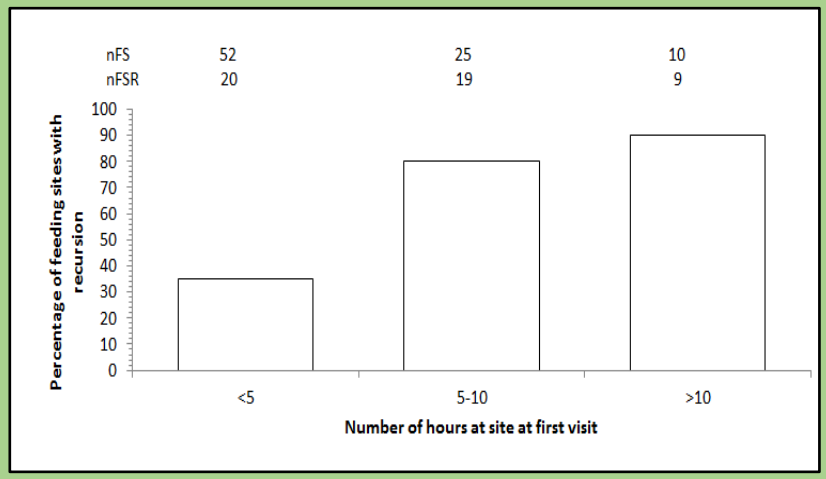
Results

1) Recursion frequency



*Two peaks in recursion times

2) Time spent at recursion sites



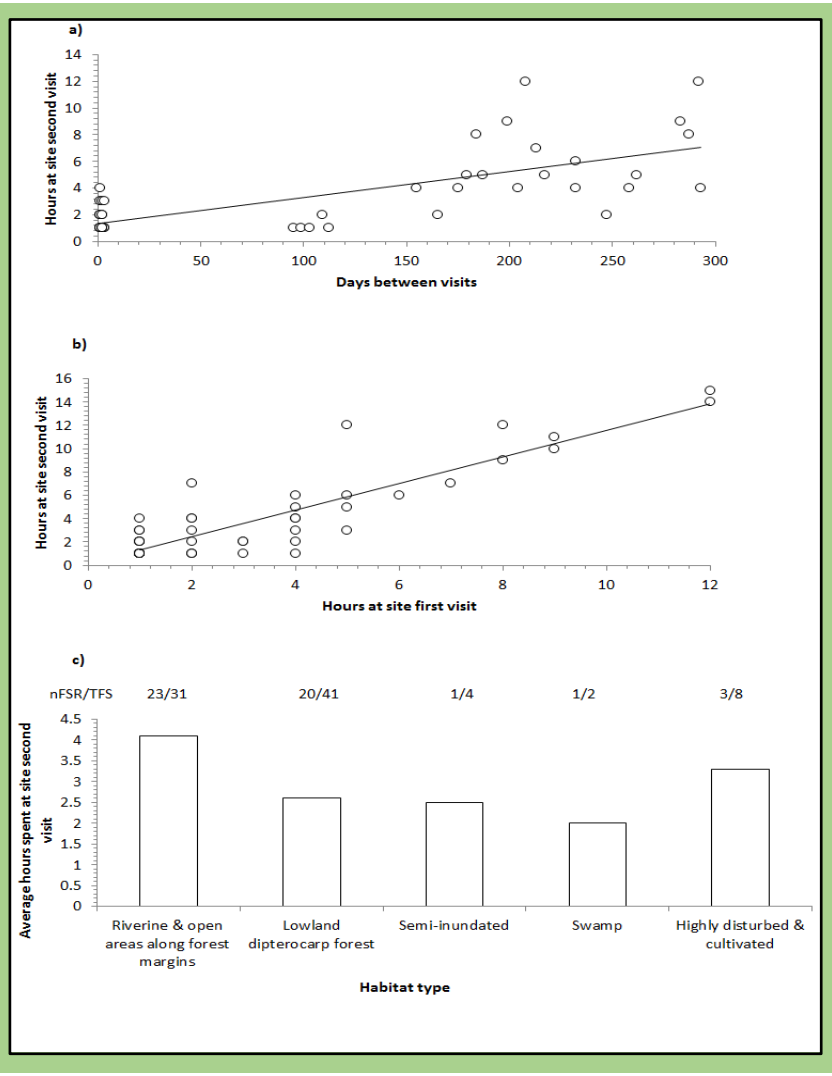
*Recursions more common to sites where more time spent in the past

3) Variables influencing time at site

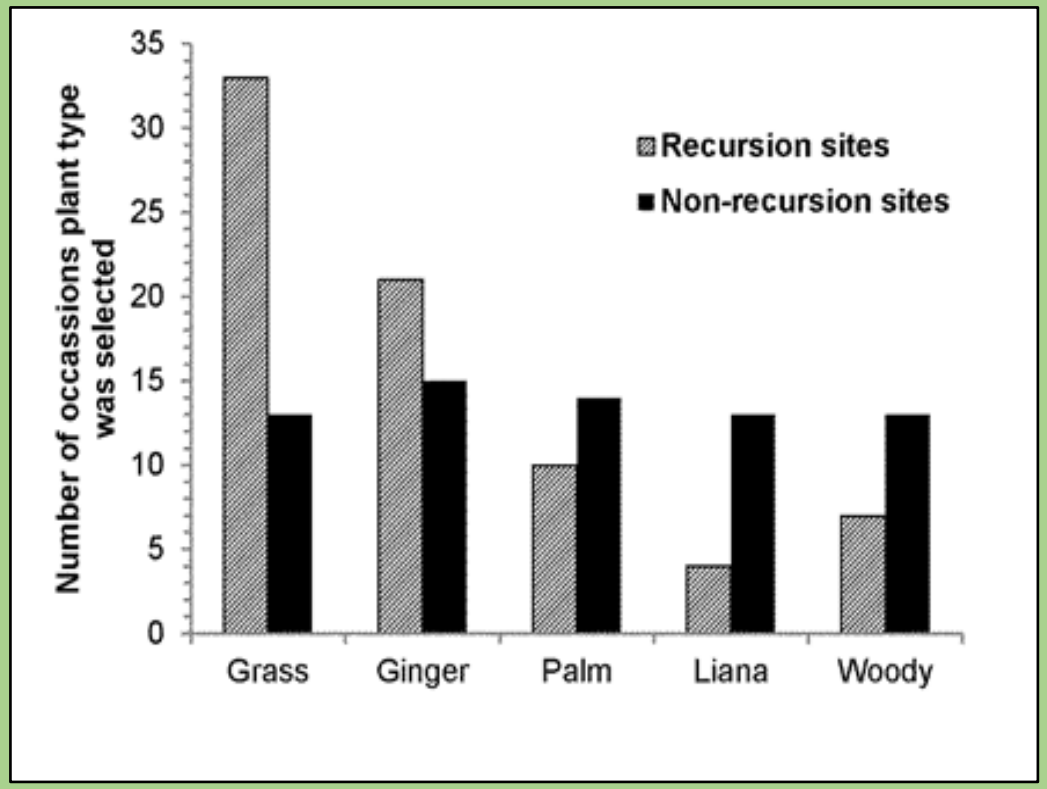
***Days between recursions greater if more time spent at site in the past – more time for resources to recover**

***More time spent at sites at recursion if more time spent there in the past – an indicator of high quality/key resource sites**

***75% of sites in Riverine/Grass areas returned to compared to < 50% in other habitat types and more time spent feeding in these sites**



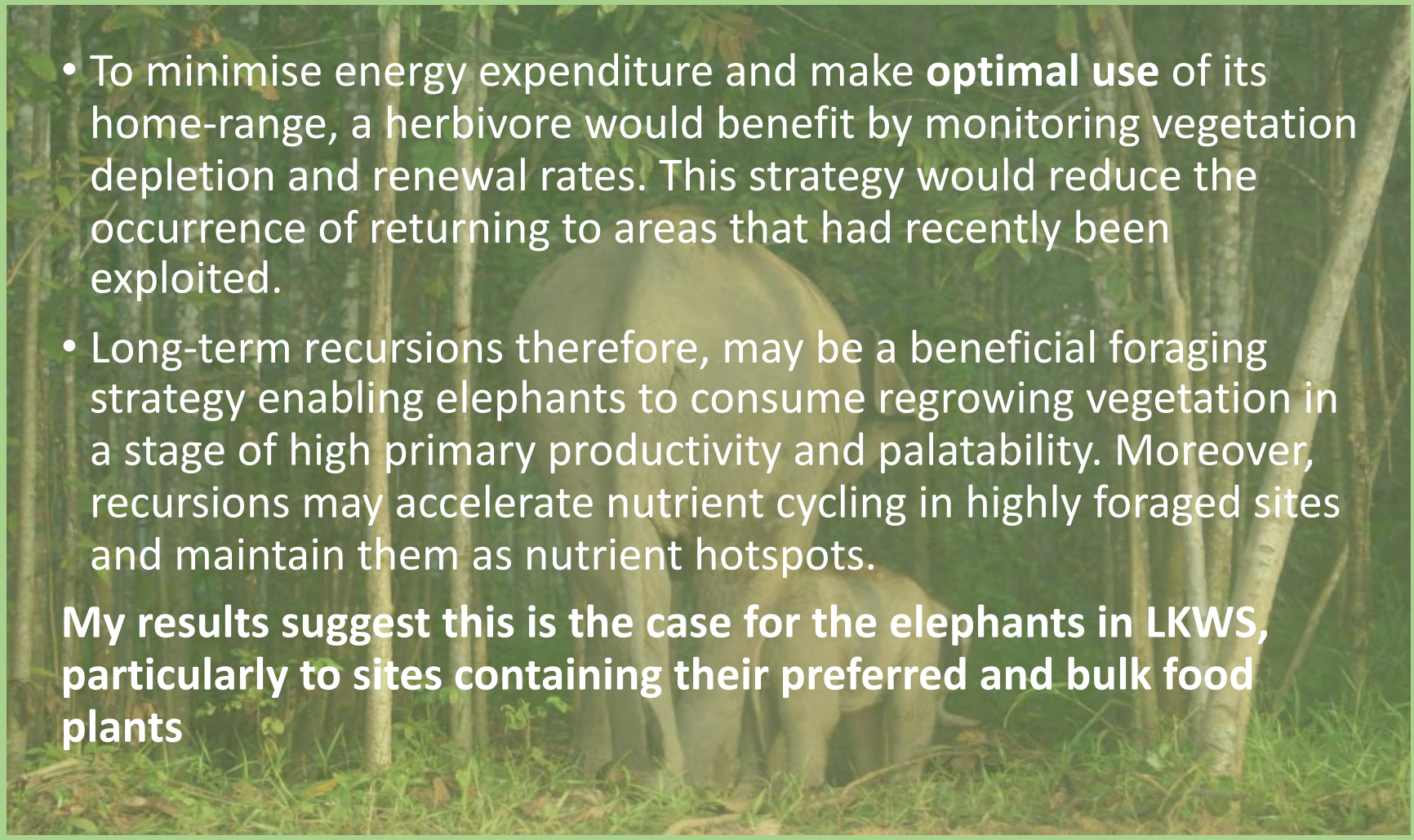
4) Food plant preferences and site recursion



***Grasses including bamboos more common at recursion sites compared to sites not returned to in the 12 months**

In summary…….

- Recursions to specific sites containing preferred resources, such as **grasses and bamboos**, occurred **frequently** and **more time was spent at these sites** per visit. Therefore these sites should be considered **high quality** for the species.
- Furthermore, If sites were utilised longer at the first visit **then more days passed** until the site was revisited, **allowing for resource recovery** as more time spent foraging at sites would result in more resources being depleted.



- To minimise energy expenditure and make **optimal use** of its home-range, a herbivore would benefit by monitoring vegetation depletion and renewal rates. This strategy would reduce the occurrence of returning to areas that had recently been exploited.
- Long-term recursions therefore, may be a beneficial foraging strategy enabling elephants to consume regrowing vegetation in a stage of high primary productivity and palatability. Moreover, recursions may accelerate nutrient cycling in highly foraged sites and maintain them as nutrient hotspots.

My results suggest this is the case for the elephants in LKWS, particularly to sites containing their preferred and bulk food plants

Implications for habitat management

- Recursion sites should be a priority in the design and management of reserves
- Loss of access to recursion sites, due to anthropogenic or natural disturbances, may lead to increased HEC
- Establish protected corridors linking recursion sites
- Buffer zones and preferred food-plants interspersed within cultivated crops
- Replanting degraded forest with preferred food-plants

Thank you

- Thesis title

'Resource-use and recursion by a megaherbivore *Elephas maximus borneensis'* available online researcharchive.vuw.ac.nz

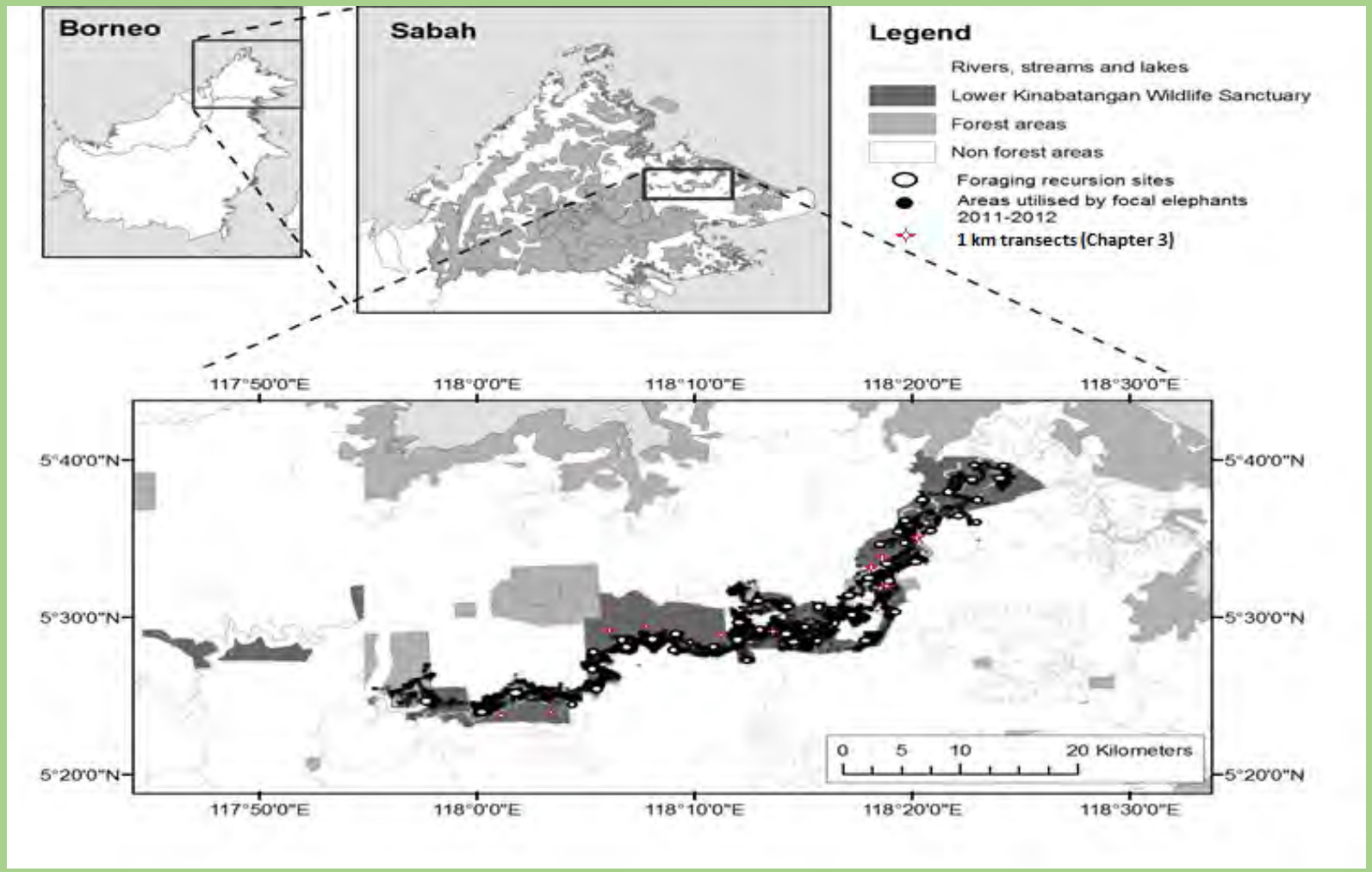
- Other publications from thesis:

English *et al*. (2014). Plant selection and avoidance by the Bornean elephant (*Elephas maximus borneensis*) in tropical forest: does plant recovery rate after herbivory influence food choices? . **Journal of Tropical Ecology, 30, pp 371-379 doi:10.1017/ S0266467414000157**

English *et al*. (2015), Recursion to food plants by free-ranging Bornean elephant. **PeerJ 3:e1030**; **DOI 10.7717/peerj.1030**

Email: megs.english@gmail.com




Borneo
Sabah
Legend
Rivers, streams and lakes
Lower Kinabatangan Wildlife Sanctuary
Forest areas
Non forest areas
Foraging recursion sites
Areas utilised by focal elephants 2011-2012
1 km transects (Chapter 3)
117°50'0"E
118°0'0"E
118°10'0"E
118°20'0"E
118°30'0"E
5°40'0"N
5°30'0"N
5°20'0"N
0 5 10 20 Kilometers

A case report treatment of iron storage disease in a black rhinoceros in western Europe



Linda Bruins – van Sonsbeek, DVM
Rotterdam Zoo, the Netherlands

15th International Elephant & Rhino Conservation and Research Symposium
Wednesday 16th of November 2016: 14:15 – 14:30, Singapore Zoo

Case and monitoring introduction



GAN Identifiers	10779275
Current Enclosure	Black Rhino 001.148
Sex	Male
Scientific Name	Diceros bicornis michaeli
Common Name	Eastern black rhinoceros
Birth	08/11/2001
Age	14Y 9M 18D
Arrival	12/09/2013
Owner	BEKESBRNE
Holder	ROTTERDAM
Last Weight Add New Weight	~1.400 kilogram (03/04/2015)
Collection	Main Institution Animal Collection
Health Status	Normal (01/08/2014)
Body Condition Score	5/9 (14/10/2013)

- Weekly blood samples for monitoring hematology (EDTA whole blood: Medonic) and chemistry (heparin plasma; Spotchem) in house
- Monthly monitoring iron values (serum send to Veterinary Faculty in Utrecht for measuring iron (Fe^{2+}), iron saturation and total iron binding capacity)
- Analyzing all roughage for iron (separate low iron batches), give branches every day

Our case: Black rhino male Vungu



- GGT levels up to 131U/L (ISIS referential values in ZIMS for black rhino: 6-54U/L)
- Iron saturation was up to 99%

- Since january 2015:
  - Reduced appetite
  - Laying a lot more than usual
  - No more hair on ear rims

The nutrition is probably still t iron rich, or some other factors play a role as well …



TIME FOR ACTION!

Our case: Black rhino male Vungu

- Chelators ?!
- General anesthesia (combination of Immobilon (2.25 mg etorphine/ml, Pharmacy Veterinary Faculty Utrecht) with Zalopine® (10 mg medetomidine/ml, Orion Pharma Animal Health)
  - Goal 8-10L
  - After 8,5L saturation dropped and decision was made to stop the procedure and give him antidote (nalaxon with atipamezole)
- After one phlebotomy under general anesthesia intensive training program for phlebotomy without anesthesia



Requirements Large Volume Phlebotomy in Black Rhino

- Training of animals
  - for blood collection
  - for being comfortable around people
  - to stand still for long periods of time
  - keep it positive
- 3 people needed for procedure
  - handling animal, needle control, flow control
  - good communication during procedure essential (flow codes)
- Chute/crush to work safely on the animal
- Heat for dilate the veins
  - warm environment (ca 23c/73f)
  - warm water (30-35c/86-95f)



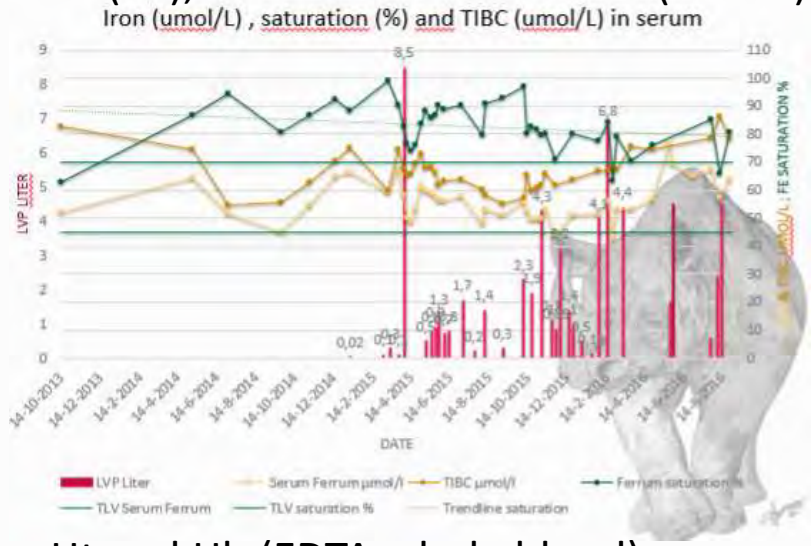
Requirements Large Volume Phlebotomy in Black Rhino

- Redon vacuum drainage system
  - Privac 600 ml, OK-model, hoose 125 cm, Large Lock Connector
  - Vacuum 0.9-1 bar
- Hoose-needle connector
  - Male luer lock ring x 1.8 inch hoose barb, Nylon, 25/pk
- Needle
  - 1 inch 18G (Luer Lock
  - > 1.5 inch does NOT work
- Additional: Coolspray (chloor-ethyl)

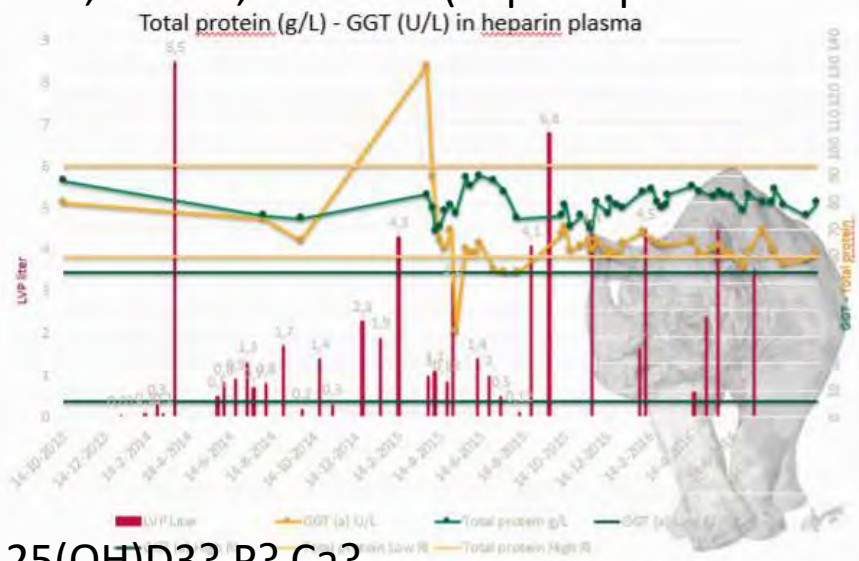


Monitoring Large Volume Phlebotomy and the general health in our black rhino

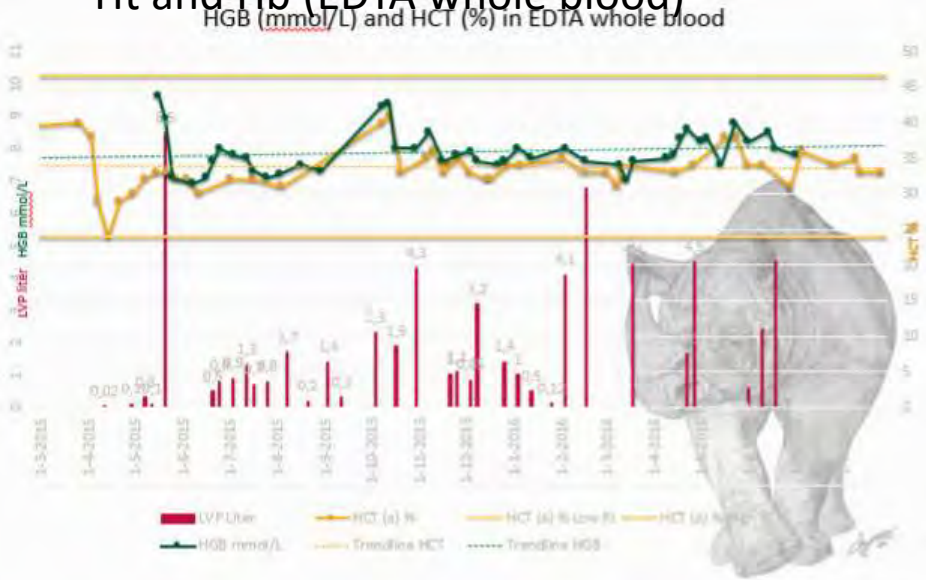
- Fe (2+), Fe saturation and TIBC (serum)



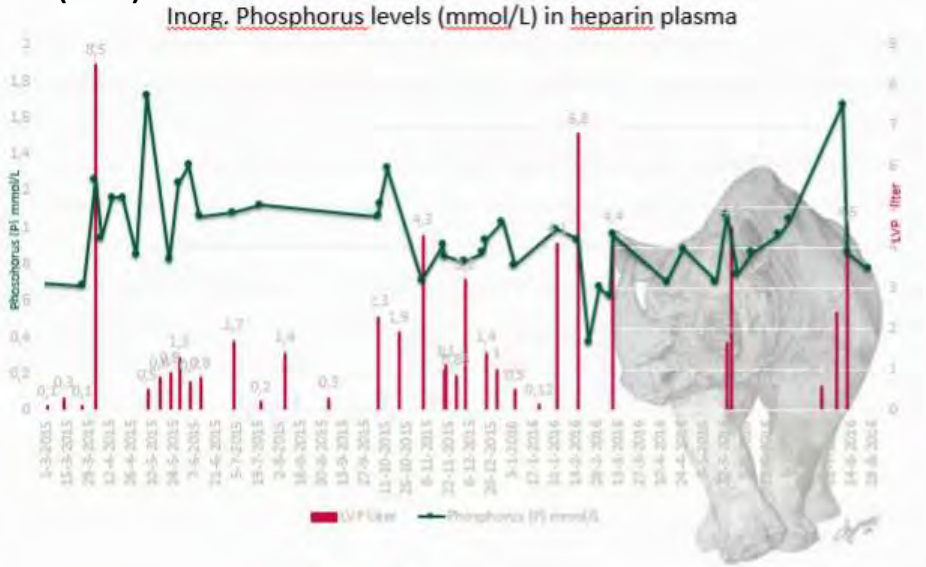
- GGT, ureum, creatinin (heparin plasma or serum)



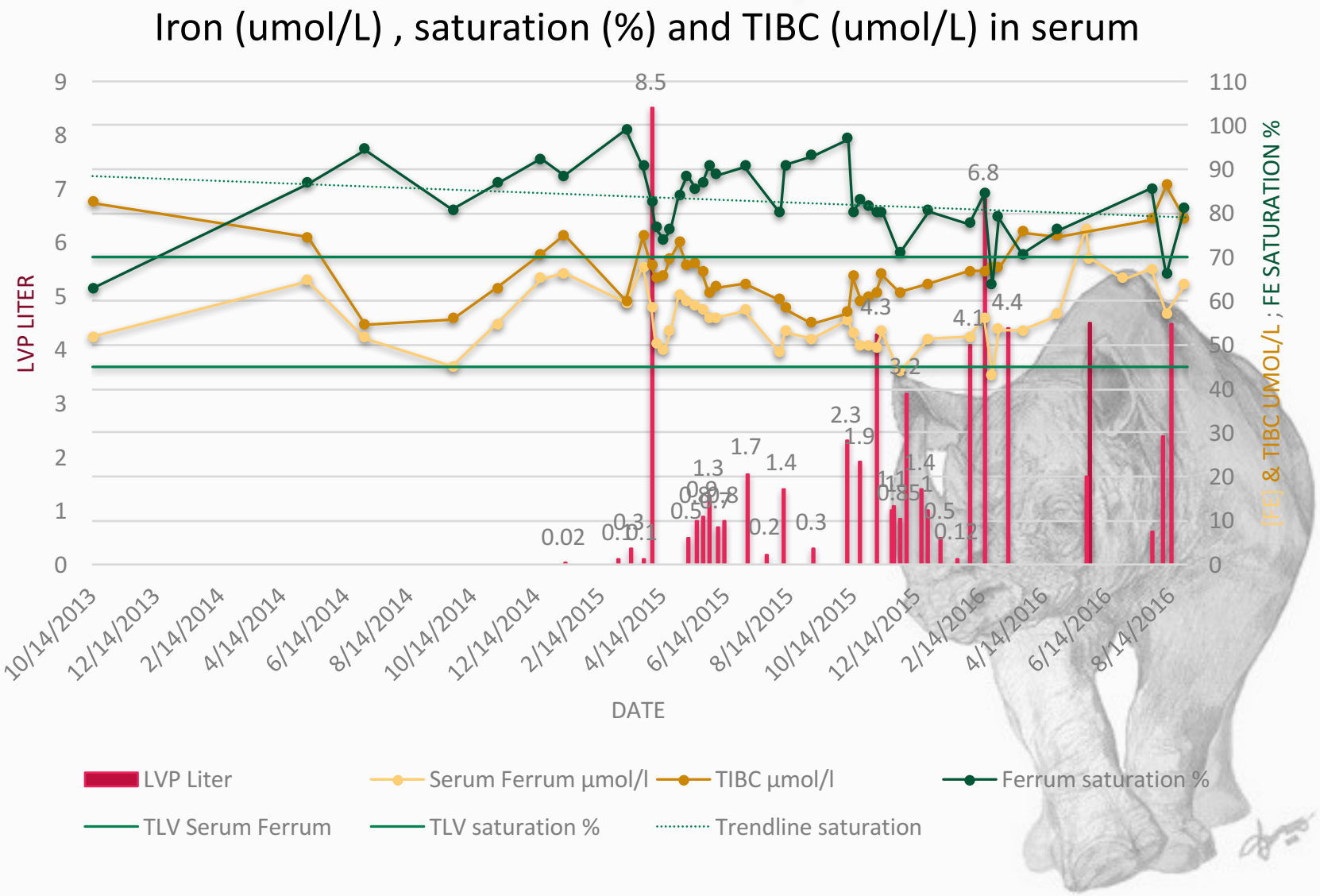
- Ht and Hb (EDTA whole blood)



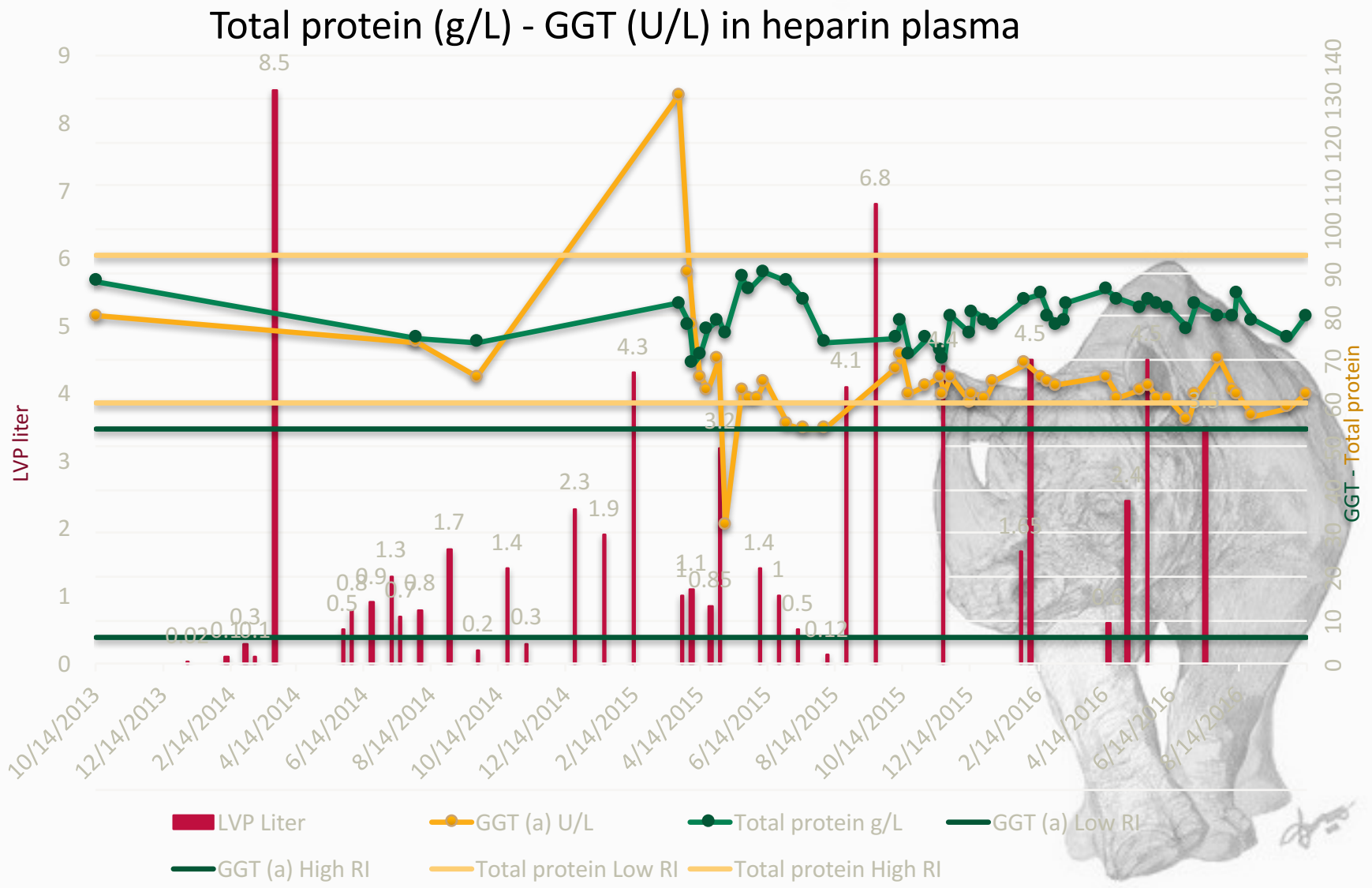
- 25(OH)D3? P? Ca?



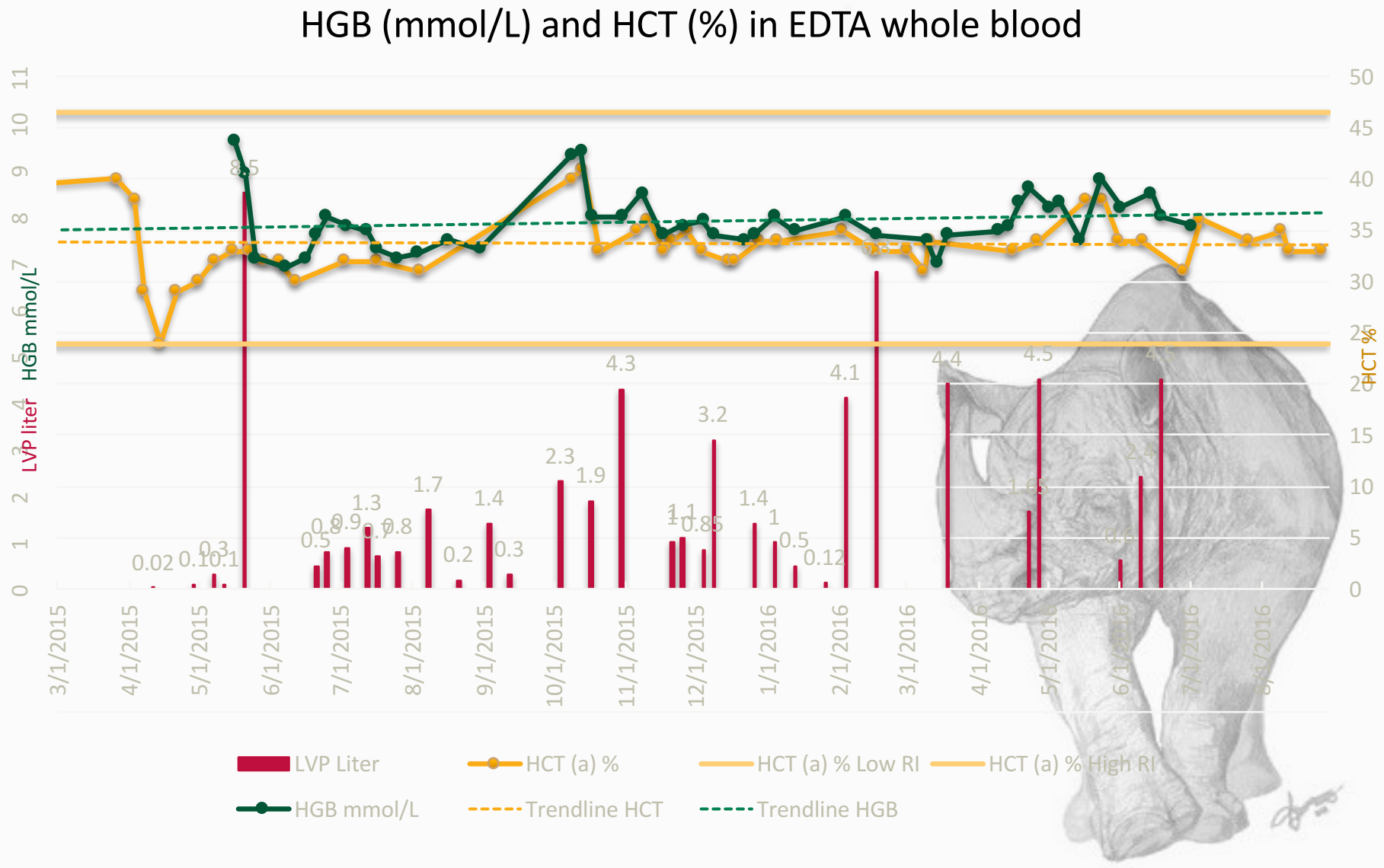
Monitoring Large Volume Phlebotomy in Black Rhino



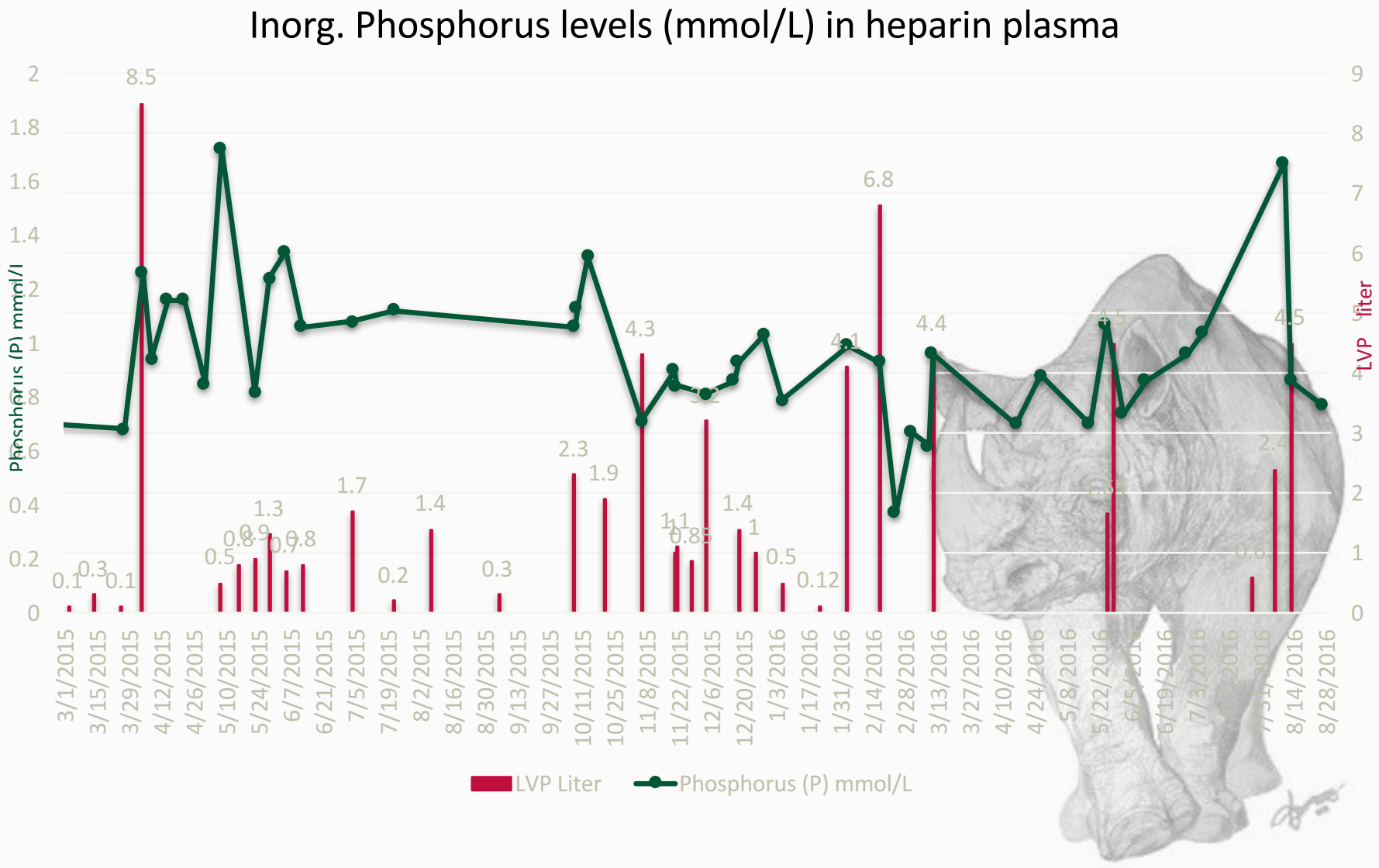
Monitoring Large Volume Phlebotomy in Black Rhino



Monitoring Large Volume Phlebotomy in Black Rhino



Monitoring Large Volume Phlebotomy in Black Rhino



Our advice regarding monitoring and ‘treatment of’ iron storage disease in captive black rhino

- Test animals regularly (every 3 months minimum)
  - Fe (2+), Fe saturation and TIBC (serum) (maybe some day ferritin?)
  - Ht and Hb (EDTA whole blood)
  - GGT, ureum, creatinin (heparin plasma or serum)
  - 25-OH D3? P? Ca?
- Minimize iron intake
  - Test every batch of roughage
  - Use pellets with low amount of iron
  - <6000 mg daily uptake [Clauss], our experience <4000 mg



And how is our case doing now…





- Eating a lot
- Walking around more than before
- Mating with our younger female



Acknowledgments

Thank you to all my collegues at the zoo and a special thank you to our senior keeper Melle van Iperen and the Africa head keeper Ben Westerveld and head curator Harald Schmidt!

Thank you Disney animal kingdom for the information for/to our keepers about the phlebotomy



Literature

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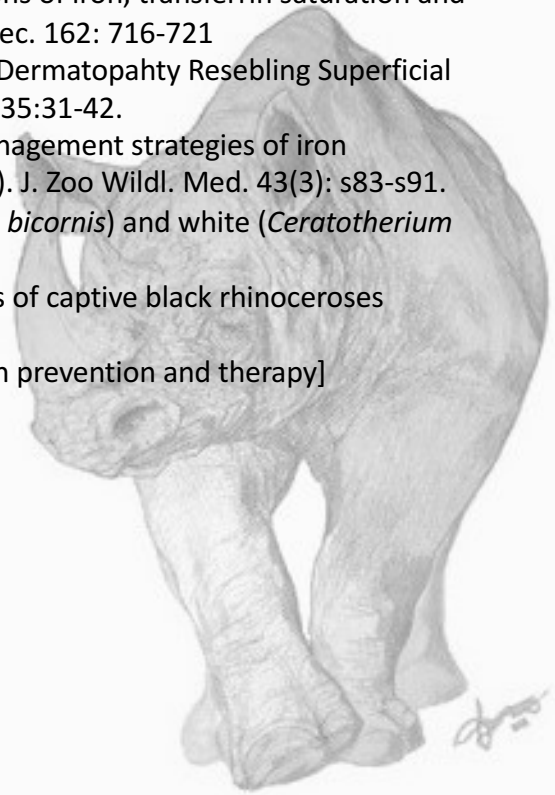


Validation of a rhino specific ferritin enzyme immunoassay for the black rhino (*Diceros bicornis*) and the impact of individual and environmental factors on serum ferritin concentrations



Jessye Wojtusik

Co-Author: Dr. Terri L. Roth

Cincinnati Zoo and Botanical Garden

Center for Conservation and Research of Endangered Wildlife

Cincinnati, Ohio

Iron Overload

Hemosiderosis = deposition of iron in organ tissue

√ African Black and Sumatran (browsers)

X African White and Greater One Horned (grazers)

√ Captive

X Wild



Photo: Mark Dumont

Iron Overload

Hemochromatosis: iron deposition results in damage

- Morbidity due to accumulation in major organs limiting function
- Treatment options often limited in effectiveness
- Important to develop methods to
  - Monitor progression
  - Diagnose disease
  - Evaluate treatment
  - Asses influences

Ferritin

- Acute phase protein complex
- Gene = highly conserved, but protein = species specific
- Binds iron for storage
- Used as indicator of total body iron stores

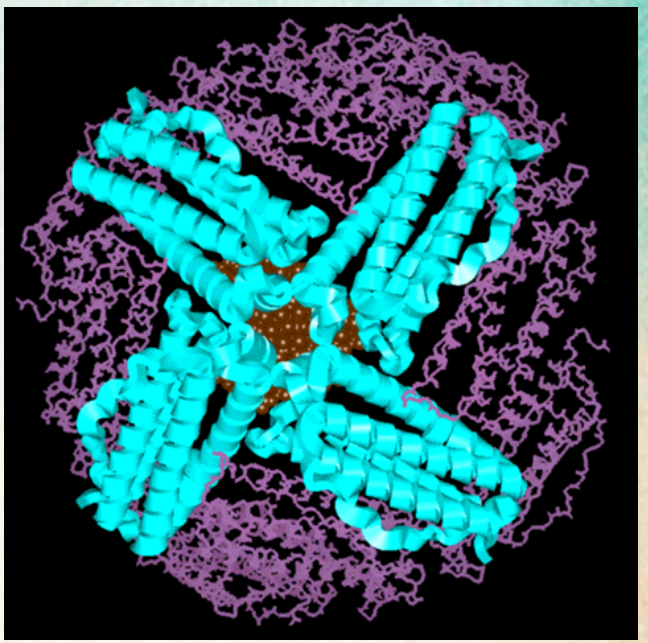


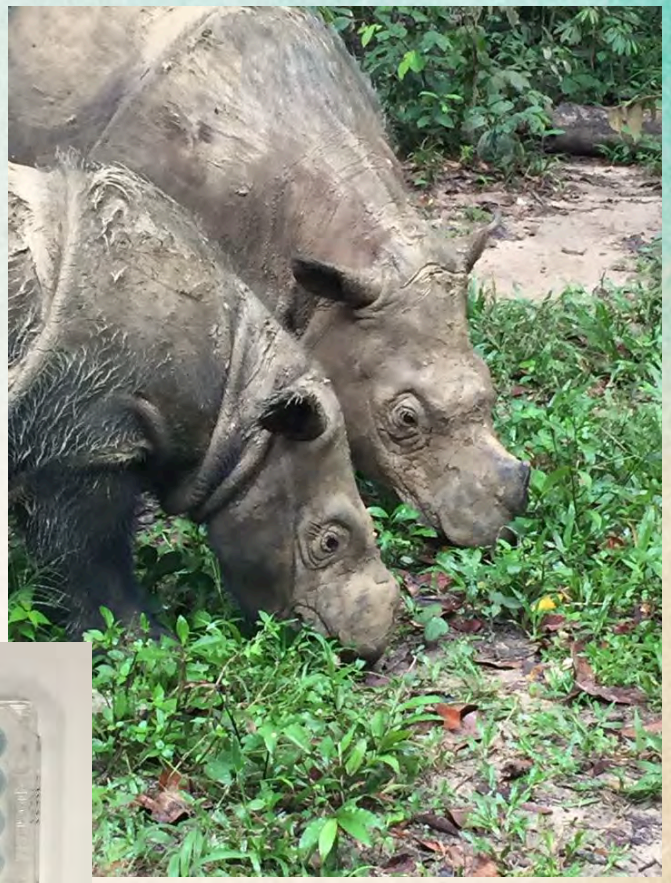
Image: chemistry.wustl.edu

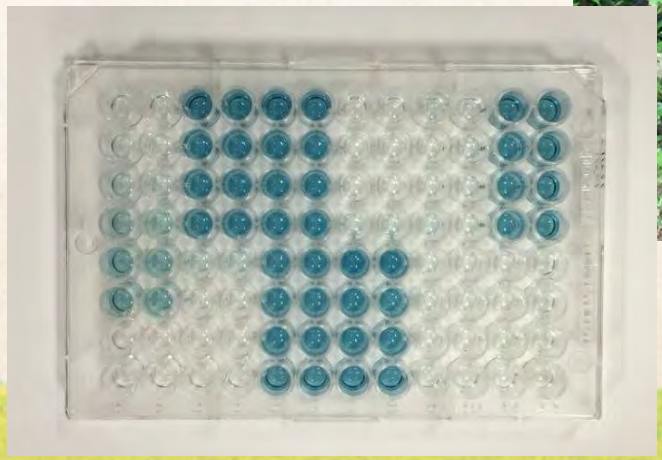
Goals

- To validate rhino ferritin specific assay for the black rhino
- To investigate influence of environmental and individual factors on ferritin concentrations in captive black rhinos
- To determine if serum ferritin is a useful biomarker for progression of iron overload disorder

Methods

A rhino specific ferritin EIA developed for Sumatran rhinos





Methods

- Ferritin was isolated from black rhino liver
  - Gel electrophoresis and western blot
    - Positive Controls: Equine and Sumatran rhino ferritin
    - Potassium ferricyanide stain to confirm isolated protein was positive for iron
- Parallelism with serum
- Mixed model with repeated measures

* **931** samples * **36** animals * **14** institutions *

11 Females (270 samples)
25 Males (661 samples)
18 Southern (611 samples)
18 Eastern (320 samples)
7 Wild Born (400 samples)
29 Captive Born (531 samples)



Photos: Mark Dumont

Results



Individual *
Age *
Sex *
Subspecies *
Location of Birth *

Collection Date
- Month
- Year
- Season

Time in Captivity

Results



Mean: 6,790 ng/ml

SD: 15,904 ng/ml

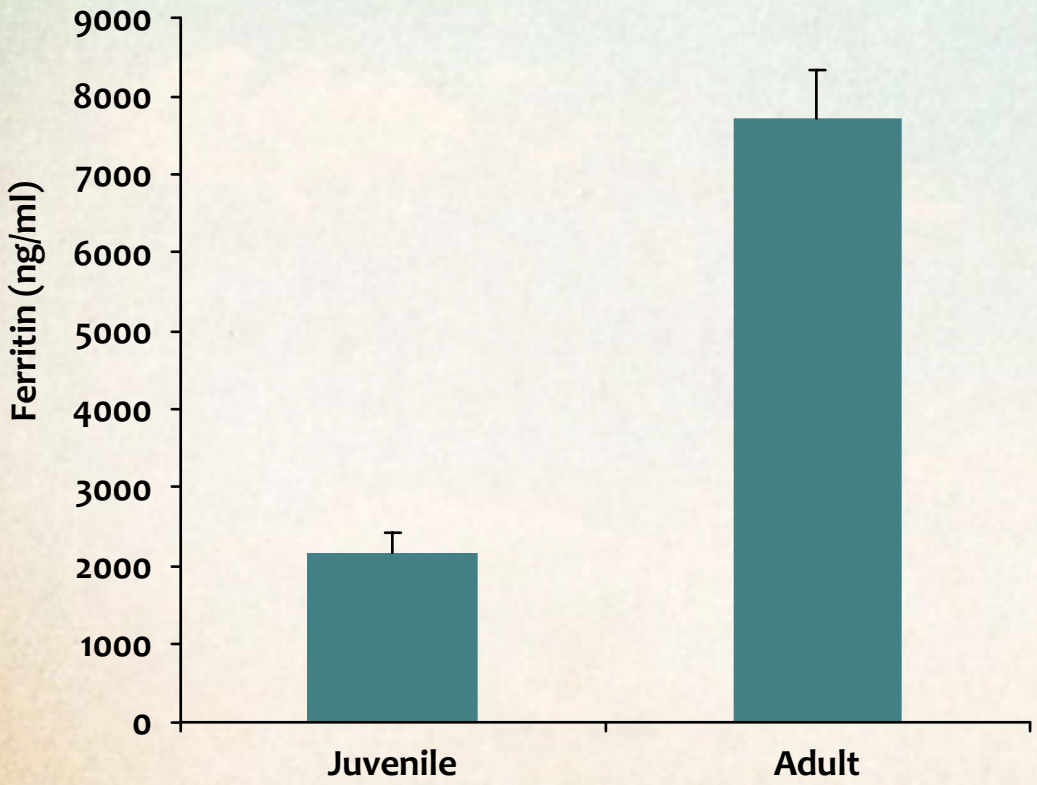
SEM: 521 ng/ml

Range: 168,366 ng/ml

Min: 85 ng/ml

Max: 168,451 ng/ml

Age Group

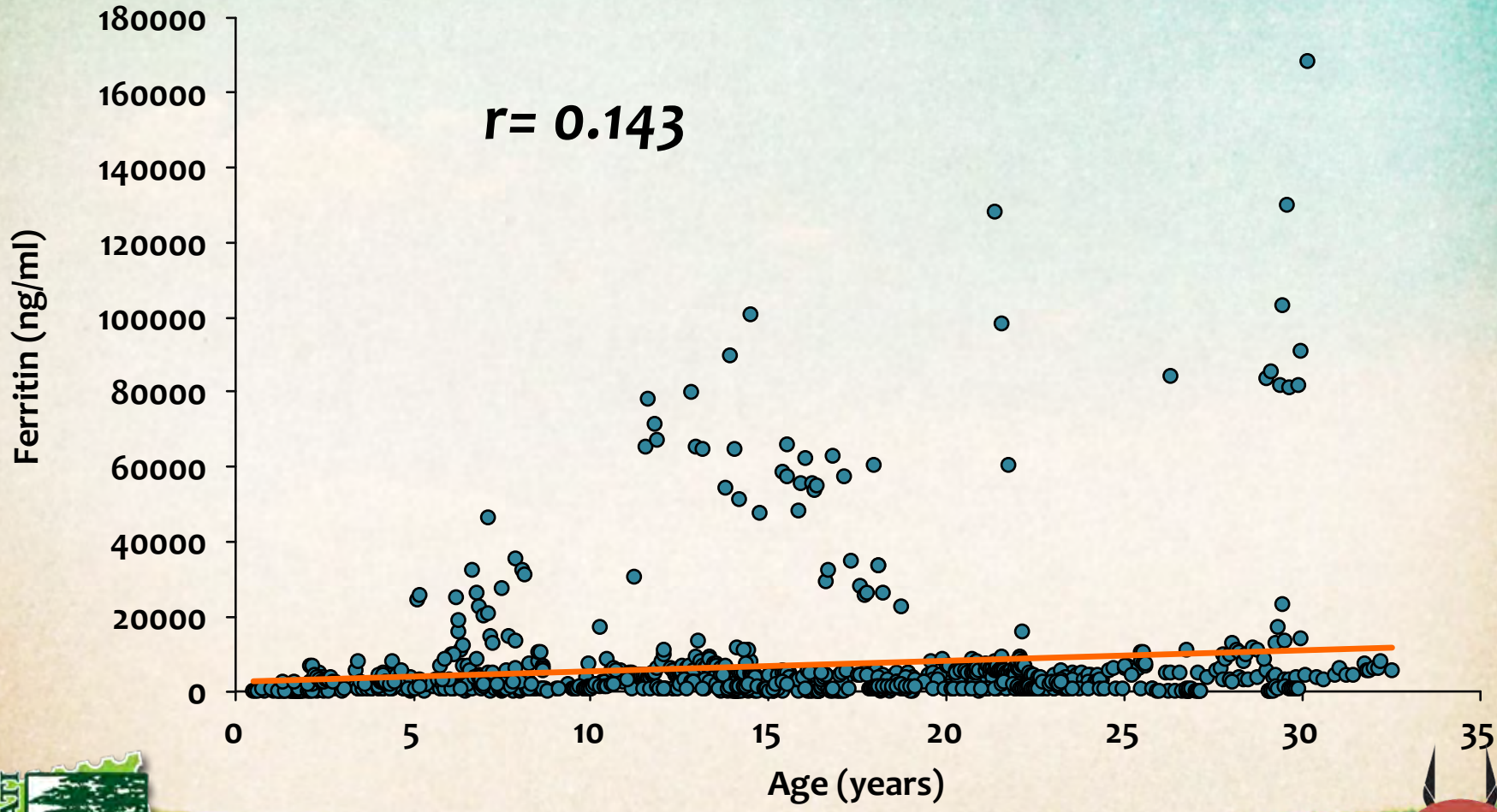


Juvenile: 2,165 ng/ml

Adult: 7,714 ng/ml

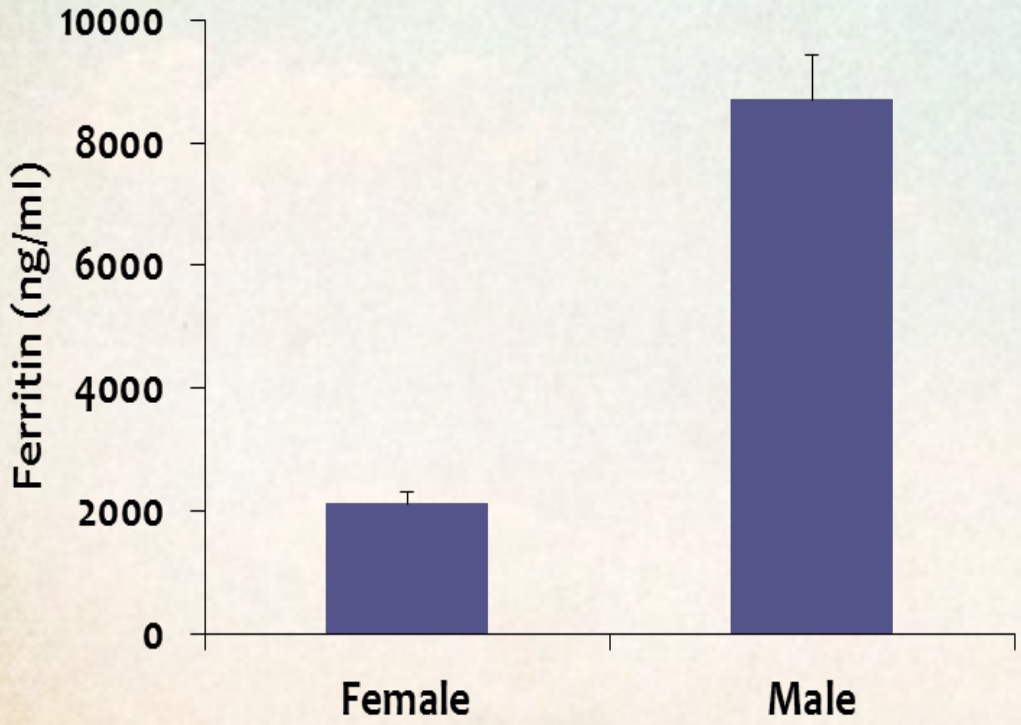
P- value : 0.277

Age



Range: 0-32 years Average: 15 years

Sex

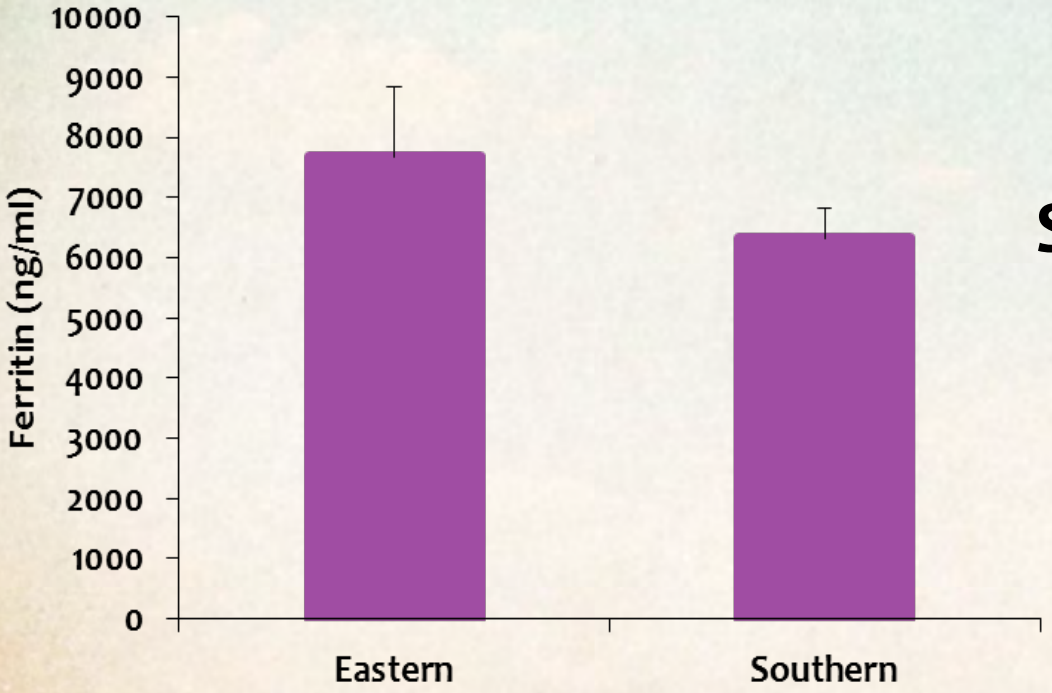


Female: 2,121 ng/ml

Male: 8,697 ng/ml

P- value : 0.339

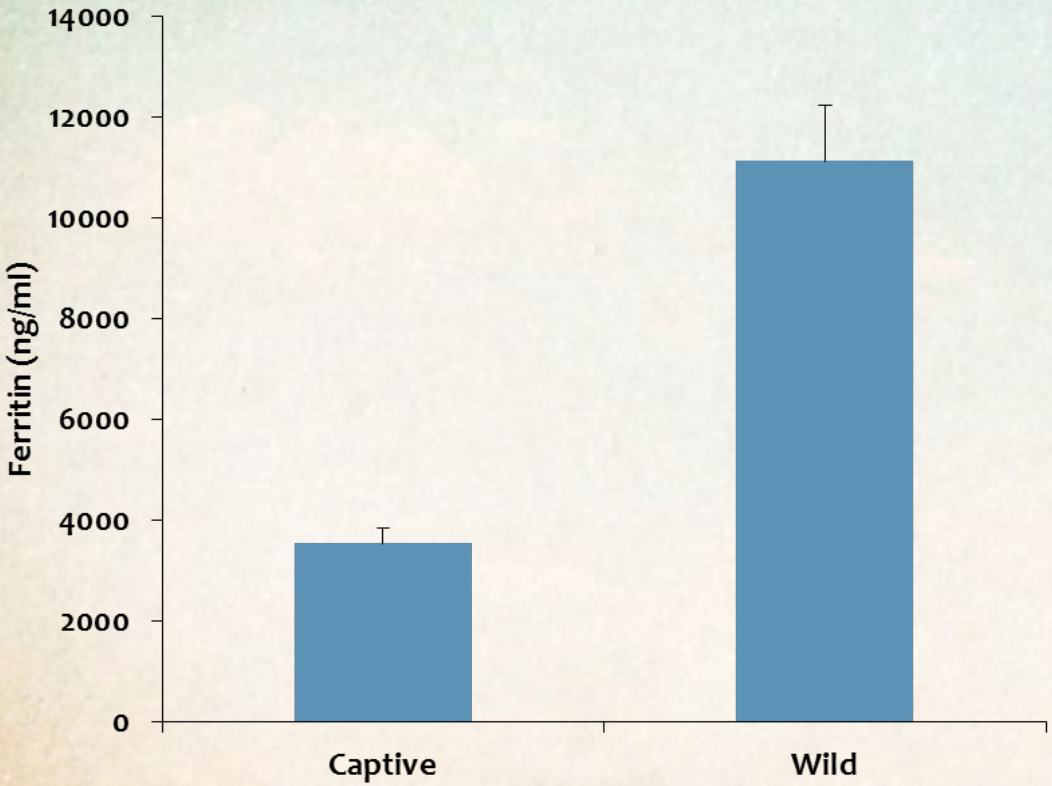
Subspecies



Eastern: 7,674 ng/ml
Southern: 6,327 ng/ml

P- value < 0.05

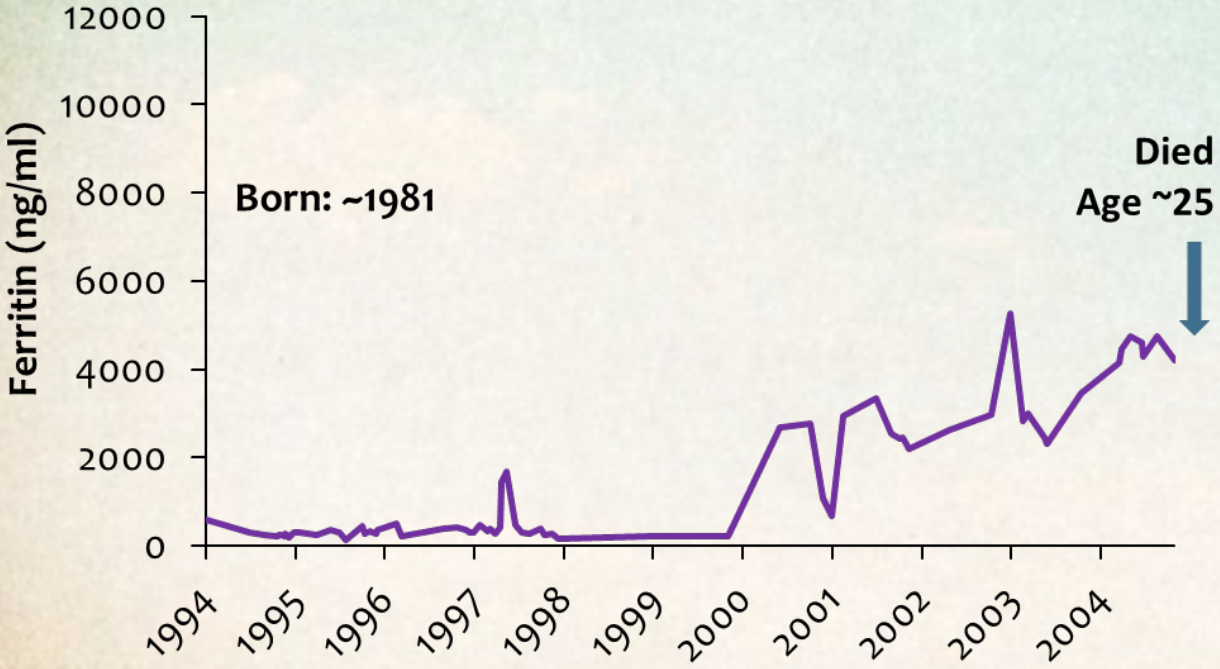
Location of Birth



Captive: 3,536 ng/ml
Wild: 11,109 ng/ml

P- value < 0.05

Case Studies





Values increased 10x +
For over 5 years

Case Studies

Sex	Avg. Ferritin ng/ml	Change in Values	Current Health Status	Hemosiderosis?
F	11,858	consistent	alive and well	Unknown
F	1,152	consistent	died w/in 1 yr	Yes
M	868	↑	died 5 yr later	Yes
M	98,336	consistent	died 6 yr later	Yes
M	23,086	consistent	alive and well	Unknown

Conclusions

- Impacted by: individual, subspecies, and location of birth
- Not impacted by: sex, age, time in captivity, collection date
- Increased concentrations not necessarily linked to hemochromatosis
- Ferritin values are extremely variable



Thank You

Donation of Samples:
Dr. Bruce Christensen
Blank Park Zoo
Brookefield Zoo
Busch gardens
Caldwell Zoo
Cincinnati Zoo
Columbus Zoo
Dallas Zoo
Fort Worth Zoo
Fossil Rim
Milwaukee County Zoo
San Antonio Zoo
San Diego Zoo
St. Louis Zoo
White Oak Conservation Center

Financial Support:
Michael & Tucker Coombe
Anonymous Donor



Effect of drought on African elephant (*Loxodonta africana*) survival in semi-arid savannas of Africa



Yussuf A Wato

Prof. Herbert Prins
Dr. Ignas Heitkonig
Dr. Frank Langevelde
Prof. Geff Wahungu

WAGENINGEN UNIVERSITY
WAGENINGEN UR

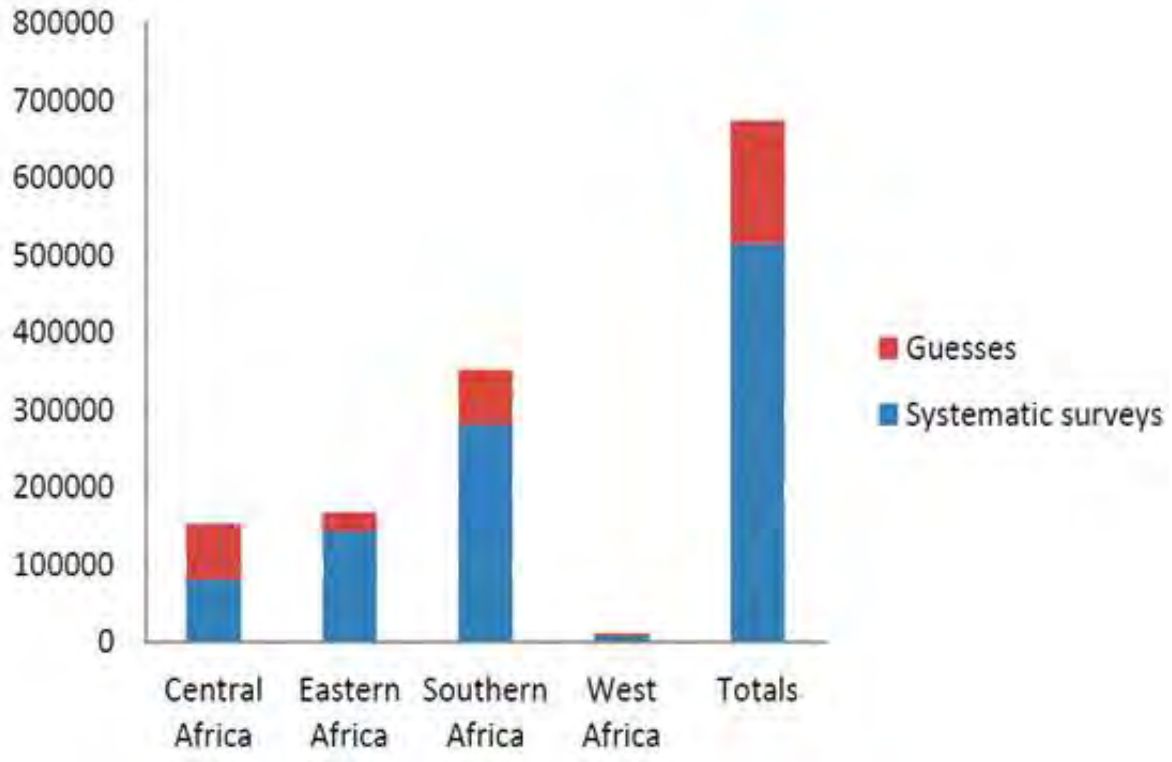
16 November 2016

Why study African Elephants (*Loxodonta africana*)

- Ecosystem engineers – Facilitative role *(e.g. Kohi et al. 2011)*
- Negative impacts to vegetation *(e.g. Beer et al. 2006, Van Aarde & Guldemond 2008)*
- Economic benefit – The "Big Five"

African elephant population is on the decline *(about 500,000)*

(Douglas-Hamilton, 1987, Kyale et al., 2011, Maingi et al., 2012a, Wittemyer et al 2011). ***Chase et al., 2016 – 352,271 -18 countries in Africa***



Africa Elephant Specialist Group - Dec 2013

- ***Poaching***
- ***Land use change***

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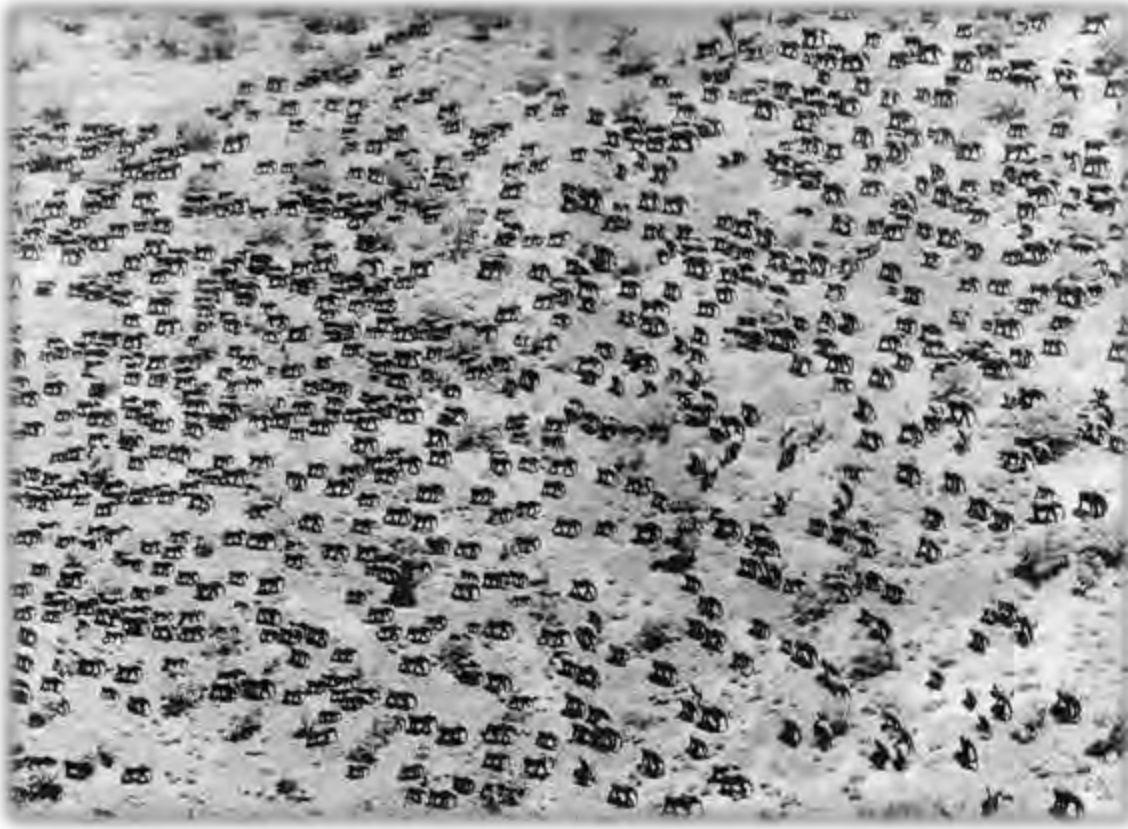
DROUGHT

Climate change

- Frequency and Intensity of drought is increasing .



- Studies of drought induced elephant mortalities are rare;
  - Generalist feeders
  - Ability to migrate
  - Lack of long term mortality data

(Dudley et al., 2001; Foley et al. 2008; Moss et al., 2011; Mumby et al. 2013, Okello et al., 2015).

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- **Elephants in Kenya ~ 38,000**
- **Over 1/2 in arid & semi arid regions**

-2012)









a)

density d) Cumulative rain

Analysis & results

Maxent Model

Elith et al 2006
Philips et al., 2006

Variables	Probability	Direction
Cumulative rainfall (4 months) (150mm)	0.5	-
NDVI (0.1)	0.95	-
Population density (25 eles/km^2)	0.4	+
Season	LW(0.1); LD(0.5)	
Distance to water (0.1 km)	0.65	-

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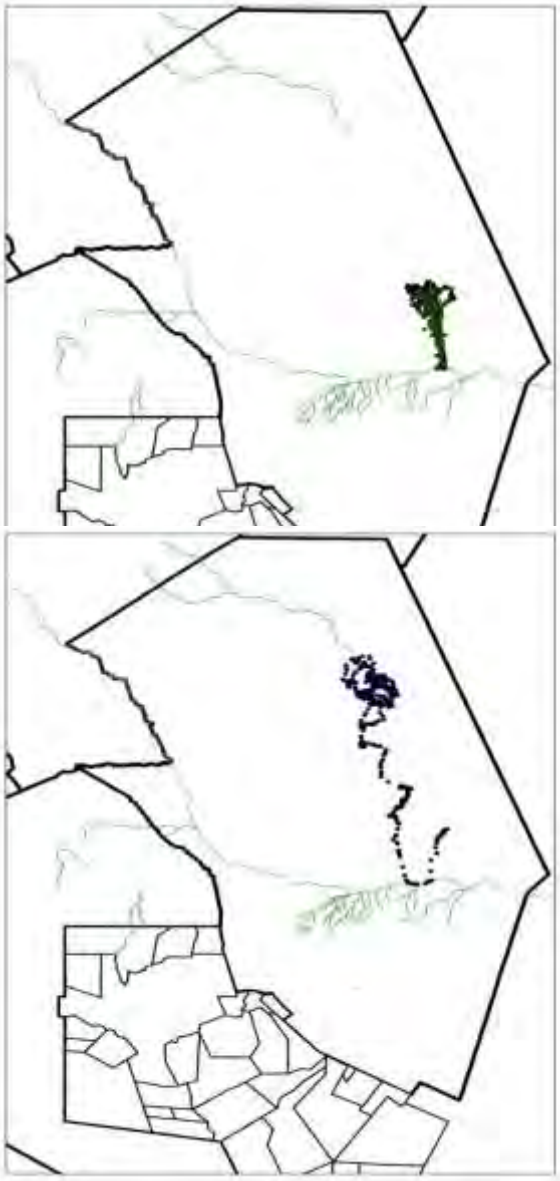
Water predicts distribution of African elephant

(Loxodonta africana)





Discussion

- Low primary production in dry periods may be the cause of elephant death probably, through starvation.

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journal homepage: www.elsevier.com/locate/bioc



Prolonged drought results in starvation of African elephant (*Loxodonta africana*)

Yussuf A. Wato [a,b,*], Ignas M.A. Heitkönig [a], Sipke E. van Wieren [a], Geoffrey Wahungu [c], Herbert H.T. Prins [a], Frank van Langevelde [a]

[a] Resource Ecology Group, Wageningen University, Droevendaalsesteeg 3a, 6708 PB, Wageningen, The Netherlands
[b] Kenya Wildlife Service, P.O. Box 40241-00100, Nairobi, Kenya
[c] National Environment Management Authority, P.O. Box 67839-00200, Nairobi, Kenya

Recommendation

- Create water-points away from the rivers
- Pay cognisance to elephant distribution and movement pattern to prevent homogenisation of elephant impacts
- Land-use planning – Migratory corridors

Thank you



KENYA WILDLIFE SERVICE
World Class Parks!

IFAW
International Fund for Animal Welfare

nuffic

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Endocrine Monitoring of Wild Asian Elephants in Modified Landscapes



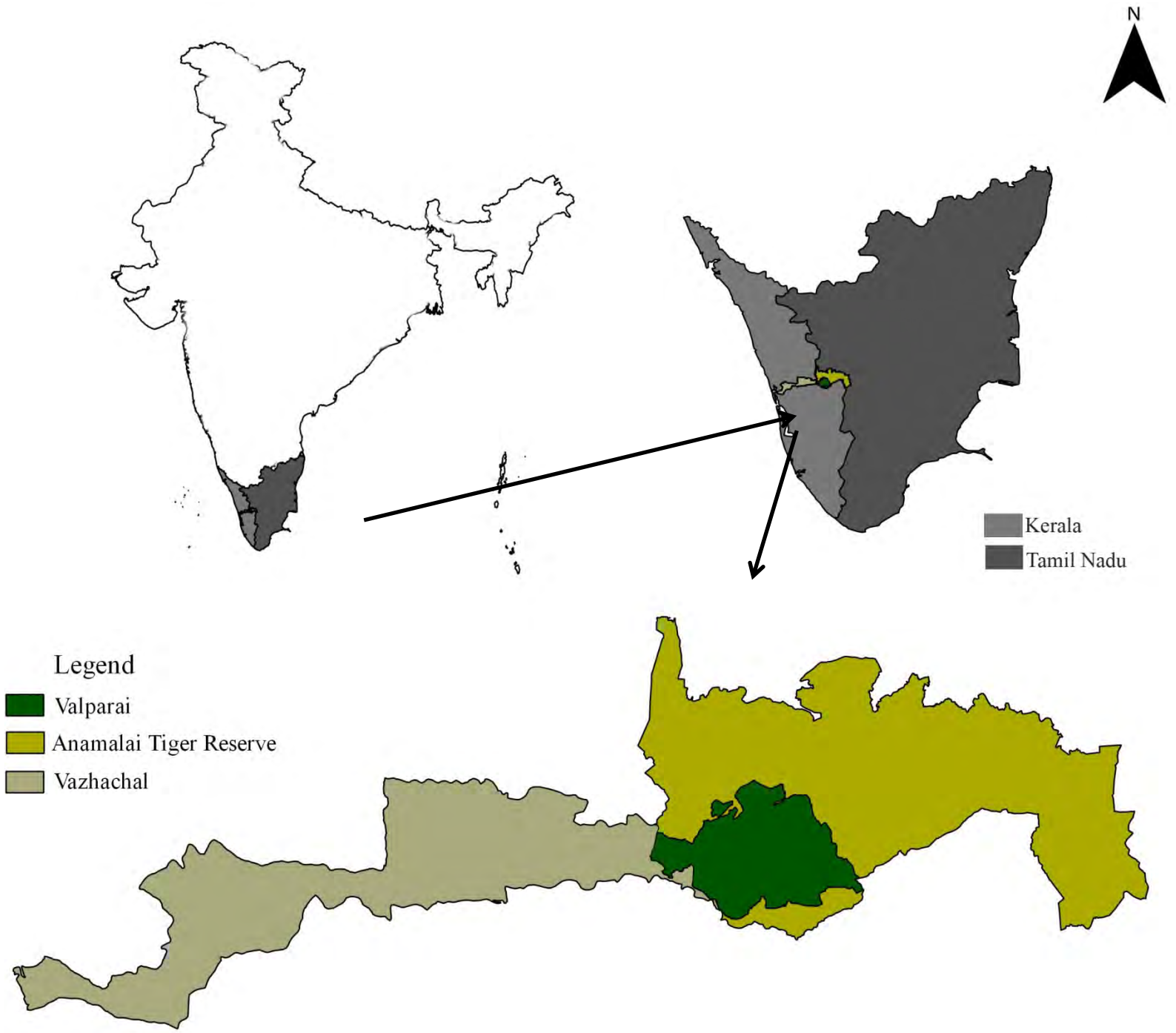
nature conservation foundation

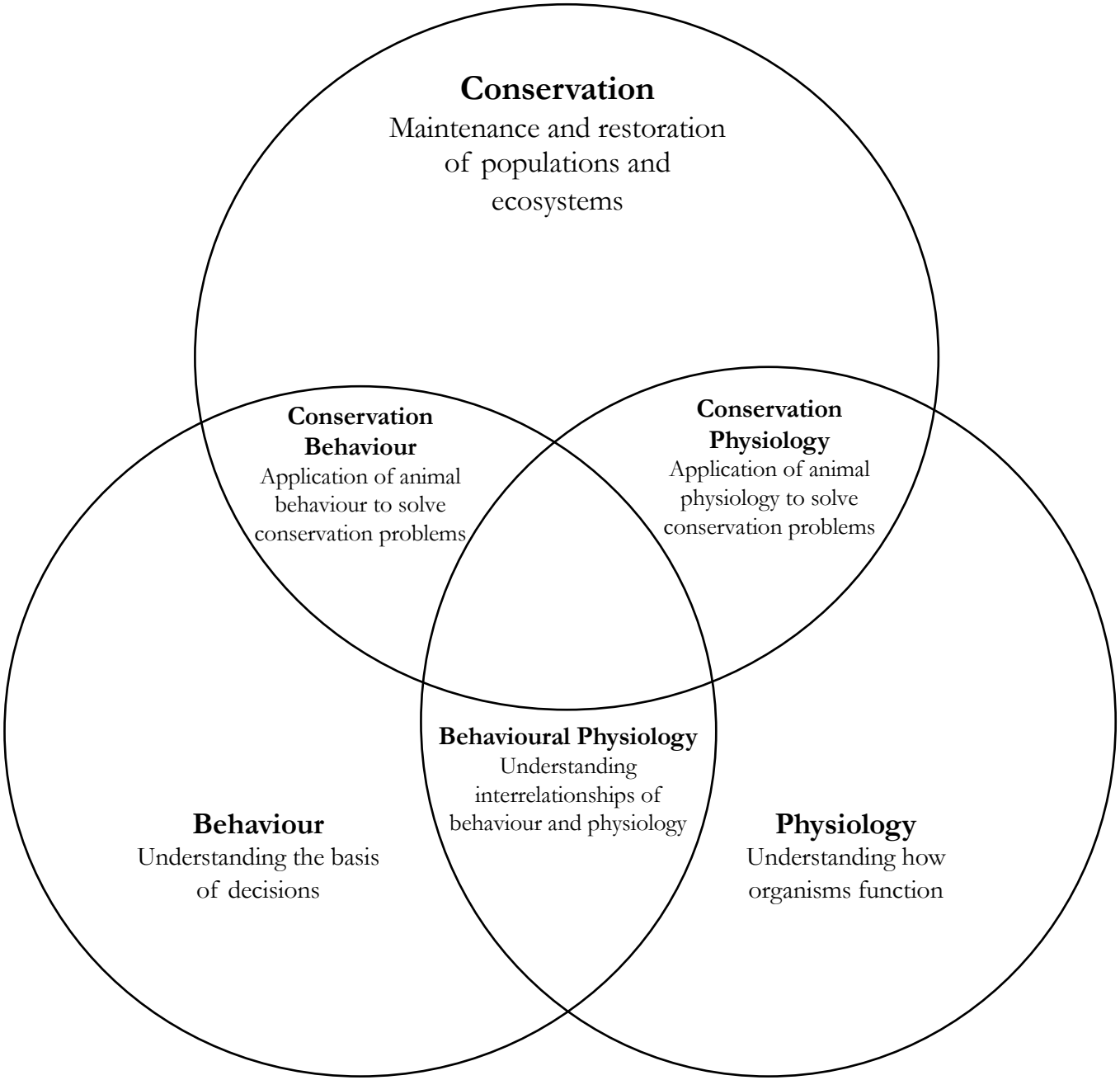
Sreedhar Vijayakrishnan, M Ananda Kumar, R Sriram, Vinod Kumar, G Umapathy, Anindya Sinha

NIAS

Objectives

- Evaluating variation in behavioural and physiological stress responses of elephants to:
  - the use of anthropogenic habitats
  - interactions with humans
  - conspecific social interactions
- Linking variation in stress responses to age, sex and social associations


N
Kerala
Tamil Nadu
Legend
Valparai
Anamalai Tiger Reserve
Vazhachal



Adapted from Cooke et al. 2014



Behavioural and physiological adaptations

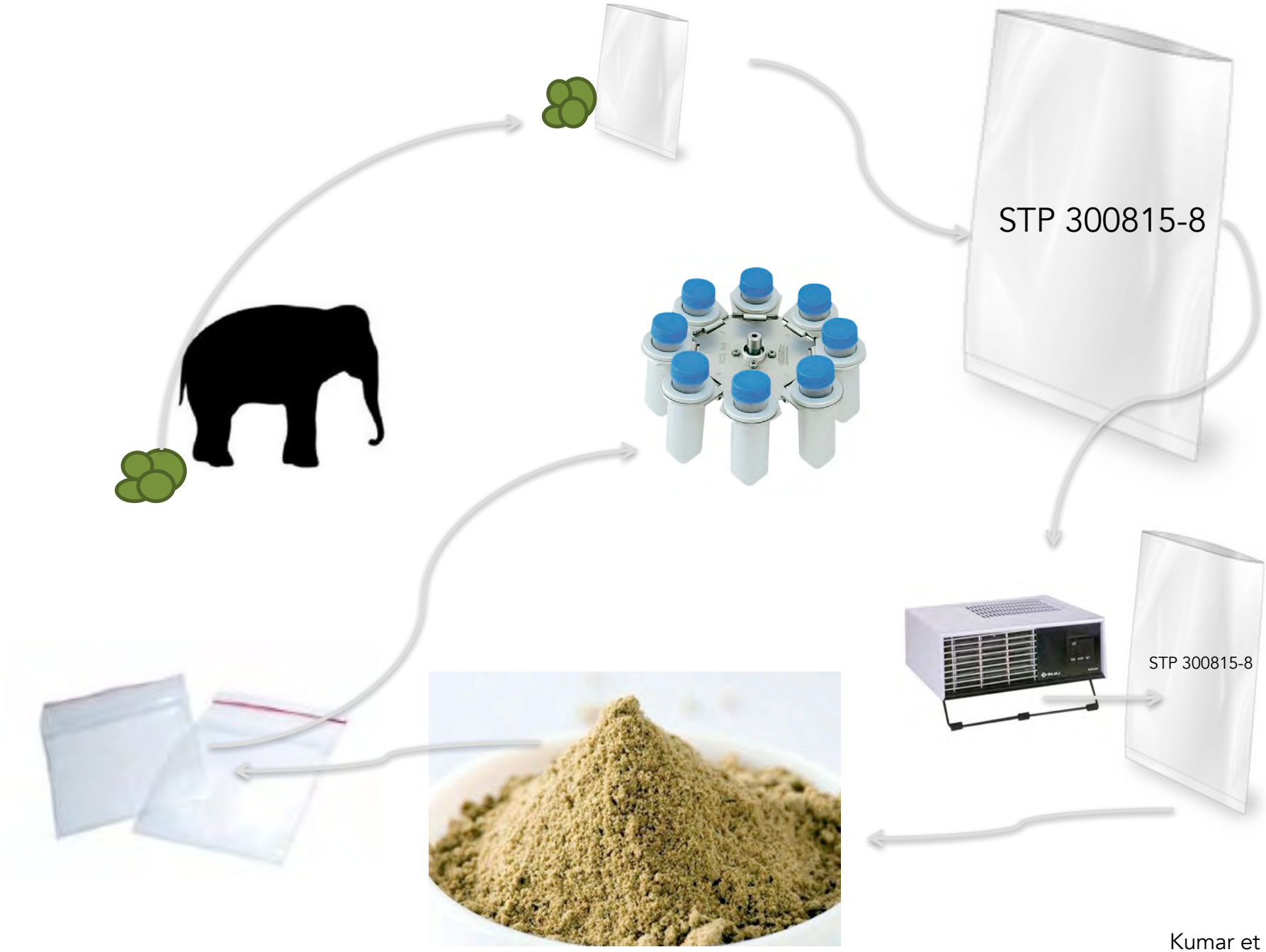


Elephants in human-dominated landscapes



Human-elephant interactions





Kumar et al. 2014

At the lab?



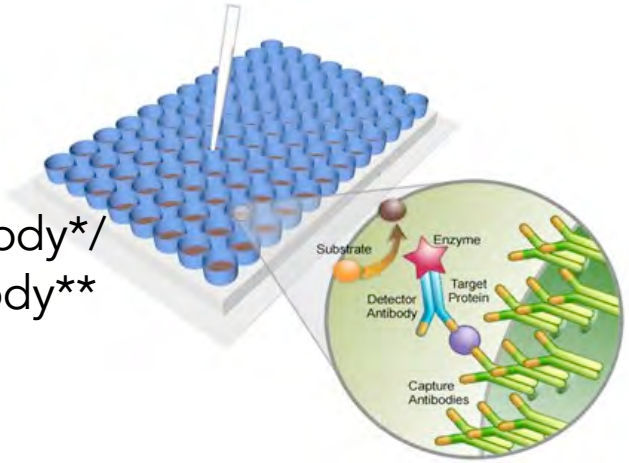
Pulverising and sieving

0.2 g of sample + 5 ml 80% methanol – vortexed for 20 min

Centrifuge – 3300 rpm



ELISA – Cortisol polyclonal antibody*/
Progesterone monoclonal antibody**

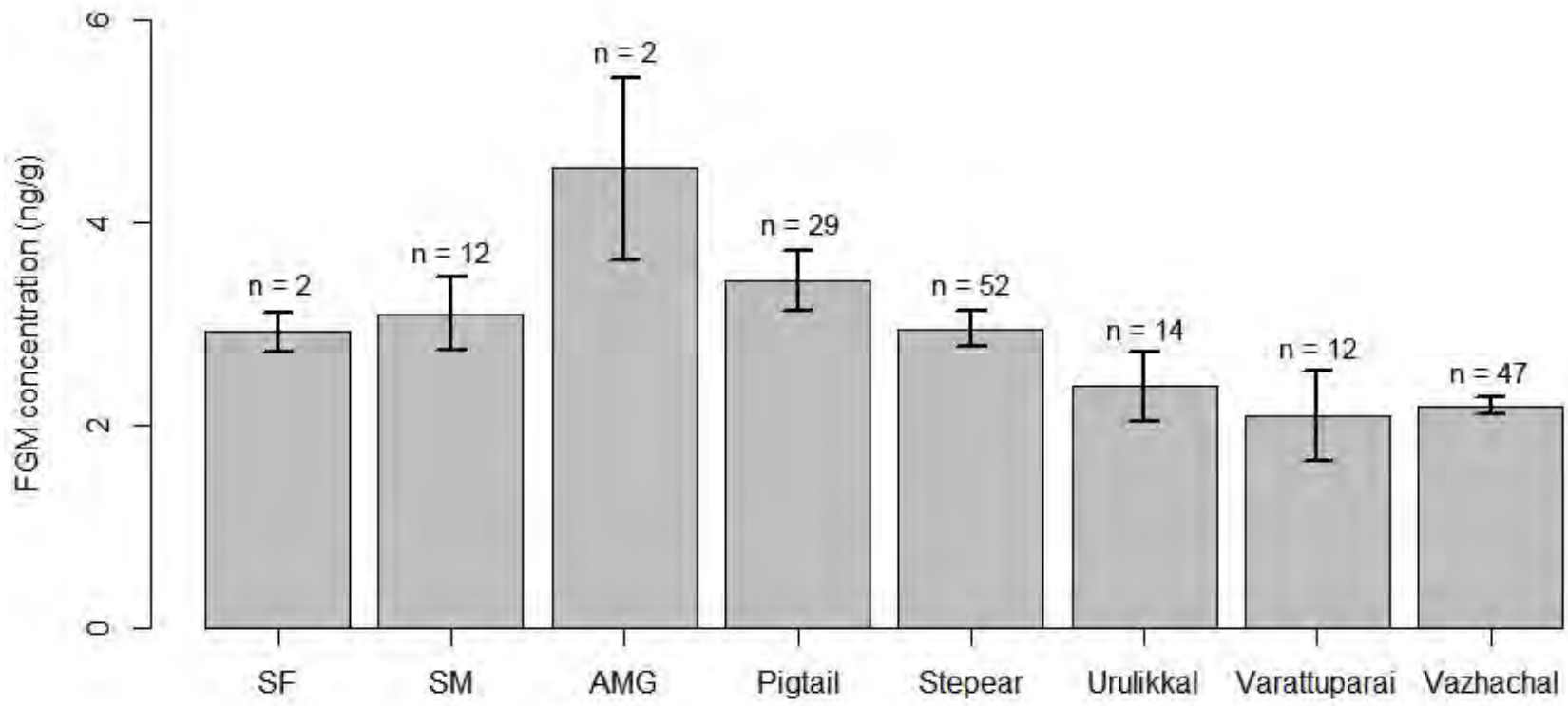


After further analysis read at 450nm in ELISA reader

* Diluted to 1:9000 HRP conjugated cortisol 1:250,000 and cortisol standards (1000-1.95pg/well)
** Diluted to 1:6000 HRP conjugated progesterone 1:100,000 and progesterone standards (200-0.39g/well)

Kumar et al. 2014

Glucocorticoid response comparable across habitats

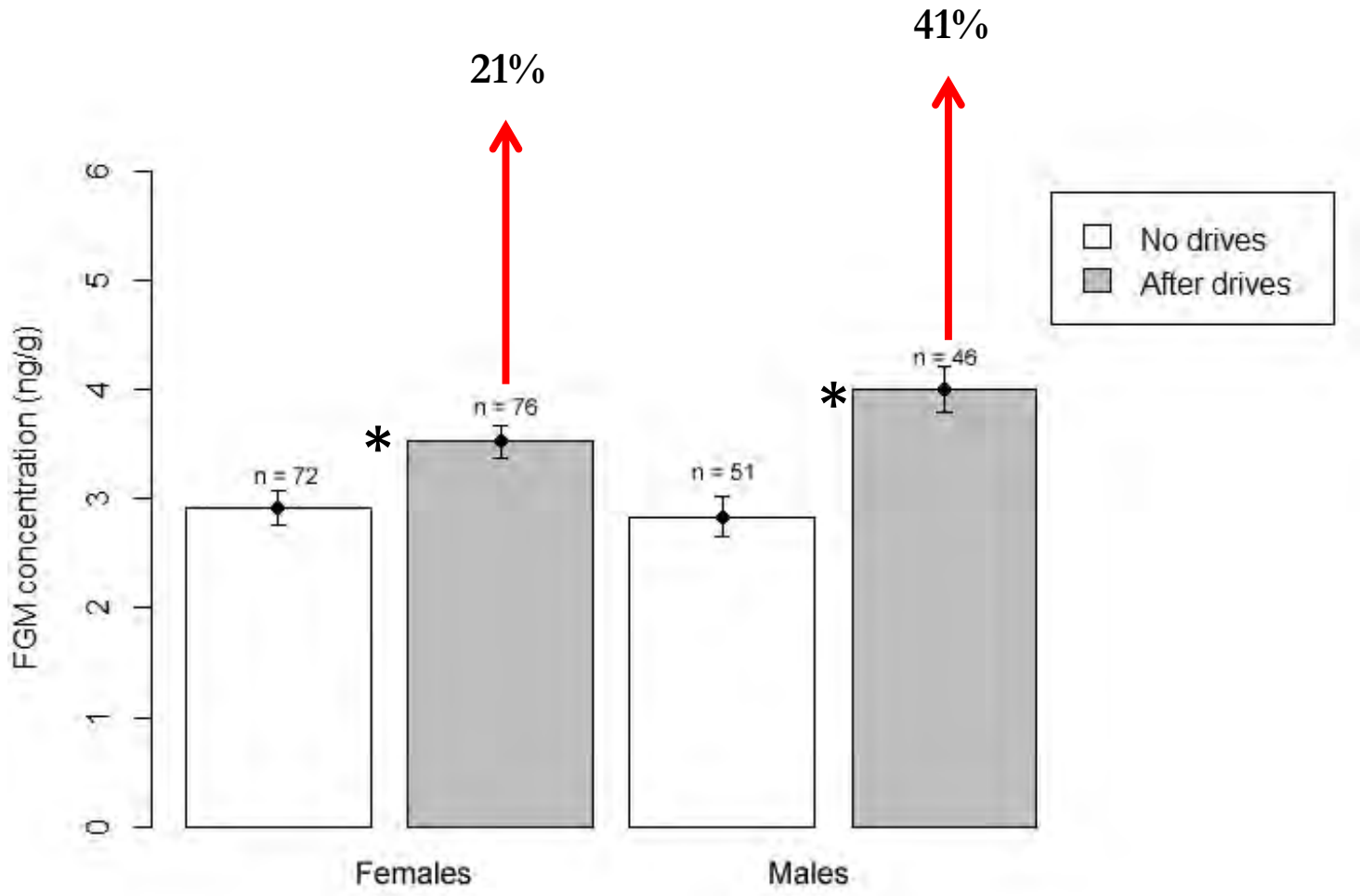


SF: Solitary Female

SM: Solitary Males

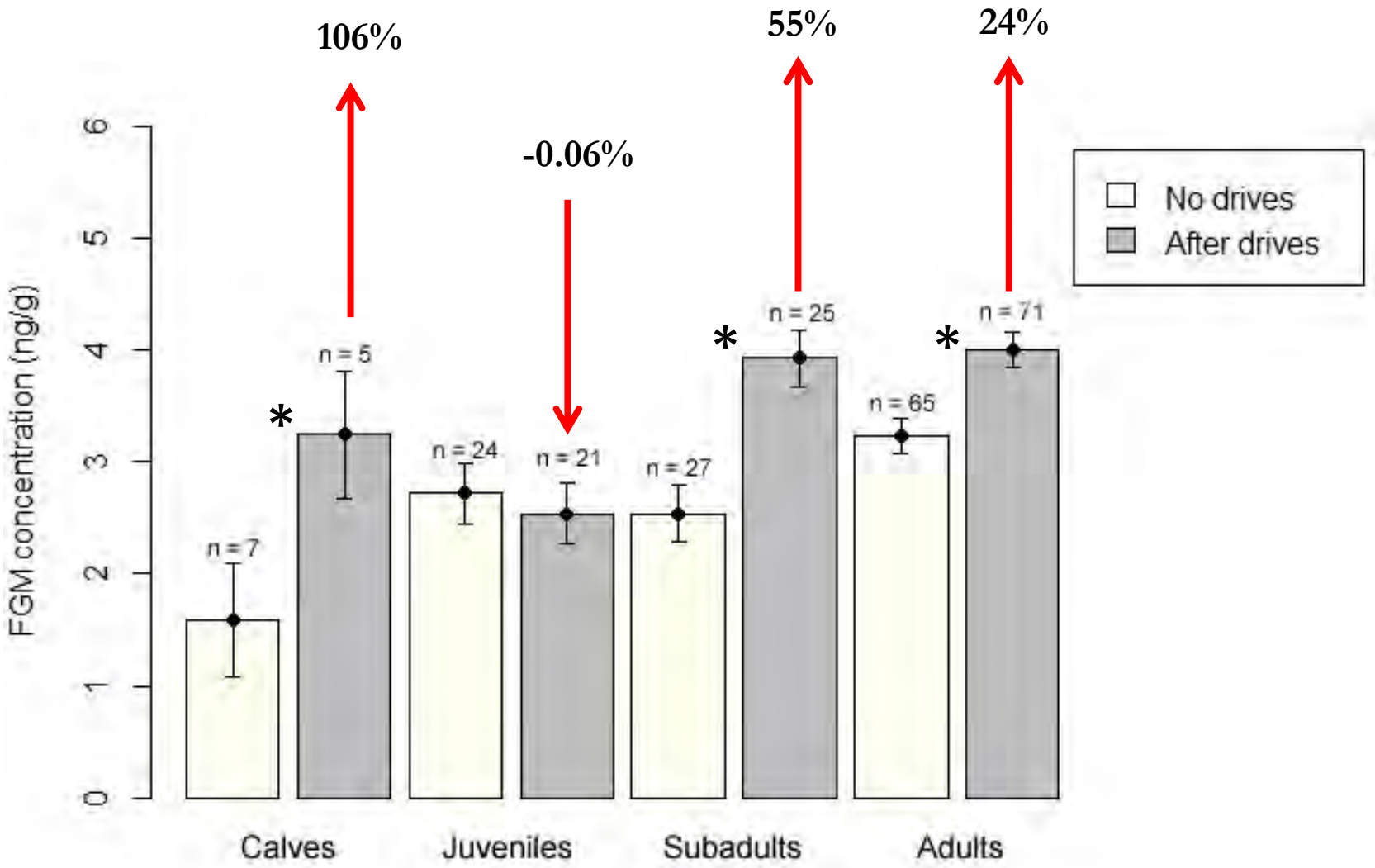
AMG: All-Male Group

Stronger stress responses in males following drives



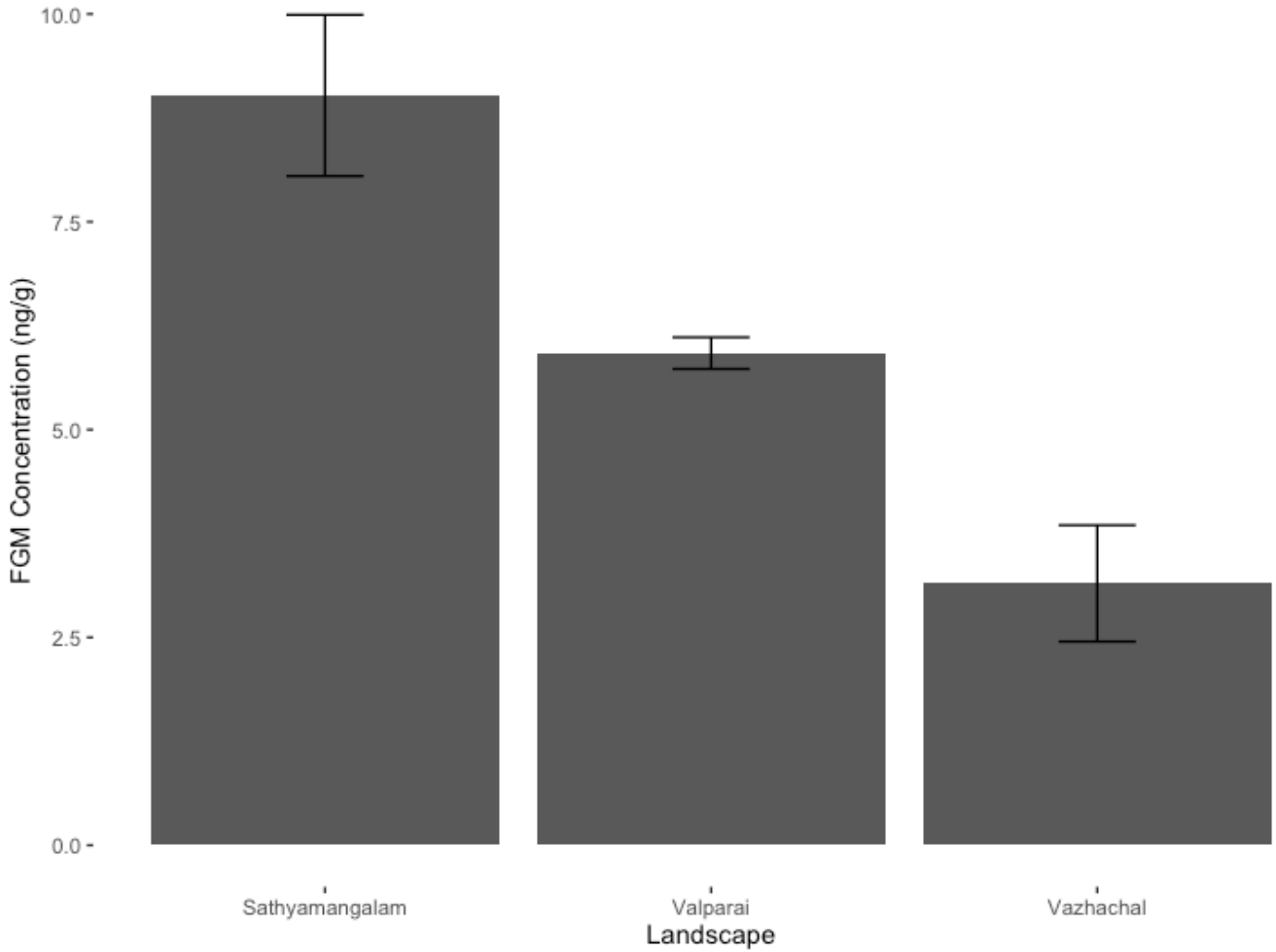
Mann-Whitney U-test, $p \leq 0.03$

Stronger stress responses in calves following drives

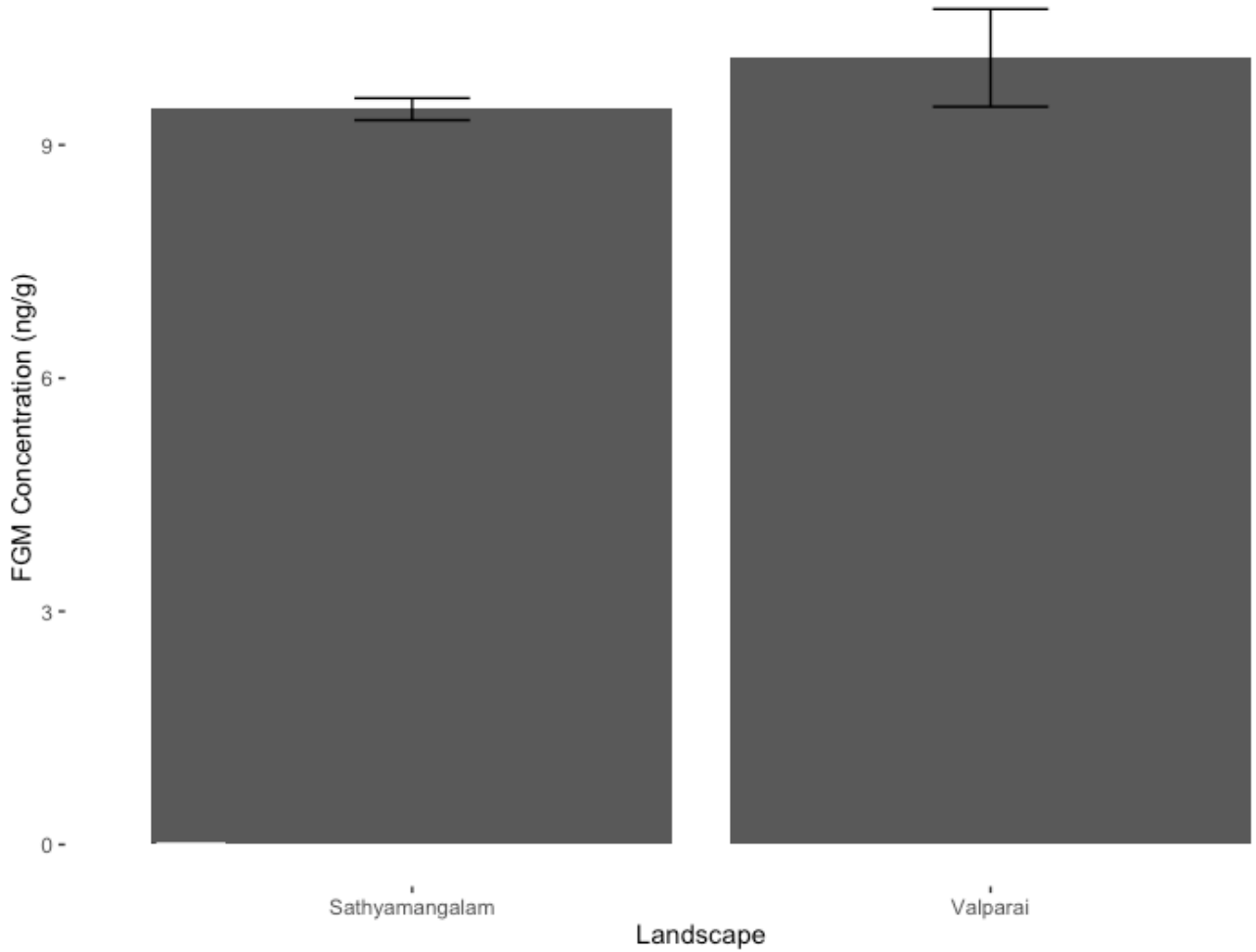


Mann-Whitney U-test, $p < 0.05$

High levels of FGM in elephants in agricultural landscape



FGM in males comparable across habitats



Mann-Whitney U-test, p = 0.36

Stress responses in Asian elephants

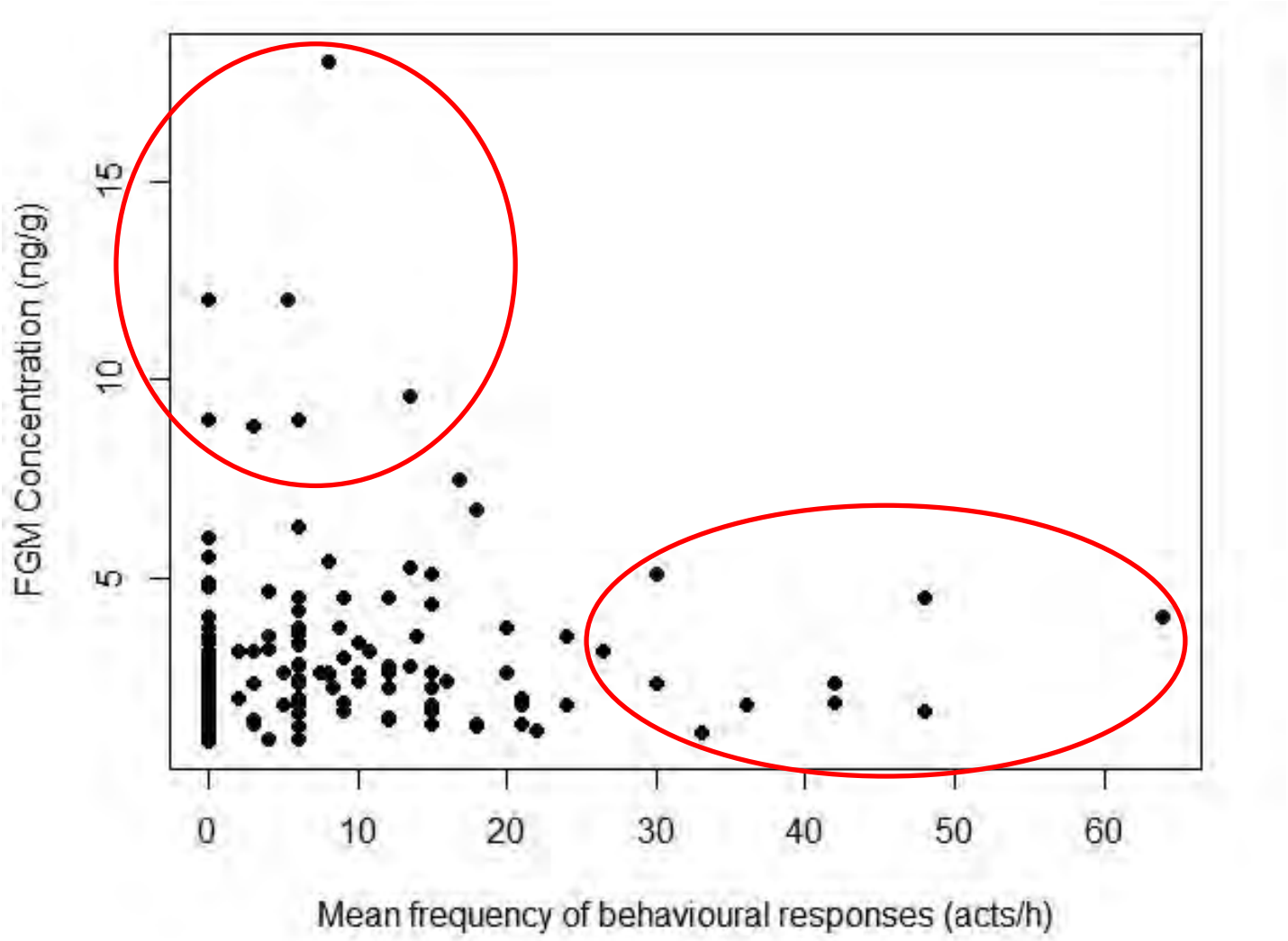
- Physiological responses and habituation in elephants
- Variation in FGM in relation to age-sex classes
- Drives as an important variable
- Conservation implications

Stress responses in Asian elephants: The way ahead

- The relationship between behavioural and physiological stress responses

- Manifestation of stress responses: Individual variation and developmental histories

Behavioural and physiological responses: Individual variation

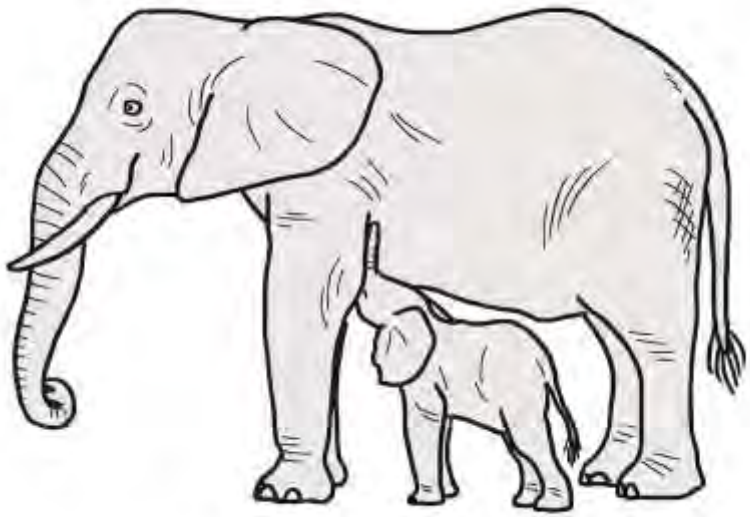



Stress, in addition to being itself, was also the cause of itself, and the result of itself.
Paul Rosch, 1951

- Anindya Sinha | Mavatur Ananda Kumar | Prithiviraj Fernando
- T R Shankar Raman | Divya Mudappa | M D Madhusudan | Ganesh Raghunathan



Endocrine changes and ovarian activity of captive African (*Loxodonta africana*) and Asian (*Elephas maximus*) elephants during the postpartum lactating period



Kazuyoshi Taya[1], Yuki Yamamoto[2], Tatsuya Yamamoto[1], Kentaro Nagaoka[1] and Gen Watanabe[1]

[1]Laboratory of veterinary Physiology, Tokyo university of Agriculture and Technology, Tokyo,
[2]Laboratory of Reproductive Physiology, Graduate School of Environmental and Life Science, Okayama University, Okayama, Japan

Lactational anovulation in elephants









Birth interval

- Length of estrous cycle: 13-18 weeks
- Length of pregnancy: 22 months
- Length of birth interval: 4-5 years
- Length of lactating anovulatory priod:?





Objective

Ovarian function is suppressed by suckling stimulus during lactation in most of mammals.

Lactating period of elephants is more than 2 years.

To investigate

1. **Endocrine changes during lactating period**
2. **Mechanism responsible for effects of suckling stimulus on ovarian function**

Case 1 [Ai]



Two African elephants
An Asian elephant

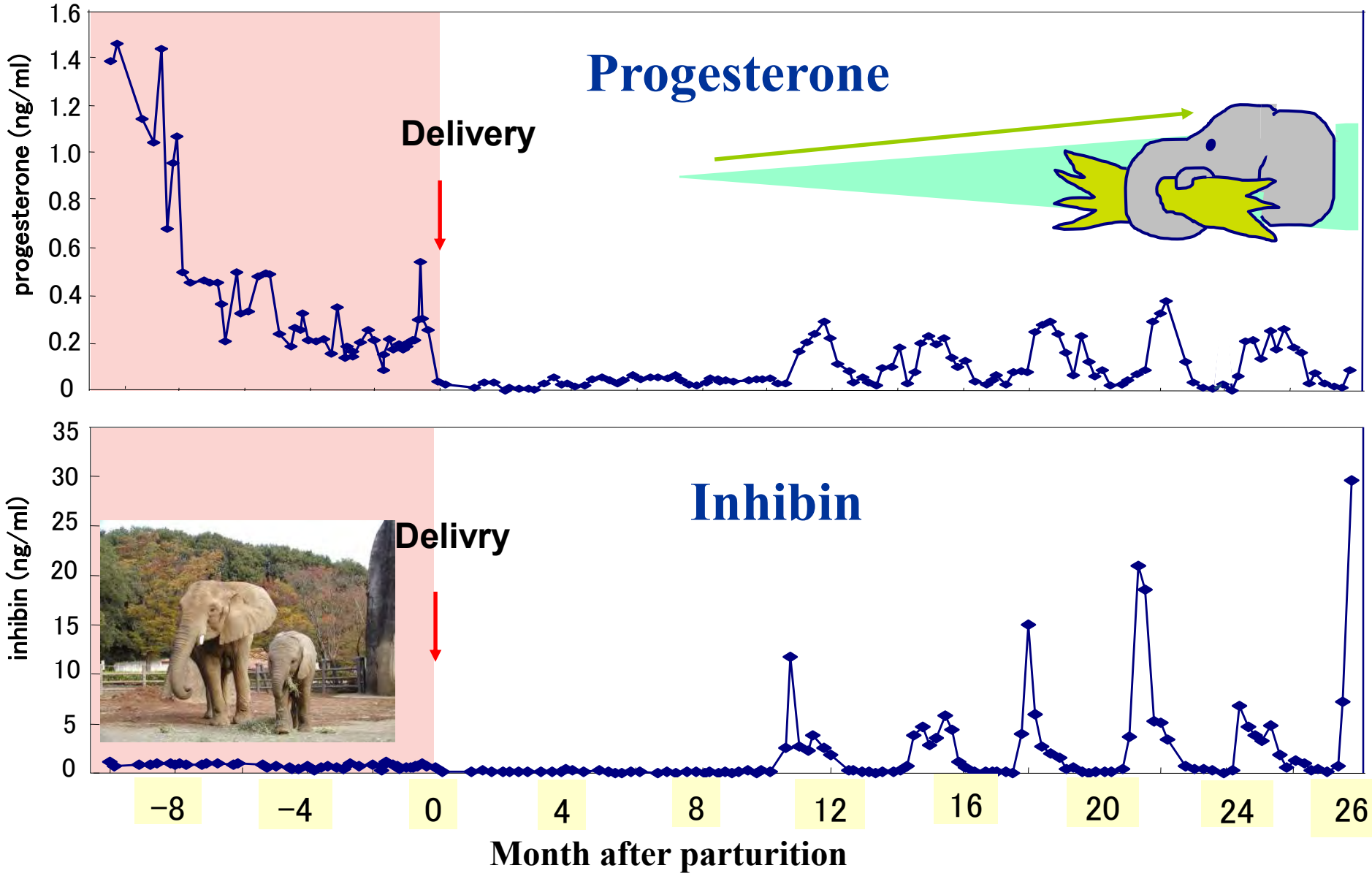
Case 2 [Rika]



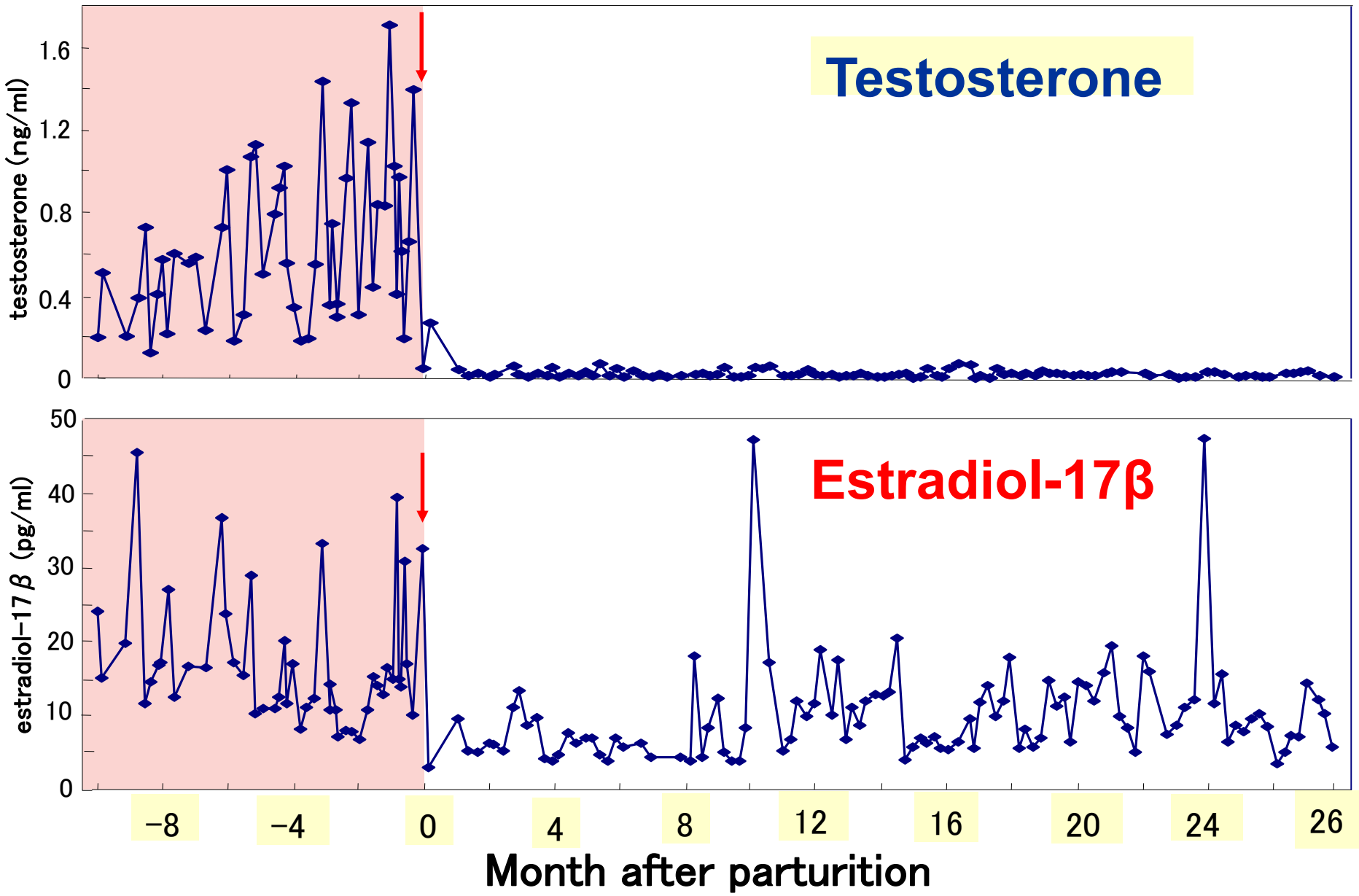
Case 3 [Zuze]



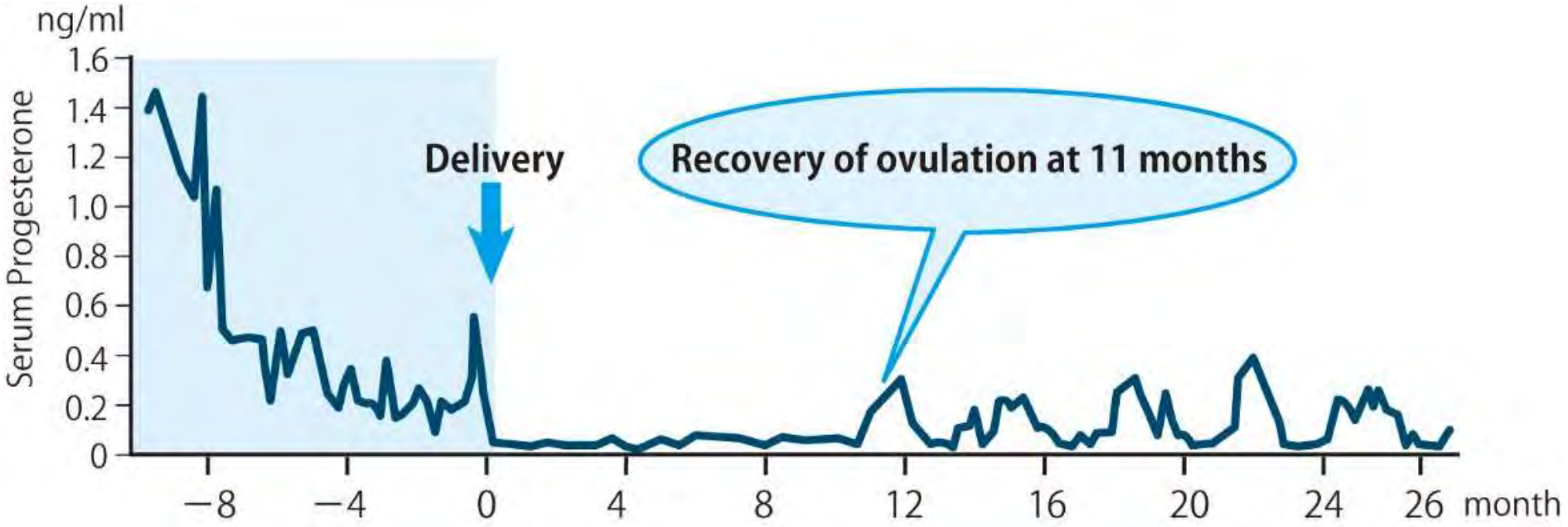
Case 1 Recovery of ovulation at 11 months after delivery



Case 1 Changes in testosterone and estradiol-17β

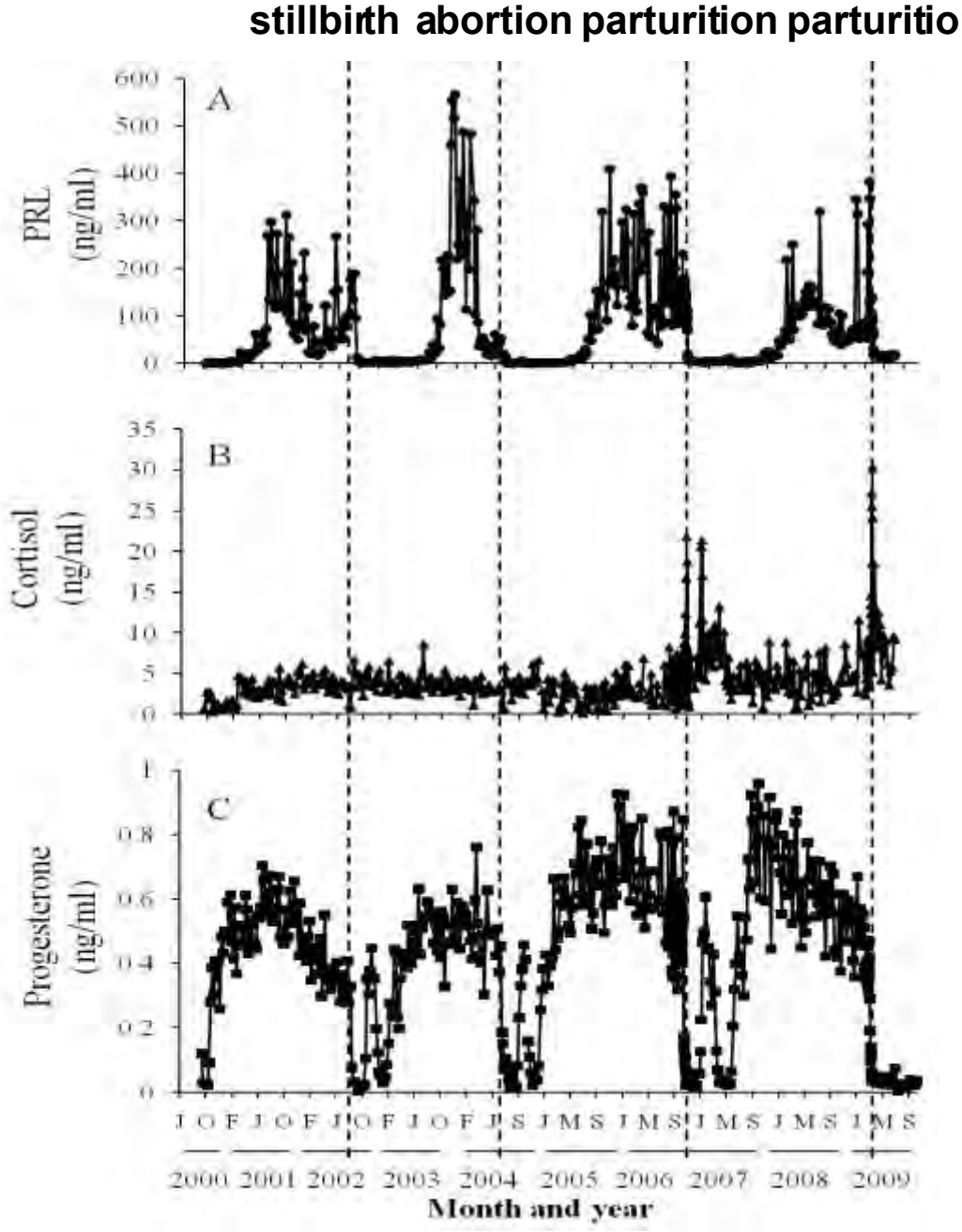


Case 1 Recovery of ovulation during lactating period









Case 2

Prolactin, cortisol and progesterone

Anovulation period:

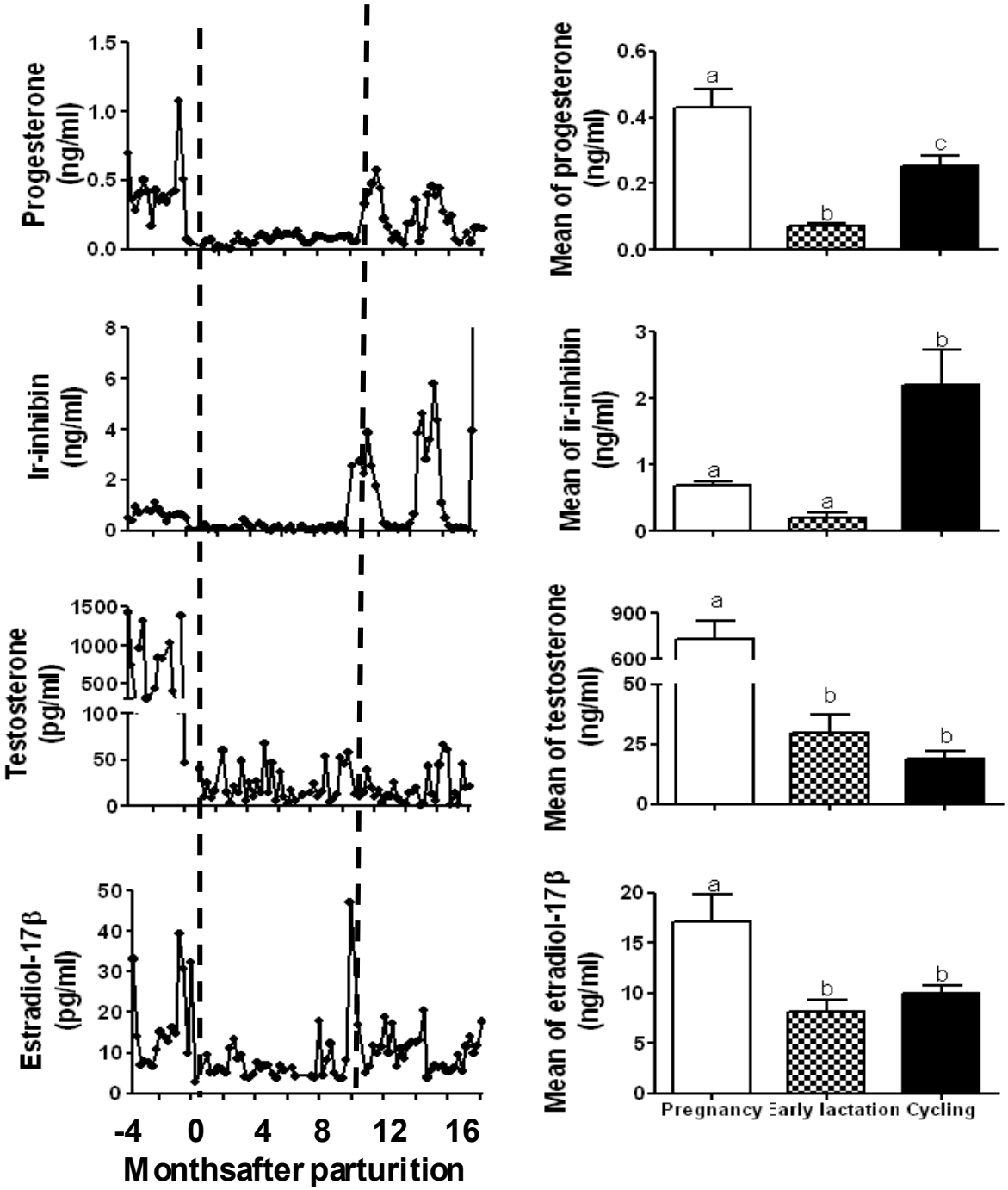
1st… 8 weeks

2nd… 9 weeks

3rd… 10 weeks

4th… 36 weeks





Case 2

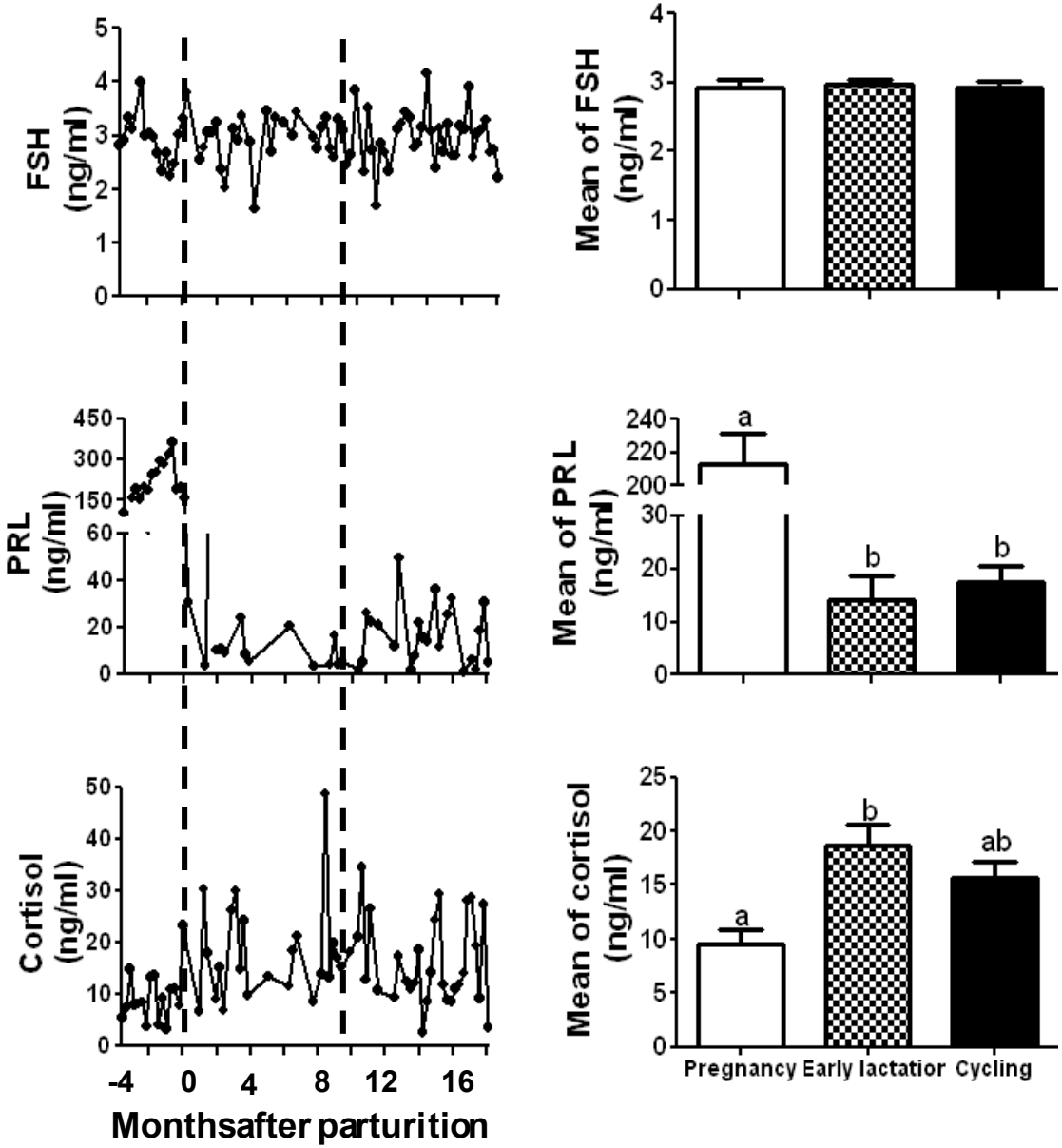
Progesterone
Inhibin
Testosterone
Estradiol-17β

Anovulation period:
4th… 36 weeks

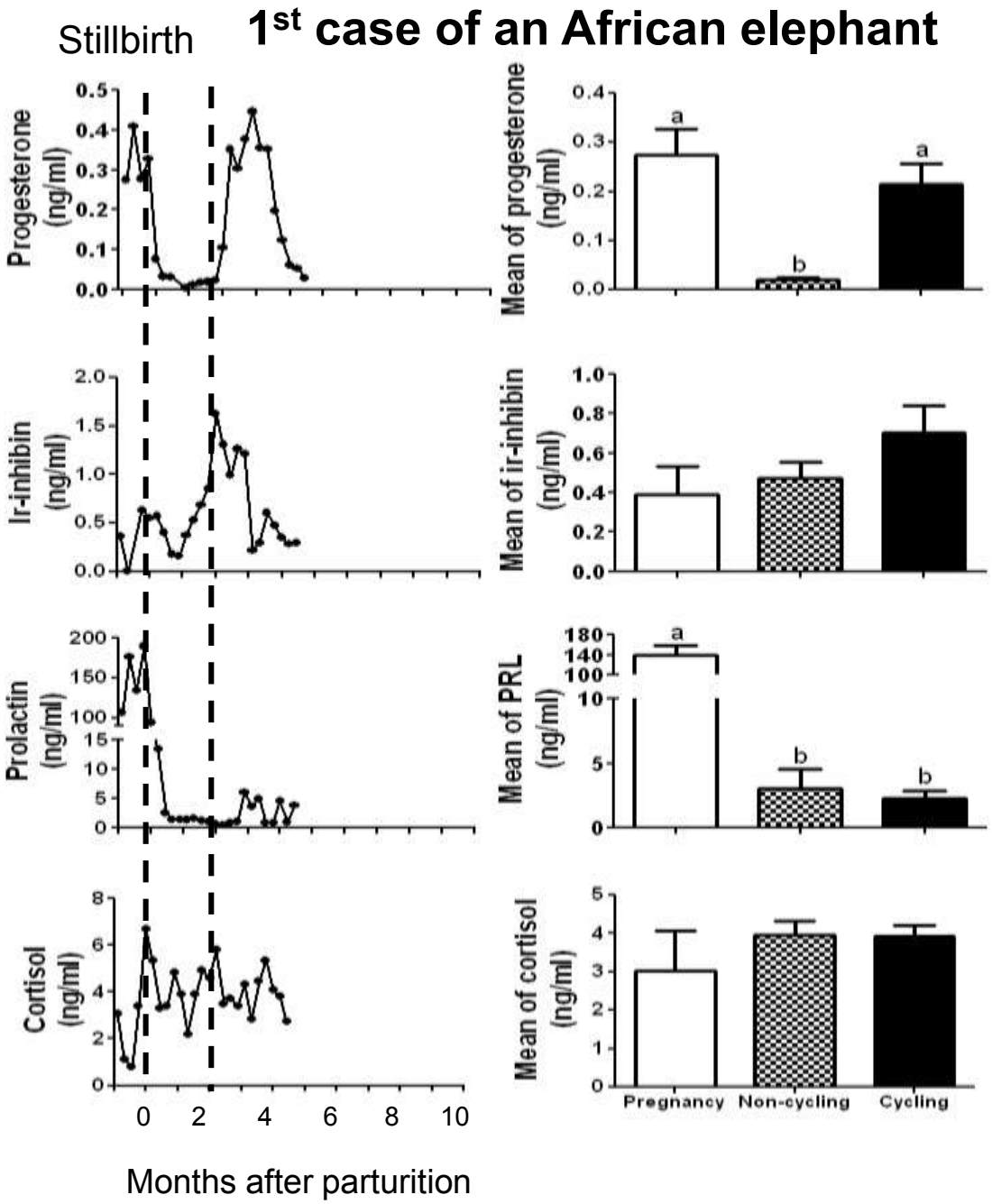
Each hormones remain basal level until recovery of estrous cycle

Case 2

FSH
PRL
Cortisol



FSH and PRL remained basal level but cortisol levels were higher during lactating period

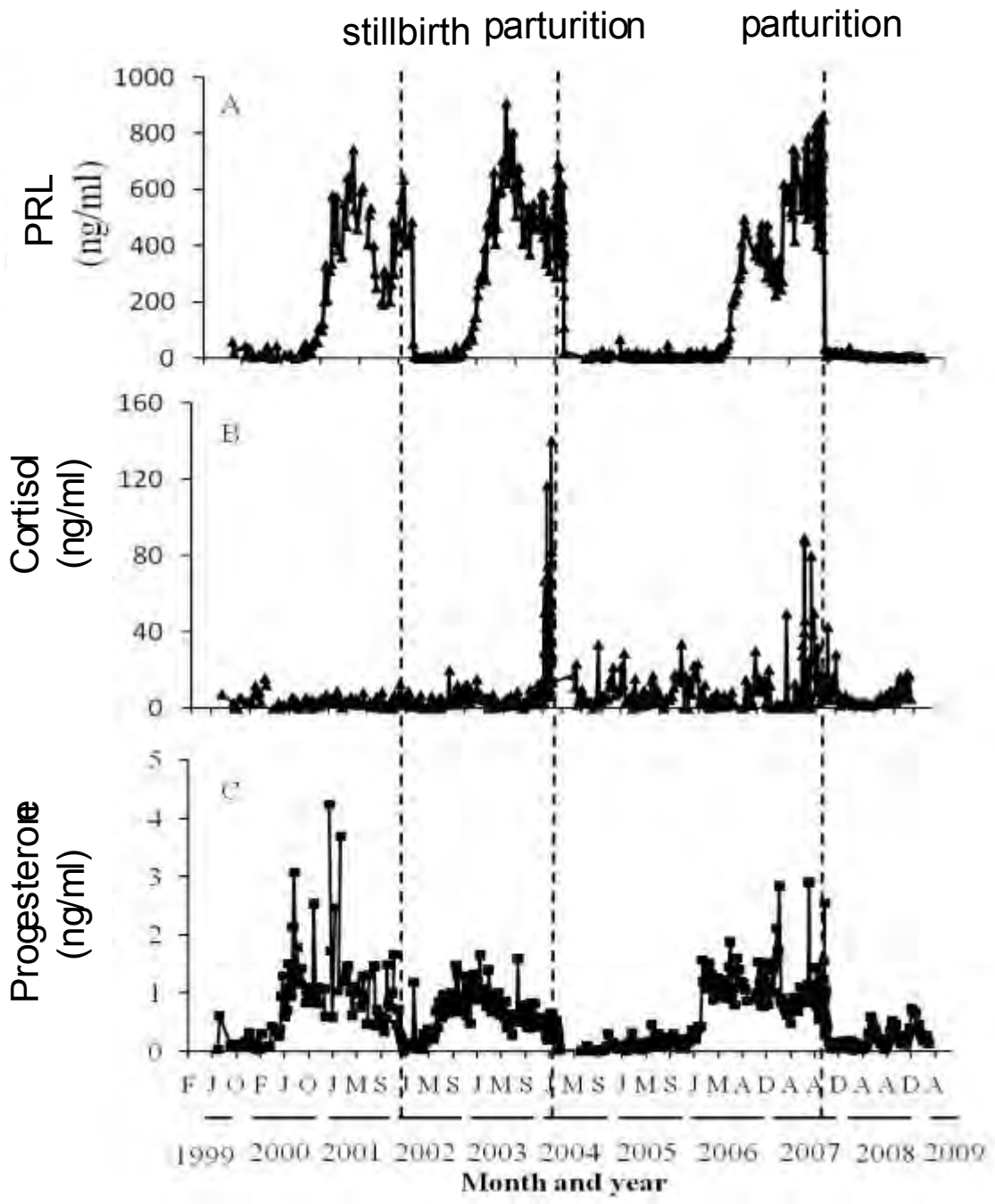


Case 2

Hormonal secretion during the postpartum period without suckling stimulation

Anovulation period:
1st… 8 weeks

Ovulation occurred at 2-3 months after stillbirth.



Case 3

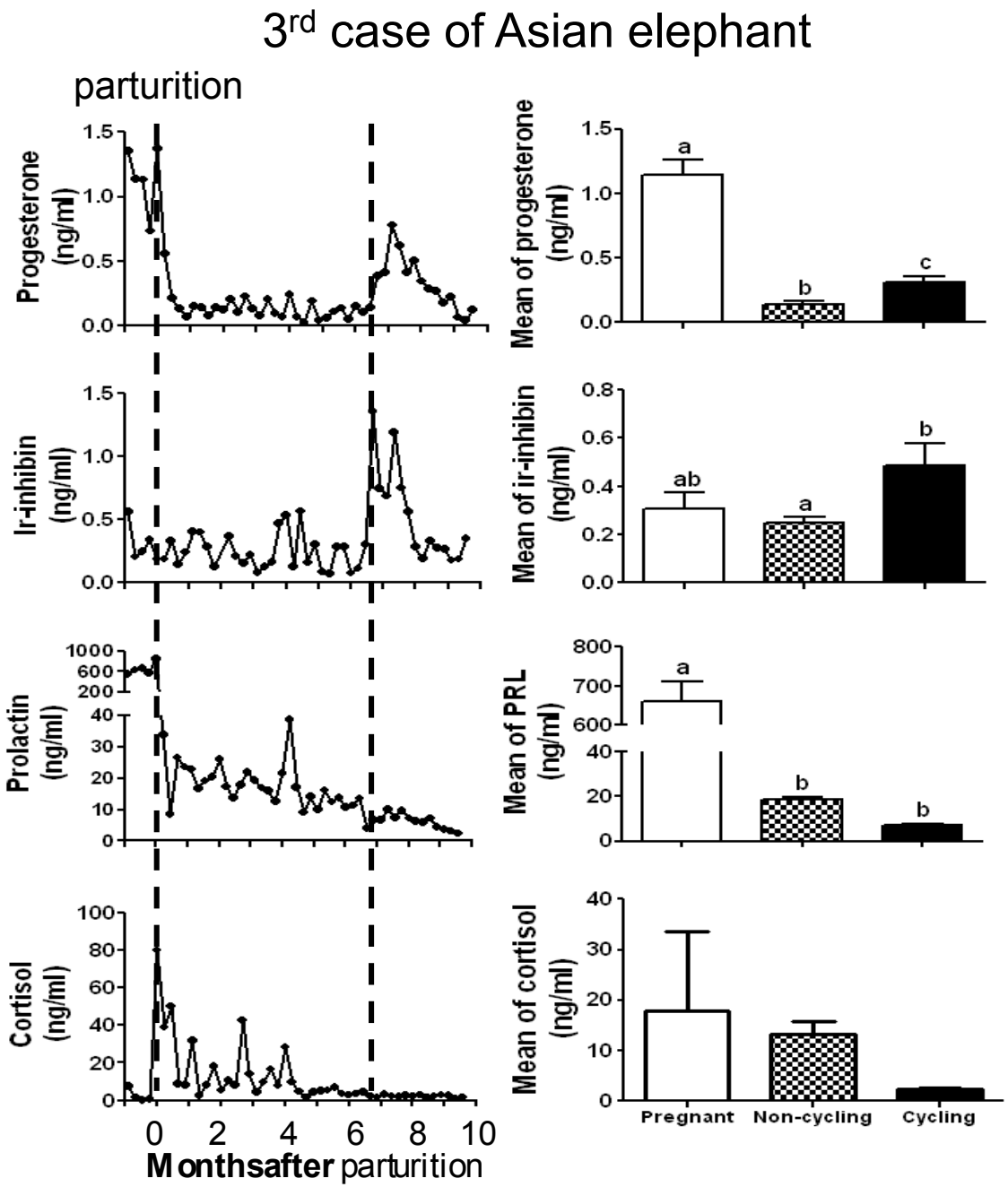
PRL
Cortisol
Progesterone

Anovulation period:

2nd… 14 weeks

3rd… 33 weeks





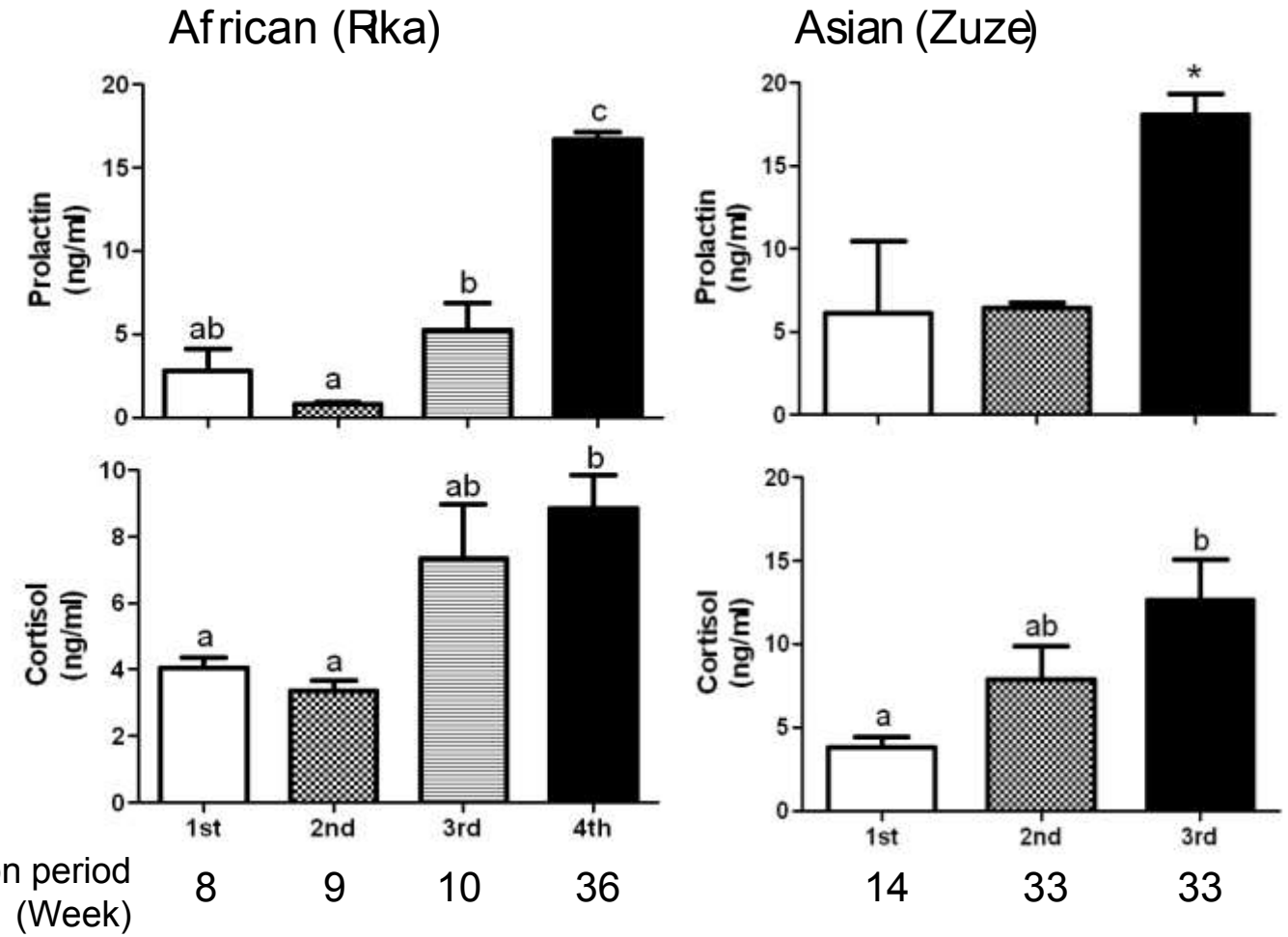
Case 3

Hormonal secretion during the postpartum period with suckling stimulation

Anovulation period:
3rd…33 weeks

Recovery of ovarian function was postponed.

Serum PRL and cortisol levels during anovulaton period after each pregnancy African and Asian elephants



Positive correlation between serum levels of prolactin and cortisol, and length of anovulation period after parturition

Summary

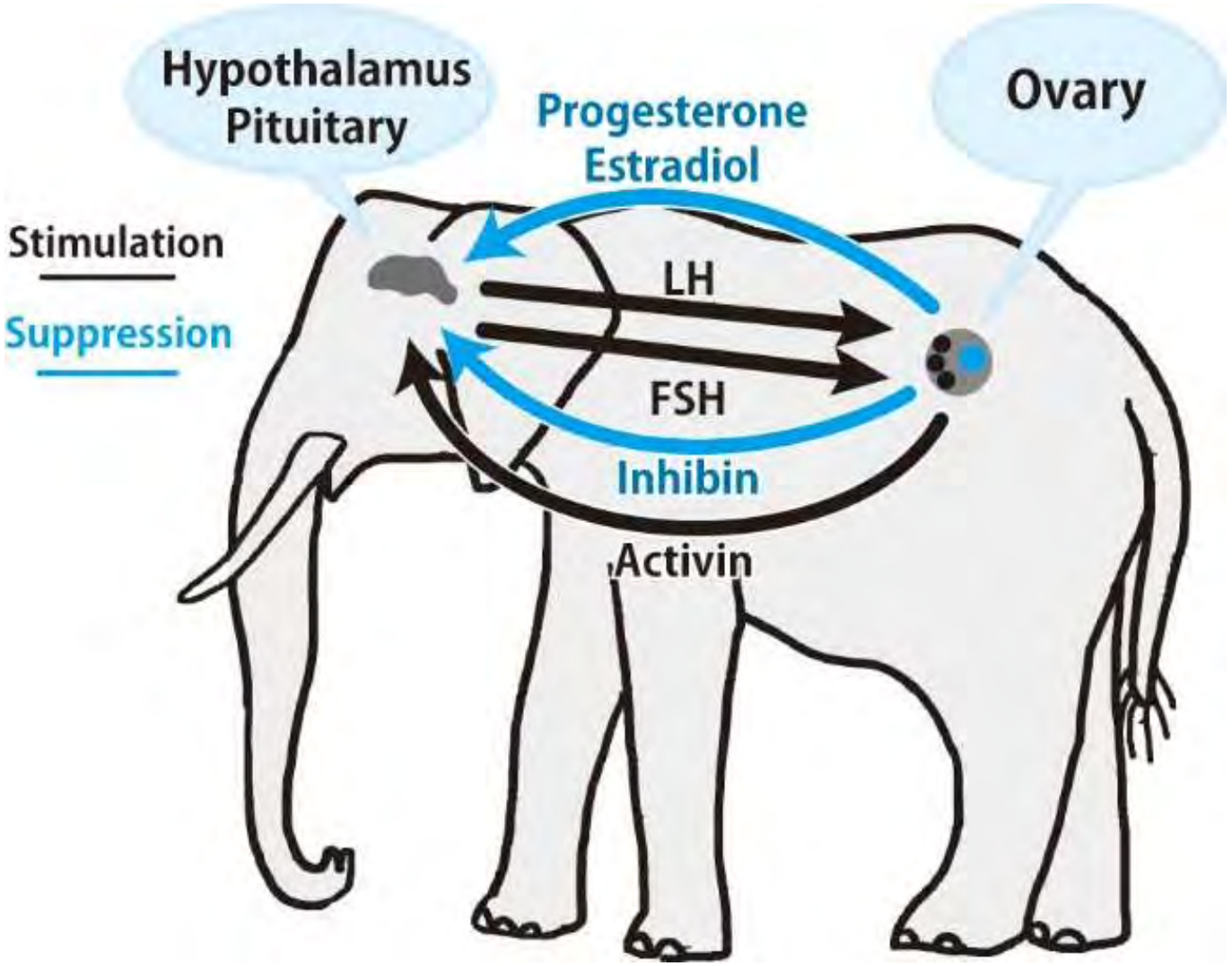
- Gonadotropins and ovarian hormones were low, but prolactin and cortisol was high during postpartum periods with suckling stimulation.

- Anovulation periods were prolonged by both of natural suckling and artificial milking stimulation.

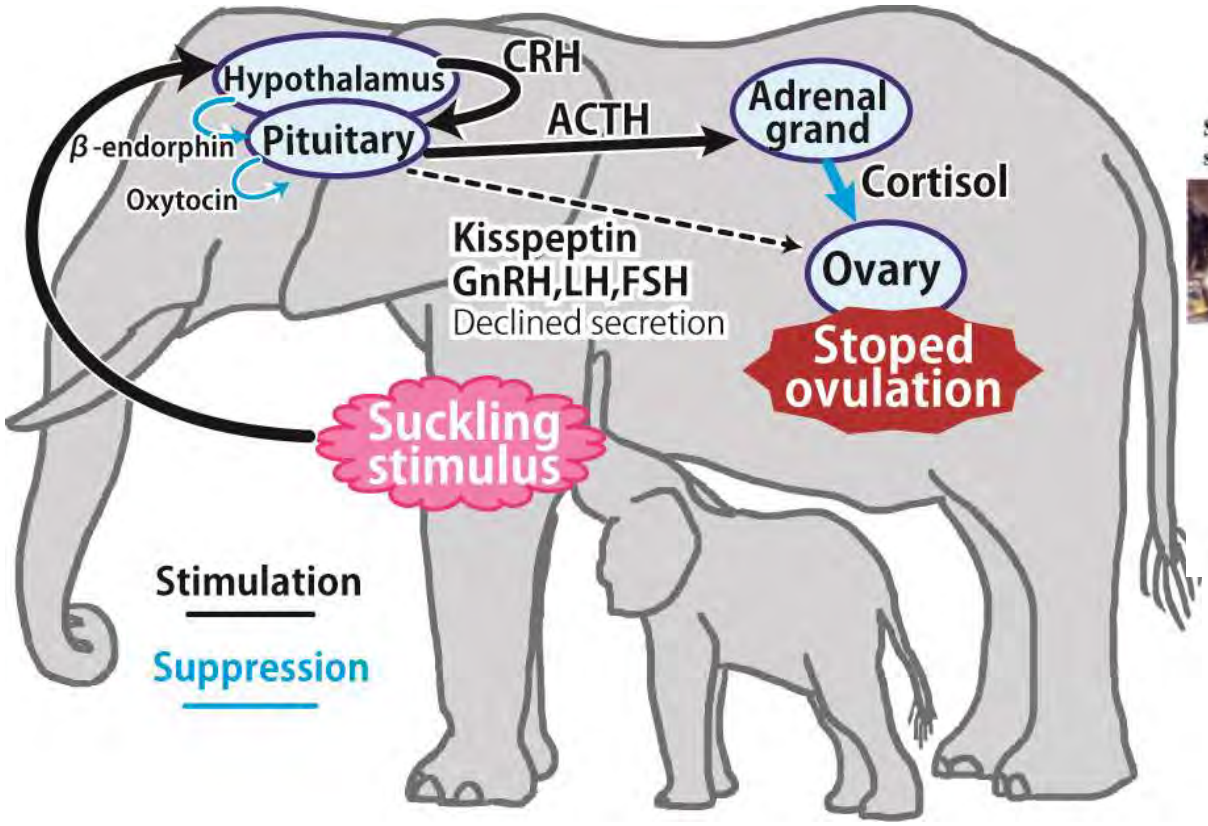
.

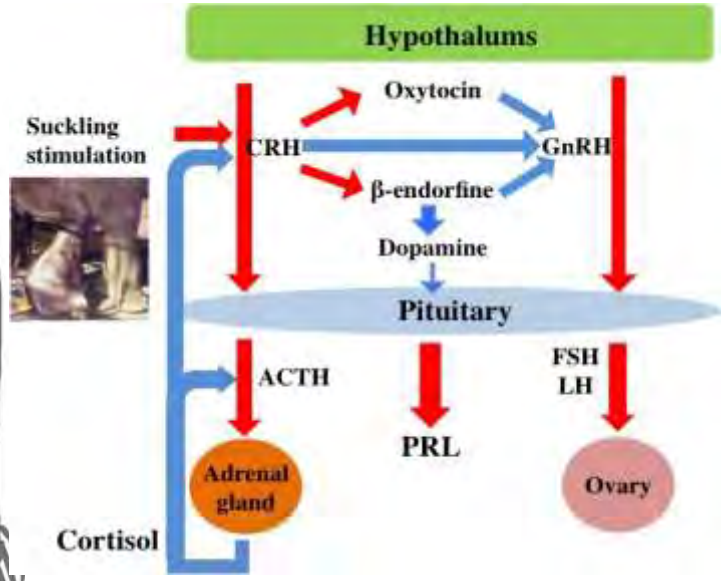
Prolactin secretion and HPA axis was activated by suckling stimulation but suppressed ovarian function in elephants.

Endocrine regulation of ovarian function in female elephants

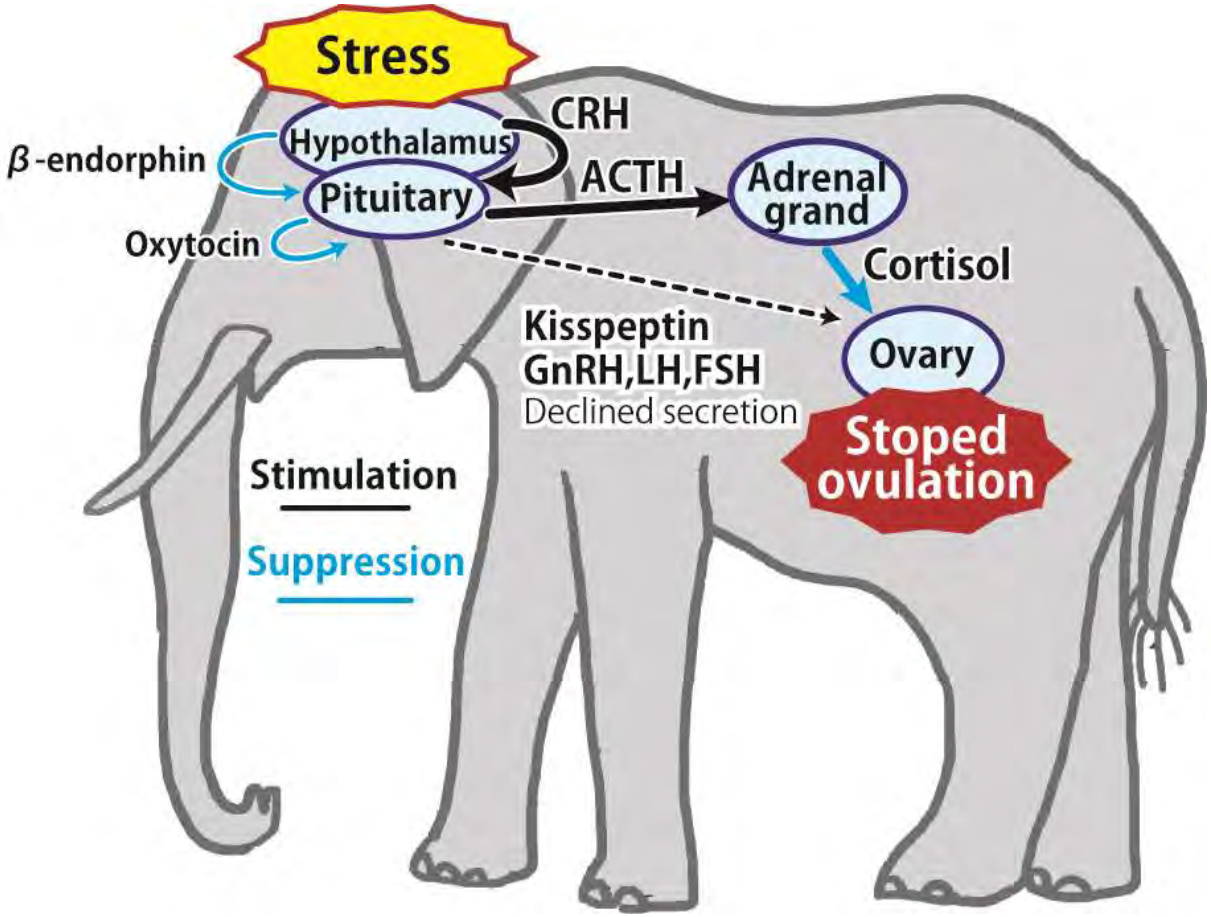


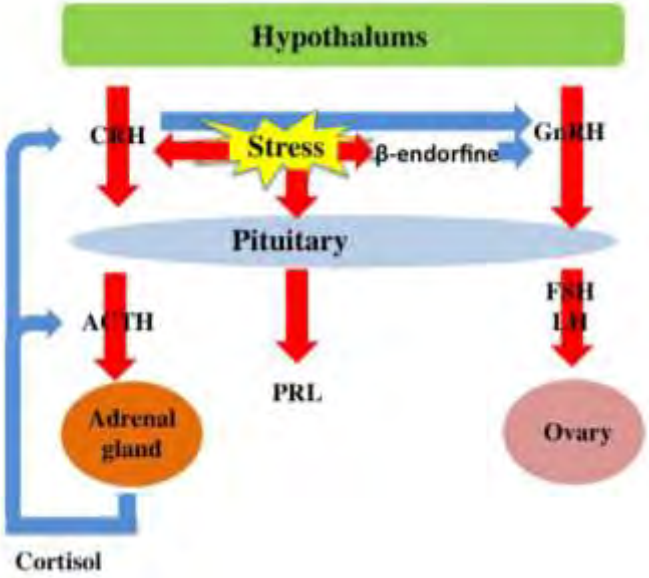
Mechanism responsible for suppression of ovarian function by suckling stimulus



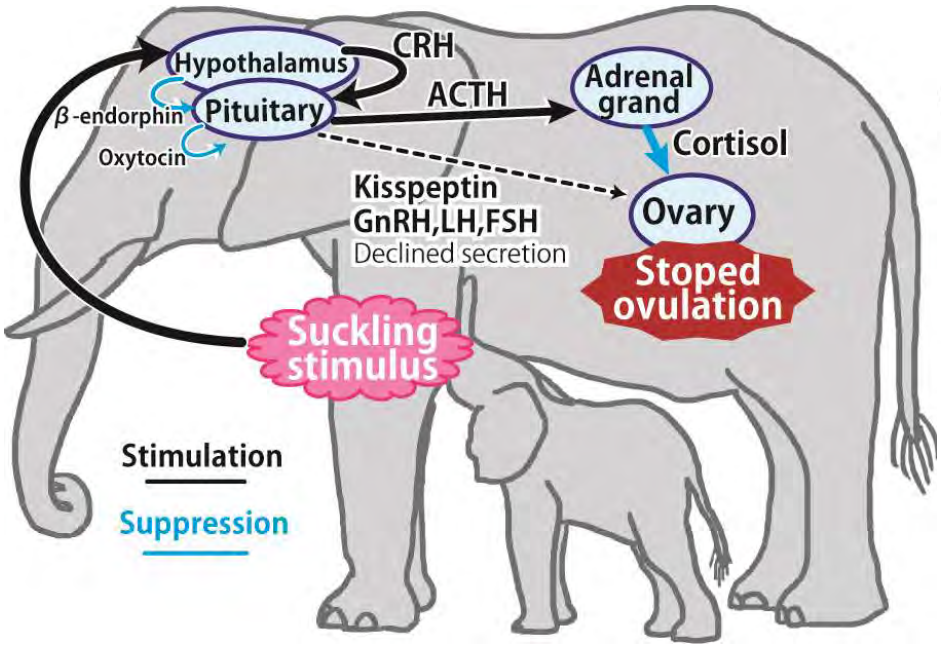


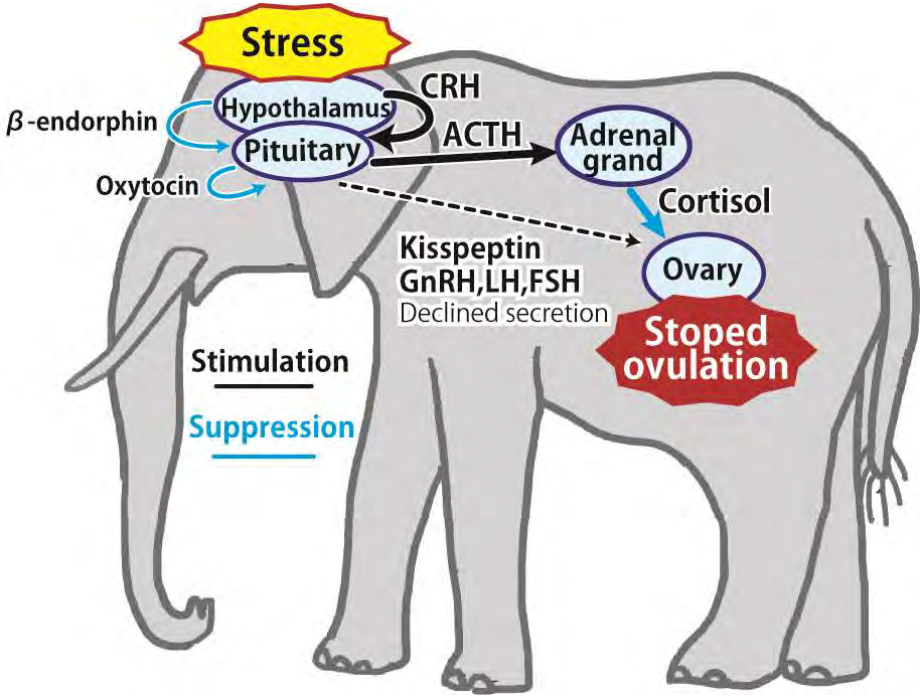
Mechanism responsible for suppression of ovarian function by stress



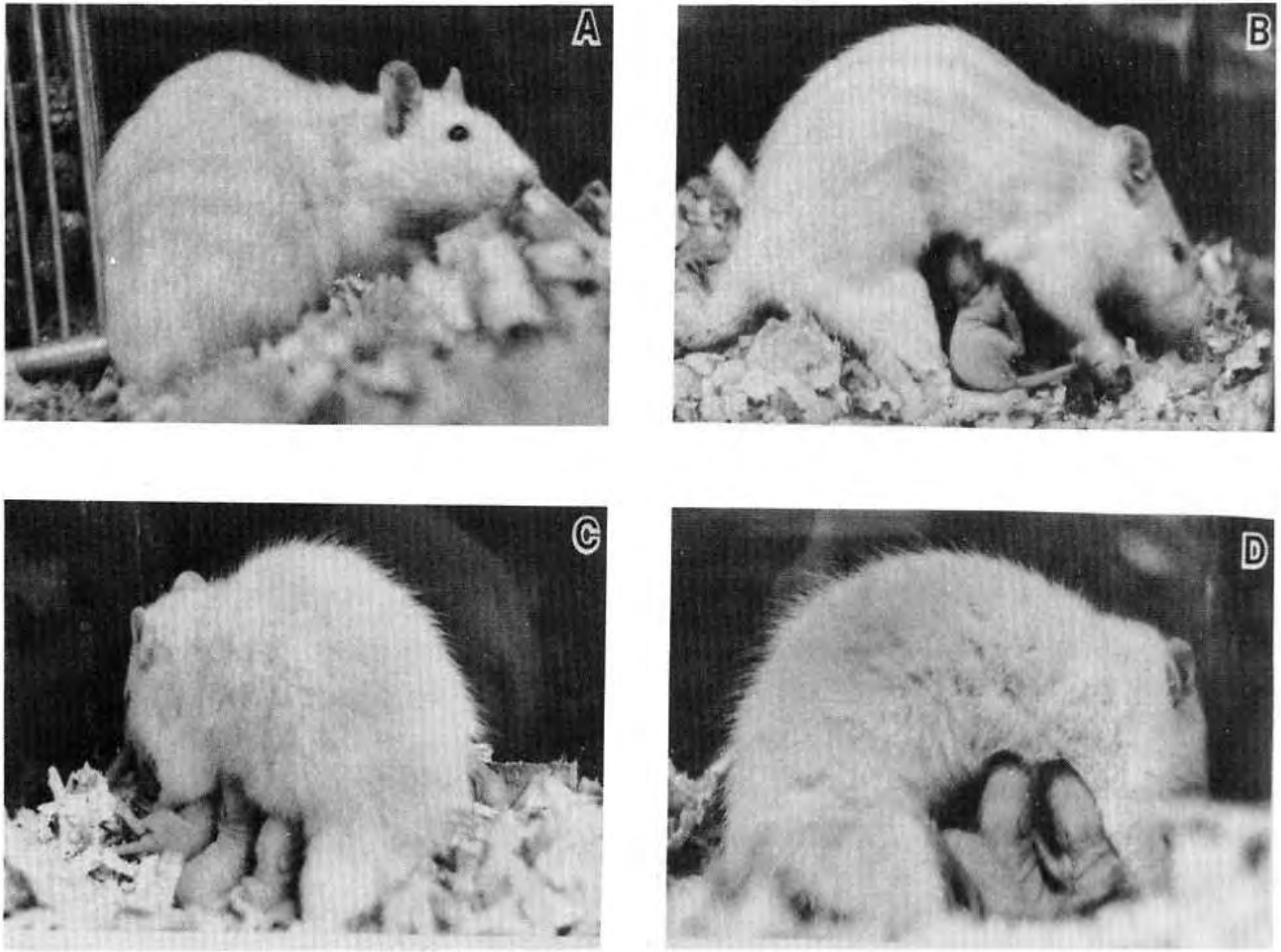


Sucking stimulus=Stress?





Timed suckling



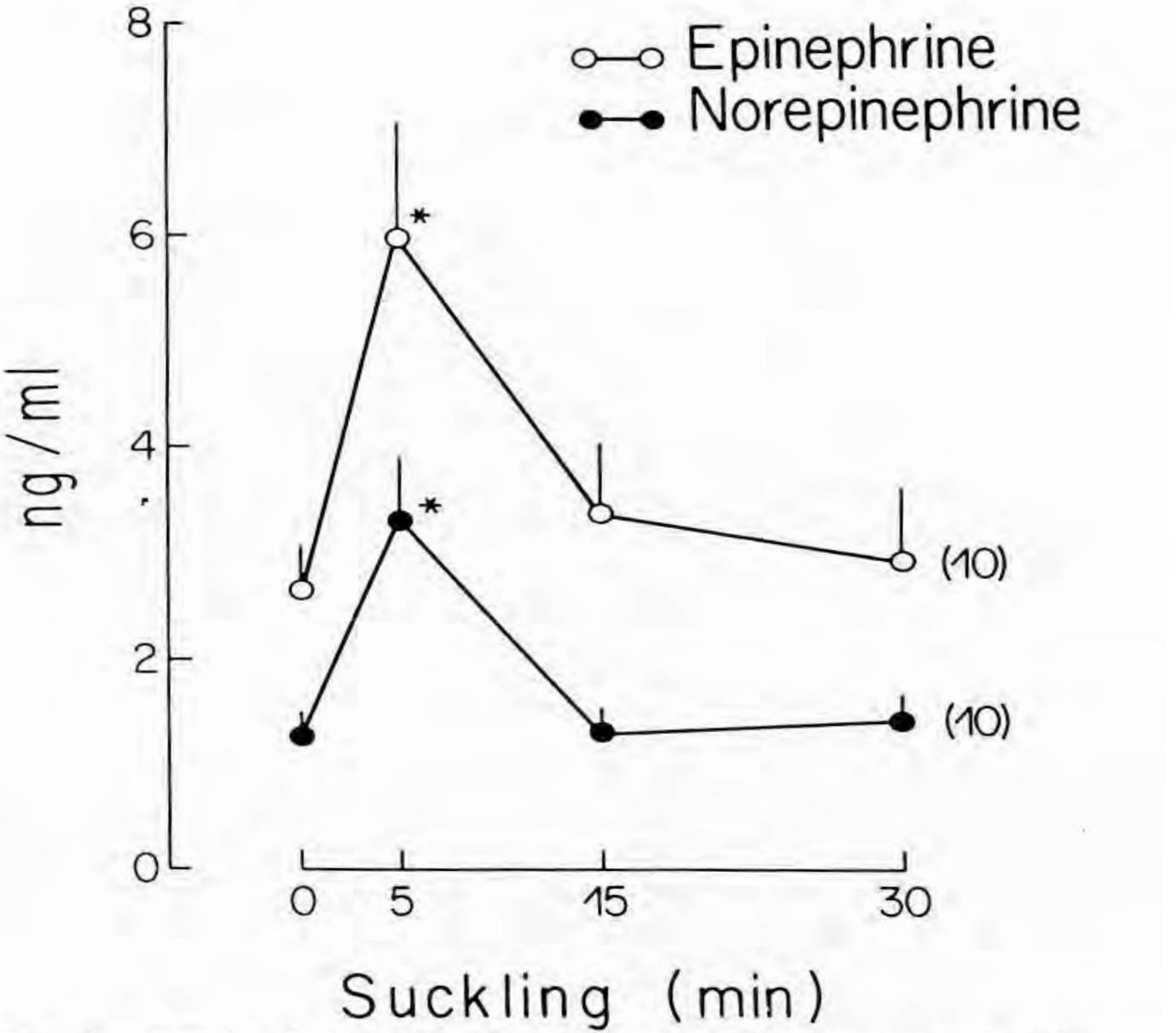
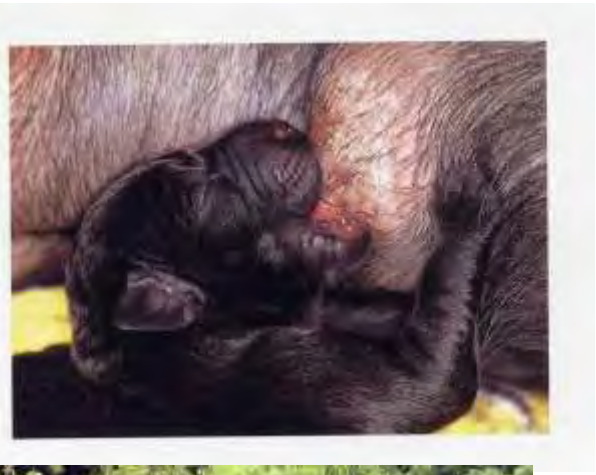


FIG. 3. Norepinephrine (●) and epinephrine (○) concentration in the plasma of lactating rats (Holtzman strain) after 5, 15, and 30 min of suckling (6 pups per litter) after 6–8 h or nonsuckling on postpartum days 12–14. Values are expressed as means ± SEM. *Numbers in parentheses* indicate number of rats. *, $P < 0.025$ *vs.* control value.

Suckling stimulus suppress ovarian function of dam by similar mechanism of stress



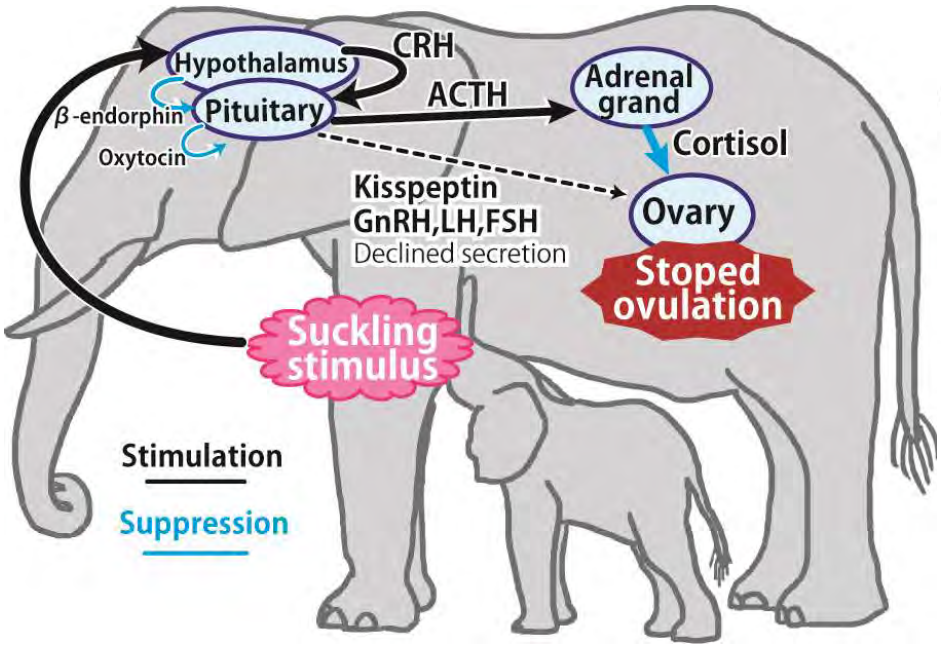


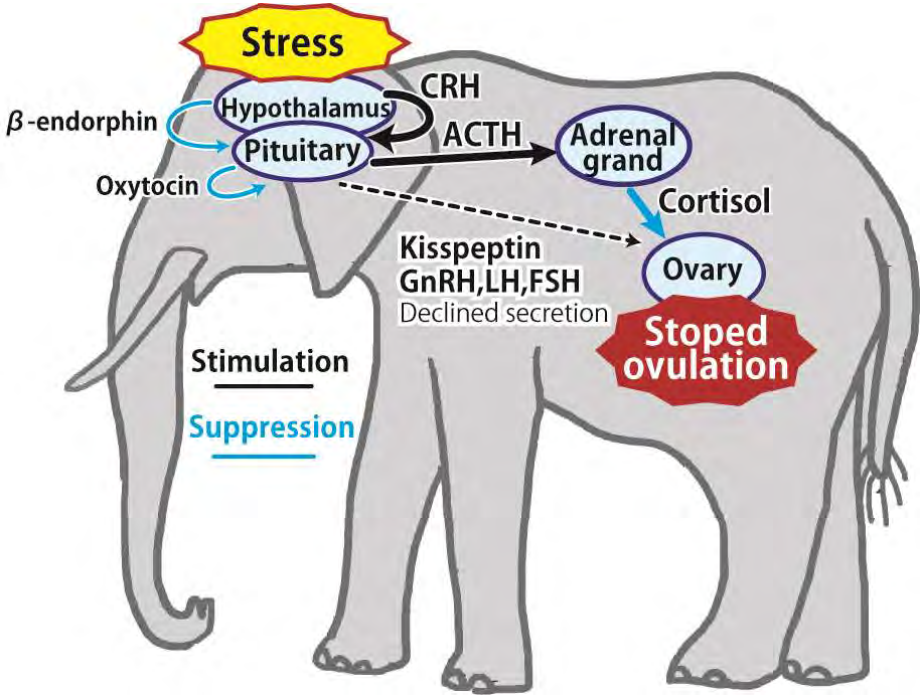




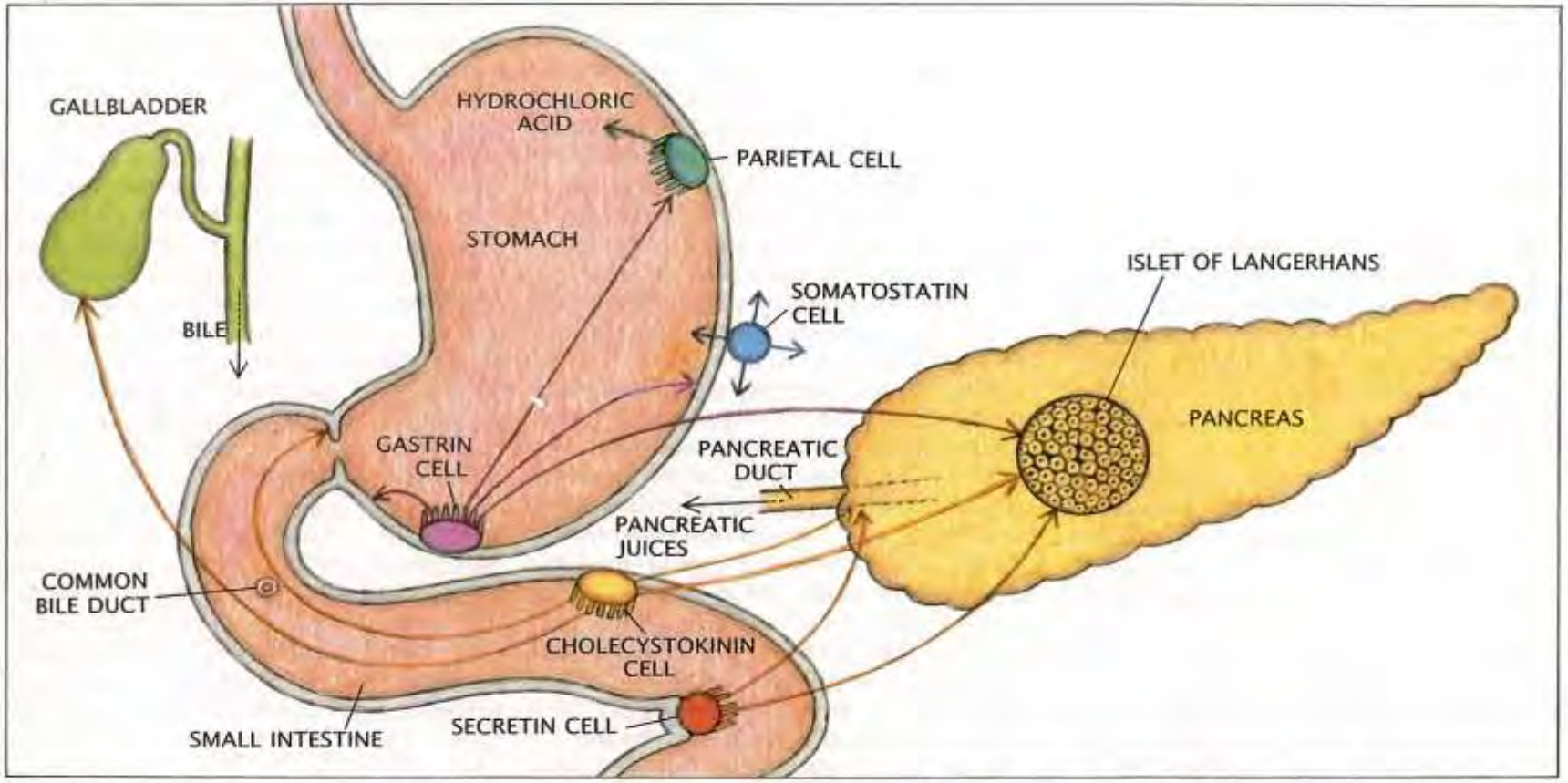


Sucking stimulus=Stress?



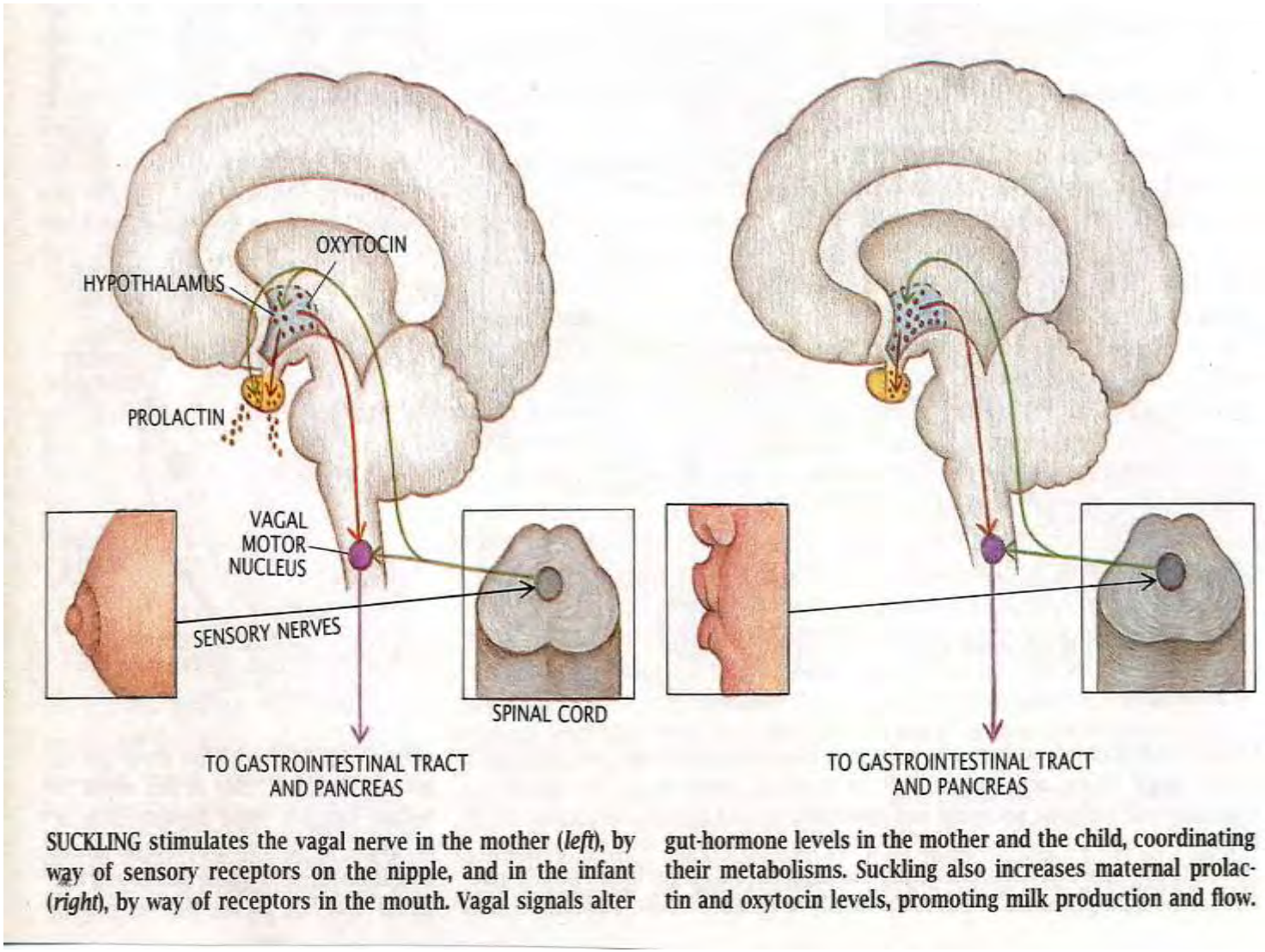


Suckling stimulus stimulate secretion of cholecystokinin in both dam and pup



GASTROINTESTINAL HORMONES are secreted into the gut and the circulation by endocrine cells in the wall of the stomach and small intestine. Gastrin, cholecystokinin and secretin enhance pancreatic insulin secretion. Gastrin also stimulates release of hydrochloric acid, growth of mucosal cells and gastric motility. Cholecystokinin slows emptying of the stomach and stimulates discharge of bile from the gallbladder and secretion of digestive enzymes by the pancreas; secretin stimulates pancreatic bicarbonate secretion. Somatostatin inhibits its secretion of gut hormones and counteracts their effects.

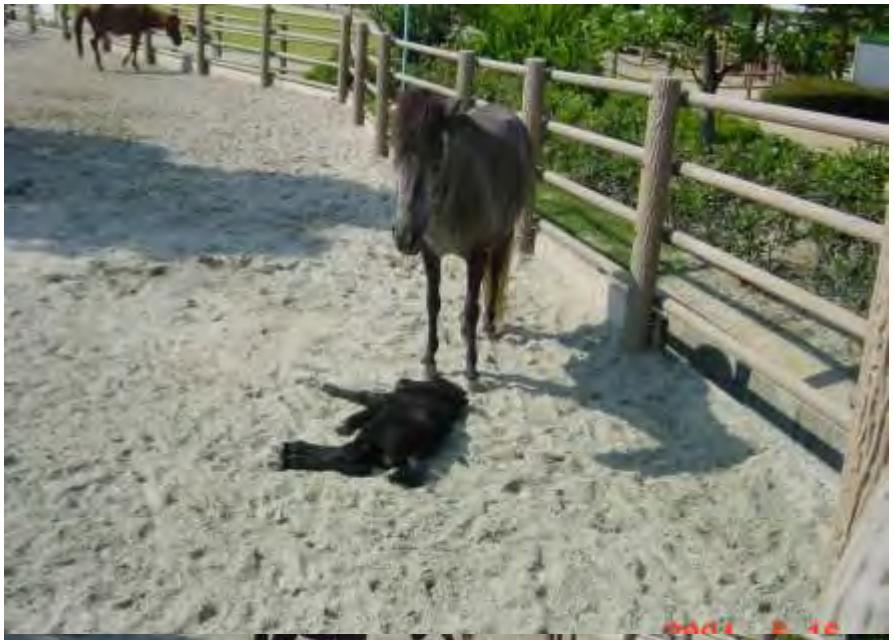
Cholecystokinin stimulate growth of intestine and sleep in both dam and pup



SUCKLING stimulates the vagal nerve in the mother (*left*), by way of sensory receptors on the nipple, and in the infant (*right*), by way of receptors in the mouth. Vagal signals alter gut-hormone levels in the mother and the child, coordinating their metabolisms. Suckling also increases maternal prolactin and oxytocin levels, promoting milk production and flow.

Dams and foals get sleep at same time after suckling









Suckling stimulus induce sleep in horses









Lactating dogs





Lactating seals









Bottle feeding has similar effects in infants



Bottle feeding to seal









Important hormones during lactation

- **Prolactin**

Stimulate milk production , immuno-function and anxiolytic effect

- **Oxytocin**

Stimulate milk release and anxiolytic effect

- **Cholecystokinin**

Stimulate growth of intestine and induce sleep in both dam and infant

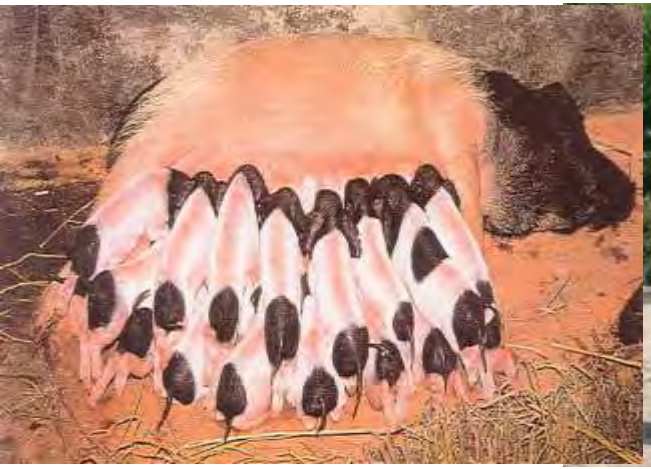
Physiological roles of prolactin in lactating dams

- Promote calcium absorption from the intestine
- Promote nest-building and nursing foals
- Promote milk production
- Promote glucocorticoid secretion by adrenocortical cells
- Promote immune function
- Anxiolytic effect during lactating stress





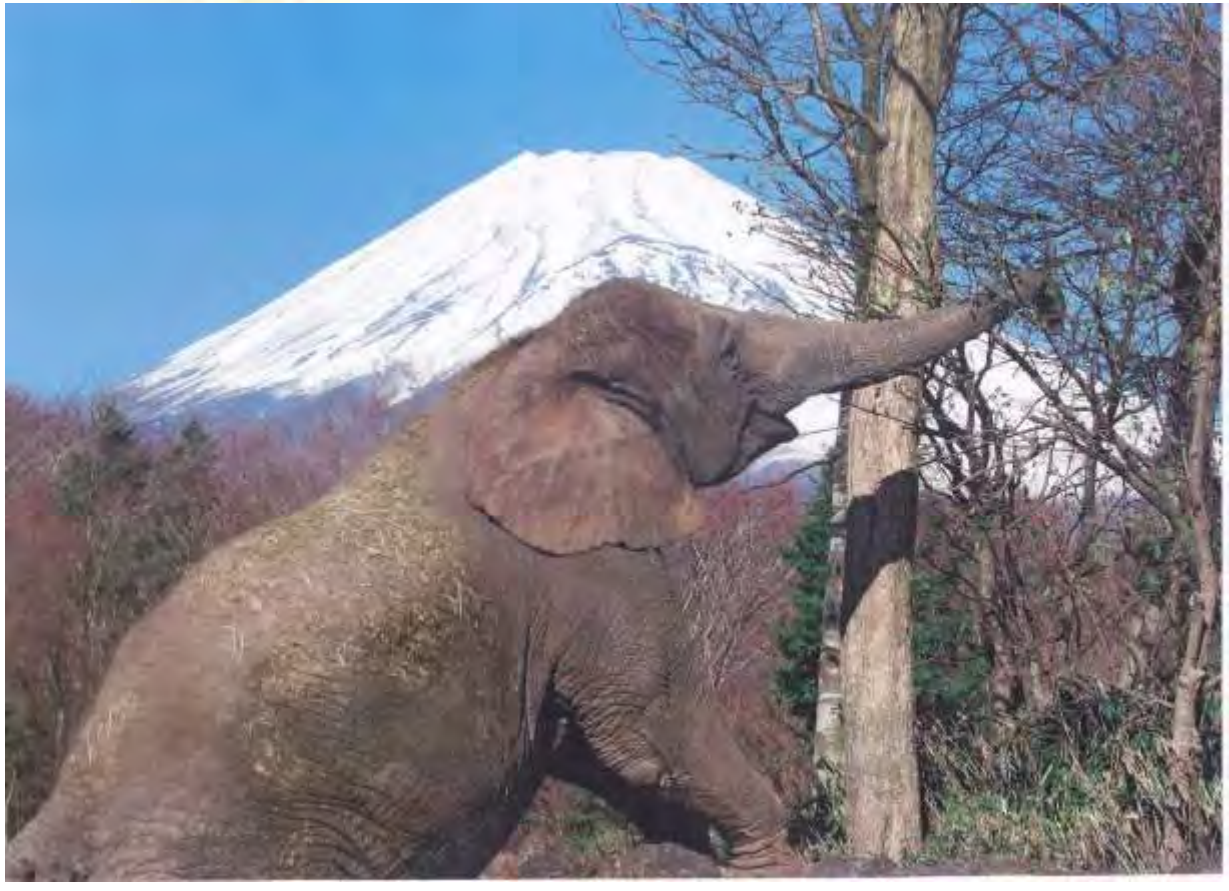

Lactation is a native contraception in mammals





Thank You Very Much





Improving our knowledge on elephant semen collection and quality

Analysis of Asian elephant (*Elephas maximus*) seminal plasma

Presented by

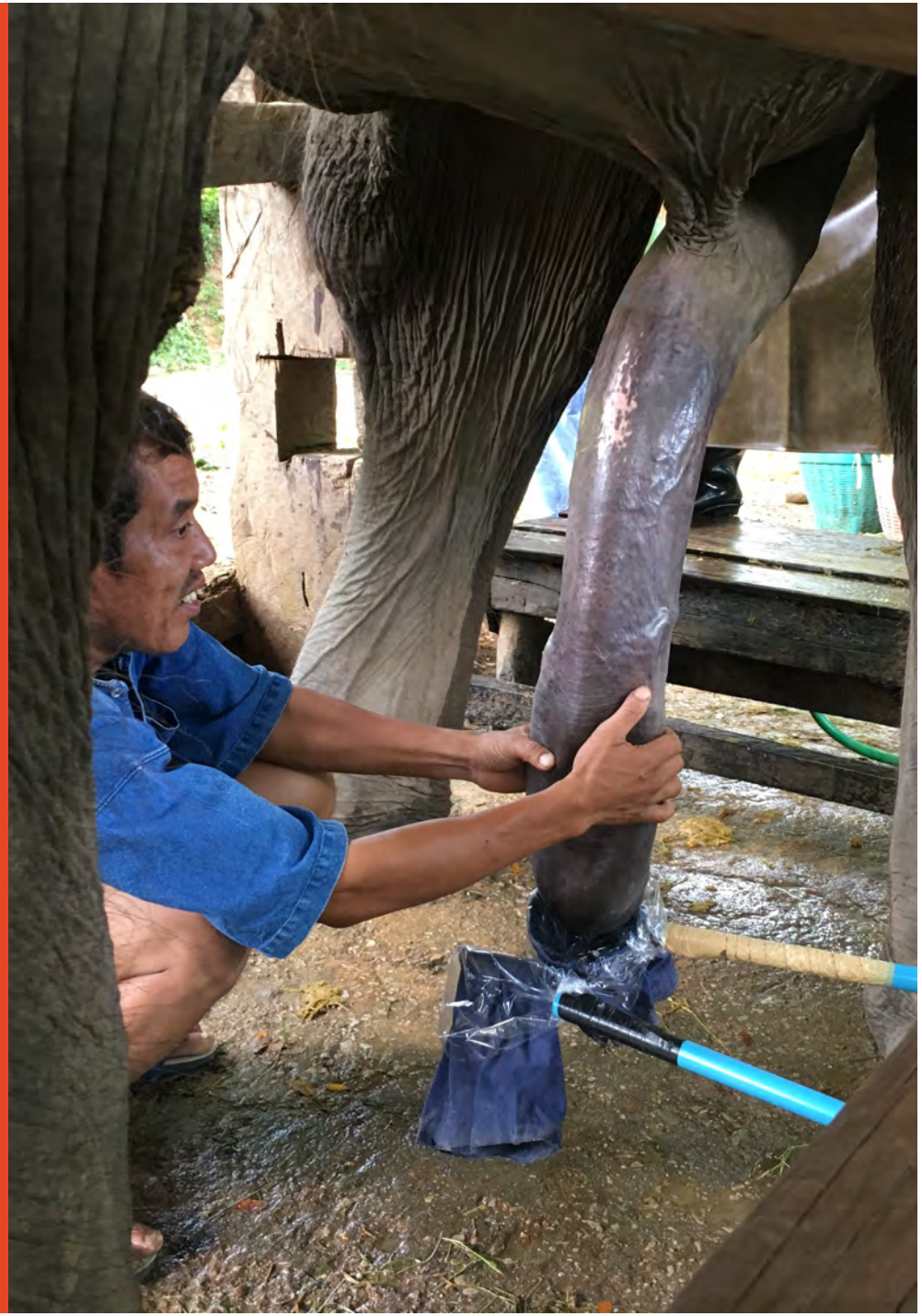
Cameron Negus

Faculty of Veterinary Science

Animal Reproduction Group

THE UNIVERSITY OF SYDNEY

ARGUS Animal Reproduction Group University of Sydney

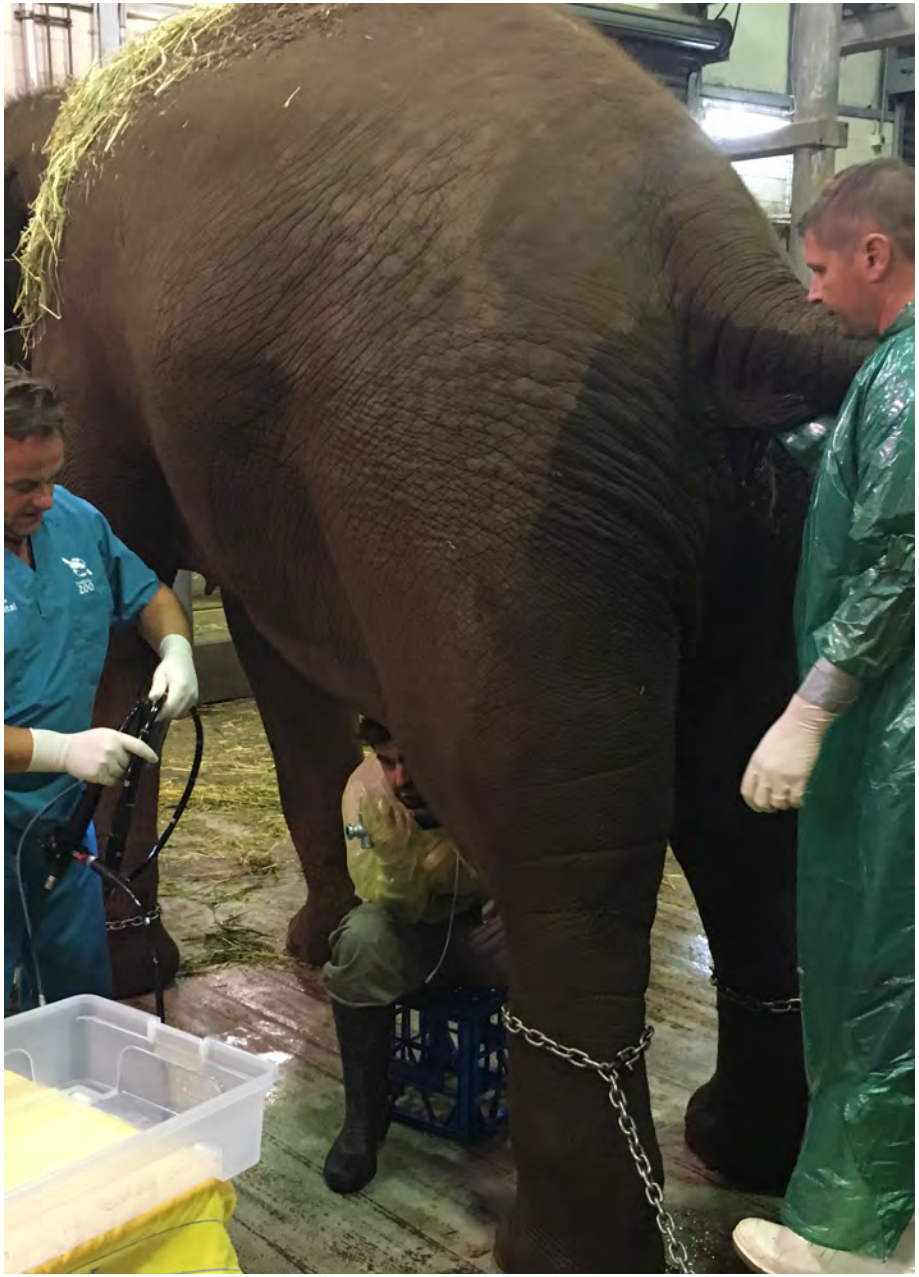


Background

Captive Asian elephants

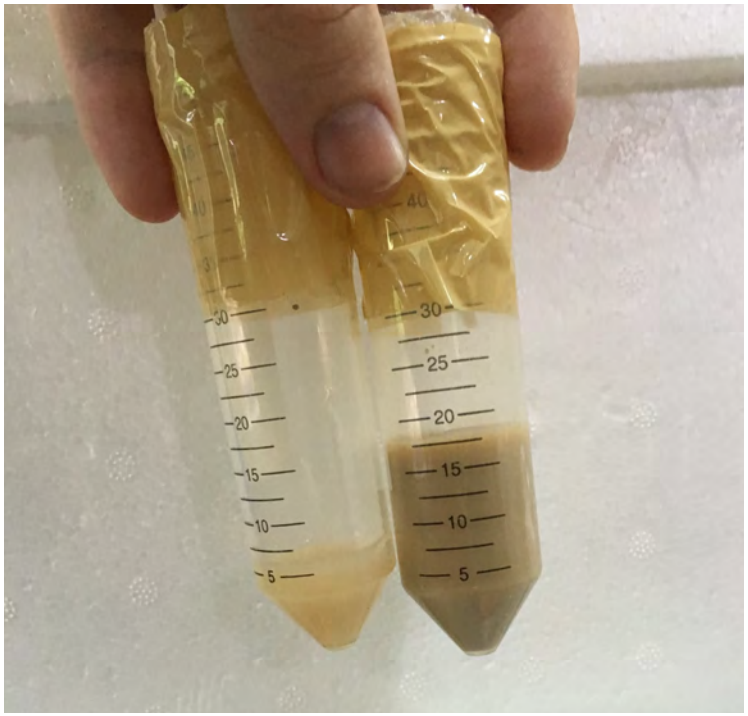


Artificial Insemination





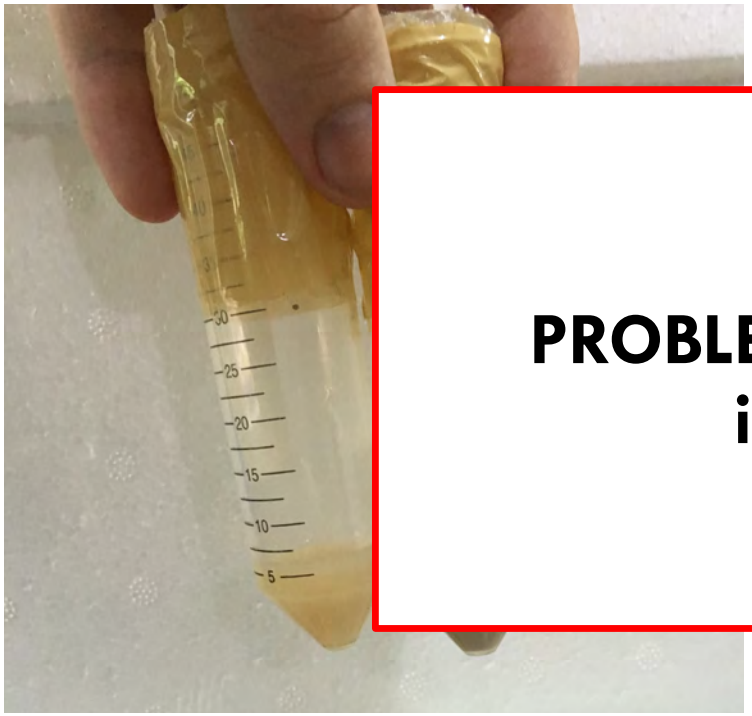
Artificial Insemination



Semen collection



Semen preservation



Semen collection

PROBLEM: semen quality inconsistent





Semen cryopreservation

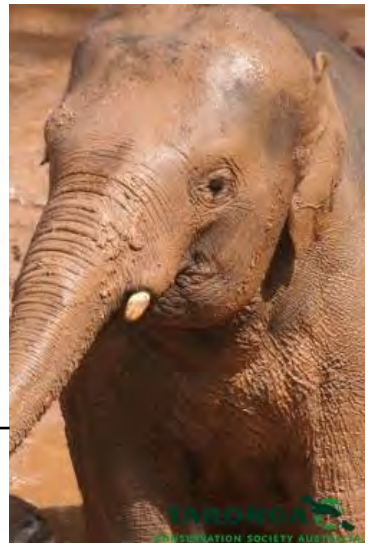
Bulls





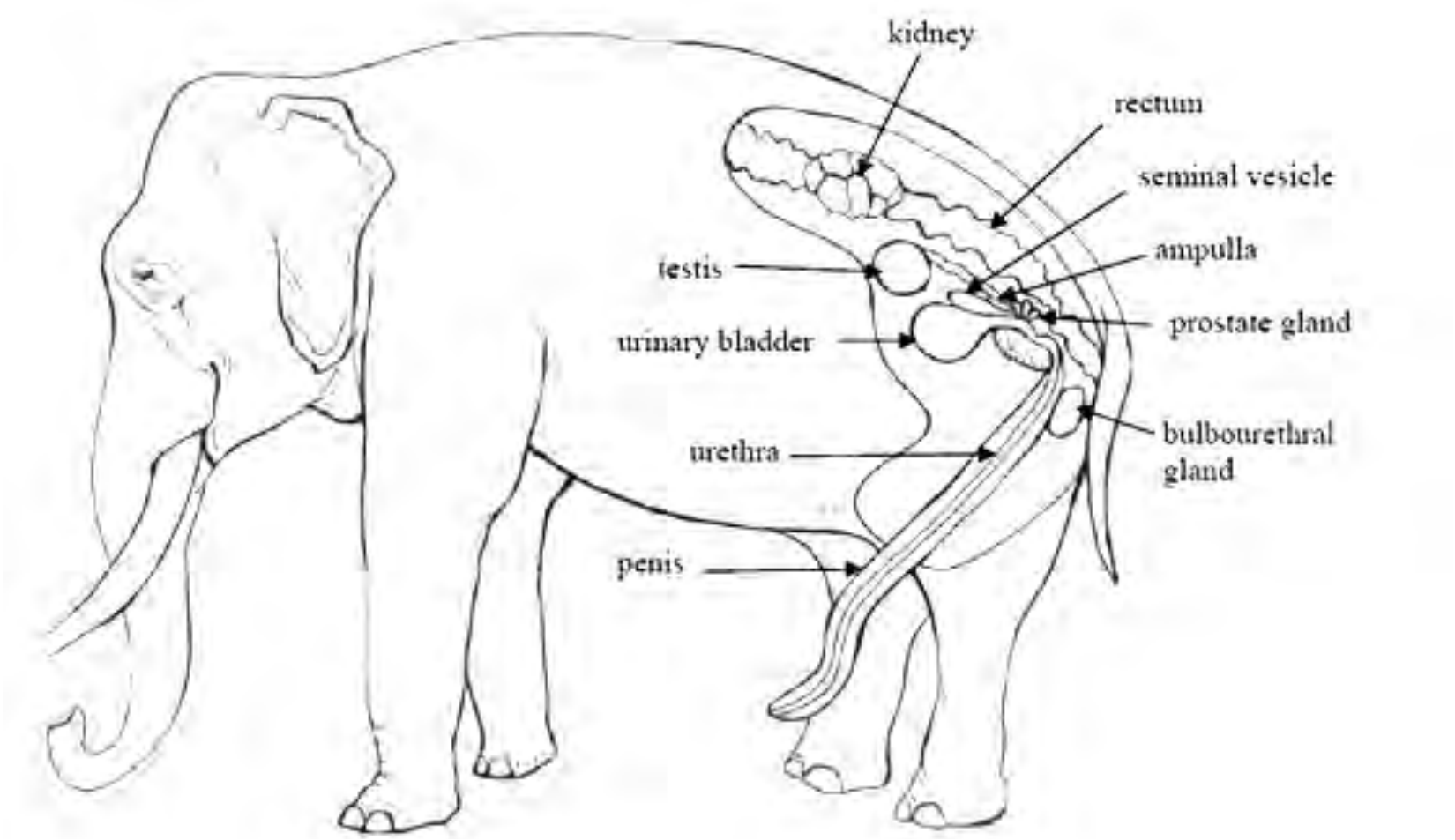
27 years of age

41 years of age



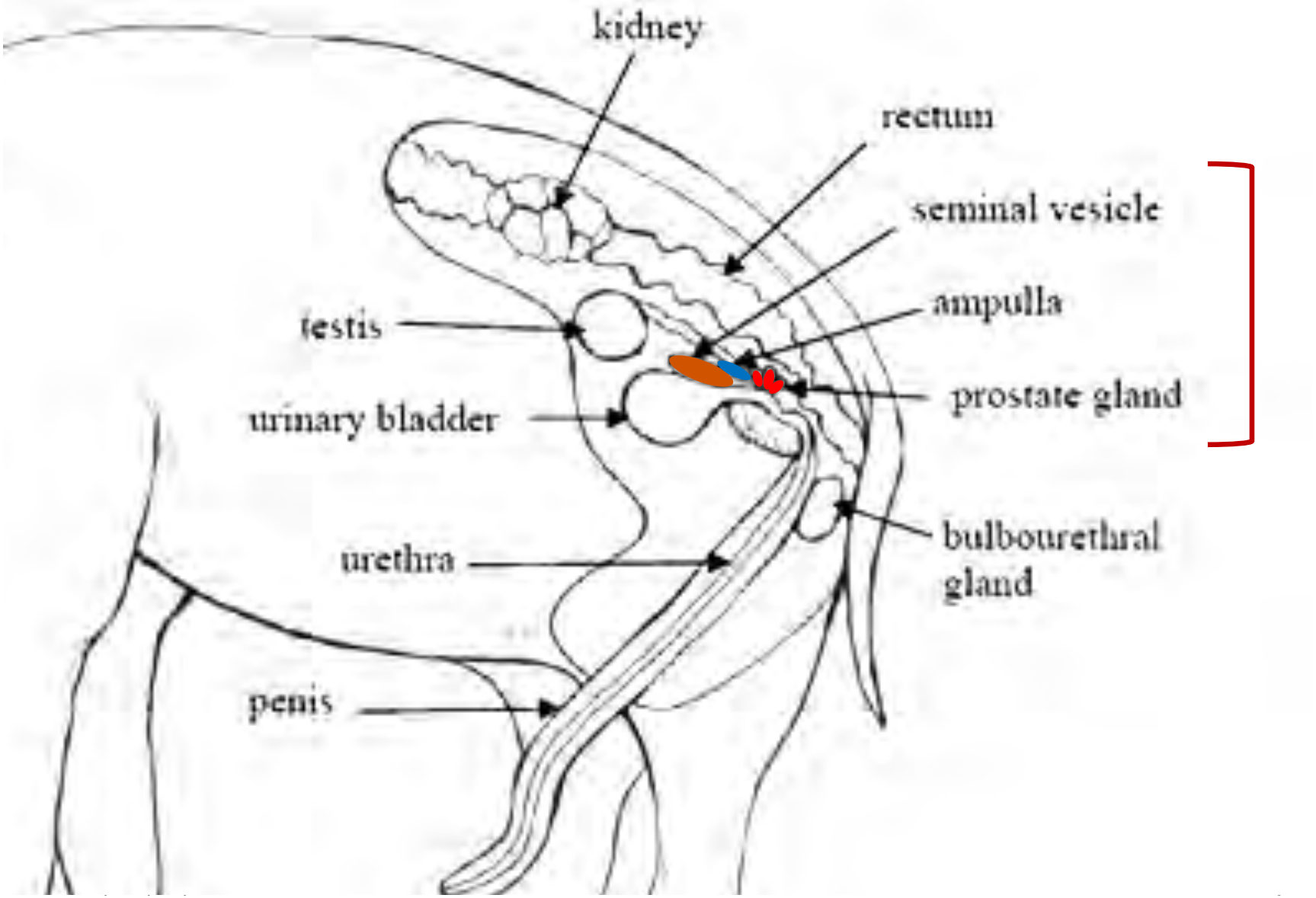
16 years of age

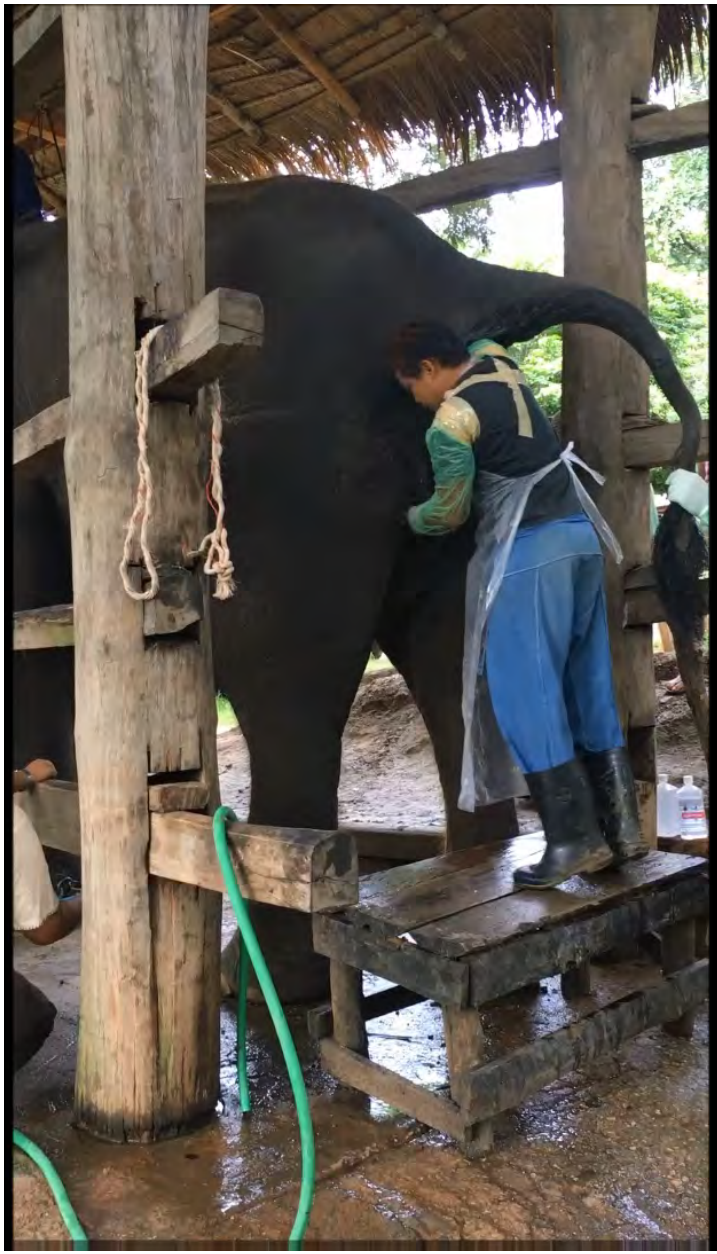
Semen collection



Male elephant reproductive anatomy (modified from Hildebrant et al., 2006; sourced from Center of Excellence in Elephant Research and Education 2013)

Manual rectal massage





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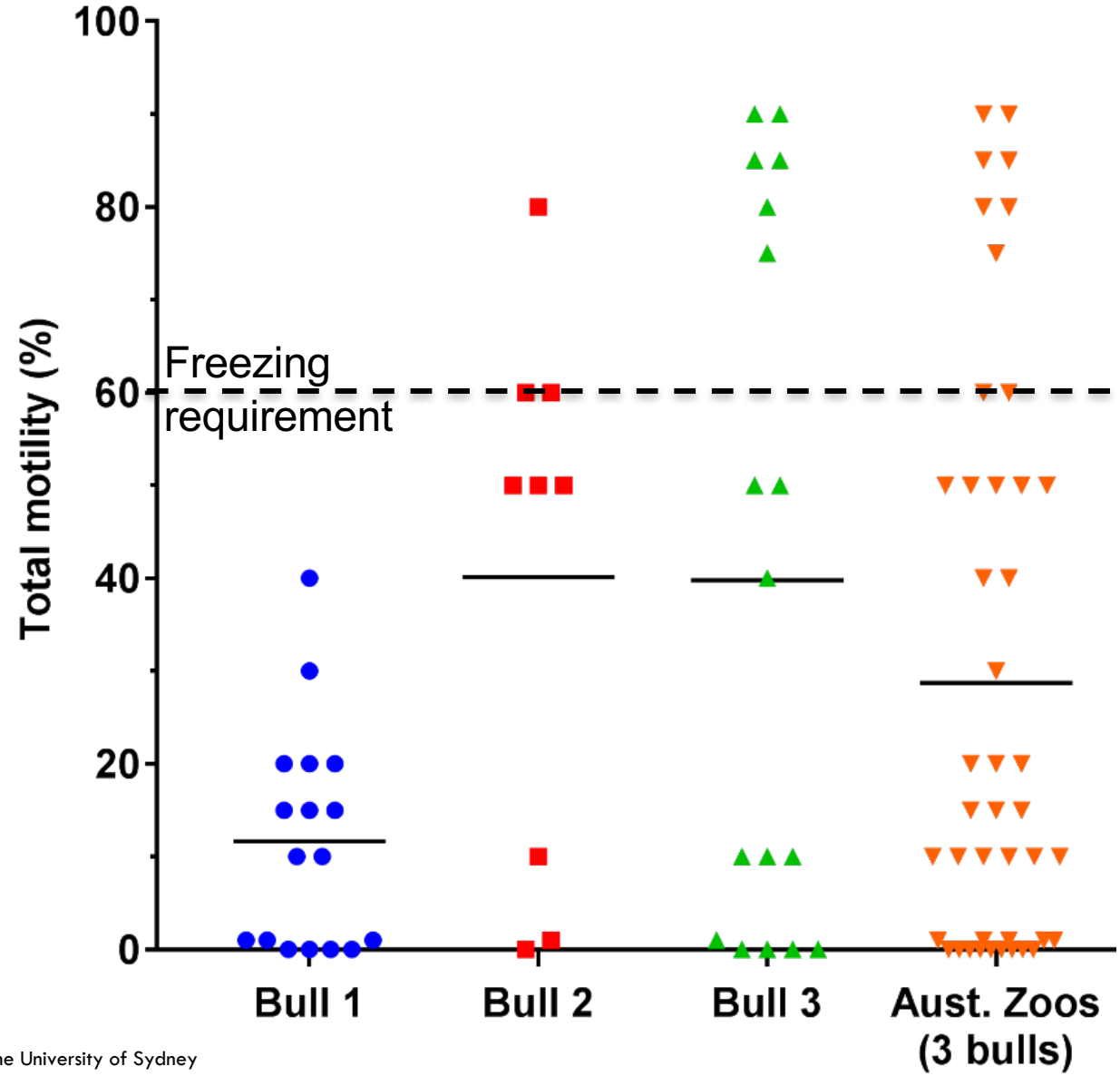
Fresh semen parameters

	3 bulls (N = 43 ejaculates)		
Parameter	Mean	St. Dev.	Range
Volume (ml)	10.6	± 14.6	(0.1 - 87)
pH	7.7	± 1.2	(5.5 - 9.5)
Concentration (x10^6 sperm/ml)	836.5	± 799.4	(0.7 - 2415)
Total motility (%)	28.7	± 30.8	(0 - 90)
Viability (%)	32.1	± 21.1	(3 - 67)
Intact acrosome (%)	35.9	± 33.7	(3 - 99)
Normal morphology (%)	56.7	± 22.4	(10 - 93)

Sperm parameters

Fresh semen quality

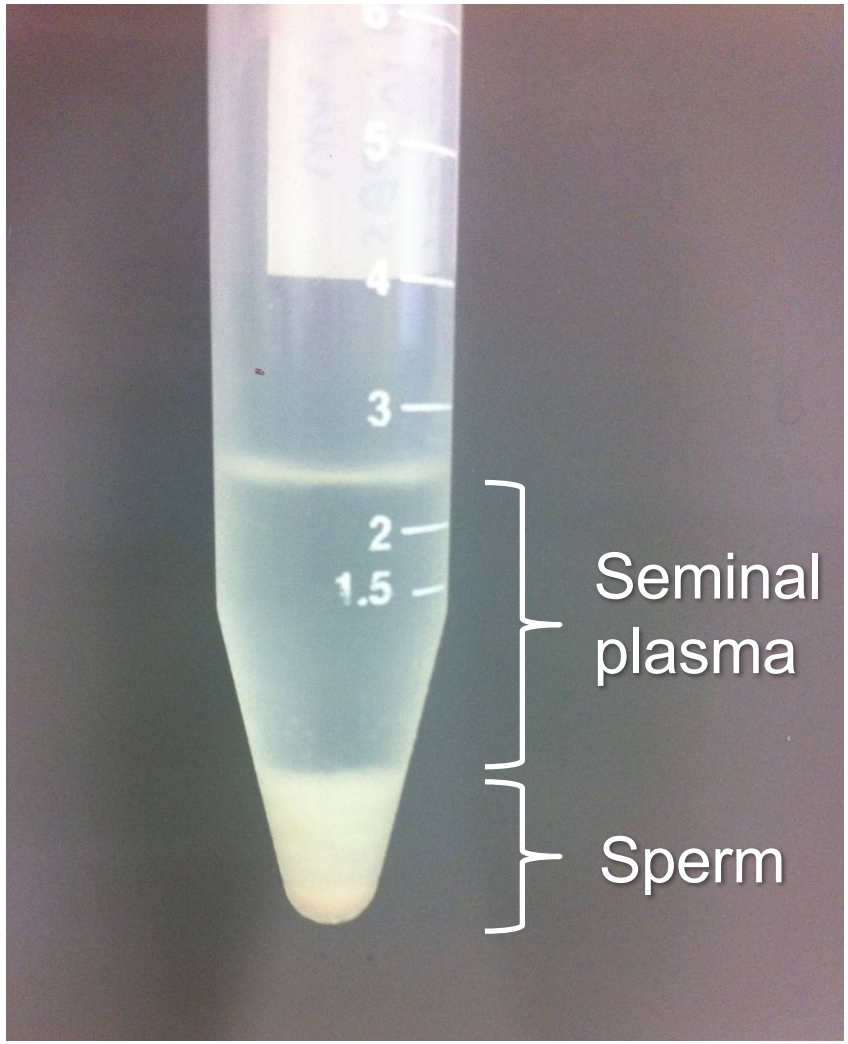
Quality if inconsistent and variable



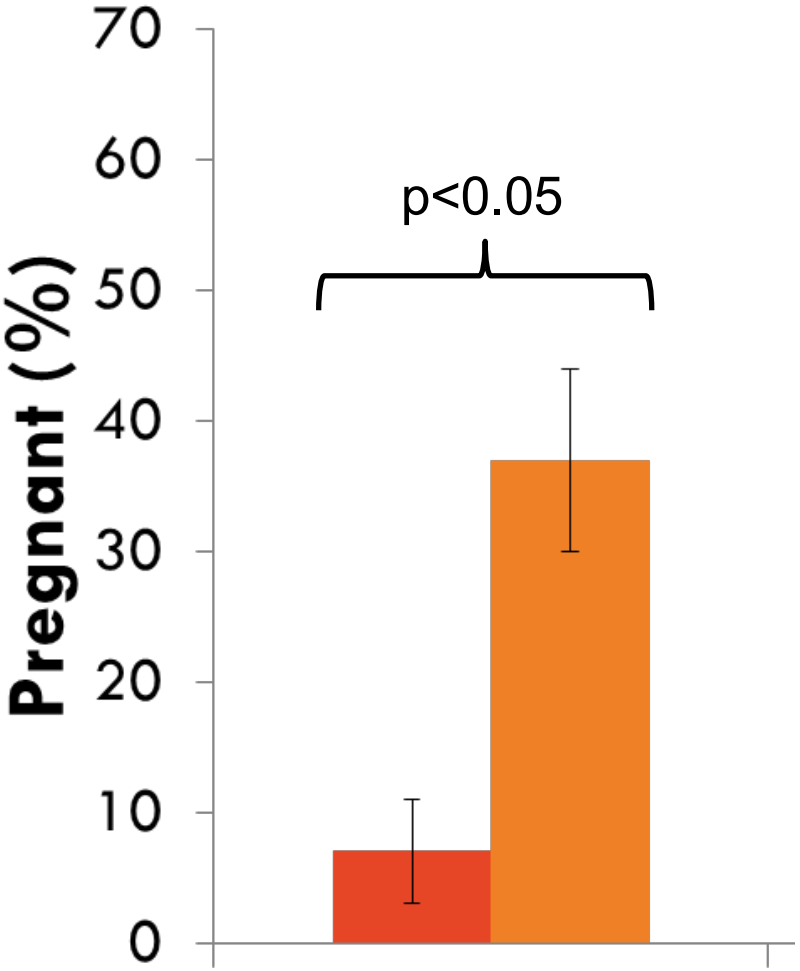
What can have an effect on sperm quality? - Seminal plasma

About seminal plasma:

- Secreted by accessory glands
- Contains sugars and organic compounds
- **Proteins**
  - Sperm metabolism
  - Sperm capacitation
  - Interaction with female tract and gamete interaction
  - Antioxidant effects
  - Sperm recovery



Effect of seminal plasma



Sperm type

- epididymal
- epididymal + seminal plasma

Seminal plasma enhances ram sperm transit through the cervix

Adapted from Rickard et al. 2014 Reproduction 148 (6): 469-478

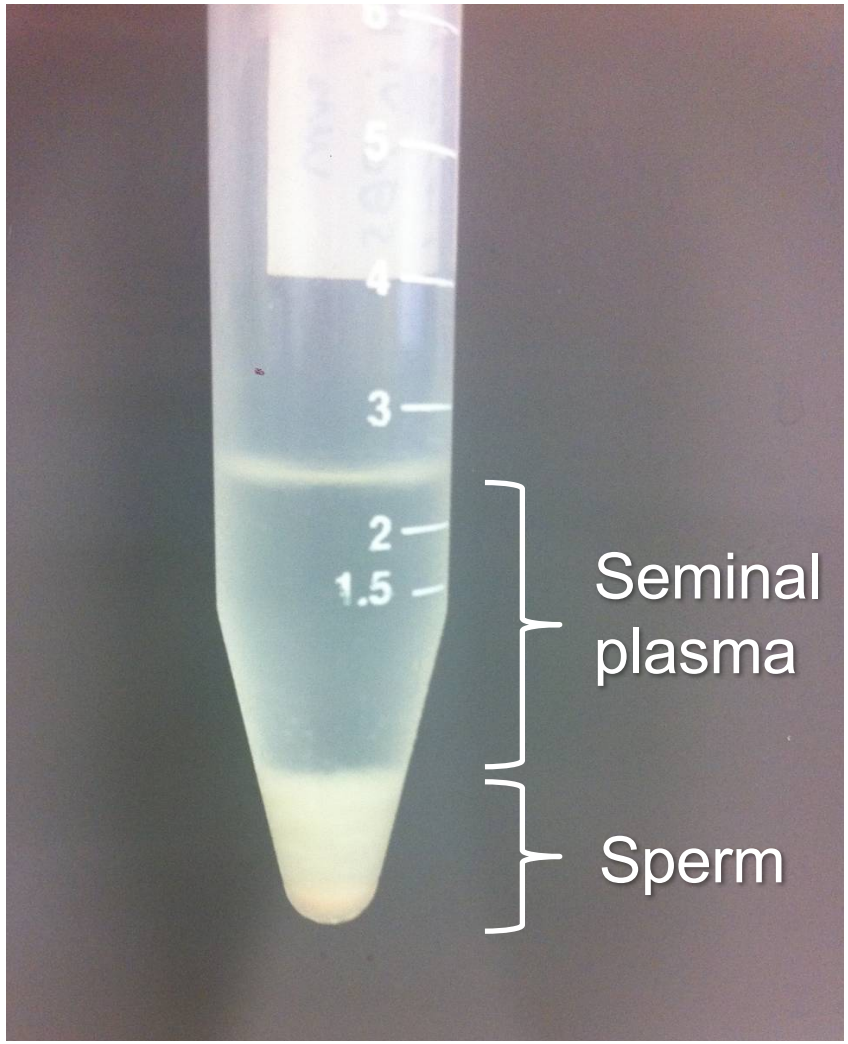
What can have an effect on sperm quality? - Seminal plasma

About seminal plasma:

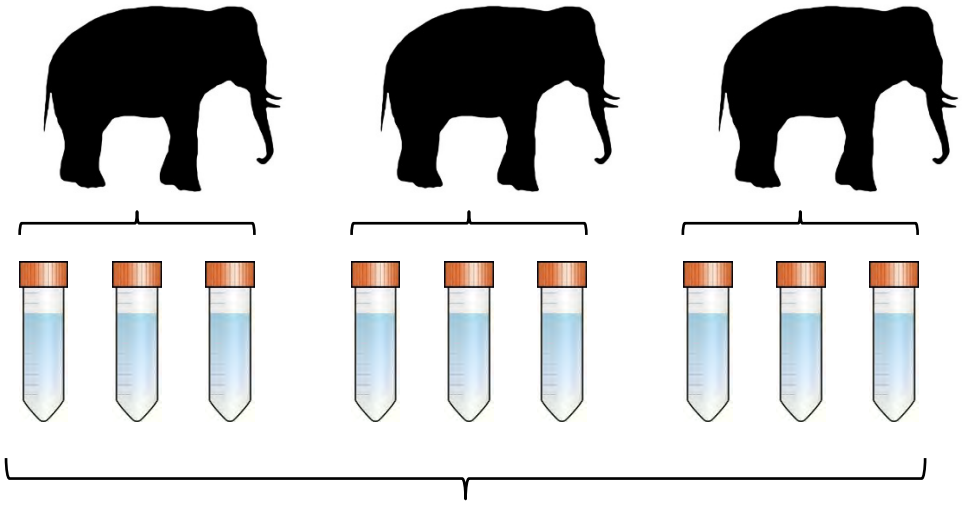
- Secreted by accessory glands
- Contains sugars and organic compounds
- **Proteins**
  - Sperm metabolism
  - Sperm capacitation
  - Interaction with female tract and gamete interaction
  - Antioxidant effects
  - Sperm recovery

Experimental aim:

Characterise the complete proteome of Asian elephant seminal plasma

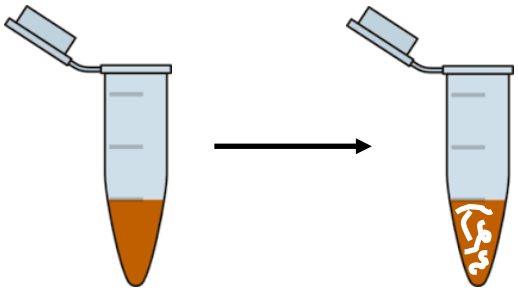


Methodology



Seminal plasma aspirated

N = 9



Proteins reduced, alkylated & digested



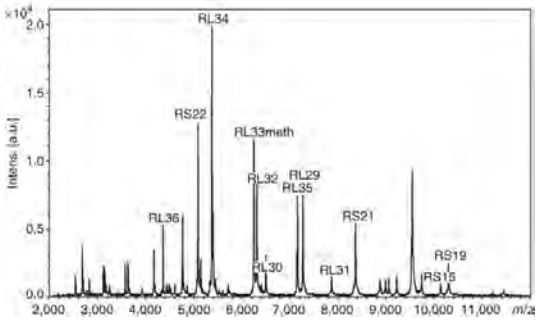
LC-MS/MS



UniProt

MATRIX SCIENCE

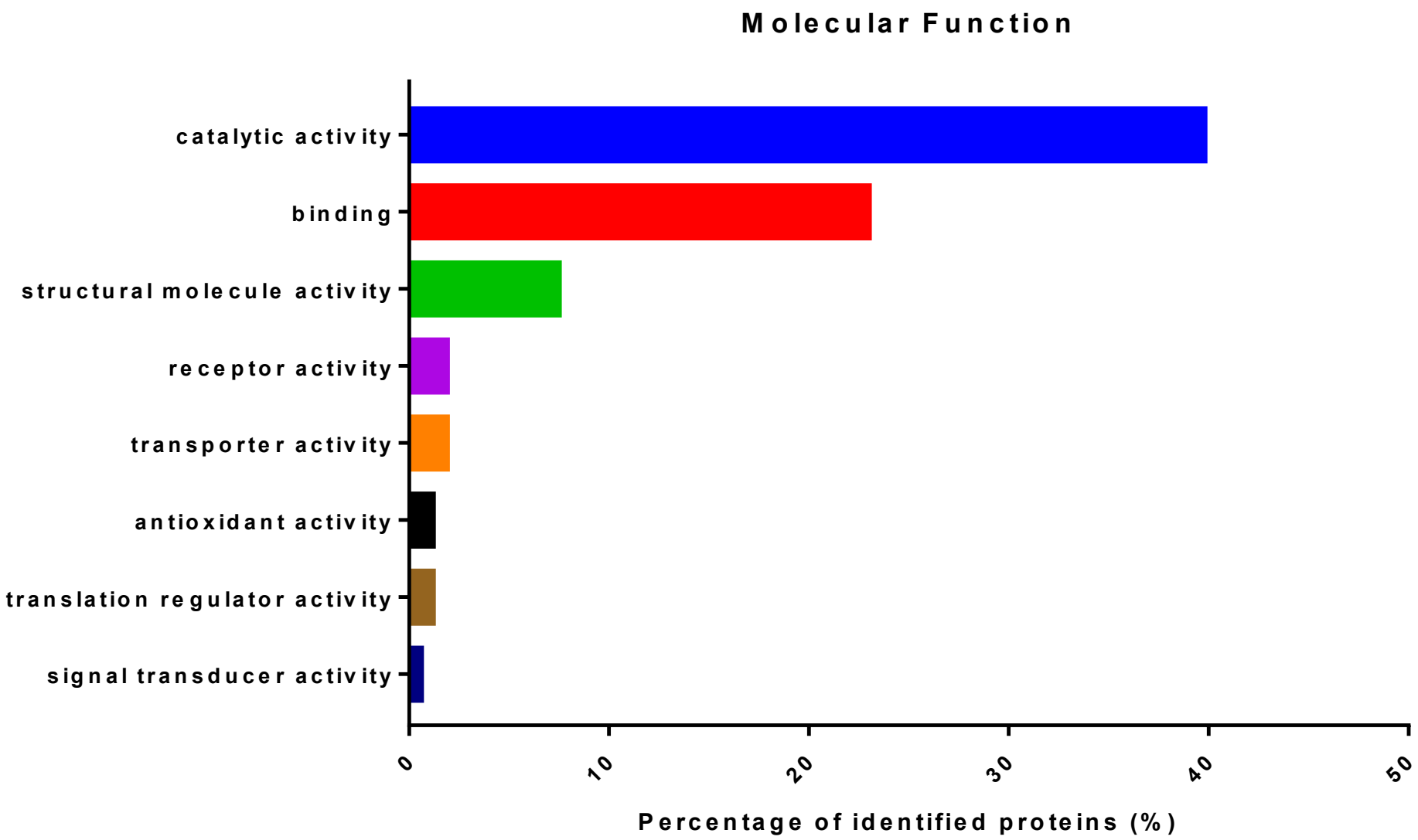
MASCOT ver 2.4



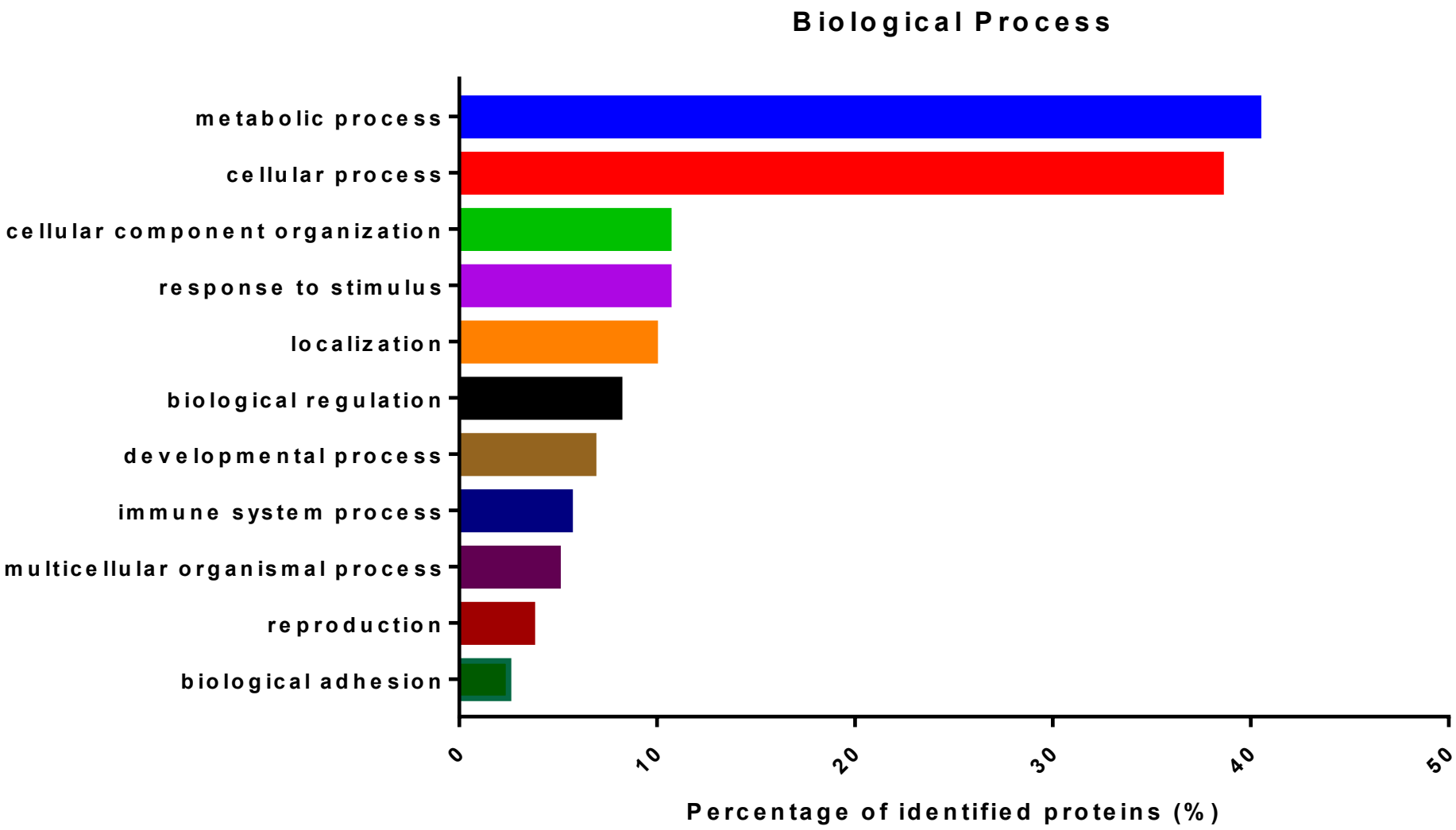
Findings

- **Total number of proteins:** 155 proteins
- Array of molecular and biological functions
- Proteins from families;
  - Transferrin
  - Nucleobindin
  - Heat shock protein
  - Lipocalin
  - Carboxylesterase/lipase

Gene ontology



Gene ontology



Example proteins

Prostaglandin D2 synthase (PTGDS)

- Binds to acrosomal cap of epididymal sperm
- Speculate role in development and maturation of sperm
- Indicator of high fertility in bulls (Gerena et al. 1998)

Lipocalins (LCN)

- Extracellular transport proteins
- Binding and transporting lipophilic molecules

Zinc-alpha-2-glycoprotein (AZGP1)

- Originate in prostate
- Cell binding properties to regulate motility via cAMP pathway
- Correlated with percentage of motility in rams (Rodrigues et al. 2013)

Summary

Take home points

- Semen quality variable & inconsistent
- Possible effect of seminal plasma proteins

Future plans

- Quantitative analysis of high v poor quality samples
- Differences between bulls and/or facilities

Significance of findings

- Improve knowledge on Asian elephant seminal plasma
- Understand reproductive processes
- Identify candidate proteins to improve sperm function

Acknowledgements

University of Sydney

- Roslyn Bathgate

Taronga Conservation Society Australia

- Rebecca Spindler
- Rebecca Hobbs

Proteomics

- Bioanalytical Mass Spectrometry Facility (BMSF), University of New South Wales

Animal facilities

- Taronga Zoo
- Perth Zoo
- Melbourne Zoo
- Thai Elephant Conservation Centre, Thailand

Thank you for listening

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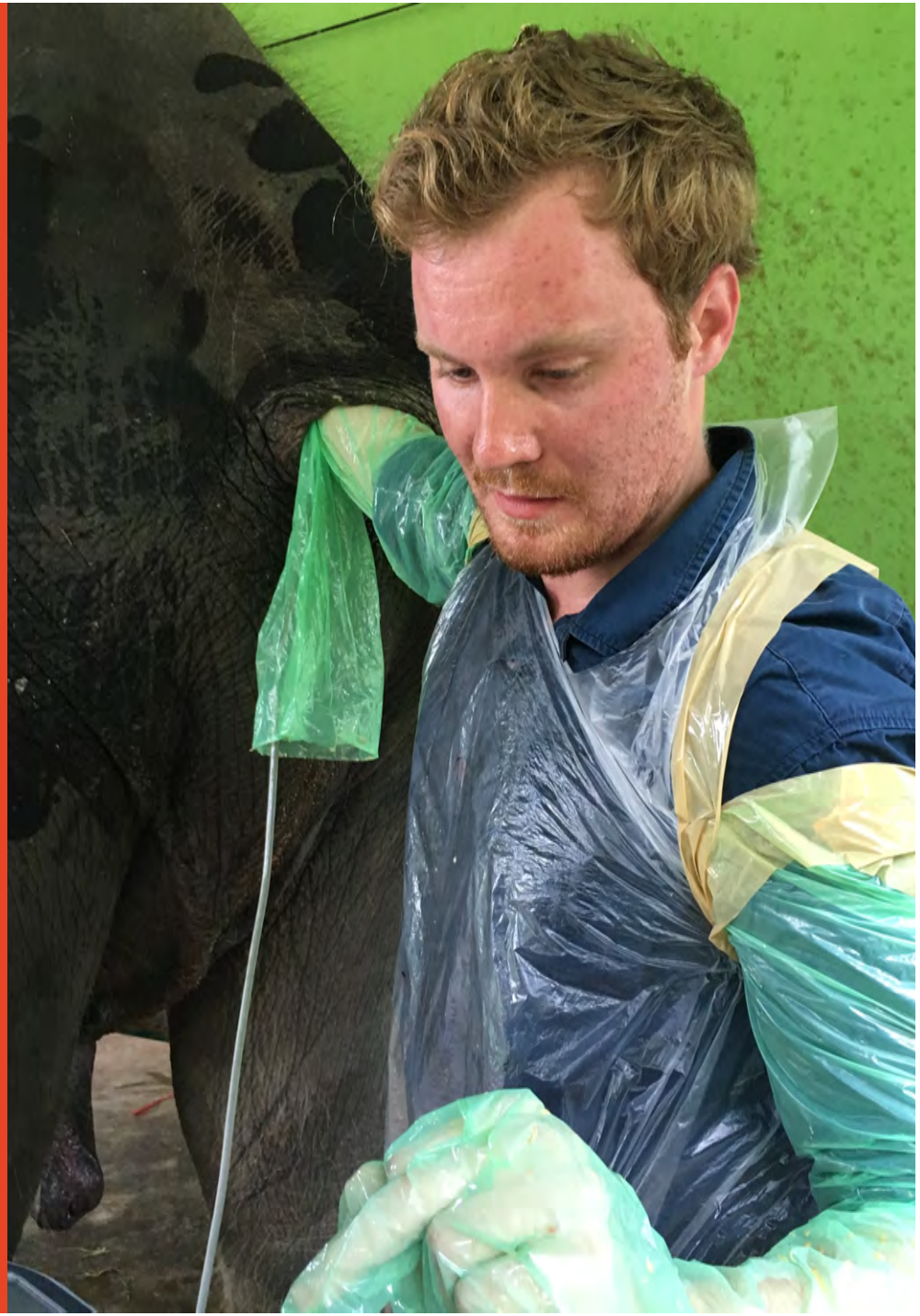
ARGUS Animal Reproduction Group University of Sydney



Progress in Sperm Sorting & Cryopreservation Technologies for Modifying Population Sex Ratio & Preserving Genetic Diversity in the Rhinoceros & Elephant

Justine. K. O'Brien, Gisele A. Montano, Karen J. Steinman
Jacqueline L. Posy, Todd R. Robeck
SeaWorld Parks & Entertainment, USA

Monica A. Stoops, Terri. L. Roth
Cincinnati Zoo & Botanical Garden, USA

Ray L. Ball
Lowry Park Zoo, USA

Rhonda Saiers
Rio Grande Zoo, USA

Jan C. Ramer
The Wilds, USA

Charles C. Love
Texas A & M, USA

Maintaining the Genetic Diversity of Ex Situ Populations

- **Challenges**
  - Unequal representation of founder genetics
  - Reproductive senescence
  - Irregular female cycling, anovulation (rhino)



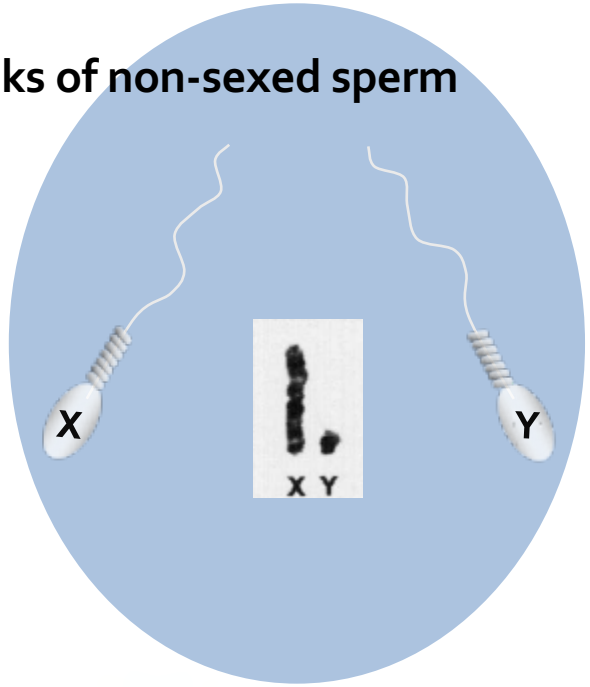
- **Assisted Reproduction**
  - Sperm cryopreservation (all species)
  - Artificial insemination

    (calves born using frozen sperm: *C.simum*[1],*R.unicornis*[2], *L.africana*[3])
  - Exogenous hormone stimulation: address irregular cycles , acylicity, anovulation[4]

[1]*Hermes et al., 2009;* [2]*Stoops et al., 2016;* [3]*Hildebrandt et al., 2012;* [4]*Hermes et al., 2012*

Maintaining the Genetic Diversity of Ex Situ Populations

- **Sperm Sorting[1] & Cryobanking**
  - Long-term preservation of biodiversity
  - Structuring of sex ratio: optimal social environment
  - Increase population growth
  - **Add sexed sperm to existing cooperative cryobanks of non-sexed sperm of high fertility potential**



[1] *Johnson et al., 1989*

Steps & Challenges For Producing Pre-sexed Offspring





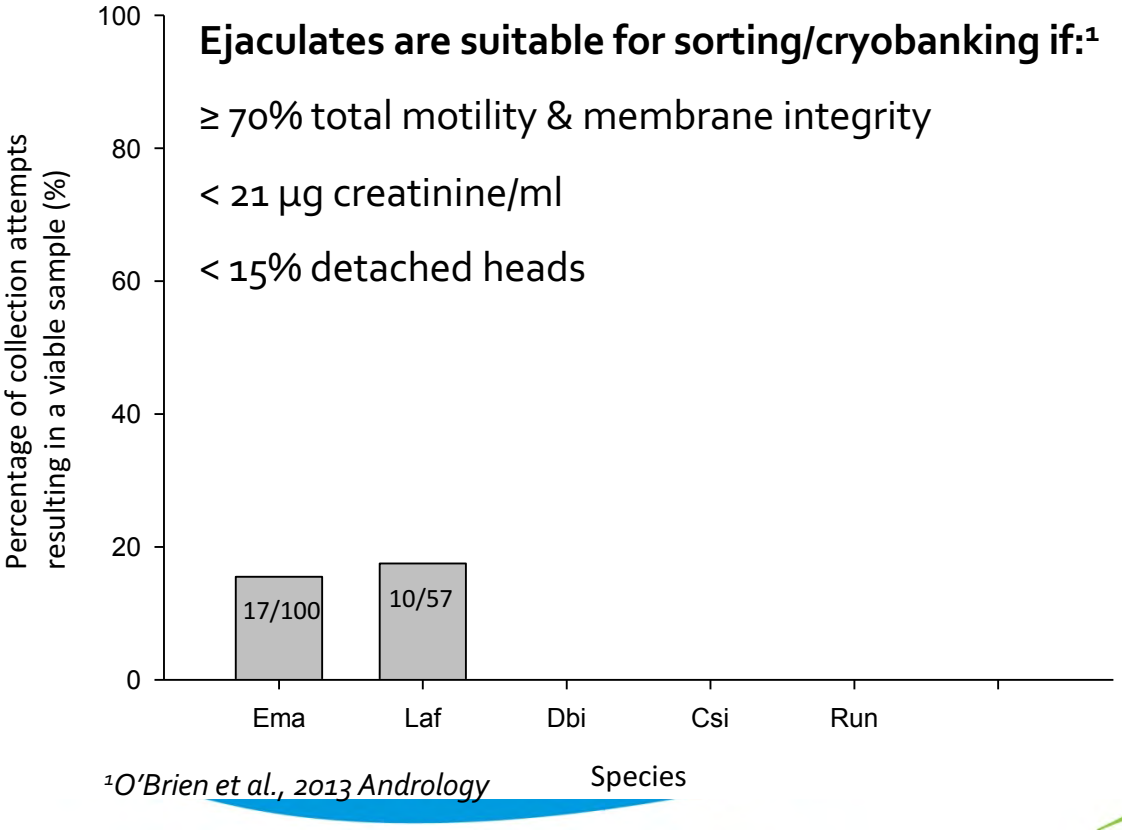
COLLECTION STRESSORS
-Urine contamination: anesthetic protocol; operant conditioning (ELE)

Ejaculates are suitable for sorting/cryobanking if:[1]

≥ 70% total motility & membrane integrity

< 21 µg creatinine/ml

< 15% detached heads



[1]*O'Brien et al., 2013 Andrology*

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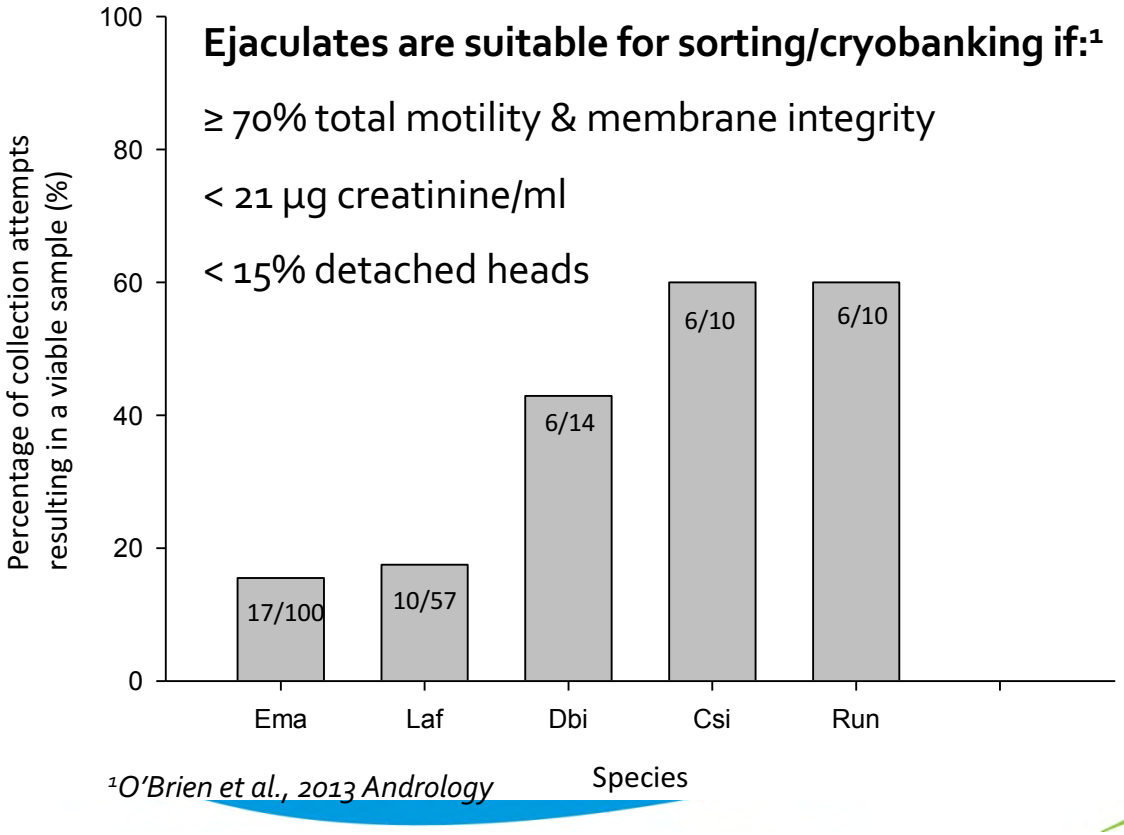

[1]*O'Brien et al., 2013 Andrology*

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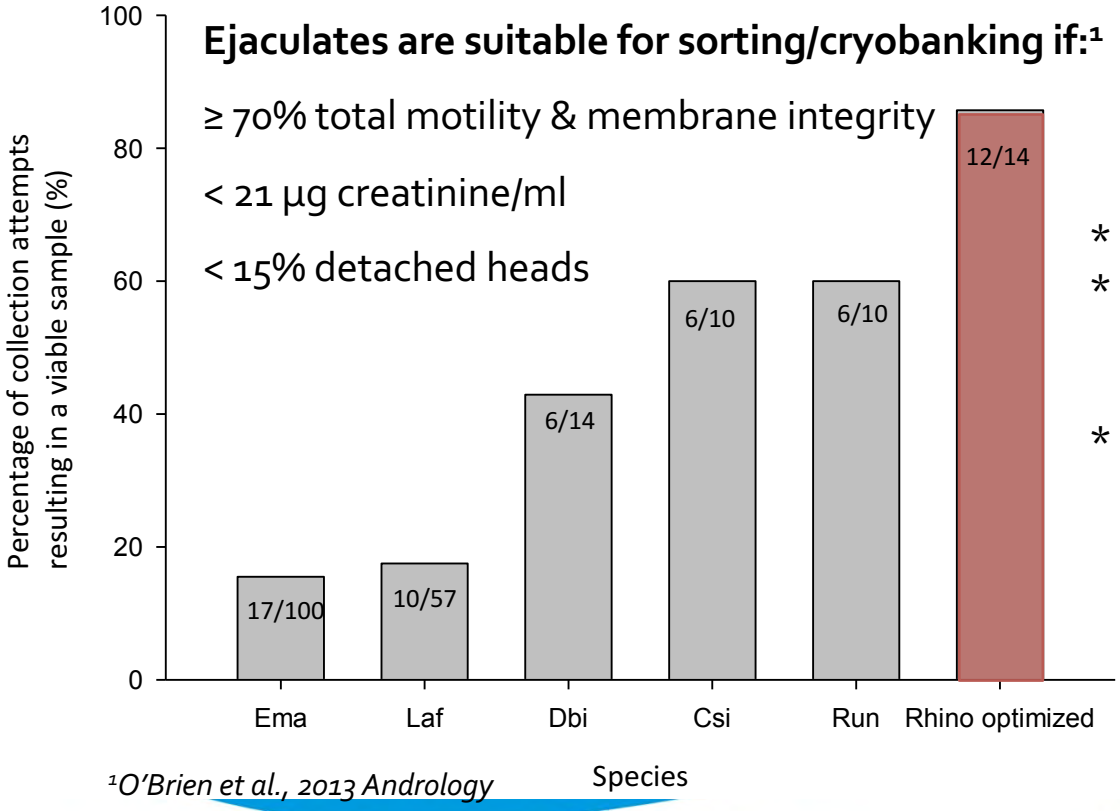

[1]*O'Brien et al., 2013 Andrology*

* Etorphine/ketamine/azaperone (Dbi)
* Etorphine/medetomidine/ketamine (Csi) (no xylazine – ↑ urine output)

* Males maintained in proximity to reproductive females

Steps & Challenges For Producing Pre-sexed Offspring





COLLECTION STRESSORS
-Urine contamination: anesthetic protocol; operant conditioning (ELE)



TRANSPORT STRESSORS (to sorting lab)
-Temperature: Extra insulation of Equitainer
-Time: ≤12 h shipment time; cryopres ≤24 h p-collection[1]
-Extender: protein type & concentration(egg yolk, BSA/serum subst, lecithin, milk-fat)

[1]*O'Brien et al., 2013 RFD*

Steps & Challenges For Producing Pre-sexed Offspring





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TRANSPORT STRESSORS (to sorting lab)
-Temperature: Extra insulation of Equitainer
-Time: ≤12 h shipment time; cryopres ≤24 h p-collection[1]
-Extender: protein type & concentration(egg yolk, BSA/serum subst, lecithin, milk-fat) **Optimum: semen centrifug & 1.8% (rhino) or 5% (Ele) egg yolk**

[1]*O'Brien et al., 2013 RFD*

Steps & Challenges For Producing Pre-sexed Offspring



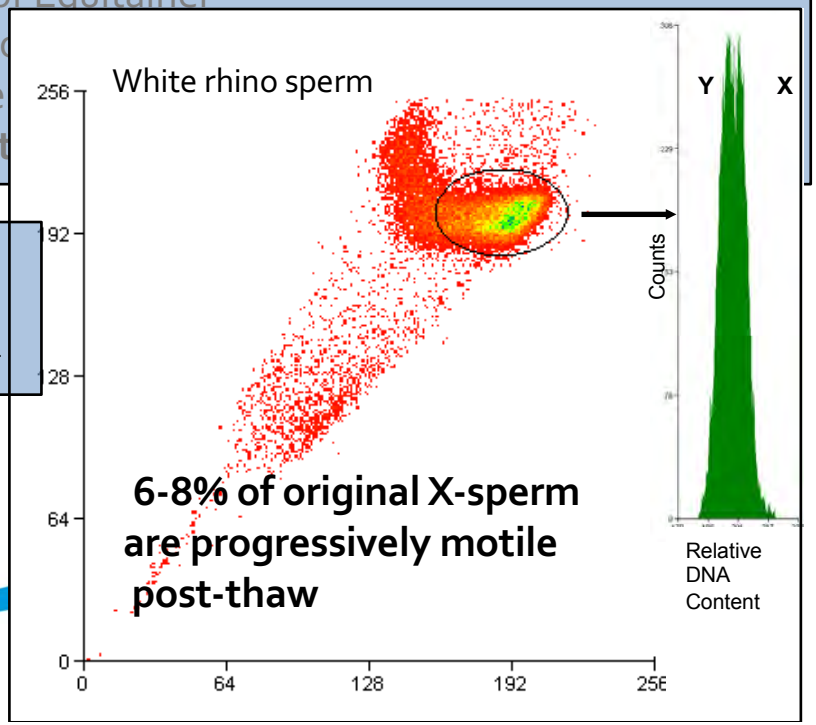


COLLECTION STRESSORS
-Urine contamination: anesthetic protocol; operant conditioning (ELE)



TRANSPORT STRESSORS (to sorting lab)
-Temperature: Extra insulation of Equitainer
-Time: ≤12 h shipment time; cryo
-Extender: protein type & conce
milk-fat) **Optimum: semen cent**

SORTING/FREEZE-THAW LOSSES/STRESSORS:
-Sorting: 20% end up in X-sort
-Freeze-thawing:30-40% survive, DIRECTIONAL freezing[2]



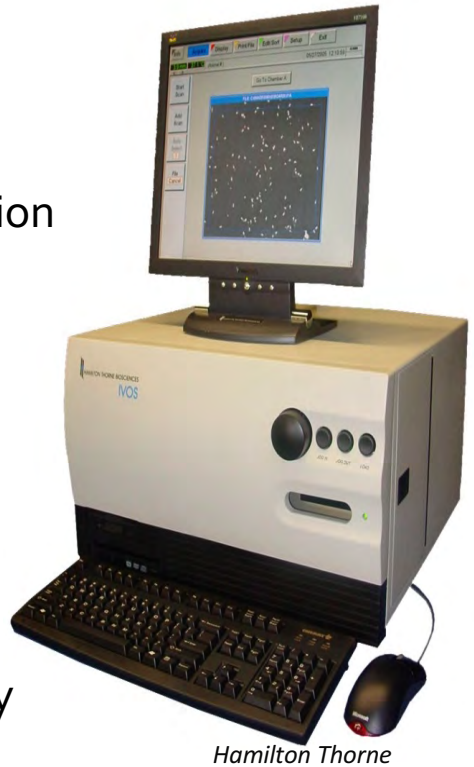
[1]*O'Brien et al., 2013 RFD.* [2]*O'Brien et al., 2015 ARS.*

Male Fertility Potential

Ejaculate & Sperm Evaluations

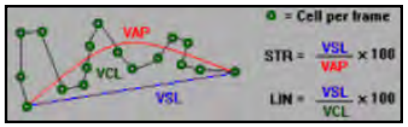
- Ejaculate parameters :
  - volume, sperm concentration
  - creatinine
  - osmolality, pH
  - microbial culture

- Sperm quality:
  - **motility parameters**
  - **morphology**
  - plasma membrane integrity
  - **DNA integrity**
  - Mitochondrial activity



Hamilton Thorne

-- **Total, Motile, Progressive**
-- **Rapid**, Medium, Slow and Static Cells
-- **VAP: Smoothed Path Velocity (um/sec)**
-- VCL: Track Velocity (um/sec)
-- VSL: Straight Line Velocity (um/sec)
-- ALH: Amplitude of Lateral Head Displacement (um)
-- BCF: Beat Cross Frequency (hertz)
-- LIN: Linearity (ratio of VSL/VCL)
-- STR: Straightness (ratio of VSL/VAP)



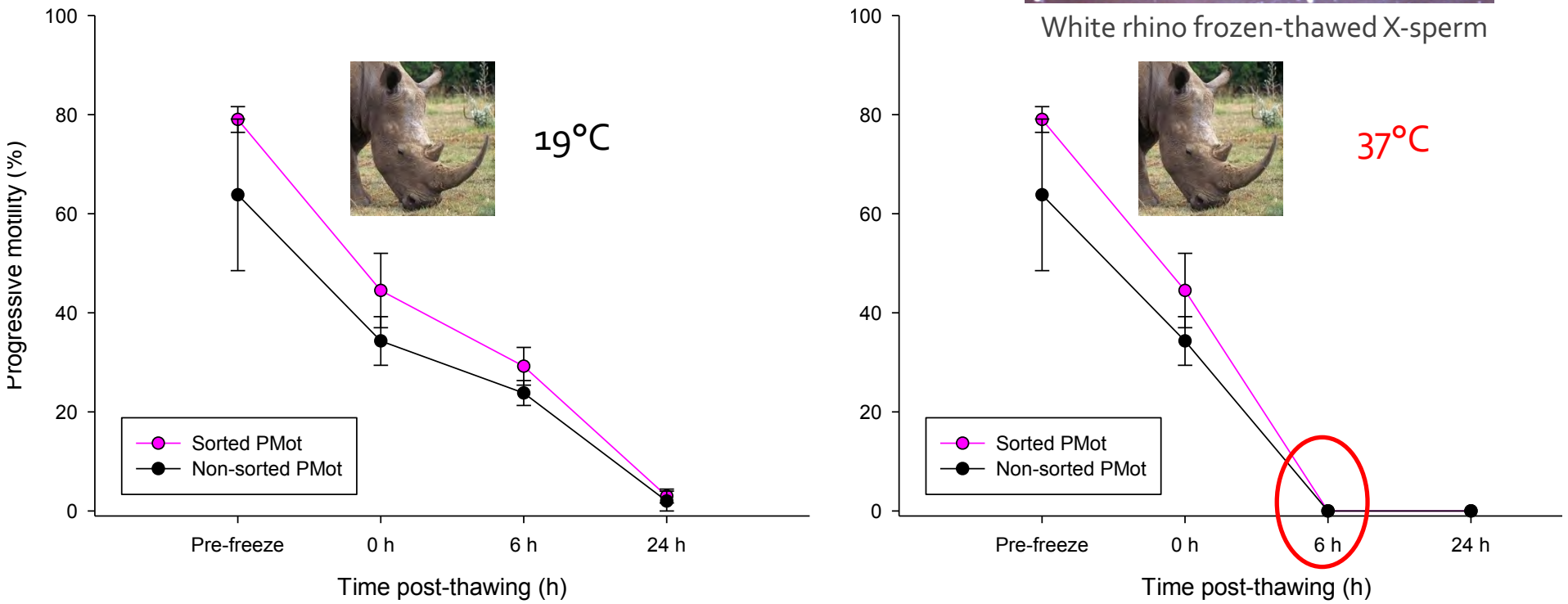
Steps & Challenges For Producing Pre-sexed Offspring

SEMEN DEPOSITION TIMING RELATIVE TO OVULATION
-Sperm deposition within 6 h prior to ovulation



White rhino frozen-thawed X-sperm

Progressive motility



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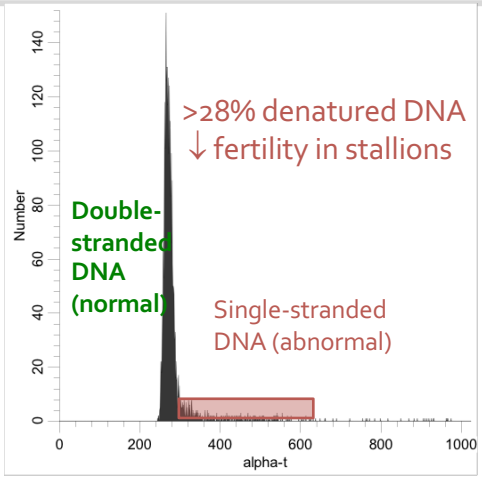
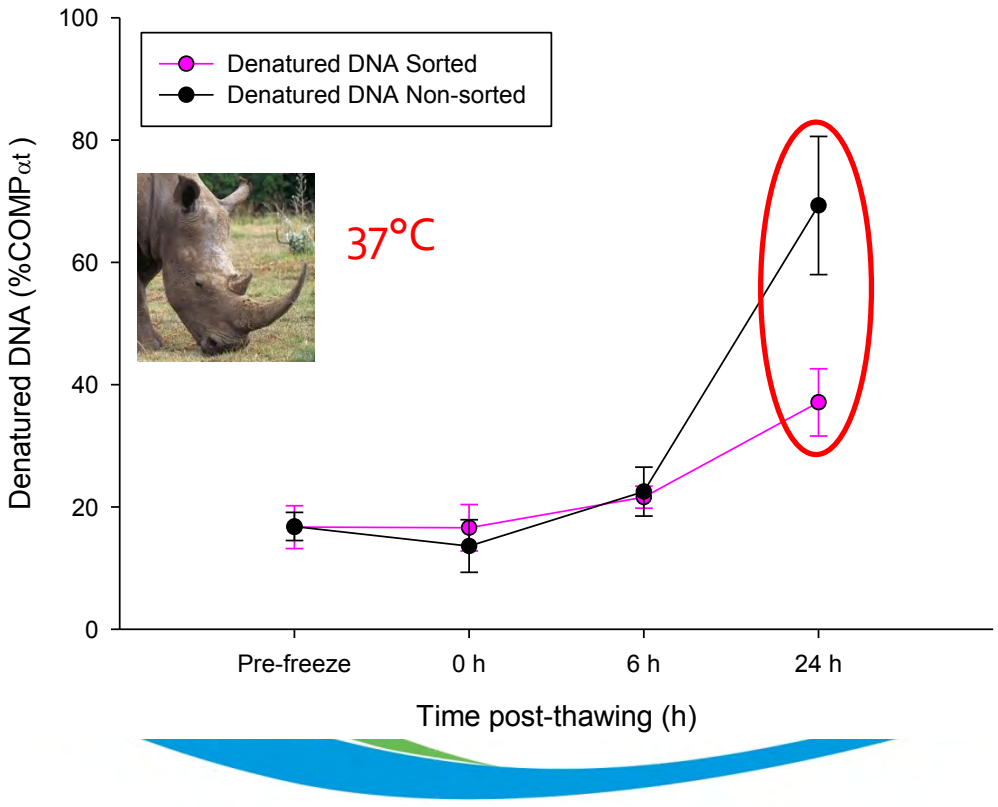
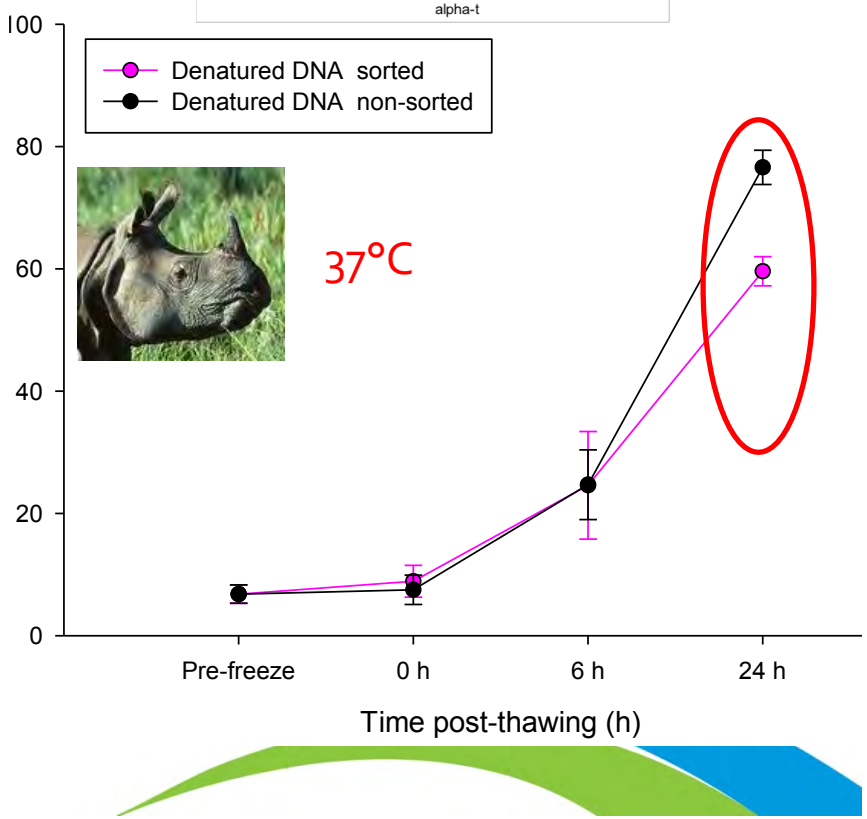


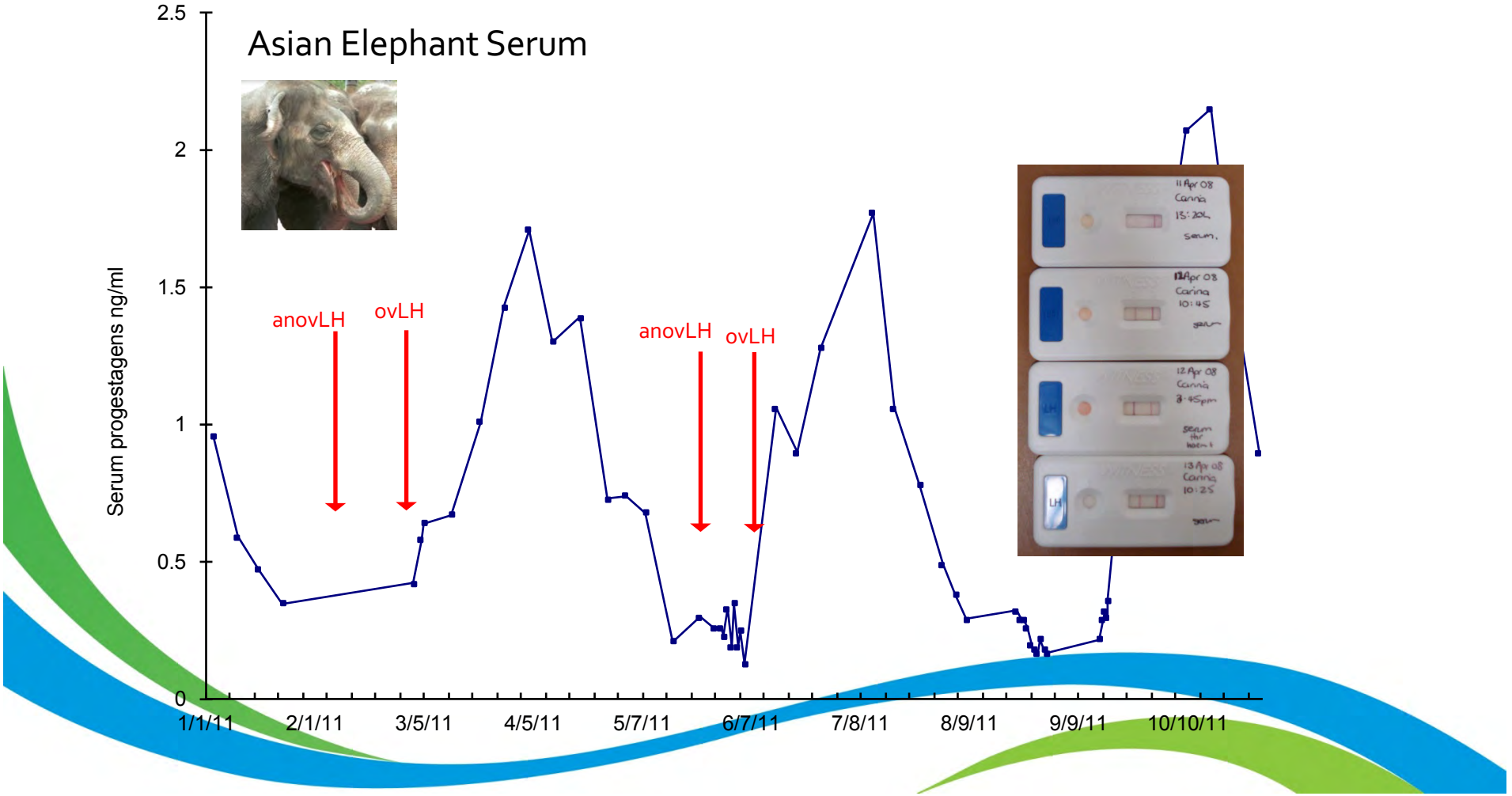
DNA integrity





Steps & Challenges For Producing Pre-sexed Offspring

DETERMINATION OF OVULATION WINDOW:
-Serum Pg: weekly
-Serum LH: 2x/3x-daily during 3 day window (Day 18-20 after 1st LH surge)
-Transrectal ultrasound: peri-ovulation



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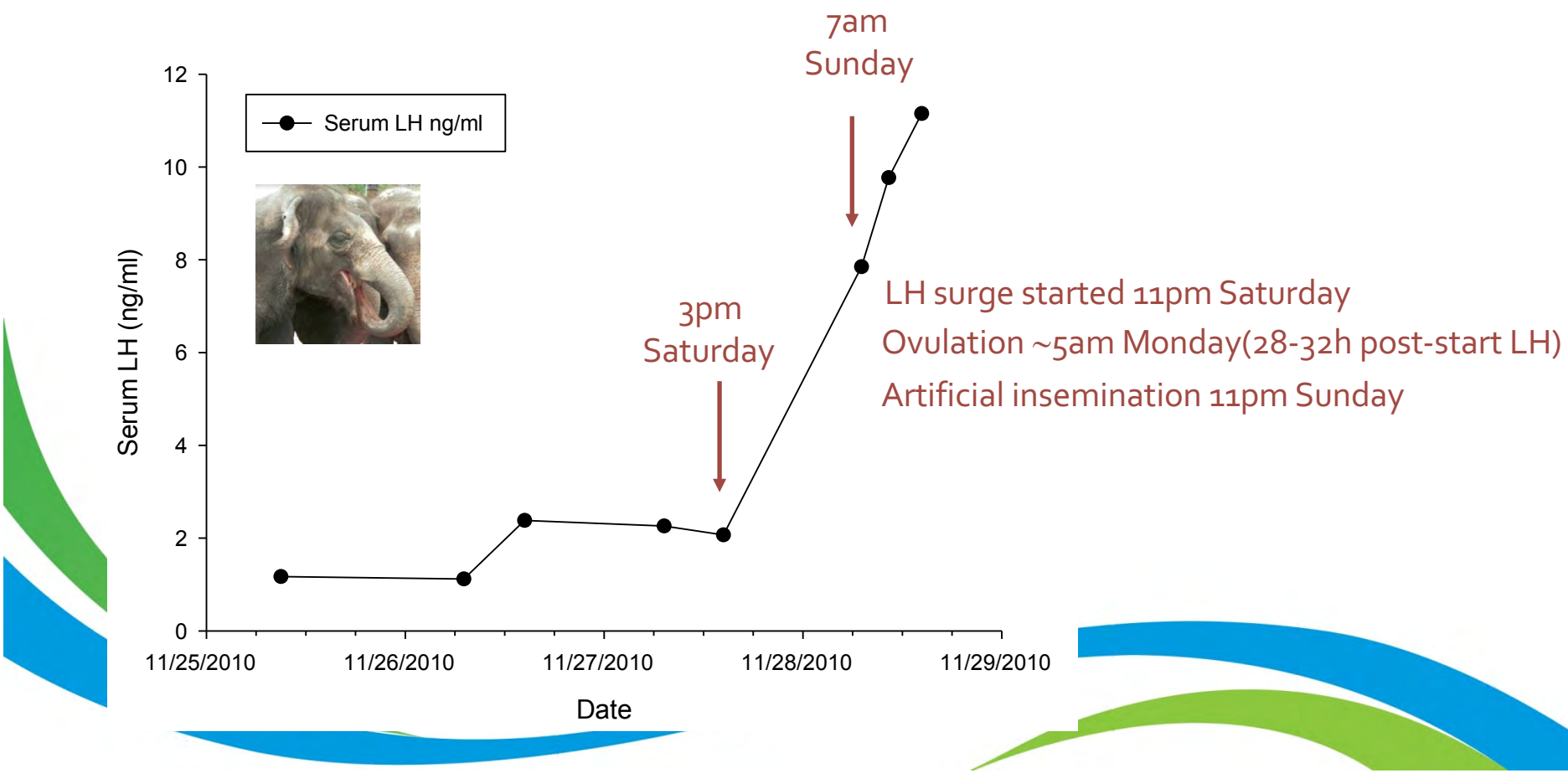
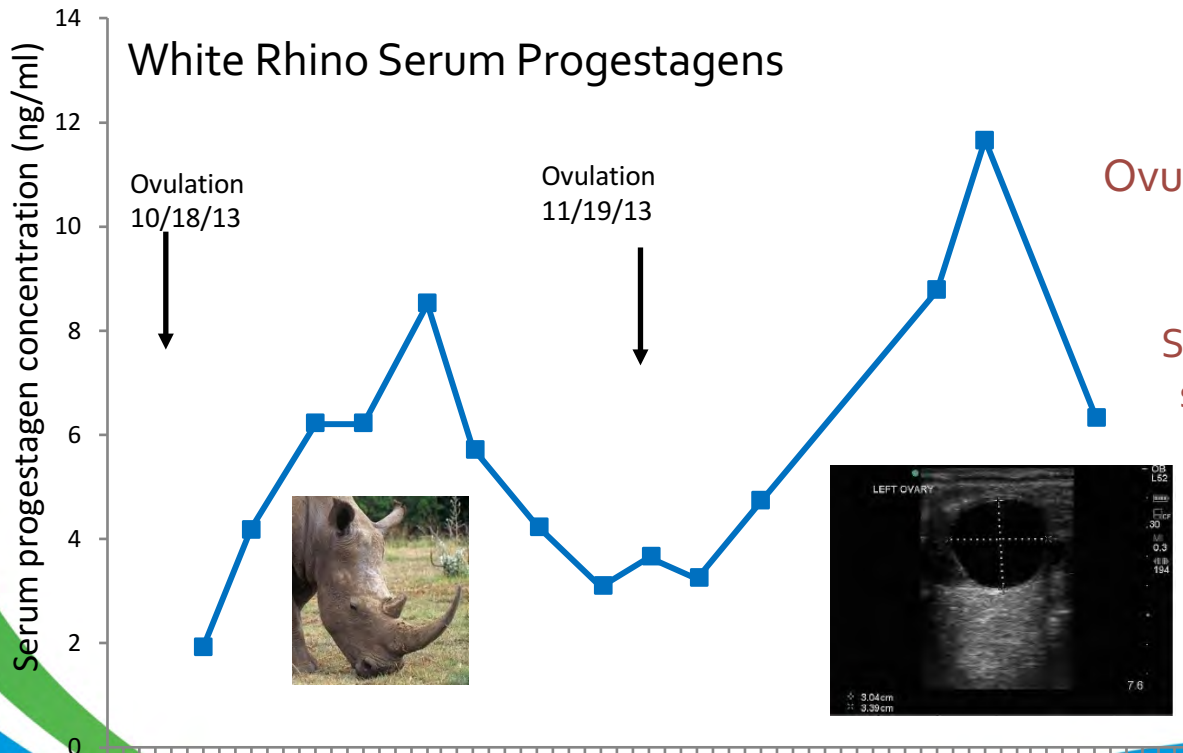


Steps & Challenges For Producing Pre-sexed Offspring

DETERMINATION OF OVULATION WINDOW:
-Serum Pg: biweekly
-Serum LH: white rhino daily/bidaily (rapid EIA or Witness LH strips)
-Urinary LH: Indian rhino (EIA?)
-Transrectal ultrasound: biweekly/daily; timing of GnRH



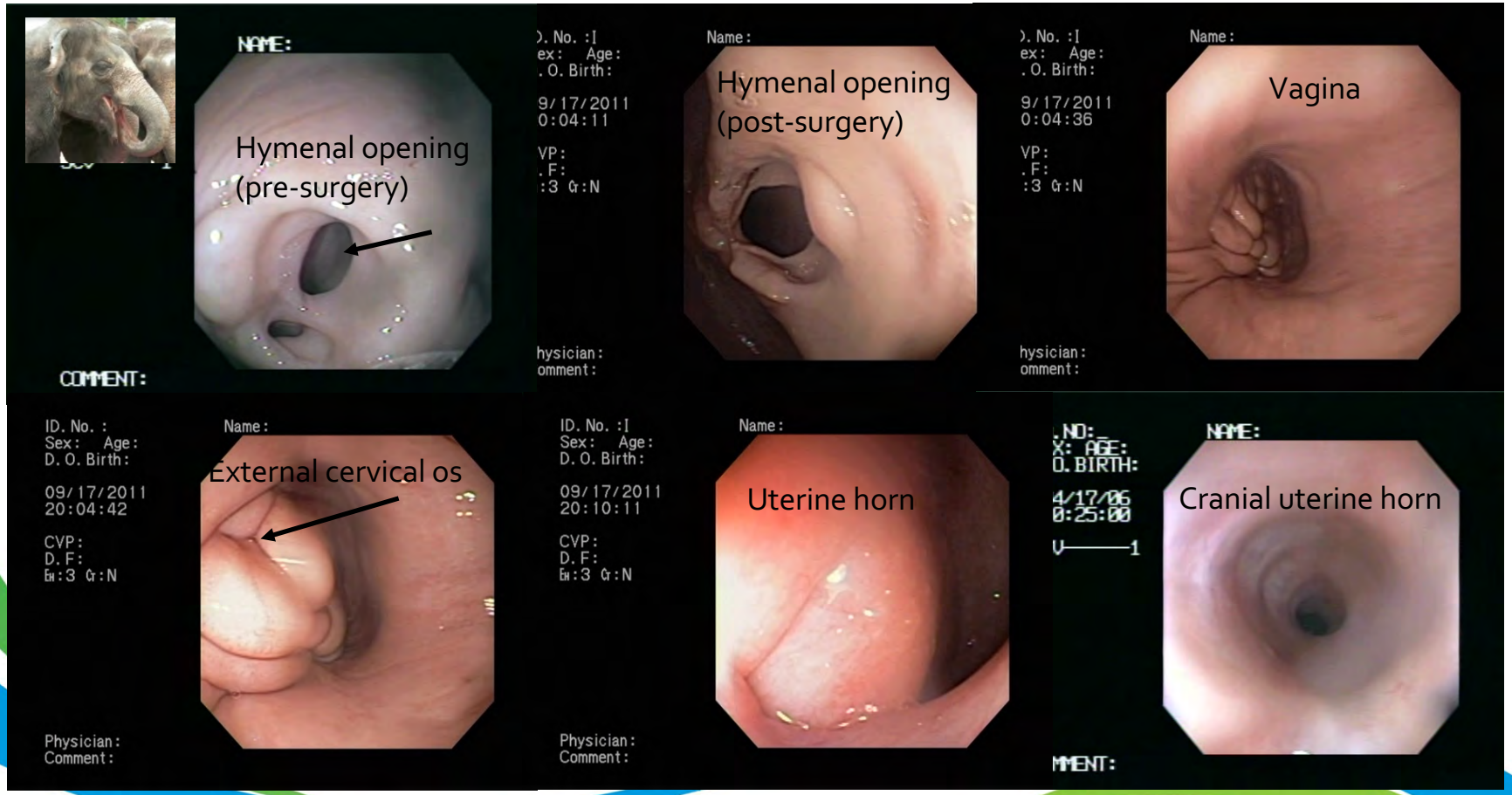
Ovulation: 36-48h post-GnRH inj/ LH surge start

Spontaneously ovulating females should have similar timeframe post- start of LH surge

Steps & Challenges For Producing Pre-sexed Offspring

DETERMINATION OF OVULATION WINDOW
SPERM DEPOSITION WITHIN 6 H PRIOR TO OVULATION

SEMEN DEPOSITION SITE:
-Uterine horn sperm placement



Steps & Challenges For Producing Pre-sexed Offspring

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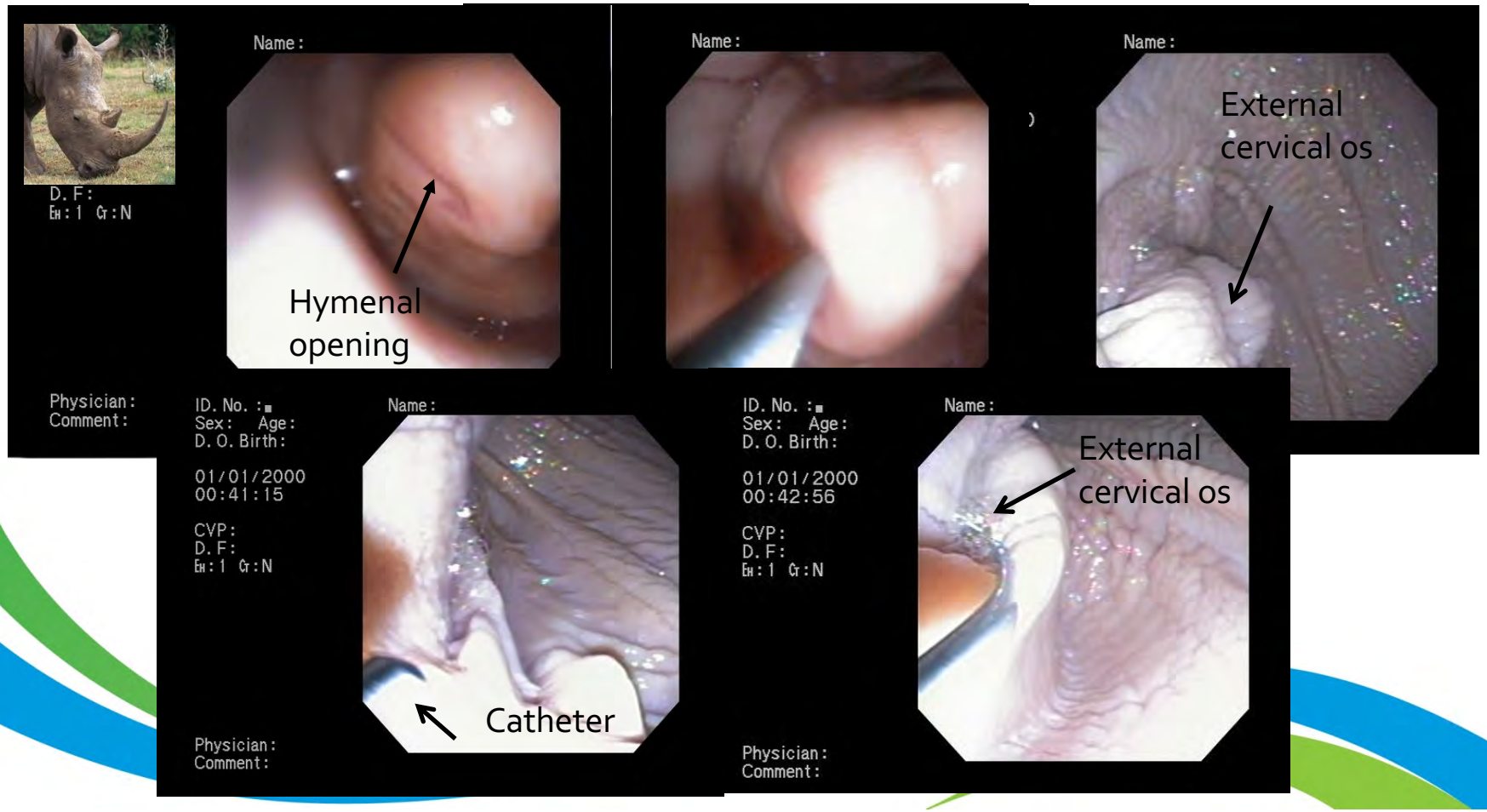


Summary

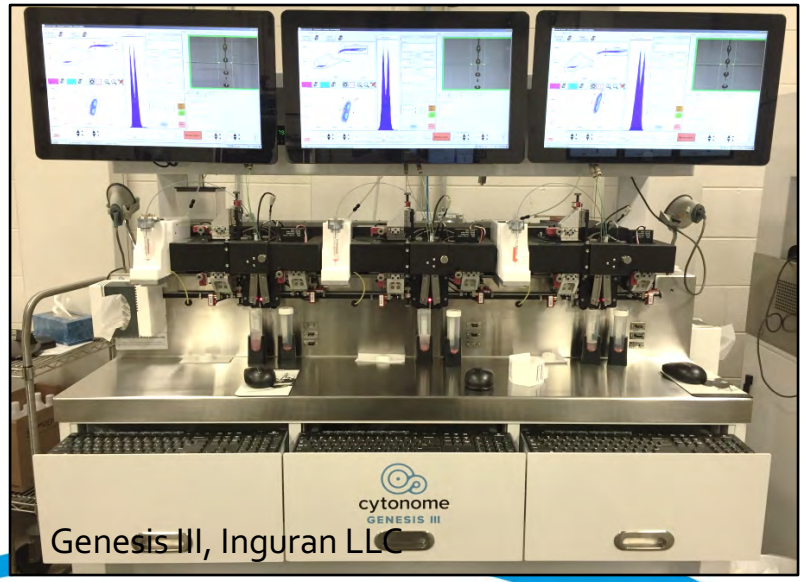
- **Progress Towards Integration of Sexed Sperm & Cryobanking Technologies into Species Management:**
  - High quality sample
  - Minimize urine contamination by anesthetic protocol type (rhino)
  - AI protocols (Ema, Csi, Run): intrauterine insemination close to ovulation

- **Next Steps:**
  - AI trials in 2017 using frozen-thawed X-sperm
  - New generation mobile sorters (Inguran/Sexing Technologies, XY Inc)

Current capabilities:
0.4-0.5 of AI dose per EEJ/collection*

Mobile sorter (3 headed):
≥ 2 AI doses per EEJ/collection*

*1 AI dose = 100 million progressively motile thawed sperm



Genesis III, Inguran LLC

THANK YOU TO:

All Curatorial, Keeper & Veterinary staff at Collaborating AZA Institutions:
Busch Garden Tampa (SPE)
Buffalo Zoo
Caldwell Zoo
Cincinnati Zoo and Botanical Garden
Denver Zoo
Dickerson Park Zoo
Disney's Animal Kingdom
Fort Worth Zoo
Fossil Rim Wildlife Center
Indianapolis Zoo
Lowry Park Zoo
Micanopy Zoological Preserve
Montgomery Zoo
Oregon Zoo
Rio Grande Zoo
Tanganyika Wildlife Park
Taronga Zoo
Tulsa Zoological Park Oregon Zoo
The Wilds
White Oak Conservation Center

SeaWorld & Busch Gardens Reproductive Research Center (SPE) A.McDonnell, K. Monahan

Texas A&M R. Serafini

Inguran/Sexing Technologies J. Moreno, M. Evans, R. Vishwanath

Funding: SeaWorld Parks & Entertainment (SPE)
Institute of Museum & Library Services Grant
Taronga Conservation Society Australia





Post Partum Ovulation in Asian and African Elephants in Europe



Ann-Kathrin Oerke & Michael Heistermann

European Elephant Service, Endocrinology Laboratory

German Primate Center, Göttingen, Germany



post partum Ovulation (ppOV)

= **first ovulation after giving birth**

= **re-start of ovarian cycle**

= **first possibility of next conception**

Time between birth and post partum ovulation (ppOV interval)

= **important parameter for breeding success of female elephant**

- the quicker she can get pregnant again, the more offspring she can produce in her life!

???

birth → ppOV + conception



WHEN?



Objectives

I. **Duration** between birth and ppOV

II. **Differences** between Asian and African elephants



Objectives

I. **Duration** between birth and ppOV

II. **Differences** between Asian and African elephants

Factors with possible effect on time of ppOV:

1. Living or dead calf / hand-rearing
2. Sex of calf
3. Age of cow
4. Duration of pregnancy
5. Parity



Data:



Asian		African
52	number ppOVs	18
31	number cows	13
19	1 ppOV	10
6	2 ppOV	1
4	3 ppOV	2
1	4 ppOV	-
1	5 ppOV	-

Detection of post partum ovulation



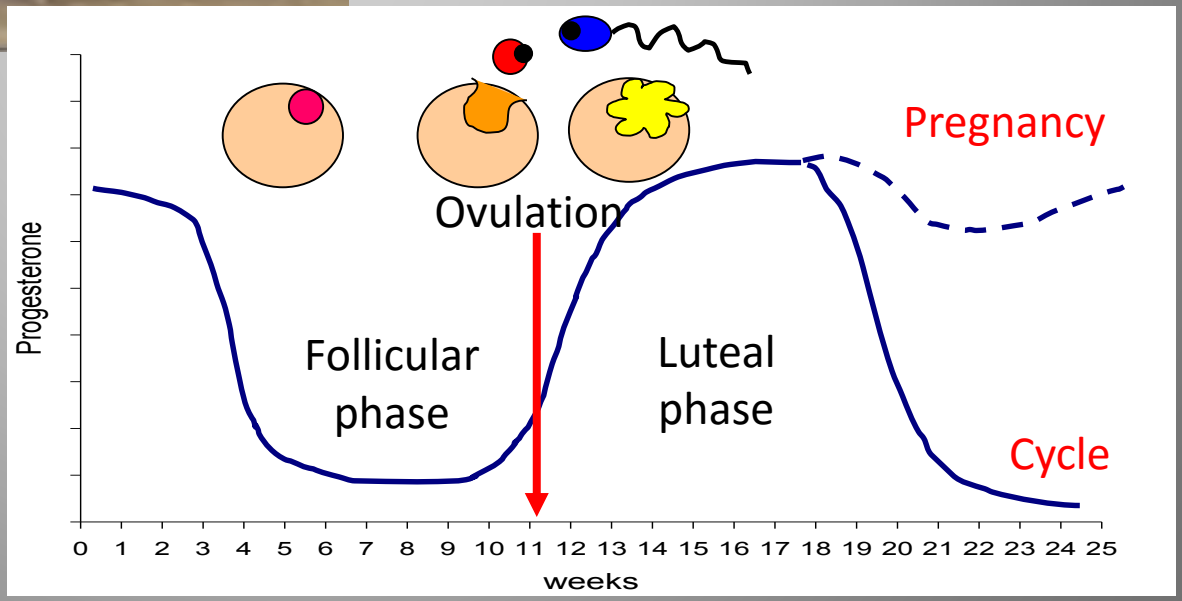
Mating?

Detection of post partum ovulation

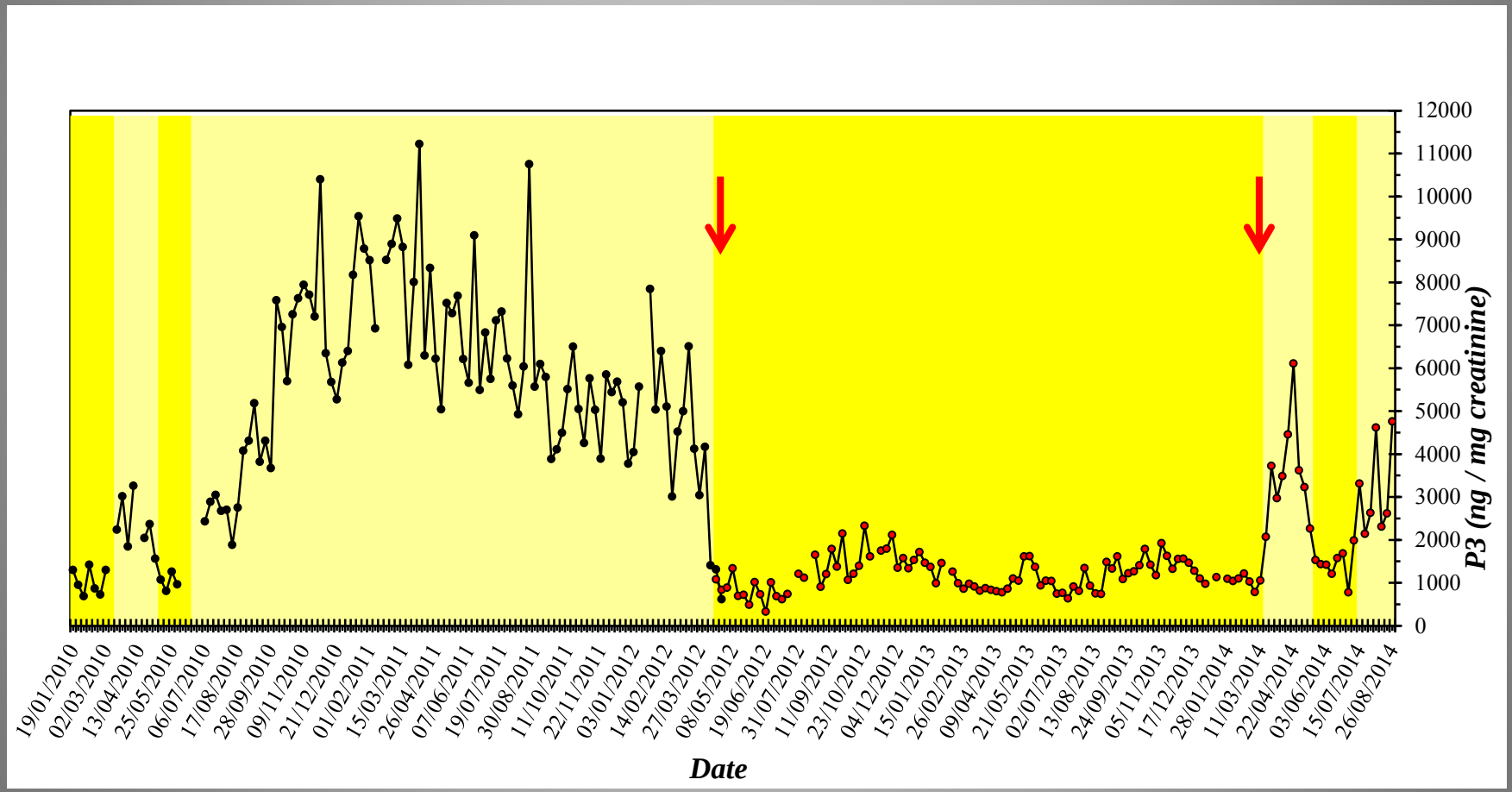


Mating?

Monitoring!

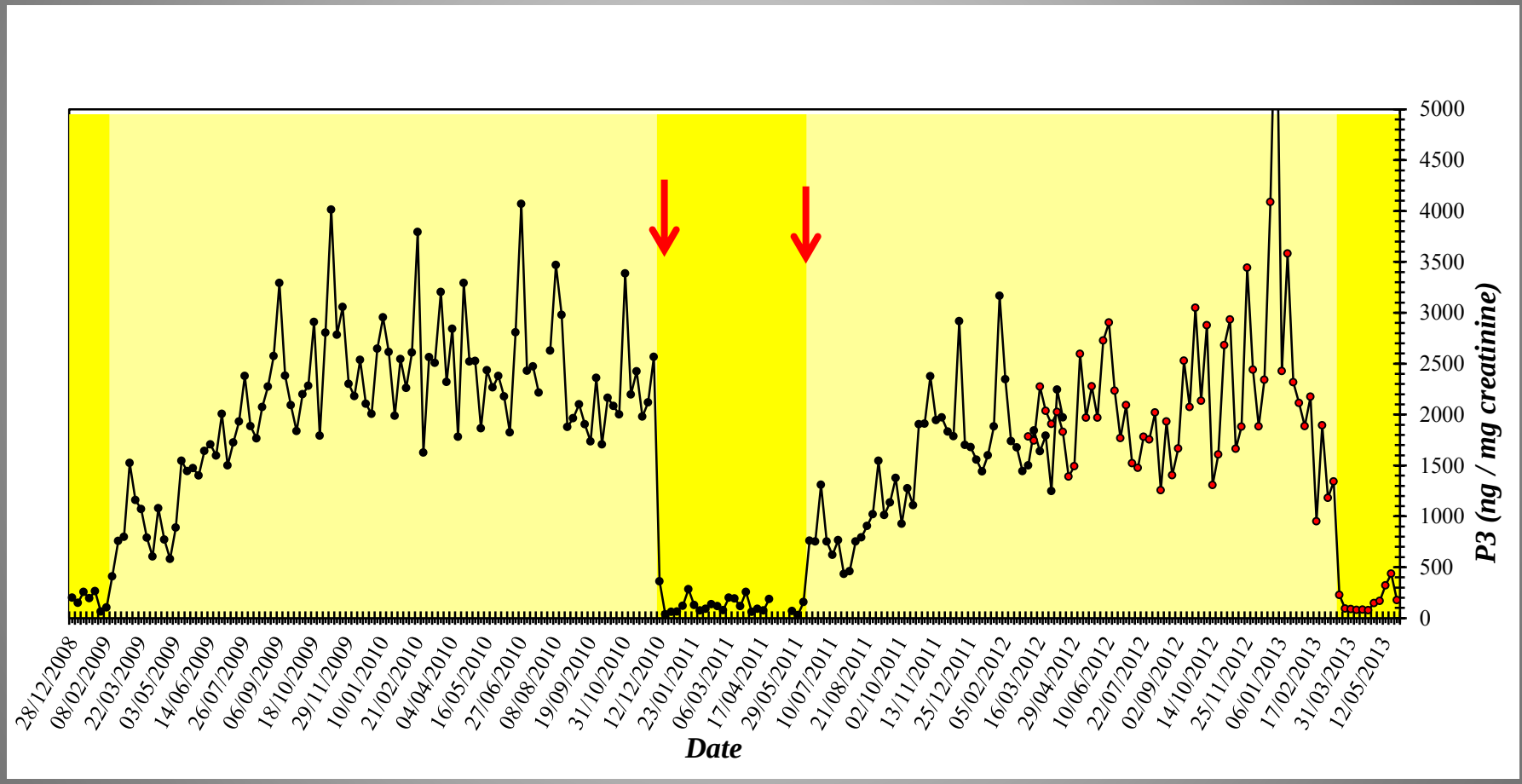


post partum ovulation
(female calf, alive)



107 weeks

post partum ovulation
(female calf, alive)



26 weeks

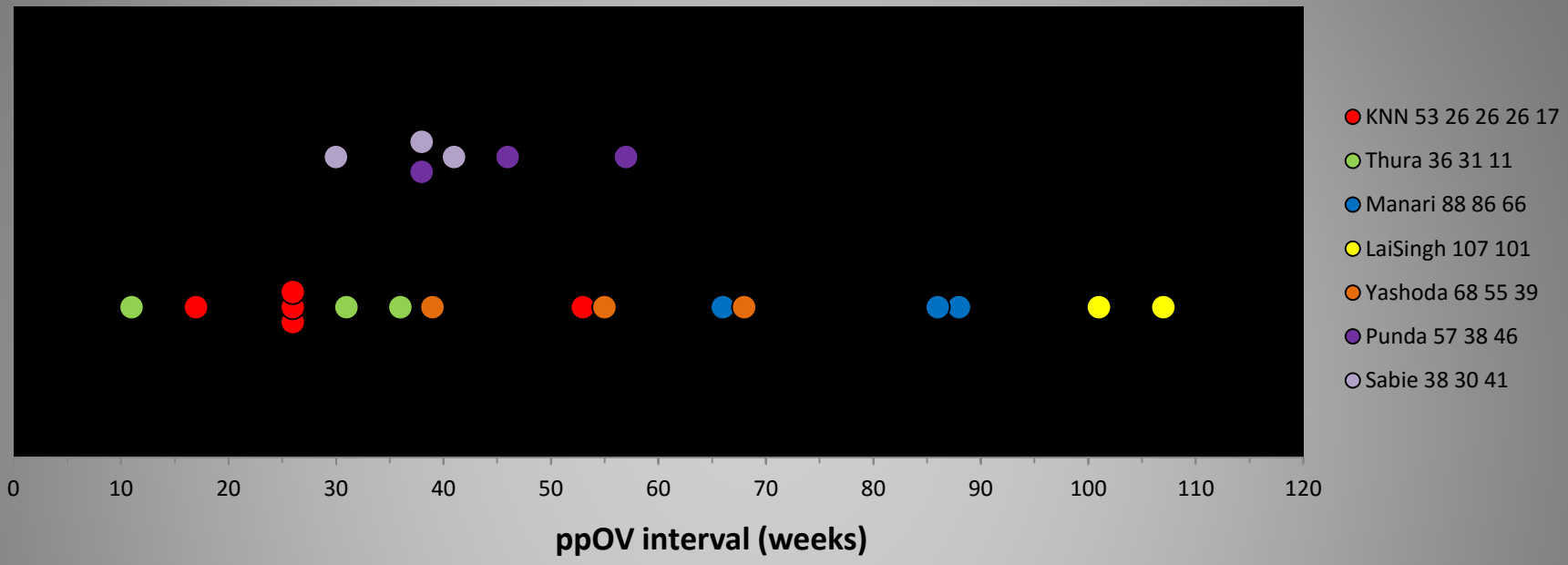
Summary

- No difference in interval between birth and ppOV in Asian and African elephants when calf alive
- Significantly shorter when calf dead or hand reared!

- No effect of:
  sex of calf
  age of cow
  duration of pregnancy
  parity
- BUT:

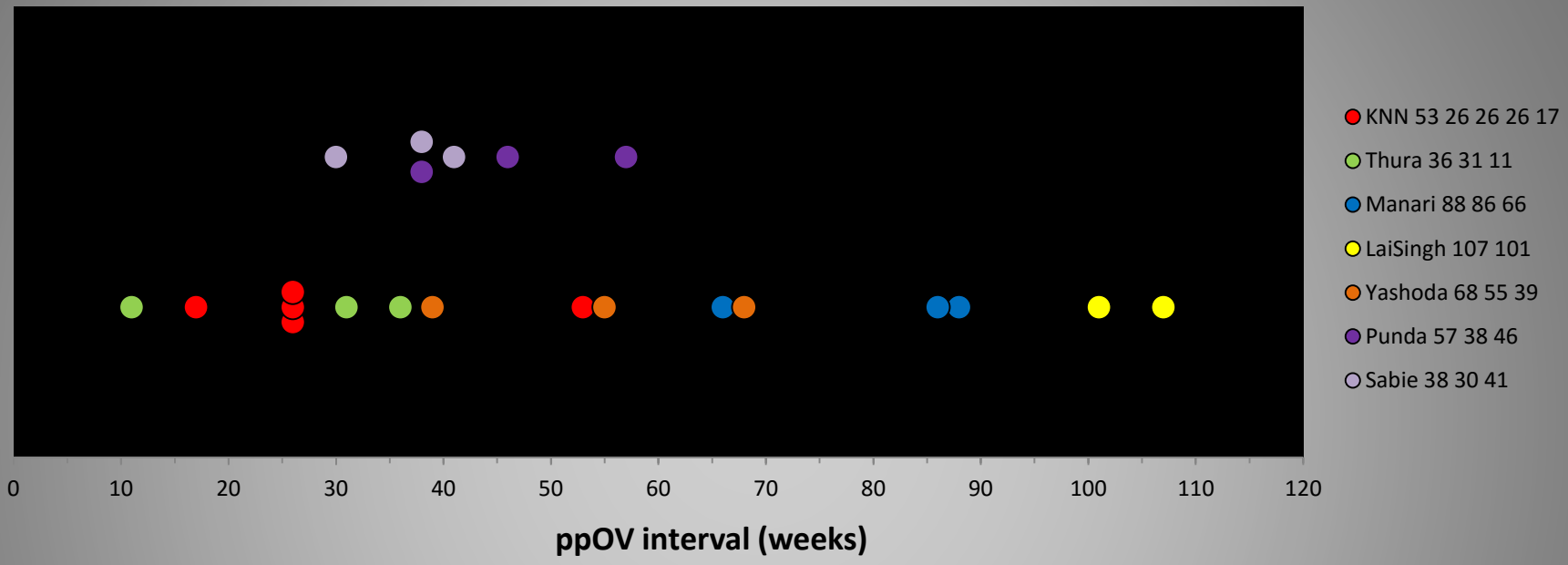


individual consistency!!!





individual consistency!!!



Effect of:

social rank, body condition, character …

number of „helpers“ for rearing calf (aunts, daughters…)

Season? Quality of food!



Thanks!

Zoos with Asian elephants:

Hagenbeck (6)
Hannover (5)
Emmen (3)
Chester (3)
Leipzig (2)
München (2)
Ostrava (2)
Münster (1)
Köln (1)
Zoo Berlin (1)
Woburn (1)
Twycross (1)
Kolmarden (1)
Kopenhagen (1)
Rapperswil (1)

Zoos with African elephants:

Wuppertal (4)
Cabarceno (3)
Hodenhagen (1)
Boras (1)
Knowsley (1)
Tierpark Berlin (1)
Halle (1)
Colchester (1)

Hormone Laboratory
German Primate Center
Göttingen, Germany:
all people since 1994!



Etorphine free anesthesia protocols optimized for Assisted Reproduction Technologies in rhinos…

…ranging from semen collection, artificial insemination to Ovum-Pick-Up (OPU)



Frank Goeritz[1], Robert Hermes[1], Chris Walzer[2], Zainal Z. Zainuddin[3], John Payne[3], Thomas B. Hildebrandt[1]

1. The Leibniz Institute for Zoo and Wildlife Research (IZW), Berlin, Germany; 2. Research Institute of Wildlife Ecology, University of Vienna, Austria; 3. Borneo Rhino Alliance, Sabah, Malaysia



“HATARI” - rhino immobilization……
……..”old school”!



Introduction

- ✓ **In order to elucidate the problems of poor reproductive performance in captive rhinos the EEP committee has encouraged intensive and serial reproductive monitoring**

- ✓ **A multi-disciplinary, multi-institutional research proposal is working on possible solutions**

Procedures which require anesthesia protocols

- ✓ Serial reproductive monitoring and sampling
- ✓ Artificial insemination

standing

- ✓ Bronchial lavage (TB diagnostic)
- ✓ Semen collection & OPU
- ✓ ET & embryo flushing?

recumbent

Anesthesia

Procedure / Technique related effect

Standing sedation

In the past years multiple reports have described standing sedation and the use of restraint chutes in rhinos

- ✓ **Detomidine 10 - 30 mg + Buthorphanol 8 - 50 mg**
- ✓ **Blood collection, rectal and ultrasonographic exams, minor medical procedures (dental exam/correction)**

Species related effect

Precaution







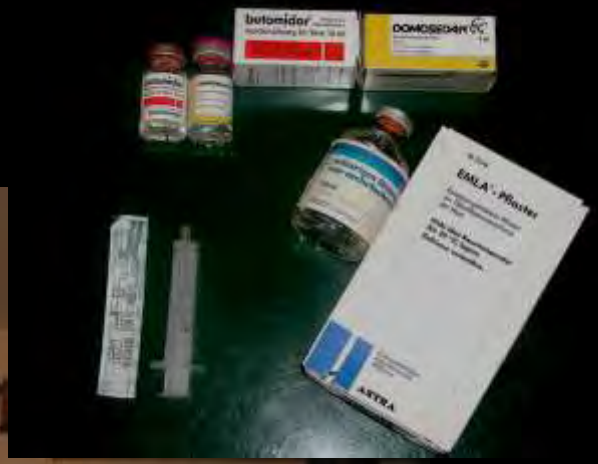


Cave! supplemental drugs i.v.!

elective procedures



Manual semen collection





Blood collection/transfusion (high volume)



Reproductive assessment / transrectal ultrasound

Dental check up / treatment





Full anesthesia (half sternal/lateral recumbency)

For (most) certain aspects this project requires recumbent anesthesia

- ✓ **Animals have no training - facilities have no restraint chutes or confined area for protected contact**
- ✓ **Equipment in animal area**
- ✓ **Long and/or painful procedures**
- ✓ **Procedures do not allow any movement of rhino**

“Advanced” reproductive assessment





“Advanced” reproductive intervention





OPU (oocyte collection)

TB diagnostic



Common protocol……"Old" Method……☺

During the period March 1999 - June 2001 a total of 51 recumbent anesthetic procedures were performed on 30 individual animals (Walzer, Goeritz et al. 2002)

- ✓ **Large Animal Immobilon ® 0,8 - 1,4 ml (1,8 - 3,15 mg)**
- ✓ **Detomidine 10 mg**
- ✓ **Buthorphanol 10 mg**



Arterial Blood gas analysis

Due to V/Q mismatch you have to deal with a partially compensated respiratory acidosis:

↓ pH : 7,29 ± 0,08 (7,07 - 7,49)

↑ paCO2 : 73 ± 13 mmHg

↓ paO2 : 67 ± 23 mmHg

Acidosis - hypercapnia - hypoxemia









Etorphine free anesthesia protocol for rhino

(Goeritz et al., 2016, submitted)

1.) Premedication (i.m.) via dart or hand injection:

detomidine 20-30 mg/animal (WR,BR,IR); 12-20 mg/animal (SR)
butorphanol 30 - 50 mg/animal (WR,BR,IR); 15-25 mg/animal (SR)
Ketamin 100-200 mg/animal (all species) and
midazolam 5-20 mg/animal (all species)

induction time i.m.:
*10-20 min



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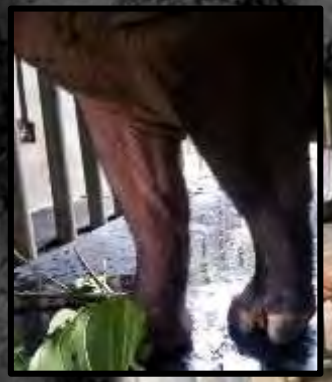

induction time i.v.:
*2-5 min

cave: i.v. half dose!

Etorphine free anesthesia protocol for rhino

(Goeritz et al., 2016, submitted)

1.) Premedication (i.m.) via dart or hand injection:

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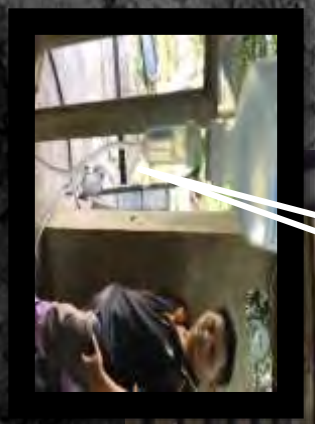


2.) drop dose/bolus: 100-200 mg Ketamin i.v.

3.) Maintenance: Quad-Drip i.v.:

500 ml NaCl + 500 mg Ketamin + 50 mg Butorphanol
+ 5 mg Detomidine + 5 mg Midazolam

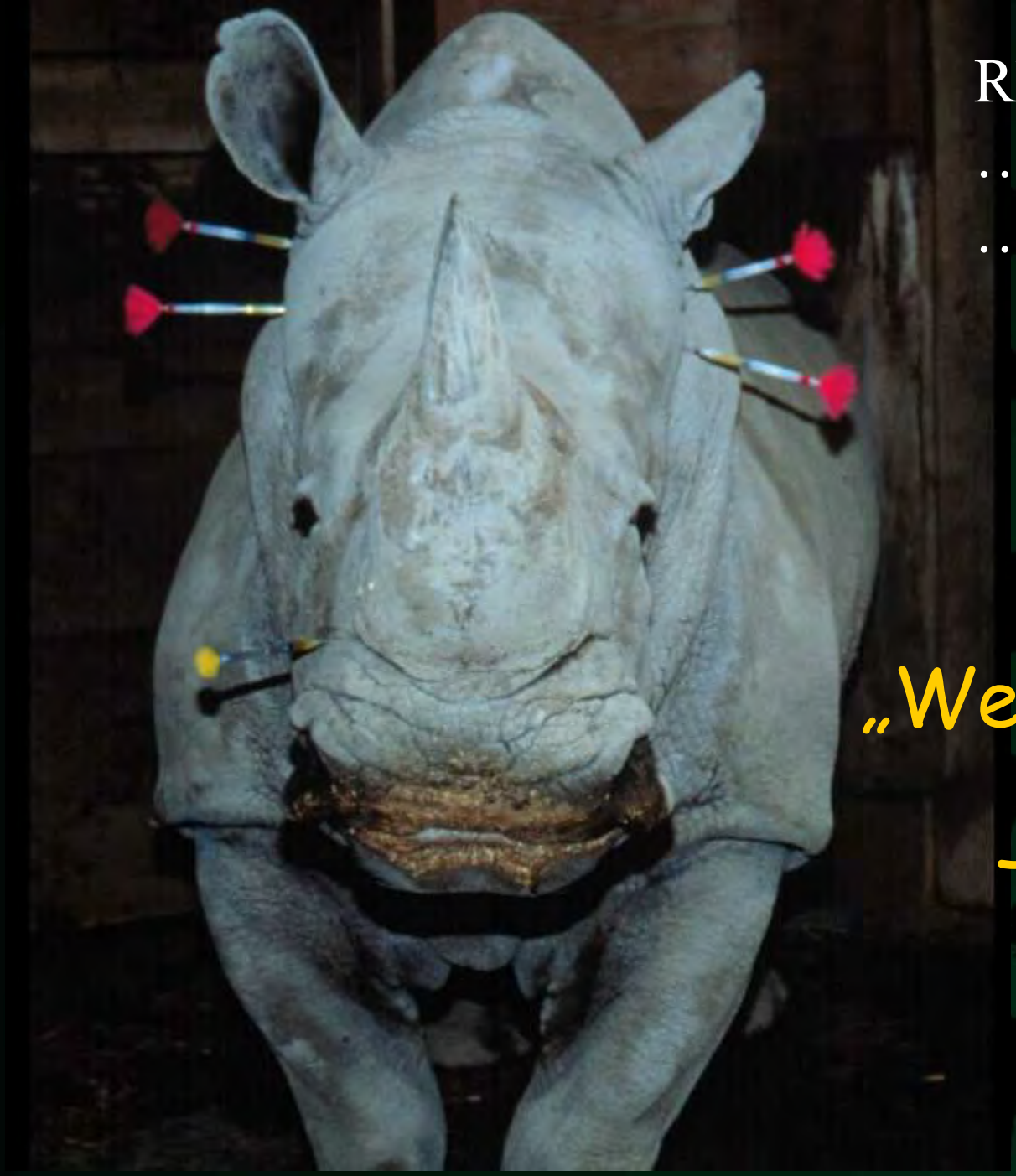


as “CRI” with flow rate of 8-20 ml/min

Field & flight proof anesthesia box



Travel light…..!



Rhino anesthesia…..
…for ART
…is a kind of art ;-)

„Weidmanns Heil“
And
Thank you!

News

Extremely Rare White Rhino Dies in Kenya—His Kind Nearly Extinct

The 34-year-old Suni was one of two breeding males of his subspecies left on Earth.



Suni, seen here at Kenya's Ol Pejeta Conservancy in November 2010, died at age 34.

Rare Rhino Dies Days After Her Rediscovery

Endangered Sumatran rhino Najaq succumbed to an infection just days after being caught in Indonesia.



Najaq, who was captured in March with the goal of moving her to a secure sanctuary, has passed away. Read about her discovery.







female Sumatran rhino
caught on March, 10th, 2014
in Sabah, Borneo







First days in Tabin Rhino Sanctuary







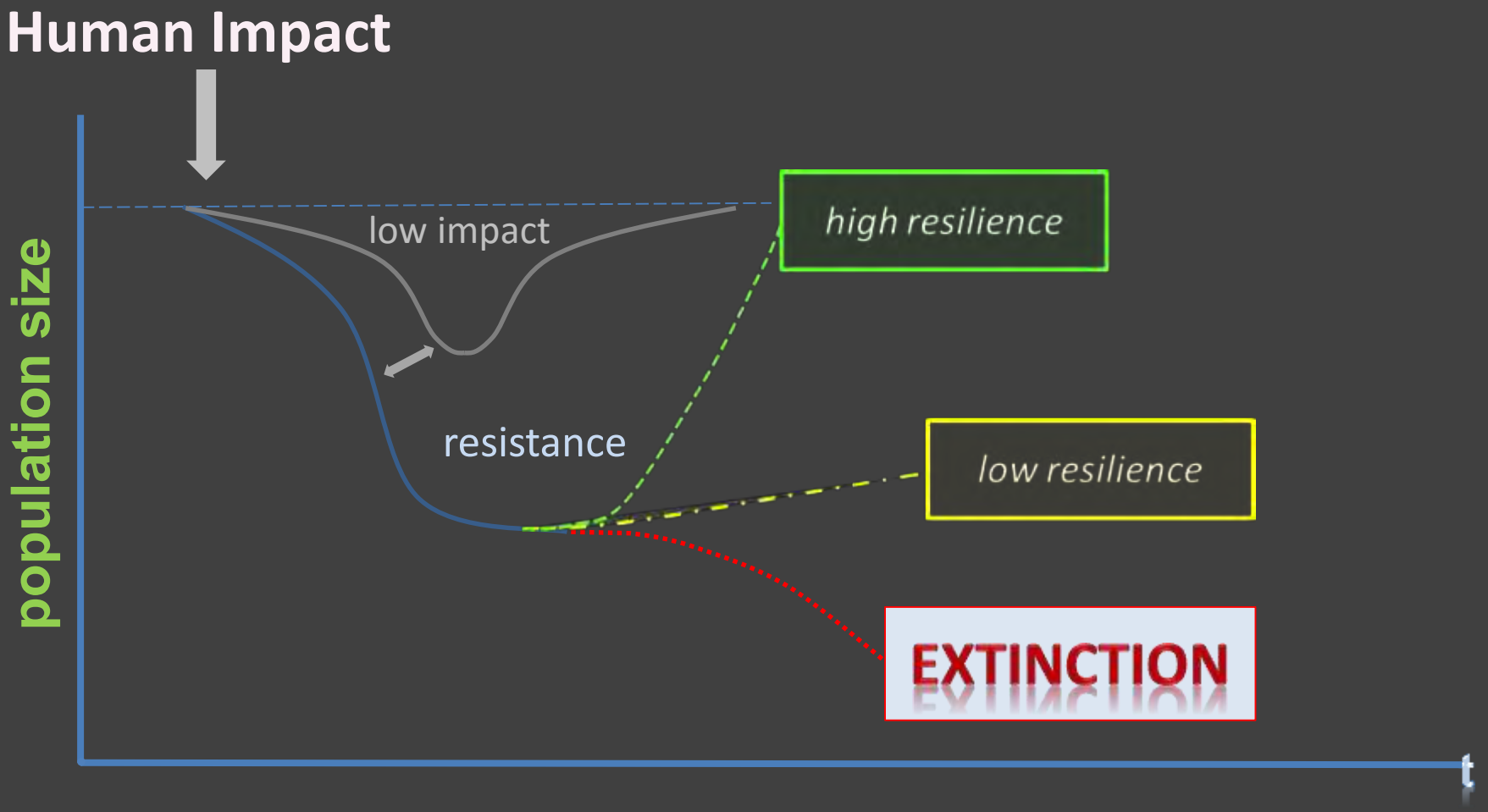








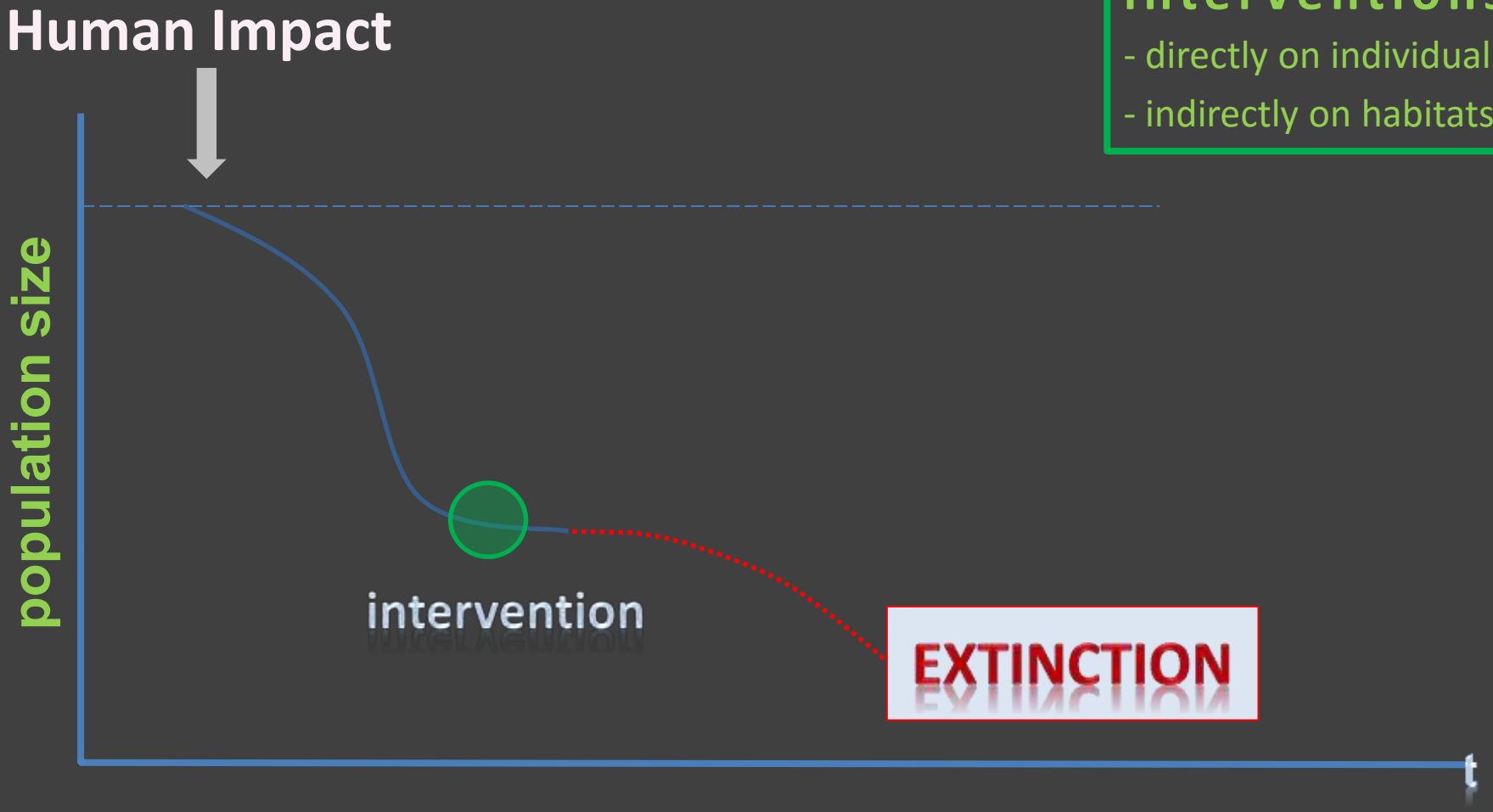
Population Dynamics





Population Dynamics

interventions
- directly on individuals
- indirectly on habitats





Population Dynamics

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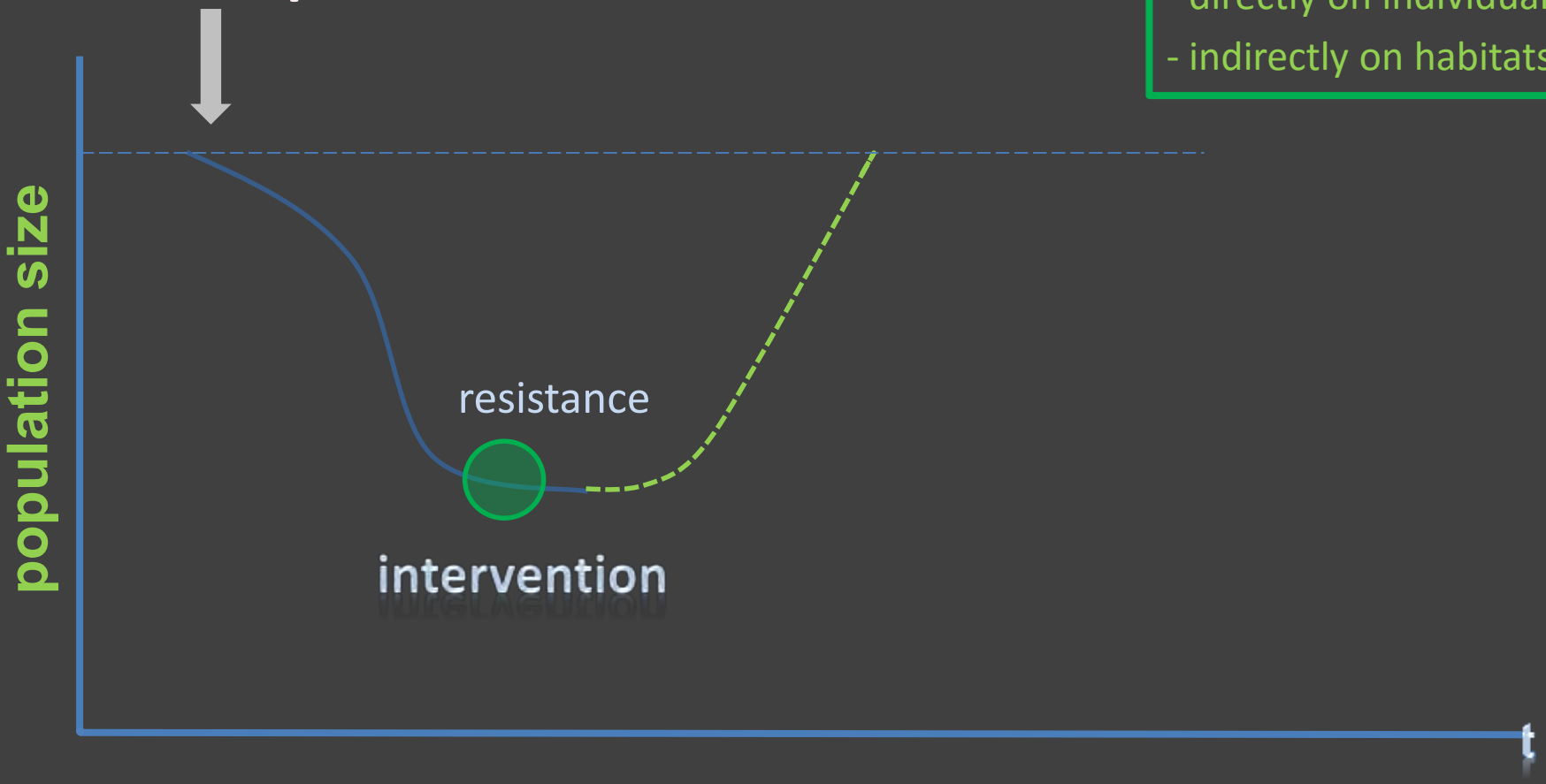
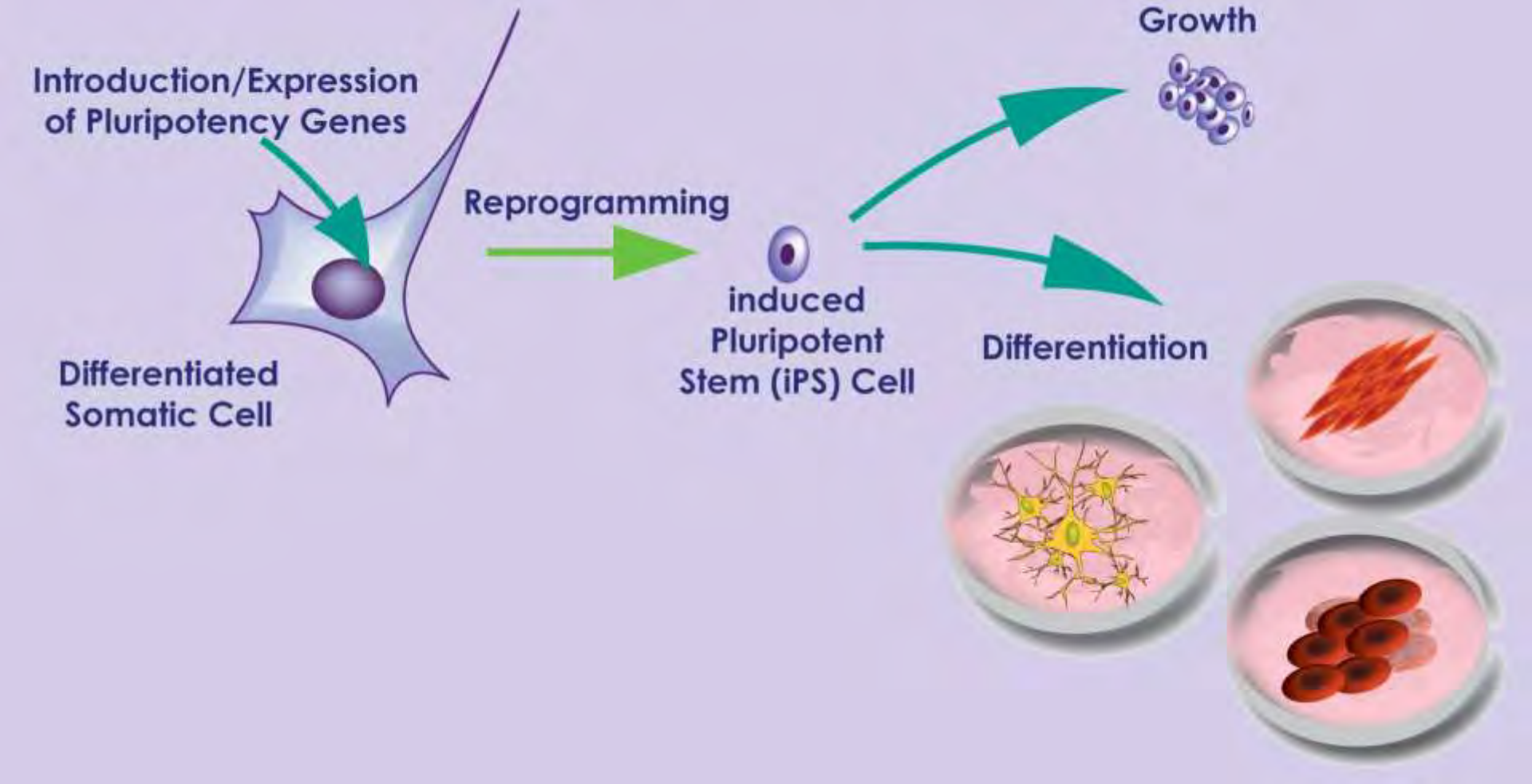






In 2012, Dr. Yamanaka was awarded the Nobel Prize in Physiology or Medicine for his discovery that adult somatic cells can be reprogrammed into pluripotent cells. By introducing the genes for four factors that turn genes on and off, he induced the skin cells of adult mice to become like embryonic stem cells, which he called induced pluripotent stem (iPS) cells.

Induced Pluripotent Stem Cells





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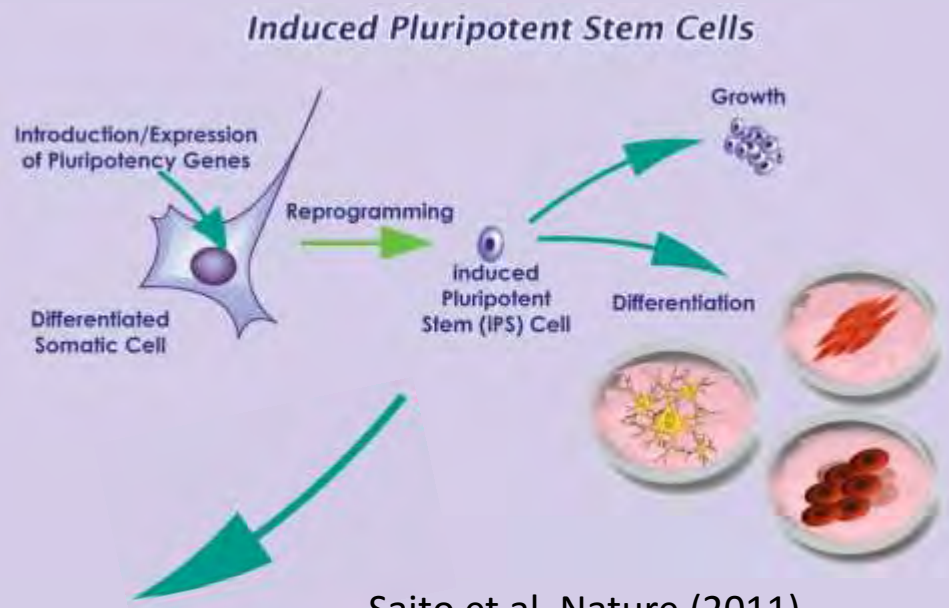

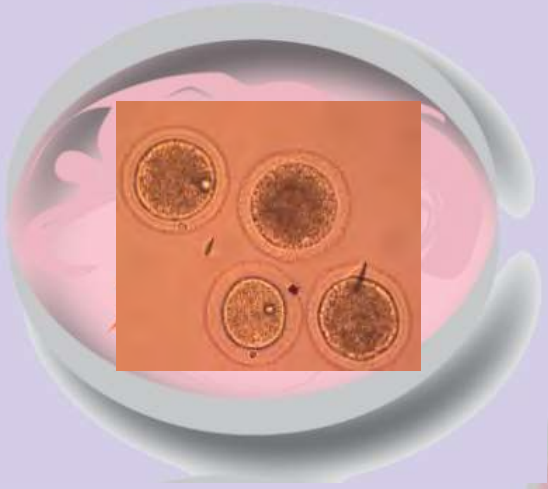

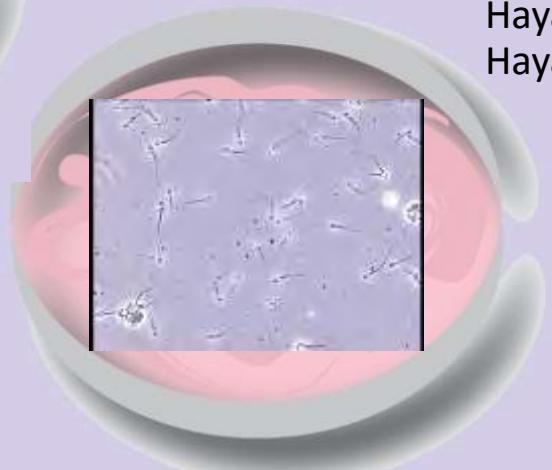

Saito et al. Nature (2011)

Hayashi et al. Science (2012)

Hayashi et al. Nature (2016)

Dream?





Induced pluripotent stem cells from highly endangered species

Inbar Friedrich Ben-Nun[1], Susanne C Montague[1], Marlys L Houck[2], Ha T Tran[1], Ibon Garitaonandia[1], Trevor R Leonardo[1], Yu-Chieh Wang[1], Suellen J Charter[2], Louise C Laurent[1,3], Oliver A Ryder[2] & Jeanne F Loring[1,3]

For some highly endangered species there are too few reproductively capable animals to maintain adequate genetic diversity, and extraordinary measures are necessary to prevent extinction. We report generation of induced pluripotent stem cells (iPSCs) from two endangered species: a primate, the drill, *Mandrillus leucophaeus* and the nearly extinct northern white rhinoceros, *Ceratotherium simum cottoni*. iPSCs may eventually facilitate reintroduction of genetic material into breeding populations.

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Induced pluripotent stem cells (iPSCs) are generated from somatic cells by direct molecular reprogramming and, as are embryonic stem cells, are capable of unlimited expansion and differentiation into multiple cell types. iPSCs have been generated from somatic cells of humans[1,2] and research animals such as mouse[3] and rhesus monkey[4]. We adapted iPSC technology to reprogram rare animal species, in an effort to use this technology to preserve genetic material of endangered species. The San Diego Zoo Institute for Conservation Research maintains an extensive collection of frozen fibroblast cultures, called the Frozen Zoo, comprised of viable cells of over 8,600 individual vertebrates of ~800 species. We report here to our knowledge the first generation of iPSCs from the endangered primate, the drill *Mandrillus leucophaeus*, and from the nearly extinct northern white rhinoceros, *Ceratotherium simum cottoni*.

The drill is one of Africa's most endangered mammals. In the wild, drills are found only in small areas of Nigeria, Southwestern Cameroon and Equatorial Guinea[5]. The number of drills is declining as a result of illegal bush meat commerce and habitat destruction. Populations of drills in North American zoos are derived from a small number of founders, which risks excessive inbreeding, raising concerns for population sustainability. In addition, disorders such as diabetes compromise population growth and management[6]. The northern white rhinoceros is hunted for its horns and is on the verge of extinction. An estimated population of 2,230 individuals in 1960 has been reduced to only seven living individuals today[7]. Two wild-born northern white rhinoceroses currently reside in the San Diego Zoo Safari Park. The other five (one wild-born and four born in captivity) were kept until recently at the Zoo Dvůr Králové in the Czech Republic. In an effort to save the species, four rhinoceroses with reproductive potential were relocated from the Zoo Dvůr Králové to the Ol Pejeta Conservancy in Kenya in 2009. However, efforts to encourage natural reproduction have so far been unsuccessful, and the last birth of a northern white rhinoceros was in 2000. Because of the critical status of both the drill and northern white rhinoceros populations, we chose these species for reprogramming to iPSCs that might aid conservation efforts.

To reprogram the primate cells, we used retroviral vectors carrying human sequences of the reprogramming factors *POU5F1* (also known as *OCT4*), *SOX2*, *KLF4* and *MYC* (also known as *cMYC*) on a cryopreserved fibroblast cell line from a male drill (named Loon) sampled at 15 years of age (now dead). We generated four iPSC lines (named drill A C, H and I) from the fibroblasts (**Fig. 1**). We initially selected these lines by their unique morphology that is characteristic of embryonic stem cells and iPSCs derived from other species (**Fig. 1a**). Drill iPSCs were karyotypically normal, as determined by comparison with the source fibroblasts (Online Methods, **Fig. 1b** and **Supplementary Fig. 1**). Genomic PCR revealed that the drill iPSCs carried the exogenous sequences for the reprogramming genes (**Supplementary Fig. 2**). Because we found that northern white rhinoceros fibroblasts could not be transduced with amphotrophic retroviruses, we used retro-VSV.G viruses (**Supplementary Fig. 3**) carrying the same four reprogramming factors, on a cryopreserved fibroblast cell line initiated from the youngest living northern white rhinoceros, a female named Fatu, born in 2000 and sampled at ten years of age (currently residing in the Conservatory in Kenya). We generated three rhinoceros iPSC lines (northern white rhinoceros (NWR) A, B and C) from this cell line (**Fig. 2**). We also selected these lines by their characteristic morphology (**Fig. 2a**). NWR iPSCs were karyotypically normal, as determined by comparison with the source fibroblasts (**Fig. 2b** and **Supplementary Fig. 4**). Genomic PCR revealed that the three reprogrammed NWR cell lines carried the exogenous sequences for the reprogramming genes *POU5F1*, *SOX2* and *MYC*, but not *KLF4* (**Supplementary Fig. 5**). This observation suggests that *KLF4* is not essential to the reprogramming process in the northern white rhinoceros.

Two critical characteristics of fully reprogrammed iPSCs are silencing of the integrated exogenous sequences and the induction of endogenous genes associated with pluripotency. Quantitative reverse transcription–PCR for the four reprogramming factor

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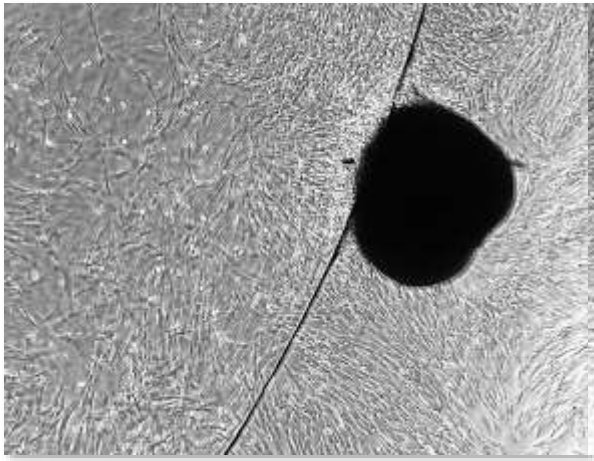
RECEIVED 8 FEBRUARY; ACCEPTED 19 AUGUST; PUBLISHED ONLINE 4 SEPTEMBER 2011; DOI:10.1038/NMETH.1706

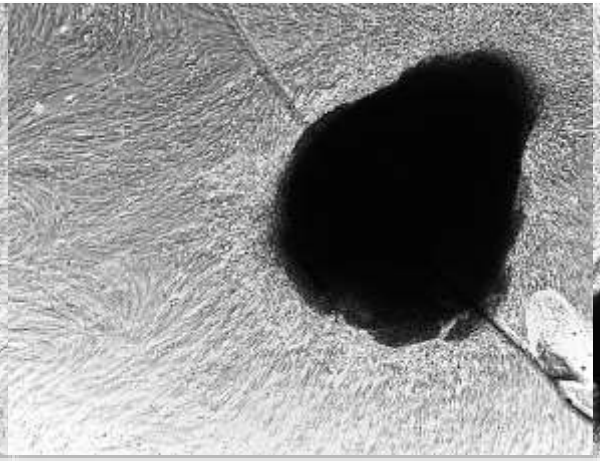
fibroblast culture (7. Passage)
Sumatran rhino Gelogob, died 2014



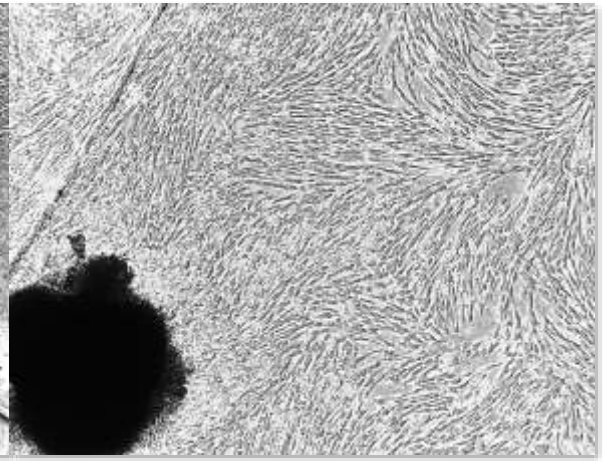
Gelogob - female Sumatran Rhinoceros was approx. 35 years in captivity, no progeny during that time, died January 2014



Puntung P0



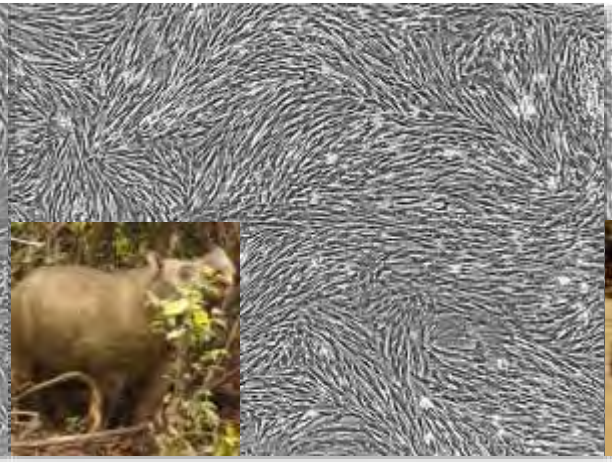
Kertam P0



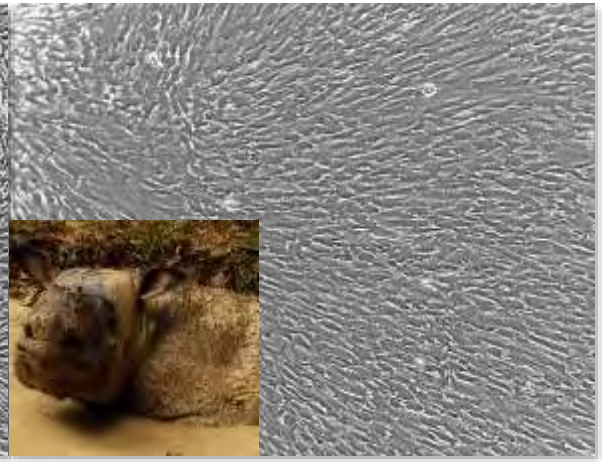
Imam P0



Puntung P1



Kertam P1



Iman P1

P0

NWR

P1

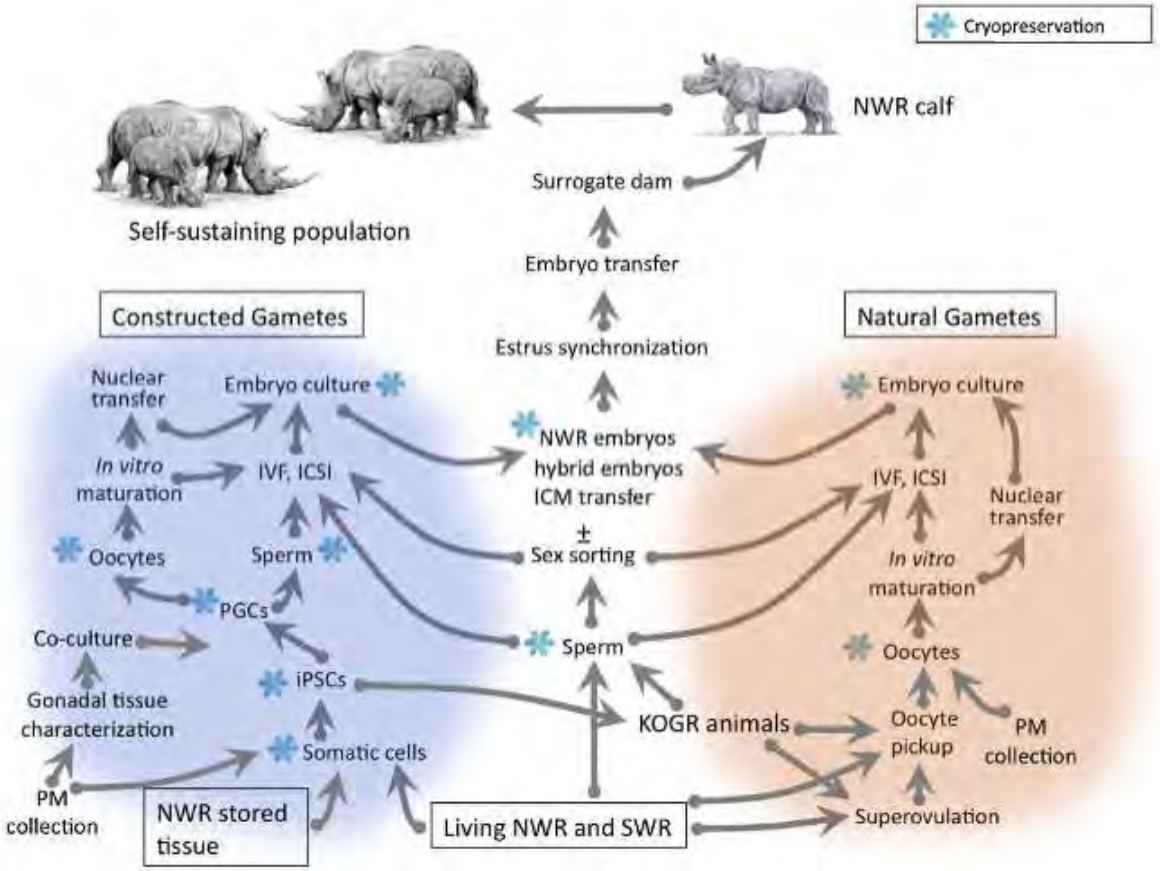
NWR

Pluripotent stem cell technologies:

Alternative Conservation Approach for extremely endangered species

ZOOBIOLOGY

Rewinding the Process of Mammalian Extinction



First results of oocyte maturation and *In-Vitro*-Fertilisation by ICSI in Sumatran and northern white rhinoceroses





Cesare Galli, Robert Hermes, Frank Goeritz, Silvia Colleoni, Sebastian Diecke, Micha Drukker, Katsuhiko Hayashi, Susanne Holtze, Giovanna Lazzari, John Payne, Endre Sos, Jan Stejskal, Miriam Wiesner, Zainal Zahari Zainuddin, Thomas B. Hildebrandt

AVANTEA


MEMPHIS
126 USA
USA
TENNESSEE



Robert Edwards

Nobel Price Physiology / Medicine 2010

The 85 year old human physiologist Robert Edwards received for his achievment in the field of In-Vitro-Fertilisation (IVF) the Nobel Price for Medicine in 2010. Edwards succeeded in the first successful human pregnancy derived from IVF together with his colleague Patrick Steptoe in 1978. The “test-tube-baby“ Louise Joy Brown was born. Today there are more than 5 million baby produced by ART globally .




Evening News

Meet Louise, the world's first test-tube arrival

SUPERBABE

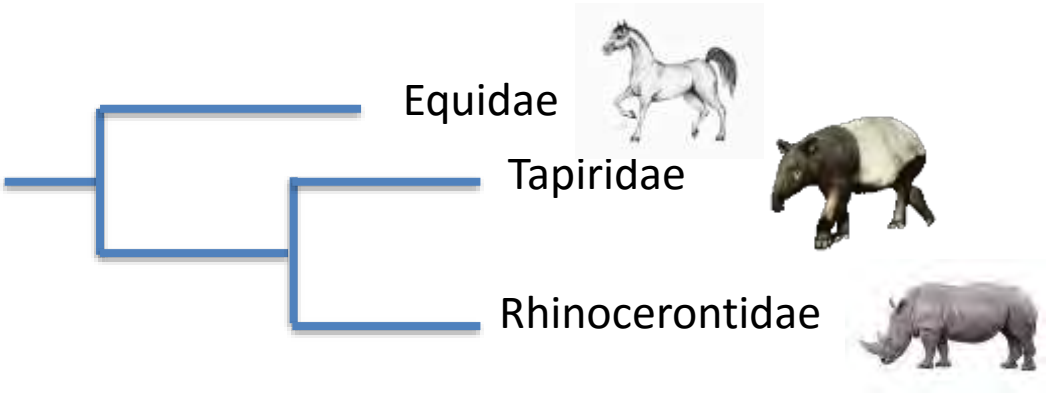
Wide-eyed Louise Brown pictured in hospital 18 hours after she was born. Today she's doing well. See Page Three





Transferability of OPU-ICSI-IVC system from Horses to Rhinoceros

The closest species in which the OPU-ICSI-IVC system is working is the equine



EQUINE: Mean oocytes recovery: 64% - n 11 per OPU
Mean maturation rate: 65%
Mean development to blastocyts: 15.5% (of cleaved), 10.5% (of injected)

AVANTEA







Aspects to be considered

OOCYTES

- In vitro maturation is still suboptimal:
  Cumulus cells do not expand as expected, it was observed often a mild expansion
  Nuclear maturation is also low (mean is 24%)

SEMEN

- Good quality for southern white rhino
- Very low quality for Sumatran rhino (only one donor up to now)

EMBRYO DEVELOPMENT

- Development up to 12 cells (no activation of embryonic genome forming a blastocyst)

AVANTEA


IZW BERLIN


THOMAS HILDEBRANDT
IZW BERLIN
14 . 11 . 2016


FRANK GÖRITZ
IZW BERLIN
14 . 11 . 2016

Ovarian down regulation by GnrF vaccination decreases reproductive tract tumour size in female white and Greater One-horned rhinoceroses

Improvac®



Does it work in rhino?

GNRF VACCINATION (IMPROVAC) IN FEMALE RHINOCEROS

Hermes R, Schwarzenberger F, Göritz F, Oh S, Fernandes T, Bernardino R, LeClerc A, Greunz E, Mathew A, Forsyth S, Saragusty J, Hildebrandt TB

Leibniz Institute for Zoo & Wildlife Research, Berlin Germany



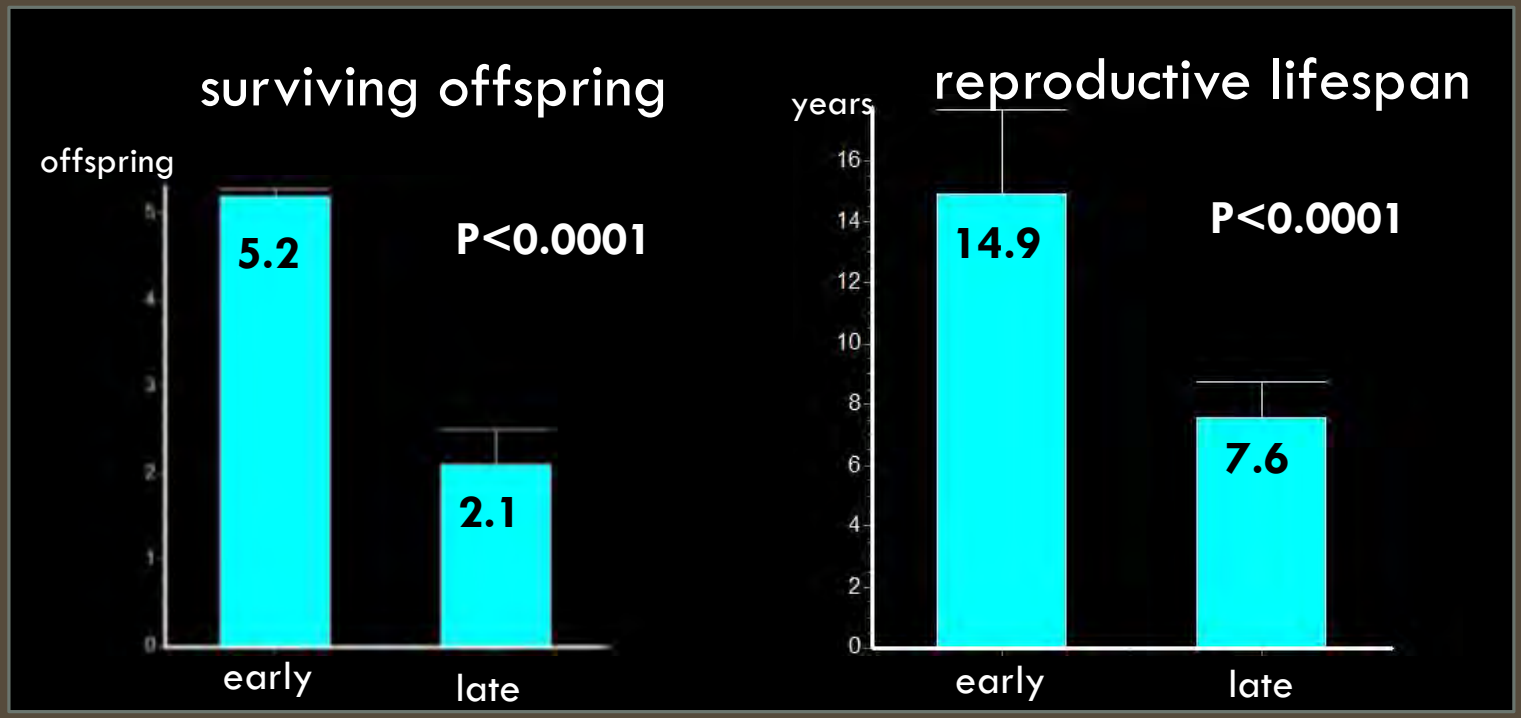
Hermes et al, PLOS ONE 2016





REPRODUCTIVE TRACT TUMORS IN INDIAN RHINOCEROS

Early breeders	5.2 ± 0.4y
Late breeders:	12.5 ± 0.8 y
Late breeders:	15.4 % no surviving offspring

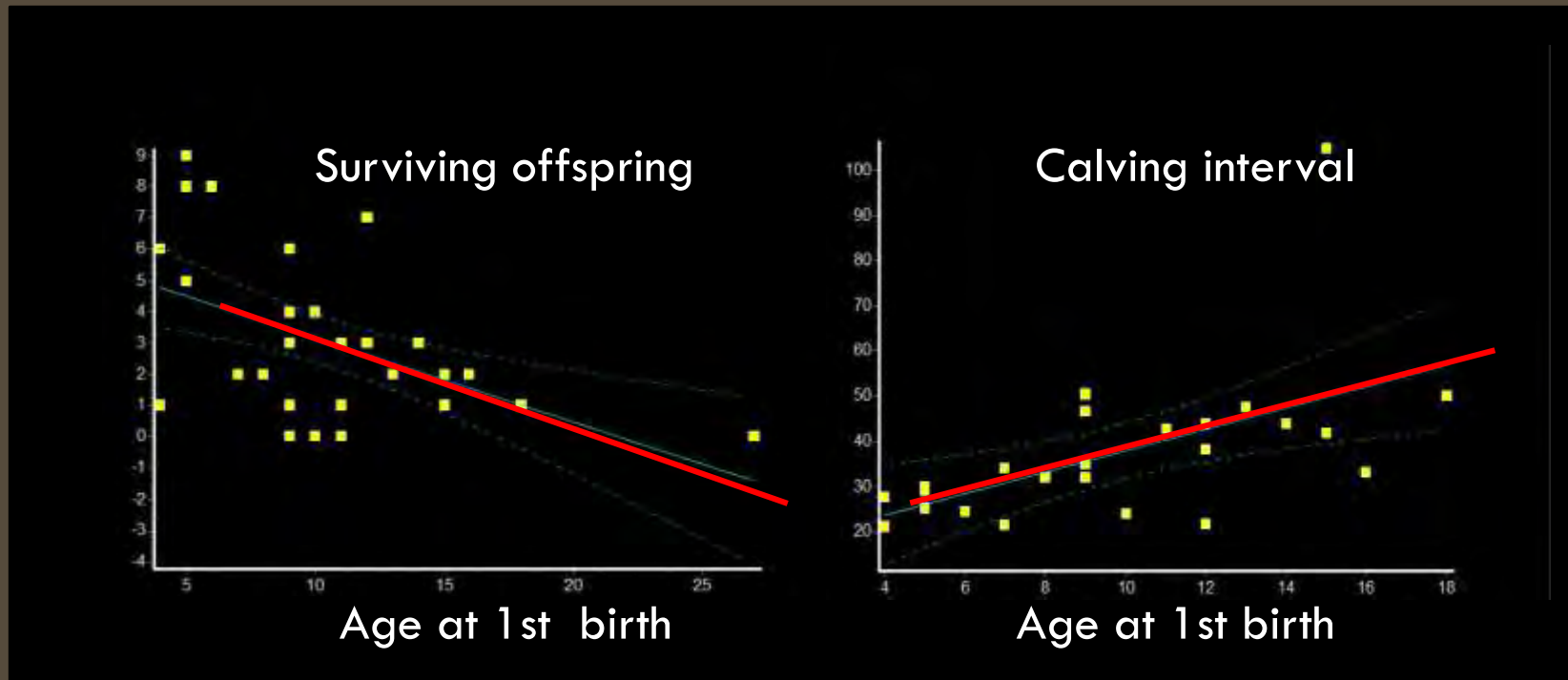




REPRODUCTIVE TRACT TUMORS IN INDIAN RHINOCEROS

Impact of the age at1st birth

surviving offspring per lifetime decreases = low fecundity







REPRODUCTIVE TRACT TUMORS IN RHINOCEROS

Clinical complications

Chronic blood loss

Journal of Zoo and Wildlife Medicine 23(4): 439–44[illegible], 1992
Copyright 1992 by American Association of Zoo Veteri[illegible]

VAGINAL HEMANGIOMA IN A WHITE RHINOCEROS (*CERATOTHERIUM SIMUM SIMUM*)

Kirk W. Reese, B.A., Bruce E. Eilts, D.V.M., M.S., and Gordon Pirie, D.V.M.

- Leiomyoma: white , Indian, Sumatran (Montali RJ 1997, Klein 1997, Schaffer 2001, Hermes 2006, 2013)
- Adenoma: Black rhino (Radcliffe 2000)
- Adenocarcinoma: White, black, Indian rhino (Wilson 2010, Geiger unpubl.)











REPRODUCTIVE TRACT TUMORS IN INDIAN RHINOCEROS

Ultrasound:

~42% female population

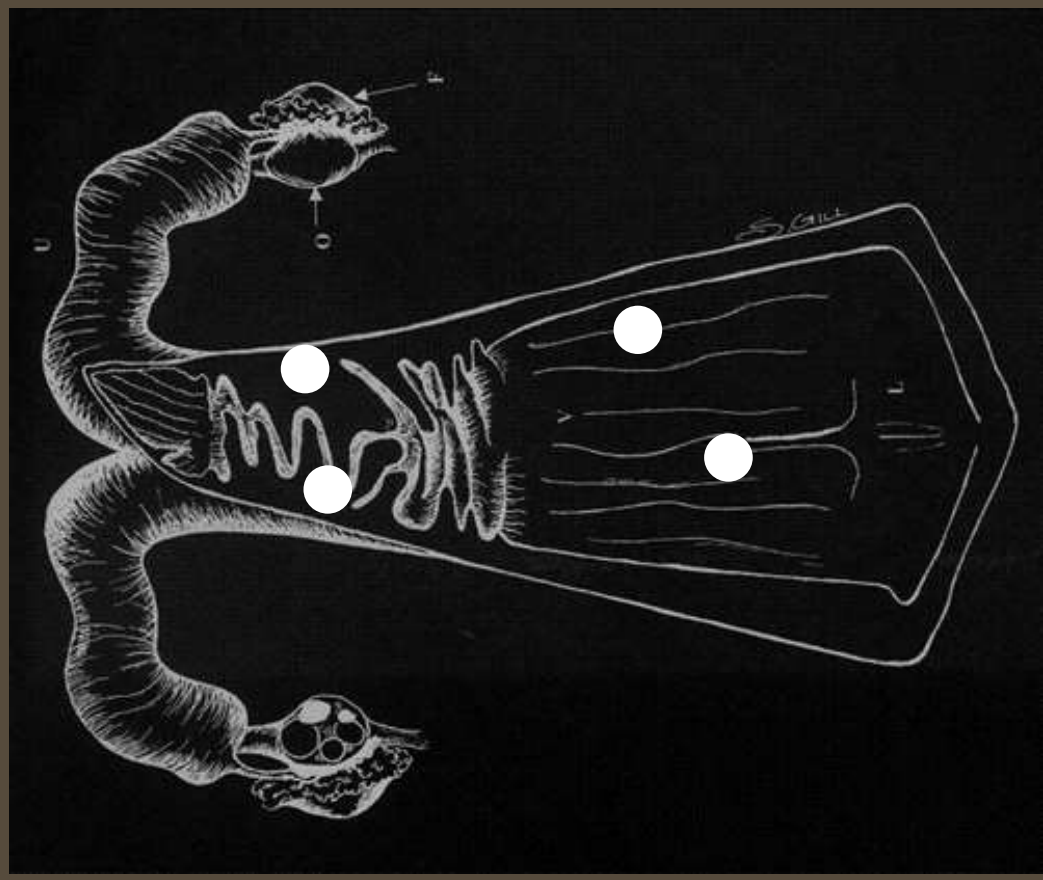
3-36 years of age

≥ 13 yrs

100% tumor incidence

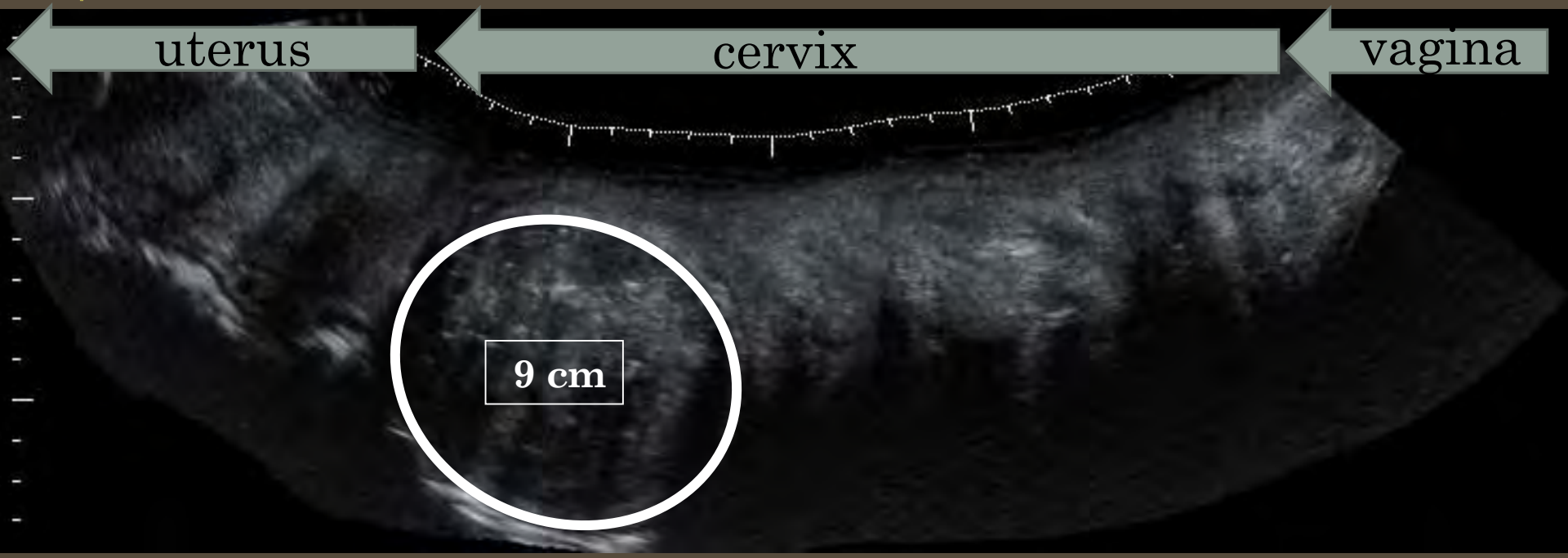
2 -12 small tumors

0.5 – 2.0 cm





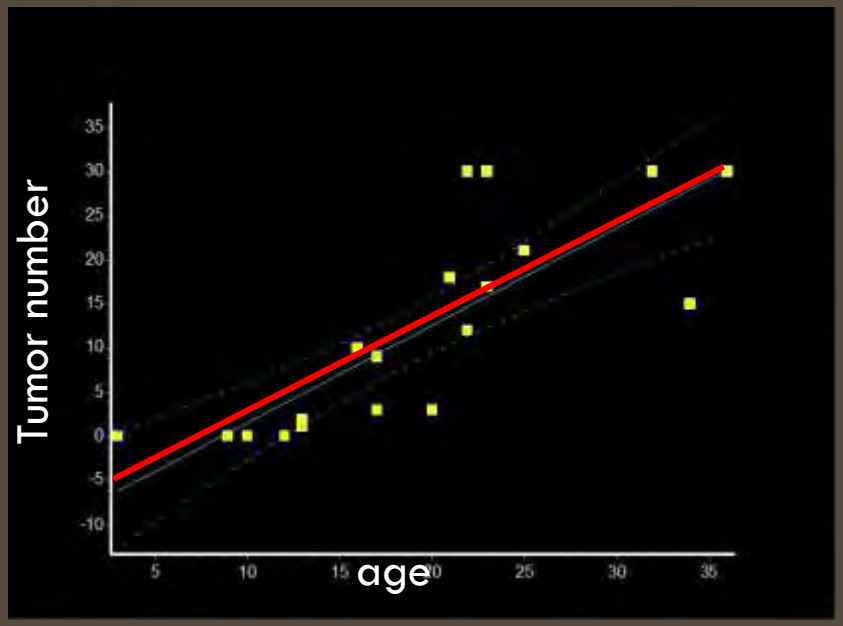
REPRODUCTIVE TRACT TUMORS IN INDIAN RHINOCEROS



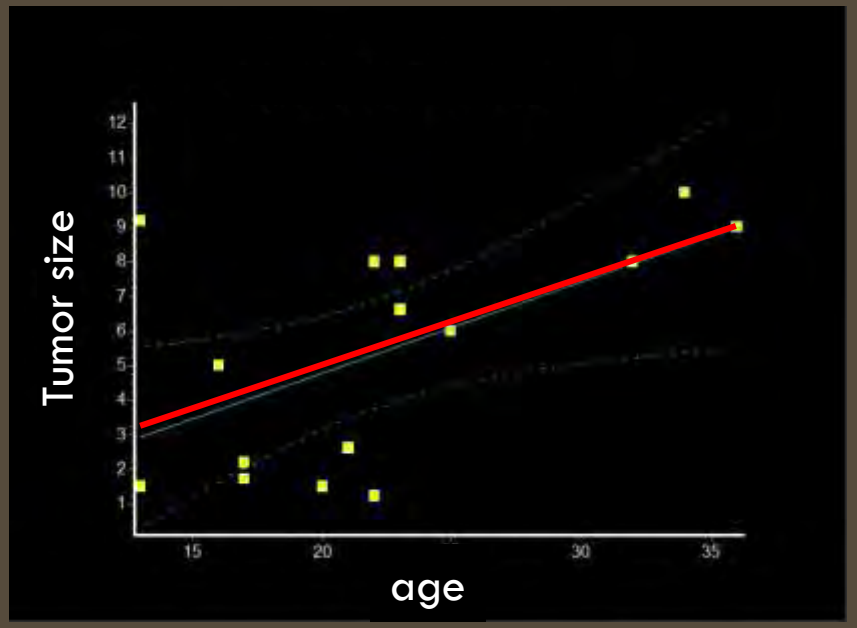


REPRODUCTIVE TRACT TUMORS IN INDIAN RHINOCEROS

Tumor number and size correlates with age



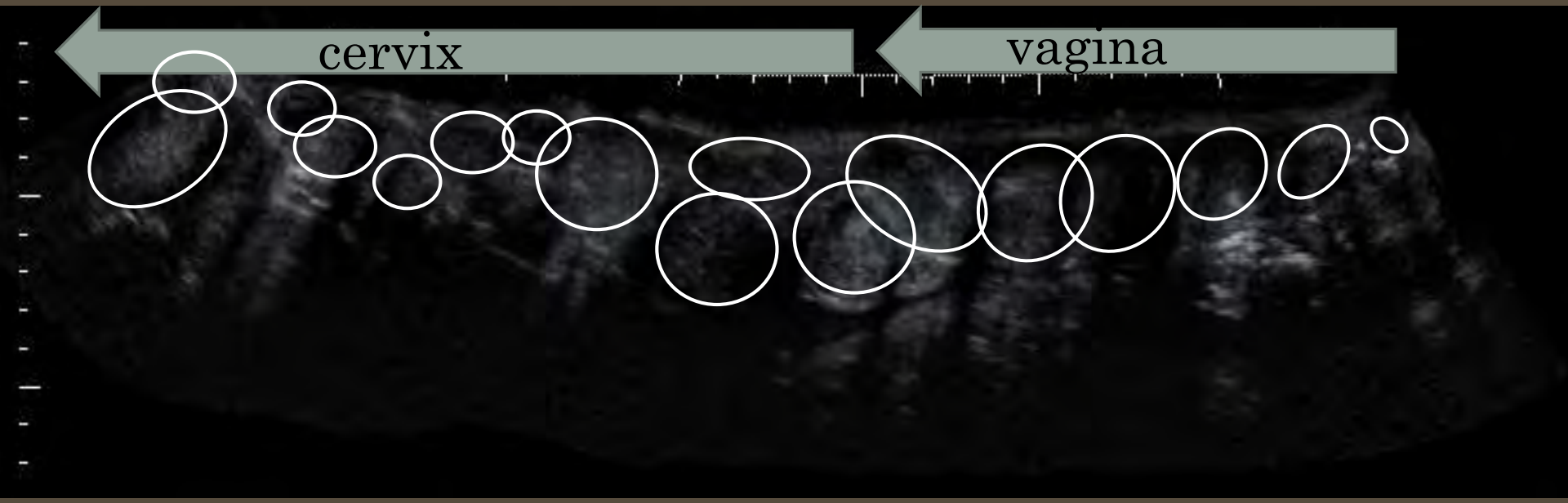
r= 0.8015, p = 0.0006



r = 0.5708, p = 0.026



REPRODUCTIVE TRACT TUMORS IN RHINOCEROS



Ultrasound: extended field of view

> 22 yrs: tumor population



REPRODUCTIVE TRACT TUMORS IN RHINOCEROS

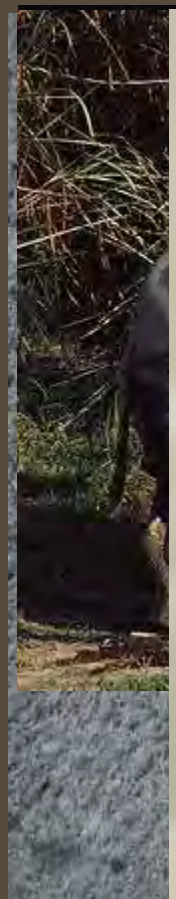
Disease progress

Tumour populations

- >20 large tumors
- 1.0 – 9.2 cm

Consequences

- Ascending infections
- no intromission
- Abortion







REPRODUCTIVE TRACT TUMORS IN RHINOCEROS

Wild caught Sumatran rhinoceros

Haemorrhagic discharge / chronic anaemia

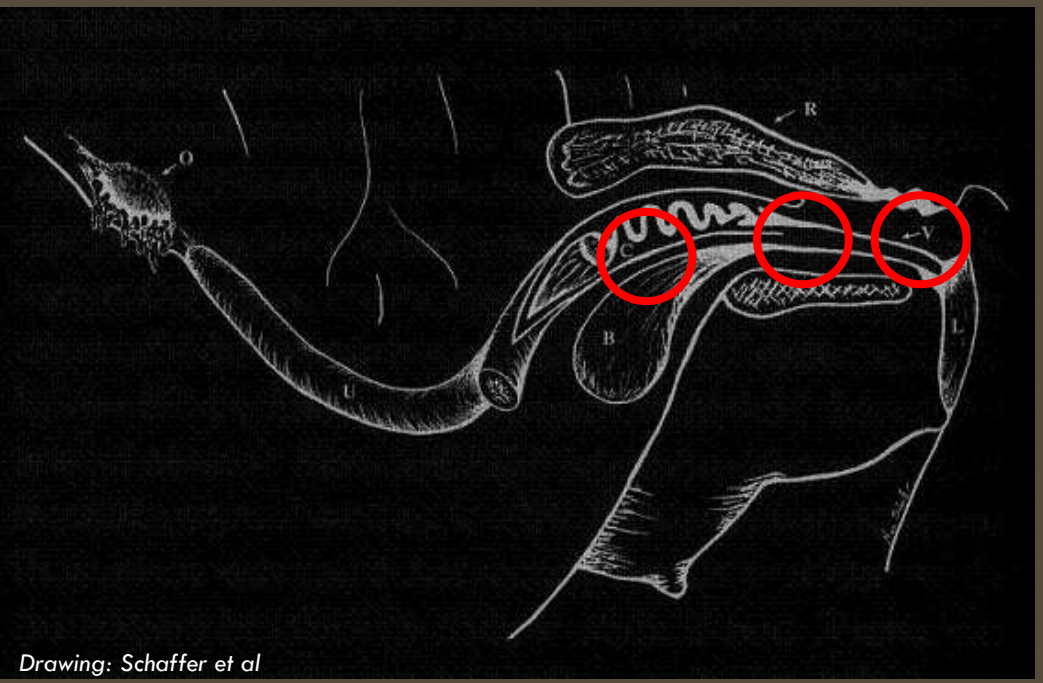






REPRODUCTIVE TRACT TUMORS IN RHINOCEROS

Clinical complications



Drawing: Schaffer et al

Obstruction of:

Ureter
Urethra
Rectum

Pain
Agressive behaviour



REPRODUCTIVE TRACT TUMORS IN RHINOCEROS

Clinical complication: ureter obstruction





REPRODUCTIVE TRACT TUMORS IN RHINOCEROS

CONCLUSIONS

- Females start breeding too late
- Resulting in low fecundity

Cause: reproductive tract leiomyoma
sex hormone dependent repro pathology

Hypothesis

Tumors growth is hormone dependent

Tumours may start from onset of puberty

Tumors grow between pregnancies

Intercalving interval is too long









REPRODUCTIVE TRACT TUMORS IN RHINOCEROS

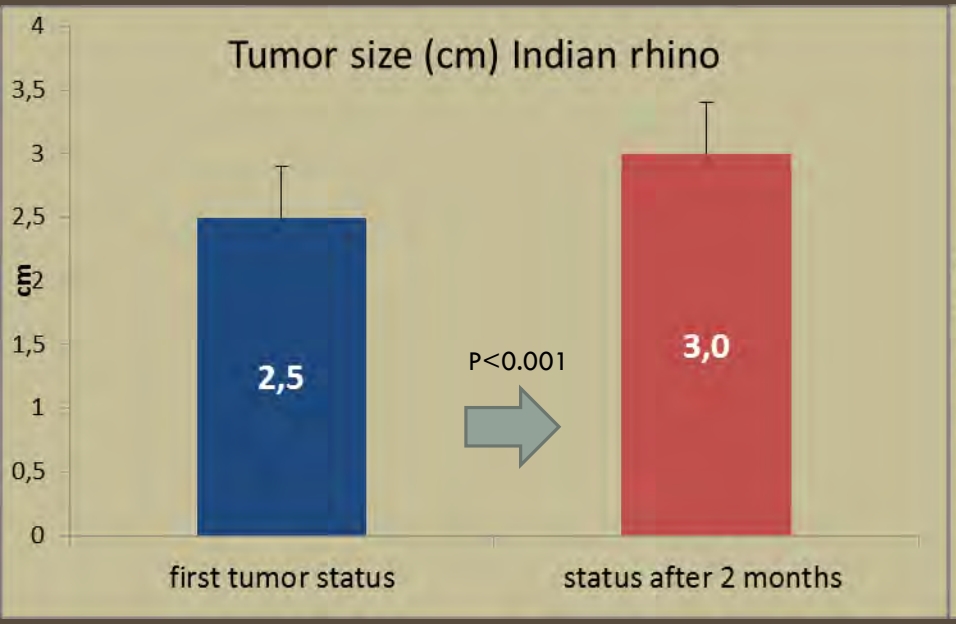
1. Laparoscopy: Radcliffe et al 2000, Portas et al 2010
2. Ovariohysterectomy? Klein et al 1997

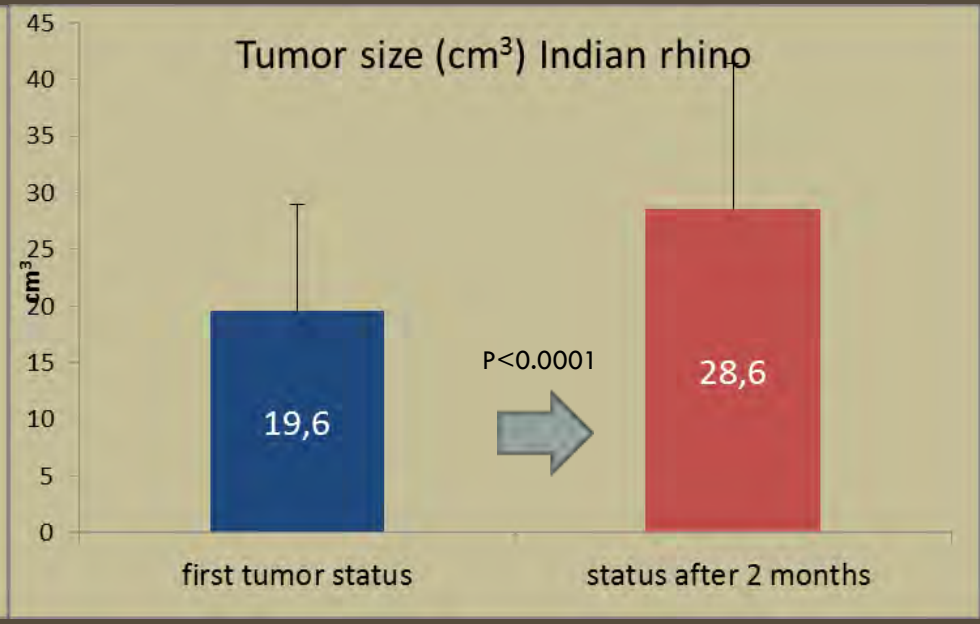




MEASUREMENT OF TUMOR GROWTH

- Animal: n=1
- Tumors monitored: n=17
- Monitor period: 2 months
- Increase of tumor volume: 45,9 ± 18,9 %







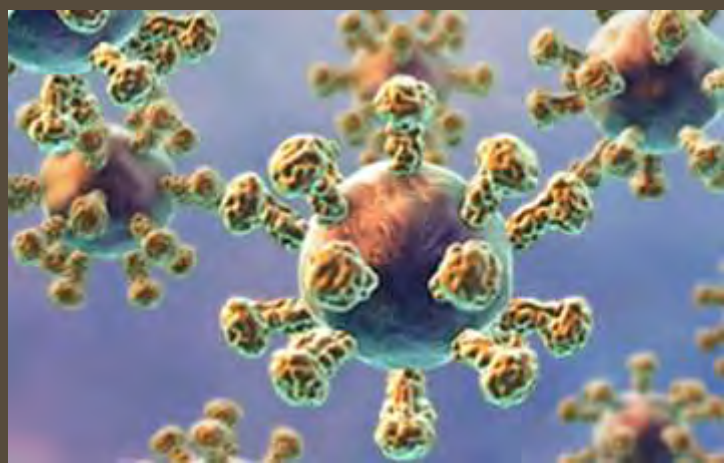
GNRF VACCINATION IN RHINO

Aim:

1. Cease ovarian activity
2. Hold tumor growth by ceasing hormonal influence
3. Cease of clinical signs







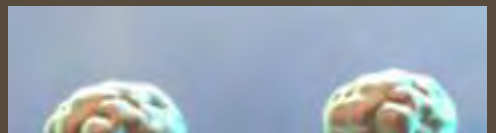


GNRF VACCINATION (IMPROVAC®)

- Reversible down regulation of reproductive function
- Temporary impairment of fertility
- Safe to use in pregnant females

Mare:	Elay, Aus Vet J 2007, Imboden, Therio 2006 Tshewang, Aus Vet J 1997,
Female elk:	Powers, Biol Reprod. 2011
Female white tailed deer:	Miller, 2008 Reprod Immunol
Female bison:	Miller, 2004 J Wildl Dis
Elephants:	Boedecker, 2012 J Zoo Wildlife Med de Nys, 2010 J S Afr Vet Assoc Benavides, 2012 Reprod Biol Endo Lueders, 2014 J Zoo Wildlife Med







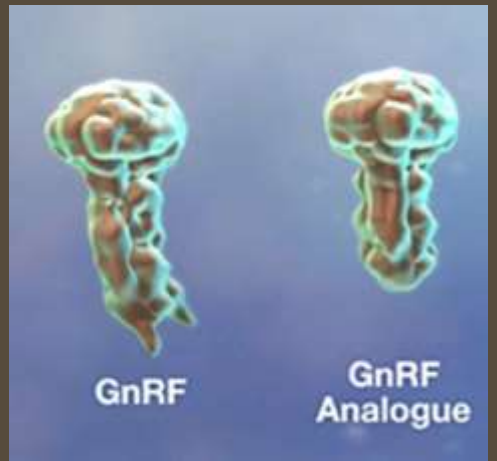


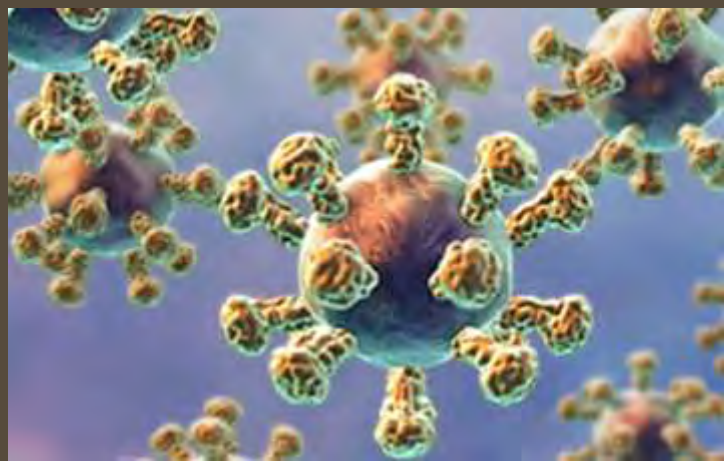
GNRF VACCINATION IN RHINO

Study group

Animals:	n = 7 (3 white / 3 Indian)
Age:	24–44 yr
Oestrous cycle:	n = 7
Tumors:	white: 2.7 ± 0.9
	Indian: 14.0 ± 1.5
Vaginal discharge:	n=4









GNRF VACCINATION IN RHINO (N=7)

Treatment:

GnRF Vaccine: Improvac, Pfizer
Vaccine dose: 3 ml
Interval: 0 + 1 + 3 + 6–8 mo





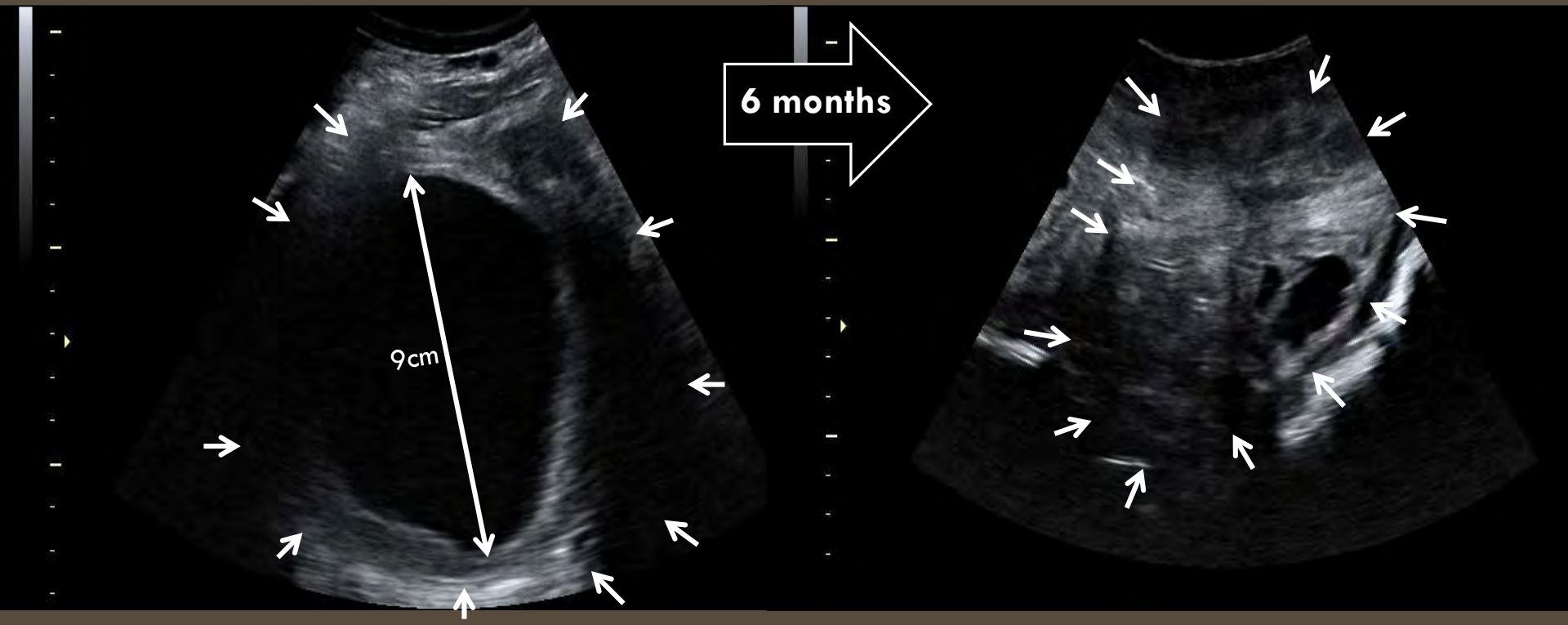




OVARIAN DOWN REGULATION USING GNRF VACCINE

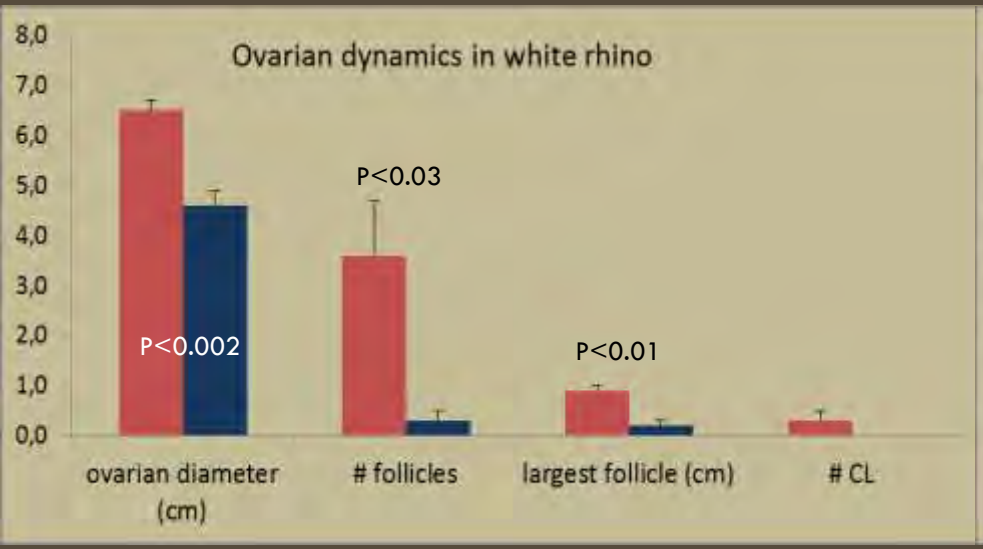
Indian rhino ovary
Active ovary / pre-ovulatory follicle

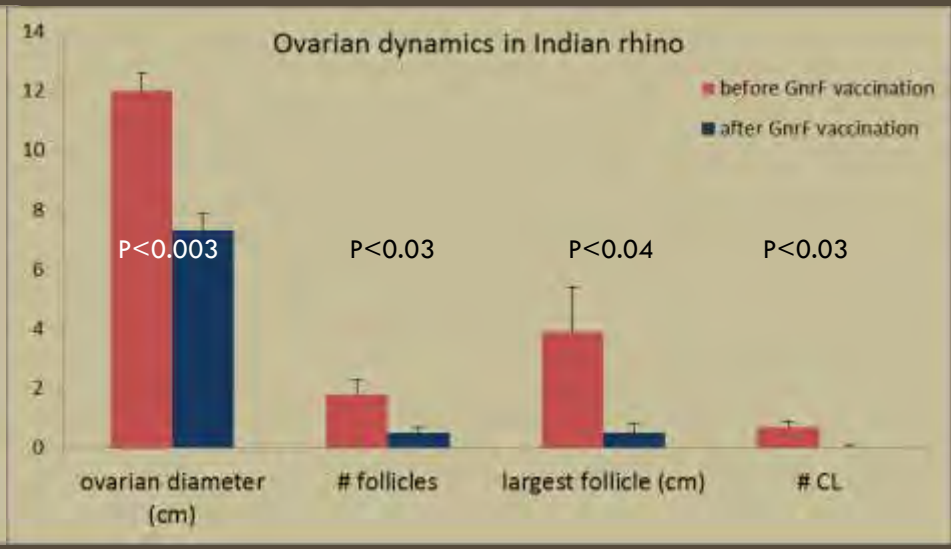
Indian rhino ovary
ceased folliculuar activity



OVARIAN DOWN REGULATION USING GNRF VACCINE

Ovarian activtiy before and after GnrF vaccination





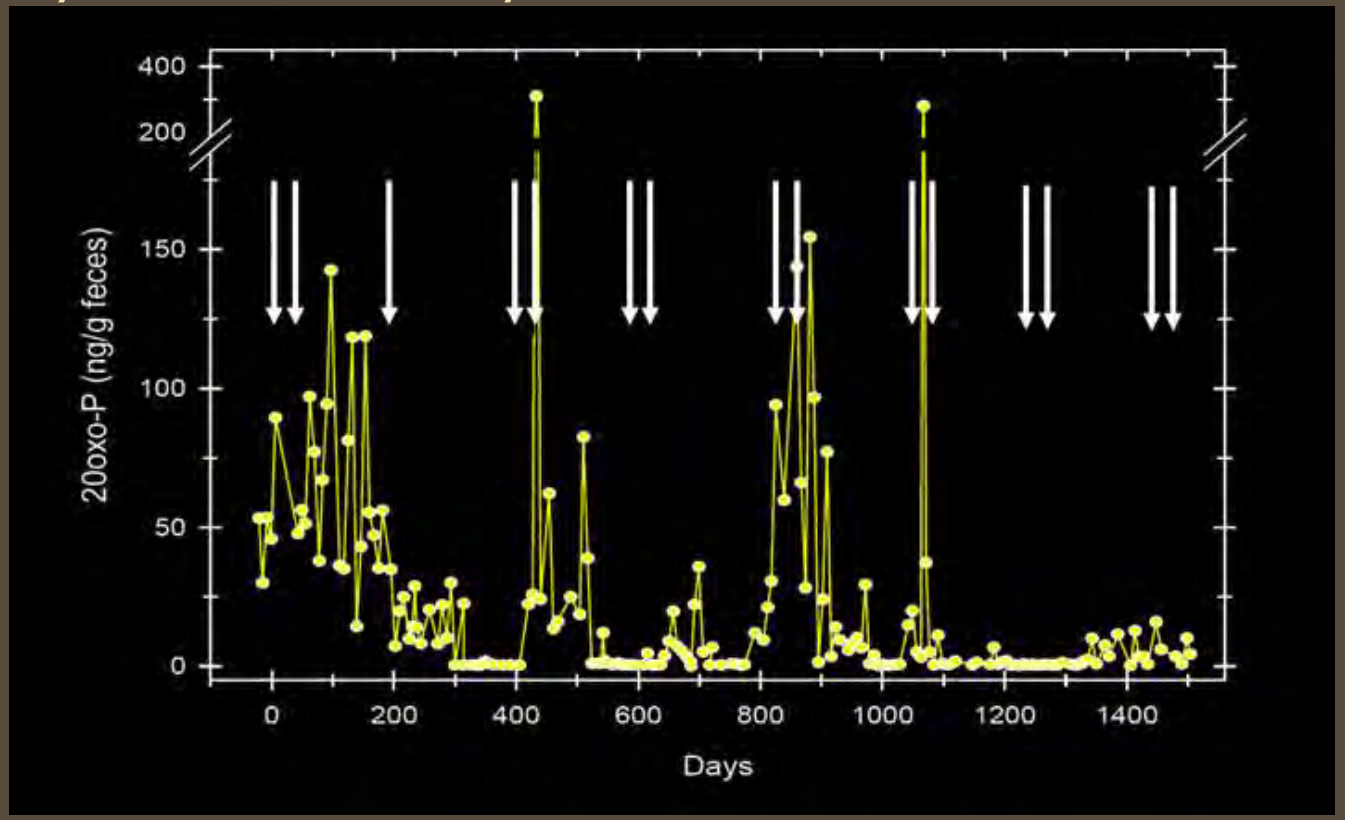
Decrease of ovarian volume:

White: 62.4 ± 7.6 %
Indian: 73.4 ± 6.1 %



OVARIAN DOWN REGULATION USING GNRF VACCINE

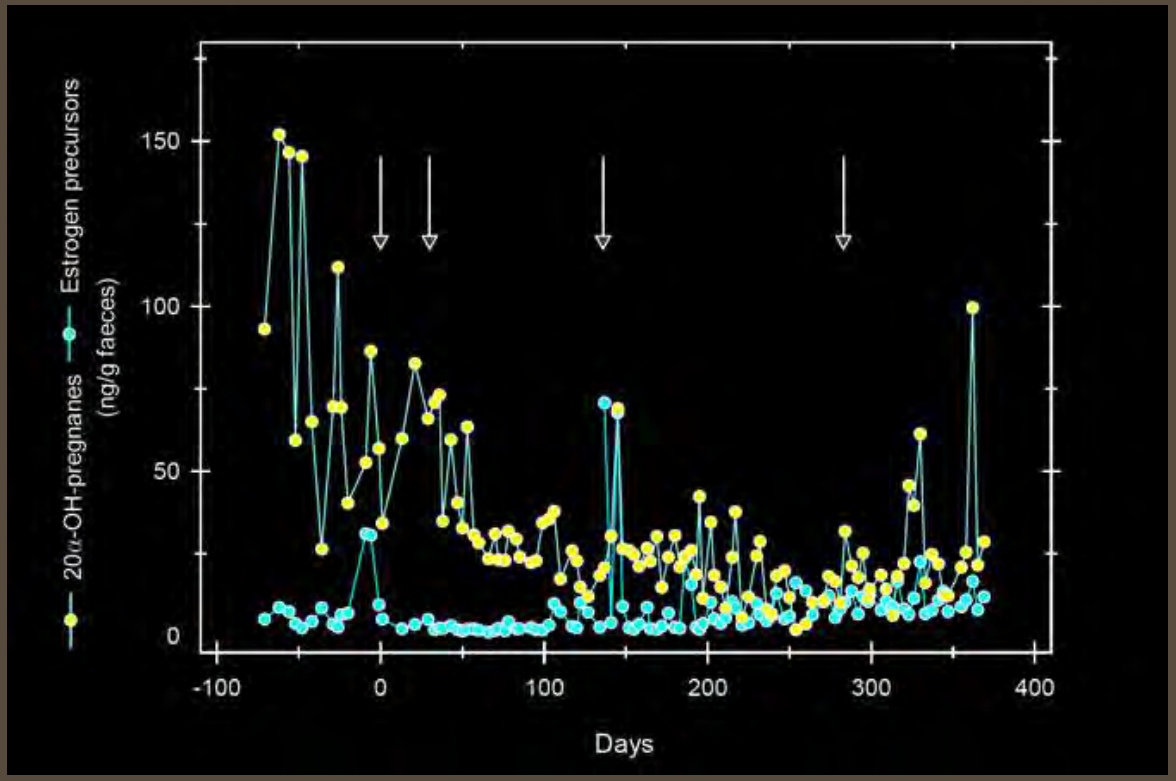
4 year luteal activity in GnrF vaccinated white rhinoceros



- Luteal activity ceases and resumes after 1 yr
- Down regulation of ovarian activity seems reversible

OVARIAN DOWN REGULATION USING GNRF VACCINE

1 year pregnane and estrogen in GnrF vaccinated Indian rhinoceros

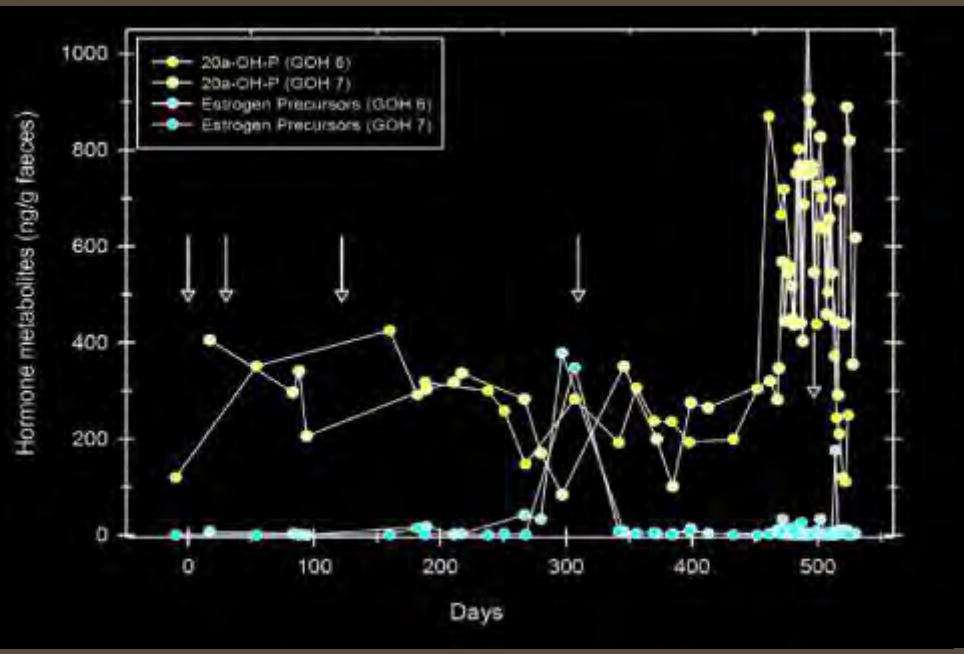


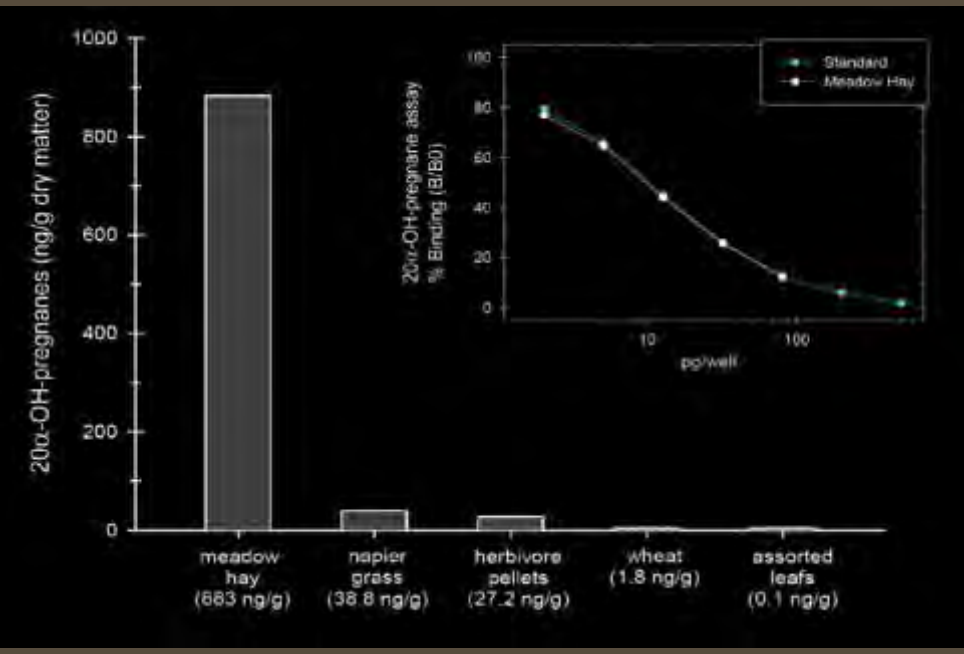


- Luteal activtiy ceases after 2 months
- Pregnane and estrogen rise shortly after 5 mo before next booster

OVARIAN DOWN REGULATION USING GNRF VACCINE

Feed cross-reacting with hormone analysis in two Indian rhinoceros

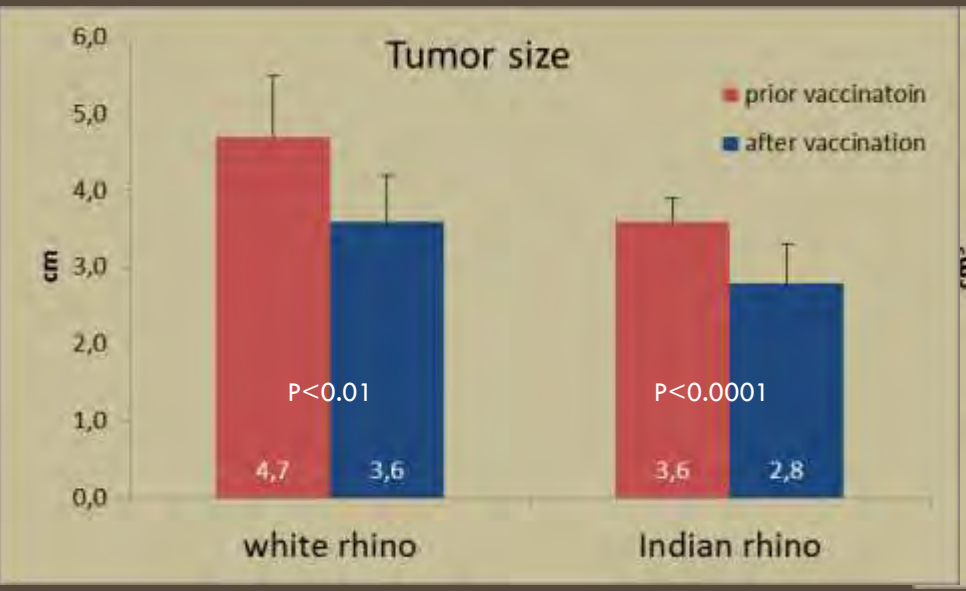


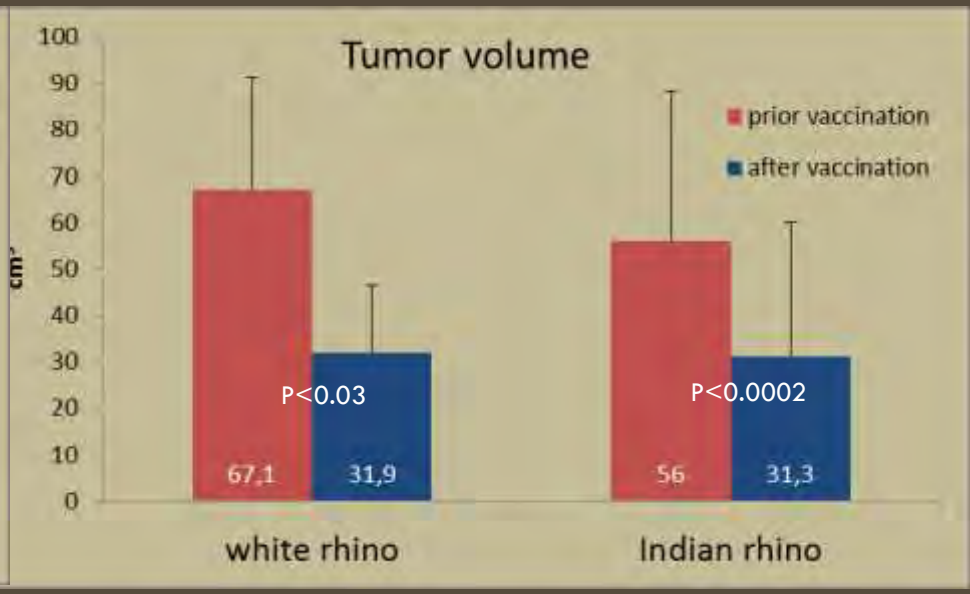


- Falsely high + erratic luteal activtiy: > 100 – 400 ng/g = pregnancy?
- Phytchemicals cross-reacted with enzyme immunoessay!

OVARIAN DOWN REGULATION USING GNRF VACCINE

- Animals: n = 6 (3 white / 3 Indian)
- Tumors measured: 8.3 ± 2.7 /animal (range: 1 – 17)





Mean reduction of size
White: 1.1 ± 0.5 cm
Indian: 0.9 ± 0.2 cm

Mean reduction of volume
White: 48.6 ± 12.9 %
Indian: 50.8 ± 6.6 %

CONCLUSIONS

1. GnrF vaccine down regulated ovarian function
2. First immuno-contraceptive in female rhino
3. GnrF vaccine decreased reproducitve tumor
4. Symptomatic therapy in tumor diseased rhino
5. Reversible
6. Restoration of fertility needs to be shown



vetmeduni vienna

Singapore Zoo

Lisboa
JARDIM ZOOLÓGICO
Portugal

THOIRY

COLCHESTER ZOO
Action for the Wild







www.plosone.org (open access): Hermes et al, PLOS ONE 2016

Human-Elephant Conflict Reduction via Deterrents, Understanding Ecological Correlates, and Climate Smart Agriculture Practices

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IEF International Elephant Foundation
Elephant Managers Association
WILDLIFE WORKS
EARTHWATCH INSTITUTE
WKU A Leading American University with International Reach
Biology

20+ years of elephant research

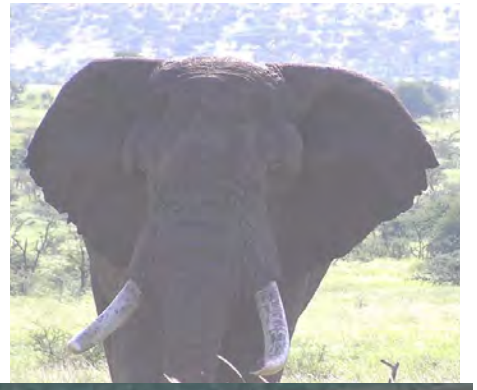


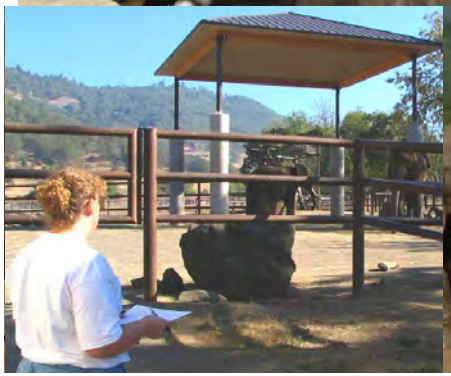












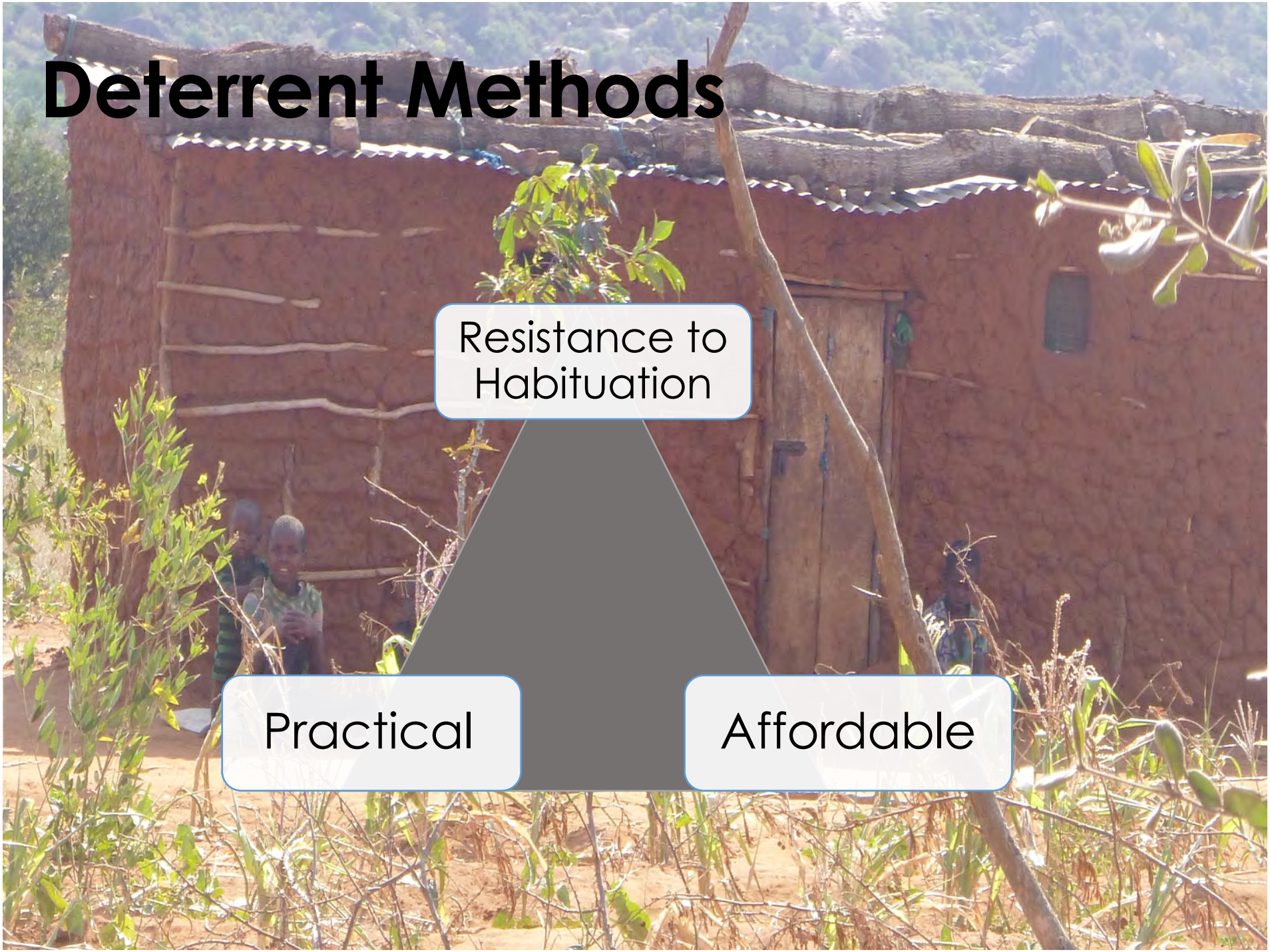


Human Elephant Conflict



- Compete over resources
- Crop Raiding
  - Habitat Loss
  - Interruption to natural foraging patterns
- Negative Outcomes
  - Farmer livelihoods
  - Elephant or human deaths

Deterrent Methods



Traditional





Resistance to Habituation

Practical

Affordable





Signal Theory, Multimodal Communication & Optimality

- Signals evolve to alter behavior of receiver
  - Multiple sensory channels => reinforce and/or modify
- Benefits and Costs of decisions







Opportunity for Collaboration with Asian Elephants: Using pheromones for conservation

Chase A. LaDue,
Thomas E. Goodwin,
Bruce A. Schulte

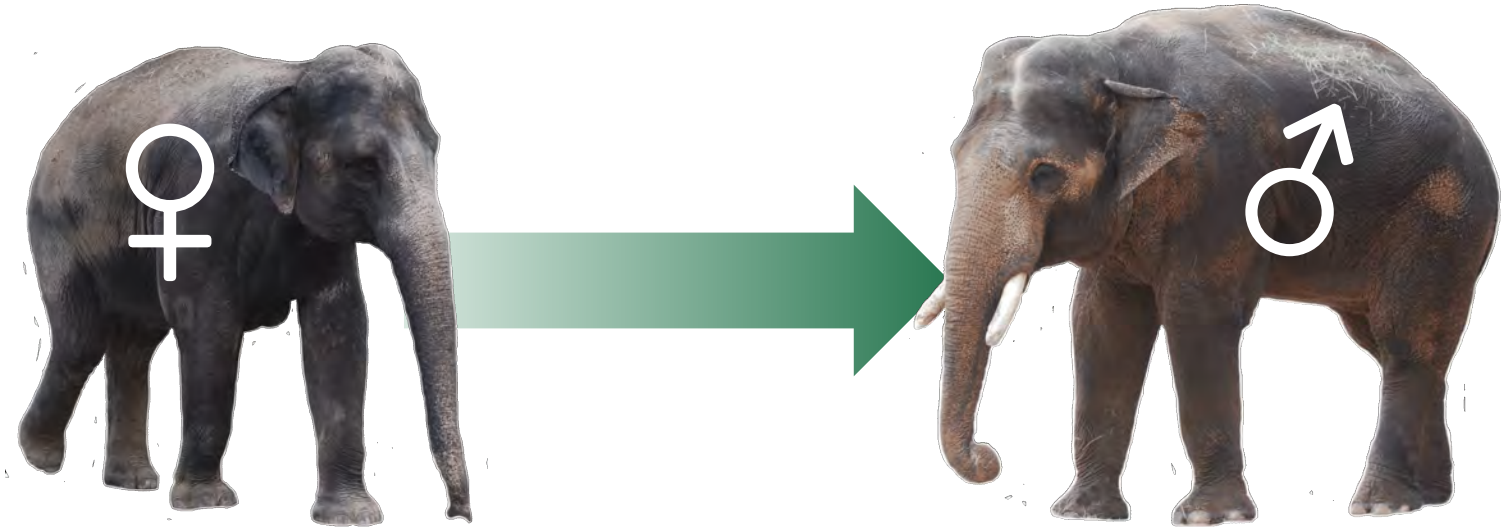


WKU

HENDRIX

Asian elephant chemical signals

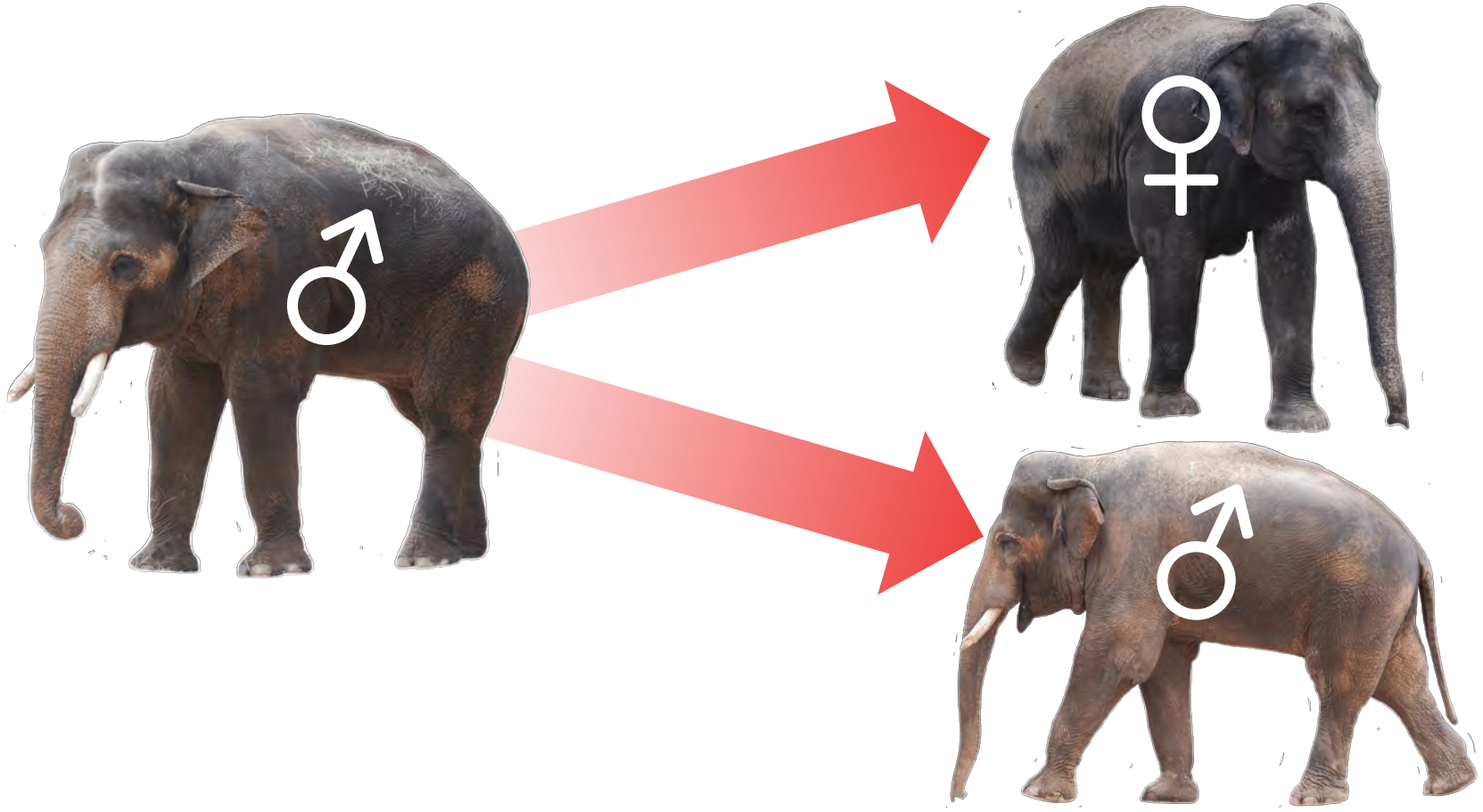
(*Z*)-7-dodecenyl acetate (Z7-12:Ac)



(Rasmussen et al. 1997)

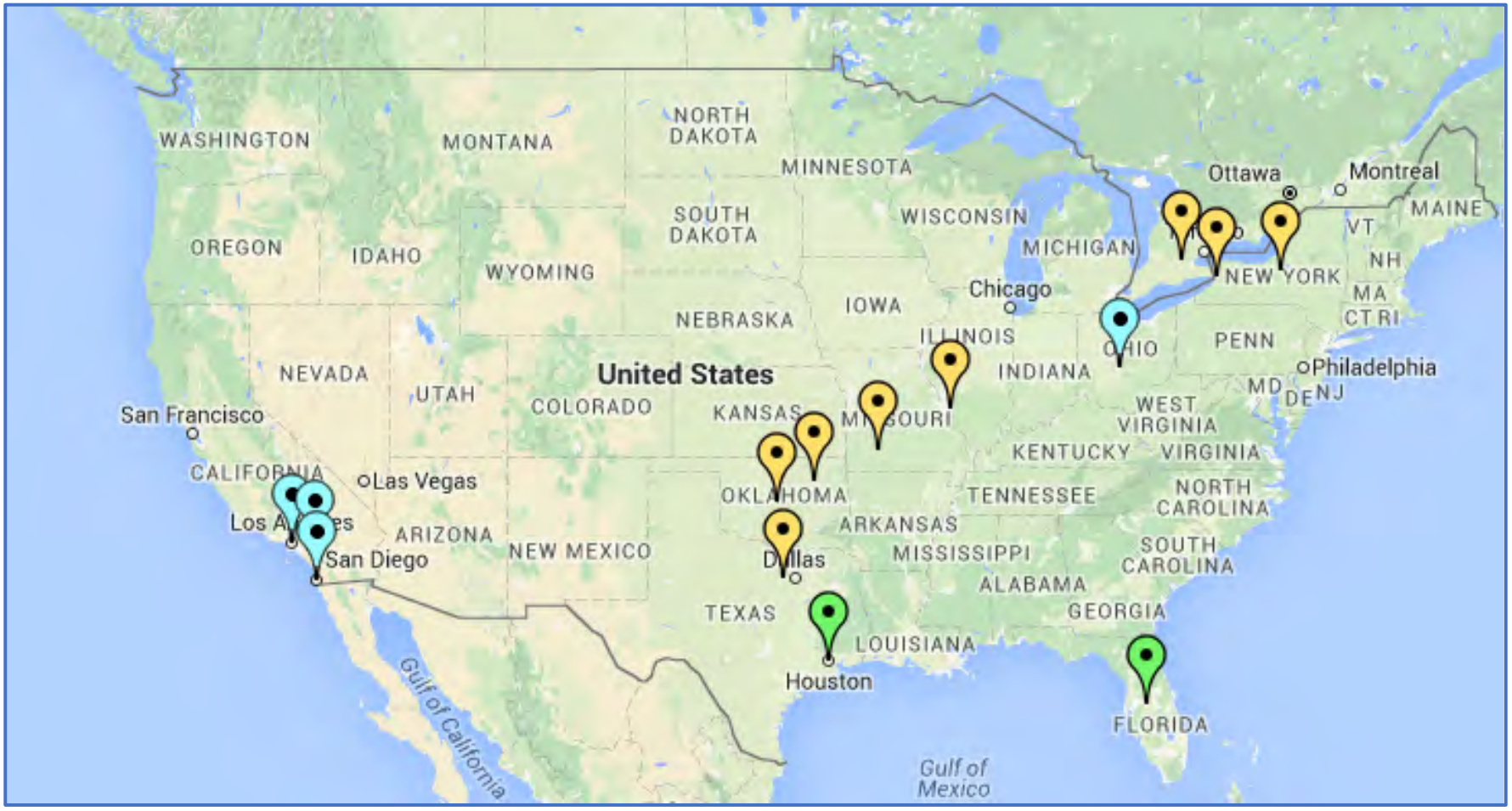
Asian elephant chemical signals

Frontalin



(Rasmussen and Greenwood 2003; Greenwood et al. 2005)

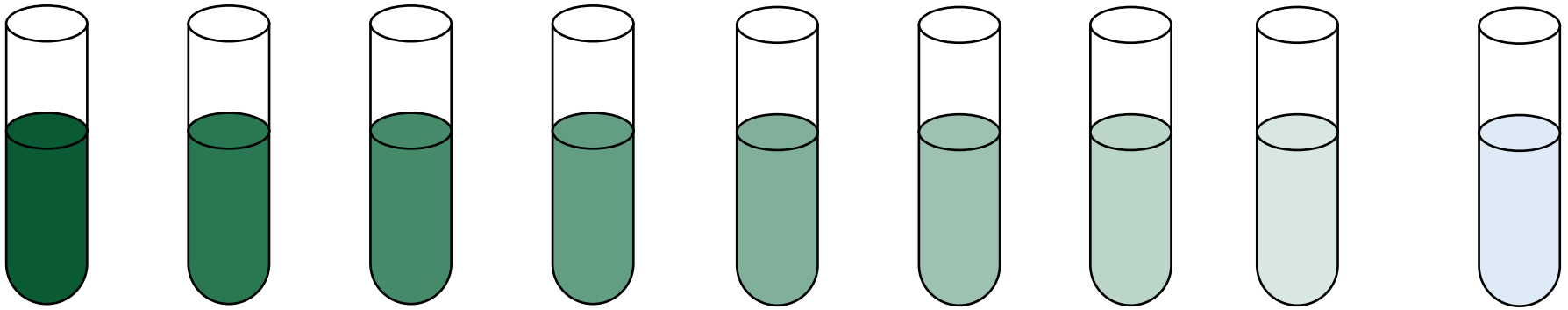
Bioassay Locations



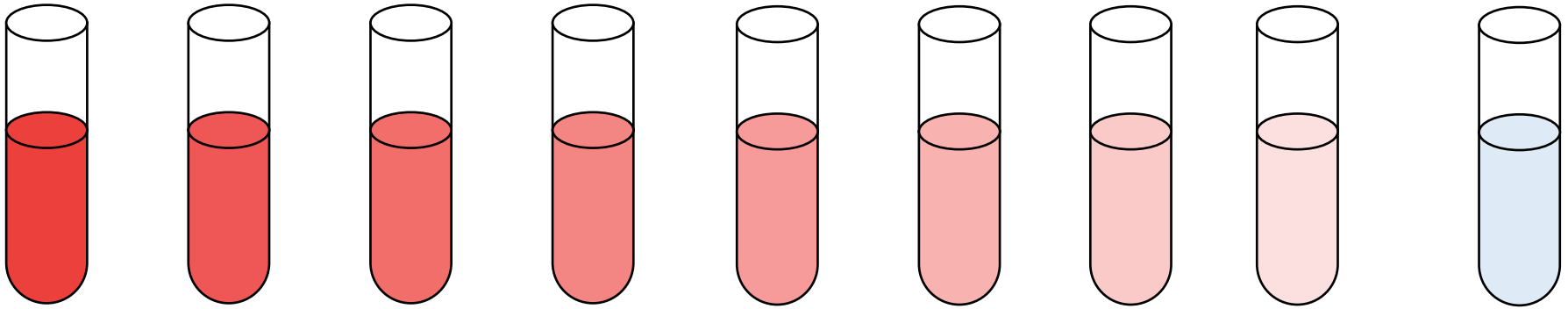
Experiment 1 Experiment 2 Both Exps.

Chemical sample **preparation**

Z7-12:Ac

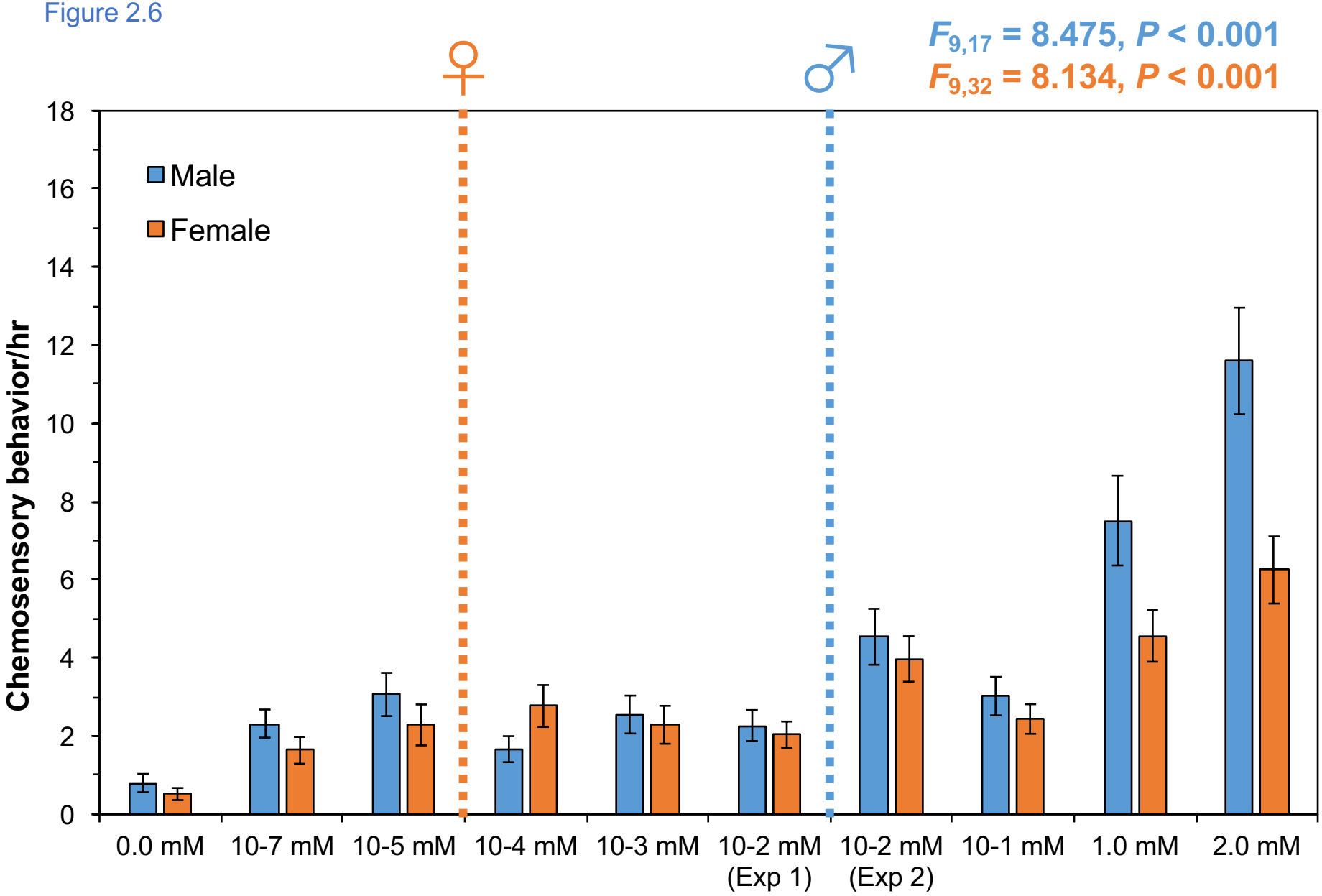


Frontalin



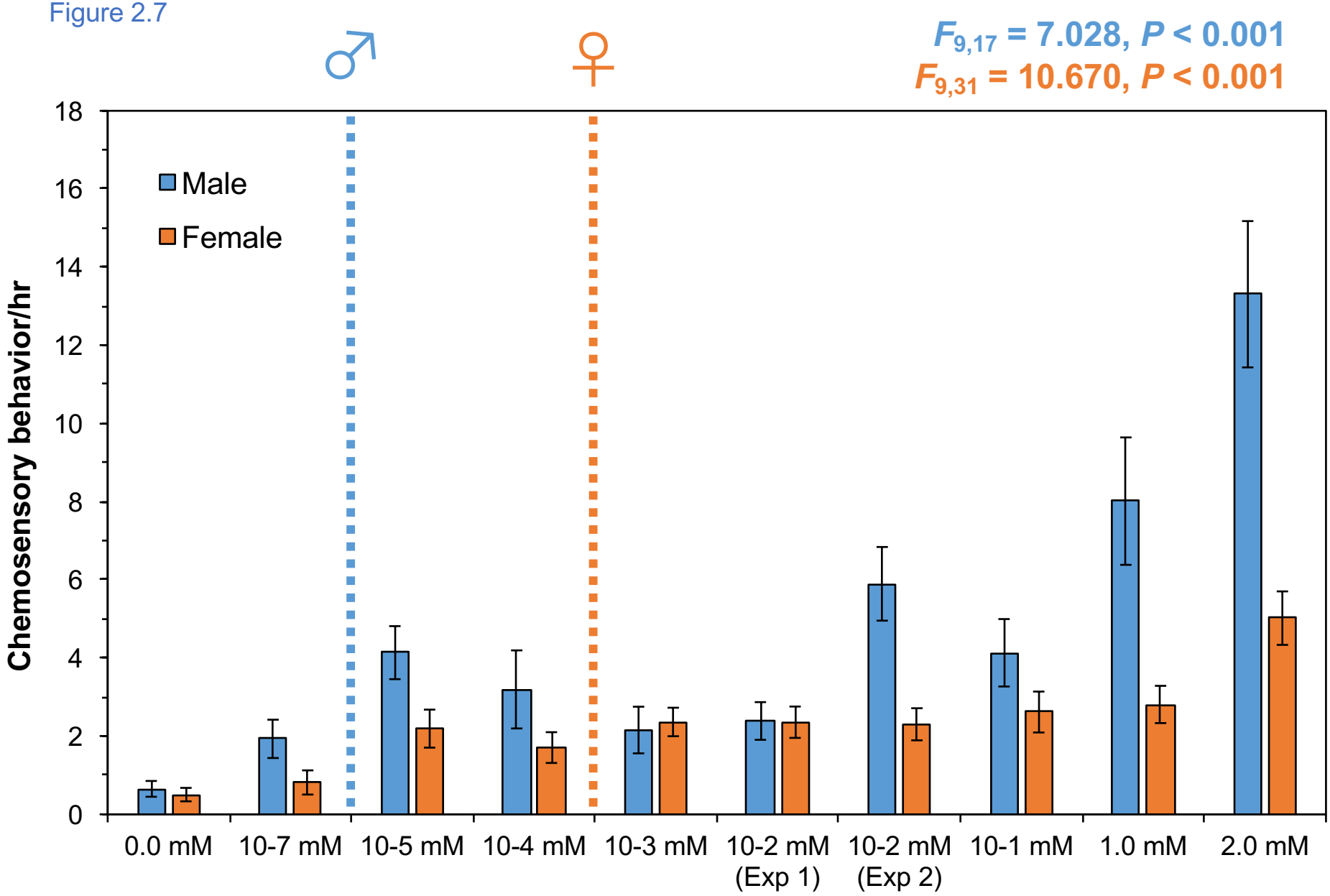
Concentration-dependent response: **Frontalin**

Figure 2.6



Concentration-dependent response: *Z*7-12:Ac

Figure 2.7



Chemosensory conclusions

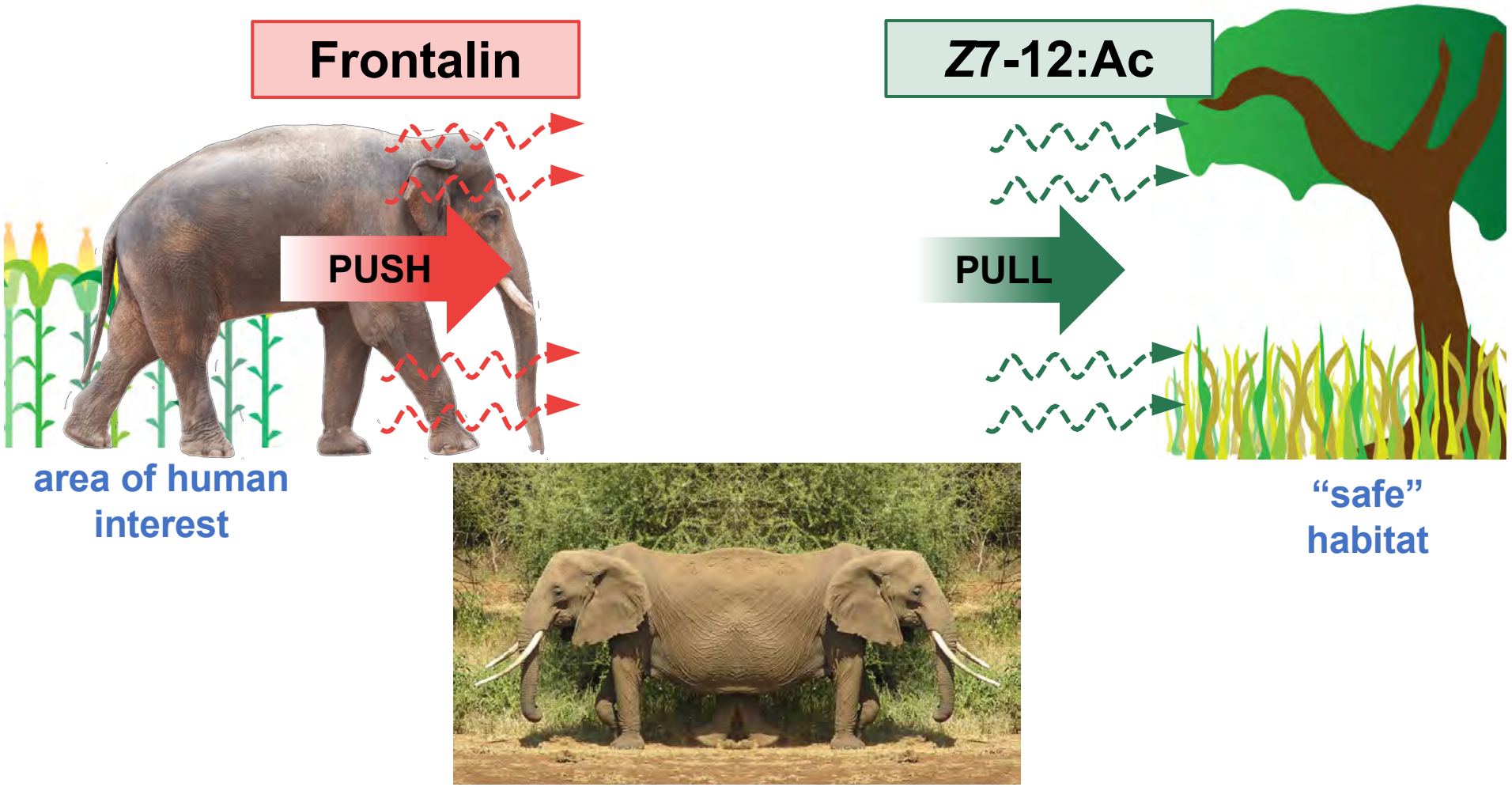
- Thresholds established for both **frontalin** and **Z7-12:Ac**
  - changes for each depending on **sex** and **reproductive experience**
- Marked changes in behavior with increasing signal **concentration**
  - concentration of **maximum response**?



Push-pull pest management

(Cook et al. 2007)

Where NOT to go and where TO go



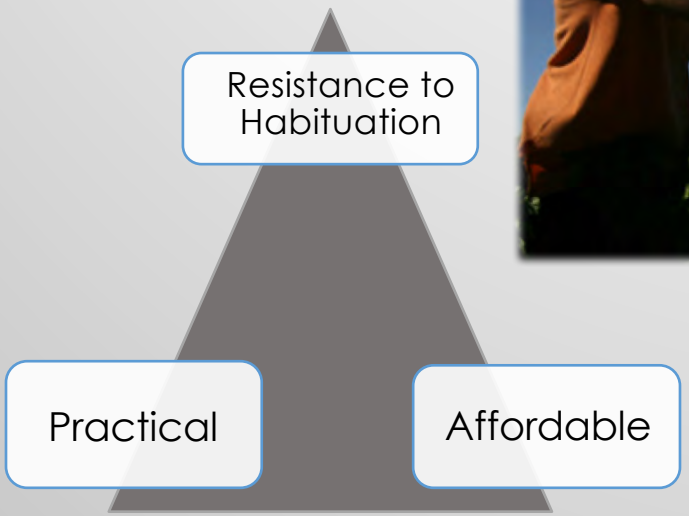
Modern

Electric Fences
Chili peppers
Bees









Project in Kenya





Metal Strip Fence



Dr. Lucy King, Save the Elephants

+ Combinations

The Kasigau Wildlife Corridor

near Tsavo National Parks, Kenya

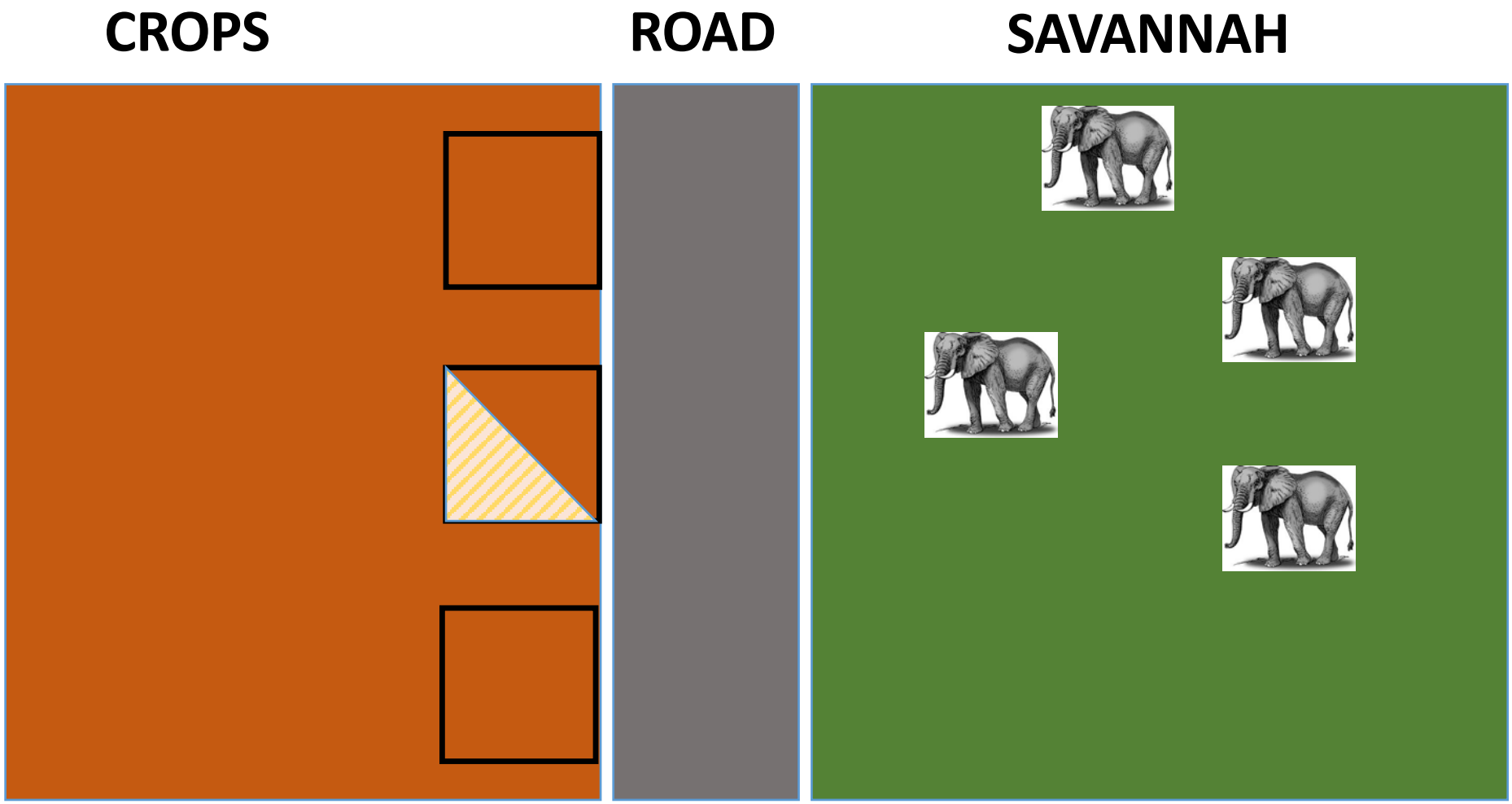






Dependent Variables

Raiding Potential, Raiding Success, Degree of Damage



Ecological Correlates

Ecological Engineers



Modify Vegetation



Relationship of Browsing to Crop Damage





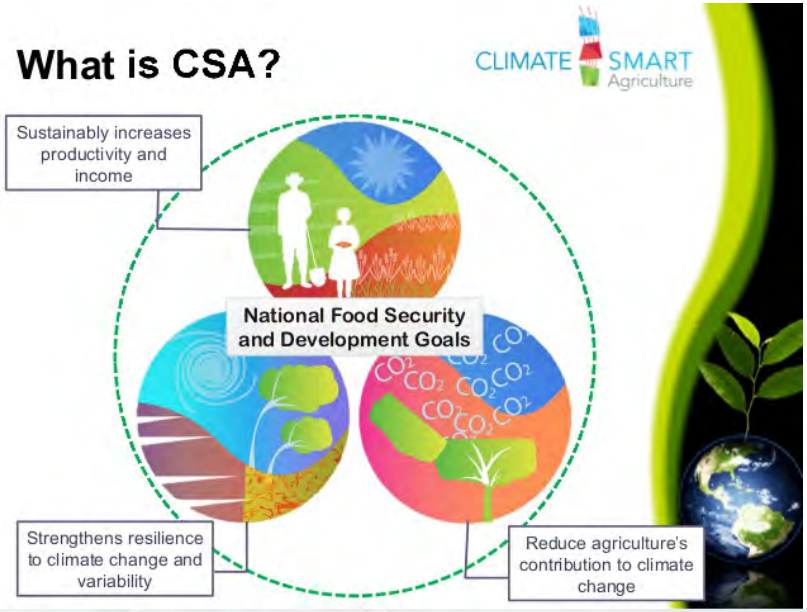
Ecological Correlate Indicator Species







Climate Smart Agriculture





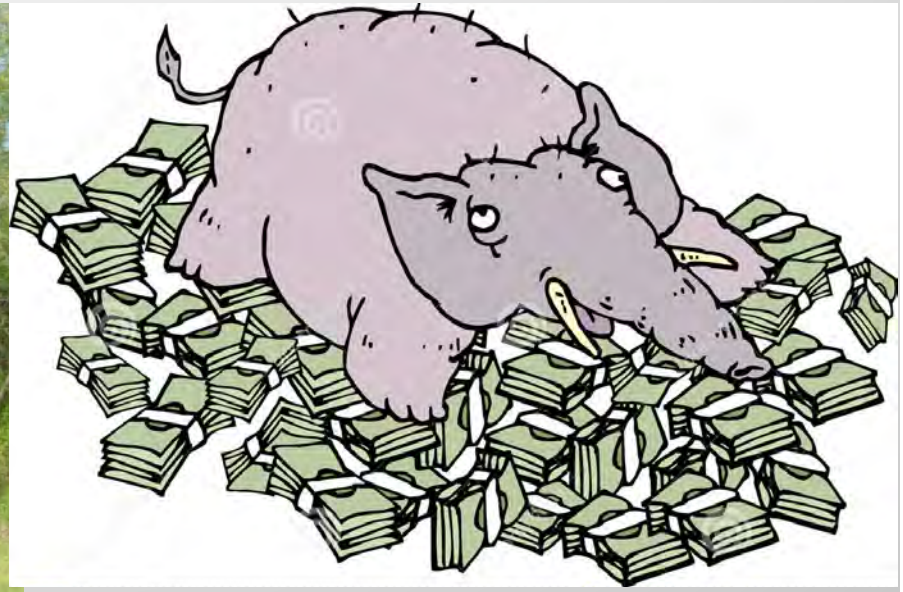




Summary

- Why & How
- Deterrents
  - Africa
  - Asia
- Ecological Correlates
- Climate Smart Agriculture
- Funding
- Collaborations





Thanks!



Finding pathways to human-elephant coexistence: A risky business

2016 INTERNATIONAL ELEPHANT AND RHINO CONSERVATION AND RESEARCH SYMPOSIUM

14th-18th November 2016

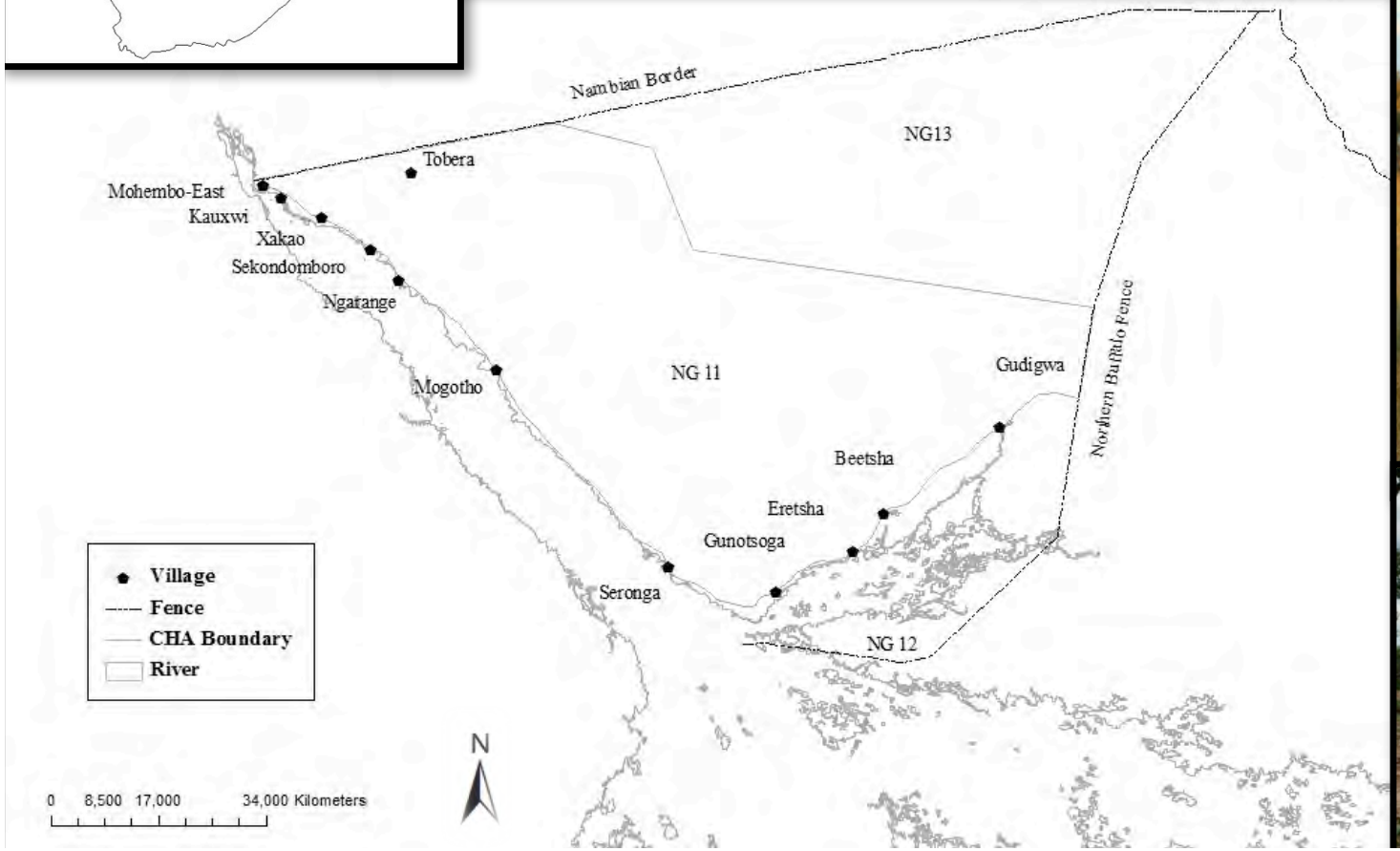
Presented by
Dr. Anna Songhurst

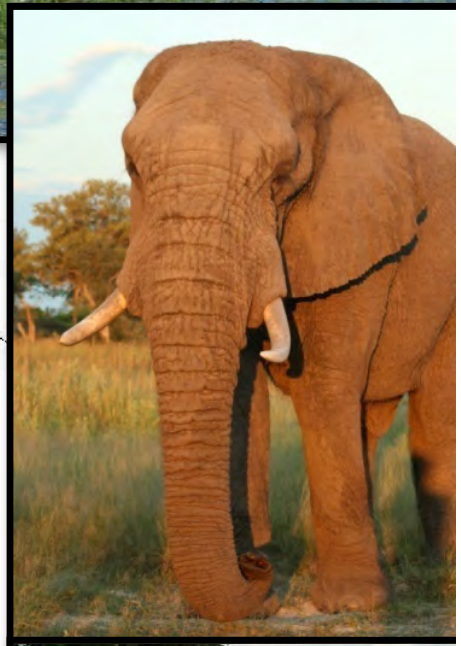
On behalf of co-authors: G McCulloch and T Coulson and co-directors: G McCulloch and A Stronza

Project Area



Okavango Delta Panhandle, Botswana





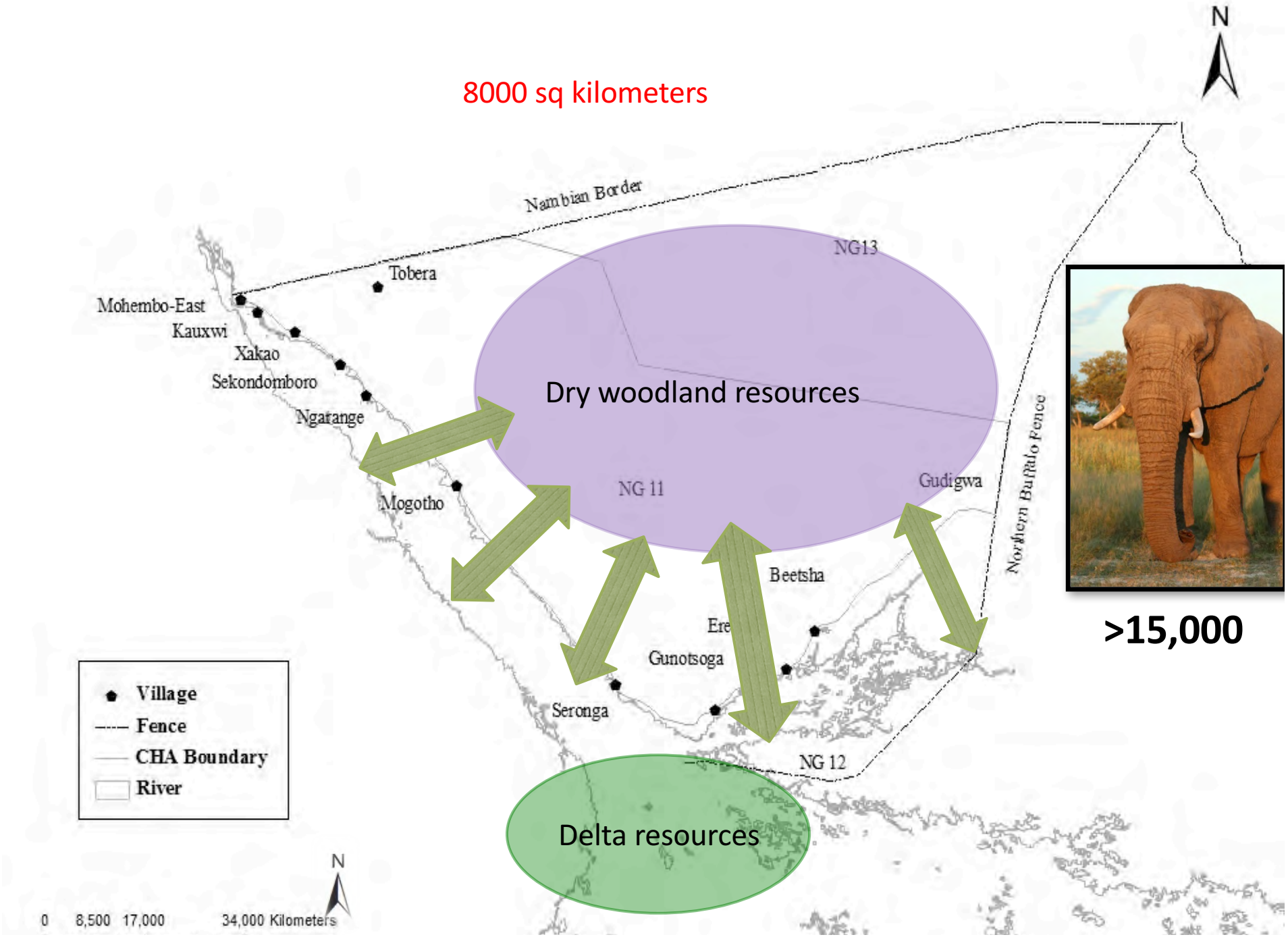


>15,000 People



Photo G. McCulloch

8000 sq kilometers



>15,000


Photo G. McCulloch



Photo A. Stronza



Most robust key driver of crop raiding

- When comparing all social & ecological contributing factors on ~1400 fields: **Distance to elephant pathway was by far the most robust key driver of crop raiding** ($p<0.01$).
- Fields further from elephant paths are less likely to be raided, **Fields <1.2km from a pathway are twice as likely (50%) to be raided.**

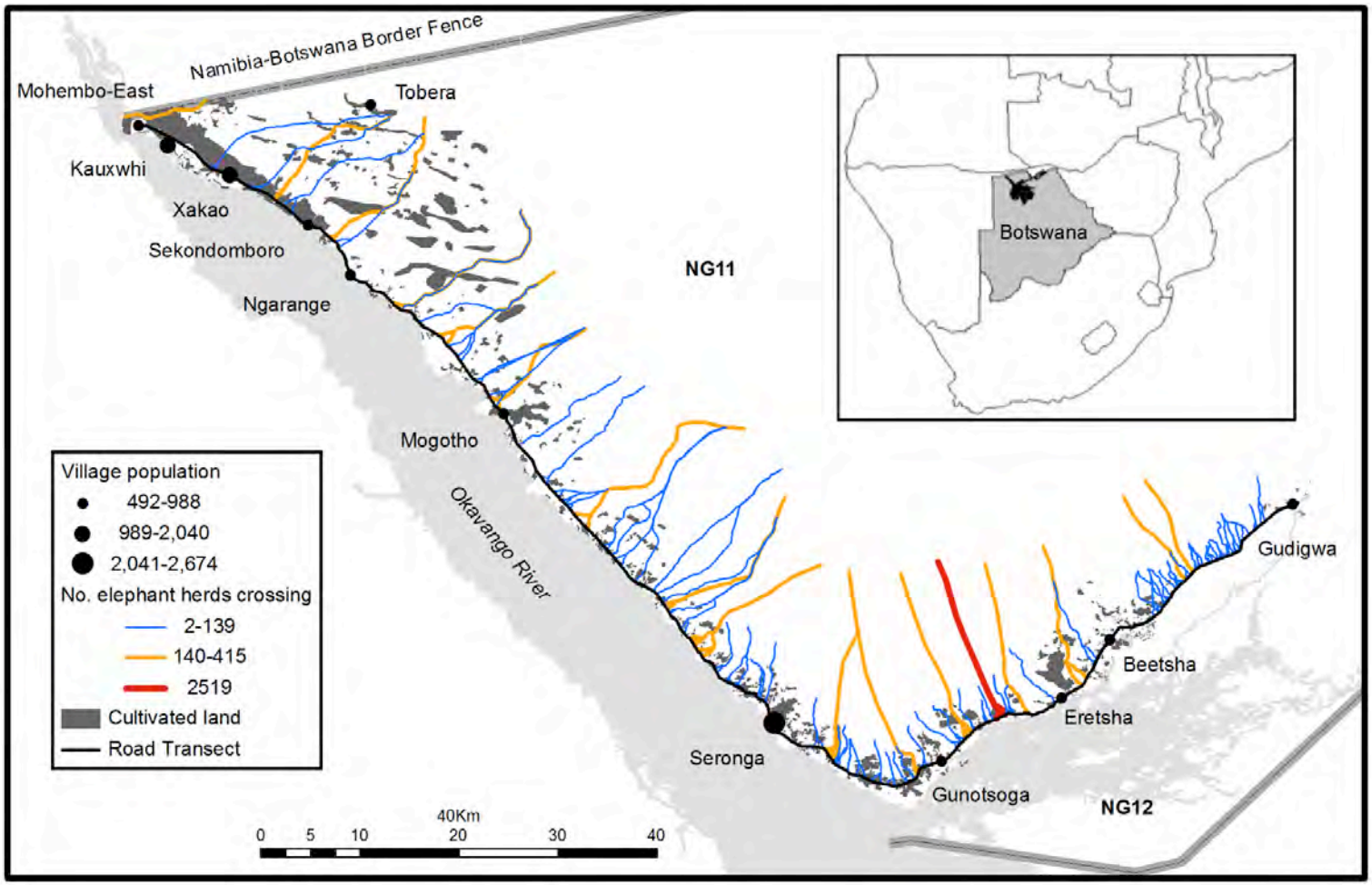
SONGHURST, A. & COULSON, T. (2014) Exploring the effects of spatial autocorrelation when identifying key drivers of wildlife crop-raiding. *Ecology and Evolution*, 4, 582–593

Monitoring & Mapping Pathways

- Bi-monthly ground surveys
- All elephant footprints were recorded and number of elephant groups counted
- Digitised and mapped well-worn elephant paths
- Paths verified through ground truthing and **indigenous knowledge**







Digitised main elephant pathways in the Okavango Delta Panhandle. Paths are colour coded to show low (blue), medium (orange), and high (red) utilisation gradients based on number of herds crossing the road over 3 years.

SONGHURST, A., MCCULLOCH, G. & COULSON, T. (2015) Finding pathways to human-elephant coexistence: a risky business. *Oryx,* 49, 1-8

Data Analysis

- Generalized linear mixed-effect models
- The identification of individual elephant tracks is difficult and therefore calculations of numbers of elephants per group are considered to be estimates
- Used two response variables the number of herds using pathways, and the number of individuals using pathways
- Covariates - i) area of cultivated land within a 1 km buffer of an elephant path, ii) the distance from a path edge to the nearest settlement, iii) human population number in nearest settlement, and iv) the elevation at the intersection between an elephant path and the main road.
- The models were fitted with two crossed random effects: elephant pathway and month.

Spatial use of elephants in relation to people

- Less elephant groups were observed close to human habitat modifications such as cultivated land, settlements and fences
- Elephant paths near sparsely populated human settlements were more likely to be utilised by elephants
- When the area of agriculture near a path increased the number of elephant herds utilising a path decreased but the number of elephants in a herd increased

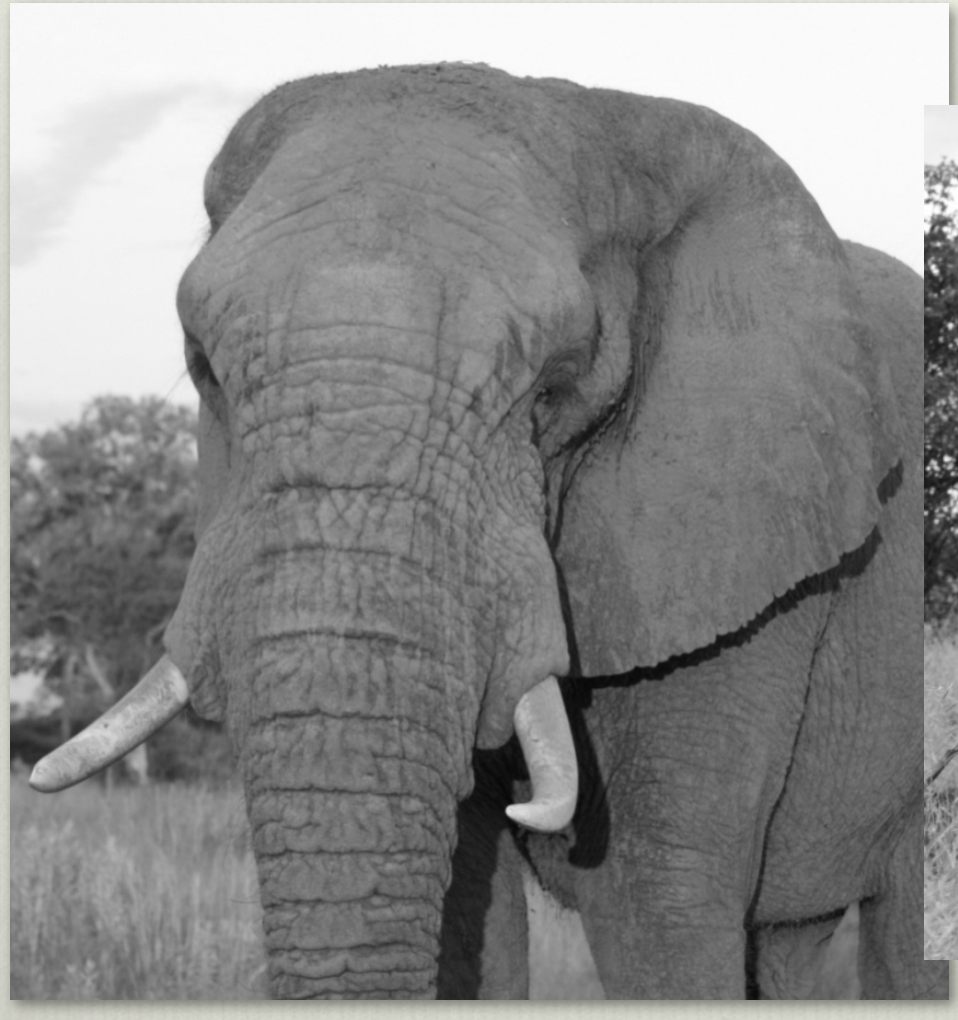
Risk Avoidance

By mapping localized elephant pathways and monitoring fine-scale movement behaviour of an elephant population, rather than individual elephants, by means of detailed ground surveys we were able to record varying behavioural strategies adopted by the elephant population that contributed to risk avoidance, including

- avoiding pathways near human settlements, particularly those close to larger settlements,
- avoiding pathways close to large cultivated areas of land, and
- adopting a safety-in-numbers strategy when moving through large areas of cultivated land close to human settlements.

Elephants in the eastern Panhandle of the Okavango Delta appear, therefore, to adapt their behaviour in response to associated levels of risk connected with humans, which influences their preferred choice of movement pathways.

Turning Science into Management Actions

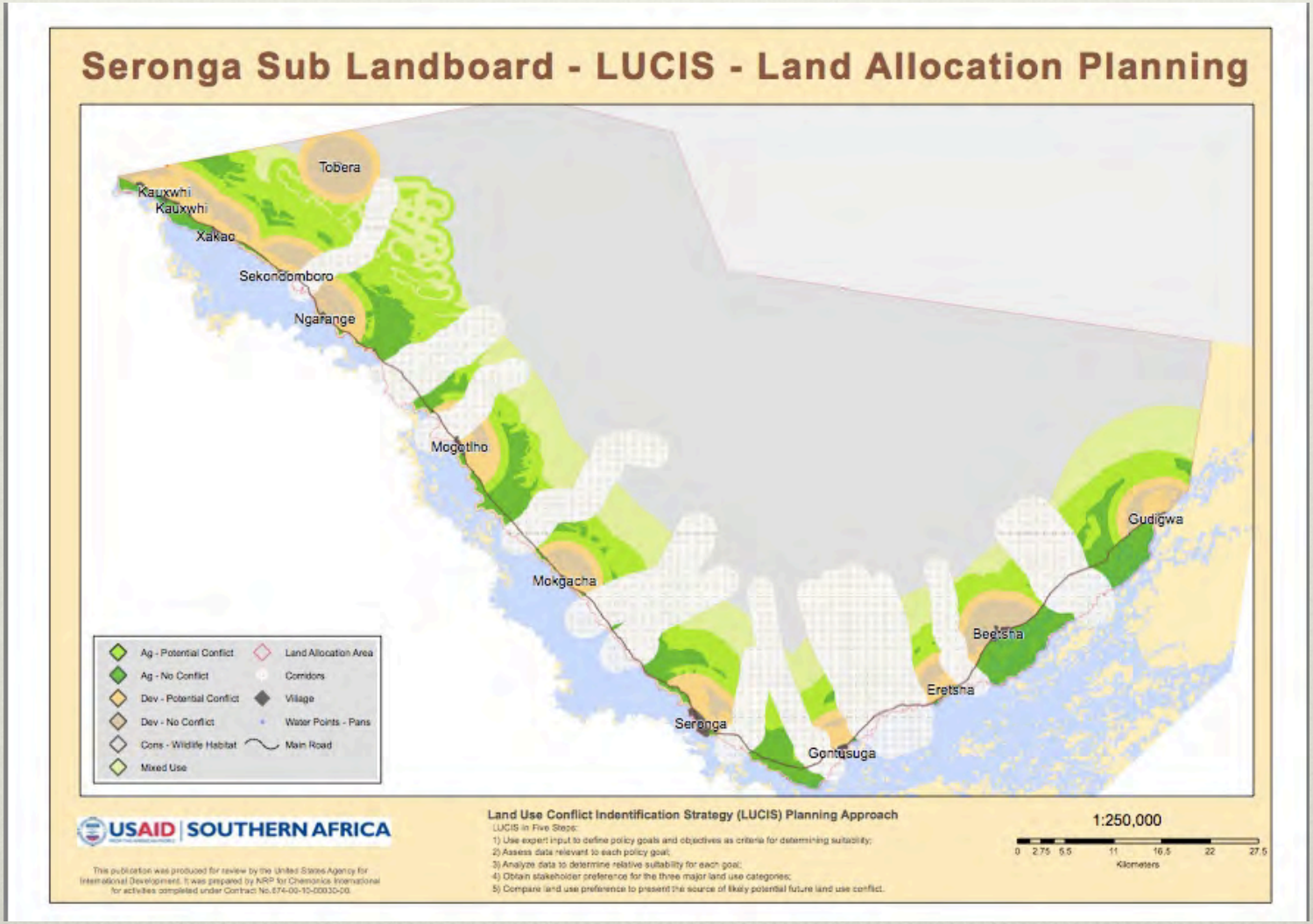




Incorporating Data into Land Use Planning

- Data from elephant crop-raiding monitoring and elephant pathway locations and use were incorporated into the Land Use Conflict Identification Strategy (LUCIS) model
- Collaborative initiative between Tawana Land Board, USAID SAREP and Ecoexist Project

13 Elephant Corridors (Pathway plus buffer)



Critical community participation and validation of corridors



Seronga Sub Landboard - LUCIS - Land Allocation Planning



USAID | SOUTHERN AFRICA

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Land Use Conflict Indentification Strategy (LUCIS) Planning Approach

LUCIS in Five Steps:

1) Use expert input to define policy goals and objectives as criteria for determining suitability;
2) Assess data relevant to each policy goal;
3) Analyze data to determine relative suitability for each goal;
4) Obtain stakeholder preference for the three major land use categories;
5) Compare land use preference to present the source of likely potential future land use conflict.

1:100,000

0 1 2 4 6 8 10

Kilometers

1st Phase Implementation



Discussion between Eretsha Kgosi, Gunotsoga Kgosi, Gunotsoga Land Overseers, Seronga Sub-Land Board and Ecoexist Team over corridor 3 and 4 having same boundaries



Mr Ntwayagae leading discussion with Mogotho Land Overseers about buffer edge overlap with Mogotho village at corridor 11



Anna Songhurst explaining 9km length of elephant corridors at corridor 6

Demarcating the Corridors





2nd Phase Implementation

- Training of Land Board T.Os and Surveyors
- Land Board can allocate future land with minimal land use conflicts
- Other key stakeholders engagement and contribution to alleviating HEC

Ecoexist Focus Activities

- Inform and contribute to land use planning
- Improve farmer resilience
- Facilitate private sector support and involvement
- Improve short-term strategies for HEC management
- Conduct research through satellite collaring telemetry studies and population surveys

Linking local scale movements with regional scale

- These local scale movement corridors are a critical component of the larger regional scale movement corridors
- Protecting important movement corridors at a local level for the purpose of addressing a key driver of human-elephant conflict facilitates the function and success of these larger migratory corridors
- Community acceptance is key for success of local scale movement corridors

Acknowledgements

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Thank you to the co-founders and Directors of Ecoexist:
Dr Graham McCulloch and Dr Amanda Stronza

www.ecoexistproject.org

Socio-economic profile of human wildlife conflict affected farmers and their perception towards human wildlife conflict in Tamil Nadu, India

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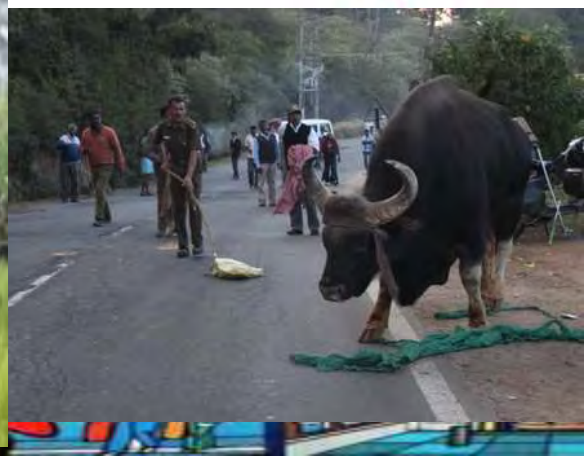
Chennai, Tamil Nadu, India

















- India- 2014- HEC-400 human causalities
- Coimbatore District- ranks 1st in Human mortality- 56 human death (*Ministry for Environment and forests & Climate Change, GOI*)











Various options to reduce HWC

- Traditional techniques
- Scientific techniques
- Establishing deterrence through law enforcement.





OBJECTIVES

- To determine the Socio-economic profile **of human wildlife conflict affected farmers**
- To find out perception about human-wildlife conflicts among the villagers in the study area



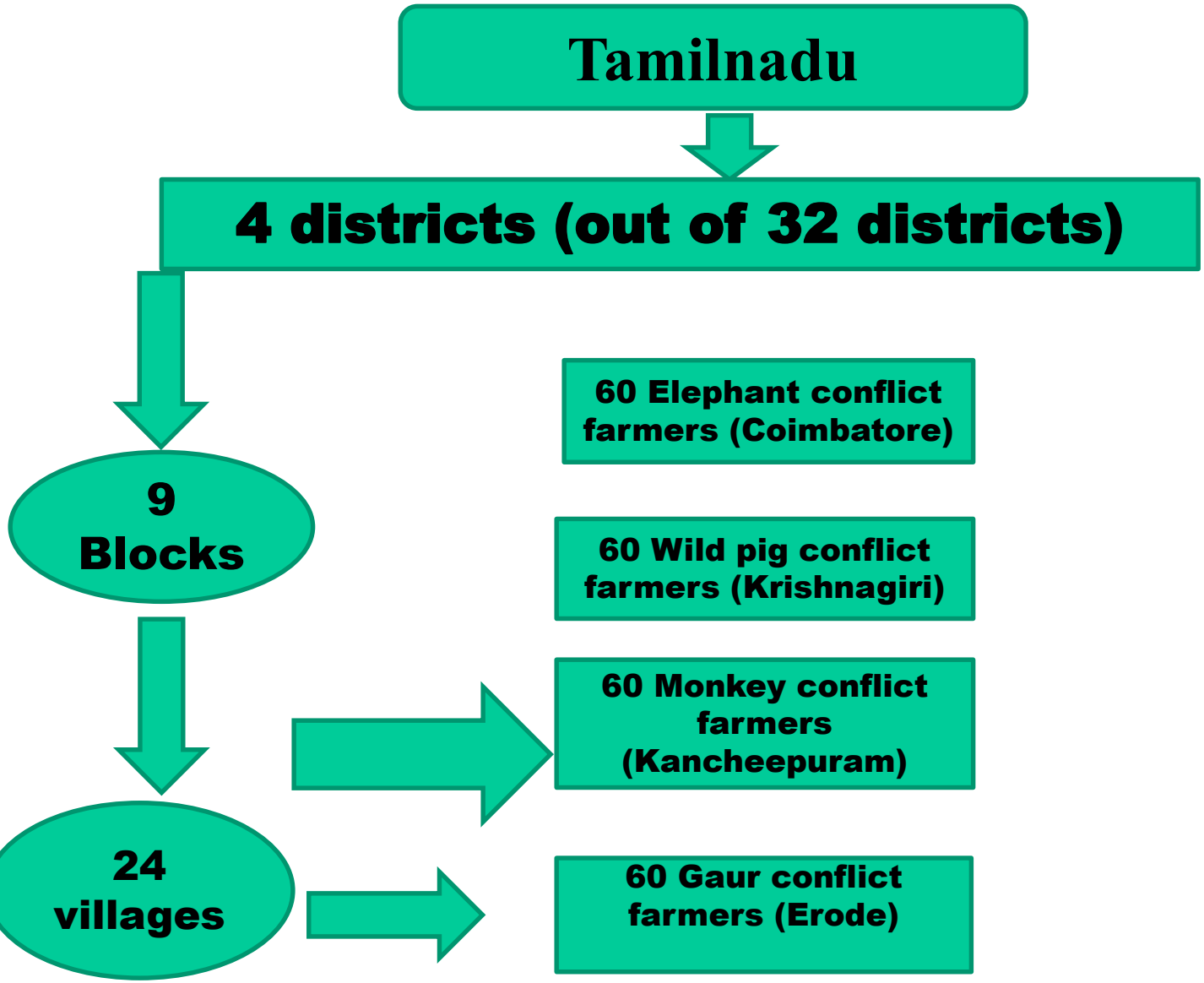


Methodology

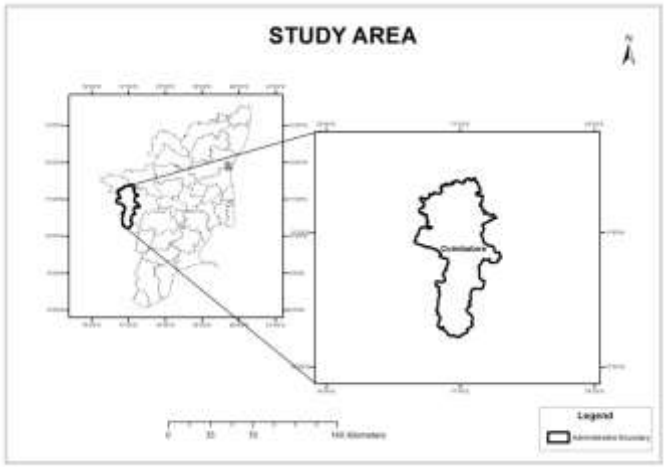
- Selection of farmers
- Secondary data collection
- Primary data from human-conflict affected farmers
- Data collection tool:
  - Interview schedule
  - Observation
- Data analysis
- Results and discussion

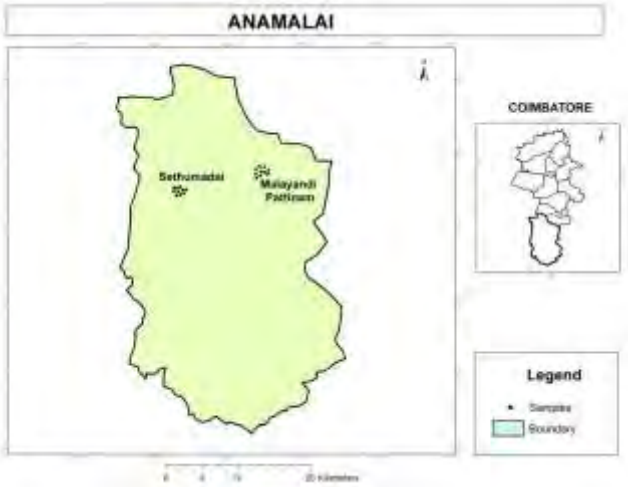


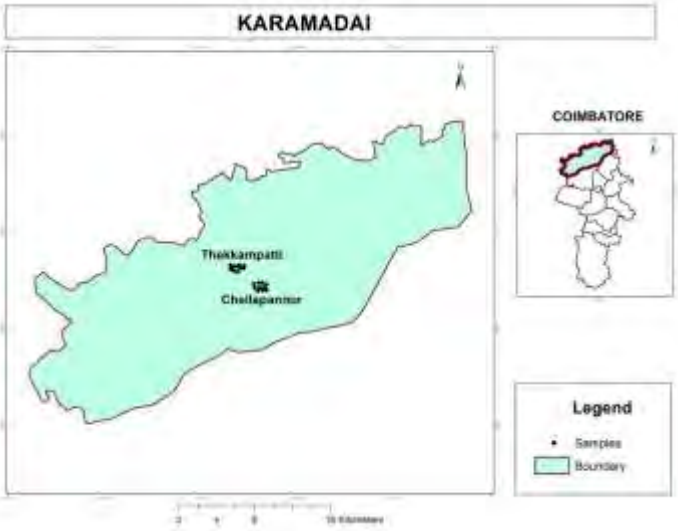
Sampling plan

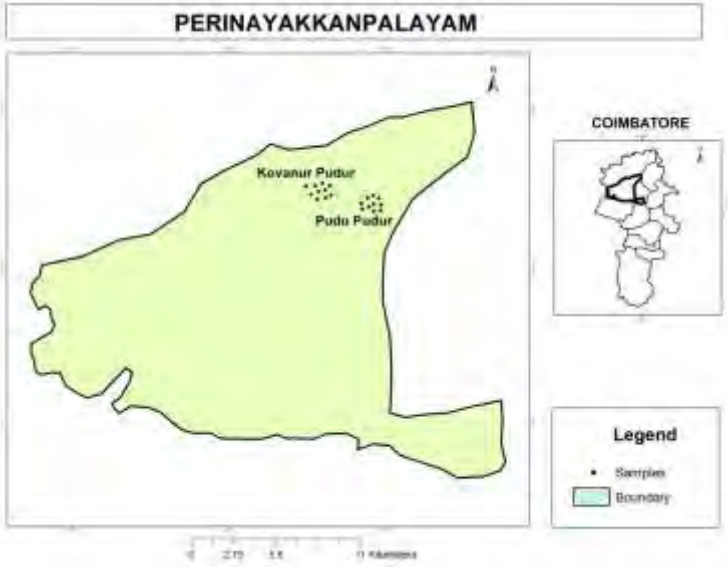


MAP SHOWING THE STUDY AREA – COIMBATORE DISTRICT









MAP SHOWING THE STUDY AREA – KRISHNAGIRI DISTRICT

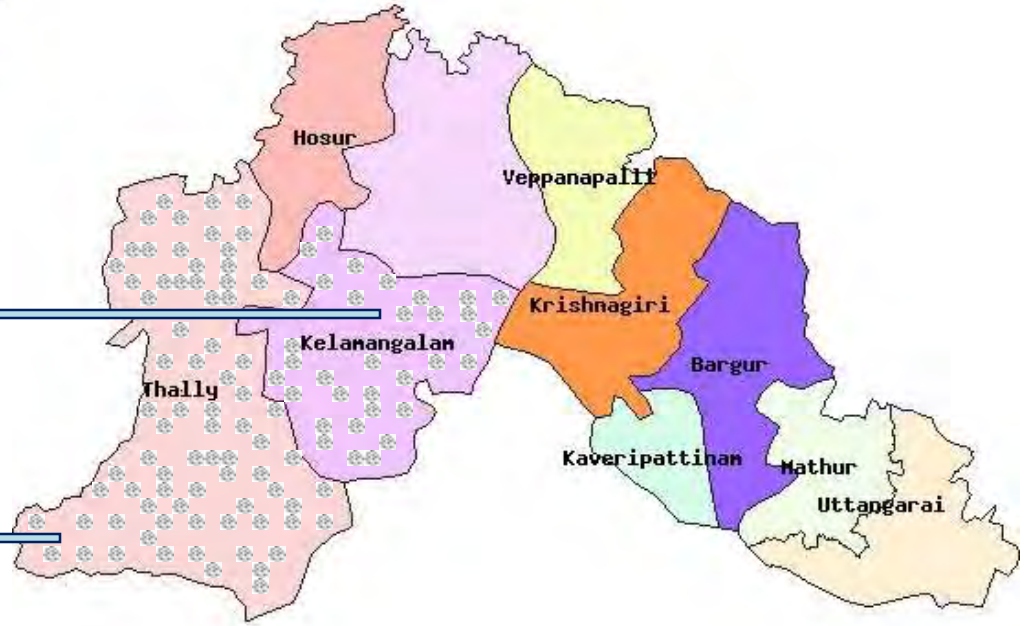
India



Tamil Nadu



Krishnagiri district



Kelamanagalam block

- Denkanikottai - 10
- Marandahalli - 10
- Hosahatti - 10

Thally block

- Chudasandiram - 10
- Manjukondapalli - 10
- Achubalu - 10

MAP SHOWING THE STUDY AREA – ERODE DISTRICT

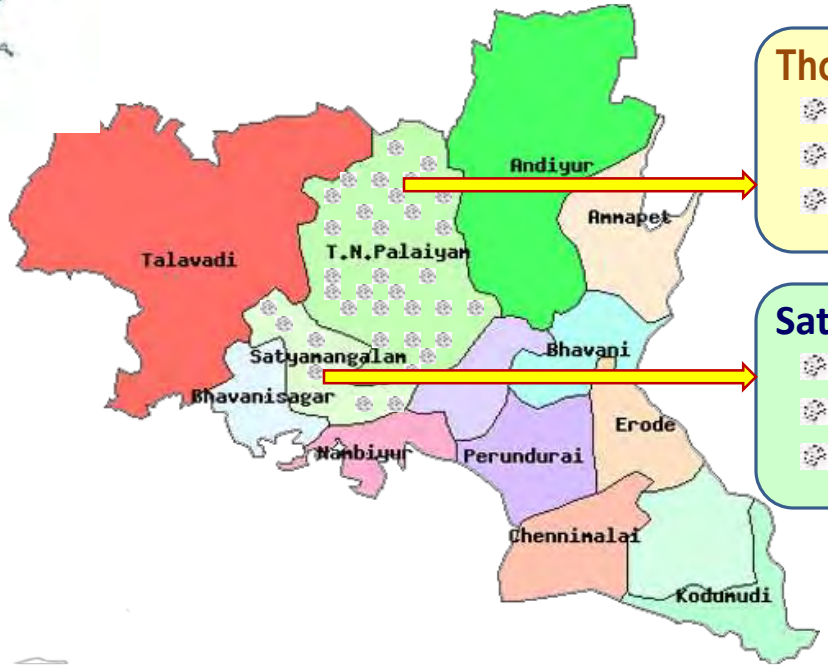
India



Tamil Nadu



Erode district



Thoockanaickenplayam block

- Kongarpalayam - 10
- Kanakkampalayam - 10
- Kondayampalayam - 10

Satyamangalam block

- Ukkaram - 10
- Kethampalayam - 10
- Kadathur - 10

MAP SHOWING THE STUDY AREA – KANCHIPURAM DISTRICT

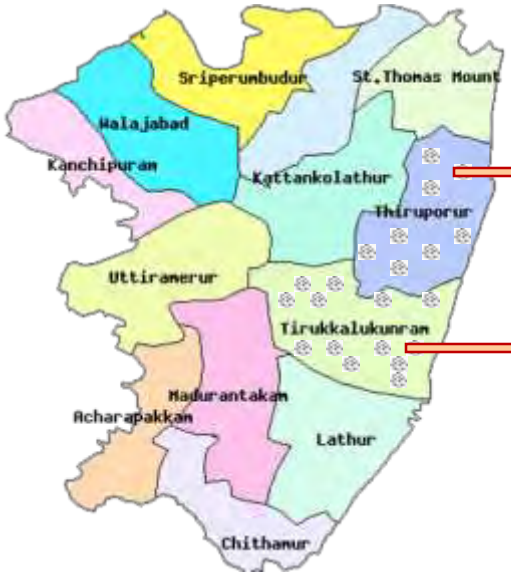
India



Tamil Nadu



Kancheepuram district



Thiruporur block

- Sembakkam - 10
- Mambakkam - 10
- Ponmar-Polacheri - 10

Thirukazhukundram block

- Desimugipettai - 10
- P.V.Kalthur - 10
- Thazhambedu - 10

Interview Schedule

S. No.	Statements		
		Agree	Disagree
I	**Economic Impact**		
1.	HWC results in less damage to crops		
2.	Sudden attack of wild animals on public property like ration shop, temporarily stored harvested sugarcane and paddy bags results in heavy loss.		
II	**Reasons for HWC**		
3.	Even animal feed inadequacy in a forest area lead wild animals remaining in the same area instead of moving to the buffer zones of forest		
III	**Efforts of the villagers after HWC**		
4.	Pressurizing the forest officials to know HWC in their area, but not informing about HWC.		
5.	Self-effort for protection against HWC		
IV	**Eco-centrism**		
6.	One cannot enjoy spending time in natural settings for the sake of being out in nature.		
7.	I need time in nature to be happy		
V	**Anthropocentrism**		
8.	Nature is important as it contributes for pleasure and human welfare		
9.	Main reason to conserve is to maintain high standard of living		
VI	**Environmental apathy**		
10.	It is too much for anybody to get concerned about environmental issues		

Statistical tools used

- **Percentage analysis**
- **Kruscal-Wallis test**
- **Zero order correlation**

Scope of this study

- Useful in planning suitable mitigation strategy for preventing Human-wildlife conflict.
- Help the policy makers to know the extent, underlying causes, perceptions of different stakeholders and possible solutions for the human-wildlife conflict.

Results and Discussion



Profile of the farmers



Figure 4.1 Distribution of farmers according to age

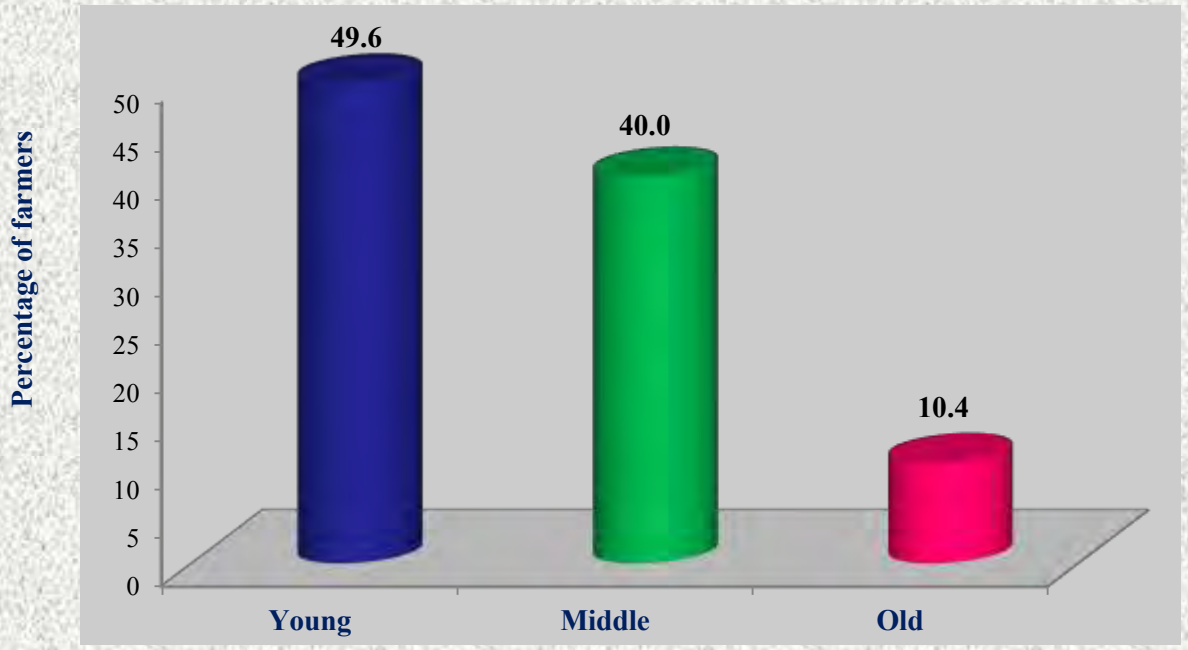


Figure 4.2 Distribution of farmers according to gender

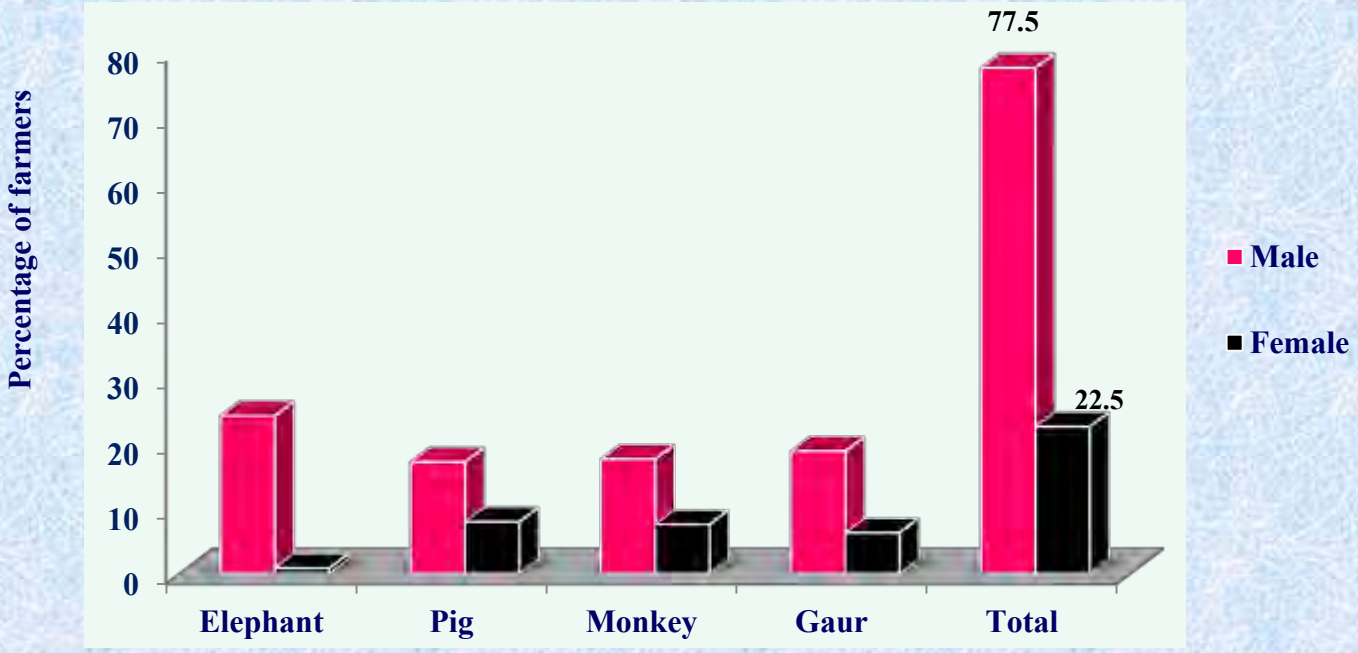


Figure 4.3 Distribution of farmers according to religion

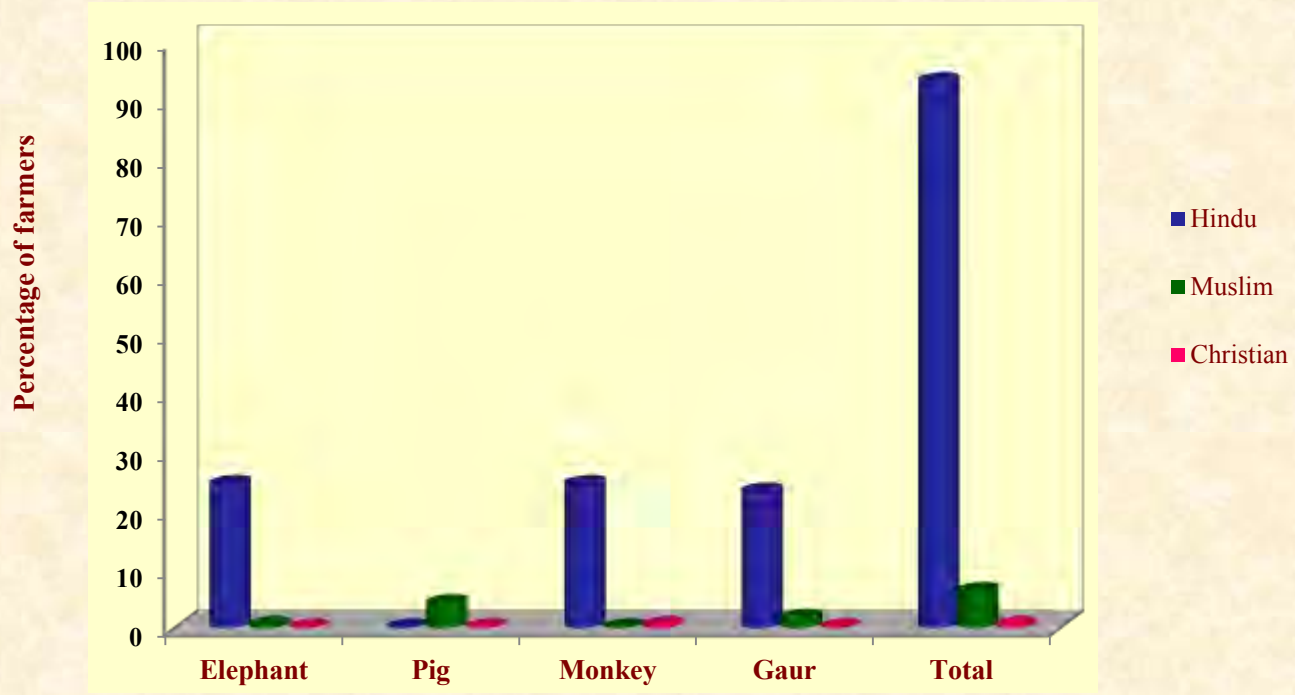


Figure 4.4 Distribution of farmers according to marital status

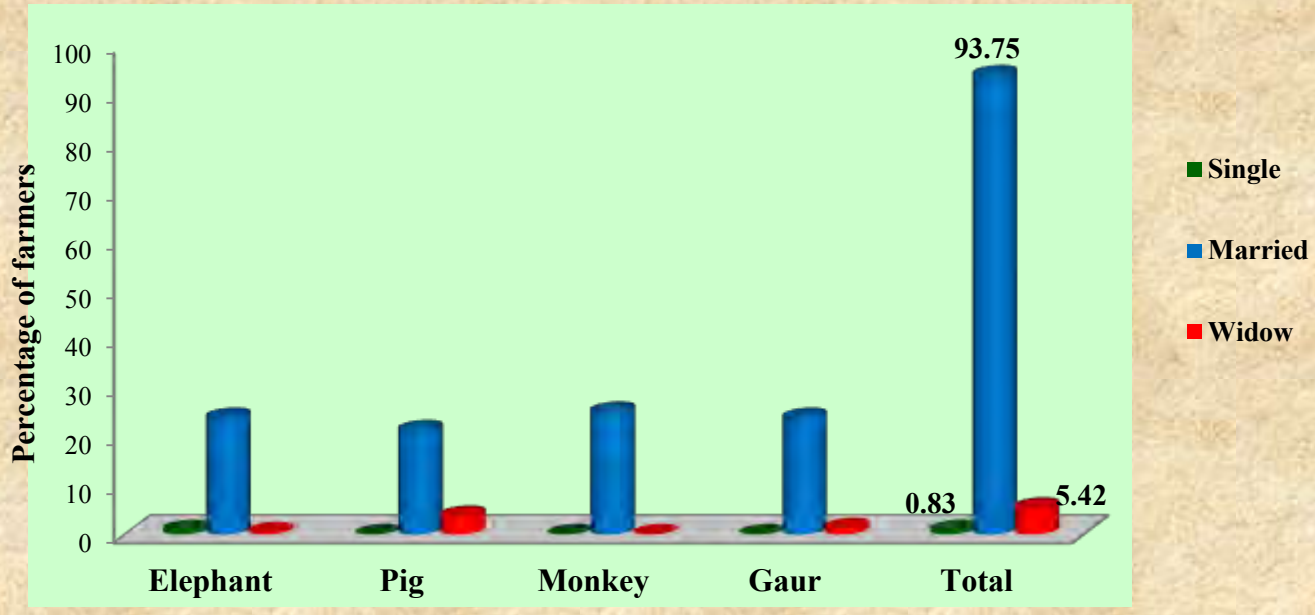


Figure 4.5 Distribution of farmers according to eduction

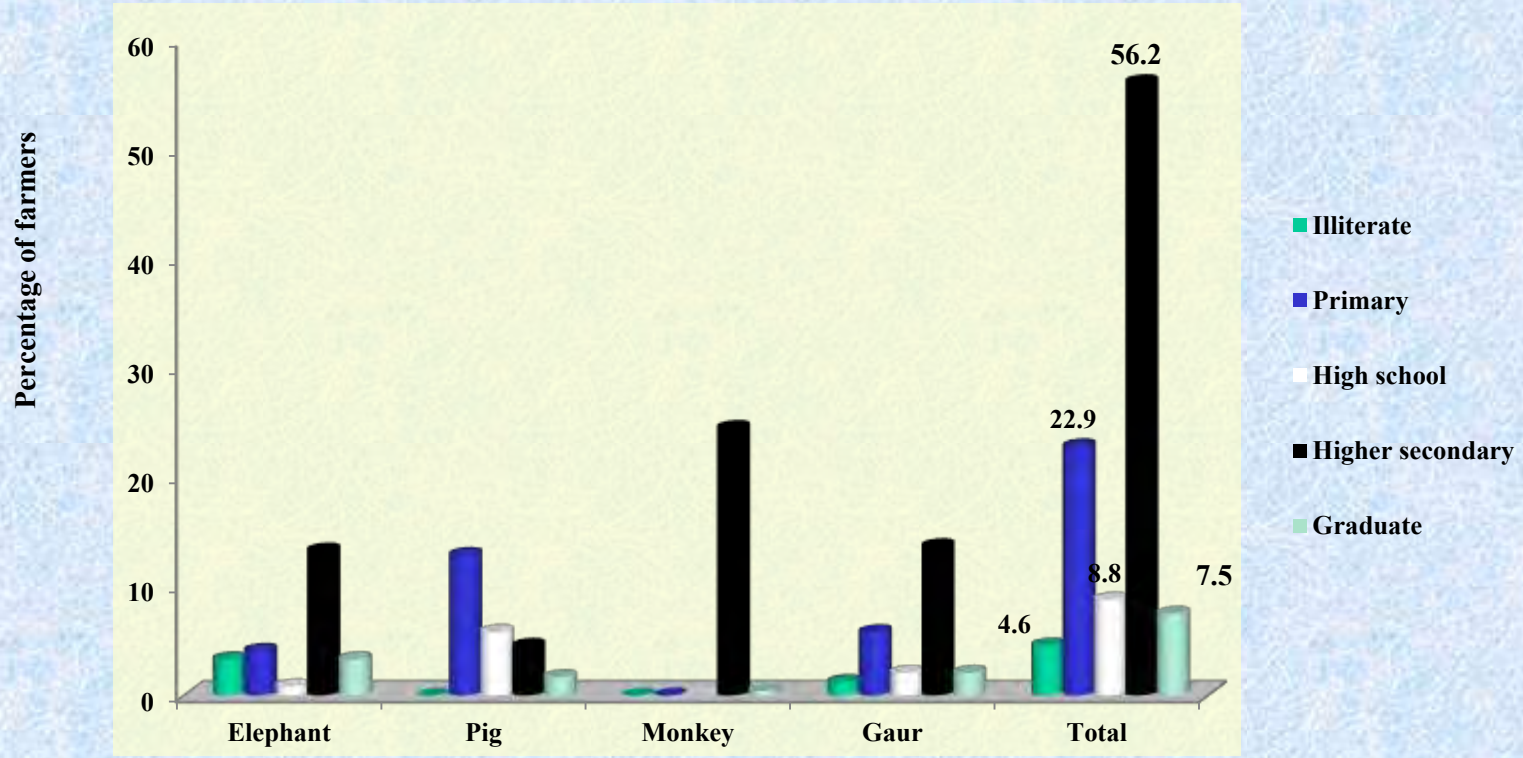


Figure 4.6 Distribution of farmers according to family type

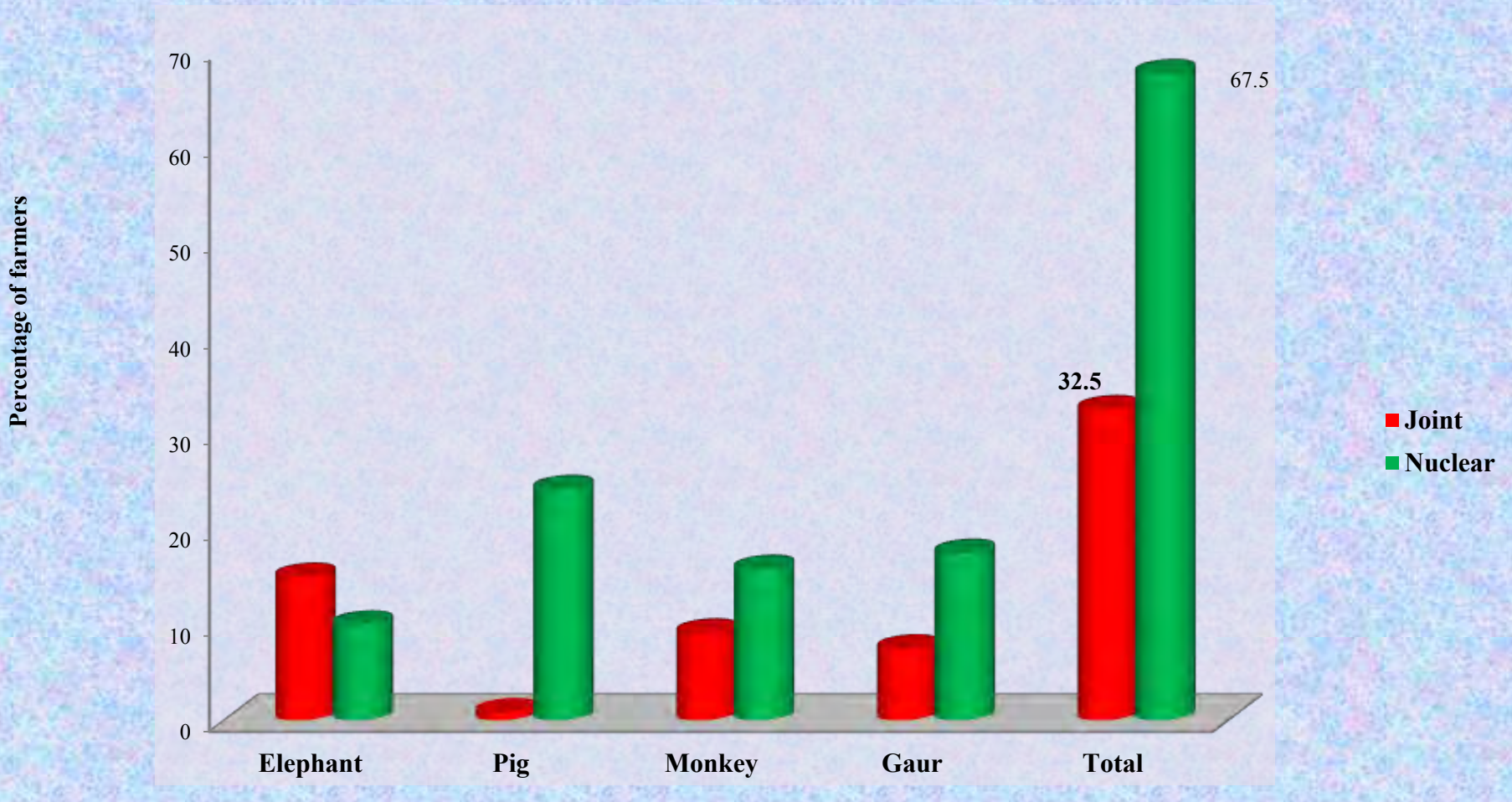


Figure 4.7 Distribution of farmers according to their occupation

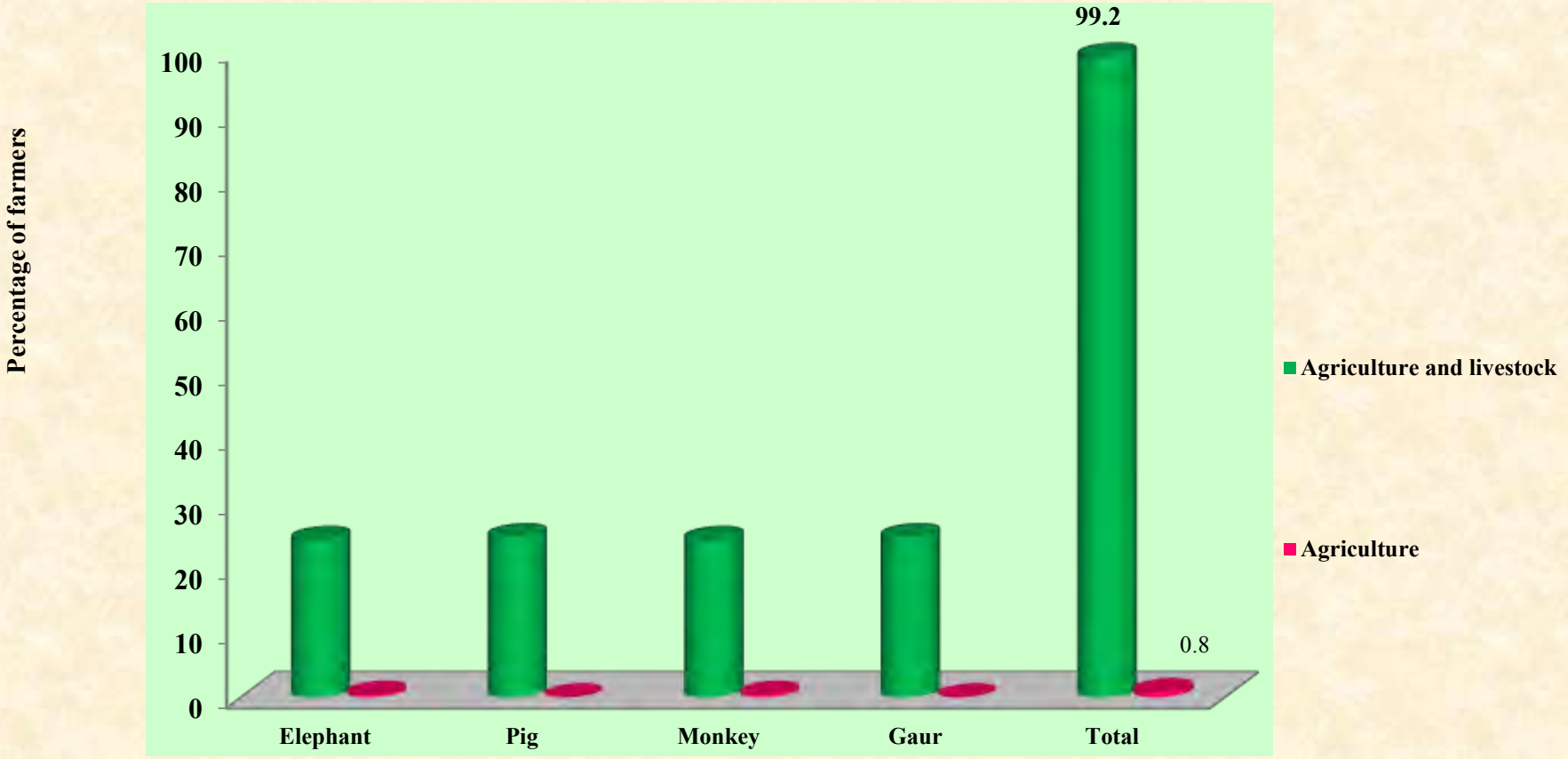


Figure 4.8 Distribution of famers according to annual income

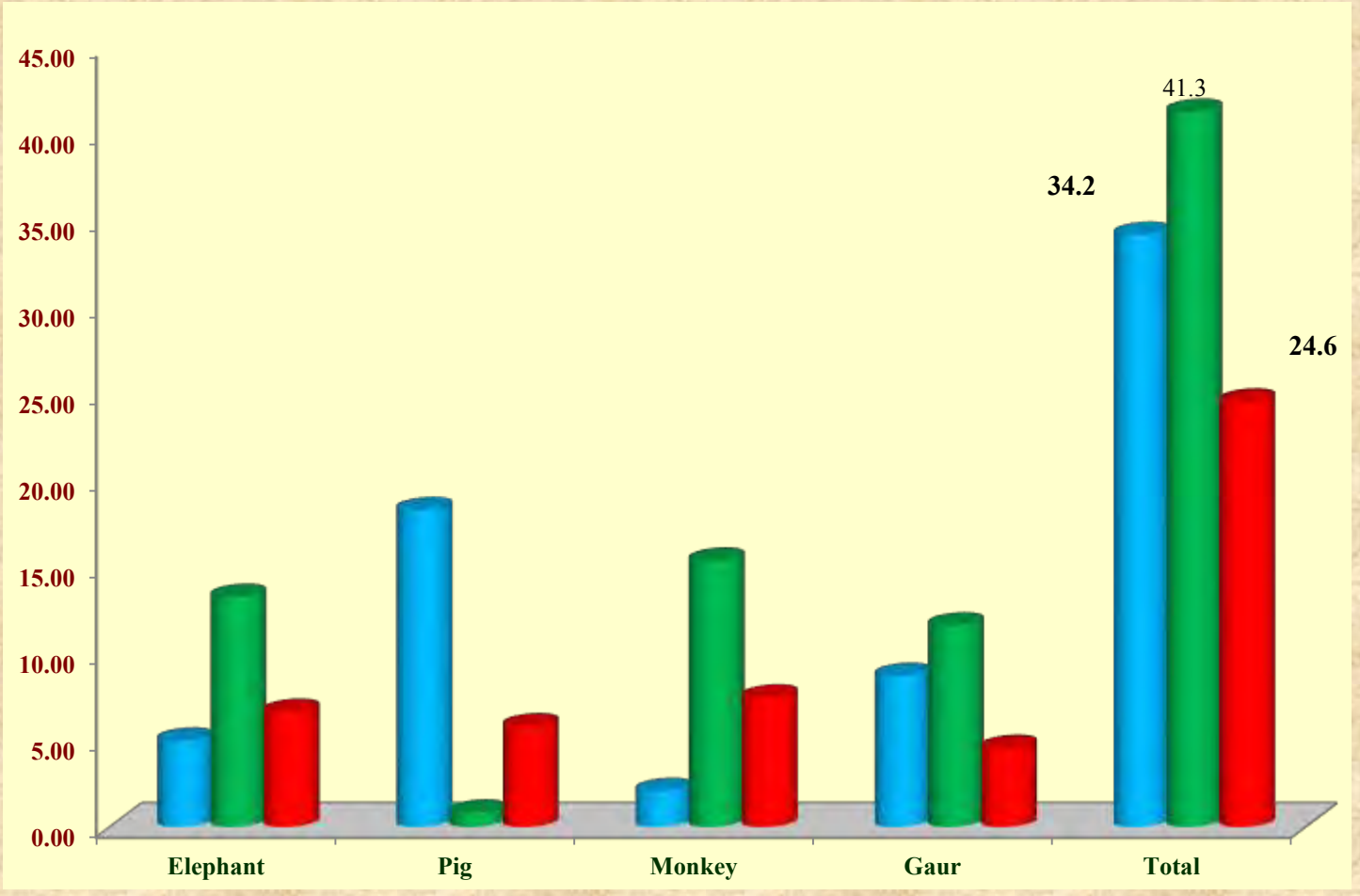


Figure 4.9 Distribution of farmers according to proximity to forest

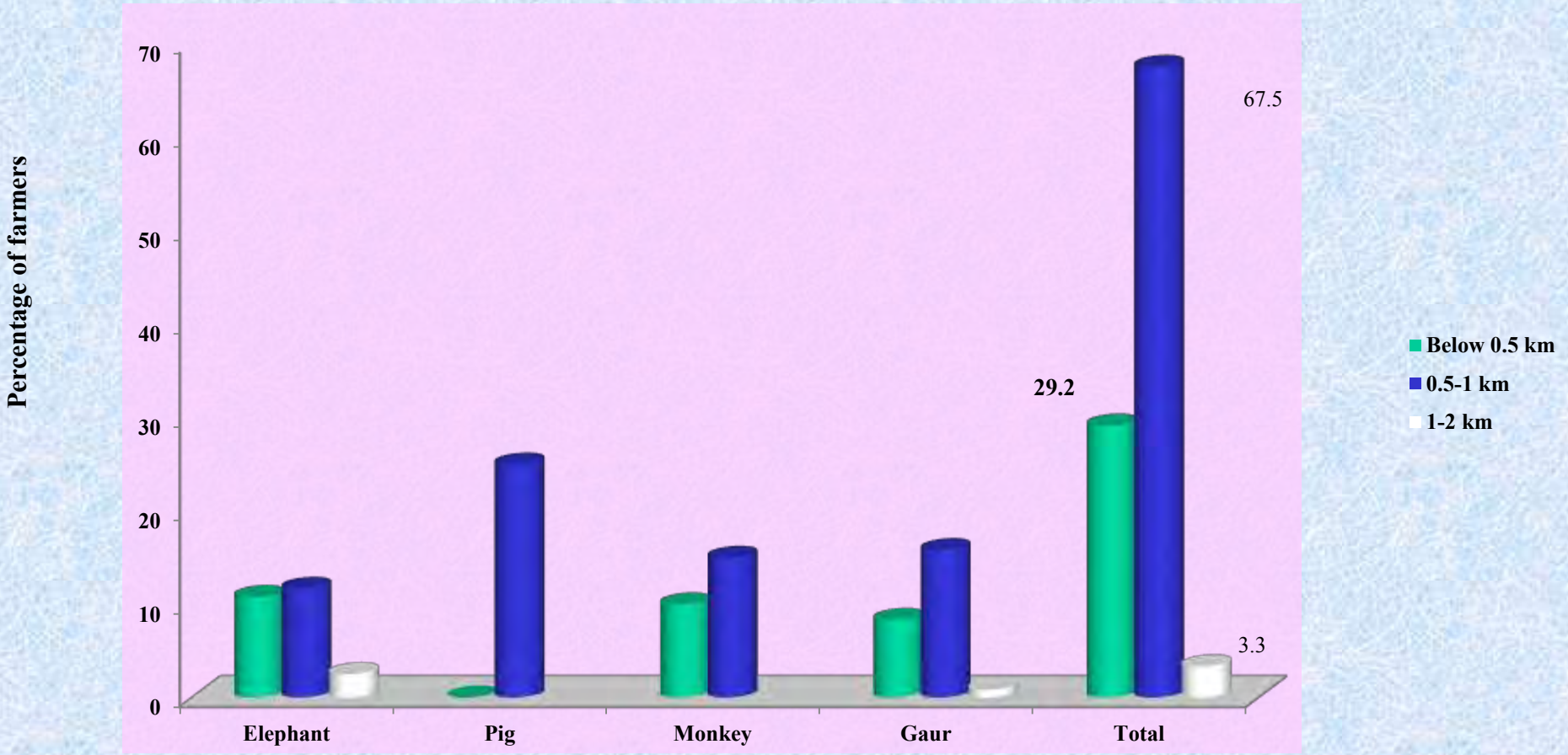


Figure 4.10 Distribution of farmers according to land holding

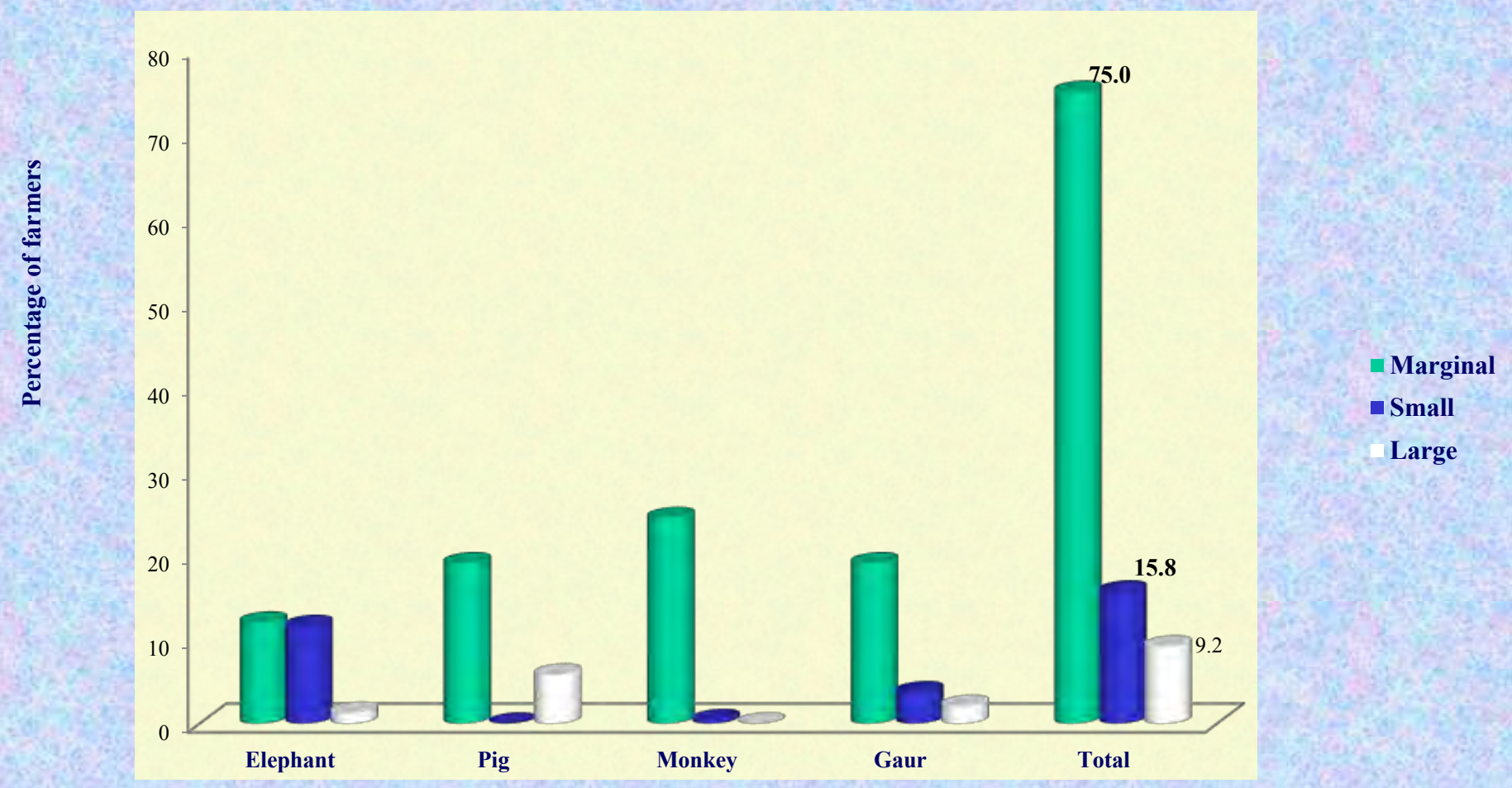


Figure 4.11 Distribution of farmers according to livestock possession

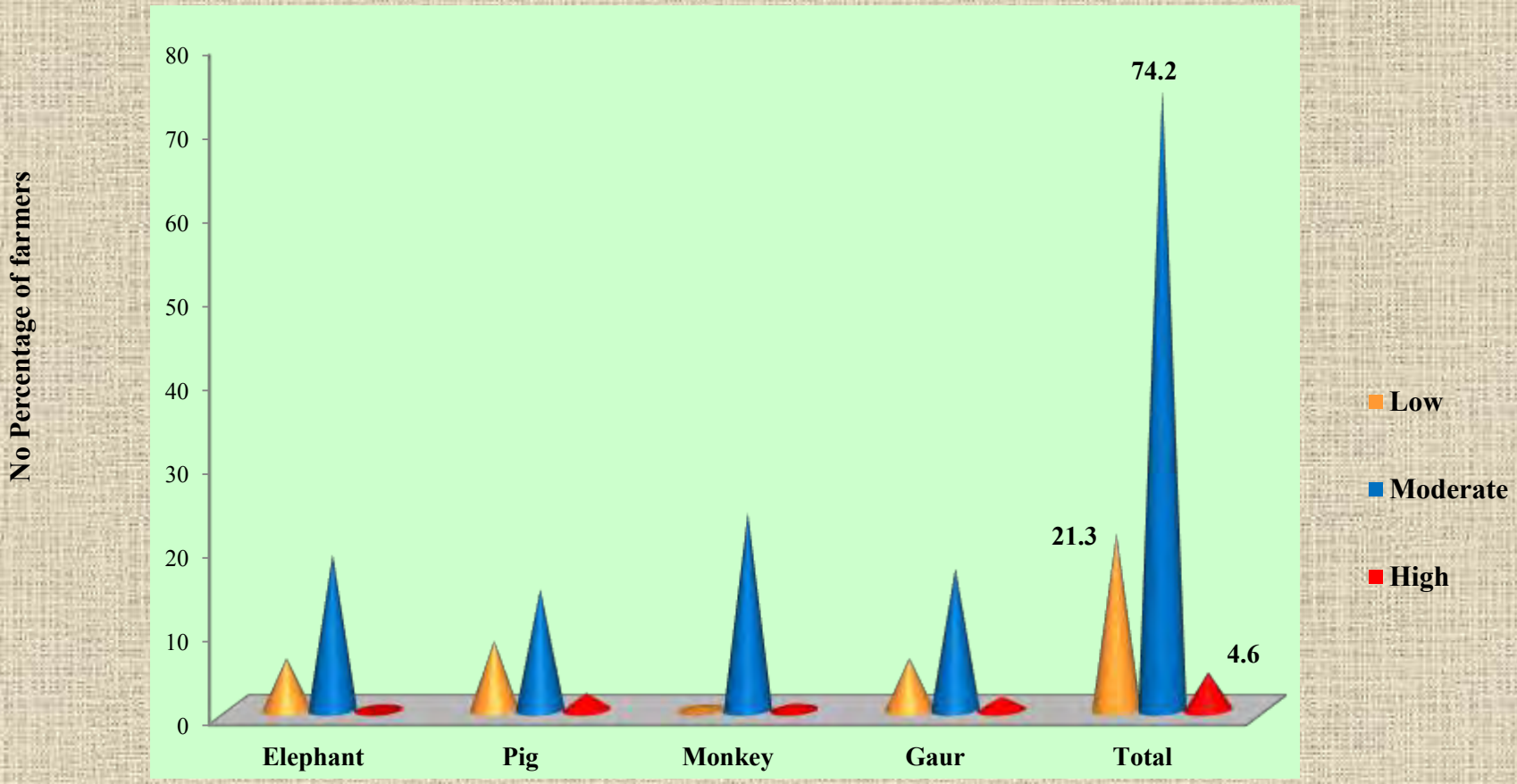


Figure 4.12 Distribution of farmers according to ICT tools possession

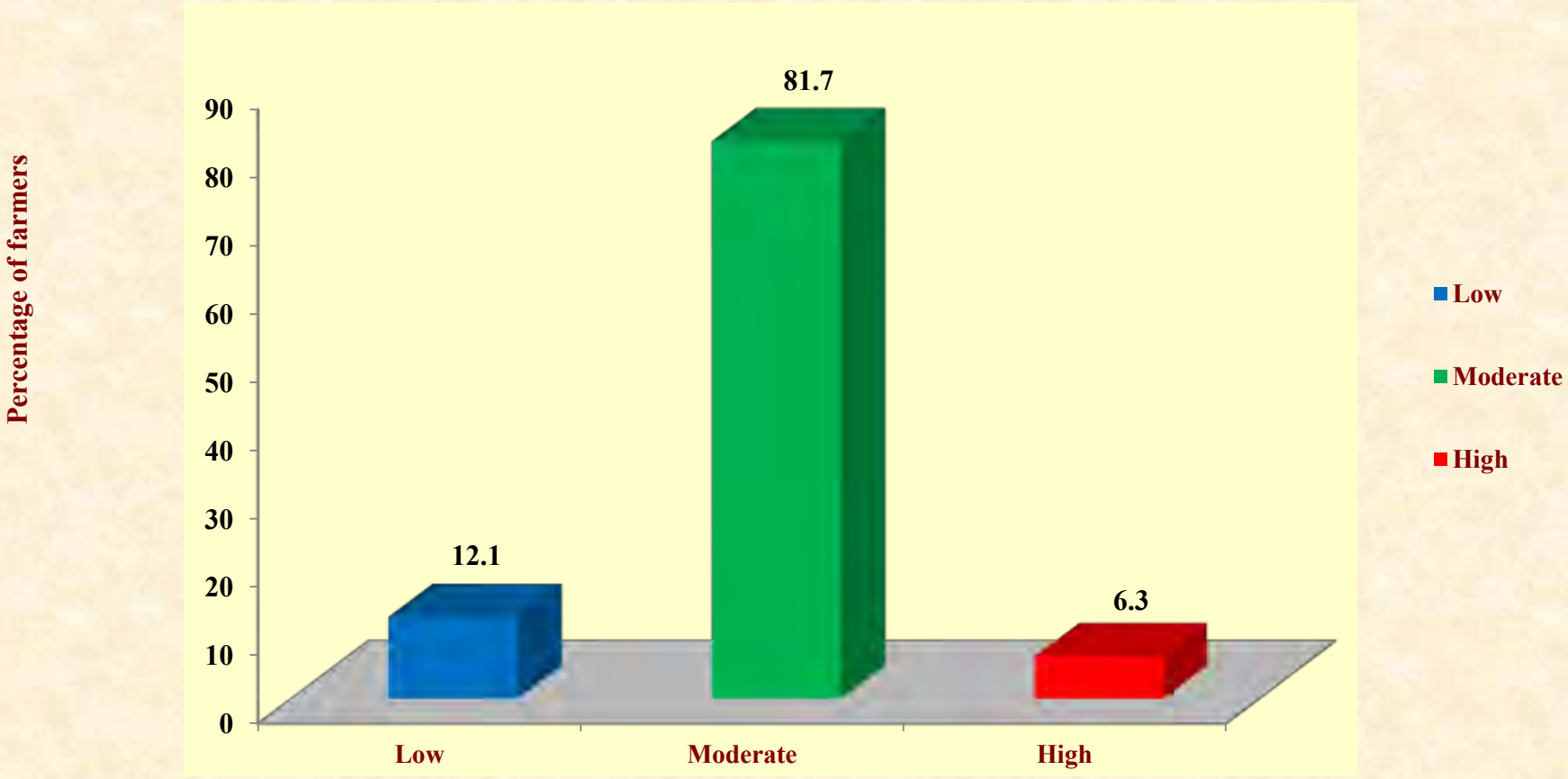


Figure 4.13 Distribution of farmers according to farming experience

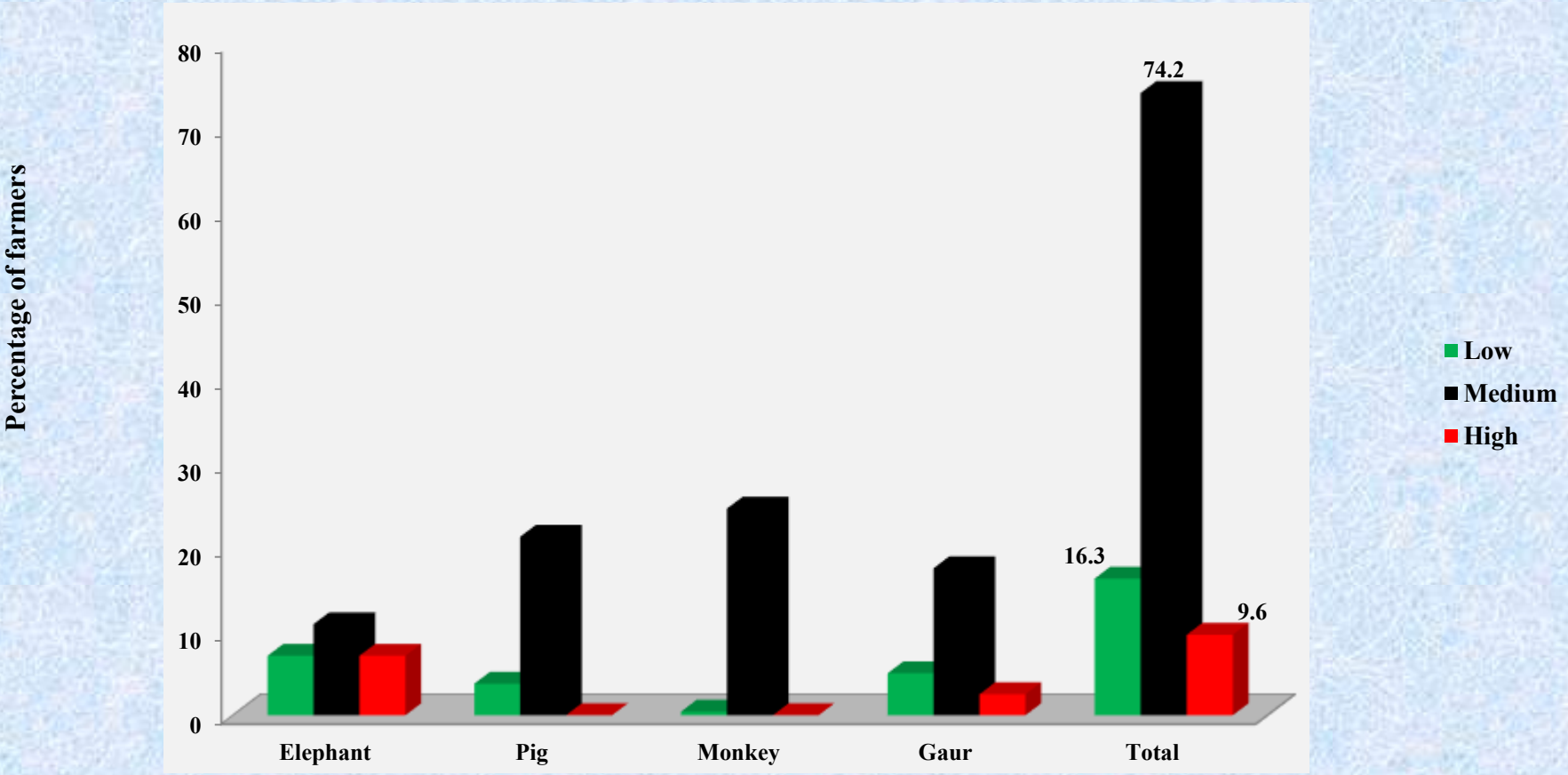


Figure 4.14 Distribution of farmers according to types of cultivating crops

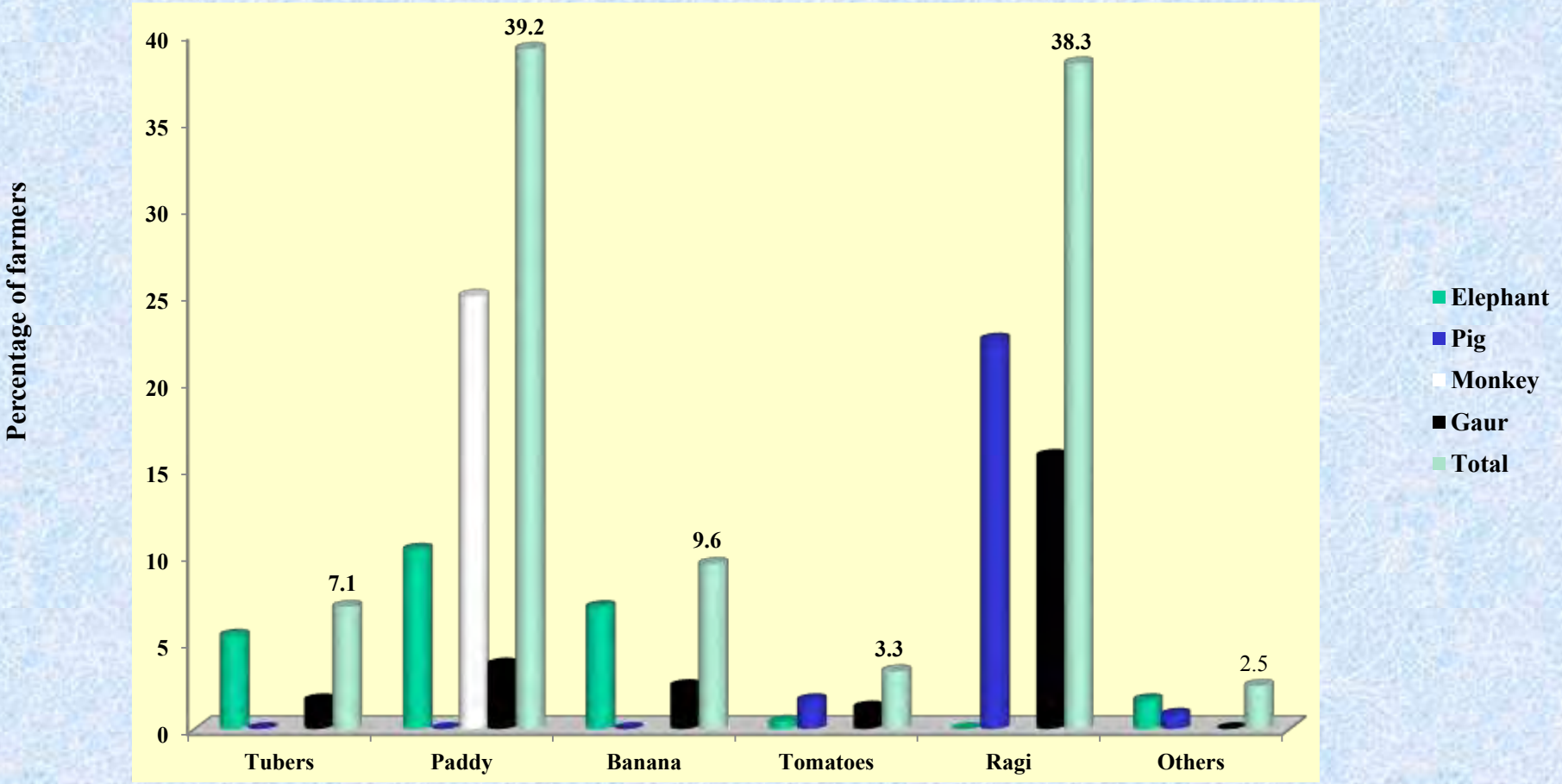


Figure 4.15 Distribution of farmers according to number of HWC exposures

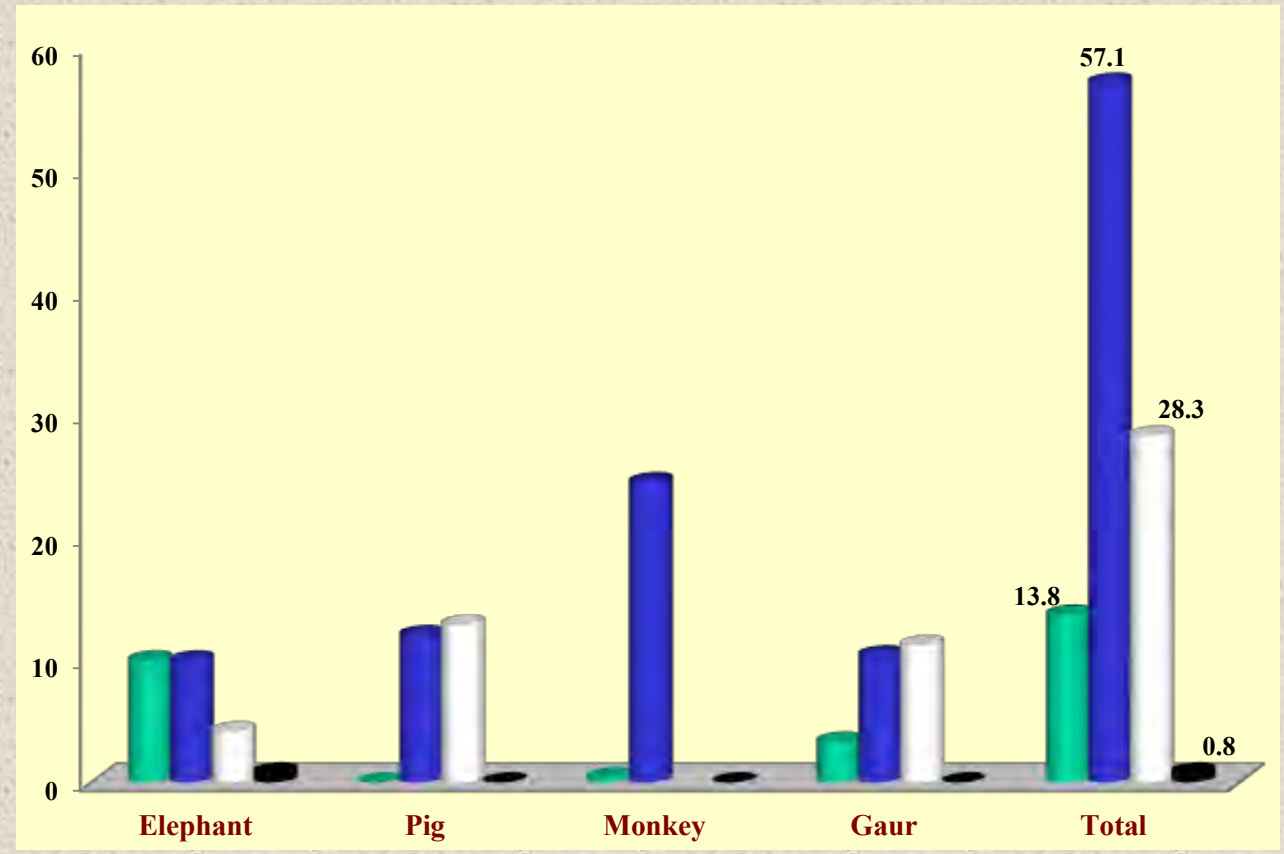


Figure 4.16 Distribution of farmers according to number of training underwent

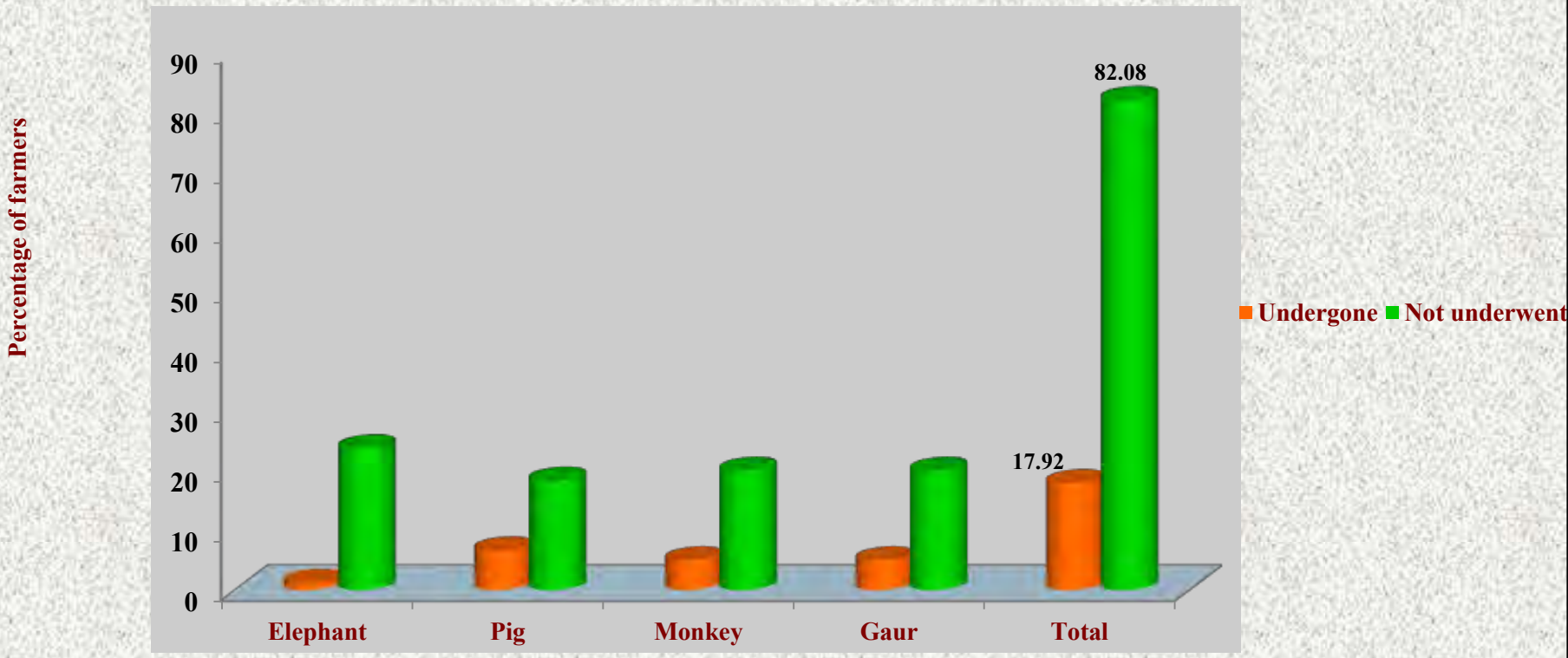


Figure 4.17 Distribution of farmers according to farmers courage

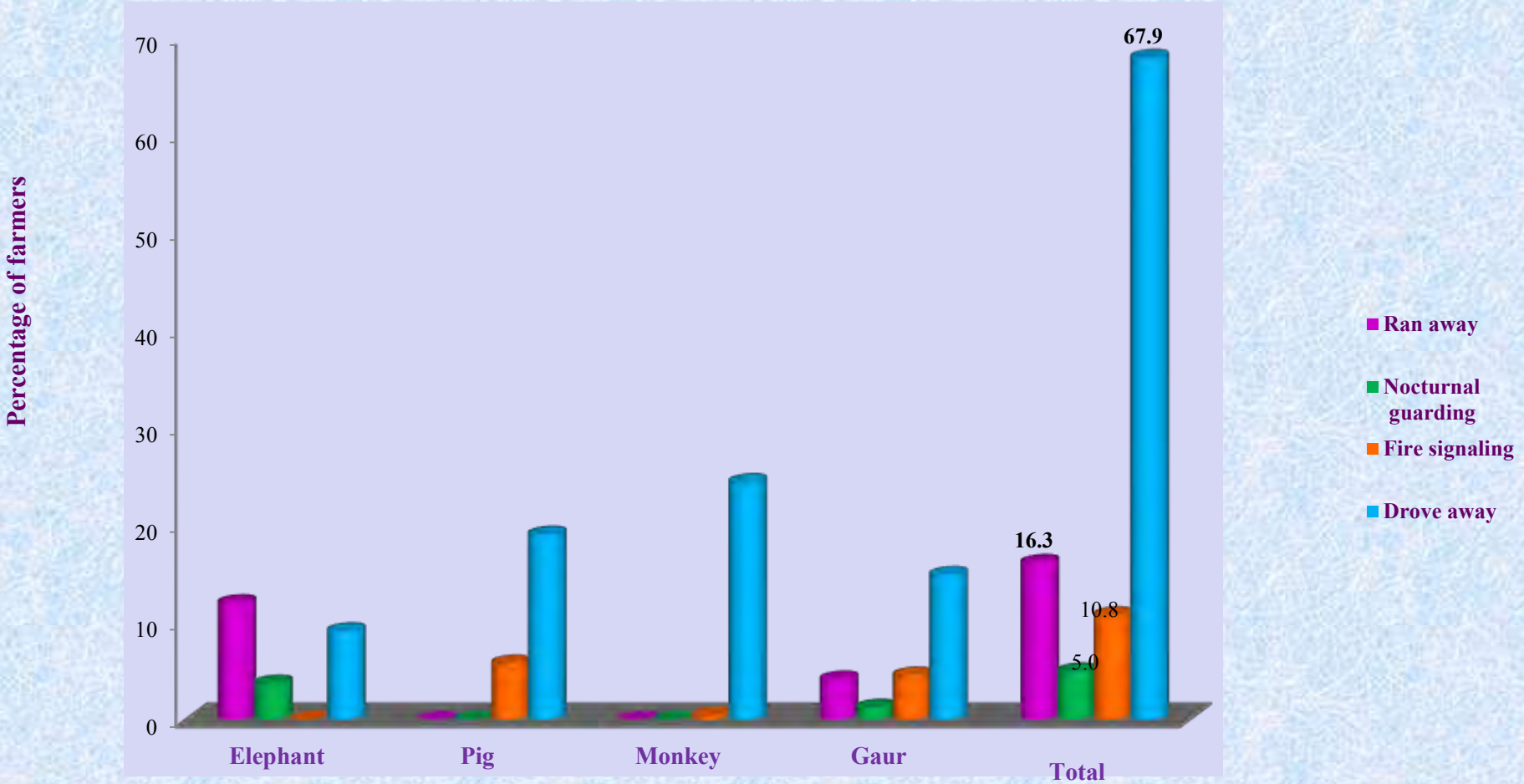
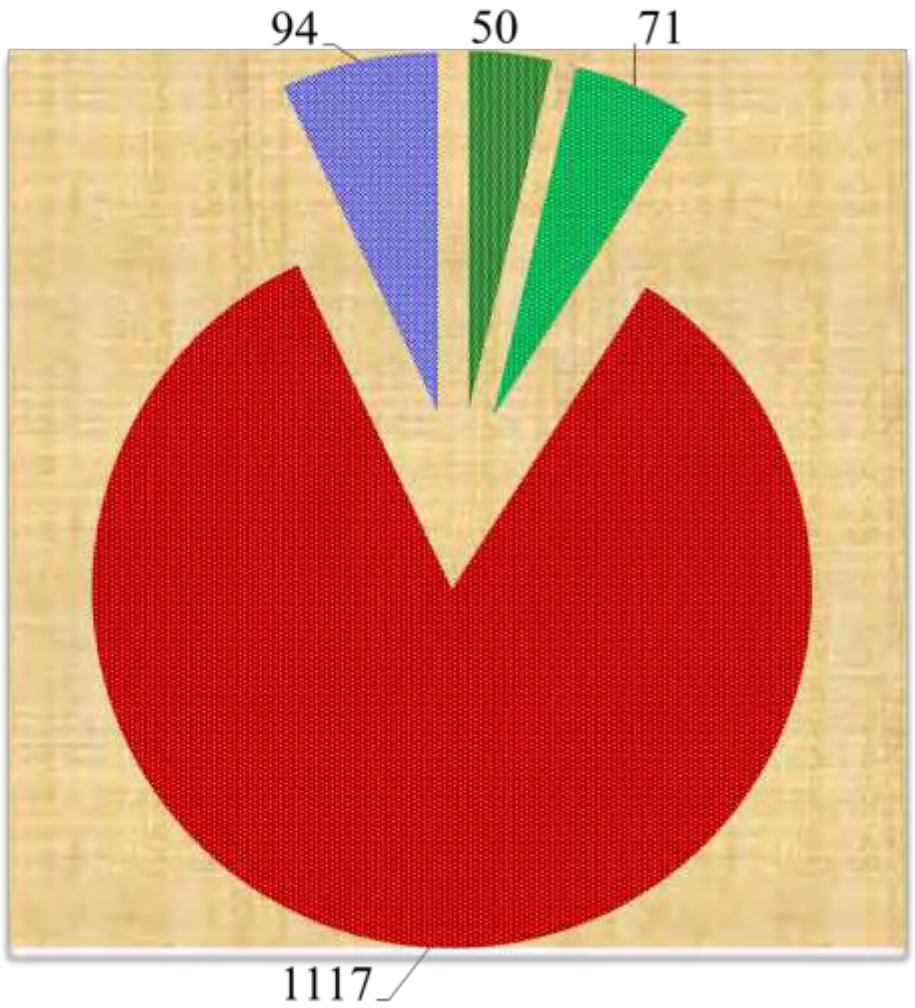


Figure 4.18 Distribution of farmers according to information seeking behaviour



Types of Human-wildlife conflict in Tamilnadu (2013-14)

No. of cases









Perception of HWC by the farmers

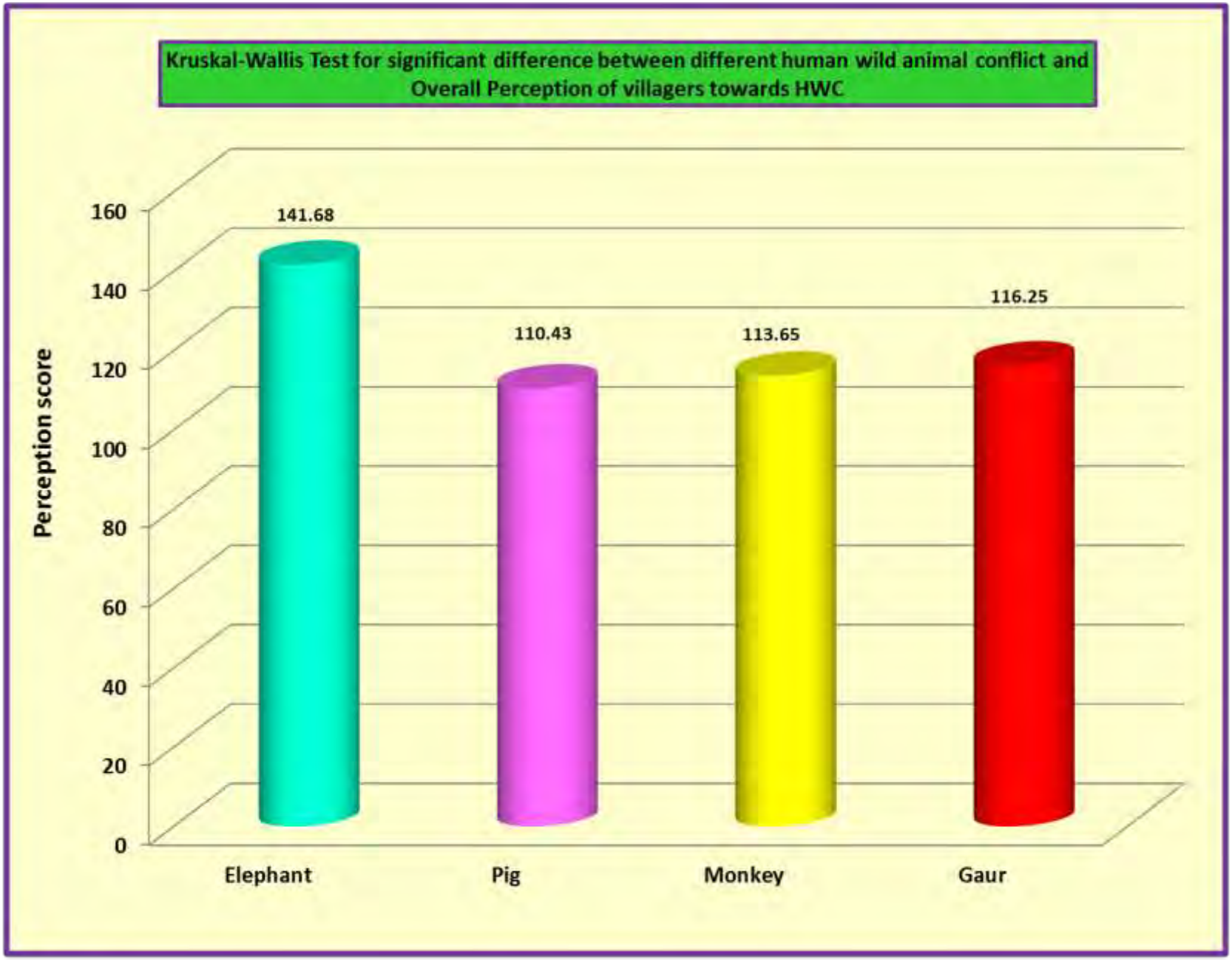






Perception of villagers on Human-Wildlife Conflict (HWC)

S. No.	Statements	Favourable response from farmers on				Total response on HWC (n=240)	
		HEC (n=60)	HPC (n=60)	HMC (n=60)	HGC (n=60)	Fav. response	Unfavourable response
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
I	**Economic Impact**						
1.	HWC results in less damage to crops	33 (17.6%)	49 (26.1%)	60 (31.9%)	46 (24.5%)	**188** 78. 3%[a]	52 21.7%[a]
2.	Sudden attack of wild animals on public property like ration shop, temporarily stored harvested sugarcane and paddy bags results in heavy loss.	60 (26.3%)	60 (26.3%)	48 (21.1%)	60 (26.3%)	**228** 95.0%[a]	12 5.0%[a]
II	**Reasons for HWC**						
3.	Even animal feed inadequacy in a forest area lead wild animals remaining in the same area instead of moving to the buffer zones of forest	36 (22.8%)	39 (24.7%)	47 (29.7%)	36 (22.8%)	158 65.8%[a]	82 34.2%[a]
III	**Efforts of the villagers after HWC**						
4.	Pressurizing the forest officials to know HWC in their area, but not informing about HWC.	32 (23.4%)	48 (35.0%)	13 (9.5%)	44 (32.1%)	137 57.1%[a]	103 42.9%[a]
5.	Self-effort for protection against HWC	54 (25.0%)	51 (23.6%)	60 (27.8%)	51 (23.6%)	**216 90.0%[a]**	24 10.0%[a]
IV	**Eco-centrism**						
6.	One cannot enjoy spending time in natural settings for the sake of being out in nature.	54 (34.8%)	35 (22.6%)	27 (17.4%)	39 (25.2%)	155 64.6%[a]	85 35.4%[a]
7.	I need time in nature to be happy	32 (19.2%)	39 (23.4%)	60 (35.9%)	36 (21.6%)	167 69.6%[a]	73 30.4%[a]
V	**Anthropocentrism**						
8.	Nature is important as it contributes for pleasure and human welfare	60 (30.8%)	35 (17.9%)	58 (29.7%)	42 (21.5%)	195 81.3%[a]	45 18.7%[a]
9.	Main reason to conserve is to maintain high standard of living	51 (31.3%)	44 (27.0%)	23 (14.1%)	45 (27.6%)	163 67.9%[a]	77 32.1%[a]
VI	**Environmental apathy**						
10.	It is too much for anybody to get concerned about environmental issues	35 (26.7%)	30 (22.9%)	35 (26.7%)	31 (23.7%)	131 54.6%[a]	109 45.4%[a]


Kruskal-Wallis Test for significant difference between different human wild animal conflict and Overall Perception of villagers towards HWC
Perception score
160
140
120
100
80
60
40
20
0
141.68
110.43
113.65
116.25
Elephant
Pig
Monkey
Gaur

Multiple regression analysis between the characteristics of the farmers and their perception on HWC

S. No.	Variables	Partial regression Coefficient (b)	Standard error of b	't' value
	Constant	2.437	1.413	1.724
1	X_1 Age	-0.197	0.124	-1.580 NS
2	X_2 Gender	0.126	0.196	.641 NS
3	X_3 Marital status	-1.254	0.386	-3.247*
4	X_4 Educational qualification	0.157	0.065	2.410 NS
5	X_5 Type of family	0.080	0.161	.495 NS
6	X_6 Occupation	-1.025	0.300	-3.413*
7	X_7 Annual income	-8.608	0.000	-2.600
8	X_8 Proximity to forest	0.381	0.132	2.880*
9	X_9 Land holding	-0.008	0.040	-.192 NS
10	X_{10} Total livestock possession	-0.129	0.028	-4.634**
11	X_{11} ICT tools possession	0.408	0.110	3.703**
12	X_{12} Farming experience	0.017	0.011	1.491 NS
13	X_{13} Type of cultivating crop	0.032	0.018	1.750 NS
14	X_{14} Number of exposures to mitigate HWC	-0.380	0.134	-2.833*
15	X_{15} Undergone training	0.692	0.202	3.428**
16	X_{16} Farmer's courage	0.246	0.081	3.046*
17	X_{17} Overall information seeking behavior on HWC	0.221	0.048	4.636**
18	X_{18} Overall tolerance level towards Wildlife intrusion	-0.063	0.029	-2.147 NS
19	X_{19} Overall knowledge on HWC	0.076	0.023	3.242*

R^2 = **0.612** NS - *not significant*

F value = **16.379**** * - *significant. at 5% level*

** - *significant at 1% level*

Conclusions

✓The favourable response expressed by the respondents for the statements on **economic impact caused by HWC was comparatively more** than the other statements.

✓one kilometer decrease in proximity to forest, an additional unit of ICT tool possession, an additional training undergone and an unit score increase in farmers' courage, information seeking behaviour and overall knowledge on HWC would increase the perception level of the respondents to 0.381, 0.408, 0.692, 0.246, 0.221 and 0.076 units, respectively, while others are kept at constant level.

✓In order to cultivate positive attitude towards wildlife conservation, the people in forest buffer zones should be fully involved in co-management decisions in the protection of the valuable resources of forests including wildlife.



Acknowledgements

✓Department of Forests, Tamil Nadu State, India – for research permits and support.

✓Dr.N.S.Manoharan, FVO, Coimbatore Division, Tamil Nadu, Indi – for kind support

✓The Dean, Madras Veterinary College, TANUVAS, Chennai

✓The Farmers of Coimbatore, Krishnagiri, Erode and Kancheepuram District

Conservation is humanity caring for the future



Thank you

Hunger Games : Understanding Human–Elephant Relationships in a Landscape Matrix of the Western Ghats, India

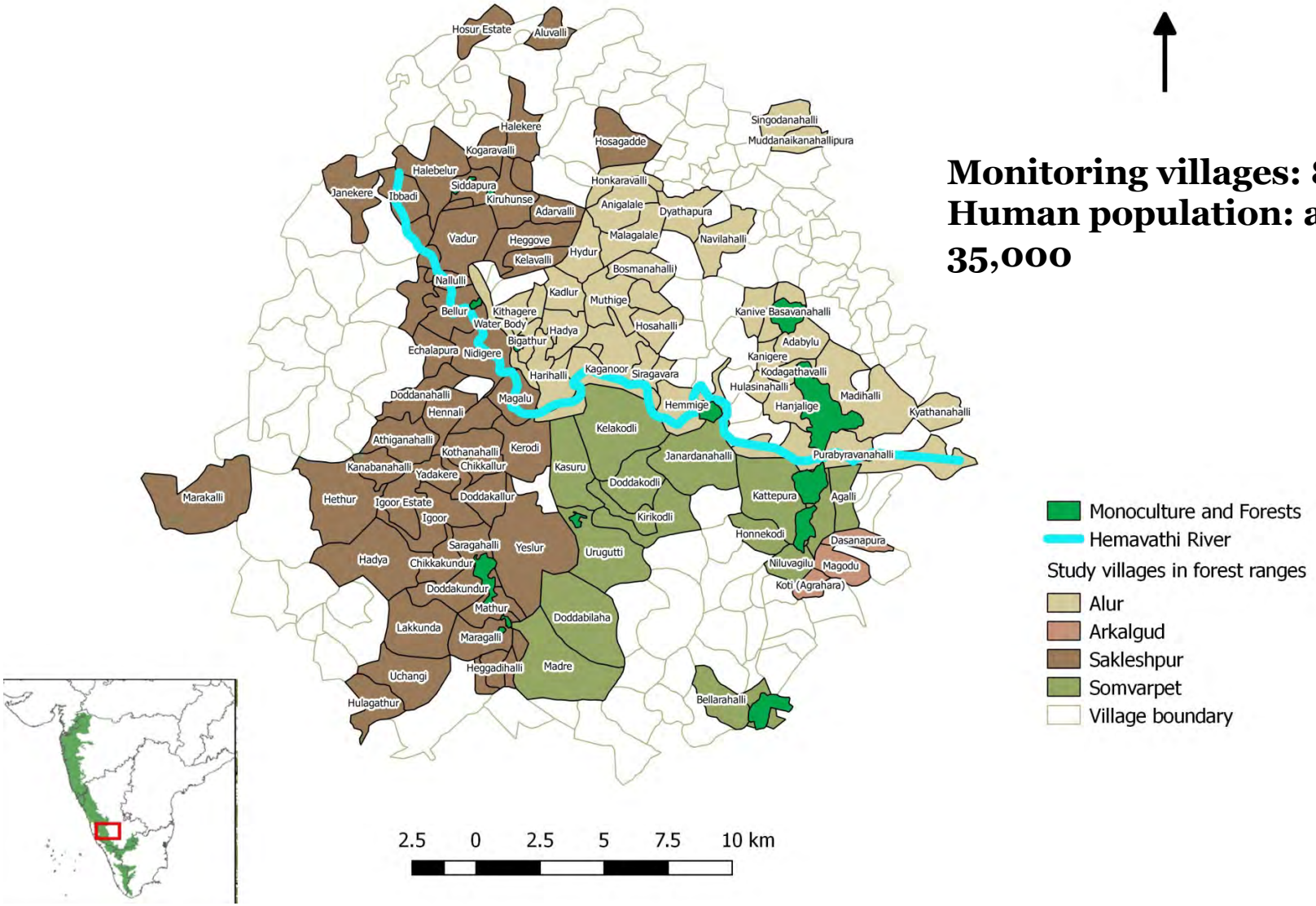


Vinod Krishnan

nature conservation foundation

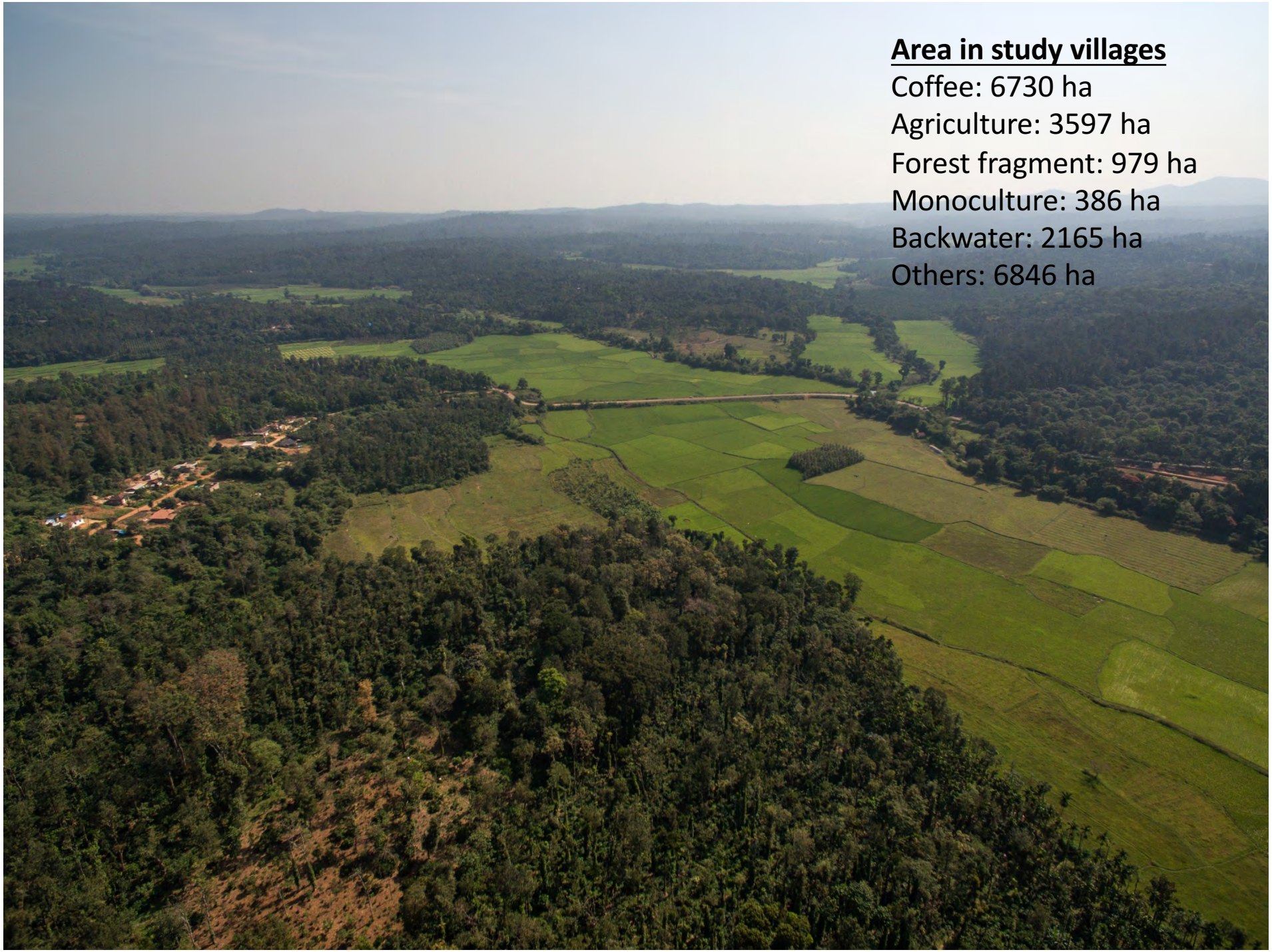

Between 1994-2014: 46 elephants captured
Largest capture operation in 2014: 22 elephants

Alur-Yeslur-Kodlipet region
(Mar 2015- Feb 2016)



Monitoring villages: 85
Human population: around 35,000

Monoculture and Forests
Hemavathi River
Study villages in forest ranges
Alur
Arkalgud
Sakleshpur
Somvarpet
Village boundary


Area in study villages
Coffee: 6730 ha
Agriculture: 3597 ha
Forest fragment: 979 ha
Monoculture: 386 ha
Backwater: 2165 ha
Others: 6846 ha

Objectives

- Understanding elephant distribution and their use of fragmented mosaic

  - Method: Herd tracking, Digitizing land use habitat and landscape variables

- Nature and distribution of conflicts

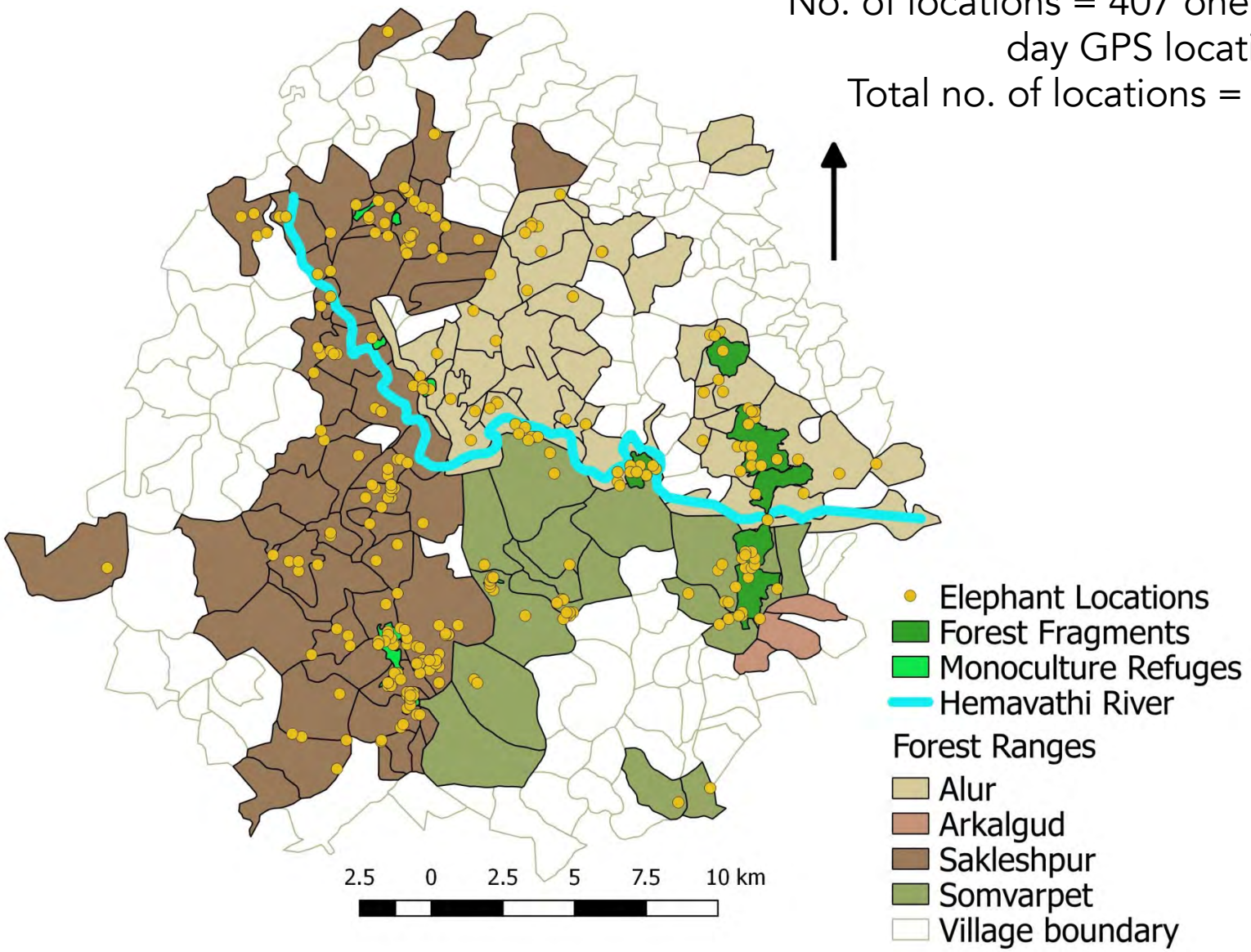
  - Method: Direct surveys, Informant network, Forest Department records, and Field Investigation

- Development of participatory Elephant Information Network (EIN)

  - Method: Interaction meetings, Sharing results, Database of informants and their phone calls

Elephant distribution

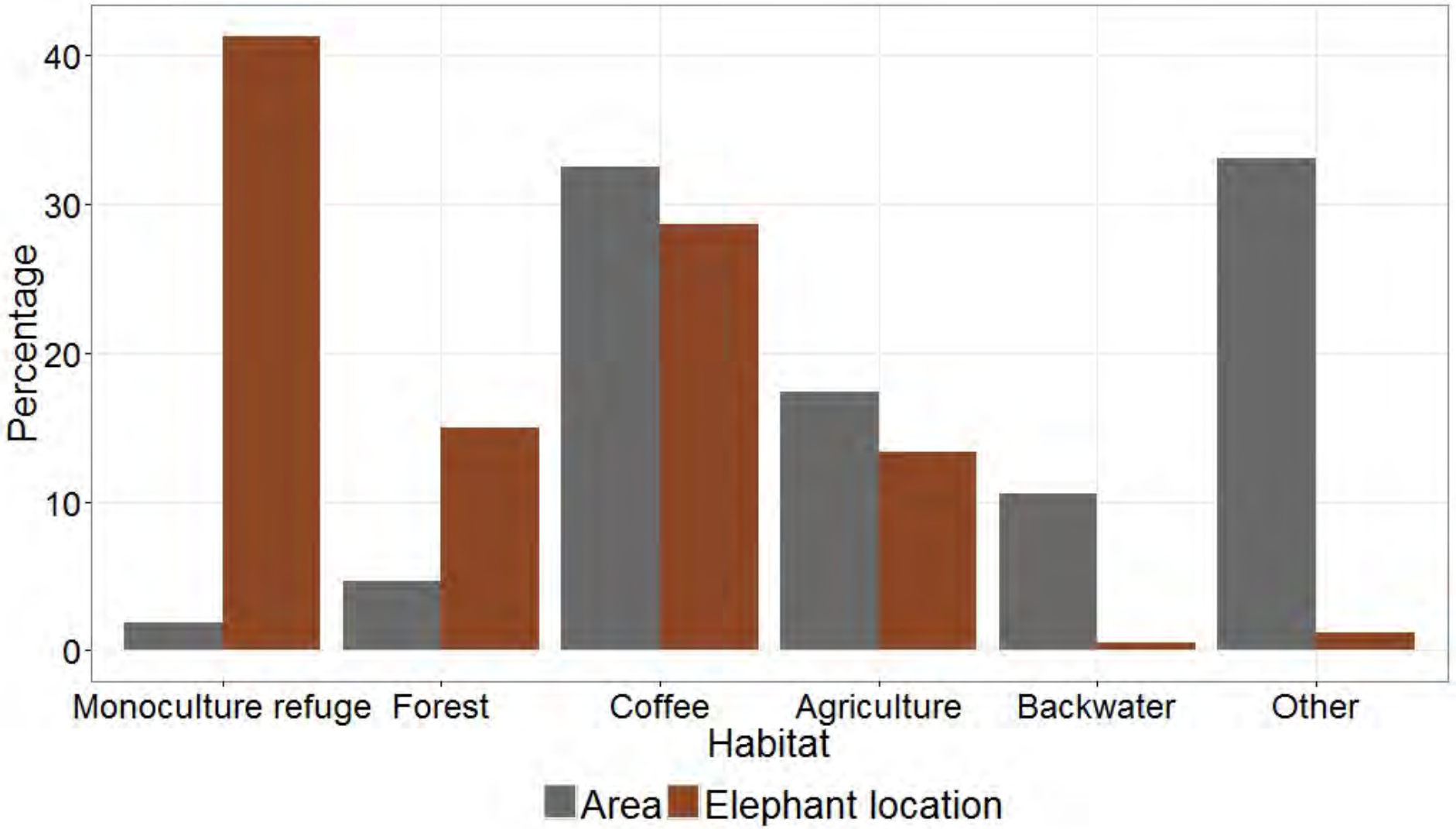
No. of locations = 407 one per day GPS locations
Total no. of locations = 741



Use of habitats by elephants (Mar 15-Feb 2016)

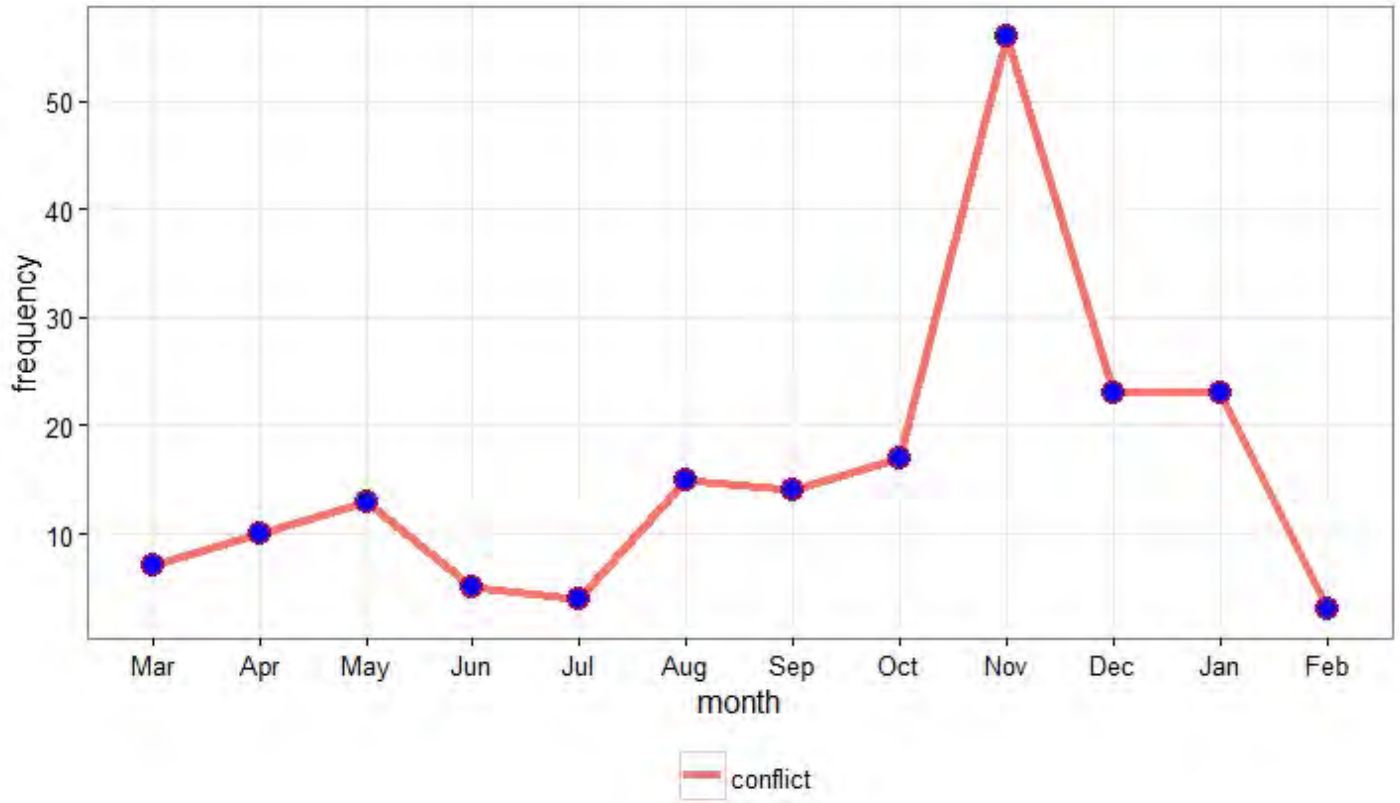
No. of GPS locations = 407 one per day locations

$\chi^2 = 3650.7$, $df = 5$, $P < 0.001$



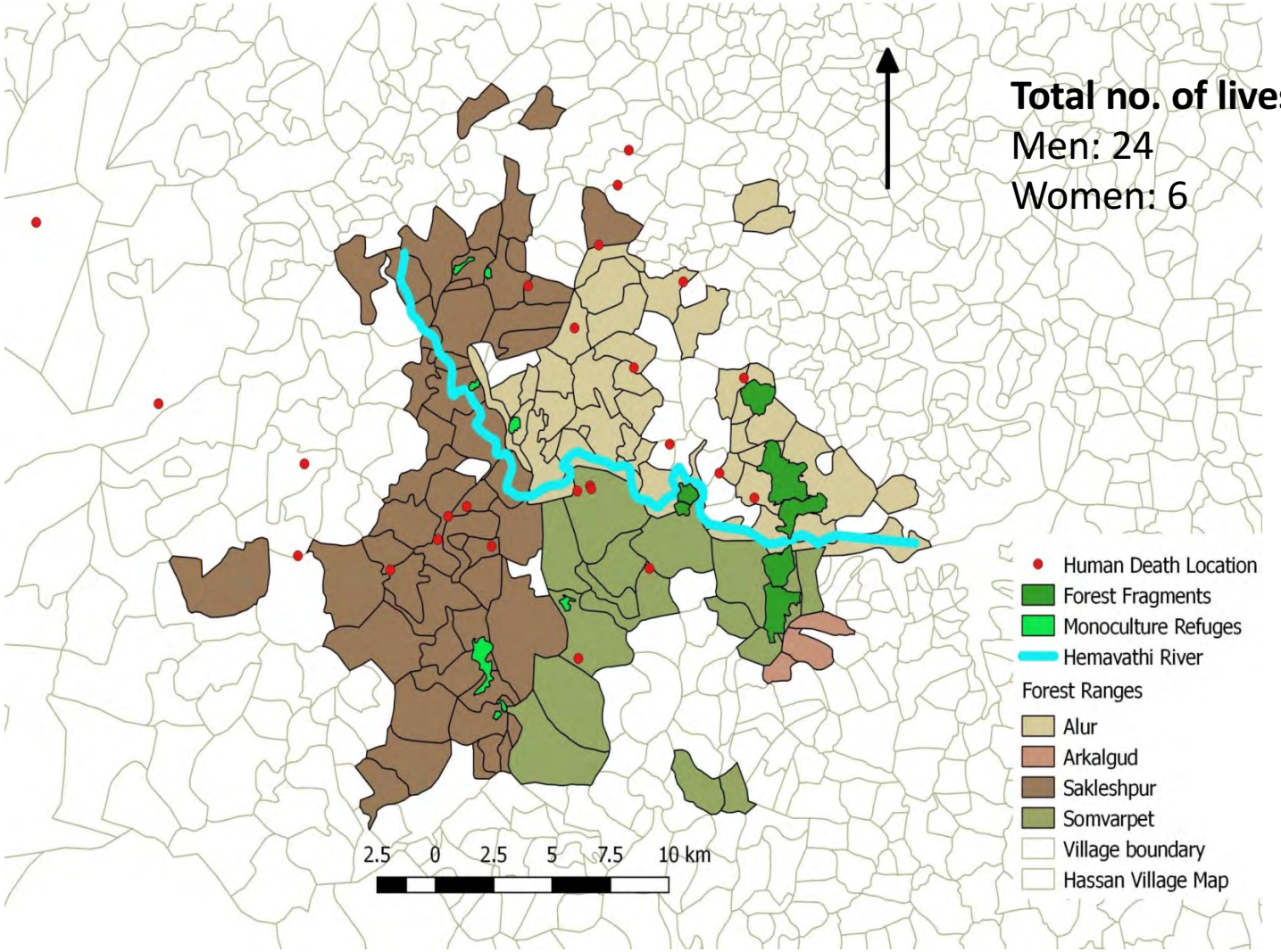
Incidents of damages across months

No. of damages incidents: 190
Paddy alone: 52% (n = 99)



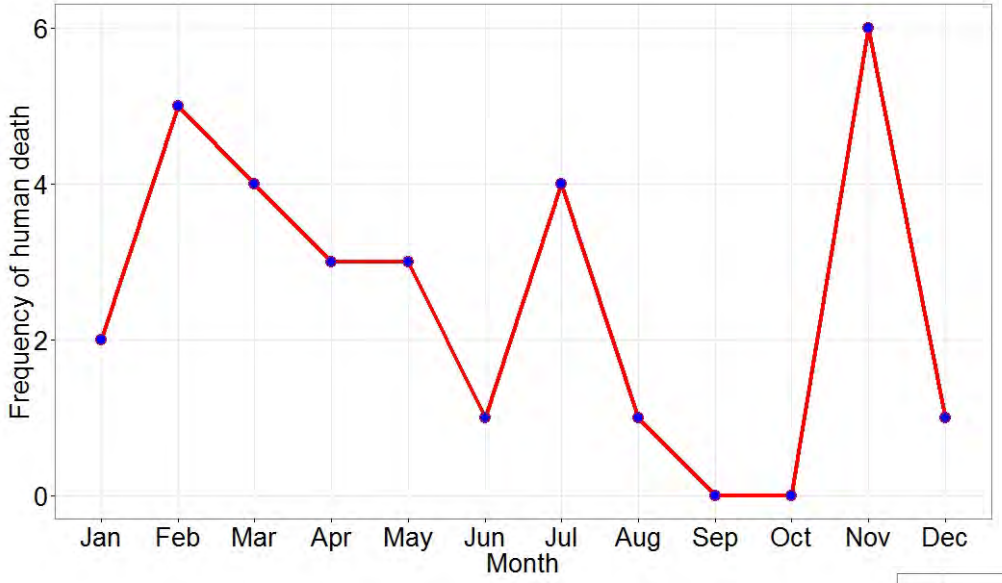
54% of damages between October -December

Spatial distribution of human deaths (2010-16)

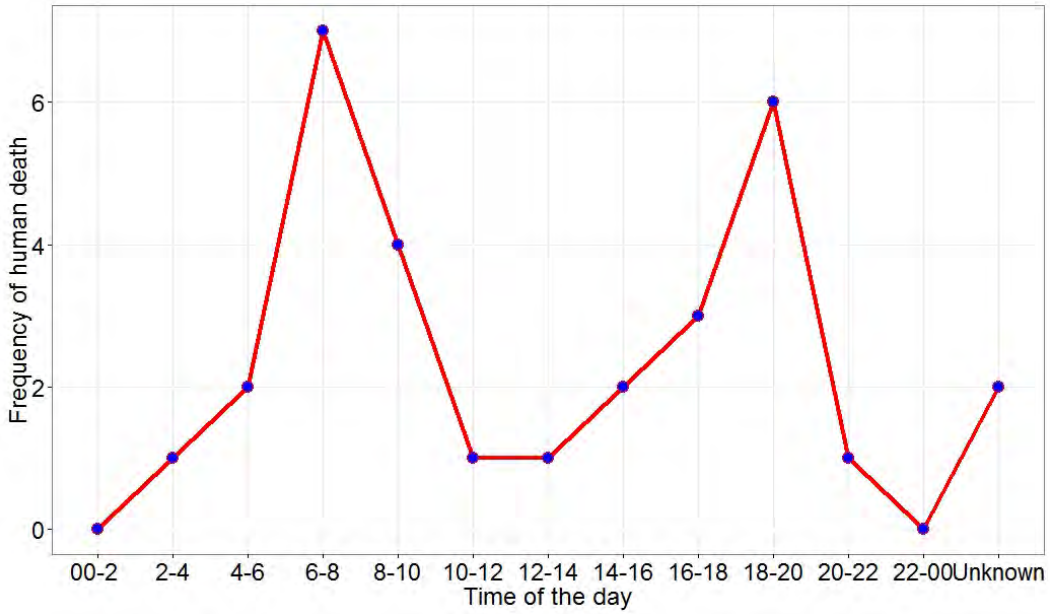


20 deaths (67%) were along roads and paths in plantations
10 incidents (33%) were in coffee, paddy, forest, uncultivated lands, and residential premises

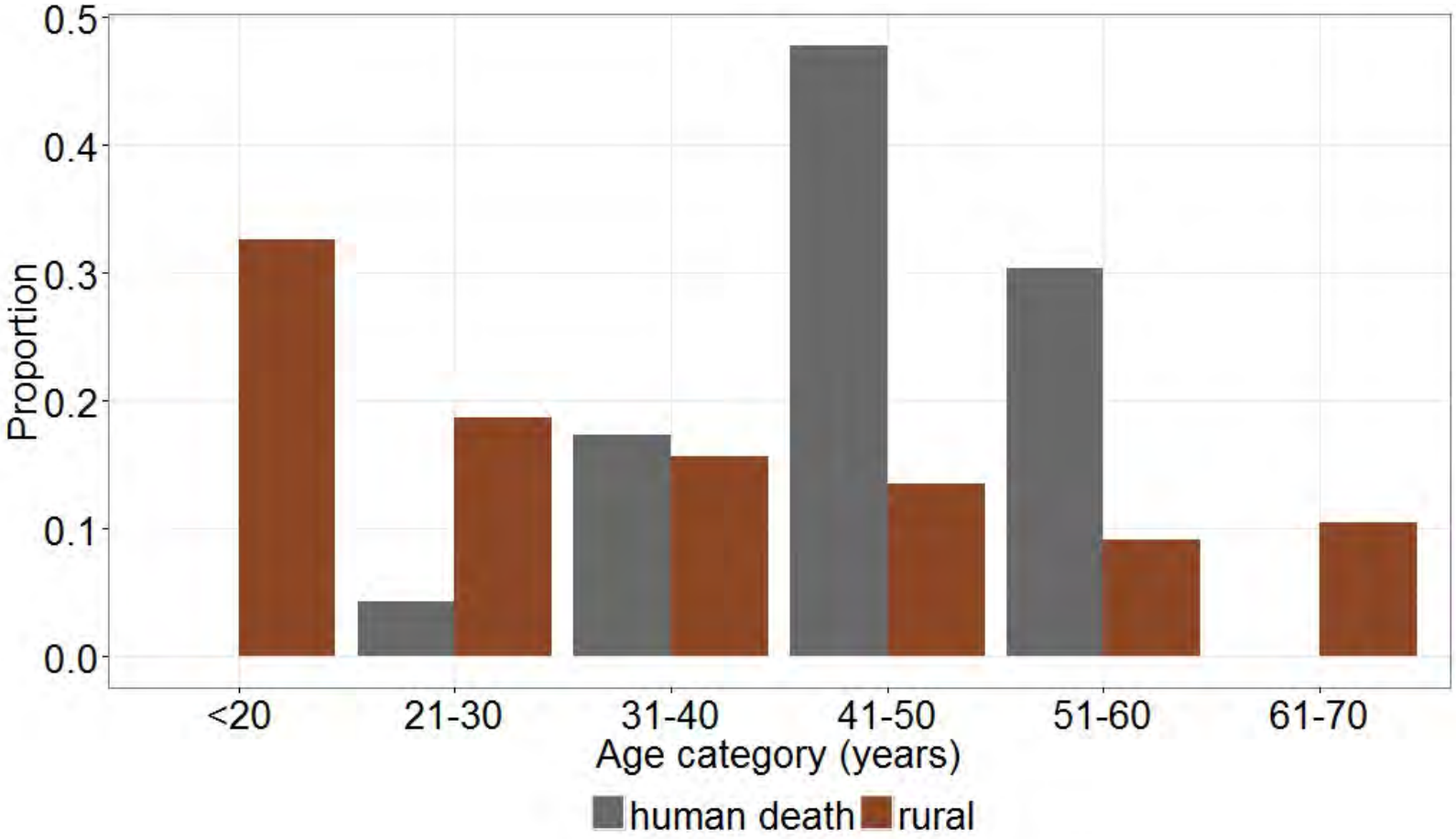
Temporal distribution of human fatal incidents



19 incidents (63%) 6 -10 AM 4 - 8 PM



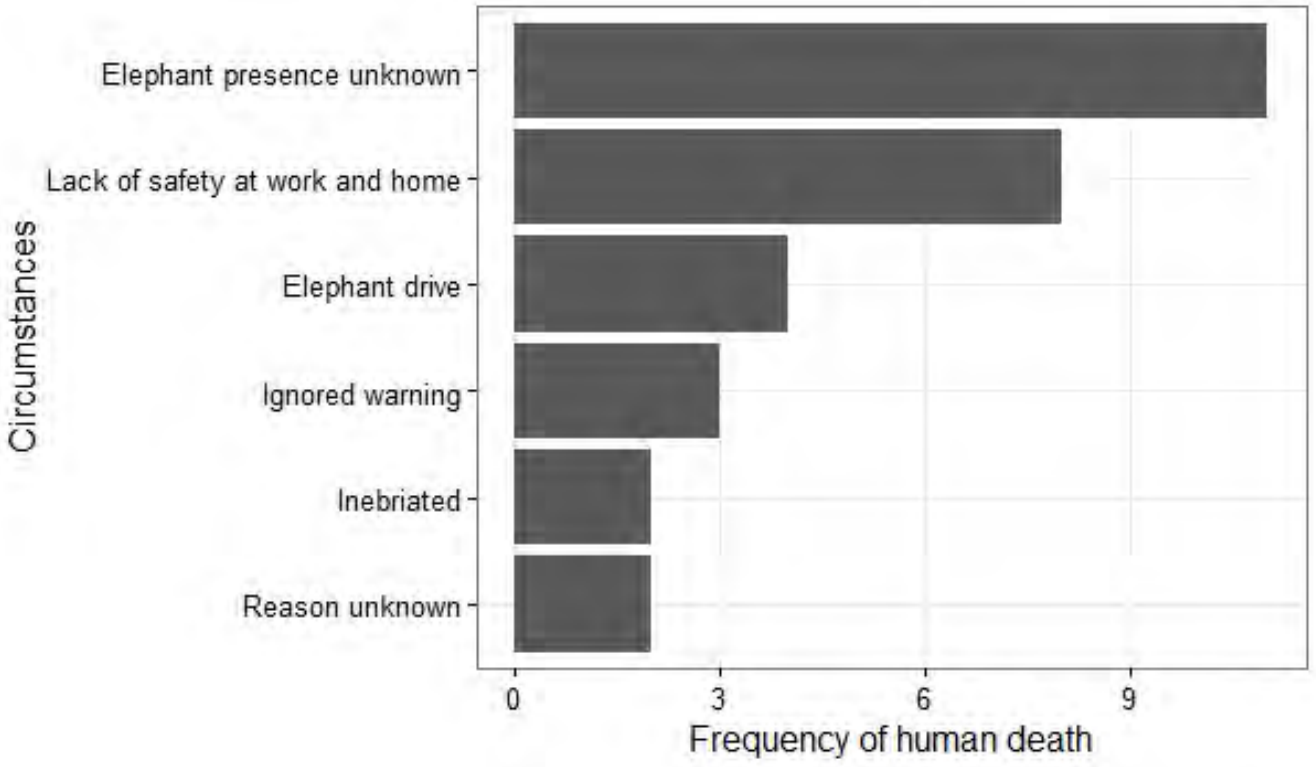
Human deaths: Vulnerability of age



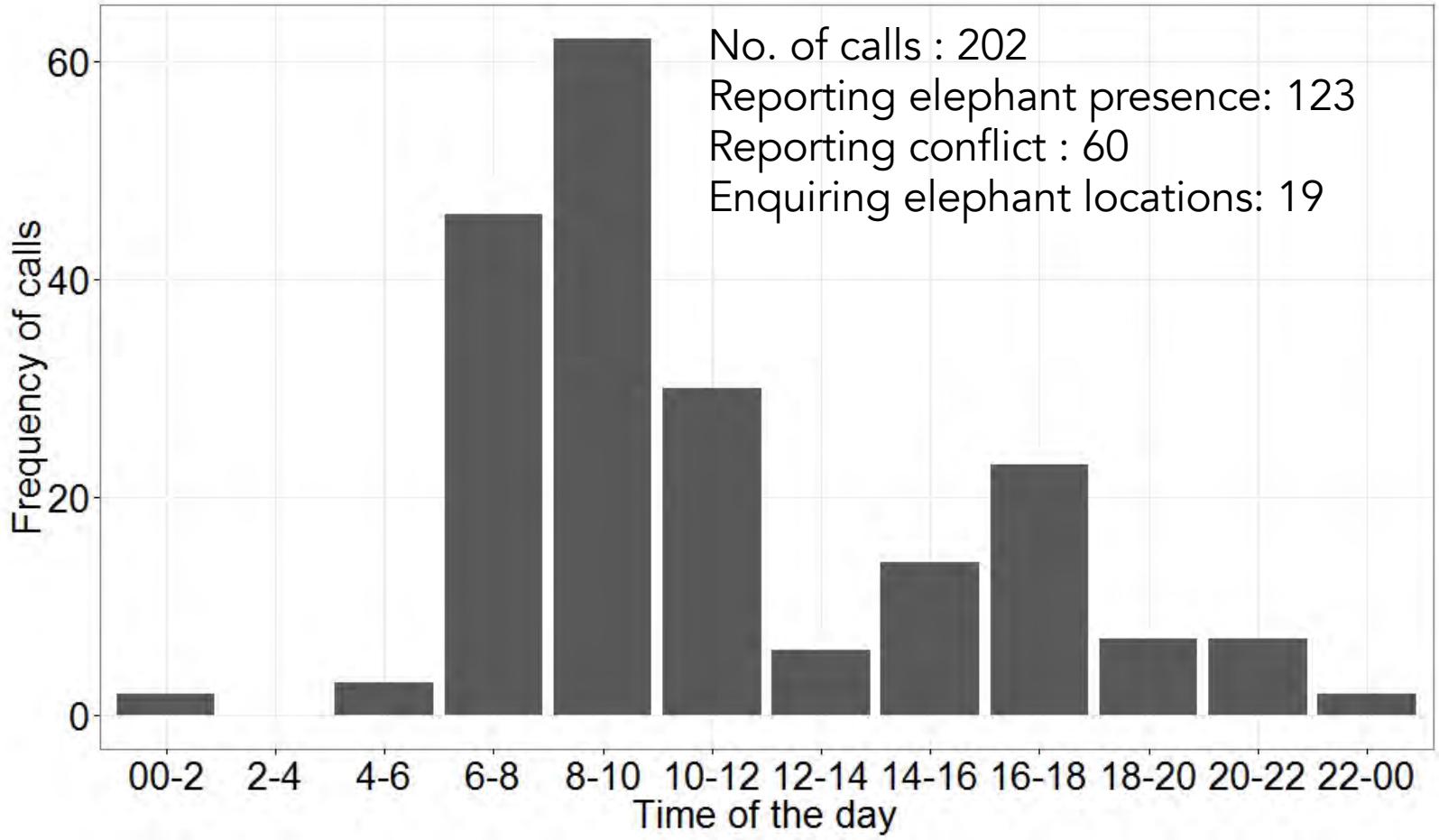
20 People 66.7% between 40-60 years of age

Human deaths : Circumstances

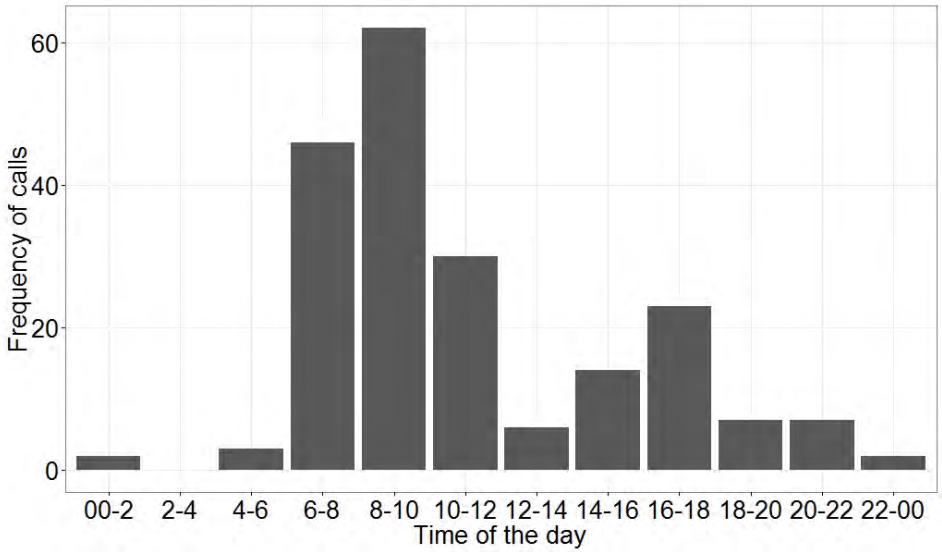
19 out of 30 cases unaware of elephants



People's call distribution across time of the day

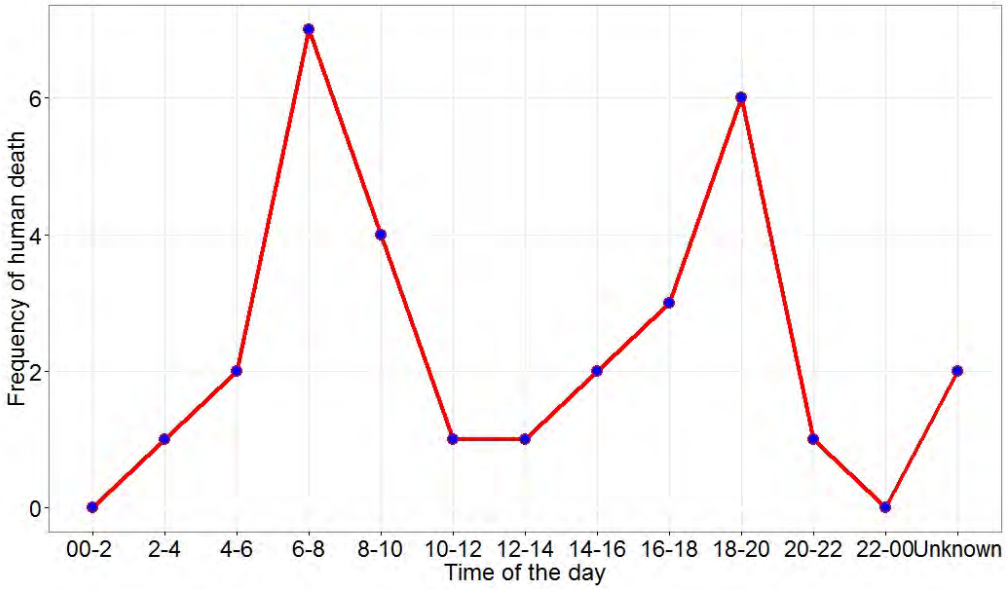


Understanding critical time periods



Time of calls

Time of death



Conclusions

- Habitat use by elephants – significant role of refuges
  - Retention of forest fragments and monoculture refuges
- Seasonality in conflict occurrence
- Vulnerability to conflict – age class of victims, lack of safety and awareness
- Elephant Information Network with people's participation is key for pro-active steps

Way Forward: Experimentation with early warning systems

- SMS initiatives (Bulk and Voice call alert systems)
- GSM based Digital Display Boards
- GSM based elephant alert indicators





Acknowledgements



ORACLE

ELEPHANT FAMILY
Protecting Asian elephants and their habitat

Dr G Jayanth, IISc

Kalyan Varma

Field staff of forest ranges

Gram Panchayats of Alur and Yeslur

Colleagues at NCF

nature conservation foundation



Finding joint solutions for HEC in an intensifying plantation landscape in Sabah, Malaysian Borneo

Cheryl Cheah Phaik Imm, Koh Pei Hue, Maxentius Donysius (WWF Malaysia)
Ram Nathan (Sabah Softwoods Berhad)
K. Yoganand (AREAS program, WWF International)

Conservation status of elephants in Sabah

- **Latest Population Estimate:**

  ca. 2,040 elephants (Alfred *et al.*, 2010)

- **IUCN red list status: Endangered**

- **CITES: Appendix I**

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

- **Major Threats:**

i) **Conversion and fragmentation of forests**

ii) **Human-Elephant Conflict (HEC)**

SOME REPORTED DEATHS & INJURIES:

- **Gunung Rara Forest Reserve, Dec 2012**
  - **14 DEAD + 1 SURVIVING CALF**
  - **CAUSE: SUSPECTED POISONING**
- **Felda Umas, August 2014**
  - 1 male dead
  - Cause: **gunshot wound**
- **Telupid, January 2015**
  - 2 females dead
  - Cause: **suspected poisoning**
- **Rinukut, Sept 2016**
  - **7 DEAD + 2 INJURED SURVIVORS**
  - **CAUSE: TRAPPED IN MUD POOL**

Conflict incidences

CBSNEWS LIVE

World

14th endangered Borneo elephant found dead in forest reserve

5 AP

Jan 31, 2013 6:29 AM EST



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Sabah's First Established Paper



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Local

Elephant shot in plantation





Human land grabs: Can elephants survive?



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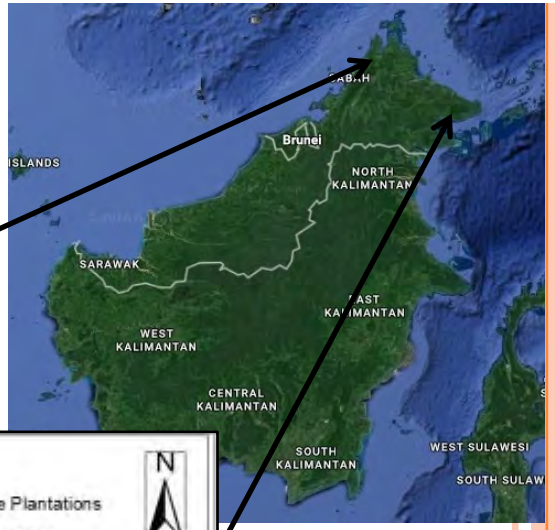
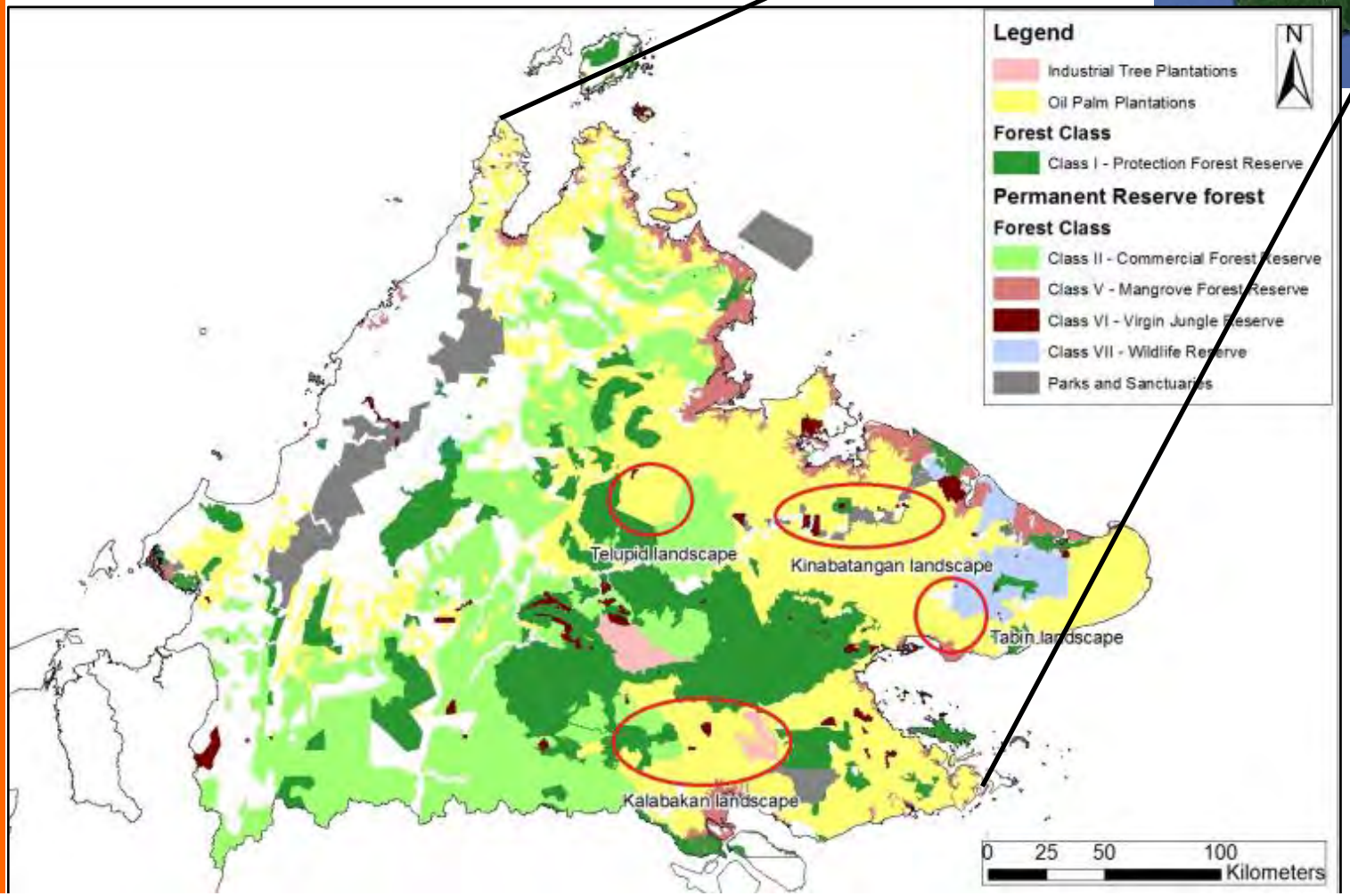
Elephants pay the price for palm oil in Malaysian Borneo, impact may reach far beyond reported kills

10th September 2014 / Mike Gaworecki

More than a dozen elephant kills were reported in Sabah in 2013 alone, but it is unknown exactly how many have lost their lives in recent years as palm plantations encroach further and further into the rainforest. What is clear is that if the loss of their forest habitat continues to drive conflicts with humans at the rate it is now, Borneo elephants' long-term survival may be in jeopardy.

HEC hotspots in Sabah



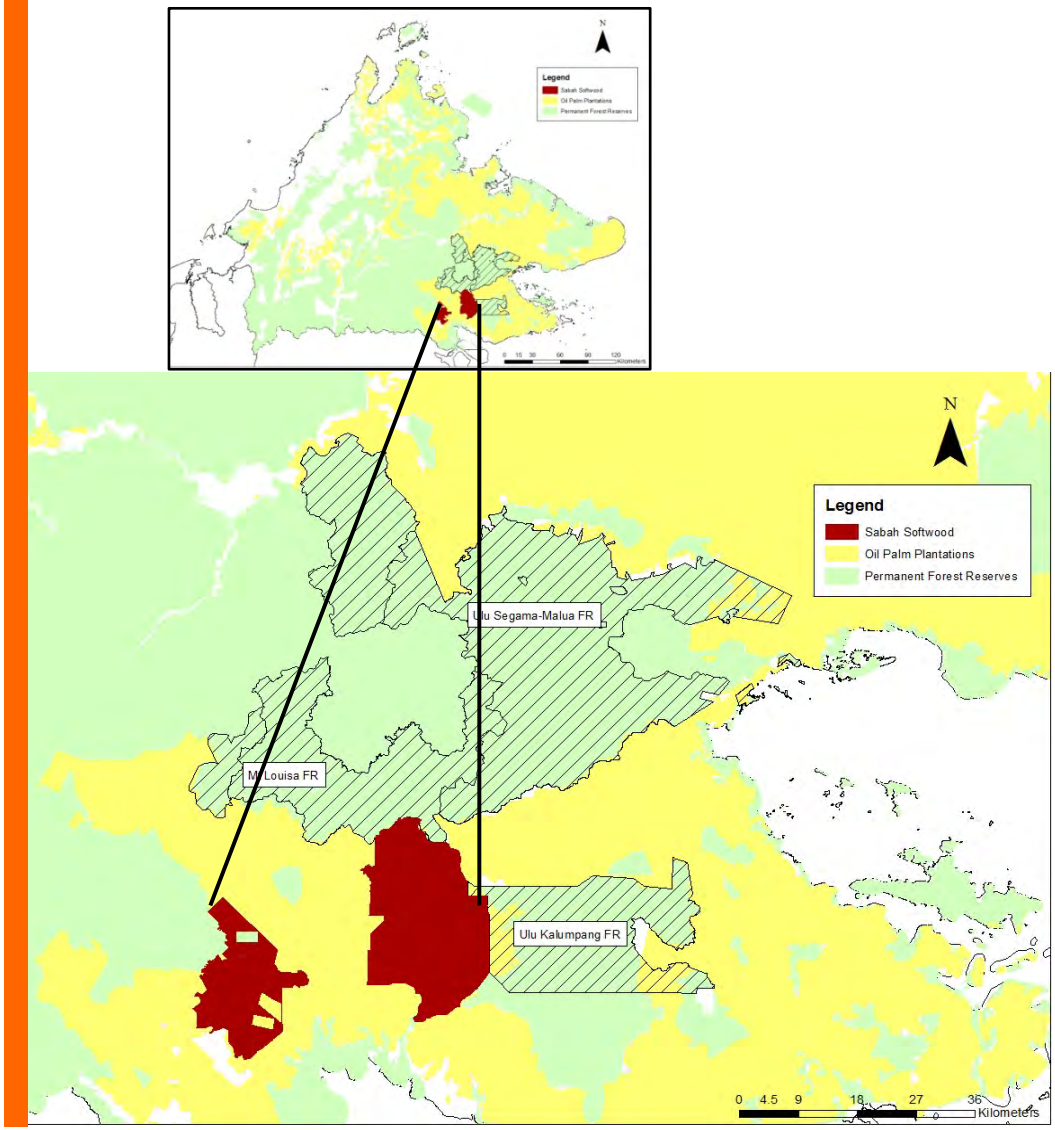


Damages due to HEC

Crop damage	Property damage
	

© Sabah Softwoods

Case Study: Partnering with Sabah Softwoods Berhad







Case Study: Strategy to reduce HEC

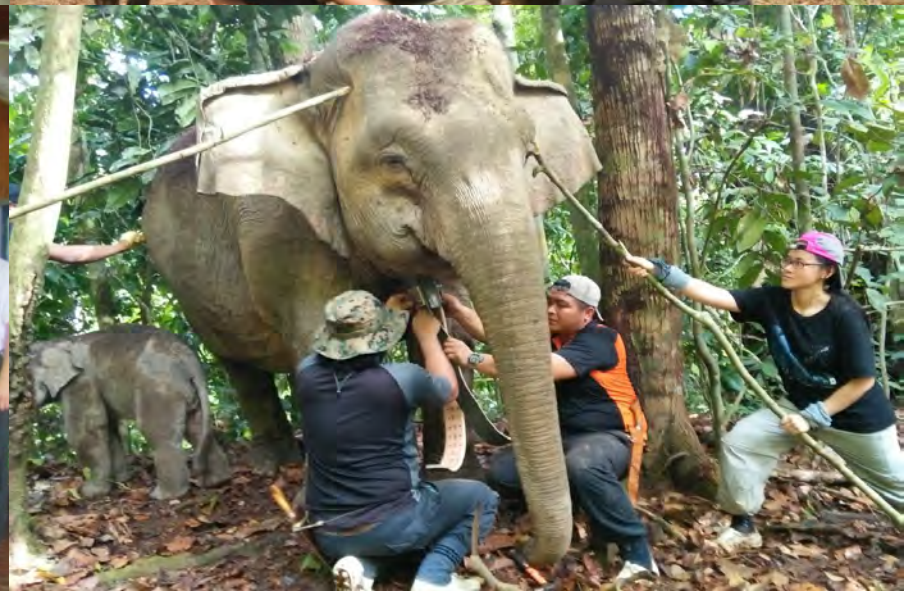
Collaboratively implement joint options through a working group





Studying movements of satellite-collared elephants





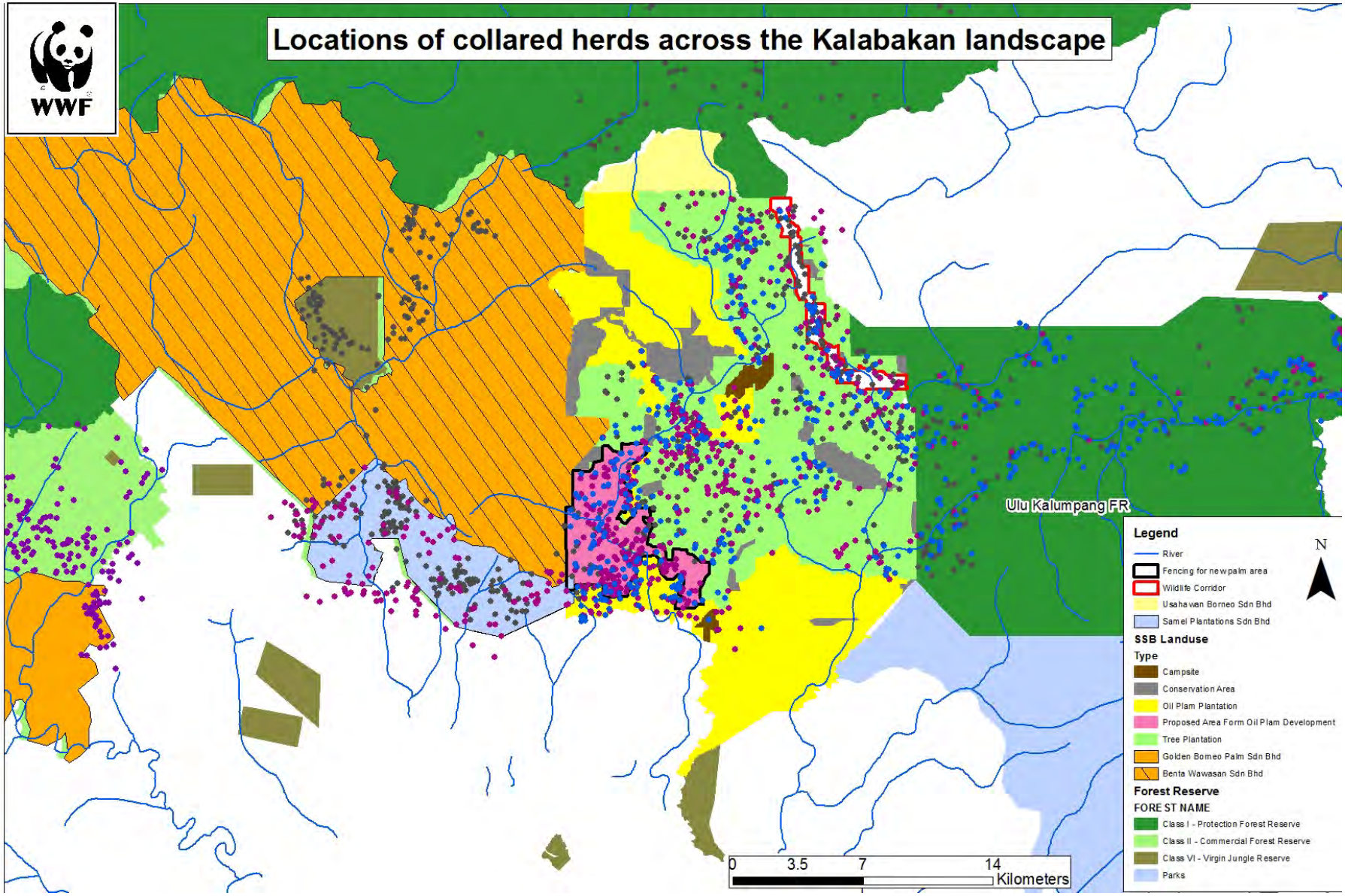
Case Study: Mitigation options recommended by WWF

- Realigning electric fences and fencing only vulnerable areas (newly planted area, housing areas, etc.)
- Allowing other areas open for elephant use (tree plantations)
- Advocating for corridors through oil palm plantations to promote connectivity





Case Study: Corridors for elephant movement



Case Study: Joint solution- 80ha corridor & riparian

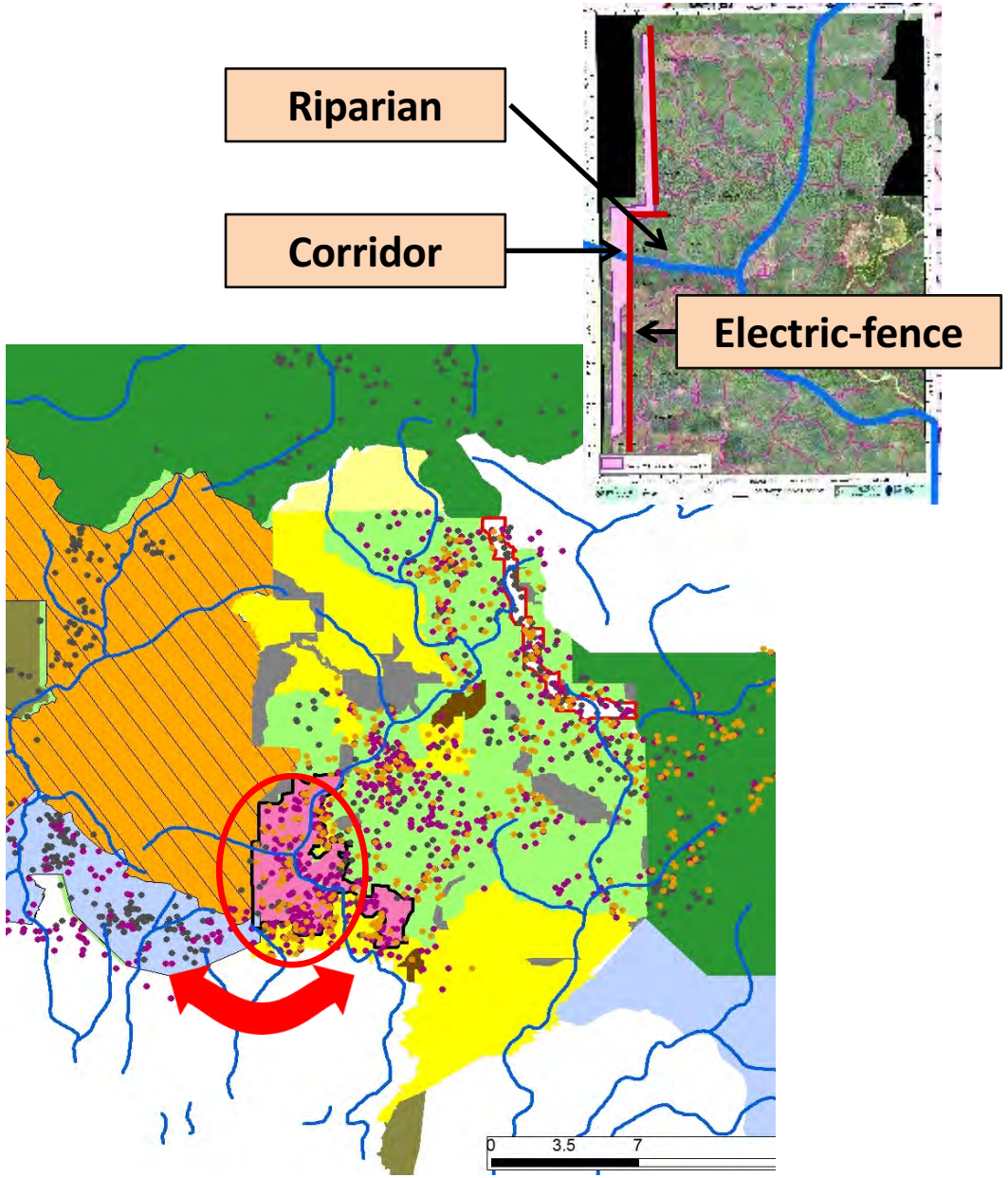
- **Location of corridor is based on:**

a) Movement of elephants

b) Topography

c) River

d) Non-steep area suitable for elephant movement

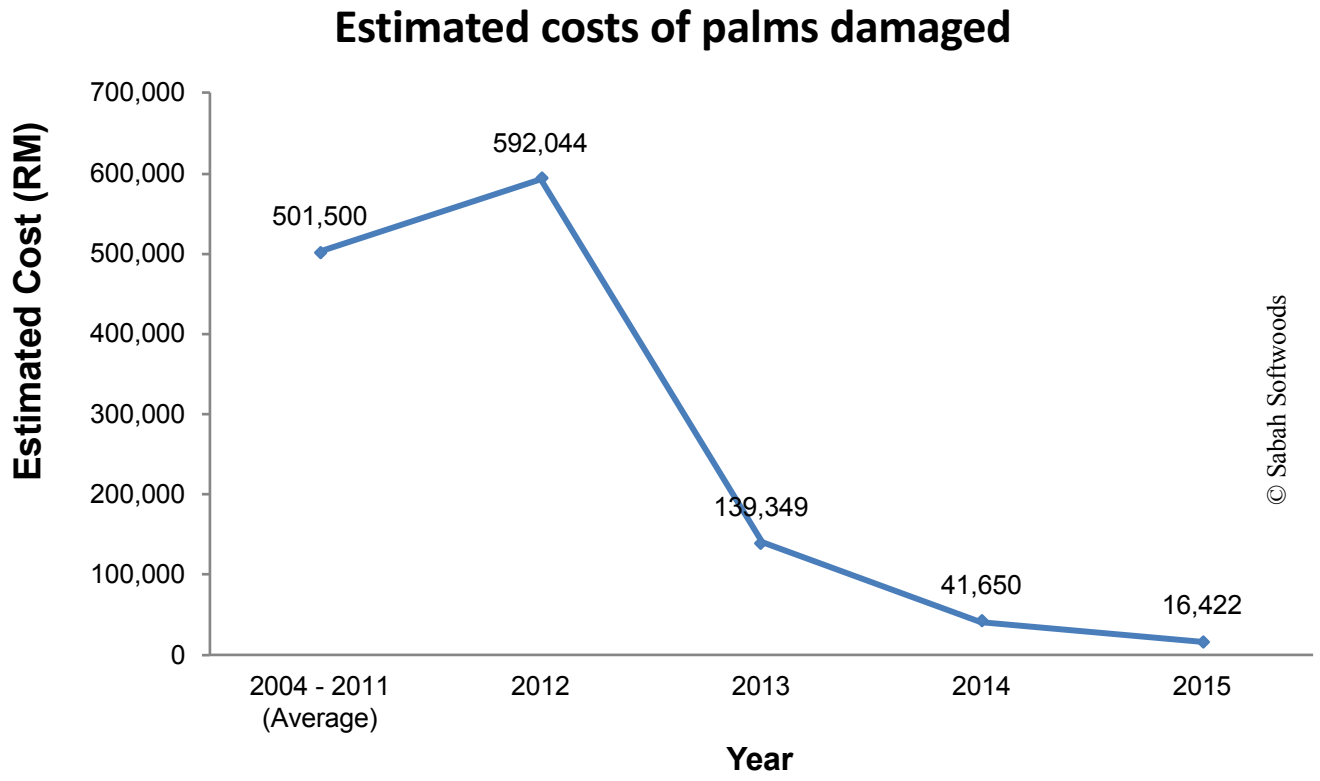


Case Study: 80ha corridor





Case Study: Reduction in crop damage



Reduction in crop losses after 2012 due to: installation of electric fence in vulnerable areas

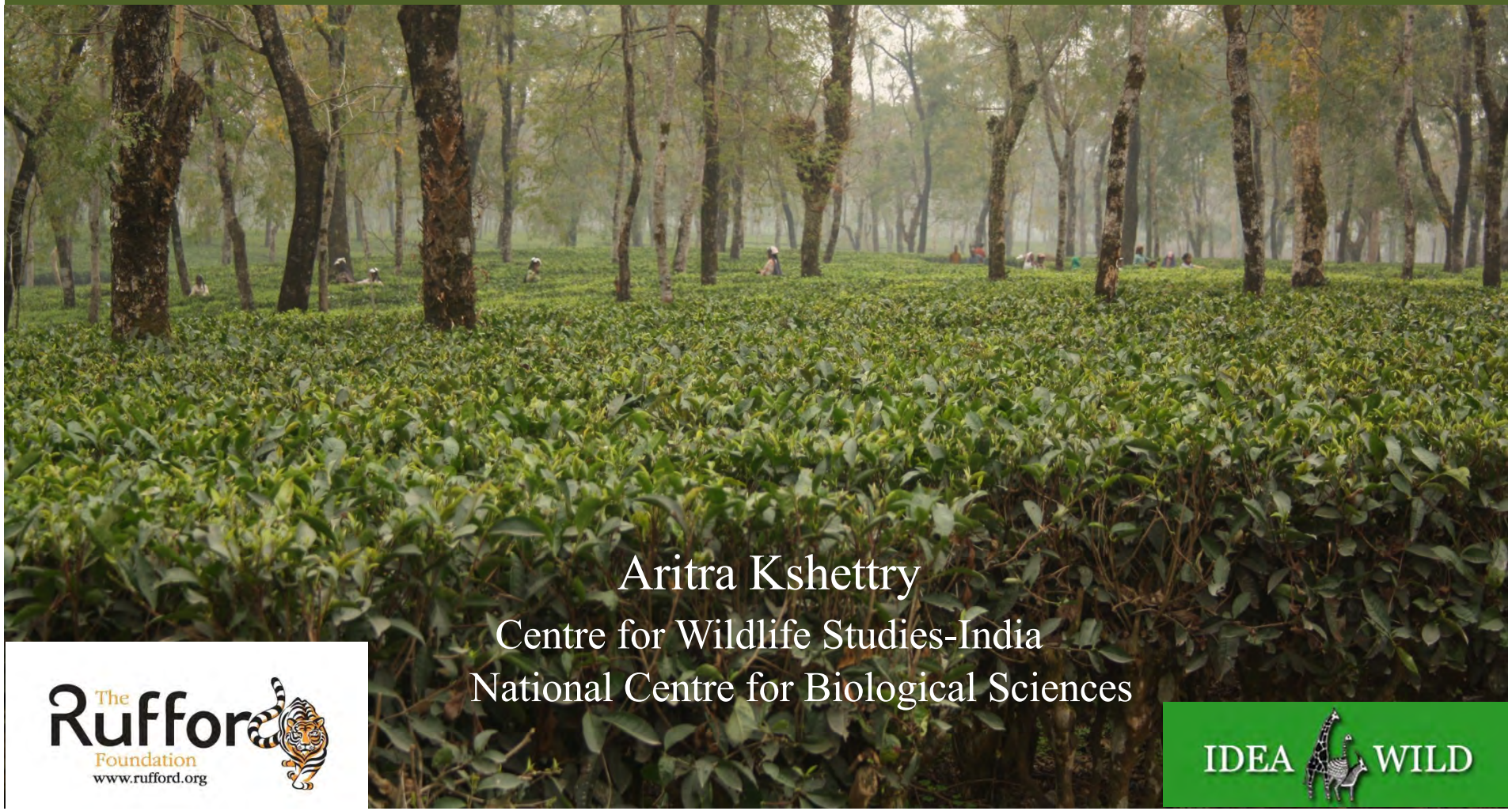
Lessons Learnt

- Proper landuse planning (placement of electric fences) and establishment of corridors can be successfully used to mitigate HEC at site level.
- HEC mitigation options are site specific and on a case by case basis
- Cooperation between neighboring plantation companies is crucial
- Elephants and oil palm plantations can co-exist together!
- Elephant movement research can be used to inform landuse/policy changes
- HEC can be reduced but not eliminated completely

Thank you!



Spatial and temporal trends in human-elephant encounters in north-eastern India



Aritra Kshettry
Centre for Wildlife Studies-India
National Centre for Biological Sciences

The Rufford Foundation
www.rufford.org

IDEA WILD

Our idea of wildlife habitat







Where do we actually find them?



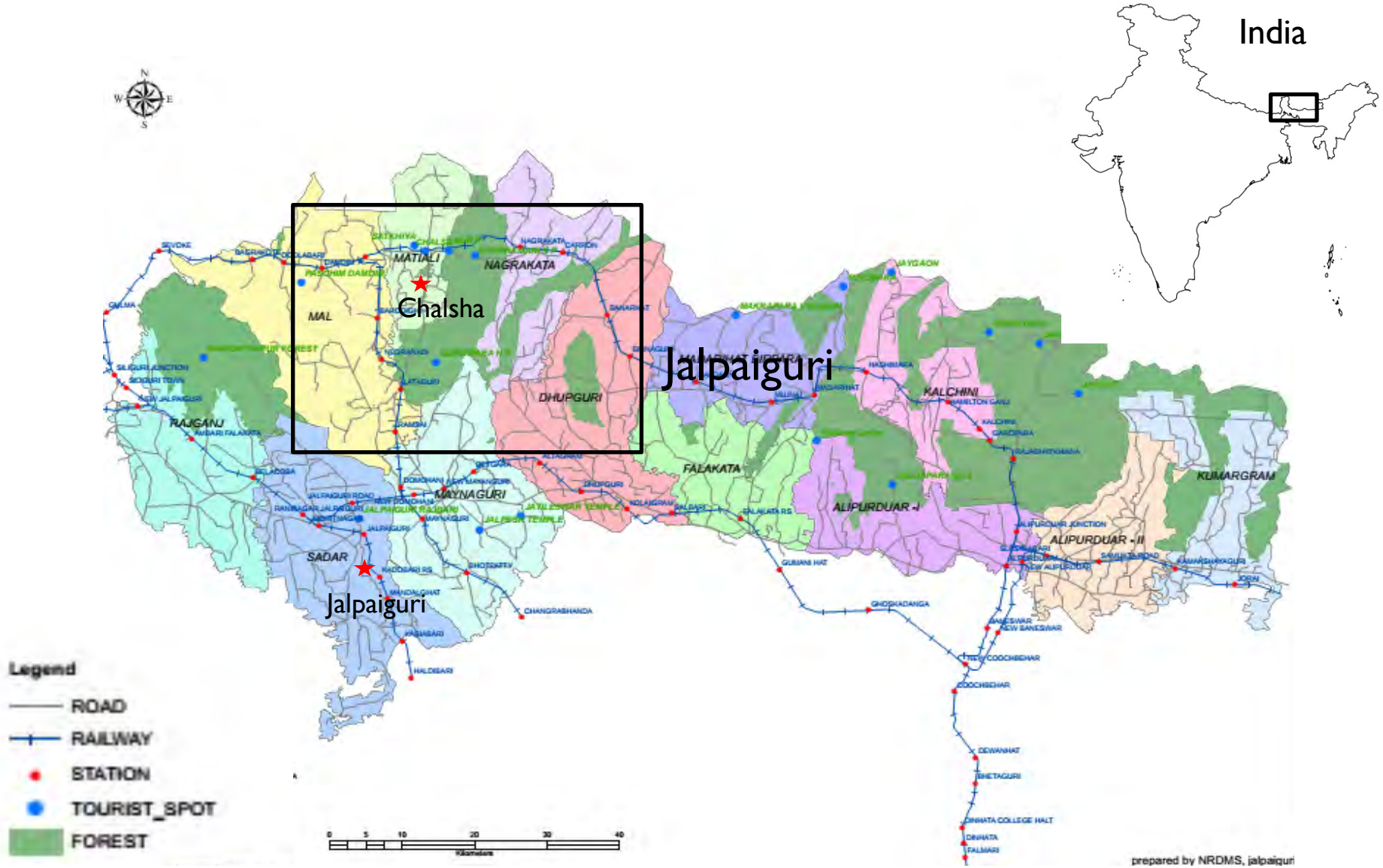




Implications?

- Large bodied wildlife require vast home ranges
- Protected areas only 12 % of global land cover (<5% in India)
- Landscape level approach to conservation
- Acknowledging challenges to shared spaces
- Minimizing damages to people and wildlife to garner local support for conservation

Northern West Bengal landscape



Consequence of shared space

- Human population density 622 km^{-2}
- Mosaic of forest fragments, tea-estates, agriculture land and rural built-up areas
- Increasing trends in elephant population
- Frequent interactions with people
- Incidences of direct encounters resulting in fatal and non fatal injuries to people
- More than 400 injuries and 60 human deaths between 2009 and 2015 due to leopards and elephants

(www.jalpaiguri.gov.in , Menon *et al* .2005, West Bengal Forest Department 2012,2015)

Conservation challenges

- People dependent on tea gardens and agriculture areas for livelihood
- Elephants use tea estates for movement between forest patches
- Elephants damage crops, houses and cause human casualties
  (150,000 USD paid per year as compensation)



Das, 2013

Project Goal

- Facilitating safer shared spaces between people and large bodied wildlife for a long term, sustainable and landscape level conservation and management strategy

Project Objectives

•Understanding circumstances of human casualties due to elephants

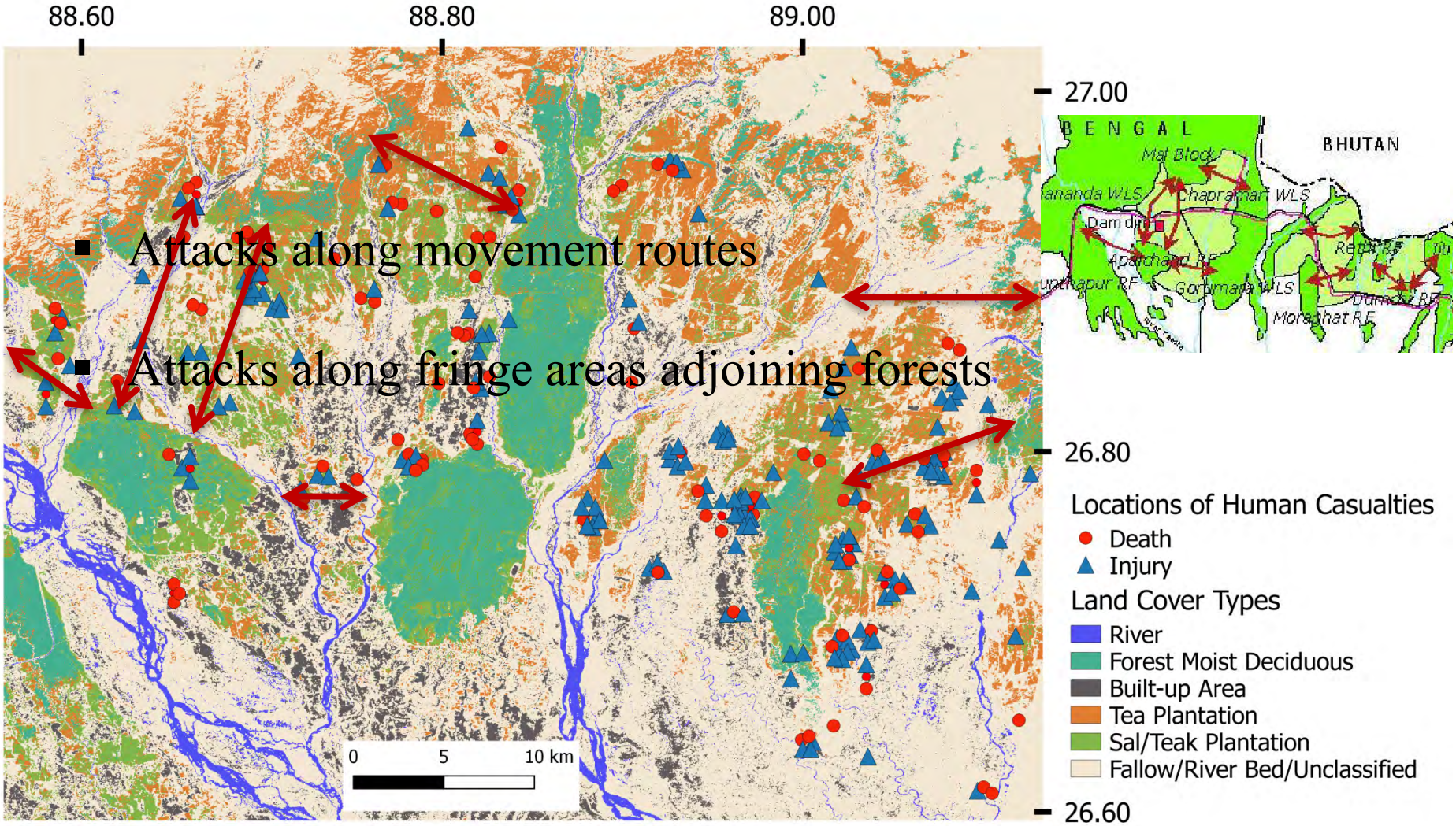
•Assessing efficacy of current management methods in minimizing negative impacts of elephants on local people

•Installing locally suitable mitigation measures to reduce losses to people due to elephants and leopards

Understanding nature of direct encounters between people and elephants

- Methods
  - Records obtained from Wildlife Wing (2009-2015)
  - Data collated and digitised
  - All records mapped to village/tea estate level
  - Sample of cases investigated using semi structured interviews: time of incident, description of incident etc
  - Landscape correlates compared in sites with incidents to sites without incidents

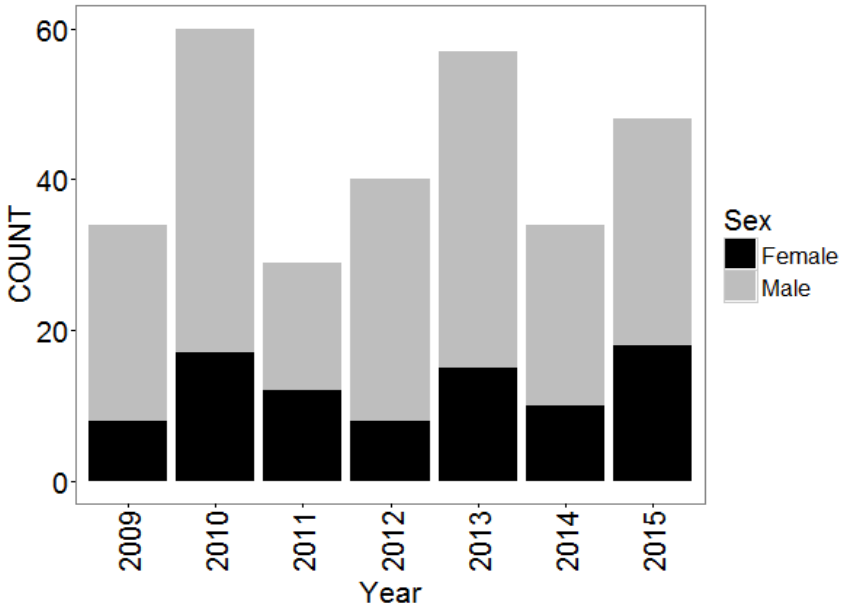
Results

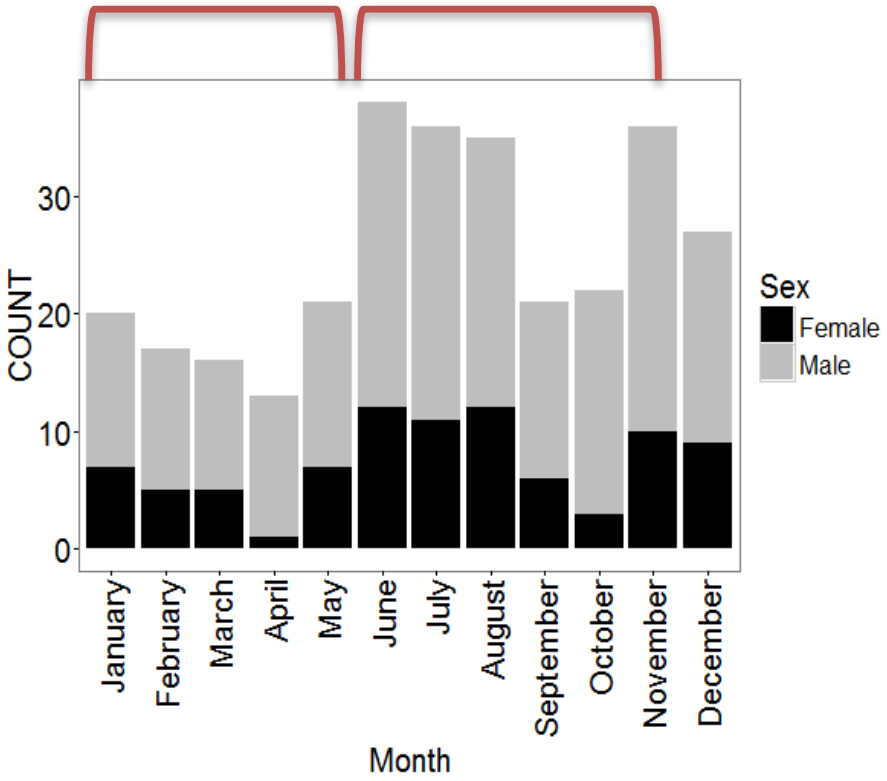

88.60
88.80
89.00
27.00
26.80
26.60
Attacks along movement routes
Attacks along fringe areas adjoining forests
0
5
10 km
BENGAL
BHUTAN
Mal Block
Chapramari WLS
Dam dim
Apalchand RF
Gorumara WLS
Morsalhat RF
Locations of Human Casualties
Death
Injury
Land Cover Types
River
Forest Moist Deciduous
Built-up Area
Tea Plantation
Sal/Teak Plantation
Fallow/River Bed/Unclassified

Annual and seasonal variation

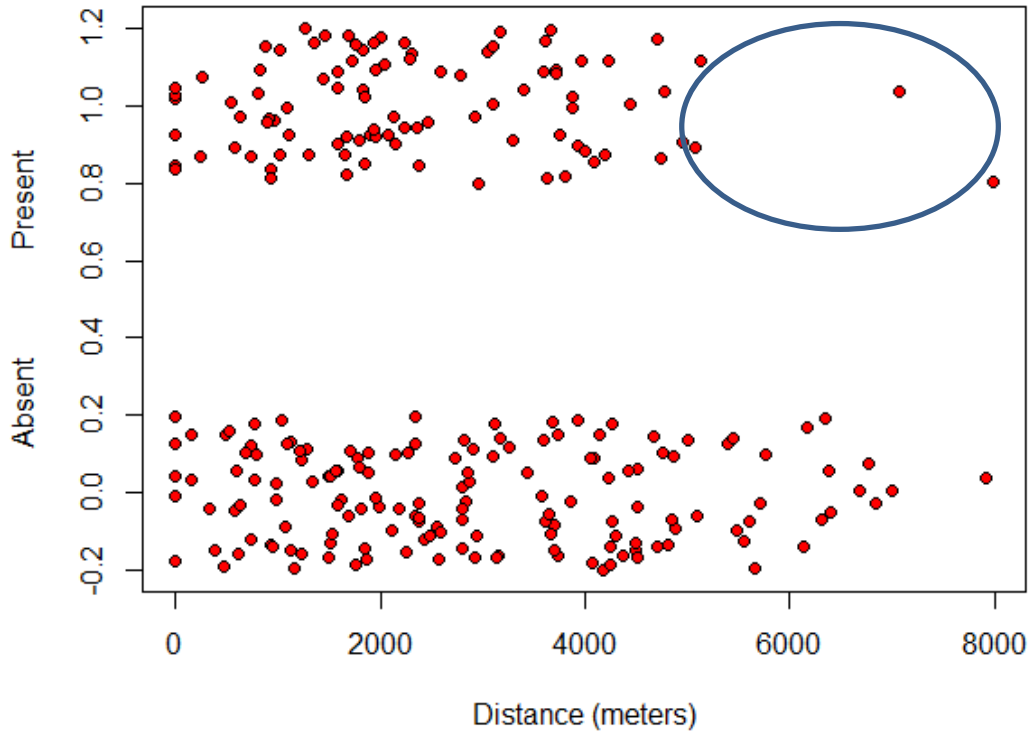
- No annual trend
- Attacks peak during paddy season



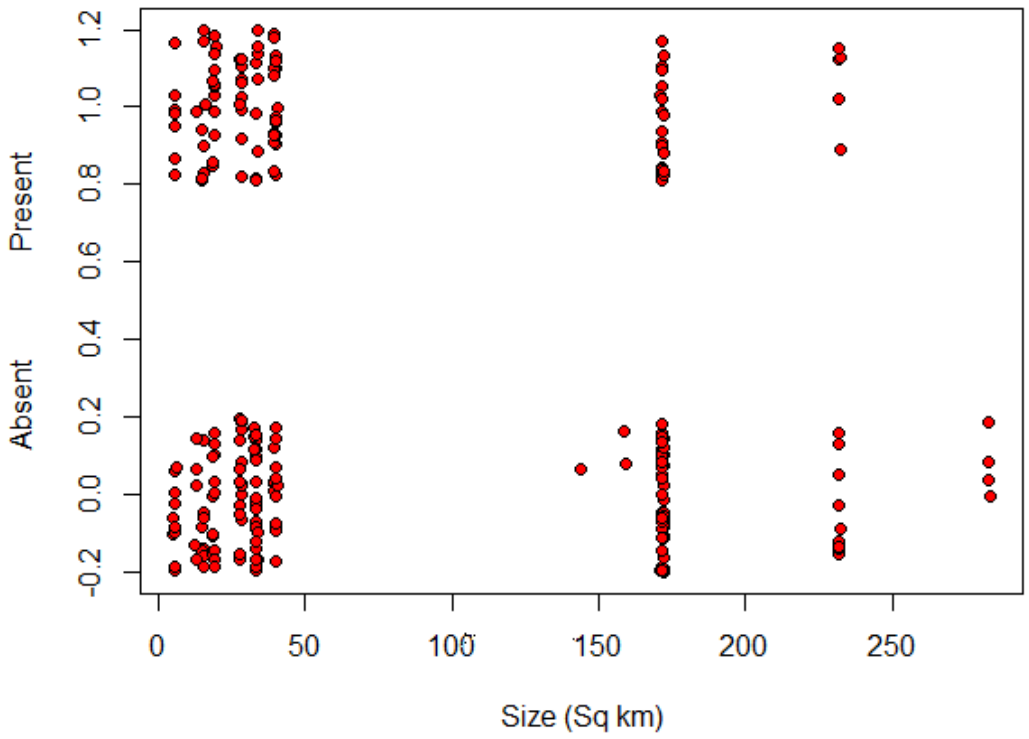




More incidents closer to forest patches



Size of patch has no influence on encounters



Characteristics of encounters

While chasing elephants from crop fields, settlements : 65% (n=108)

Due to house breakage by elephants : 24% (n=108)

Suddenly encountering elephants during early morning or after dark: 10% (n=108)

Others: 1%





Conclusions

Incidents of human injuries due to elephant not random events

Incidents more likely along elephant movement routes and forest fringe areas

Incidents peak during paddy season

Incidents occur mostly while elephants are being chased away

Rampant alcoholism could potentially lead to heightened attacks

Future directions

Need for focussed conservation efforts in the hotspots

More pro-active measures during paddy season to protect crops

Cessation of reactive measures like elephants drives and other aggressive tactics

Making local inhabitants more aware about safely sharing space with wildlife by minimizing potential threats

Accepting elephants and other wildlife as part of the landscape for long term and sustainable conservation

Research Team

Vidya Athreya, PhD : Project Supervisor

Mavatur Ananda Kumar, PhD: Advisor, Elephant Program

Aritra Kshettry, M.Sc: Project Design, fieldwork, analysis

Sumita Ghatak, West Bengal Forest Department: Technical and logistical guidance

Acknowledgements:
WWF-India, The Rufford Foundation, IdeaWild, West Bengal Forest Department


Thank you
Images: Ganesh Raghunathan, Aritra Kshettry, Siddhant Chakraborty

Sensitizing local communities in India: Conservation of the declining Greater one-horned Rhino (*Rhinoceros unicornis*) Through training and education

B.A. Daniel[1] and Sally R. Walker[2]
[1]Scientist/Education Coordinator
[2]Founder / Director
Zoo Outreach Organization, Tamil Nadu, India

15th International Elephant & Rhino Conservation and Research Symposium, 14-18 Nov 2016, Singapore Zoo

Kaziranga National Park in Assam holds the highest number of the Greater one-horned Rhino.

Location	Area	# Rhino	Year estimated	
India				
Kaziranga National Park, Assam	**430km²**	**2290**	**(2013)**	**69%**
Orang National Park, Assam	79 km²	100	(2012)	
Pobitora Wildlife Sanctuary, Assam	38km²	93	(2012)	
Manas National Park*, Assam	391km²	22	(2012)	
Katerniaghat Wildlife Sanctuary*, UP	28km²	4-5	(2011)	
Dudhwa National Park, Uttar Pradesh	490km²	31	(2011)	
Jaldapara National Park, West Bengal	216km²	186	(2012)	
Gorumara National Park, West Bengal	80 km²	42	(2013)	
Nepal:				
Chitwan National Park	932 km²	503	(2011)	
Bardia National Park*	968 km²	27	(2011)	
Sukla Phanta Wildlife Reserve*	305 km²	7	(2011)	

*(*Re-introduced)*

Total 3,306

In India, small populations of the Greater One-horned Rhino are found in Uttar Pradesh and North Bengal (264 Rhinos which is about 10% of the Indian Rhino population (2769).

Location	Area	# Rhino	Year estimated
India			
Kaziranga National Park, Assam	430km^2	2290	(2013)
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Gorumara National Park, West Bengal	**80 km^2**	**42**	**(2013)**
Nepal:			
Chitwan National Park	932 km^2	503	(2011)
Bardia National Park*	968 km^2	27	(2011)
Sukla Phanta Wildlife Reserve*	305 km^2	7	(2011)

10%

*(*Re-introduced)*

Protected Areas having small populations and its habitats should be strengthened so as to have a viable global rhino population.

One of the major impediments of rhino conservation is lack of support from local communities.

The primary requirement for Rhino conservation is to bring about attitudinal and behavior change among local people living in and around Protected Areas holding Rhino populations, appreciate species and its role in ecosystem.

Objectives:

To reach out community people though educators by way of giving lively training and effective education materials.

To convey positive attitudes and effective preventive and practical behavior with respect to rhino and human-rhino conflict

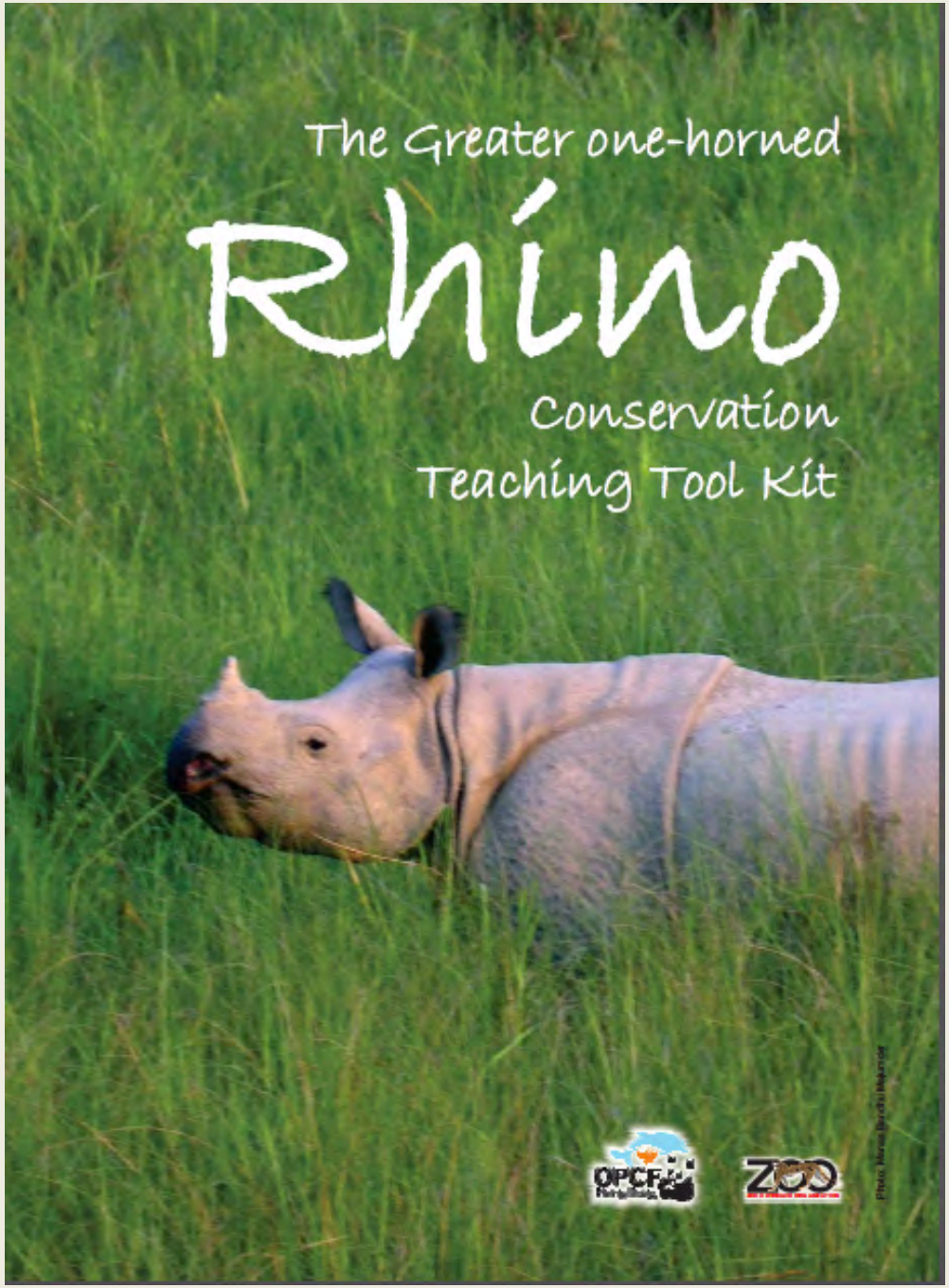
Create a network of conservation educators in North Bengal, India

Products

- Developed unique teaching tools

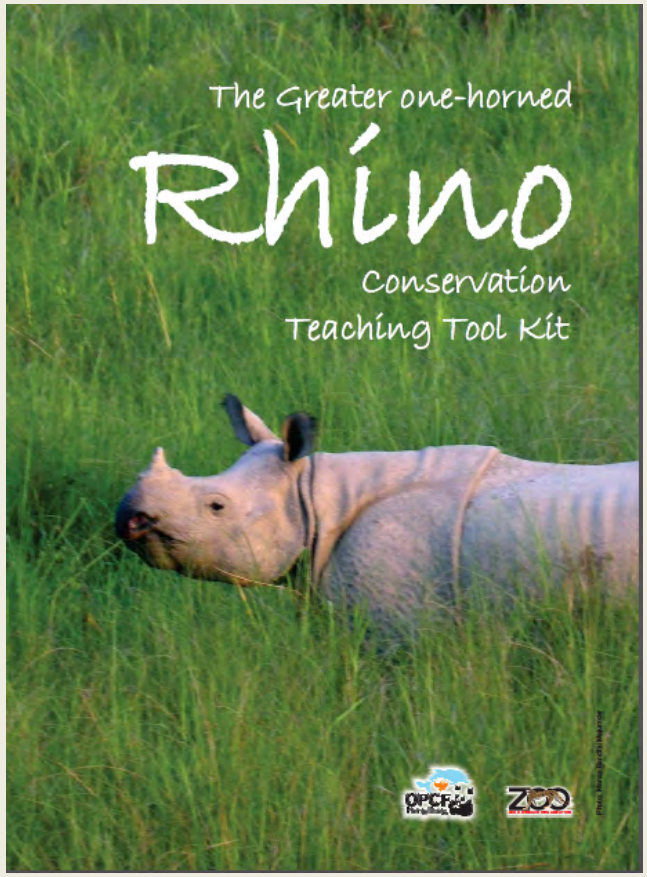
- Introduced and practiced new teaching / learning methods to help improve scientific thinking process.

1. Teaching guide
2. Rhino packet



Rhino teaching guide

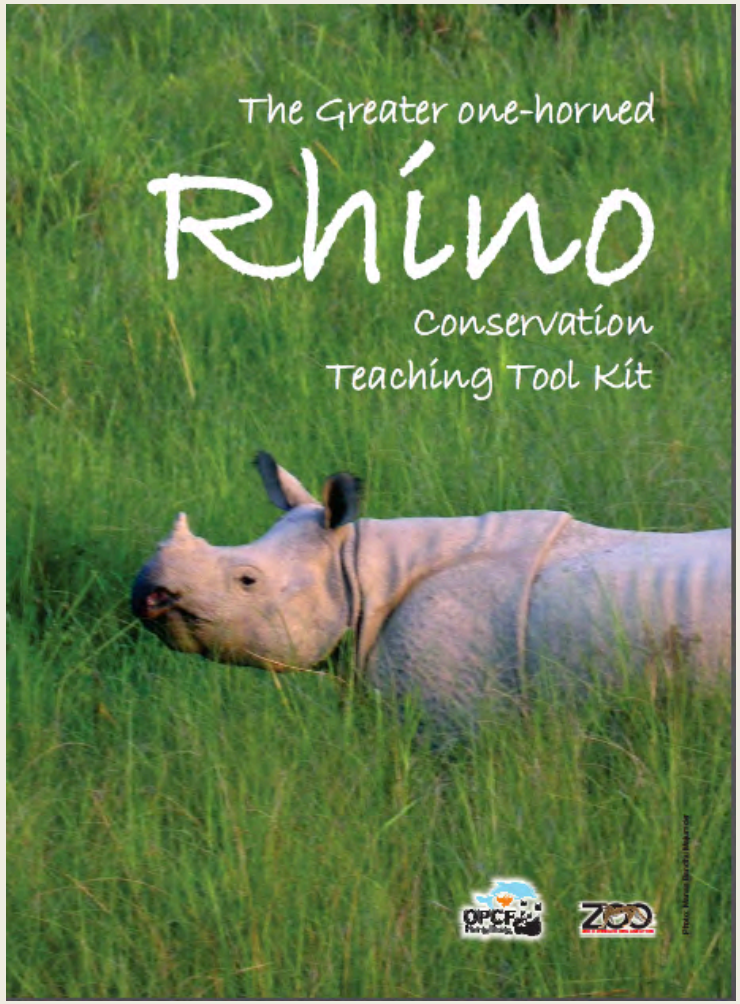
The aim of the teaching guide is **to translate scientific data** about the Greater one-horned rhino from different sources **into stimulating concepts and messages** that appeal to stakeholders and connect with their emotions and personal benefits.



Rhino teaching guide

Creates interest among target groups and **helps to contribute at the individual level** to help protect the species and their habitats.

The approach is to teach and to attract non-traditional as well as traditional **educators to adopt new teaching techniques and activities**, which are more effective in influencing comprehension, retention and behavioural changes.



Rhino education packets are used during awareness programs



Rakhi **– Friendship bands**



Placards





Two target groups:	**Methods / Tools**
1. Educators	Teacher Training
1. Community	Active leaning tools / packets

Educators: Teacher Training

35-40 Selected dedicated Educators

3 to 5 days training with enough time to practice

Network of educators for future awareness programs

Training objectives:

1. To empower educators to teach about conservation importance of Rhino and to confront the issue of conflict and



2. to demonstrate innovative teaching and learning techniques designed to change human attitudes and behaviour for the better



Teaching method

The education modules that we use are designed to provide a systematic exploration of the topic using the scientific thinking processes.

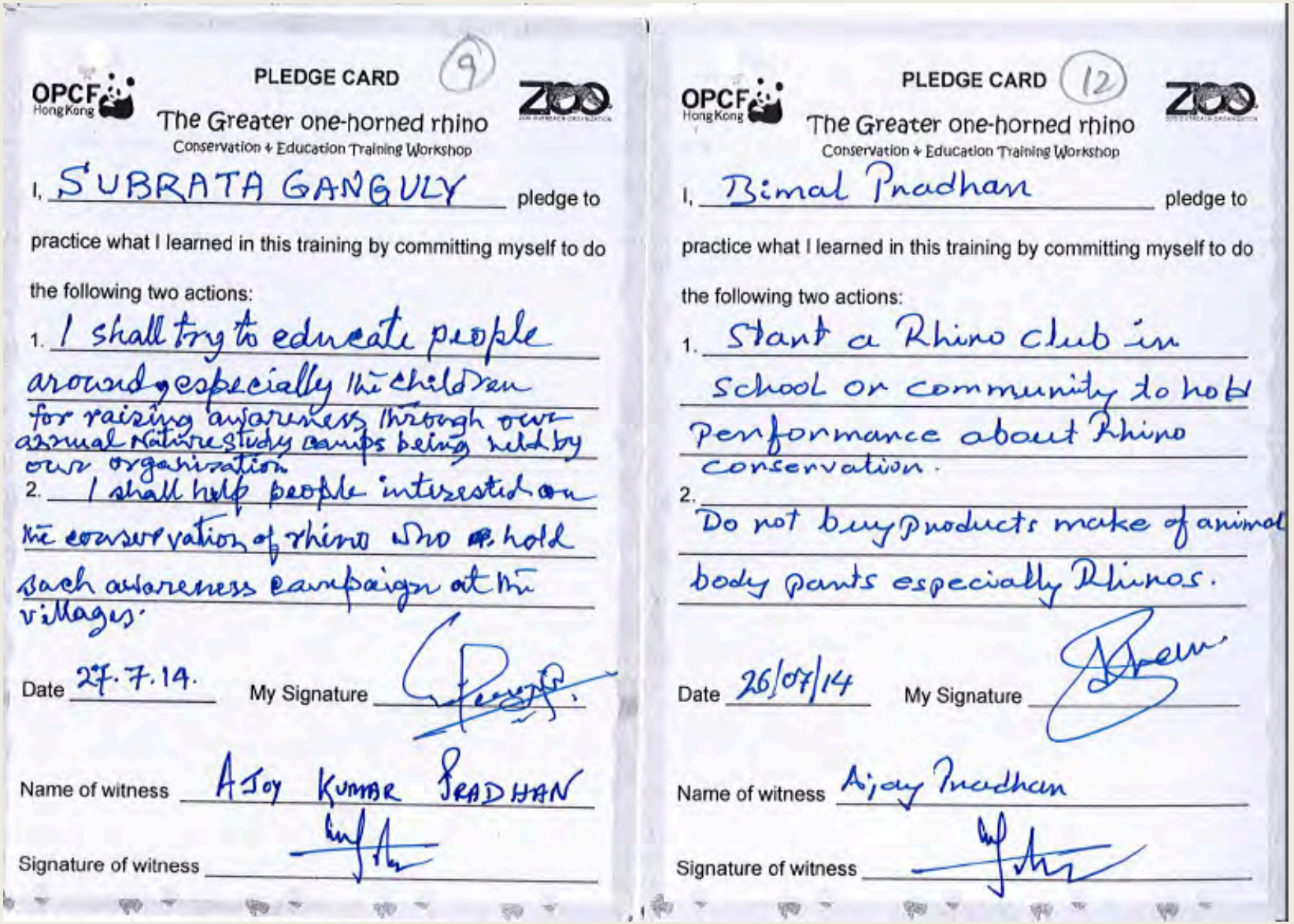
Primary target group: Educators, Lataguri, NB







Teachers' training Program



PLEDGE CARD (9)

OPCF Hong Kong

The Greater one-horned rhino

Conservation + Education Training Workshop

I, SUBRATA GANGULY pledge to practice what I learned in this training by committing myself to do the following two actions:

1. I shall try to educate people around especially the children for raising awareness through our annual Nature study camps being held by our organisation.
2. I shall help people interested on the conservation of rhino who hold such awareness campaign at the villages.

Date 27.7.14. My Signature

Name of witness AJOY KUMAR PRADHAN

Signature of witness

PLEDGE CARD (12)

OPCF Hong Kong

The Greater one-horned rhino

Conservation + Education Training Workshop

I, Bimal Pradhan pledge to practice what I learned in this training by committing myself to do the following two actions:

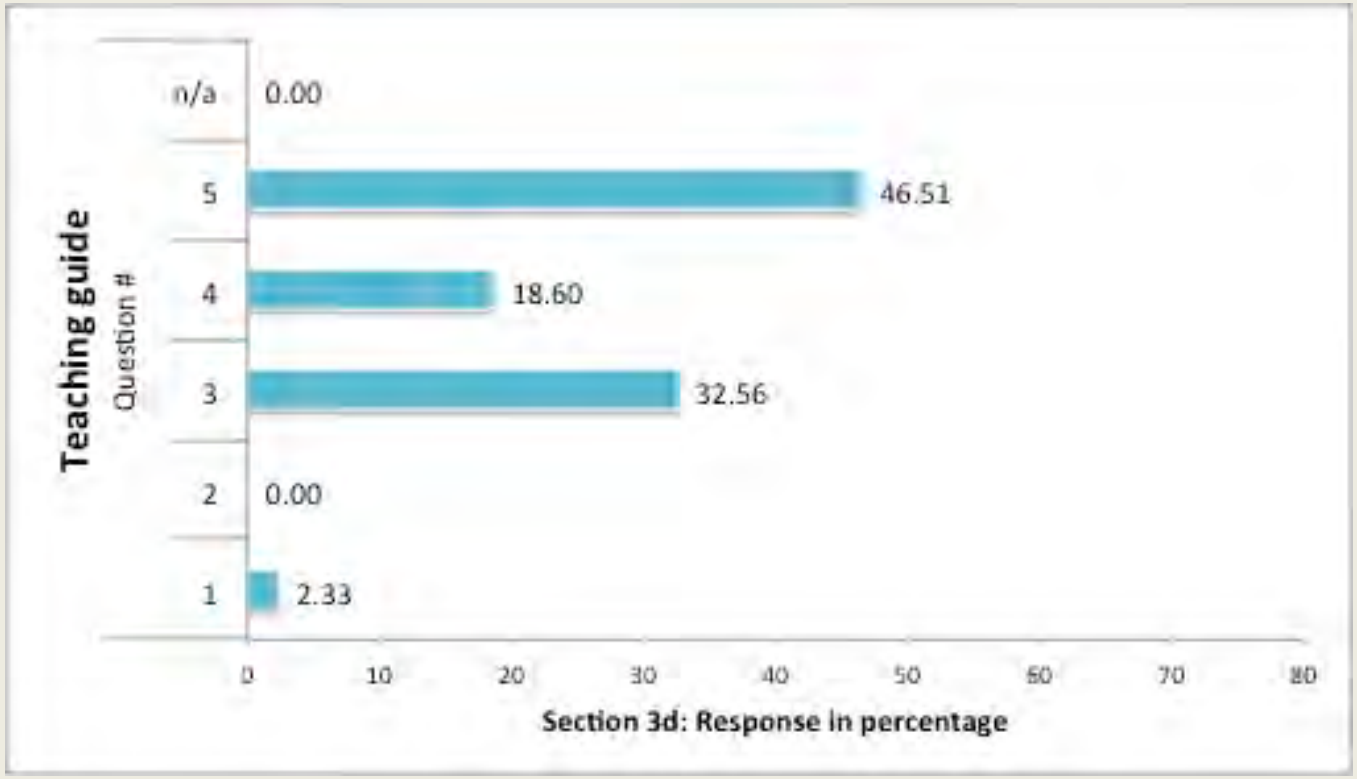
1. Start a Rhino club in school or community to hold Performance about Rhino conservation.
2. Do not buy Products make of animal body parts especially Rhinos.

Date 26/07/14 My Signature

Name of witness Ajay Pradhan

Signature of witness

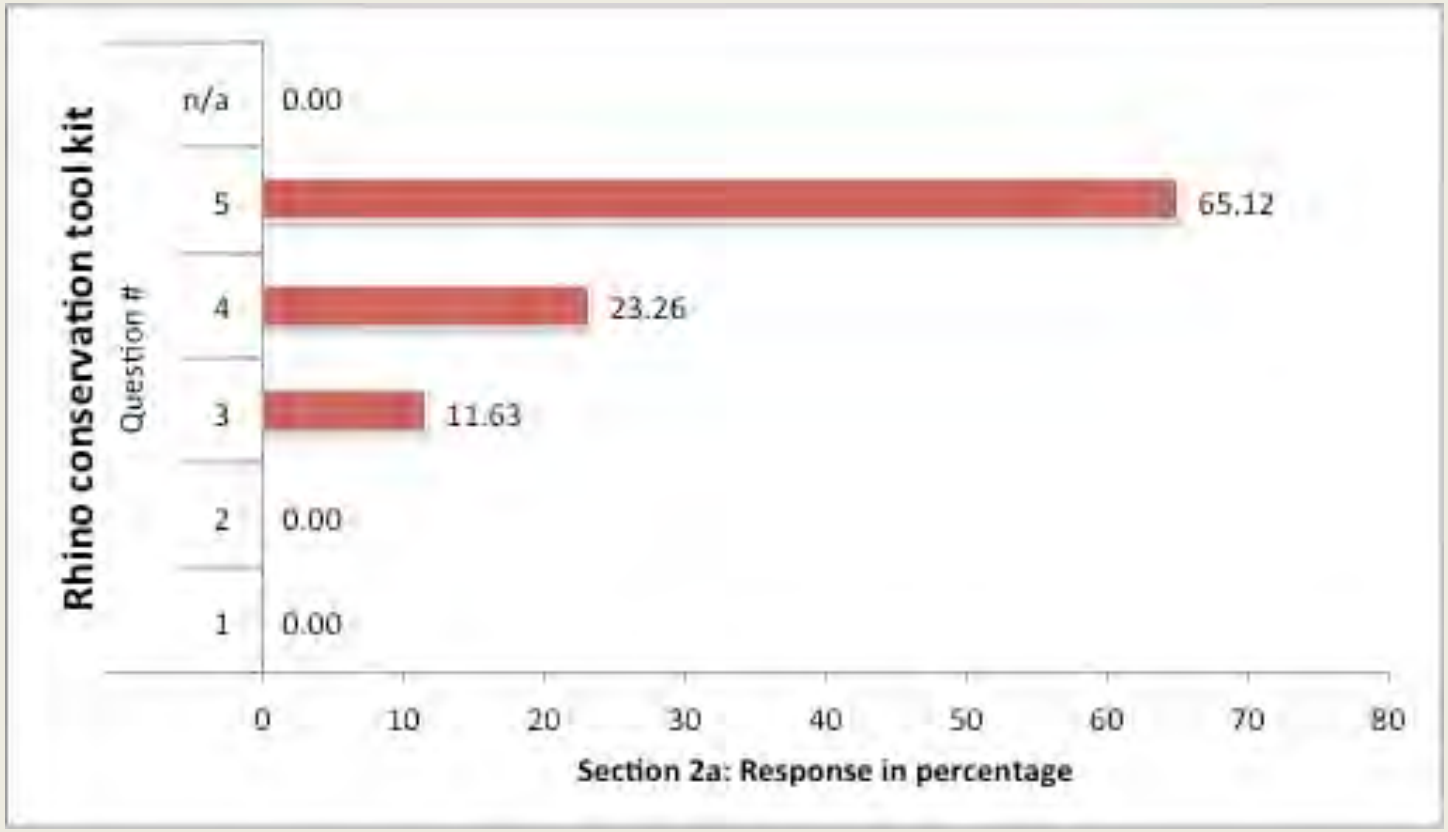
The participants commit to do two quick awareness programs with in three months after the training



n=90

Teaching guide

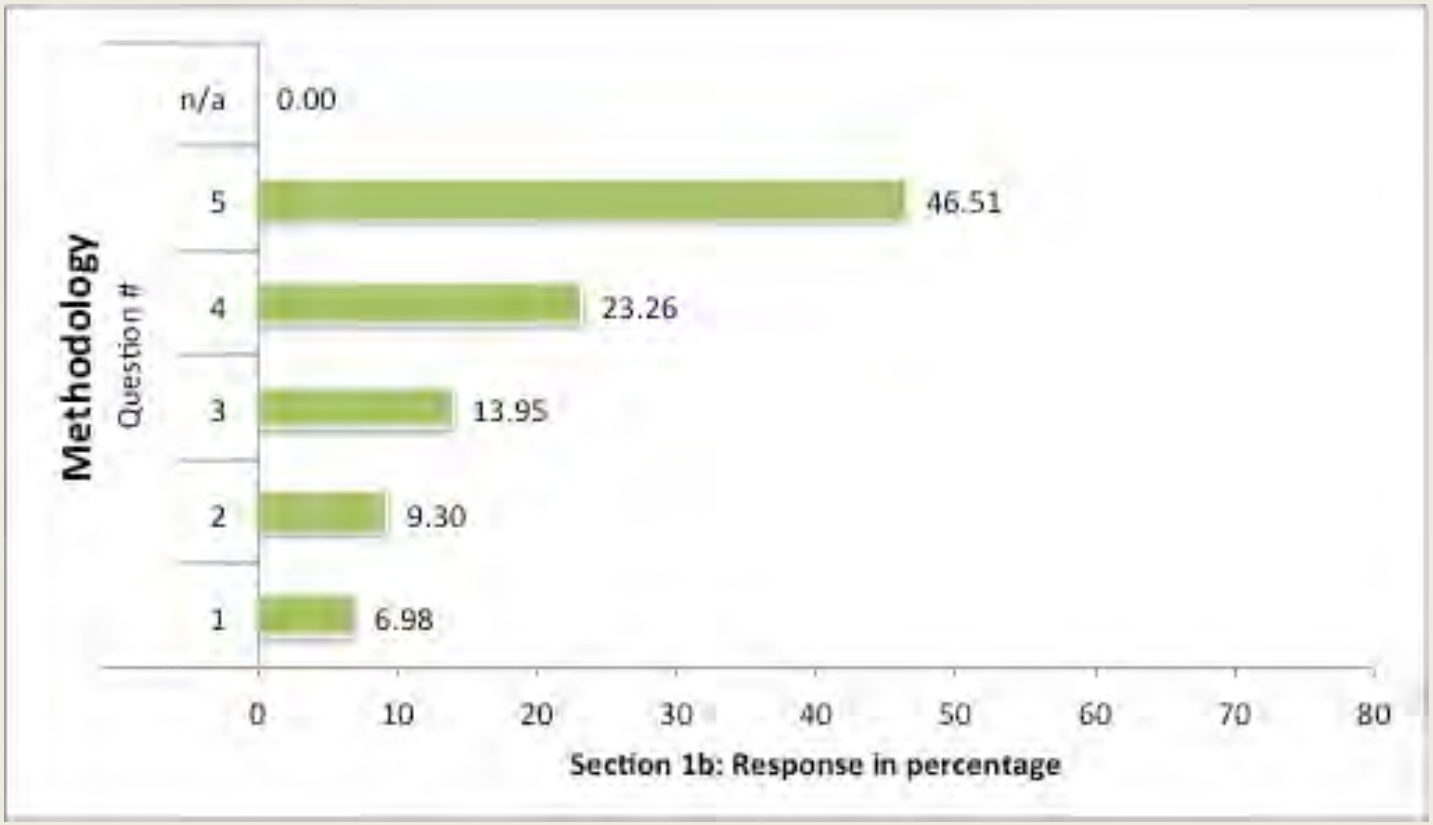
1. The Rhino tool kit has very high technical information
2. The Rhino tool kit is difficult to understand and practice
3. The Rhino tool kit has many useful information and nicely presented
4. The Rhino tool kit is good
5. The Rhino tool kit was user friendly and very useful



n=90

Rhino tool kit (packet and manual)

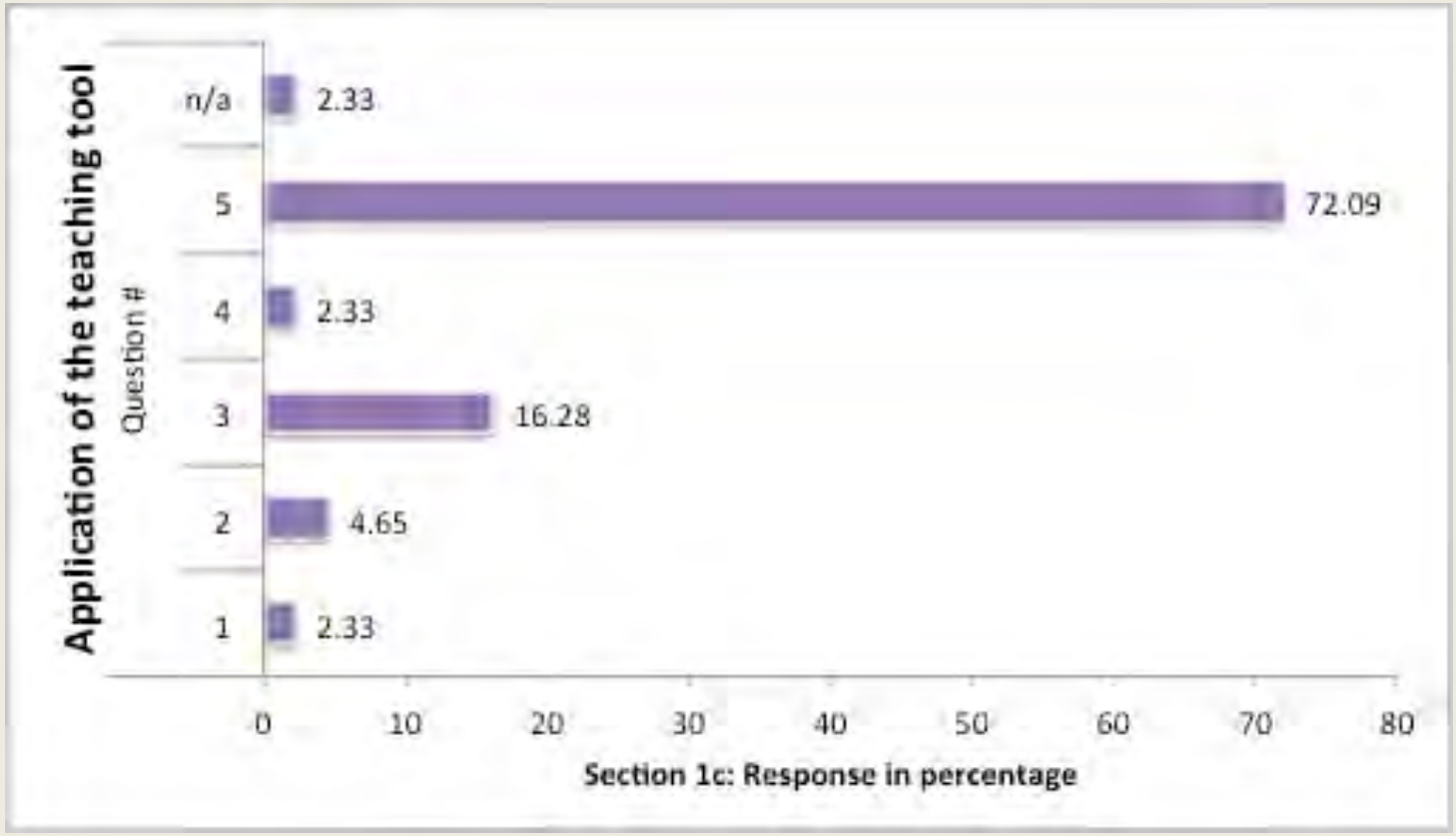
1. The teaching took kit is highly technical and not reader friendly
2. The teaching took kit cannot be used by me but can be used by colleagues
3. The teaching took kit is just usable
4. The teaching took kit is appropriate for use to use and teach
5. The teaching took kit is very good and very useful to teach



n=90

Methodology

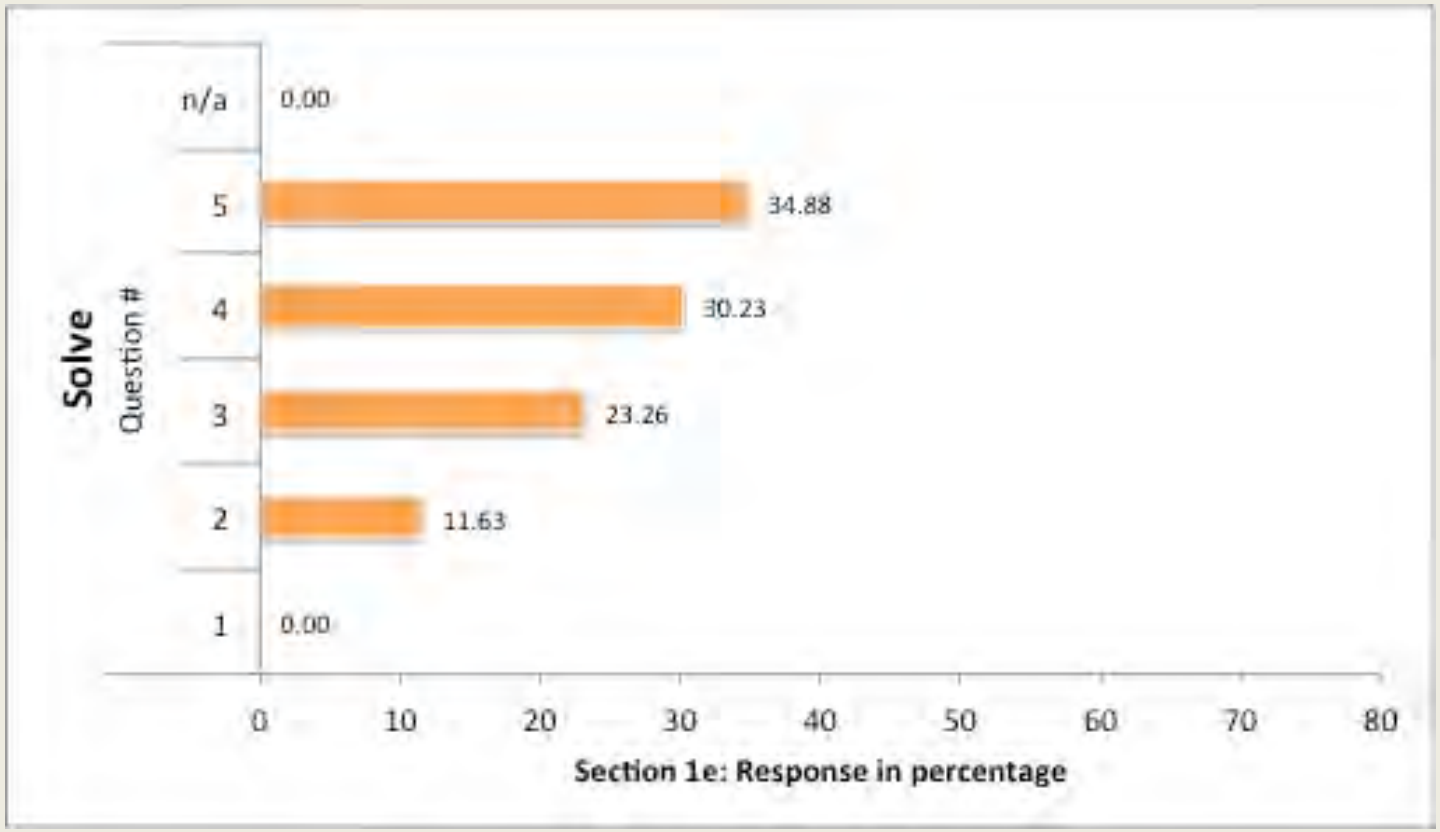
1. I am aware of this kind of teaching methods given in this training
2. Most of the teaching methods are known to me
3. Some of the teaching methods are known to me
4. I am aware of one or two teaching methods given in this training
5. This method of teaching is completely new to me



n=90

Application of the teaching tool

1. This teaching tool cannot be applied in my State / Village
2. Most of the teaching tools can be applied in my State / Village
3. Some of the teaching tools can be applied in my State / Village
4. A few teaching tools can be applied in my State / Village
5. This teaching tool is most useful and can be fully applied in my State / Village

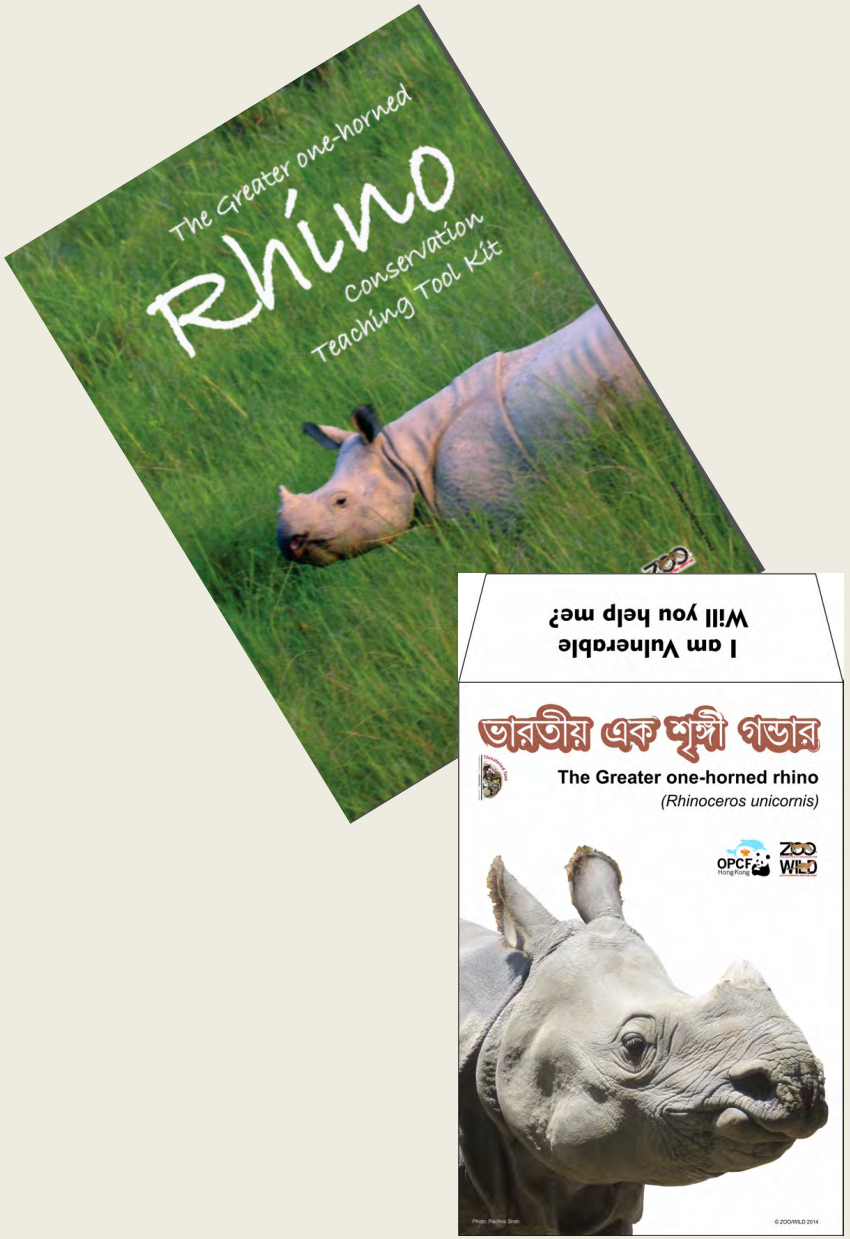


n=90

Usefulness

1. This training will not help to conserve Rhino in my State
2. This training may help to conserve Rhino in my State
3. This training will help to a certain extent to Rhino in my State
4. This training will help to conserve Rhino in my State
5. This training will definitely help to conserve Rhino in my State

The greatest advantage of this module is that it can be used with a variety of audiences such as children, school and college students and also both with literate and illiterate adults.





Ultimate target group(s)

Around Gorumara National Park

School students of age 12 – 15

A school program for municipality run children school, Jharmatiali, Matiali Block, Jalpaiguri District








Don't buy
rhino horn products


Don't buy
rhino horn products




The Greater one-horned rhino
(Rhinoceros unicornis)
I am Vulnerable
Will you help me?
ভারতীয় এক শৃঙ্গী গন্ডার

Ultimate target group(s)



Village community program in the primary school campus in Ramsai Village

Ultimate target group(s)



Children who live very close to the Protected areas



Ultimate target group(s)

Program for mixed age group





Ultimate target group(s)

Specially challenged children







Ultimate target group(s)

Students from Urban areas

Play way method of learning

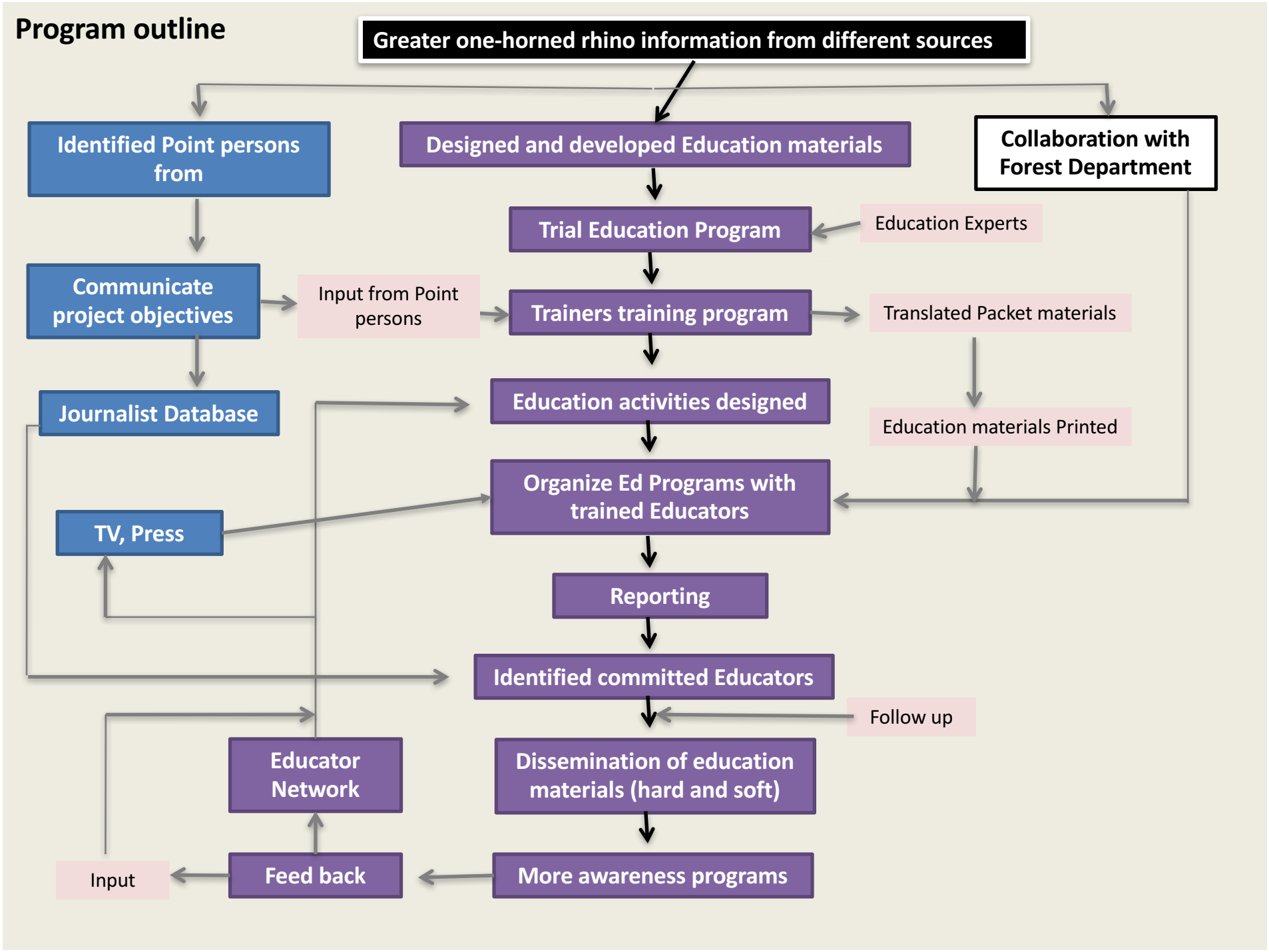






Pro

Commit to help Rhino Survival


Program outline
Greater one-horned rhino information from different sources
Identified Point persons from
Designed and developed Education materials
Collaboration with Forest Department
Trial Education Program
Education Experts
Communicate project objectives
Input from Point persons
Trainers training program
Translated Packet materials
Journalist Database
Education activities designed
Education materials Printed
Organize Ed Programs with trained Educators
TV, Press
Reporting
Identified committed Educators
Follow up
Educator Network
Dissemination of education materials (hard and soft)
Input
Feed back
More awareness programs



The trainees after the training conducted education programs reported us. Thus the reports helped us to evaluate the impact of the effort.

Thank you for listening

Forest Department, West Bengal

Thanks to Ocean Park Conservation Fund, Hong Kong for the initial funding to design and develop the concept and USFWS for my travel to attend this symposium and for the upcoming programs in West Bengal and Uttar Pradesh, India. Thanks to the Forest Department, West Bengal for their support & Nature Wildlife Conservation Society, Jalpaiguri, North Bengal.

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The Use of Audio Playback to Deter Crop-Raiding Asian Elephants

Evan Bittner

Thursday November 17th 2016

15th International Elephant & Rhino Research Symposium





Wildlife Society Bulletin 40(2):375–379; 2016; DOI: 10.1002/wsb.652

Tools and Technology

The Use of Audio Playback to Deter Crop-Raiding Asian Elephants

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B. V. P. PERERA, *Elephant Transit Home, Department of Wildlife Conservation, Udewalawe, Sri Lanka*
ROGER RASSOOL, *School of Physics, University of Melbourne, Parkville, VIC 3010, Australia*
EVAN P. BITTNER,[1] *Faculty of Veterinary and Agricultural Sciences, University of Melbourne, Parkville, VIC 3010, Australia*

ABSTRACT Human–elephant conflict (HEC) and poaching are the foremost threats to the survival of elephants (African, *Loxodonta africana*; Asian, *Elephas maximus*) in their natural environments. Reducing HEC has the potential to save hundreds of elephant and human lives annually across Asia and Africa. Lone adult male elephants are the principal crop raiders; therefore, we investigated the effectiveness of a variety of audio playbacks at deterring 22 wild adult male Asian elephants from food sources in a wildlife reserve in southern Sri Lanka in January, 2011. Food was provided *ad libitum*, and the reactions of the elephants in response to various stimuli were recorded and analyzed. Vocalizations from a wild Asian elephant matriarchal group resulted in a flight response in 65% of trials conducted, in contrast to a control sound, a chainsaw, which produced no flight responses from any adult male. We demonstrated that audio playbacks could be used as a short-term deterrent to wild adult male Asian elephants from crop raiding; thus, providing a simple, natural, cost-effective, and humane way of mitigating HEC. © 2016 The Wildlife Society.

KEY WORDS Asian elephant, human–elephant conflict, Sri Lankan hornet, vocalization.

African (*Loxodonta africana*) and Asian (*Elephas maximus*) elephant populations have been in decline over the past few

approximately 5,000 elephants left in Sri Lanka by 2011 (Fernando et al. 2011); with the human population expected

Aliya: Elephants in Sri Lanka

- Well over 10% of the global Asian elephant population (approx. 5879 on the entire island) in less than 2% of the remaining elephant range (DWC data 2011)
- One of the highest human densities of any elephant range country
- Recognised as a distinct subspecies
- Association with elephants extends back millennia
- Elephant's hold central position in the countries two main religions, Buddhism and Hinduism, as well as Sri Lankan Culture



Data and Figure: Fernando *et al.* 2011

Current elephant Distribution



- Areas of dist. highlighted by the heavy red line
- Absent in areas demarcated by thin red line
- Green areas represent DWC protected zones

Fernando *et al*. 2011

Human-Elephant Conflict (HEC)

- Foremost threat to the survival of elephants in their natural habitat
- In 2010 accounted for 227 elephant and 81 human deaths in Sri Lanka alone (Fernando *et al*. 2011)
- With exponential increases in human population expected, HEC will only increase as an issue worldwide
- Current mitigation methods are ineffective or too expensive to implement

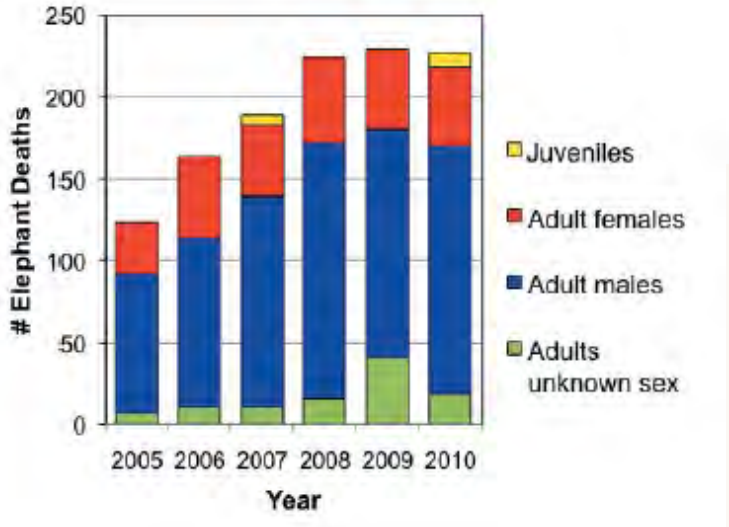


Table 1. Causes of elephant deaths recorded annually 2005-2010 (DWC data).

Year	2005	2006	2007	2008	2009	2010	Total
Shot	73	93	85	123	113	87	574
Unknown	14	16	40	30	49	30	179
Electrocuted	9	21	19	20	19	17	105
Train accidents	14	7	23	18	14	14	90
Natural (old age)	3	4	16	22	8	2	55
Poisoned	0	3	6	10	4	8	31
Hakka-patas	0	0	0	0	0	11	11
Other	10	19	0	1	21	58	109
Total	123	163	189	224	228	227	1154

Fernando *et al.* 2011

A Future with Elephants

Background Research

Anecdotal Evidence

- “the African elephants could not stand the smell and trumpeting of the enemy’s Asian elephant army...”

  - *Elephants,* C Spinage 1994

- “The entire herd of African elephants fled immediately at the vocalisations of the Asian elephant, not even the Bull stood his ground...”
- “The zookeeper had never before seen behaviour anything like this...”

  -Natures Masterpiece; available from www.brainsmatter.com (Ep. 78)

A Future with Elephants

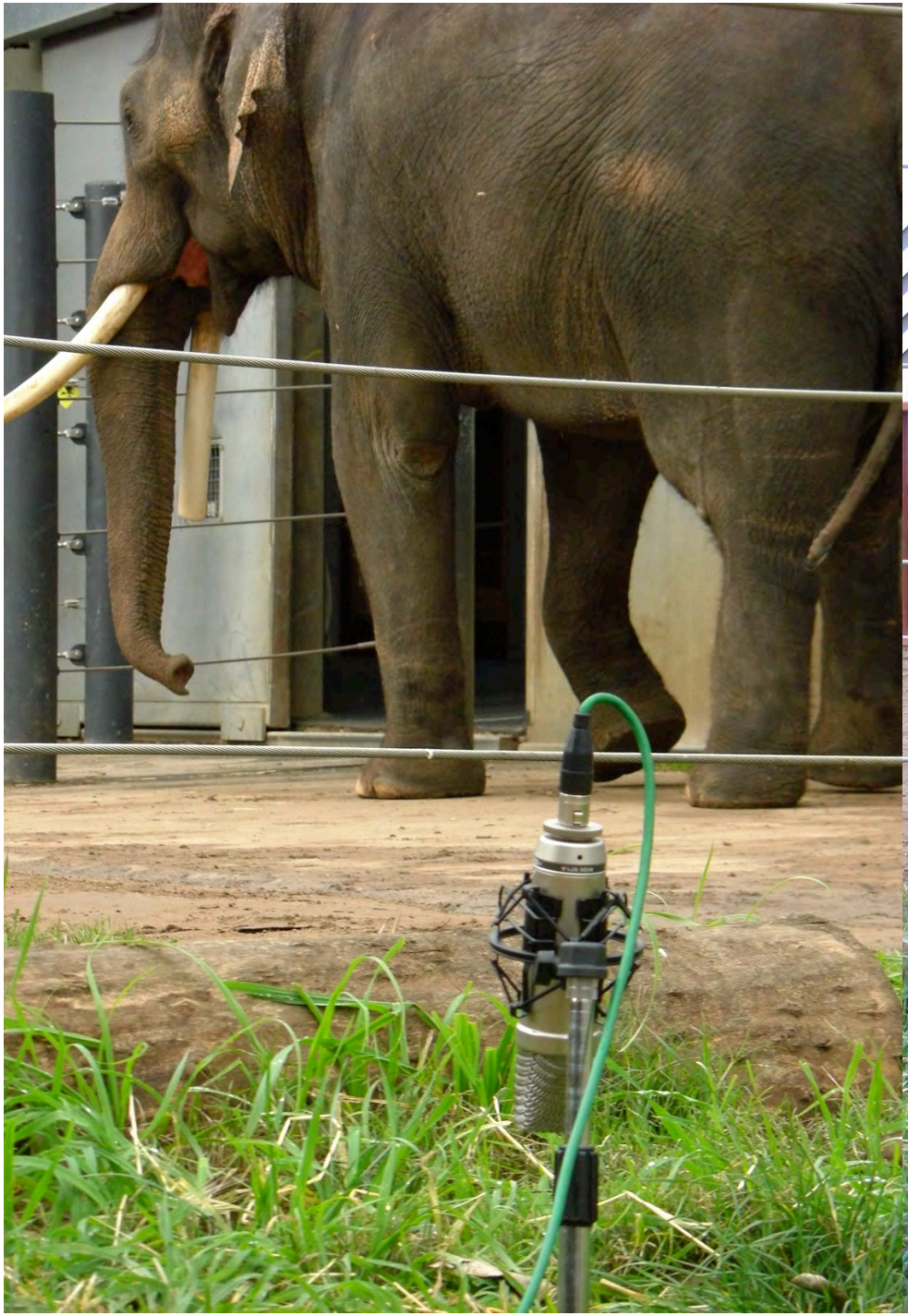
Background Research

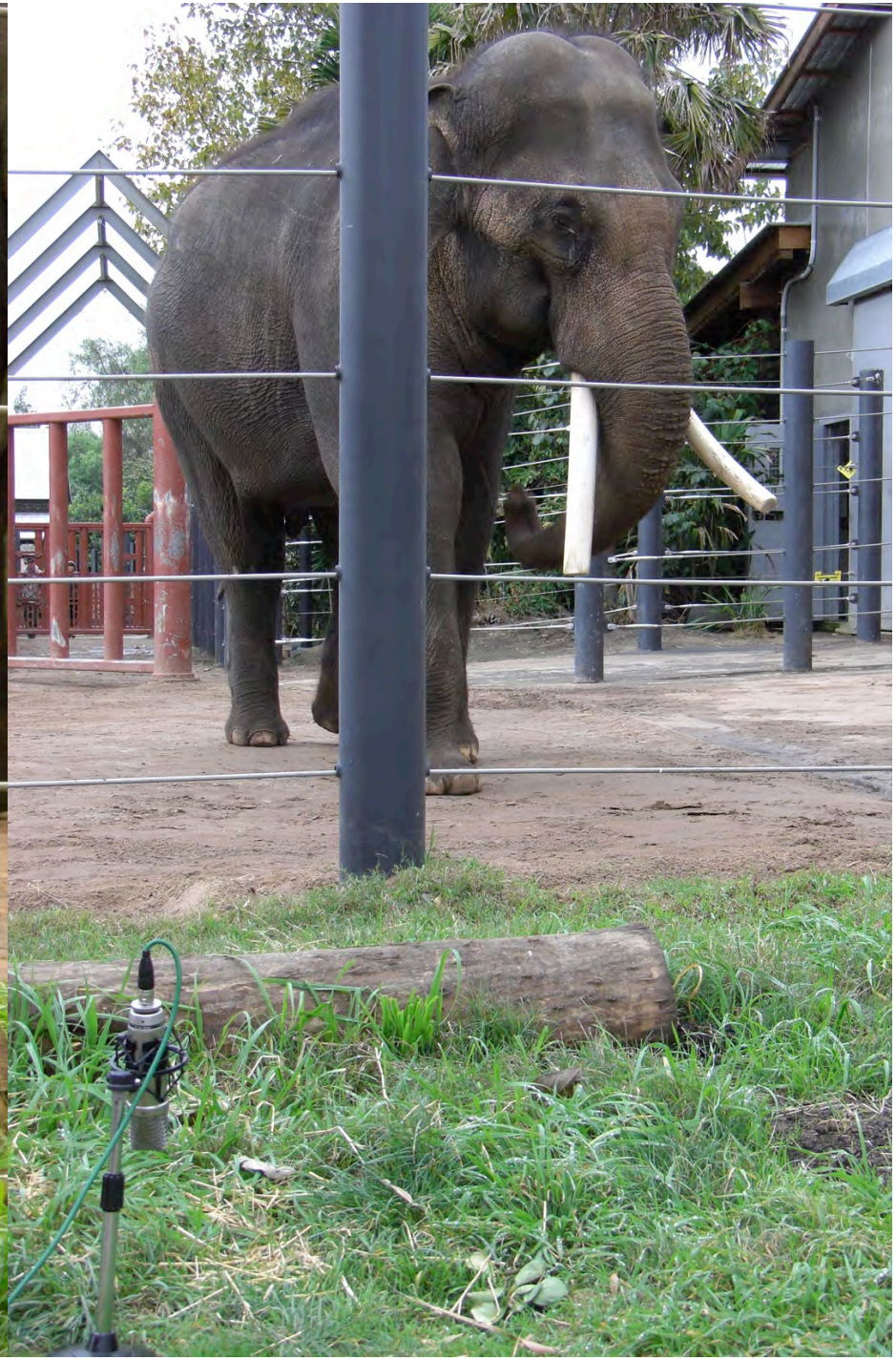
Scientific Evidence

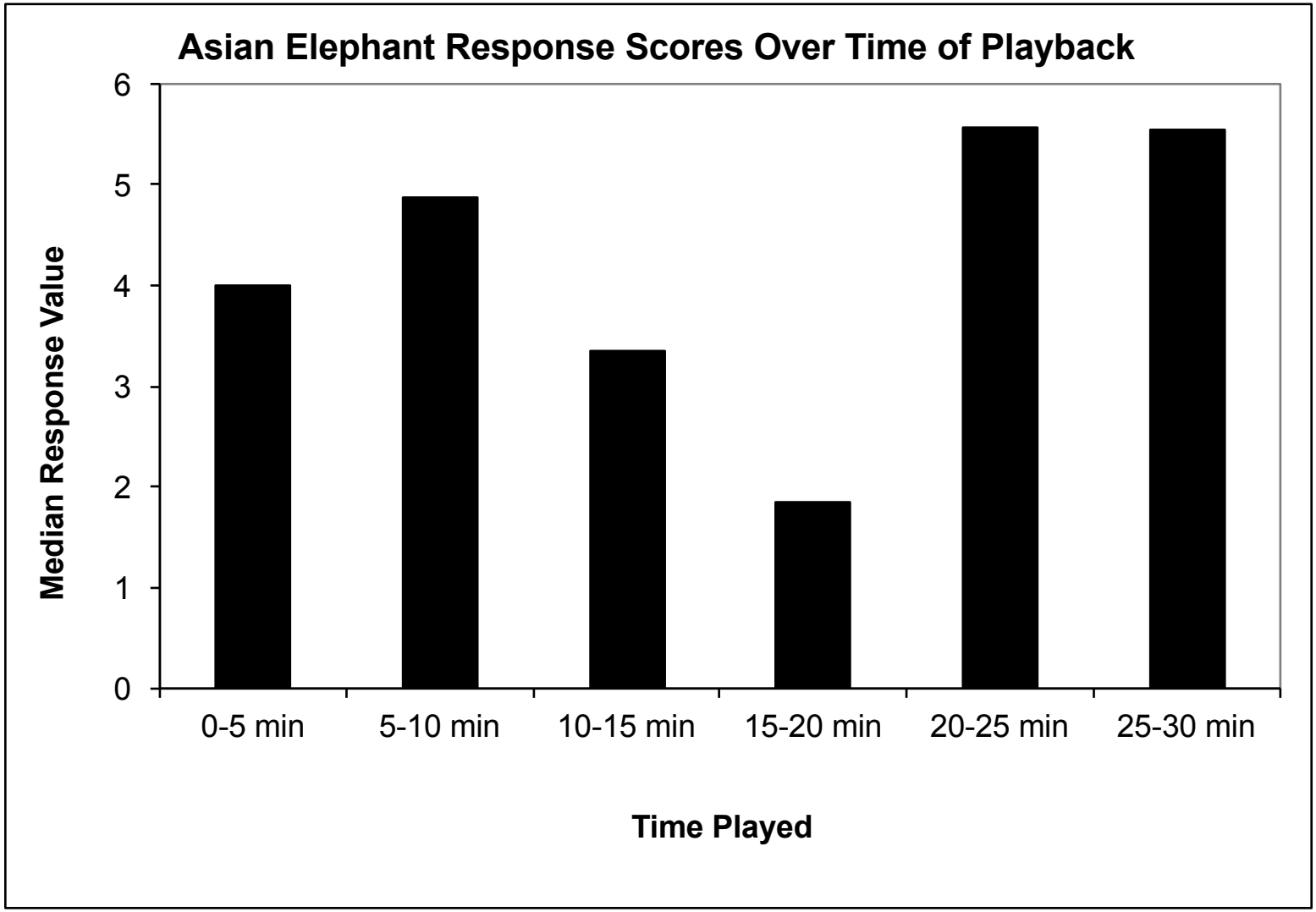
- Helena Harrington – Field recording of wild Asian elephants in Bandipura National Park and Tiger Reserve, Karnataka, India (2004)

- Melanie Ross – Playback recordings to determine if captive elephants in Perth Zoo could distinguish between elephant calls an similar, non-animal sounds (2006)

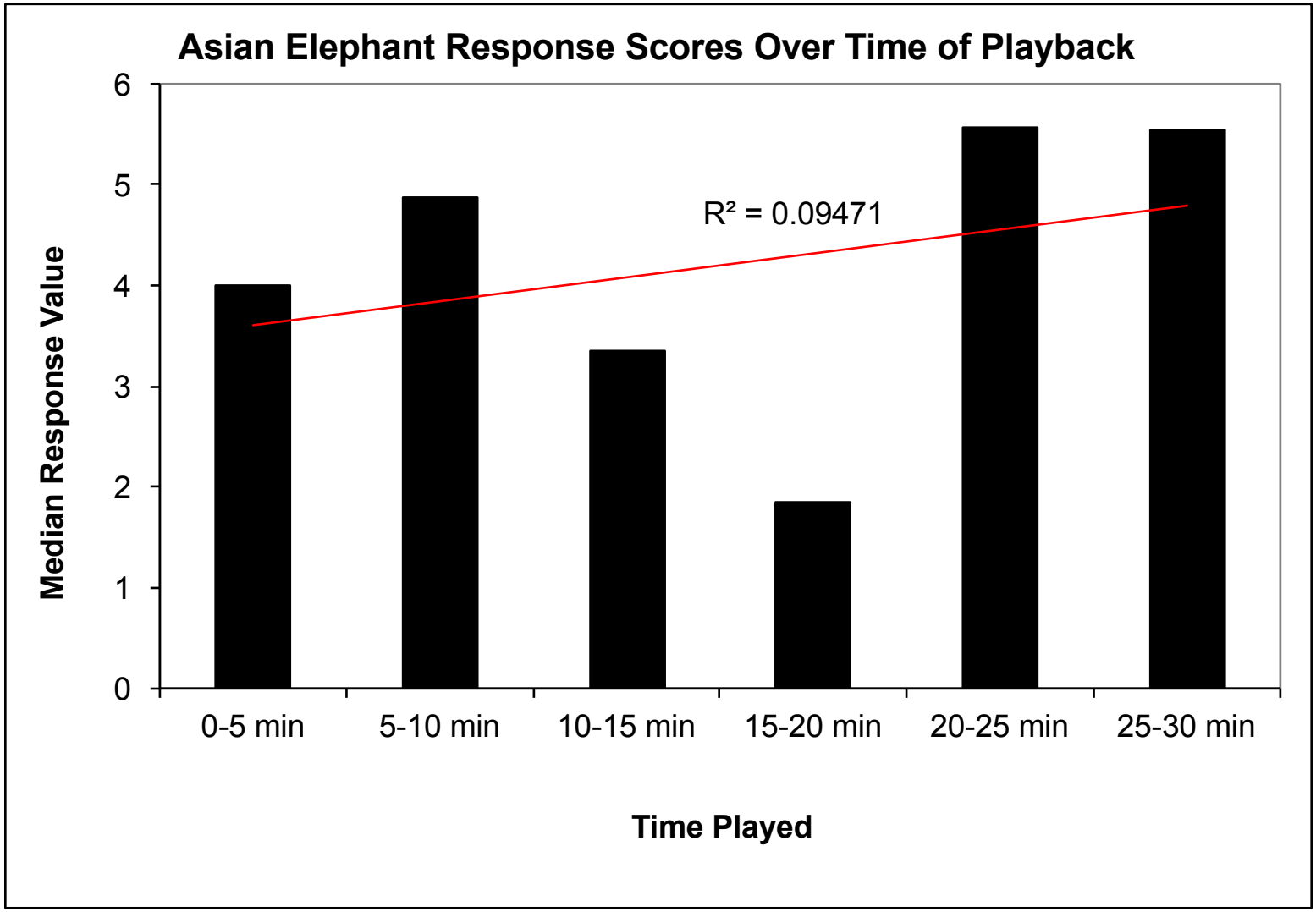
A Future with Elephants



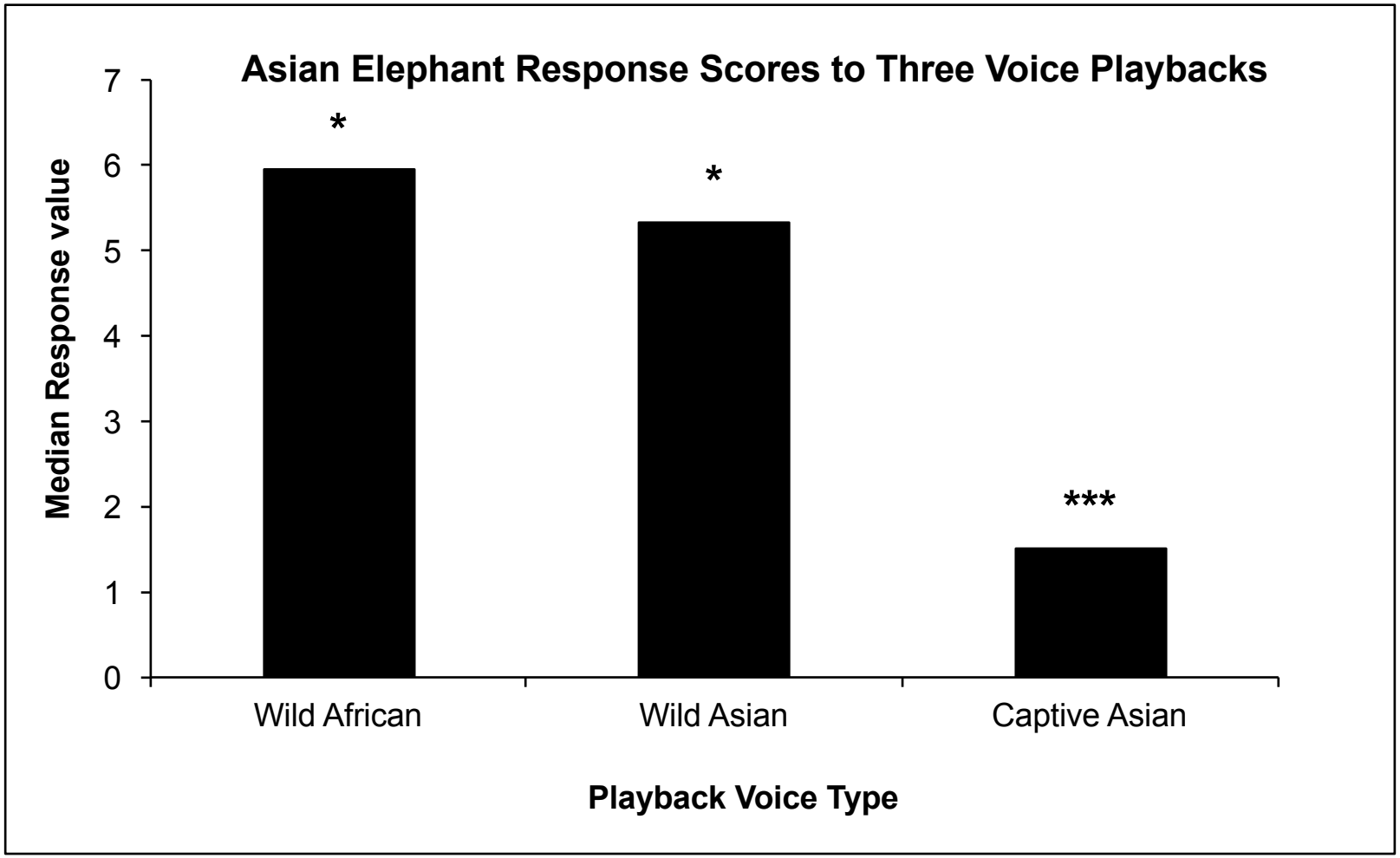




Bittner, E. (2008)



Bittner, E. (2008)



* p= <0.05, *** p= <0.001

Bittner, E. (2008)

Background Research

Previous research has established that Asian elephant's…

- can distinguish between control sounds and pre-recorded vocalisations
- can distinguish between the vocalisations of Asian and African elephants
- can distinguish between vocalisations of individual elephants and groups of elephants
- have predictable and repeated behavioural responses to certain vocalisations and sounds





A Future with Elephants

Background Research

Dr. Lucy King working with African elephants successfully showed the African elephants…

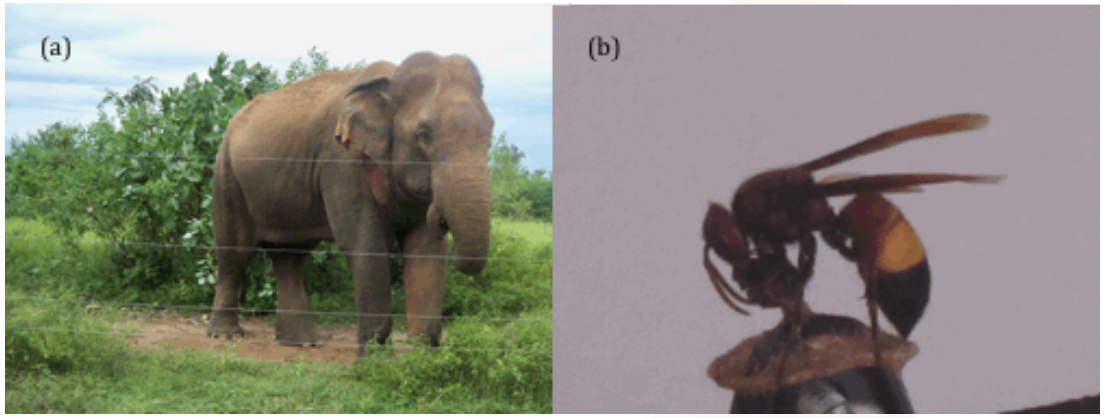
- Recognise, and are fearful of the sound of swarming African honey bees
- Will flee from the playback of these sounds
- Elicit an alarm call in response to this sound
- Will also flee from the playback of the recorded alarm call

Vallrath & Douglas-Hamilton 2002, King *et al.* 2007, 2010



A Future with Elephants

Sri Lankan Research



(a) Wild Asian bull (*Elephas maximus*) photographed during experiments behind the electric fencing on the periphery of the Udawalawa National Park. (b) Sri Lankan hornet or "Debara" (*Vespa affinis affinis*)

A Future with Elephants

Sri Lankan Research

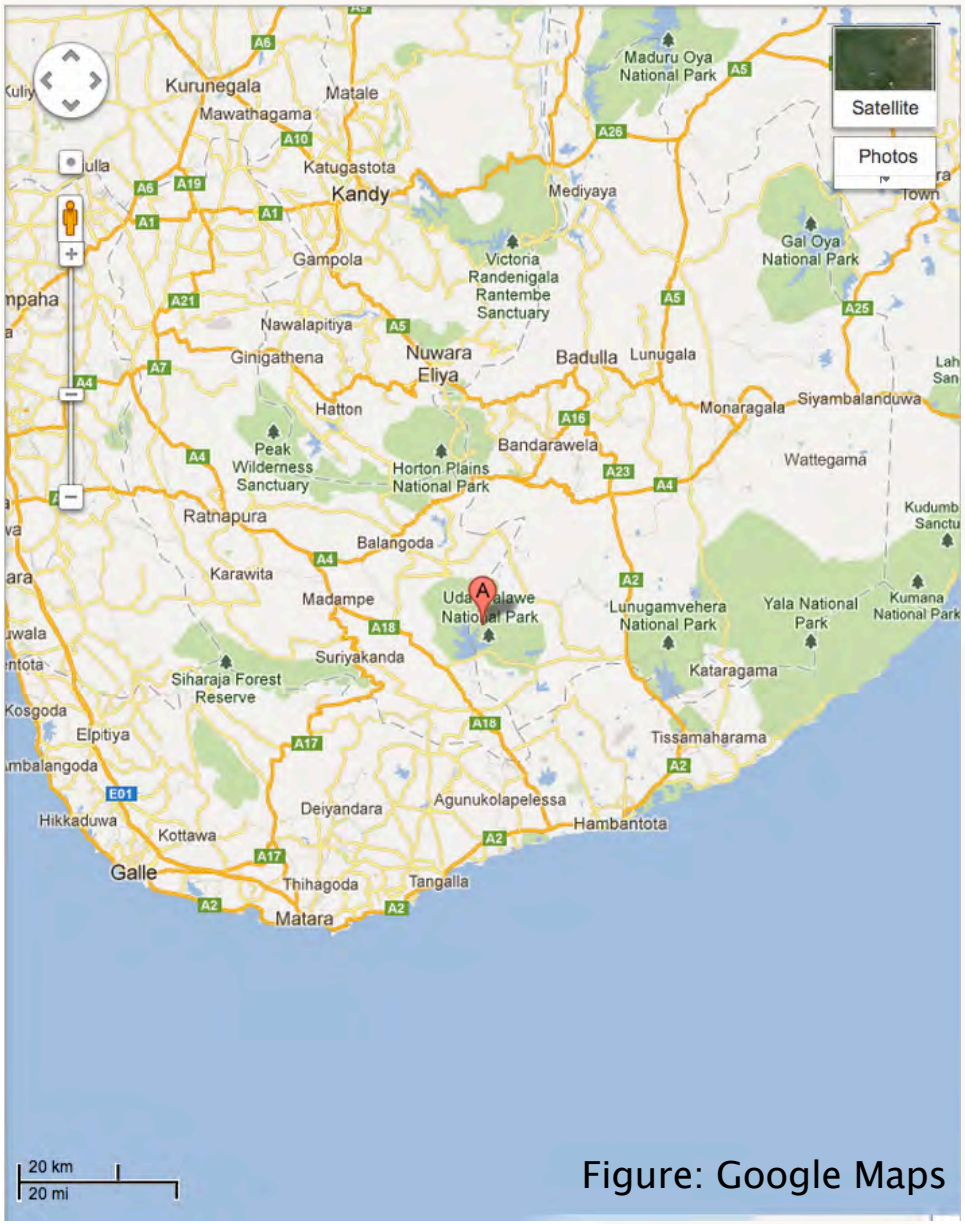
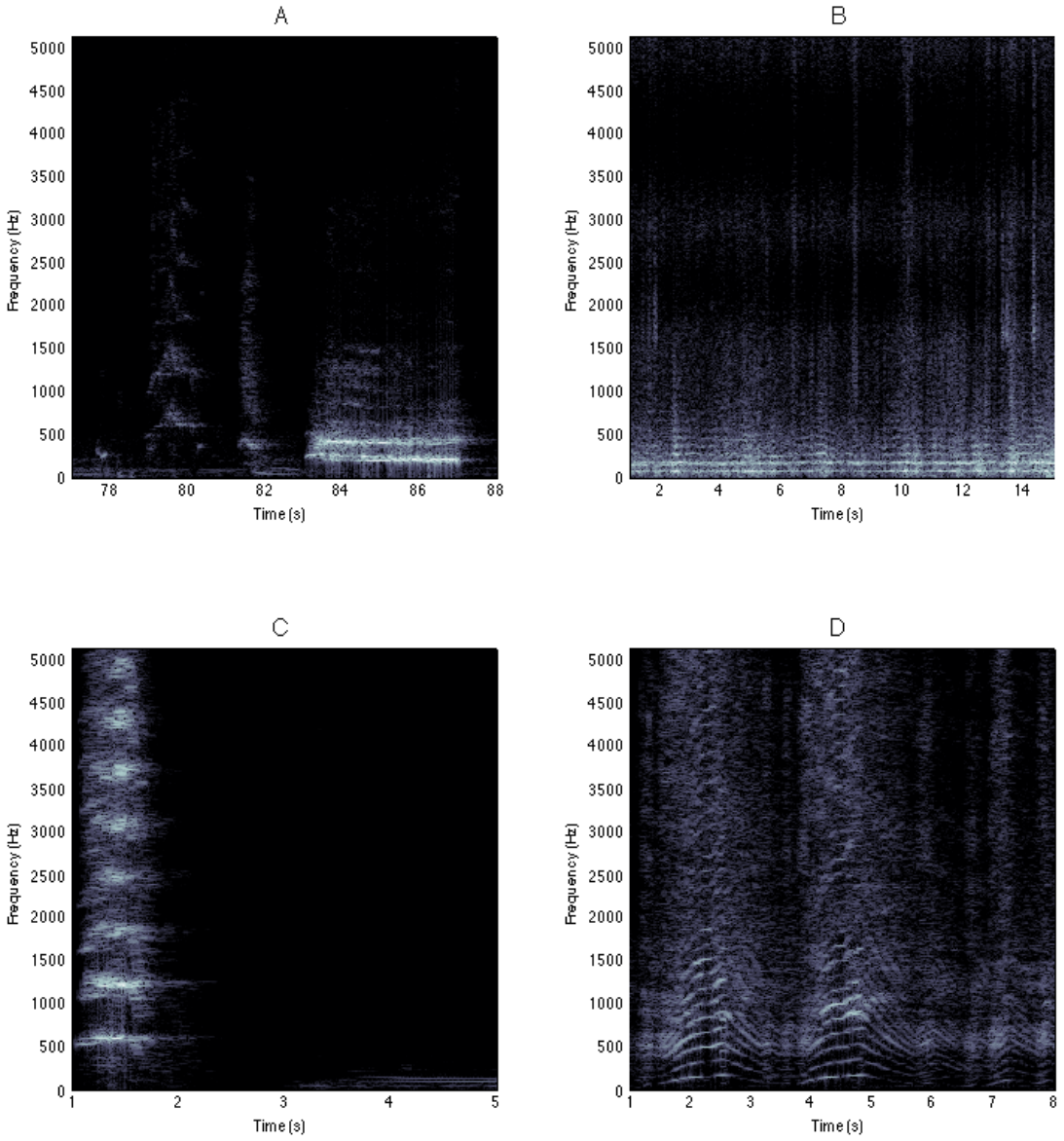


Figure: Google Maps

Playback experiments were conducted using wild Asian bull elephants (n=22) in Udawalawa National Park (30821 ha), on the boundary of Sabaragamuwa and Uva provinces in Southern Sri Lanka.

A Future with Elephants

Sri Lankan Research



A. Wild Asian elephant Matriarchal Family Group
B. Disturbed Sri Lankan hornets
C. Lone (wild) Female Asian Elephant
D. Control Sound (Chainsaw)

A Future with Elephants











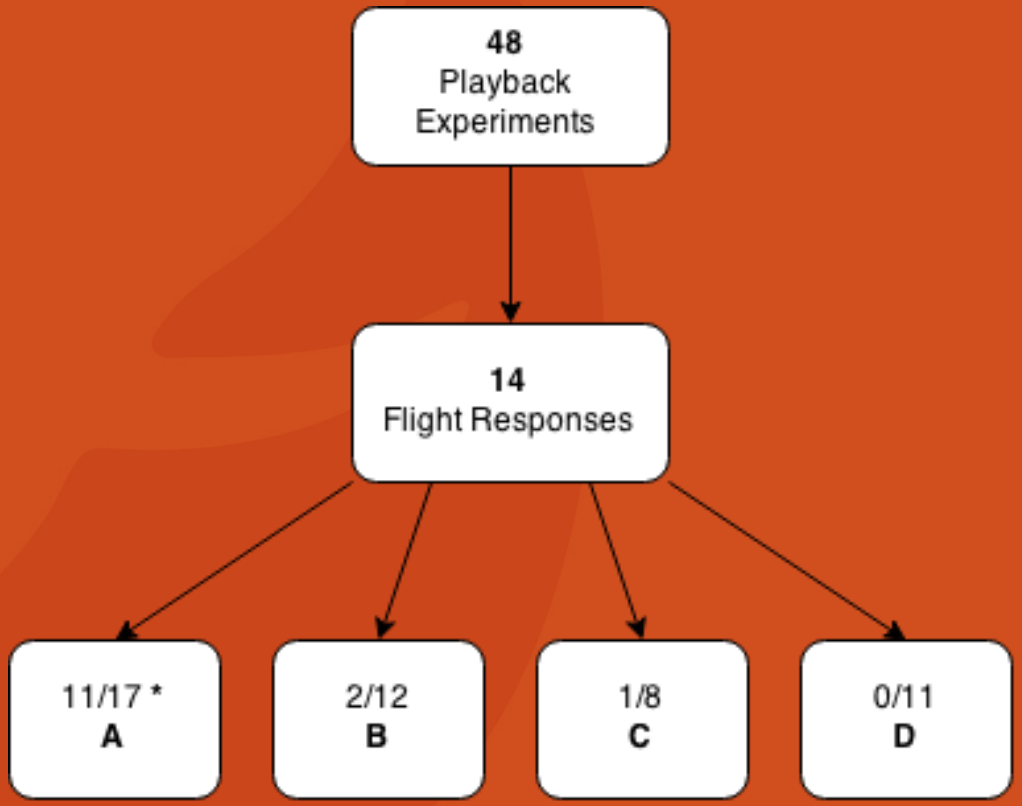






Results

A. Wild Asian elephant Matriarchal Family Group
B. Disturbed Sri Lankan hornets
C. Lone (wild) Female Asian Elephant
D. Control Sound (Chainsaw)



Wijayagunwardane et al. 2016

Conclusions

- Direct evidence that the playback of appropriate pre-recorded sounds has the potential to elicit a flight response in wild Asian bull elephants
- Male elephants can recognise the sounds of female elephants, and distinguish between the call of a single female or a matriarchal family group
- Male elephants will flee from a group of females but not an individual
- Flight responses to the sounds of swarming hornets are dependent on life experience.

A Future with Elephants

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Is Elephant Proof Trench an effective mitigating measure against Human – Elephant Conflict?



By

B. RAMAKRISHNAN, S. Karthick., G.Sivasubramanian., M. Ilakkia., S. Dineshkumar, A. Balamurugan and B. Murugan

Dept. of Zoology and Wildlife Biology & Dept. of Physics

GOVERNMENT ARTS COLLEGE
UDHAGAMANDALAM, THE NILGIRIS,
TAMILNADU, INDIA

INTRODUCTION

- Human-Elephant Conflict (HEC) causes significant loss of human lives, property and livelihoods each year around the world.
- The HEC is one of the challenging issues posing on elephant conservation across the elephant range countries.
- HEC results in about 400 human deaths and damage to 10,000-15,000 houses and 8-10 million hectares of crops, while over 100-200 elephants die due to human-related activities in each year in the country

- Various methods have been adopted to reduce HEC. These include traditional farm-based deterrents (the use of watchtowers, fires, ditches and loud noises), novel farm-based deterrent.

- Elephant Proof Trench (EPT) has become an increasingly important strategy used nowadays for reducing HEC.

- Although huge amount is being spent every year by state and centrally sponsored schemes, the effectiveness of EPT depends on a number of factors.

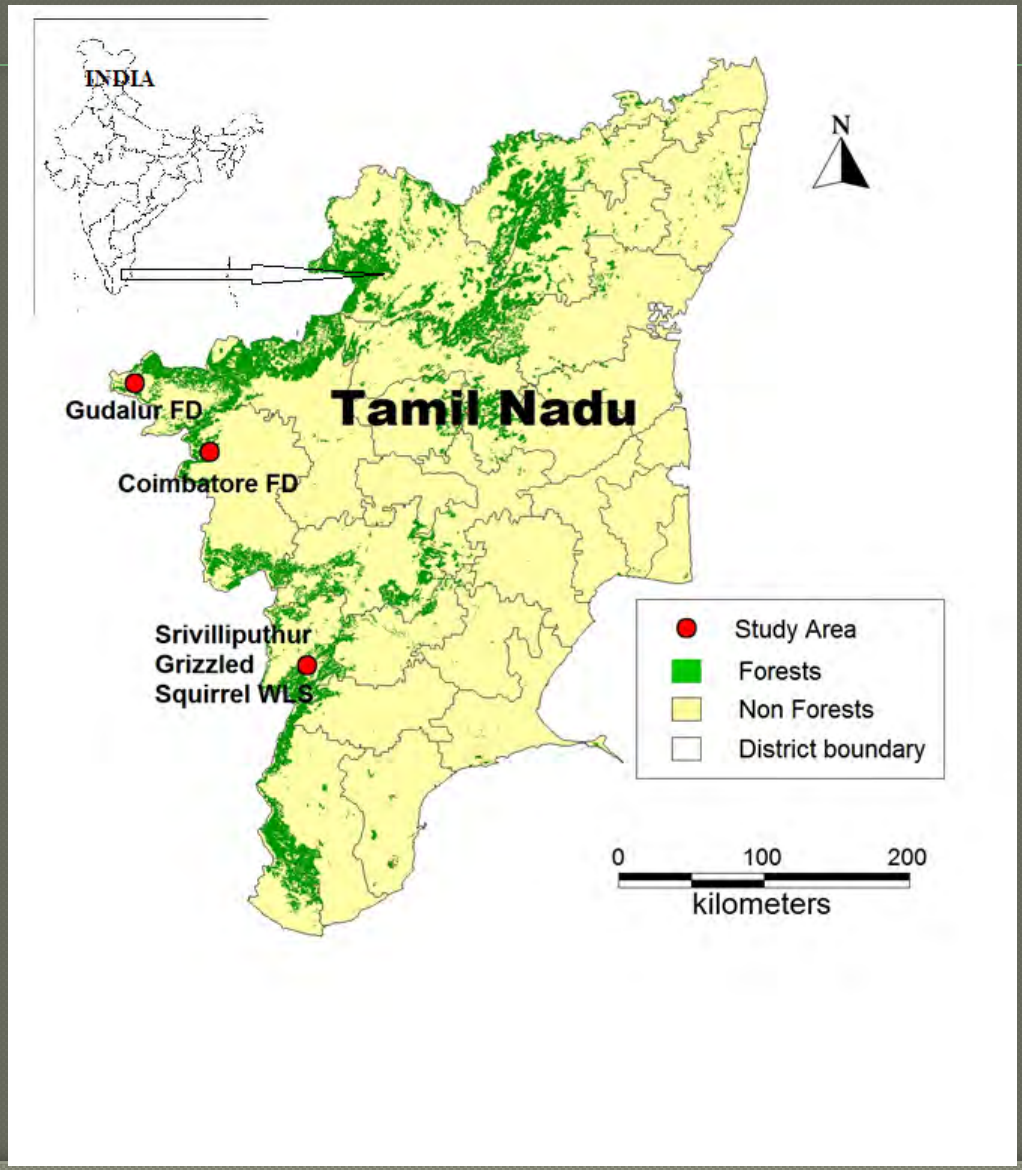
Objectives

- I. To assess the efficacy of EPT.
- II. To find out the extent of use by various mammalian species along the EPT
- III. To understand the peoples' perceptions on EPT and
- To suggest feasible management implications to the managers.

STUDY AREA

- Coimbatore Forest Division (CFD)
- Gudalur Forest Division (GFD)
- Grizzled Giant Squirrel Wildlife Sanctuary (GGSWS)

Locations of focused study areas in the Western Ghats



METHODOLOGY

I. Assessment of EPT

- The effectiveness of EPT was assessed by Encounter Survey (Ramakrishnan, 2008).

II. Animal density estimation along the EPT was assessed by Line transect method & Quadrate Method

Totally 75km transects were laid in CFD (48), GFD (17) and GGSWS (10). Similarly 150 quadrates were laid to study indirect evidences in CFD (96), GFD (34) and GGSWS (20). The length of each transect was 2 km and size of each quadrat was 50m x 20m

III. People's perception on EPT

Questionnaire method was used to understand people's perception on EPT.

"Precise and closed" and "Broad and open ended" types of questions were conducted from 311 persons.

Totally 110 personnel from CFD, 95 from GFD and 106 persons from GGSWS were met for questionnaire survey.

RESULTS

- **Table 1. Total kilometres and amount sanctioned for EPT in the study areas (2010 - 2016)**

S.No	Name of the Forest Division/ Sanctuary	Amount Sanctioned (in USD)	Total Kilometres of EPT
1	**Coimbatore Forest Division**	**1.3 Mil.**	**358.48**
2	Gudalur Forest Division	0.2 Mil.	38
3	Grizzled Giant Squirrel Wildlife Sanctuary	0.39 Mil	74.00
Total		**1.89 Mil.**	**470.48**

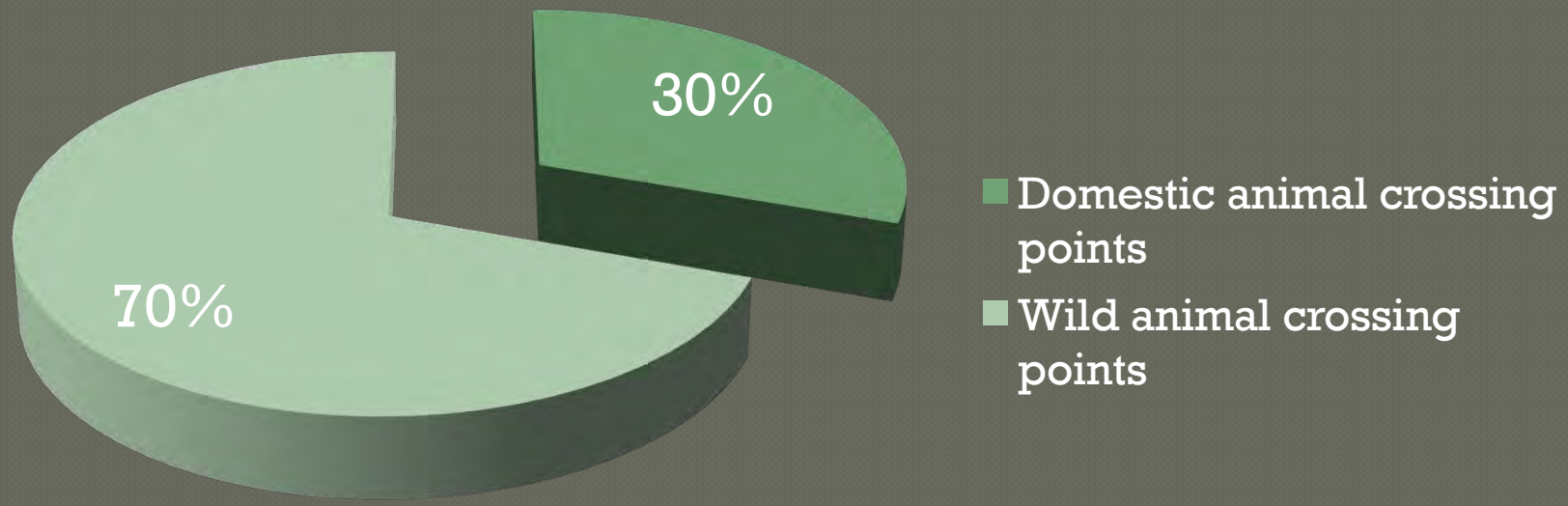
Table 2. Year wise (2010 - 2016) amount allocation and length of EPT dug in focused study areas.

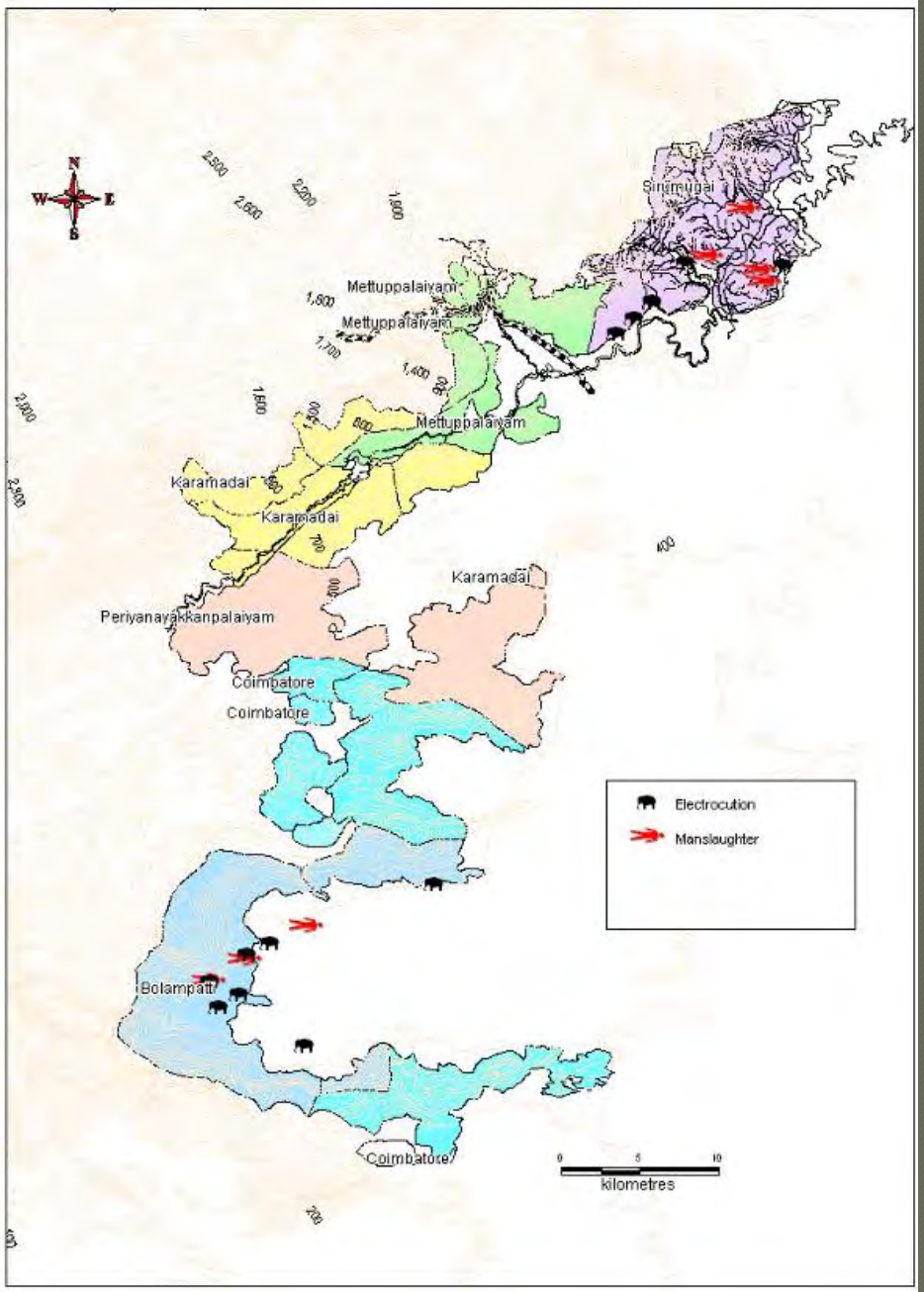
S.No	Year	Name of the Forest Division / Sanctuary (Distance of EPT in KM)			Total distance of EPT (Km)	Amount spent (USD)
		CFD	GFD	GGSWS		
1	2010-11	5.50	3.2	1	9.7	0.03 Mil.
2	2011-12	85.00	6.8	16.03	107.83	0.38 Mil.
3	**2012-13**	**111.00**	**5.3**	**6.5**	**122.8**	**0.50** Mil.
4	**2013-14**	**66.59**	**7.5**	**31.39**	**105.48**	**0.67** Mil.
5	2014-15	21.00	8.2	15.08	44.28	0.02 Mil.
6	2015-16	10.98	7.0	10.00	27.98	0.01 Mil.
Total		**358.48**	**38.0**	**74.00**	**470.48**	**1.89** Mil.

- **Table 3. Locations of wild and domestic animal crossing points and other than animals damaged points recorded along the EPT in three focused study areas.**

S.No	Name of the Forest Division/ Sanctuary	Total distance of EPT (KM)	Total number of wild and domestic animal crossing points	Total number of damages caused due to Nullahs, soil erosions, rocks and foot paths
1	**Coimbatore**	**358.48**	**582**	**680**
2	Gudalur	38	41	115
3	Srivilliputhur	74.00	104	114
	Total	**470.48**	**727**	**909 (1636)**

Figure 1. Percentage of Wild and domestic animal crossing points




N
W
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Sirumugai
Mettuppalaiyam
Mettuppalaiyam
Mettuppalaiyam
Karamadai
Karamadai
Karamadai
Periyanayakkanpalaiyam
Coimbatore
Coimbatore
Bolampatti
Coimbatore
Electrocution
Manslaughter
0
5
10
kilometres



Wild and domestic animals crossing locations

























Pictures showing Elephants crossing EPT



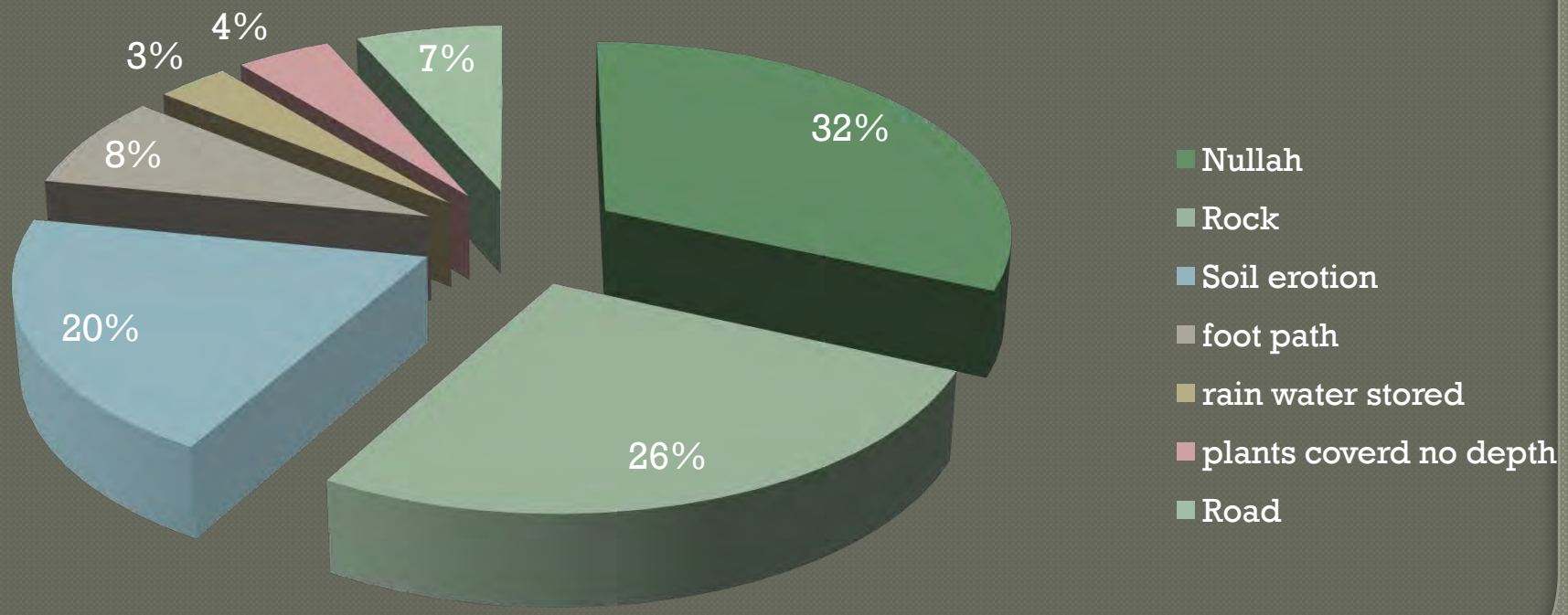








Figure 2. Damages caused due to nullahs, soil erosions, rocks and foot paths




Cont....

Photographs of damaged EPT









A. Direct sightings of animals along the EPT

S.No	Common Name	Scientific Name	Total number of individuals sighted	Demography				ER/KM
				AM	AF	Y/C	UI	
1	**Elephant**	***Elephas maximus***	**189**	**68**	**101**	**18**	**2**	**0.63**
2	Gaur	*Bos gaurus*	72	19	41	9	3	0.24
3	**Wild boar**	***sus scrofa***	**157**	**23**	**90**	**39**	**5**	**0.52**
5	Sambar deer	*Cervus unicolor*	67	21	36	8	2	0.22
6	Monitor lizard	*Varanus bengalensis*	26	-	-	-	13	0.09
7	Black-naped hare	*Lepus nigricollis*	21	-	-	-	13	0.07
8	**Wild dog**	***Cuon alpinus***	**17**				**17**	**0.06**

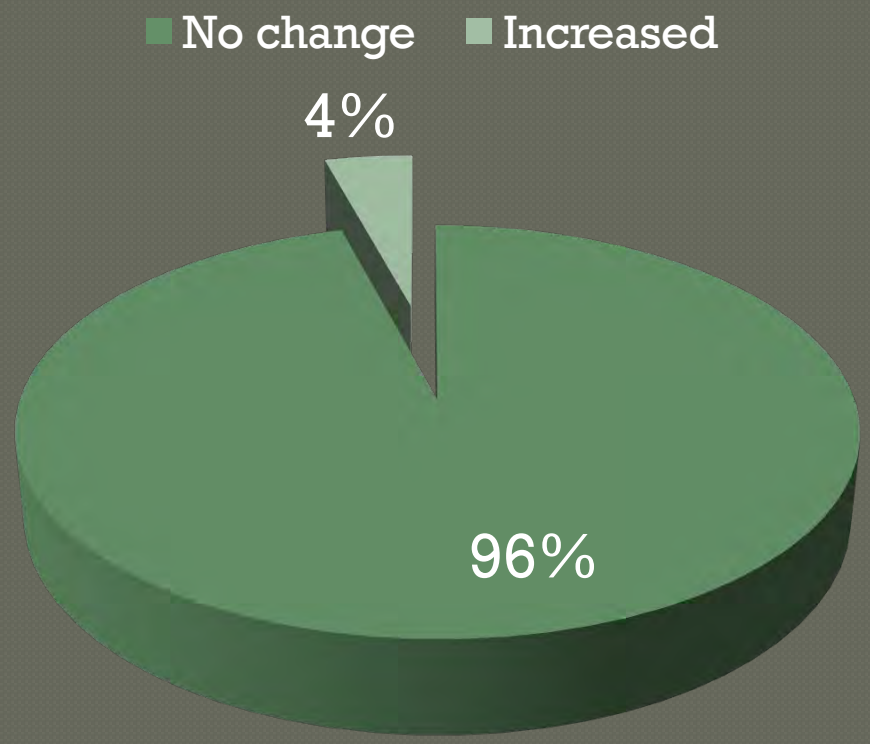
B. Indirect evidences of animals along the EPT (Total Sampled Area = 1.5 Sq.Km

S.No	Common name	Scientific Name	Density of Dung piles/Scats/Pellet Groups/ Sq.Km	Relative Density %
1	**Elephant**	***Elephas maximus***	**258.0**	**37.9**
2	**Wild boar**	***Sus scrofa***	**62.0**	**9.1**
3	**Indian gaur**	***Bos gaurus***	**90.7**	**13.3**
4	Sambar deer	*Cervus unicolor*	64.7	9.5
5	Spotted deer	*Axis axis*	55.3	8.1
6	Barking deer	*Muntiacus muntjak*	39.3	5.8
7	Black- naped hare	*Lepus nigricollis*	52.7	7.7
8	Sloth Bear	*Melursus ursinus*	8.7	1.3
9	Leopard	*Panthera pardus*	36.0	5.3
10	Tiger	*Panthera tigris*	12.7	1.9

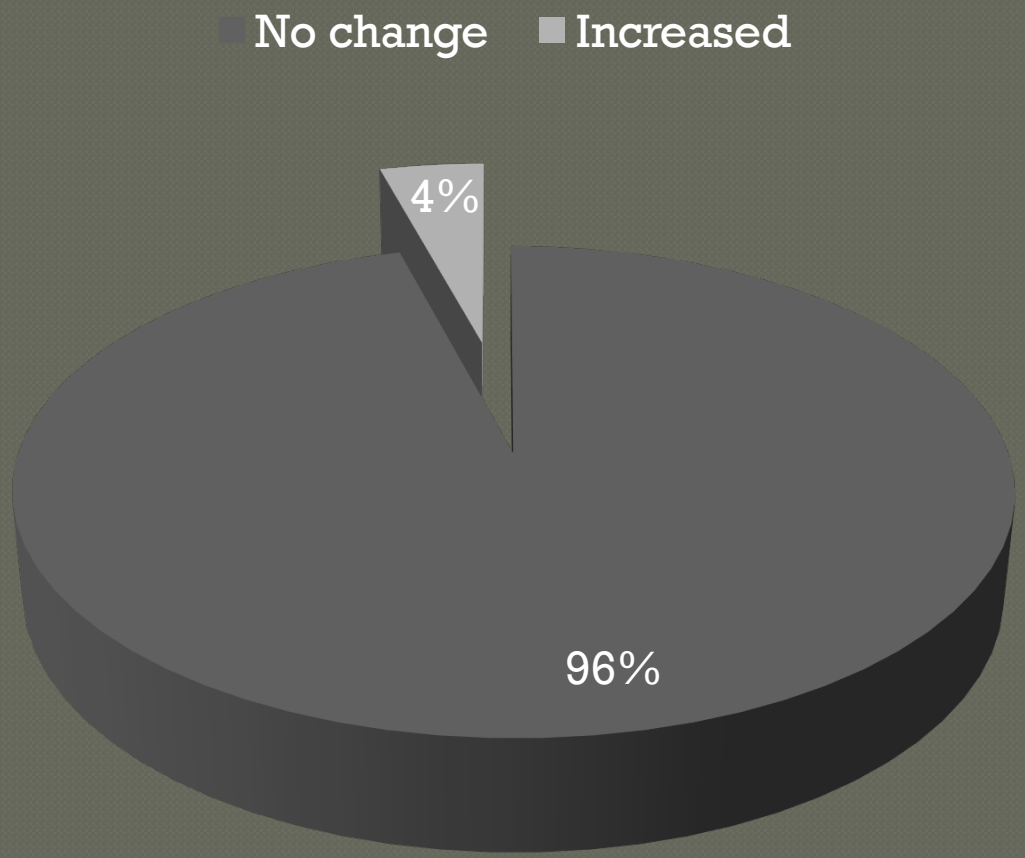

survey on usage of EPT by wild animals

People’s perception on the effectiveness of EPT

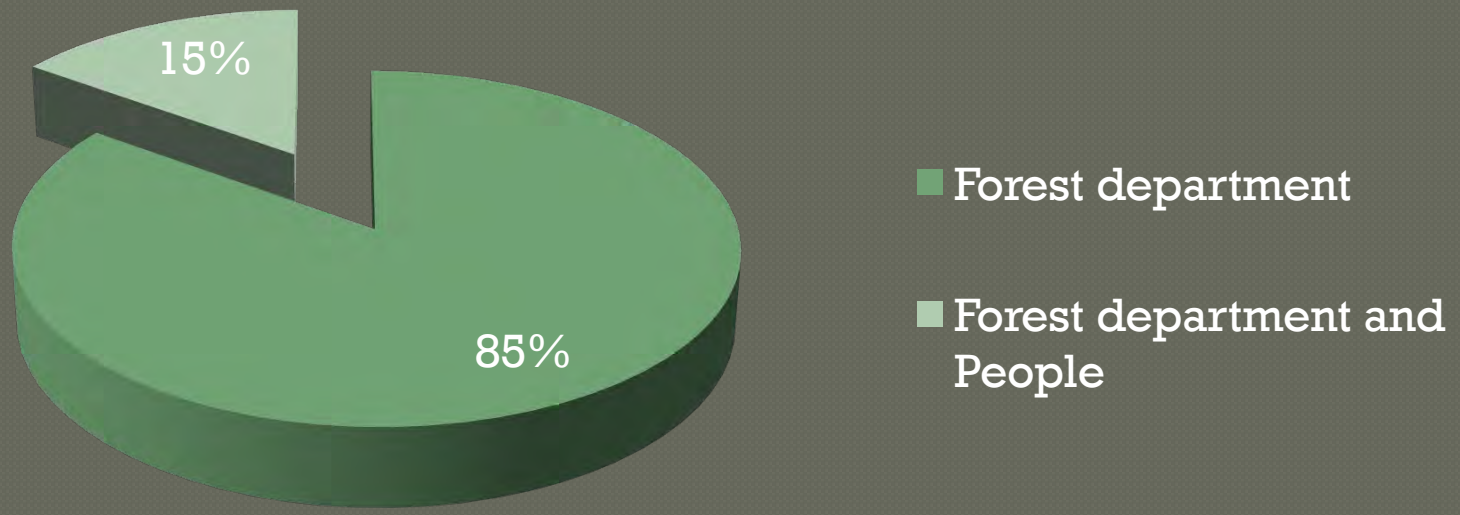
- **People's perception on the change of cropping pattern after the establishment of EPT in the study areas.**



People's perception on the increase of cropping area after the establishment of EPTes in the study areas.



People's perception on the responsibility of EPTes maintenance




Questionnaire survey

Discussion

- Farmer measures to protect crops and household vary from zero cost to very expensive barriers like solar power electric fencing.

- The current approaches to dealing with conflict has largely been headache, and predisposed to failure because of inappropriate application of methods, lack of involvement of local people, lack of monitoring of conflict and conflict mitigation measures (IUCN 2006).

- Every year huge amount of money is being spent for various mitigating against HEC.
- the EPT is also found as one of the methods mostly Government fund is being allocated.
- This present study has recorded that the Elephant was frequently used wild animal species rather than others along the EPT.

Conclusion

- Either the forest department has no provision for annual maintenance or community or beneficiaries does not have their participation for EPT. At the end a huge amount of money ended with zero result.

- A committee should be formed for all EPT which were dug earlier and forth coming EPT which include forest officials, panchayath presidents or head man of the villages, farmers including elephant researchers for the long run sustenance of EPT with the appropriate policy level changes.

ACKNOWLEDGEMENT

- The University Grants Commission (UGC) for the financial assistance, Major Research Project F.No.42-594/2013 (SR).

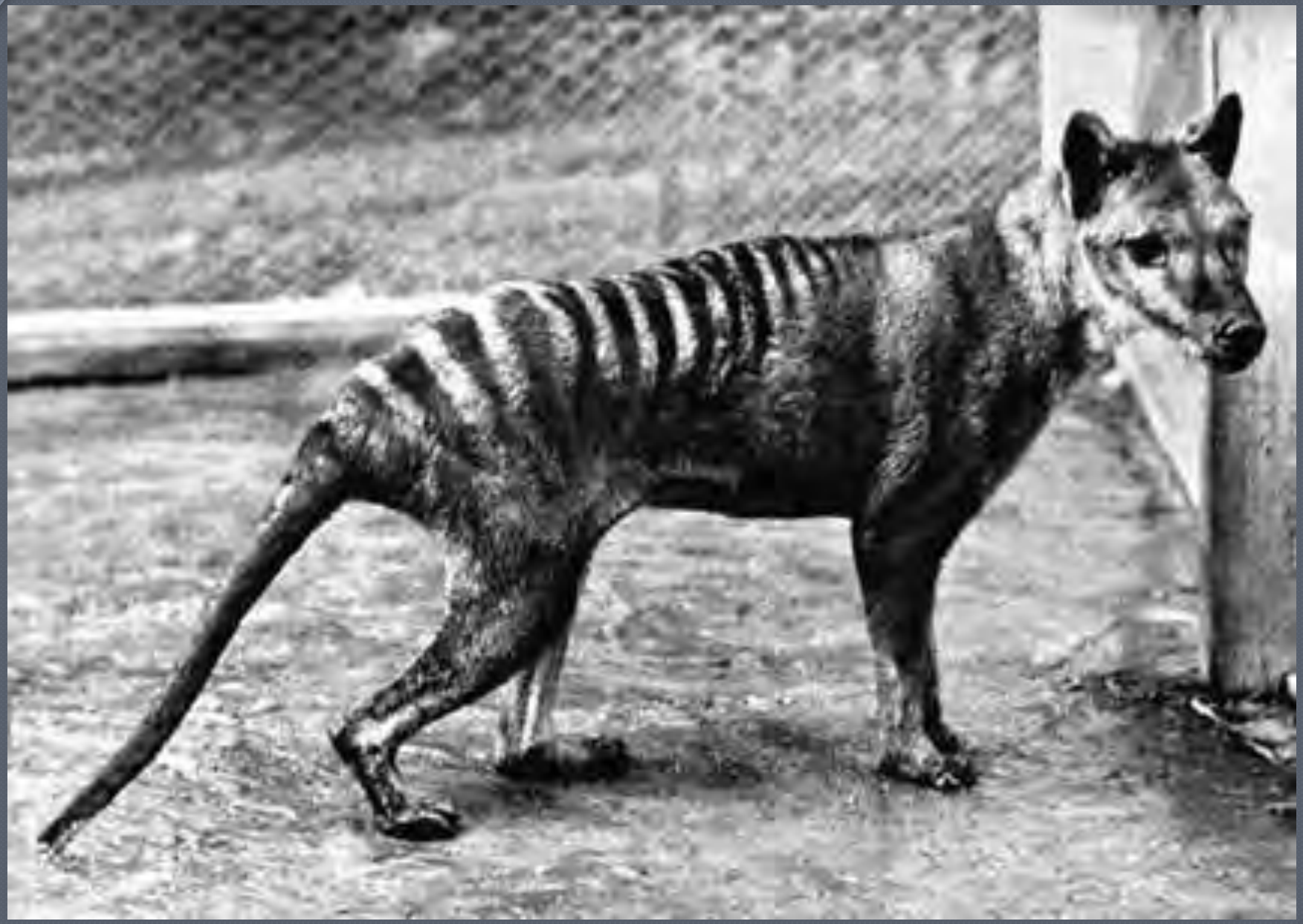
- We extend our heartfelt thanks to Principal Chief Conservator of Forests (PCCF) and Head of Forest Force of Tamil Nadu for issuing necessary permission to carryout filed work.

- We are thankful to District Forest officers and all filed staff of the Coimbatore and Gudalur Forest Divisions and Wildlife Warden, Srivilliputhur for providing all logistic supports to carry out this work.


THANK YOU

Prerequisites to prevent extinction of the genus Dicerorhinus

Abdul Hamid Ahmad, J. Payne & Zainal Zahari Zainuddin
Borneo Rhino Alliance
Sabah, Malaysia



First extinction of a terrestrial mammal genus since 1936 will happen in Indonesia around 2030











Why?

- Death rate has exceeded birth rate since 1930s …
- even without poaching
- sub-populations are too small & scattered to breed
- and are likely inbred
- extinction is guaranteed under the current trajectory
- a radical but simple plan can change that …

How to prevent Dicerorhinus extinction?

- A single program with a single goal ..
- to boost births by any means possible
- everyone involved collaborates
- STARTING NOW
- capture as many as possible
- fertile ones .. natural breeding, artificial insemination, embryo transfer
- sub-fertile ones .. embryos produced in vitro

Is it worth the bother?



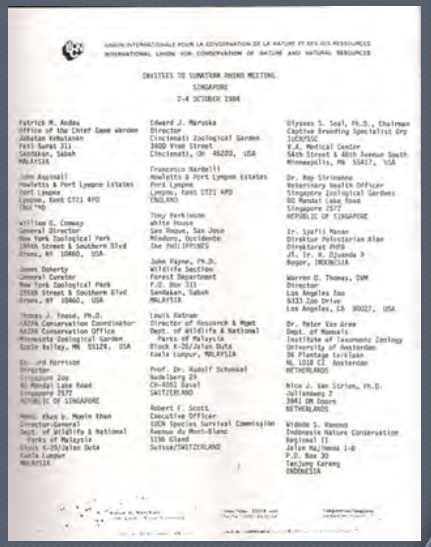
3.7 mill – 10,000 BP



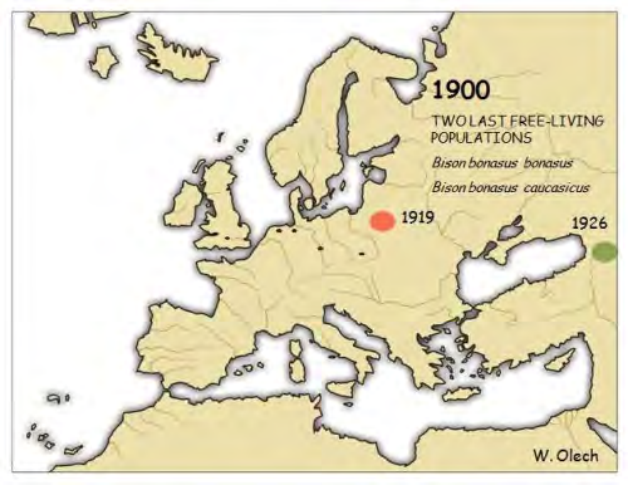
20 mill BP - 2030

Endless & fruitless discussions

- April 1982 IUCN SSC Asian Rhino Group
- Oct 1984 IUCN Singapore Sumatran rhino meeting to establish global meta-population
- 2009-12 Global Management & Propagation Board meetings
- Nov 2012 Malaysia meets Indonesian Forestry Minister
- April 2013 Sumatran Rhino Crisis Summit
- Oct 2013 1st Asian Rhino Range States Meeting, Indonesia
- Dec 2013 Indonesia-Malaysia MoU
- Nov 2016 Heart of Borneo agreement



INVITEES TO SUMATRAN RHINO MEETING
SINGAPORE
2-4 OCTOBER 1984





Name	Wisent
Description	Wild cattle species
Distribution	Europe & Russia
Status	5,500 living. In 1927, the last wild one was shot, but there were 54 wisent in zoos, derived from 12 individuals.
Reason not extinct	Collaboration between zoos, land-owners and individuals in several nations allowed 54 to become 5,500 in 90 years, most now living wild.

The present Number 1 enemy in Indonesia and amongst its advisors - cognitive bias

9. Information bias.

The tendency to **seek information when it does not affect action**. More information is not always better. With less information, people can often make more accurate predictions.



10. Ostrich effect.

The decision to **ignore dangerous or negative information** by "burying" one's head in the sand, like an ostrich. Research suggests that investors check the value of their holdings significantly less often during bad markets.



11. Outcome bias.

Judging a decision based on the **outcome** — rather than how exactly the decision was made in the moment. Just because you won a lot in Vegas doesn't mean gambling your money was a smart decision.



12. Overconfidence.

Some of us are **too confident about our abilities**, and this causes us to take greater risks in our daily lives. Experts are more prone to this bias than laypeople, since they are more convinced that they are right.



13. Placebo effect.

When **simply believing** that something will have a certain effect on you causes it to have that effect. In medicine, people given fake pills often experience the same physiological effects as people given the real thing.



14. Pro-innovation bias.

When a proponent of an innovation tends to **overvalue its usefulness** and undervalue its limitations. Sound familiar, Silicon Valley?



15. Recency.

The tendency to weigh the **latest information** more heavily than older data. Investors often think the market will always look the way it looks today and make unwise decisions.



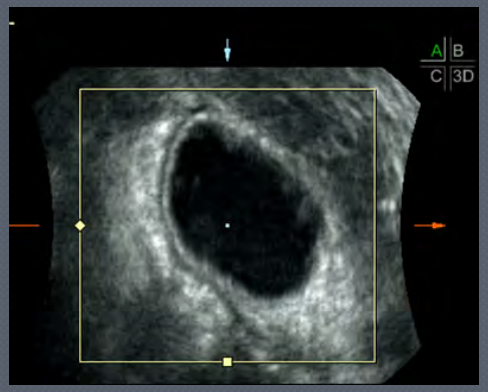
16. Salience.

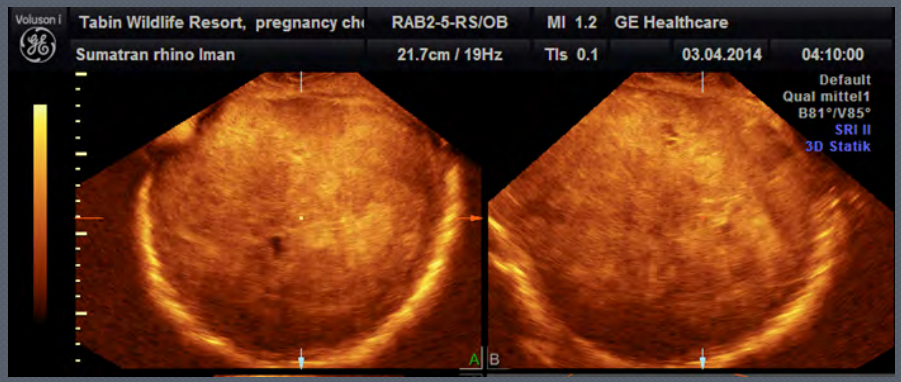
Our tendency to focus on the **most easily recognizable features** of a person or concept. When you think about dying, you might worry about being mauled by a lion, as opposed to what is statistically more likely, like dying in a car accident.



A single program can succeed

- captive husbandry is well advanced
- capture & translocation is safe
- female reproductive pathology
- bring gametes together
- 1000s of mammal embryos annually
- Advanced reproductive technology underway on *Ceratotherium*





Elements of rescue program

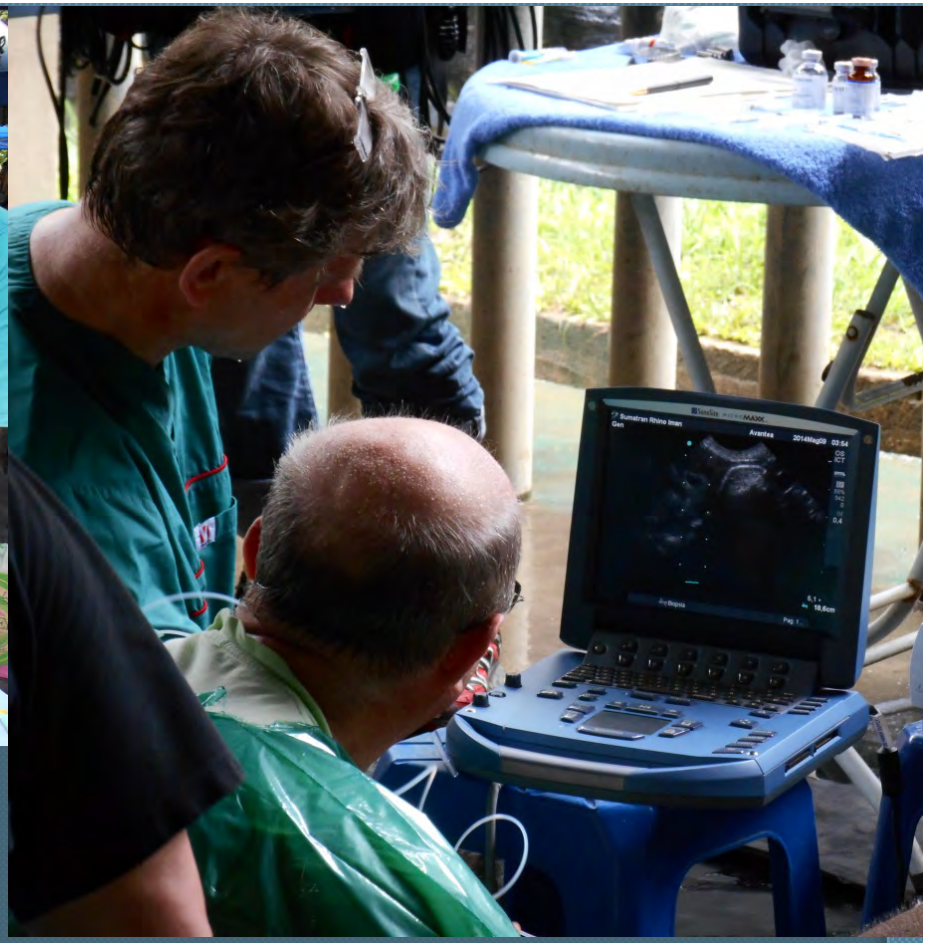
- 1 meta-population
- capture more rhinos
- excellent facilities
- natural breeding
- develop in vitro fertilization
- do not waste gametes
- transfer between facilities
- advanced reproductive technology



Constraints that need to be smashed

- decision-making in Indonesia based on conservative forestry thinking supported by mainstream NGOs
- factions do not move from entrenched positions
- no leadership from international conservation organisations
- baseless worries (funding, "stakeholder" views, habitat) prevent correct policy decisions





Removing oocytes from Iman, Leibniz Institute for Zoo & Wildlife Research (Berlin) with Prof Cesare Galli (Italy), 2014



Wahid Haron Universiti Putra Malaysia

Loo Shu San ABI

Zainal Z Zainuddin Borneo Rhino Alliance

Arief Boediono IPB

Still no policy or funding support for any of the above from any of the following :

- IUCN
- WWF
- WCS
- International Rhino Foundation
- Indonesian Rhino Foundation
- Tropical Forest Conservation Action Sumatera
- Government of Indonesia

The threats are not poaching or habitat loss

- But …
- cognitive bias and inaction amongst the people supposed to be preventing the extinction of endangered wildlife

THE END

- of this presentation
- but hopefully not of the genus

Lessons learned from the decline of the Sumatran rhino (*Dicerorhinus sumatrensis harrissoni*) in Sabah

Dr. Petra Kretzschmar

Leibniz Institute for Zoo & Wildlife Research (IZW)



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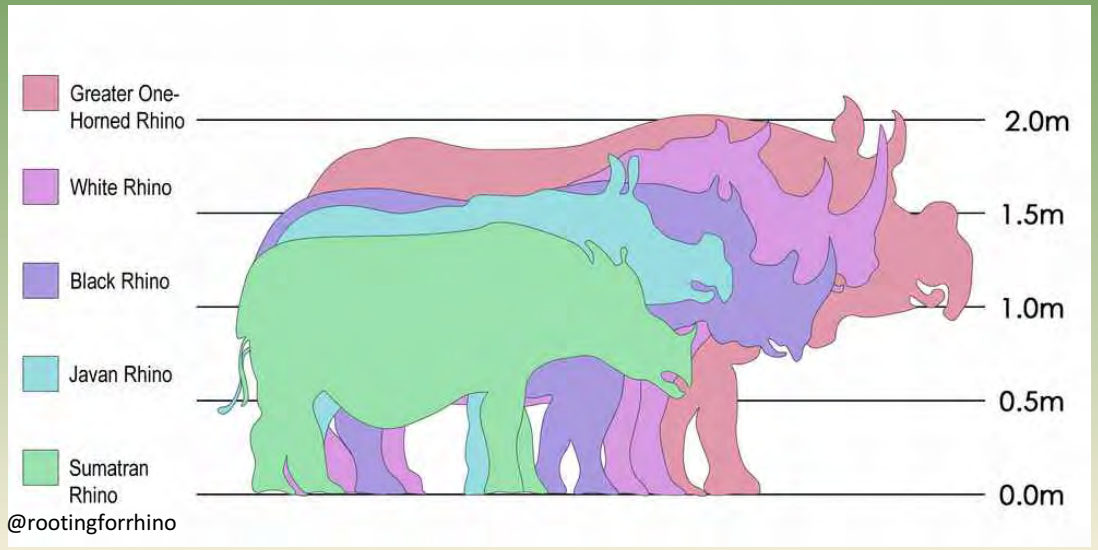
Characteristics of the Sumatran rhino (*Dicerorhinus sumatrensis*)



- Occurs in tropical rainforests of SE Asia

Characteristics of the Sumatran rhino (*Dicerorhinus sumatrensis*)



@rootingforrhino


@Zoo Leipzig

- Smallest rhino in the world

Status of the Sumatran rhino (*Dicerorhinus sumatrensis*)

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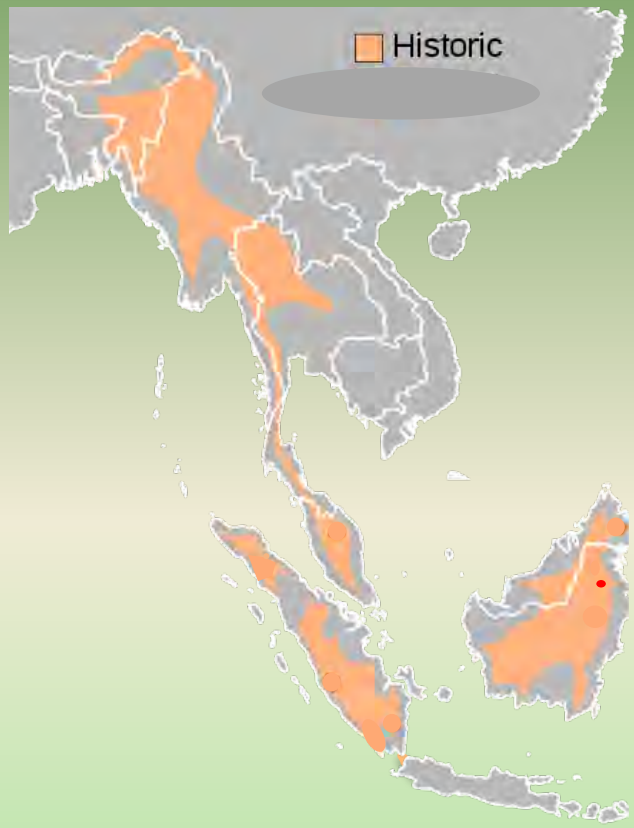
Sumatran rhino

Dicerorhinus sumatrensis

Subspecies:

D. s. lasiotis	*northern*	†
D. s. sumatrensis	*southern*	< 100
D. s. harrissoni	*Bornean*	< 10

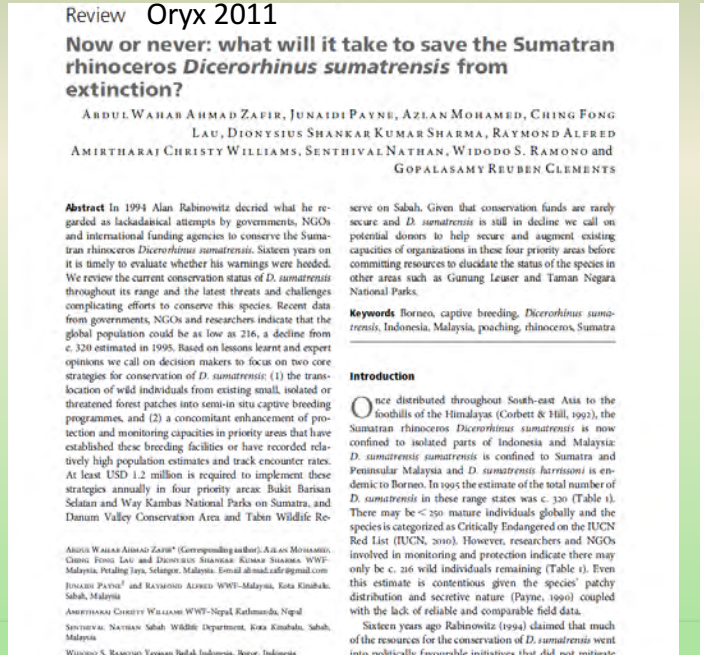
Distribution in SE Asia



- One of the most endangered rhinos in the world

Current conservation strategies

- Currently several rescue measures of the Sumatran rhino are beeing dabated
- Various publications have been published on the best strategies for the conservation of the Sumatran rhinos



Review Oryx 2011

Now or never: what will it take to save the Sumatran rhinoceros *Dicerorhinus sumatrensis* from extinction?

Abdul Wahab Ahmad Zafir, Junaidi Payne, Azlan Mohamed, Ching Fong Lau, Dionysius Shankar Kumar Sharma, Raymond Alfred Amirtharaj Christy Williams, Senthival Nathan, Widodo S. Ramono and Gopalasamy Reuben Clements

Abstract In 1994 Alan Rabinowitz decried what he regarded as lackadaisical attempts by governments, NGOs and international funding agencies to conserve the Sumatran rhinoceros *Dicerorhinus sumatrensis*. Sixteen years on it is timely to evaluate whether his warnings were heeded. We review the current conservation status of *D. sumatrensis* throughout its range and the latest threats and challenges complicating efforts to conserve this species. Recent data from governments, NGOs and researchers indicate that the global population could be as low as 216, a decline from *c.* 320 estimated in 1995. Based on lessons learnt and expert opinions we call on decision makers to focus on two core strategies for conservation of *D. sumatrensis*: (1) the translocation of wild individuals from existing small, isolated or threatened forest patches into semi-in situ captive breeding programmes, and (2) a concomitant enhancement of protection and monitoring capacities in priority areas that have established these breeding facilities or have recorded relatively high population estimates and track encounter rates. At least USD 1.2 million is required to implement these strategies annually in four priority areas: Bukit Barisan Selatan and Way Kambas National Parks on Sumatra, and Danum Valley Conservation Area and Tabin Wildlife Reserve on Sabah. Given that conservation funds are rarely secure and *D. sumatrensis* is still in decline we call on potential donors to help secure and augment existing capacities of organizations in these four priority areas before committing resources to elucidate the status of the species in other areas such as Gunung Leuser and Taman Negara National Parks.

Keywords Borneo, captive breeding, *Dicerorhinus sumatrensis*, Indonesia, Malaysia, poaching, rhinoceros, Sumatra

Introduction

Once distributed throughout South-east Asia to the foothills of the Himalayas (Corbett & Hill, 1992), the Sumatran rhinoceros *Dicerorhinus sumatrensis* is now confined to isolated parts of Indonesia and Malaysia: *D. sumatrensis sumatrensis* is confined to Sumatra and Peninsular Malaysia and *D. sumatrensis harrissoni* is endemic to Borneo. In 1995 the estimate of the total number of *D. sumatrensis* in these range states was *c.* 320 (Table 1). There may be < 250 mature individuals globally and the species is categorized as Critically Endangered on the IUCN Red List (IUCN, 2010). However, researchers and NGOs involved in monitoring and protection indicate there may only be c. 216 wild individuals remaining (Table 1). Even this estimate is contentious given the species' patchy distribution and secretive nature (Payne, 1990) coupled with the lack of reliable and comparable field data.

Sixteen years ago Rabinowitz (1994) claimed that much of the resources for the conservation of *D. sumatrensis* went

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Junaidi Payne[1] and Raymond Alfred WWF-Malaysia, Kota Kinabalu, Sabah, Malaysia

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Senthival Nathan Sabah Wildlife Department, Kota Kinabalu, Sabah, Malaysia

Widodo S. Ramono Yayasan Badak Indonesia, Bogor, Indonesia



***The* last chance for the Sumatran rhinoceros?**

Pachyderm 2014

Francesco Nardelli

Patron, Save the Rhino International, 16 Winchester Walk, London SE1 9AQ, UK; and Member, IUCN/SSC Asian Rhino Specialist Group, 219c Huntingdon Road, Cambridge CB2 0DL, UK

Abstract

The Sumatran rhino (*Dicerorhinus sumatrensis*) is very close to extinction in Indonesia. Three major ad hoc meetings, not two as generally reported, to discuss ways to save the Sumatran rhino were held in 1984, 1993 and 2013. Their targets have never been achieved. Despite the great efforts of the participants and other parties, the world population of *D. sumatrensis* has collapsed during the last 30 years from over 800 to fewer than 100. Besides worldwide phenomena like habitat loss and poaching, other specific causes lie behind this tragedy. The status of the Sumatran rhino has been optimistically overestimated. Precious time is being wasted in finding theoretical solutions rather than implementing the recommendations of these meetings. Political will to save the habitat and protect the species is lacking. After carefully evaluating the present Sumatran rhino conservation status, a breeding project greater than those so far managed has to go ahead as soon as possible to support the ongoing in situ programme and form a viable population in controlled environments for future reintroductions into the wild.

Résumé

Le rhinocéros de Sumatra (*Dicerorhinus sumatrensis*) est très proche de l'extinction en Indonésie. Il y a eu trois grandes réunions ad hoc et pas deux comme on l'a généralement signalé, organisées en 1984, 1993 et 2013 afin de discuter les voies et moyens pour sauver le rhinocéros de Sumatra. Leurs objectifs n'ont jamais été atteints. Malgré les efforts des participants et d'autres parties, la population mondiale de *D. sumatrensis* s'est effondrée à partir de plus de 800 rhinocéros à moins de 100 rhinocéros au cours des 30 dernières années. Outre les phénomènes à travers le monde comme la perte de l'habitat et le braconnage, il existe d'autres causes spécifiques derrière cette tragédie. La situation du rhinocéros de Sumatra a été surestimée avec optimisme. On gaspille un temps précieux dans la recherche des solutions théoriques plutôt que dans la mise en œuvre des recommandations de ces réunions. La volonté politique de sauver l'habitat et de protéger l'espèce fait défaut. Après avoir soigneusement évalué l'état actuel de la conservation du rhinocéros de Sumatra, un projet de reproduction plus grand que ceux gérés jusqu'ici doit être mis en place dès que possible pour soutenir le programme in situ déjà en cours et former une population viable dans des environnements contrôlés en vue des réintroductions futures dans la nature.

Introduction

This paper focuses on the plight of the Sumatran rhinoceros (*Dicerorhinus sumatrensis*) in Indonesia. I hope to show that only immediate action will save this rhino species from extinction, and that a large-scale capture operation of isolated animals is feasible with existing expertise, and presently is the only course of action with a chance of success.



Short Communication

Oryx 2015

Will current conservation responses save the Critically Endangered Sumatran rhinoceros *Dicerorhinus sumatrensis*?

Rasmus Gren Havmøller, Junaidi Payne, Widodo Ramono, Susie Ellis K. Yoganand, Barney Long, Eric Dinerstein, A. Christy Williams Rudi H. Putra, Jamal Gawi, Birbar Kumar Talukdar and Neil Burgess

Abstract The Critically Endangered Sumatran rhinoceros *Dicerorhinus sumatrensis* formerly ranged across South-east Asia. Hunting and habitat loss have made it one of the rarest large mammals and the species faces extinction despite decades of conservation efforts. The number of individuals remaining is unknown as a consequence of inadequate methods and lack of funds for the intensive field work required to estimate the population size of this rare and solitary species. However, all information indicates that numbers are low and declining. A few individuals persist in Borneo, and three tiny populations remain on the Indonesian island of Sumatra and show evidence of breeding. Rhino Protection Units are deployed at all known breeding sites but poaching and a presumed low breeding rate remain major threats. Protected areas have been created for the rhinoceros and other in situ conservation efforts have increased but the species has continued to go locally extinct across its range. Conventional captive breeding has also proven difficult; from a total of 43 Sumatran rhinoceros taken from the wild since 1984 there were no captive births until 2001. Since then only two pairs have been actively bred in captivity, resulting in four births, three by the same pair at the Cincinnati Zoo and one at the Sumatran Rhino Sanctuary in Sumatra, with the sex ratio skewed towards males. To avoid extinction it will be necessary to implement intensive management zones, manage the metapopulation as a single unit, and develop advanced reproductive techniques as a matter of urgency. Intensive census efforts are ongoing in Bukit Barisan Selatan but elsewhere similar efforts remain at the planning stage.

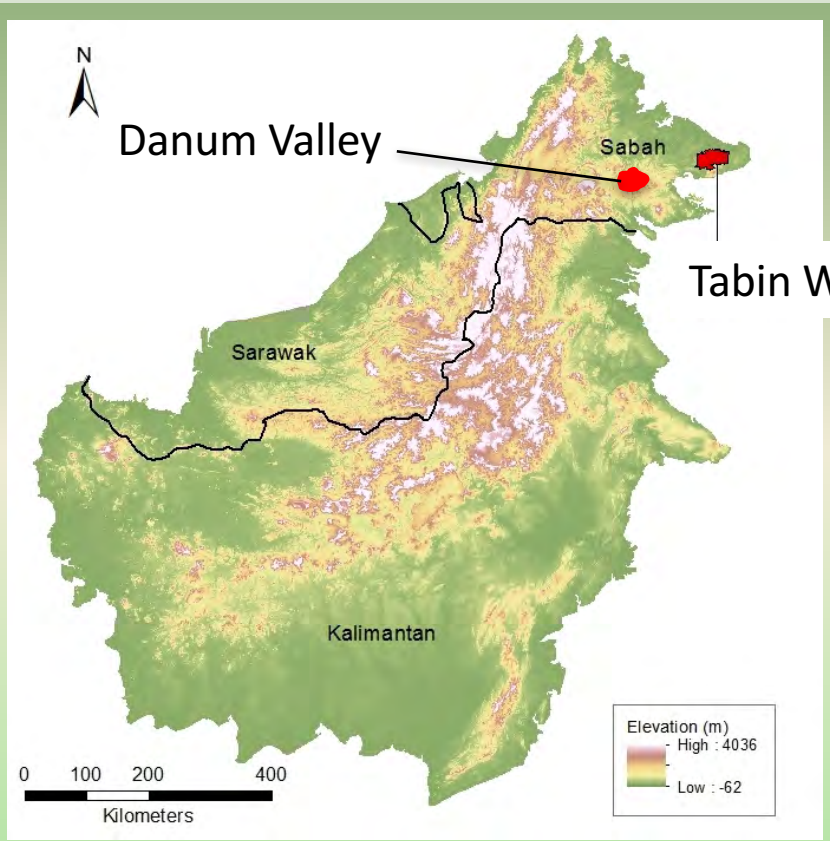
Keywords Conservation planning, Critically Endangered, extinction, advanced reproductive technology, intensive management zones, metapopulation management, Sumatran rhino, South-east Asia

The Sumatran rhinoceros *Dicerorhinus sumatrensis* is categorized as Critically Endangered on the IUCN Red List (van Strien et al., 2008). It has been extirpated from > 99% of its former range, is threatened by poaching for its horn and has proven difficult to breed in captivity (Dinerstein, 2011). Poaching of rhinoceroses has soared in recent years (Emslie, 2013) and was the primary cause of extinction of the western black rhinoceros *Diceros bicornis longipes* and wild northern white rhinoceros *Ceratotherium simum cottoni* in Africa (Emslie, 2012a, b), and the Javan rhinoceros *Rhinoceros sondaicus annamiticus* in mainland South-east Asia (Brook et al., 2012). It has also been a causal factor in the decline of the Sumatran rhinoceros, which has also been affected by habitat loss and isolation (Ahmad et al., 2015). Here we outline the population status of the Sumatran rhinoceros, summarize the threats to its survival and highlight the main components and progress of the emergency plan developed during the April 2013 Sumatran Rhino Crisis Summit in Singapore and later agreed upon in the Bandar Lampung Declaration in October 2013.

Reliable population estimates for Sumatran rhinoceros have always been difficult to obtain. After years of suspected decline, the population was assessed in 2009 to comprise 200–216 individuals (Zafir et al., 2011). We provide an updated estimate (Fig. 1) but it should be noted that robust

Conservation of wild populations

- Estimated rhino numbers in 2004: 15 - 20 in Tabin
- Estimated rhino numbers in 2009: 15 in Tabin

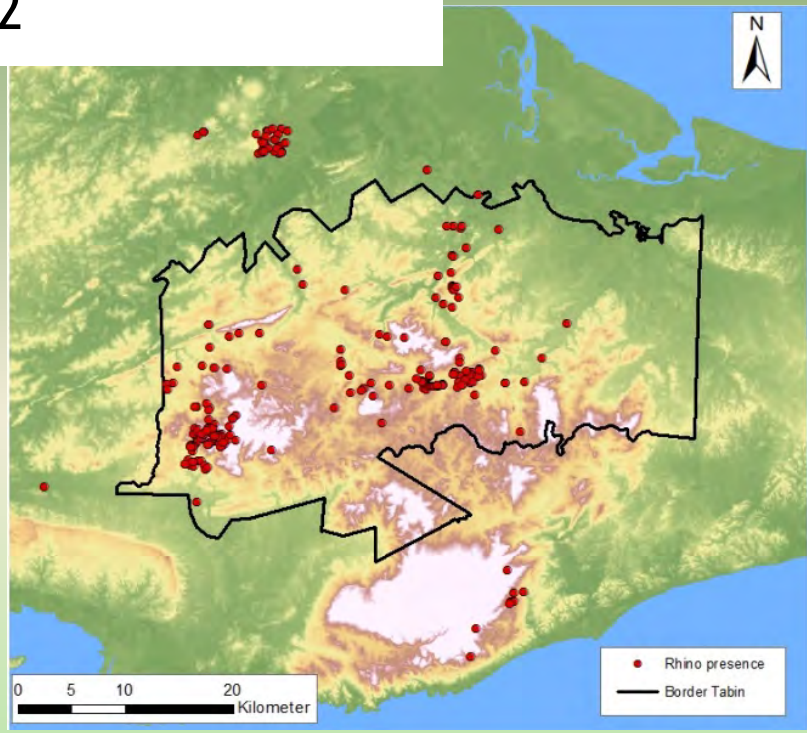


Conservation of wild populations

Tabin Wildlife Reserve

- Estimated rhino numbers: 15
- Numbers encountered in surveys: 3 - 12

1980	4 - 6	Flynn 1981
1981	5 - 10	Andau (1982)
1979 - 1881	7 – 12 +	Davies & Payne (1982)
1982	7	Andau (1987)
1986	6	Andau (1987)
1988	3	Nor et al. (1989)
1995 - 1996	3 - 9	Boonratana (1997)
2000 - 2007 monthly surveys	Rhinos present	SOS Rhino unpublished reports
2007	5	Tayaparan (2008)
2008 - 2013 irregular surveys	Rhinos present	BORA unpublished reports



Field study in 2012 – 2013

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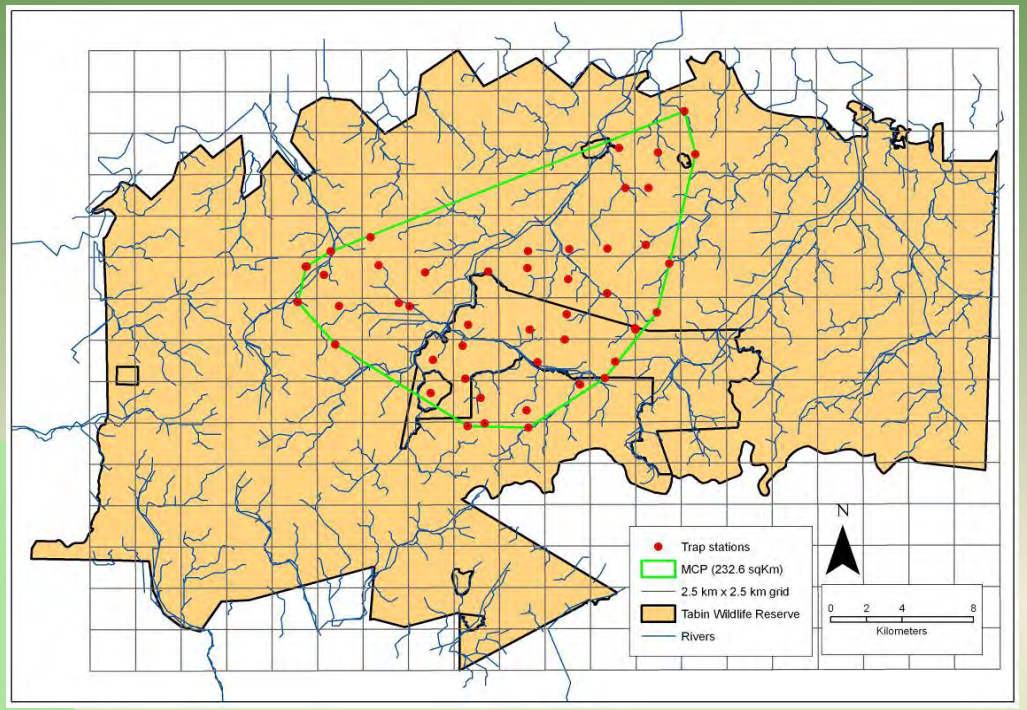

Field study in 2012 – 2013

- 4,161 observation days
- 782 km walked
- 35 species detected
- 0 rhino sightings





Conservation of wild populations

- **Why hasn´t it been detected earlier?**

year	estimated rhino no.	Source	No. teams	No. days	km walked	size of survey area
1980	4 - 6	Flynn 1981	**no**	yes	**no**	**no**
1981	5 - 10	Andau (1982)	**no**	**no**	**no**	**no**
1979 - 1881	7 - 12+	Davies & Payne (1982)	**no**	**no**	**no**	**no**
1982	7	Andau (1987)	yes	yes	no	yes
1986	6	Andau (1987)	yes	yes	yes	yes
1988	3	Nor et al. (1989)	yes	yes	yes	no
1995 - 1996	3 - 9	Boonratana (1997)	**no**	**no**	**no**	yes
2000 - 2007 monthly surveys	rhinos present	SOS Rhino unp. rep.	yes	yes	**no**	**no**
2007	5	Tayaparan (2008)	yes	yes	**no**	**no**
2008 - 2013 irregular surveys	rhinos present	BORA unp. reports	yes	yes	**no**	**no**
2012/2013	0	Kretzschmar et al. (2016)	yes	yes	yes	yes

Literature review

Historic and recent estimates of the number and distribution of the Sumatran rhino in Borneo. Kretzschmar et al. (2016)

Source	Census year	numbers	quality of data	hunting evidence
Wallace (1874)	/	not abundant	guesstimate	rhino horn sold frequently in Kalimantan
Pryer (1881)		frequent		/
				natives ask high price for rhino horn
Anonymous (1890)	1883-1888	frequent	guesstimate	
Bartlett (1891)	/	numerous	guesstimate	frequently hunted
Jentink (1897)	/	/	estimate	
Shelford (1916)	/	common	estimate	high prize for rhino horn
Ridley (1916)	/	common	estimate	/
Mjoeberg (1929)		less common		
				numerous rhinos are killed every year
Banks (1931)	/	/	estimate	36 trophies in 2 years
Banks (1935)	1934/35	/	estimate	
Heynsius Viruly & Heurn (1935)	/	/	guesstimate	/
Banks (1937)	/	/	estimate	price for rhino between $300 -$400
Comyn Platt (1937)	/	/	guesstimate	chinese will pay any price for the horn
Schneeberger (1945)	/	/	estimate	16 killed by natives
Harrisson (1946)	1945/1946	5	Sarawak: loc. Surv; Kalimantan, Sabah: estimate	16 rhinos killed by a native
Harrisson (1948)	1945/46	considerable number	estimate	/
Harrisson (1956)		very few		native hunters have driven rhinos into remote areas
Harrisson (1949)	1946/46	many	estimate	many hundred rhinos killed in Sarawak during this century
Harrisson (1955)	/	some	guesstimate	/
Harrisson (1956)	1956	very few	localised surveys	/
Harrisson (1961)	/	~10	guesstimate	/

Population development in Borneo



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Habitat destruction

- 1960 intensified logging started





Population viability analysis

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What happened, why are they gone?

Stochastic growth rate and extinction risk of 63 PVA scenarios for the rhino population in the TWR (mean ± SD).

Description	Growth rate	Probability of extinction [%]	Years until first extinction	Population size for extant populations	Genetic diversity [%]
No poaching	**-0.021 ± 0.101**	20 ± 1	28 ± 6	10 ± 6	80
One time poaching of ♂ and ♀	**-0.025 ± 0.109**	31 ± 1	29 ± 5	10 ± 6	80
Poaching of ♂ and ♀ every 10 years	**-0.033 ± 0.123**	47 ± 1	27 ± 5	9 ± 5	78

Sensitivity analysis

Table 12: Relative influence on growth rate for changes in parameters of ± 10% for the rhino population in the TWR with different poaching scenarios.

Parameter	no poaching sensitivity indices		one poaching event sensitivity indices		poaching every 10 years sensitivity indices	
	+ 10%	- 10%	+ 10%	- 10%	+ 10%	-10%
Reproductive age of females	3,81	3,33	2,00	3,20	1,82	1,82
Percentage of females breeding	3,97	3,57	2,67	2,67	1,77	2,02
Total mortality of juvenile females	0,48	0,48	0,40	0,00	1,52	0,3
Total mortality of juvenile males	0,48	0,00	0,40	0,40	0,00	0,00
Total mortality of adult females	0,76	1,14	1,28	0,80	0,73	0,61
Total mortality of adult males	0,24	0,48	0,20	0,60	0,15	0,15
Percentage of males in breeding pool	0,00	0,30	0,40	0,80	0,00	0,00
Initial population size	1,07	0,00	0,60	1,50	0,45	0,45
Femals harvested	/	/	/	/	0,21	0,21
Males harvested	/	/	/	/	0,12	0,06
Harvest interval	/	/	/	/	0,00	0,30

Population development



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Population viability analysis

Stochastic growth rate and extinction risk of 63 PVA scenarios for the rhino population in the TWR (mean ± SD).

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Poaching of ♂ and ♀ every 10 years	**-0.033 ± 0.123**	47 ± 1	27 ± 5	9 ± 5	78
No poaching +10% higher percentage of breeding females + 10% higher rep. age of females	**-0.006 ± 0.094**	9 ± 1	28 ± 6	16 ± 9	83

Combined efforts of total protection and an increase in the reproductive performance of females could have saved the Tabin population.

Lessons learned

- Small populations need to be condensed
- Fertility needs to be increased
- The intercalving interval needs to be shortened

Captive breeding programme

- **Since the mid 80´s 48 Sumatran rhinos were caught and brought in captivity**



Captive breeding programme

- **Where did they go?**



What happened to the rhinos?

- 42 of the 48 captured rhinos died
- 5 juveniles were born (3 ♂: 2 ♀)

Captive breeding programme

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What are the reasons for the failure?

- Absence of basic data on diet, habitat requirements and mating behaviour
- Poor management and hygiene
- Low food quality and variety

Has the situation improved?

- Knowledge has improved
- High standard of management and hygiene
- Reproduction still low

Number of publications on Sumatran rhinos between 1995 and 2014 published at the Rhino Resource Center (http://www.rhinoresourcecenter.com/)

subject	number of publications
reproduction	24
conservation	16
survey	14
health	10
program report	9
genetic	6
captive management	5
nutrition	5
historic	3
status report	3
anatomy	2
behaviour	2
ancient	1
pathology	1
total	101

Conclusions

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Captive breeding:

- Natural reproduction in combination with assisted re-production techniques to boost population numbers

- Only in well managed breeding centers with high hygiene standards, excellent veterinary care and a diverse diet.

Acknowledgements

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: L Ambu

: Payne J, Zainal ZZ

: Schaffer N, Thayaparan ST



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Saving the Sumatran Rhino : Amalgamation in the Leuser Ecosystem

Rudi Putra, Dedyansyah, Mukhlis R, Ridha A
LEUSER CONSERVATION FORUM (FKL)
Aceh, Indonesia

Leuser Ecosystem

2,6 million hectares in Aceh & North Sumatra, Indonesia

We focus on protecting the 2,2 million ha in Aceh

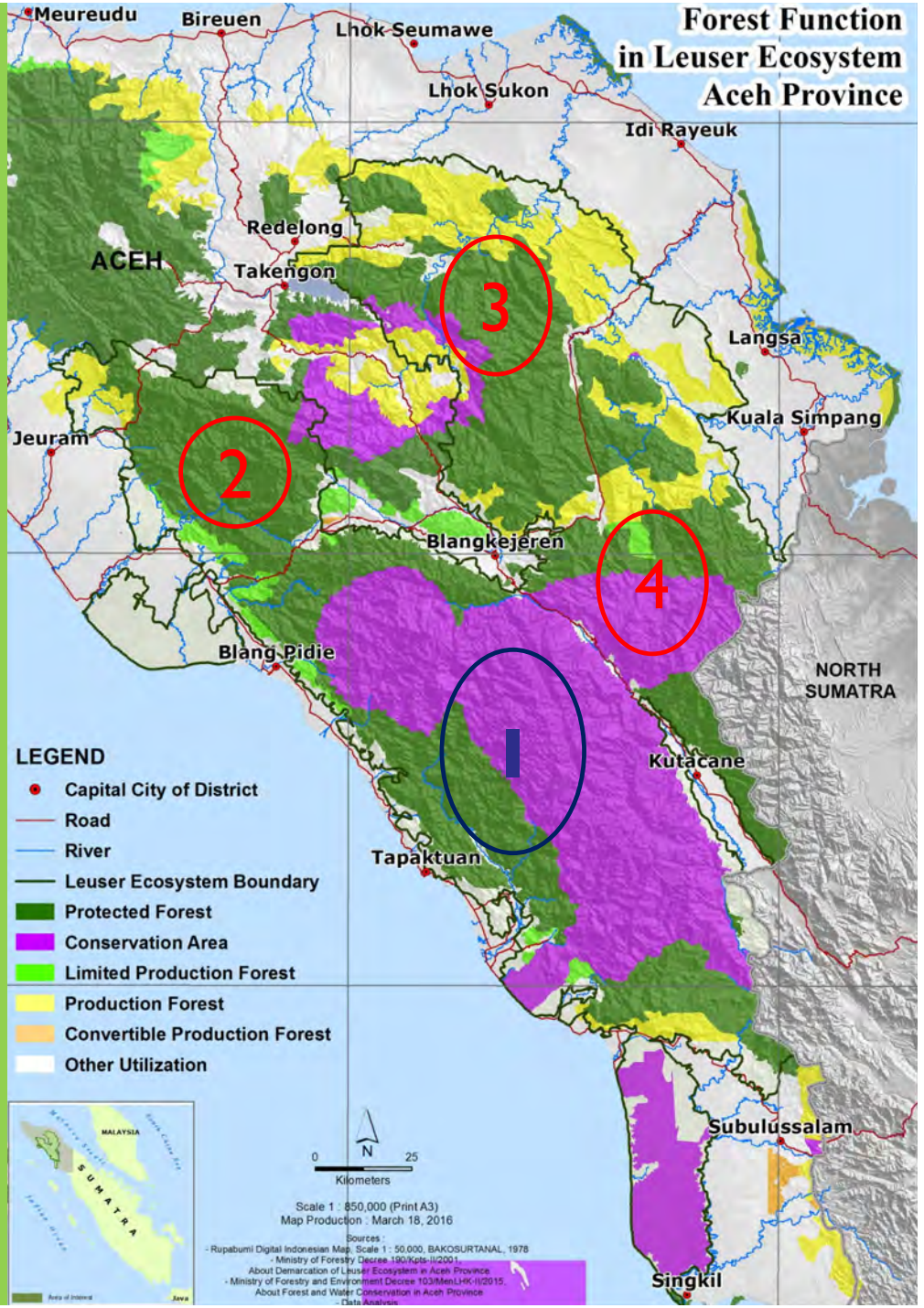


Rhinos in Leuser :

1. Western Leuser
2. Beutong
3. Samarkilang
4. Kappi






Forest Function
in Leuser Ecosystem
Aceh Province
Meureudu
Bireuen
Lhok Seumawe
Lhok Sukon
Idi Rayeuk
Redelong
ACEH
Takengon
Langsa
Kuala Simpang
Jeuram
Blangkejeren
Blang Pidie
NORTH
SUMATRA
Kutacane
Tapaktuan
Subulussalam
Singkil
1
2
3
4
LEGEND
Capital City of District
Road
River
Leuser Ecosystem Boundary
Protected Forest
Conservation Area
Limited Production Forest
Production Forest
Convertible Production Forest
Other Utilization
MALAYSIA
SUMATRA
Java
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25
Kilometers
Scale 1 : 850,000 (Print A3)
Map Production : March 18, 2016
Sources :
- Rupabumi Digital Indonesian Map, Scale 1 : 50,000, BAKOSURTANAL, 1978
- Ministry of Forestry Decree 190/Kpts-II/2001
About Demarcation of Leuser Ecosystem in Aceh Province
- Ministry of Forestry and Environment Decree 103/MenLHK-II/2015
About Forest and Water Conservation in Aceh Province
- Data Analysis

1. Breeding Population (western Leuser)

Estimated minimum 2 calves/year







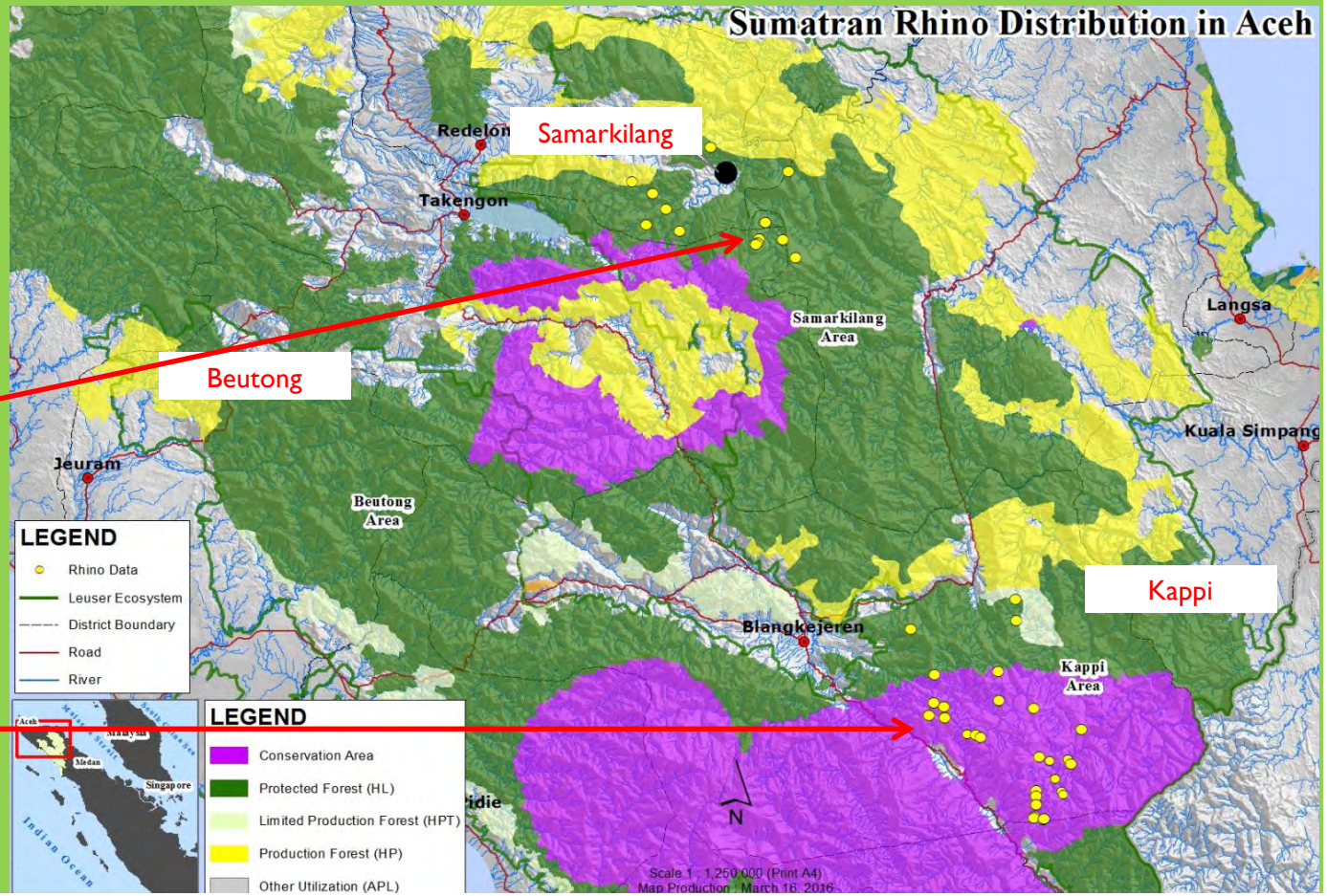


1. Non Breeding Population (Kappi, Samarkilang, Beutong)

- Secondary sign of rhino (86 signs in last 3 years)
- 13 – 18 individuals (estimated)
- No breeding indication







Intervention

1. Breeding Population

- Full protection (IPZ)
- 11 Rhino Patrol Units deployed
- Plan to form 16 units total





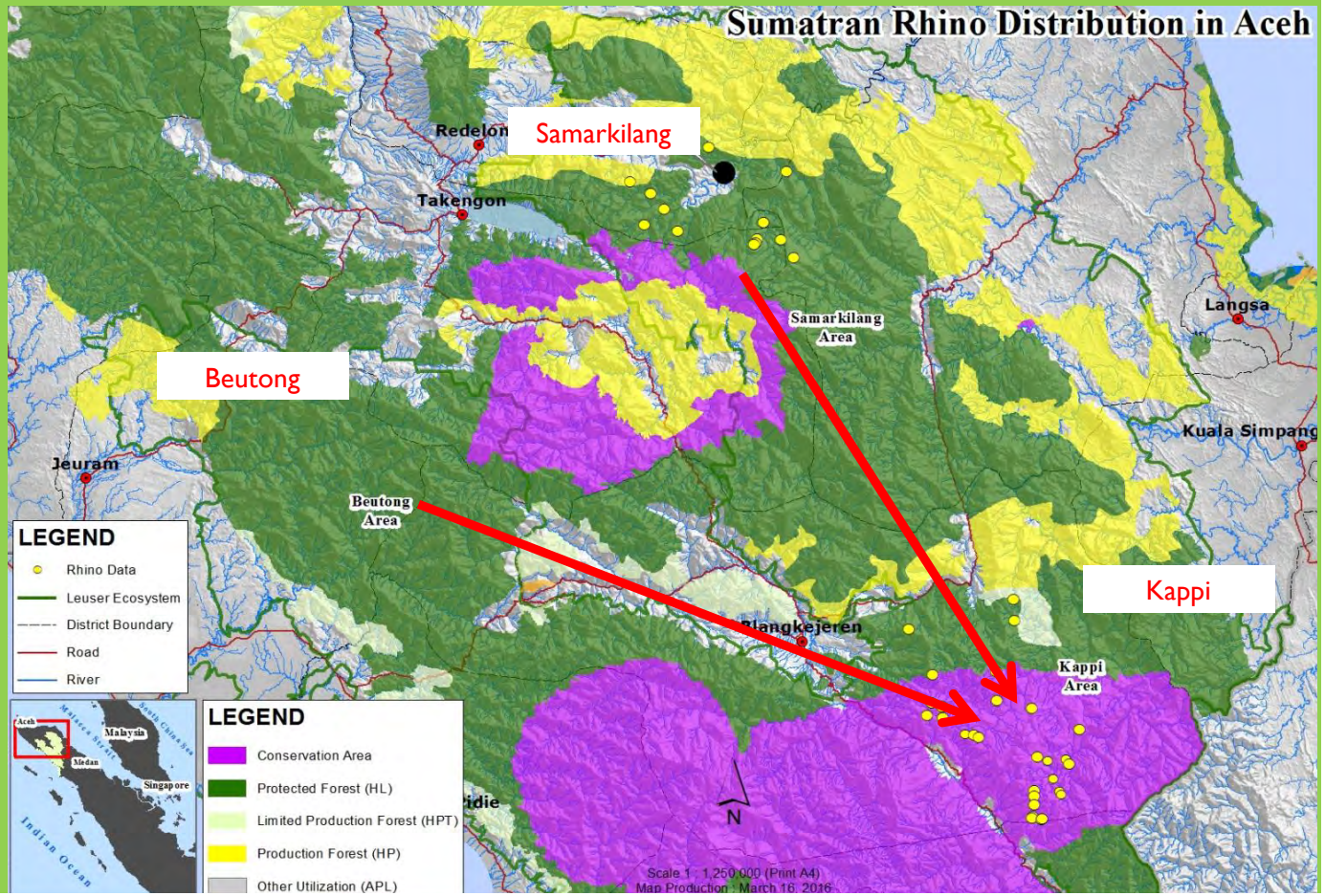


Intervention
2. Non Breeding Population

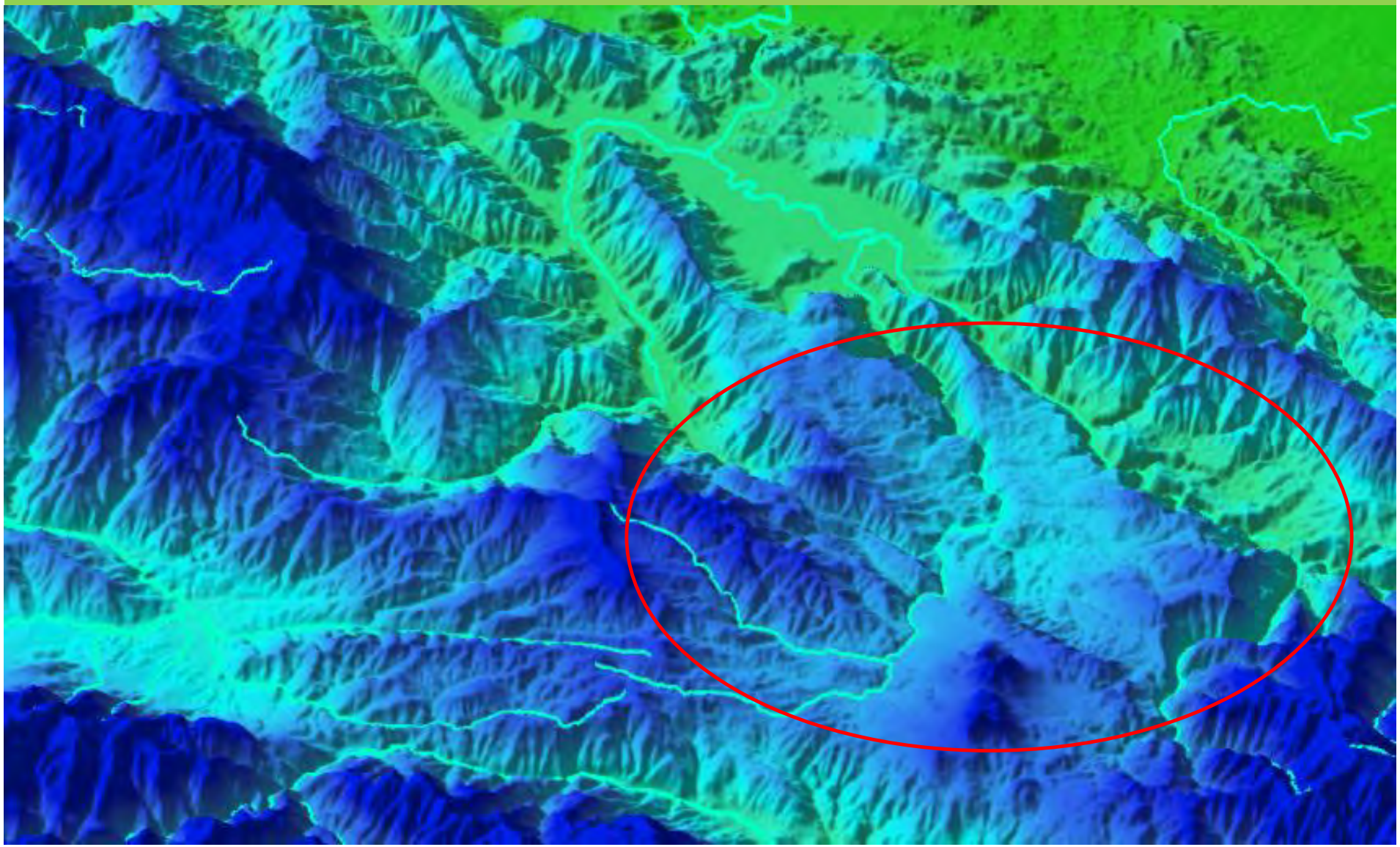
Scenario 1 : Capture and translocation to Kappi Plateau





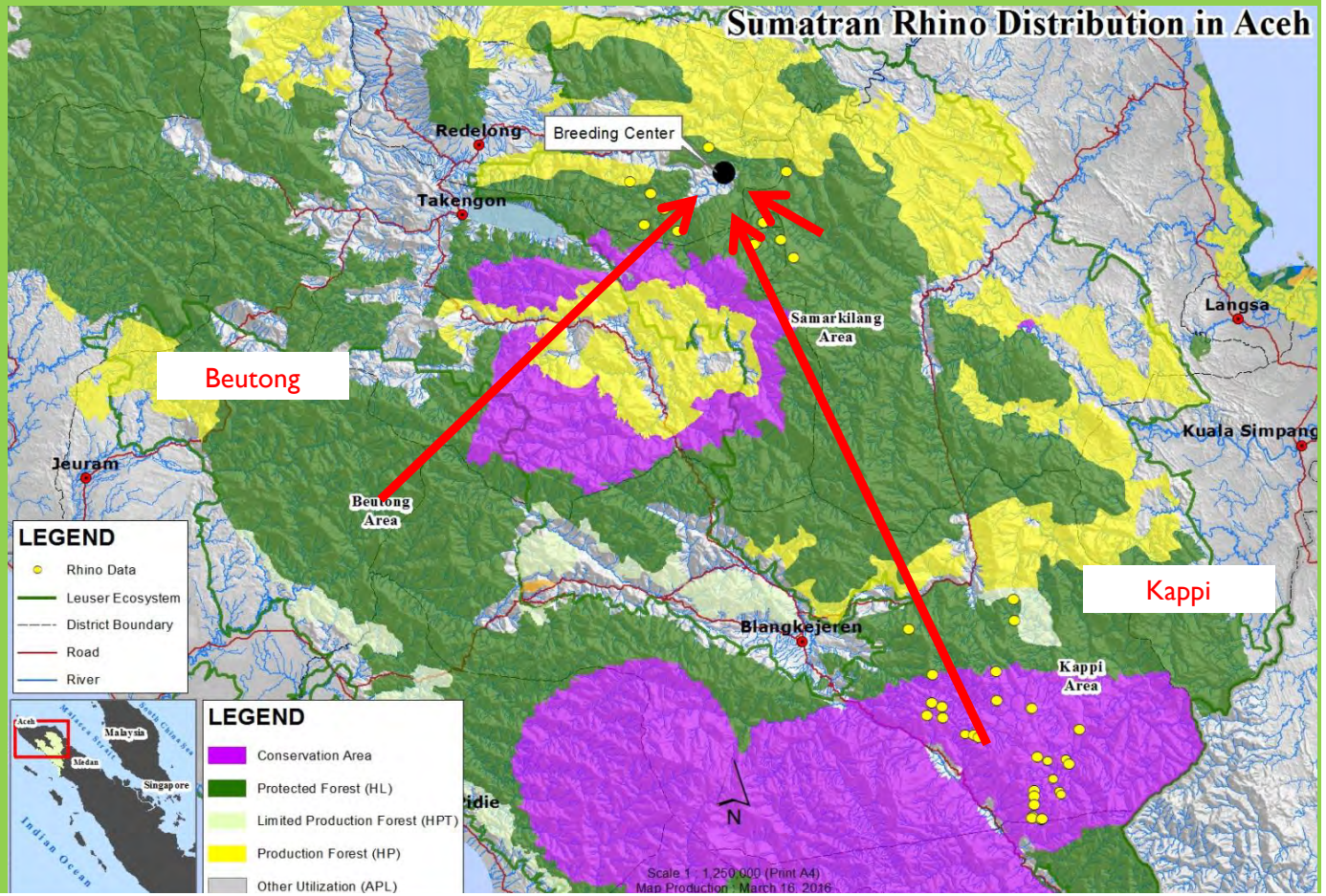


Kappi Plateau (1,500 km^2)



Intervention.....
2. Non Breeding Population

Scenario 2 : capture and release to breeding center in Samarkilang (or Way Kambas?)



Intervention .....

2. Non Breeding Population

Scenario 3 : capture and translocation to western Leuser



Amalgamating rhinos is not without risks but radical intervention is now needed to give Sumatran rhinos any chance of survival



Thank You

Conserving Javan Rhino Through Special Interest Ecotourism

Ofat Sofwatuddin, S.Ip

FRIENDS OF RHINO

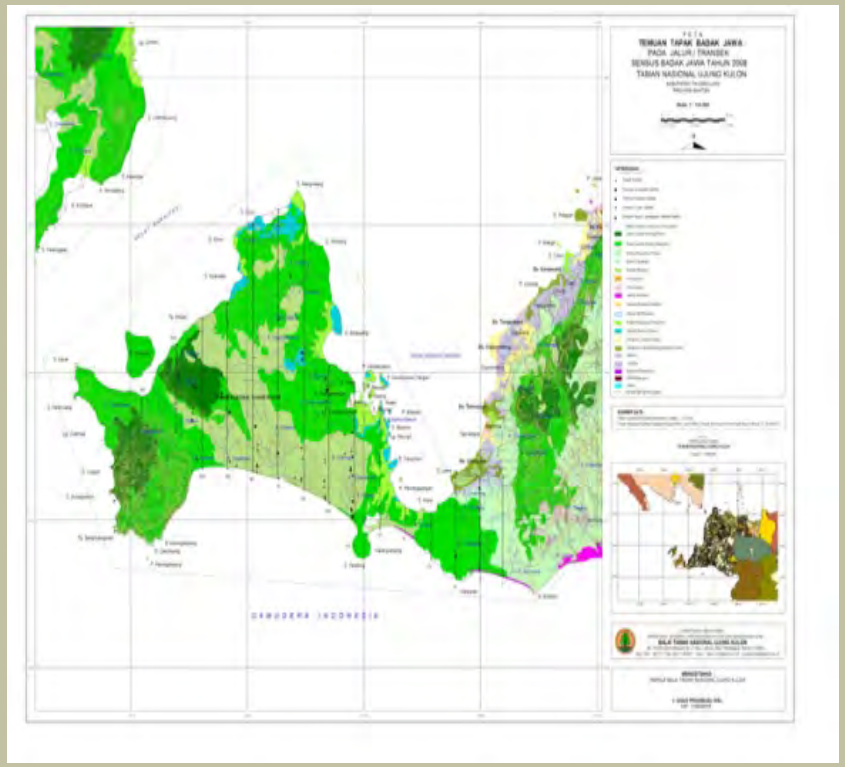
Conservation & Community Empowerment



The 15th International Elephant and Rhino Conservation & Research Symposium. Singapore Zoo,
November 14 -18, 2016.

Indonesian Rhinos

Ujung Kulon National Park







The Javan Rhino Population





RED LIST

1996– Critically Endangered
1994– Endangered
1990– Endangered
1988– Endangered
1986– Endangered

- ❑Protected animal
- ❑Priority Species

Threats to the Javan Rhino

- Human Pressures
- Invasive Vegetation.
- Competition from other species.
- Poaching.









Commitment and Substantial Funding





Conservation strategy

- **PROTECTION OF LIFE SUPPORT SYSTEM .**
- **PRESERVATION OF PLANTS AND ANIMAL TYPE VARIETY TOGETHER WITH THEIR ECOSYSTEM.**
- **SUSTAINABLE USE OF BIODIVERSITY AND ITS ECOSYSTEM**

SUSTAINABLE USE OF BIODIVERSITY AND ITS ECOSYSTEM

- Special Interest Ecotourism offers an opportunity to both raise funds for the conservation of the specie, and to increase awareness of it`s plight.





Friends Of Rhino offers :

Rhino Monitoring Tour

(Special Interest Ecotourism through Community Based Partnership)

- Small groups of people to UKNP.
- observe rhino behaviour in their natural habitat.
- Strict rules to protect the fauna and the ecosystem.
- focus on the Cikeusik and Cigenter area (coastal areas, estuaries and along the river).
- Tours are restricted to July to mid - September .
- Spending at least 7 to 10 days travelling through where they are most likely to observe rhino..

Team Involved

- Local Community
- Rhino Monitoring Unit
- Friends Of Rhino







The anticipated Benefits

- **Visitor**
  Increased awarness and knowledge about conservation of Javan Rhino.

- **Local Community**
  To create sustainable business opportunities and employment .

- **Javan Rhino**
  Provide a funding source for Javan Rhino conservation



Let's standing on the rhino side

Conservation & Community Empowerment

Office : Jalan Jenderal Sudirman 290
Labuan Pandeglang 42264
Banten INDONESIA

Phone: (+62)81387274466
E-mail: ofatbadak@yahoo.com
FB:Friends of Rhino
Website :

Current threats to Asian rhinos from illegal rhino horn trade

Bibhab Kumar Talukdar, Ph.D.
CEO, Aaranyak
Asia Coordinator, International Rhino Foundation

IUCN STATUS OF ASIAN RHINOS

Javan Rhino CR 60-63



IUCN STATUS OF ASIAN RHINOS

Sumatran Rhino CR < 100 ??



IUCN STATUS OF ASIAN RHINOS

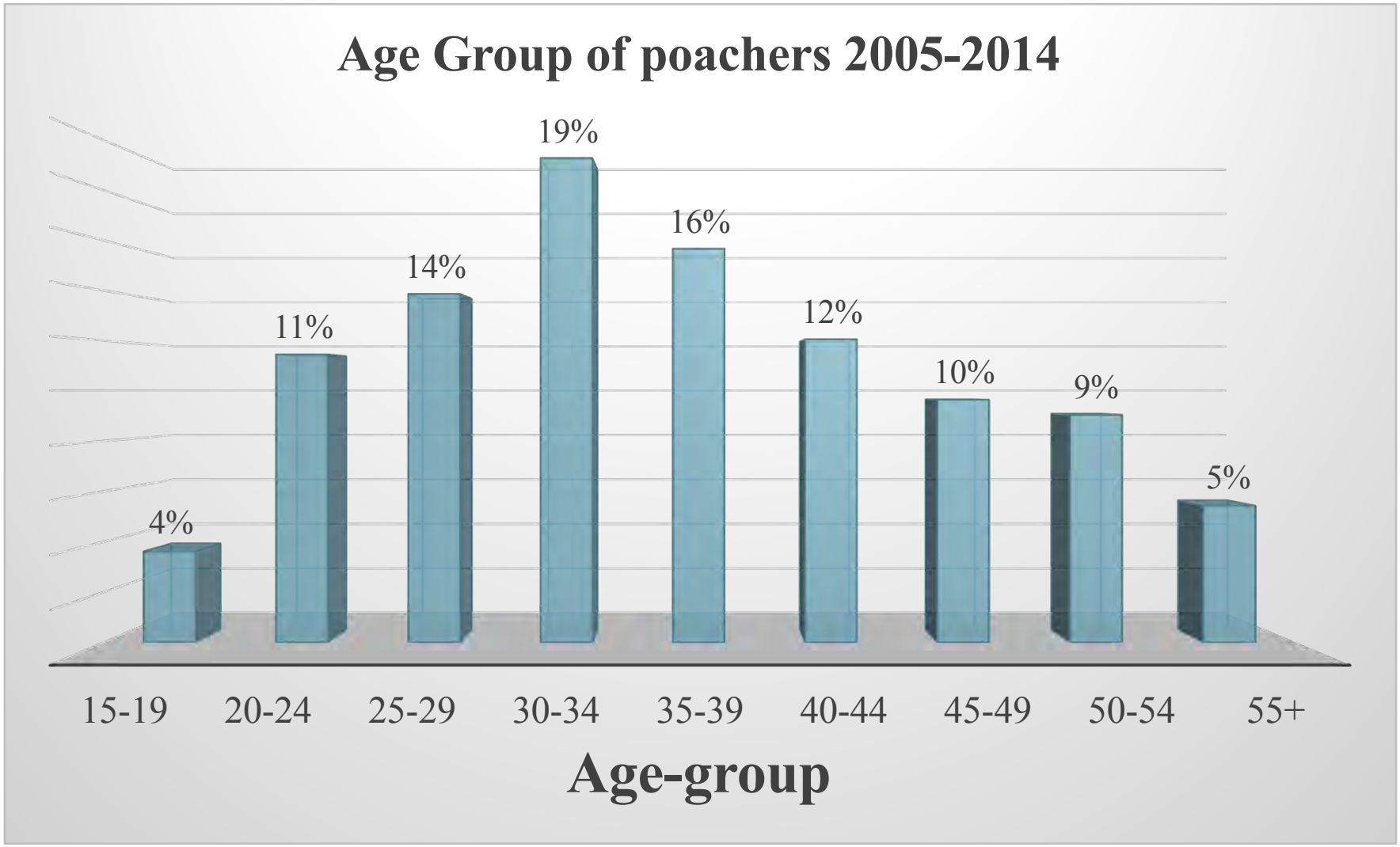
Greater One Horned Rhino	VU	3550+



Greater One Horned Rhino Population 2016

Sites	1980s	2000	2009	2013	2015	Trend
Kaziranga NP	1000	1552	2048	2329	2401	↑
Orang NP	60	46	64	100	100	↑
Pabitora WLS	50	74	84	92	92	↑
Manas NP	50-60	??	8+3	31	30	↓↑
Laokhowa WLS	50-70	??	0	0	0	↓
Jaldapara WLS	14-24	84	128	186	204	↑
Gorumara NP	0-8	22	31	43	51	↑
Dudhwa NP	2+3	24	29	29	32	↑
Chitwan NP	300+	544	435	503	605	↓↑
Bardia NP		104	20	24	29	↓↑
Suklaphanta WR		4	7	8	8	→
Parsa WL Reserve					3	

People associated with poaching

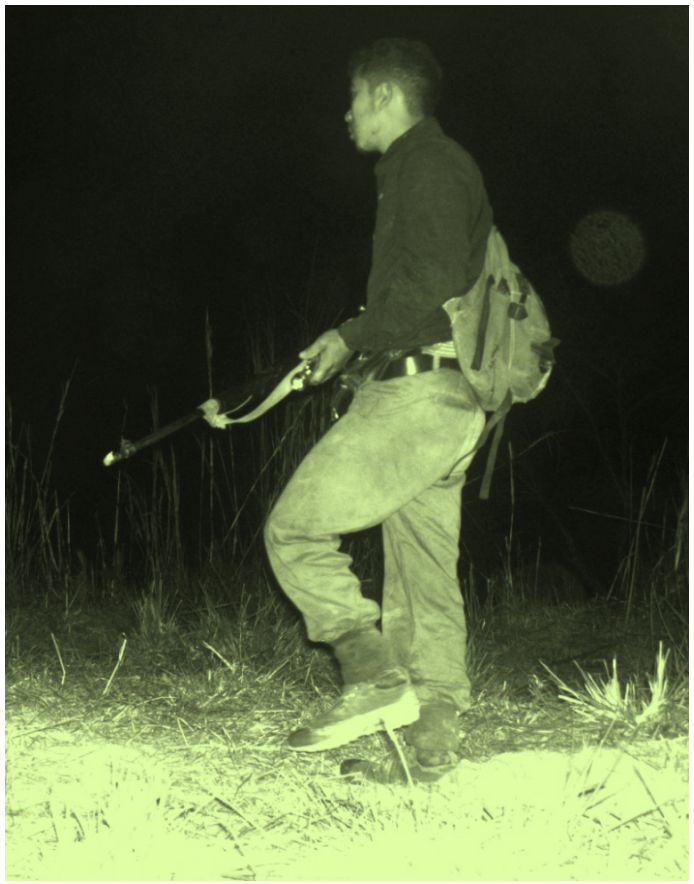


Comparison of Used cartridge with 303, Mission Rifle and Machine gun



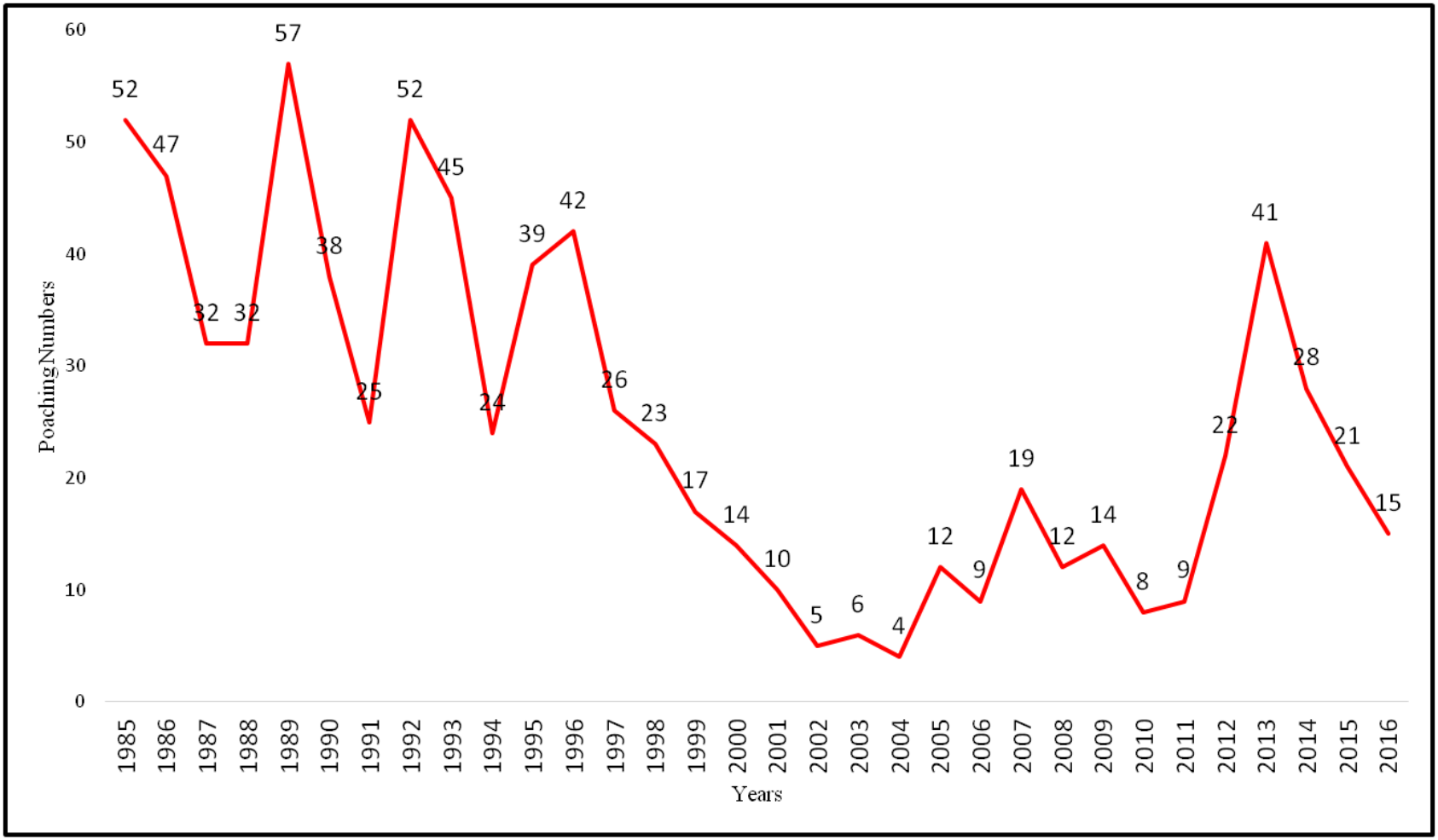
Evolution of Poachers

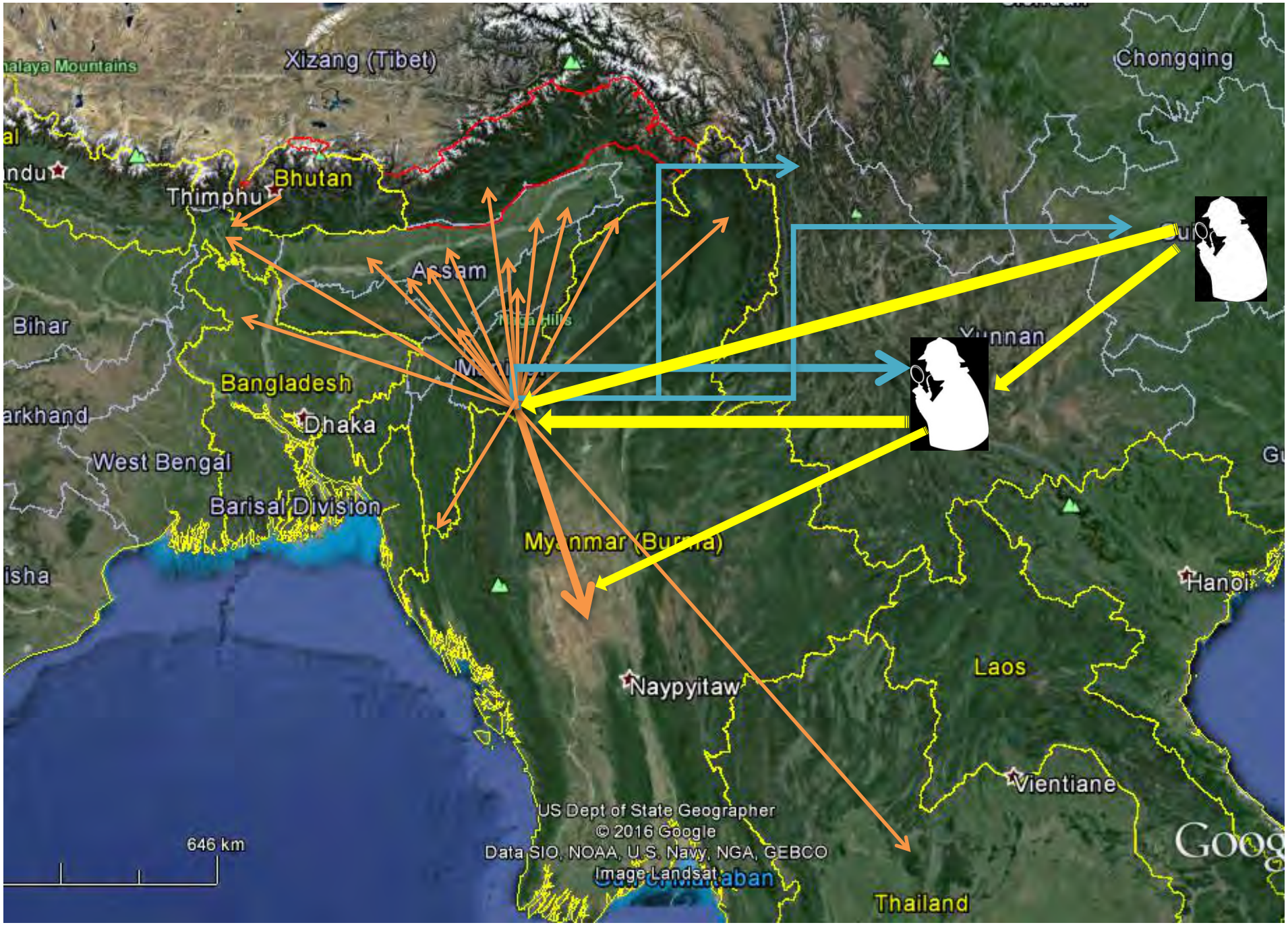




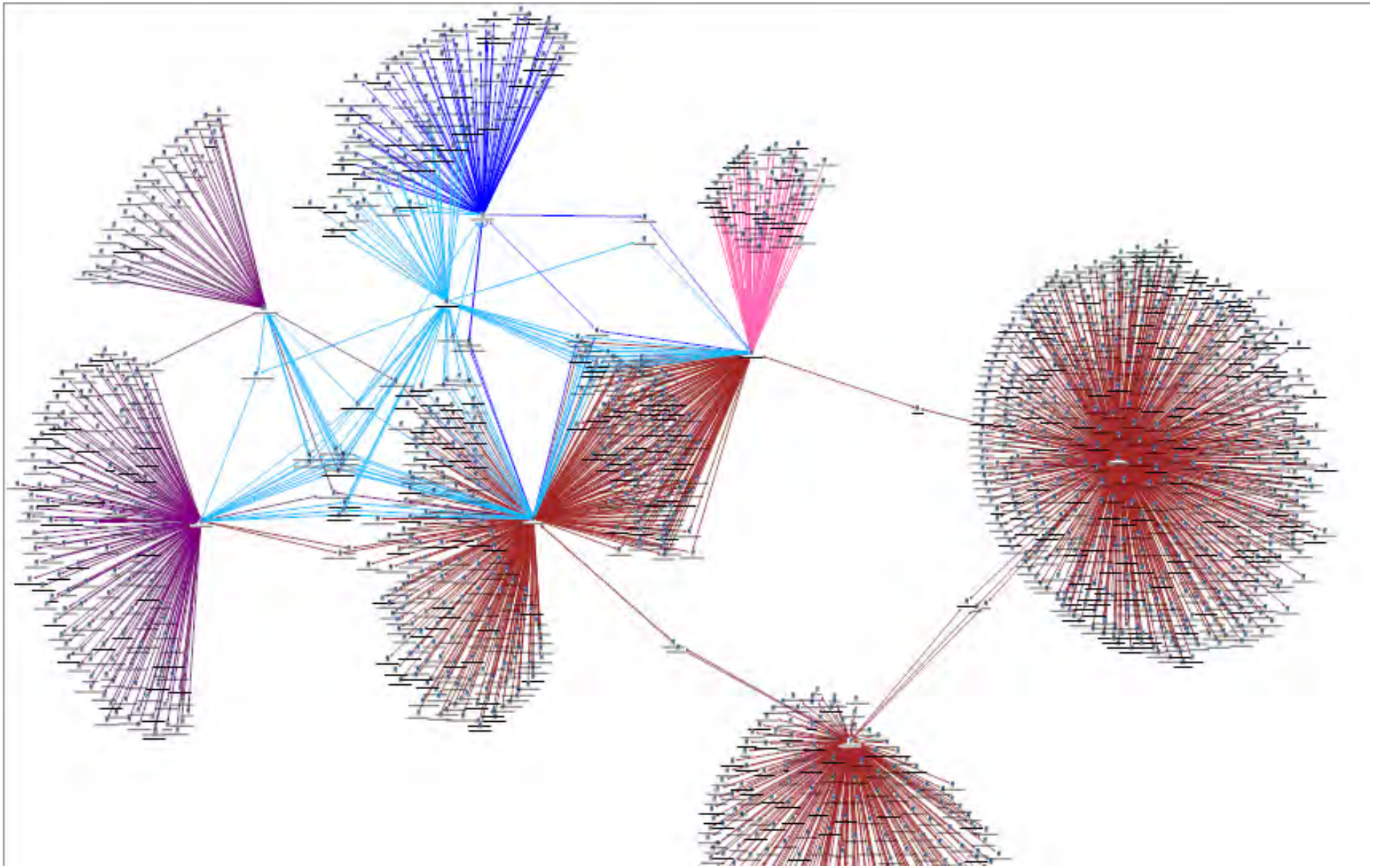


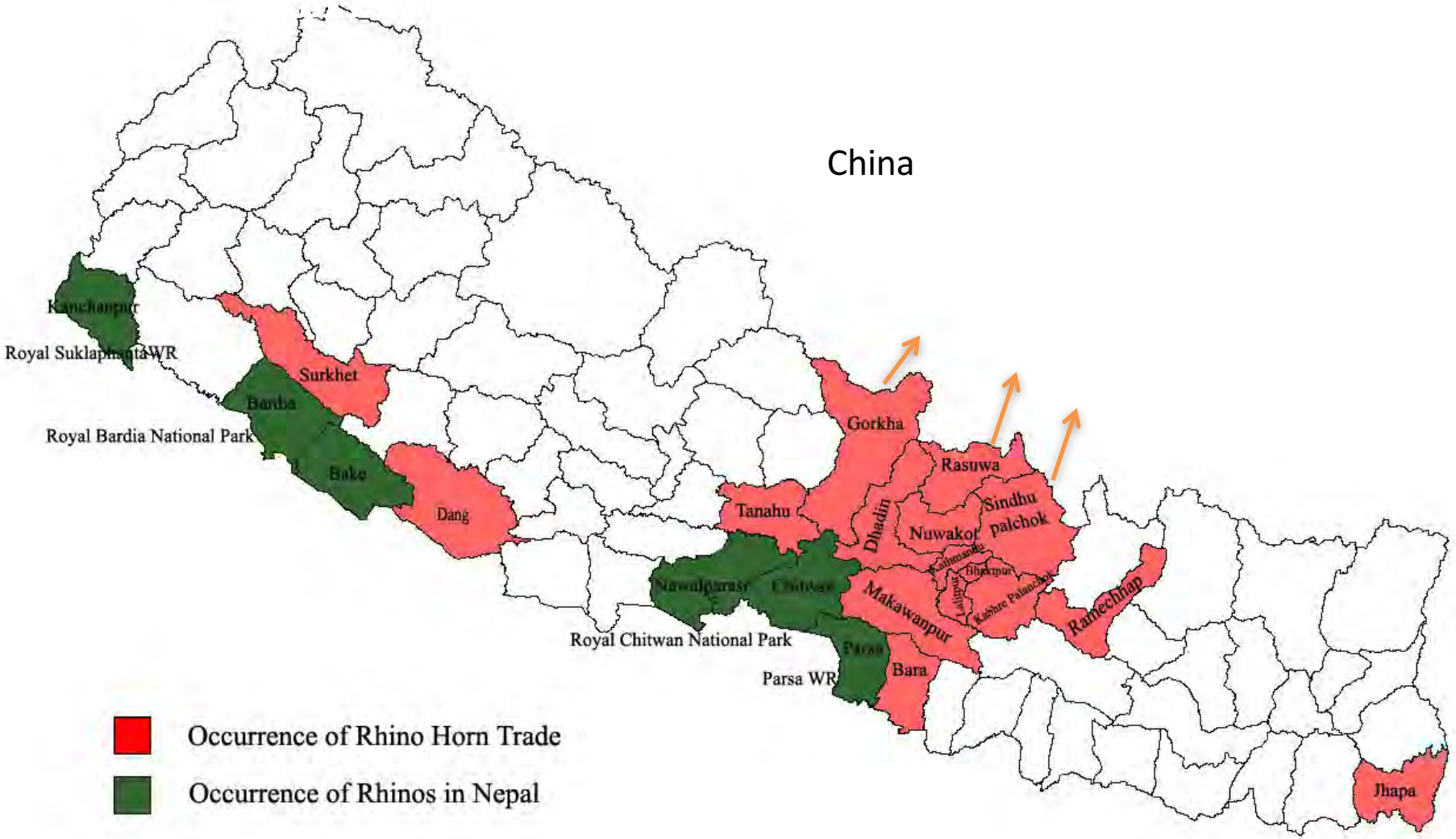
Rhino poaching trend in Assam during 1985 – 2016 (September)




Xizang (Tibet)
Chongqing
Bhutan
Thimphu
Assam
Bihar
Yunnan
Bangladesh
Dhaka
West Bengal
Barisal Division
Myanmar (Burma)
Hanoi
Laos
Naypyitaw
Vientiane
Thailand
646 km
US Dept of State Geographer
© 2016 Google
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat

Culprits can be narrowed down





Map Courtesy: Wildlife Conservation Nepal

Special Meeting with Police, Para military and army officials in India



Emphasis more on rhino horn trade leading to national insecurity

K9 in Field Action











Sniffer Dog









Legal Orientation









Reaching Communities to enhance conservation awareness







Keeping rhinos alive is a continuous fight!









- Challenges bring opportunities!

- Let's explore the opportunities to curb rhino poaching and illegal trade on rhino horn.



Thank you



Population modeling of Asian elephant in a rain forest

Jyoti P Das

Abhijit Boruah

Bibhuti Lahkar

Aaranyak

www.aaranyak.org

U.S. FISH & WILDLIFE SERVICE

Introduction

- Easternmost India
- Oil industry
- Last remaining patches of Rain forests
- Regarded as '**amazon of the east**'
- Important trans-boundary landscape with Burma



Background

- No information on Asian elephant population
- First attempt using dung count method in a rain forests (Assam valley wet evergreen)
- Study period 2014-2015

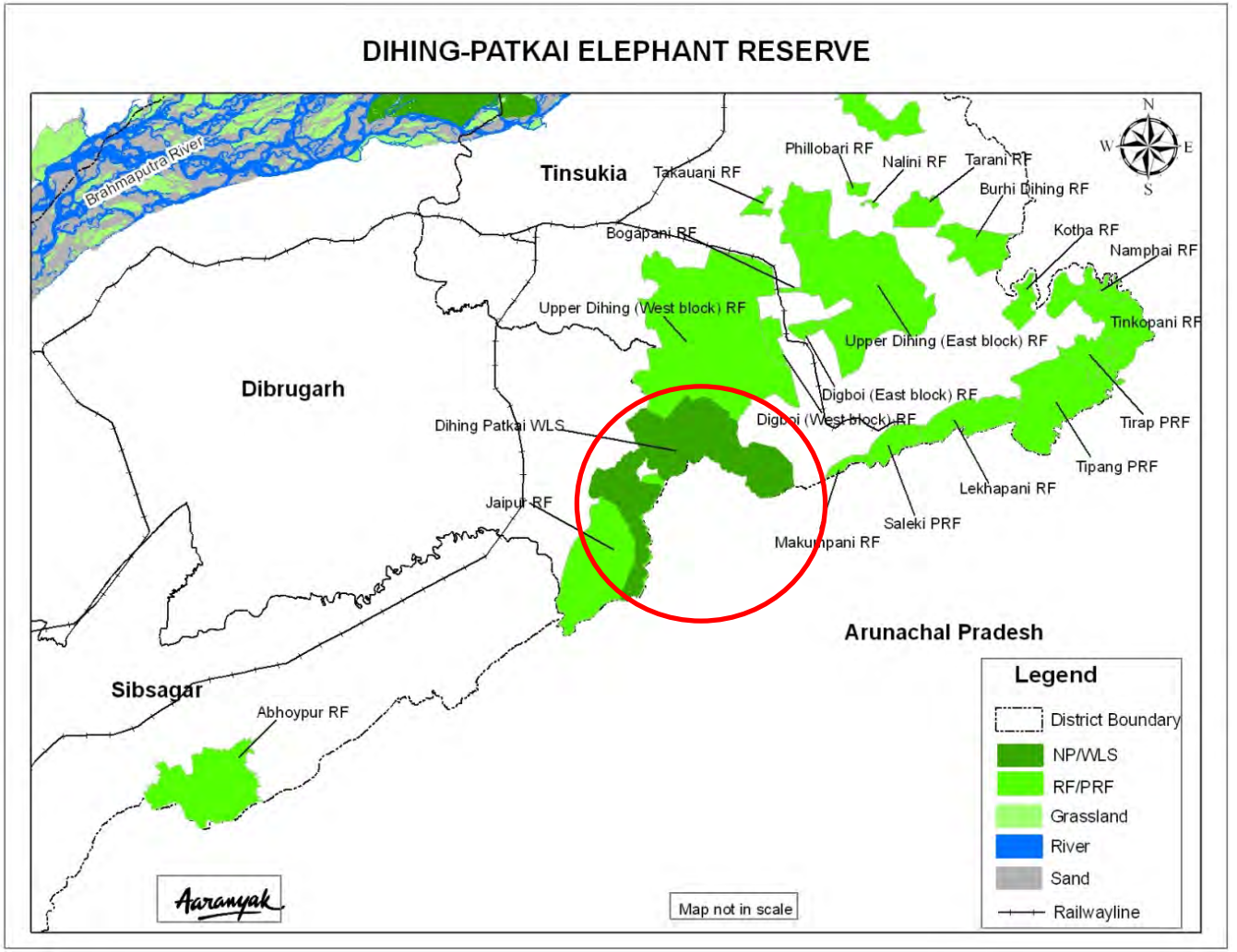


Study Area





Dehing Patkai Wildlife Sanctuary – 111.19 sq km
Dehing Patkai Elephant Reserve – 937 sq km



Methods

- **Population estimation**

E = (Y x r) / D

Where,

E = Density of elephants,

Y = Dung density

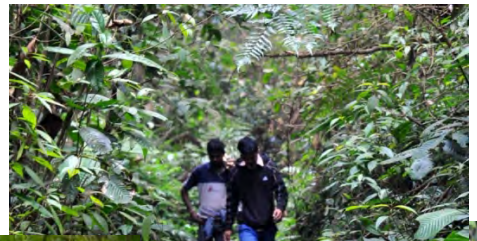
r = decay rate

D = defecation rate
(18.07±0.068) (95 % CI)

MIKE standard

Line transect ~ 1 km length

- Dung count
- Fresh dung pile marking for decay rate estimation



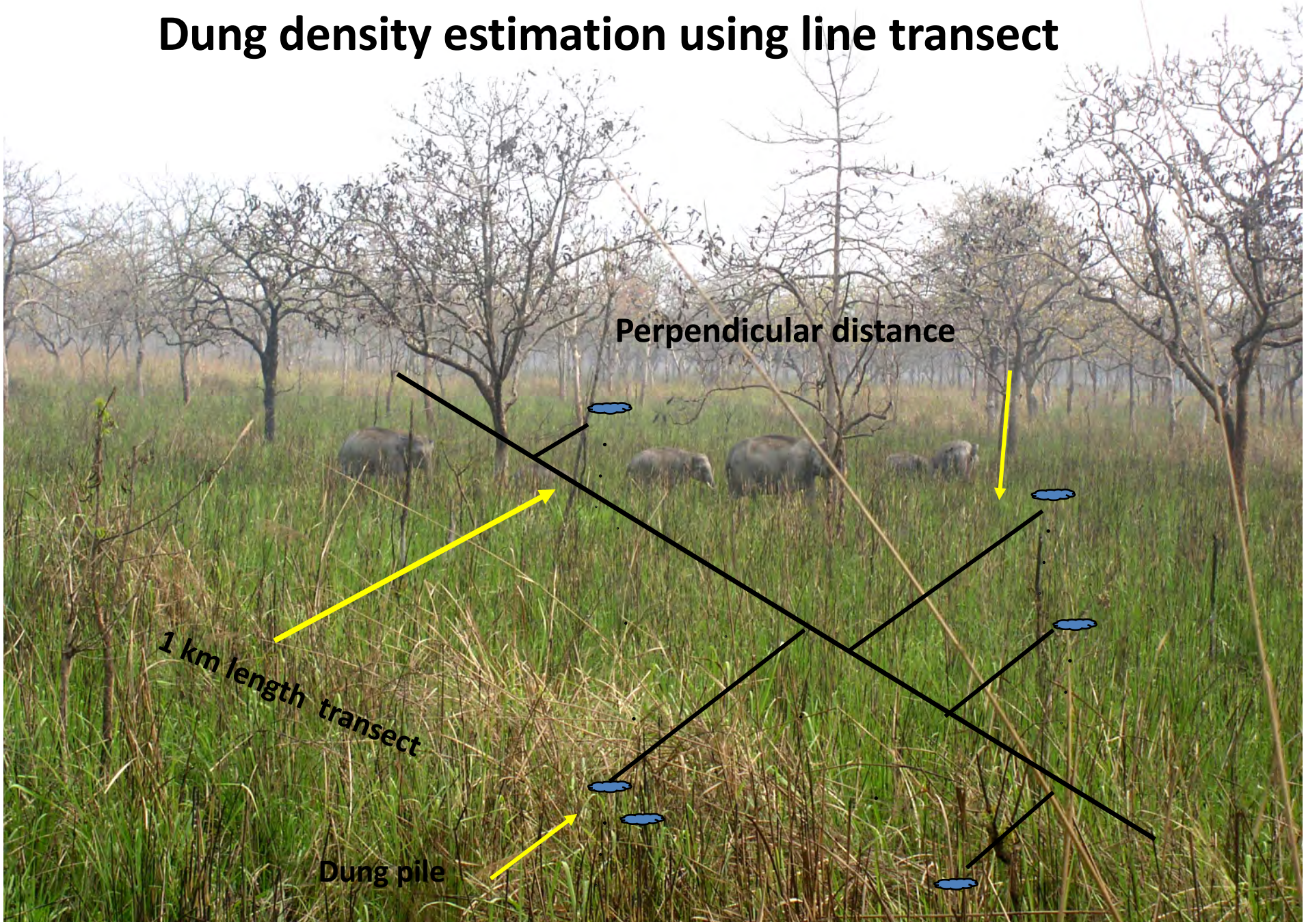








Dung density estimation using line transect



Decay rate monitoring

- Marking fresh dung piles
- Monitoring until it disappears





The S - System

Stage	Definition
S1	Fresh, All boli are intact.
S2	One or more boli are intact, but not all.
S3	No boli are intact, but coherent fragments remain
S4	Only traces remain, no coherent fragments
S5	No faecal material







Factors affecting decay rate

- Rainfall
- Diet
- Temperature
- Sunlight
- Humidity
- External factors



Defecation rate

- Difficult to obtain in wild.
- Studies on zoo and captive elephant.
- Average 14-19 times/day.
- 18.07 ± 0.0689 times per day (95% CI)

  after MIKE (2004)



Study design

- Study area size

Habitat type	Area (km^2)
Wet evergreen	94.02
Mixed moist deciduous	17.17
Total area	111.19

- Total transects – 32

	Survey habitat	no of transect	average (km)	min (km)	max (km)	total (km)	ESW (m)
1	Mixed moist deciduous forest	8	1	1	1	8	2.52
2	Wet evergreen forest	24	1.05	0.8	1.2	25.20	1.76

Dung decay estimation

Total marked fresh dung pile = 21

MMD (n = 5)		Wet Evergreen (n = 16)	
Mean (days)	SE (95 % CI)	Mean (days)	SE (95 % CI)
74.46	13.42	76.34	12.87

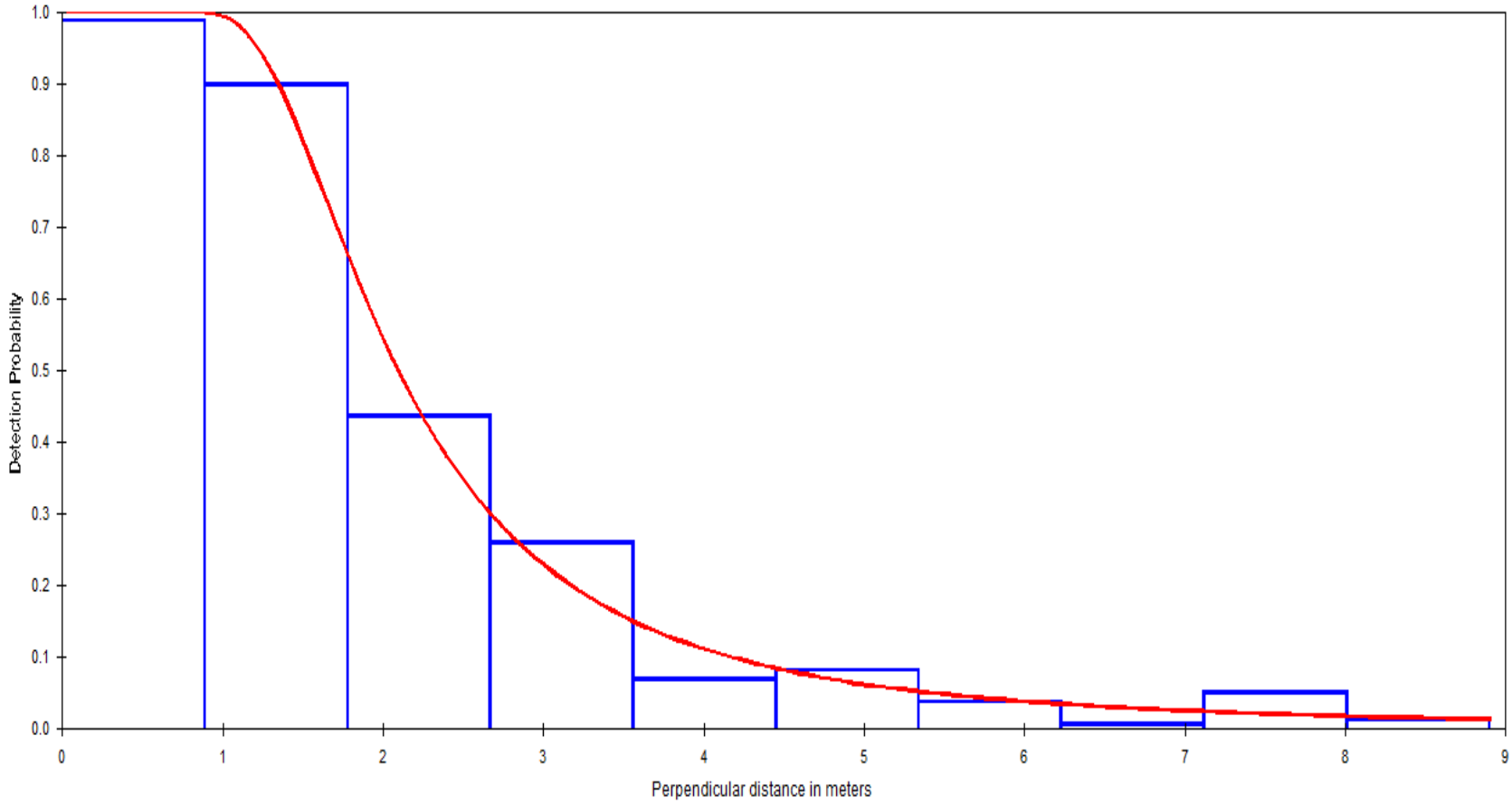
Decay rate

- No significant difference in the mean days to decay of dung between MMD and WEF (Unpaired t-test: t = 0.49, df = 19, NS)
- The mean decay of dung pile in the study area = 75.46 ± 11.19 (n = 21) (95 % CI)

Analysis

- Post stratification - separate detection function for each habitat.
- Global density = the mean of each habitats weighted by the habitat area.
- Various combinations of the key and adjustment function that provide flexibility in modeling the detection function g (x).
- The model that generated the lowest AIC is considered as a reasonable density.
- In the trial analysis, the model fit was poor based on goodness-of-fit tests, due to observation far from line and some significant outliers.
- Data truncation at the distance where g(x) = 0.15

A typical visibility curve of recorded dung piles



Buckland *et al.* (2001) models

Parameters/ Models	Uniform + Cosine	Uniform + Simple Polynomial	Half normal+ Cosine	Half normal + hermite Polynomial	Hazard rate + cosine	Hazard rate + simple poly
Density (km^2)	2.16	2.13	2.28	1.97	2.02	2.12
CV %	14.09	14.14	14.23	14.17	14.22	14.37
Upper CL	3.31	3.26	3.51	3.01	3.12	3.27
Lower CL	1.41	1.39	1.48	1.29	1.31	1.38
AIC	1217.5	1218.74	1217.22	1221.93	1216.38	1219.41

Density estimates

	D (Density parameter)			N (Number parameter)		
Habitat type	Point estimate	SE	Percent Coef. of Variation	Point estimate	SE	95 % CI
Mixed moist deciduous forest	2.06	0.43	15.97	35	10.76	25-46
Wet evergreen forest	1.98	0.27	20.82	186	26.43	160-212

- **The global density of the entire study area was estimated as 2.02 per km^2 (CV=14.22 %, 95% CI: 1.31-3.12)**

- **Population of elephants estimated as 225 (CV-18.19 %, 95% CI: 177-272)**

Conclusion

- Not to compare with department block count result (roughly 250-300).
- Our finding now serves as the new baseline data.
- Dung count method can serve as the suitable method in this type of forests.
- Proposed to upgrade to a National Park.
- Vital population covering transboundary landscape.

Acknowledgement

- Forest Department, Government of Assam
- Sanctuary staff, Digboi division
- Surendra Varma, ANCF, Mysore

- Financial support





Thank you for your attention

A Decade monitoring on influance of forest fire to Spatial Distribution of Sumatran Rhino Calves in Way Kambas National Park (2006 - 2015)



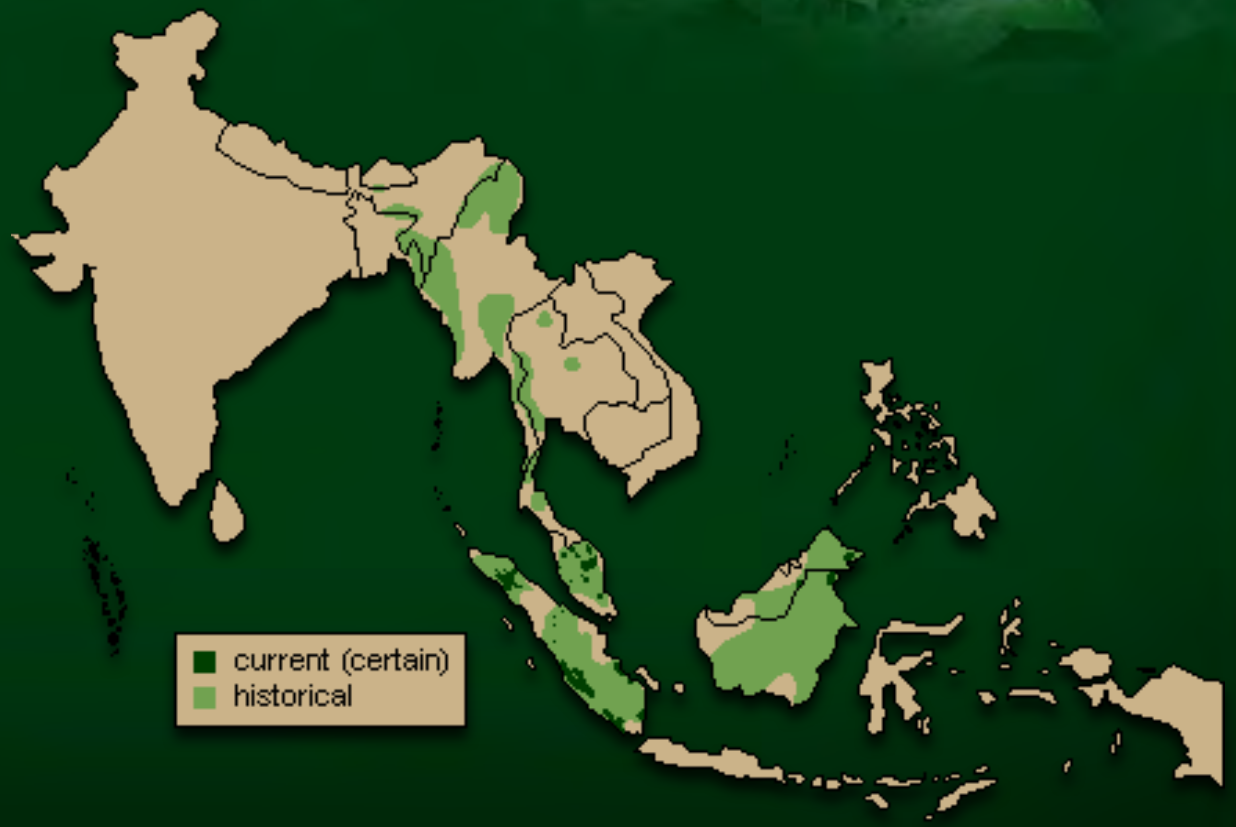
Arief Rubianto *
Yusep Herdiana**
Widodo Ramono***

14 – 18 NOVEMBER 2016

Critically endangered mammal of the world

umatran rhino
Population had declined to half in 10 years (Foose & Strien 1997: 12).

educed to ~ 100 (SRCS, 2013)



Sumatran Rhino Distributiontion in SUMATERA

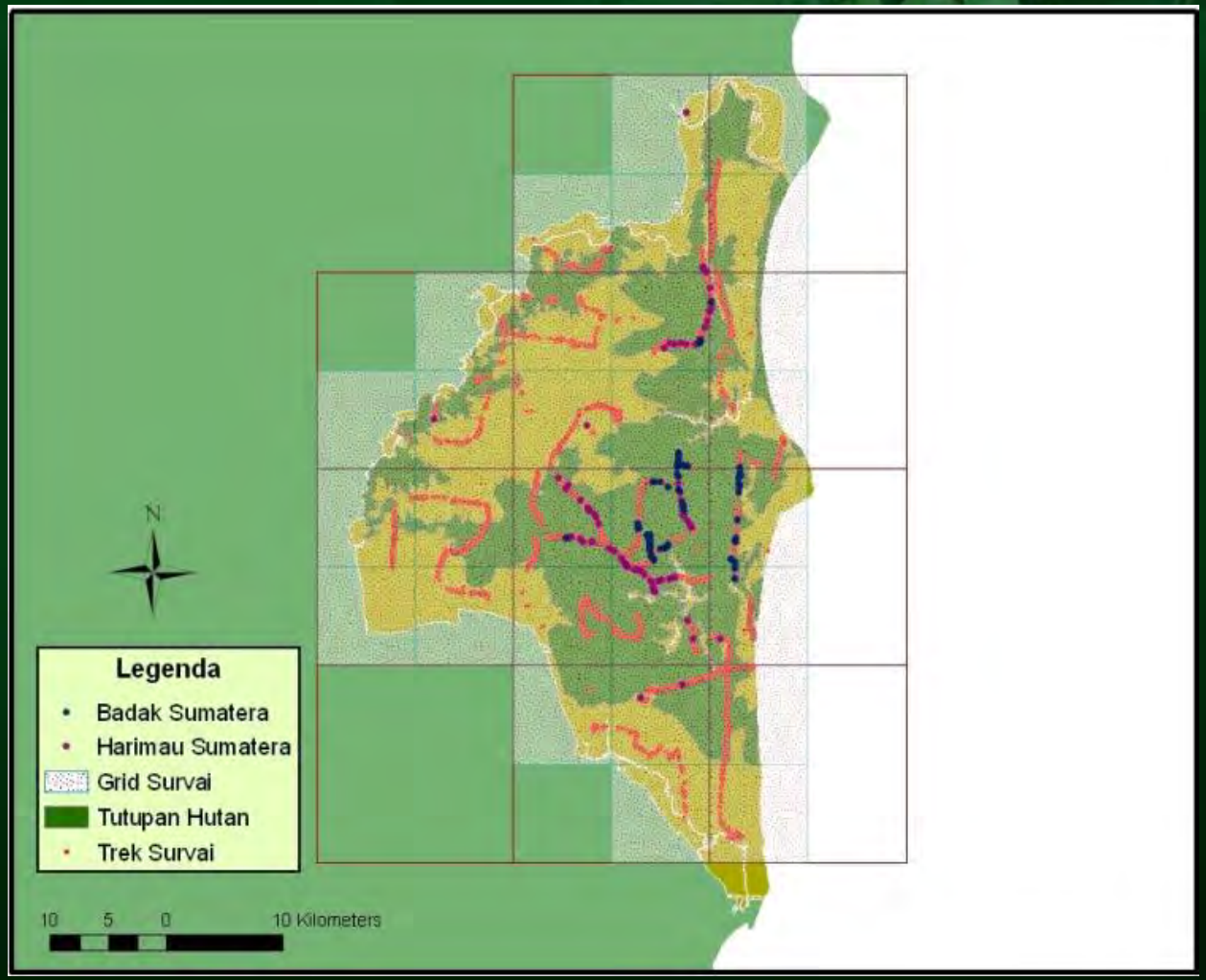


Gunung Leuser NP
(10.233 Km^2)

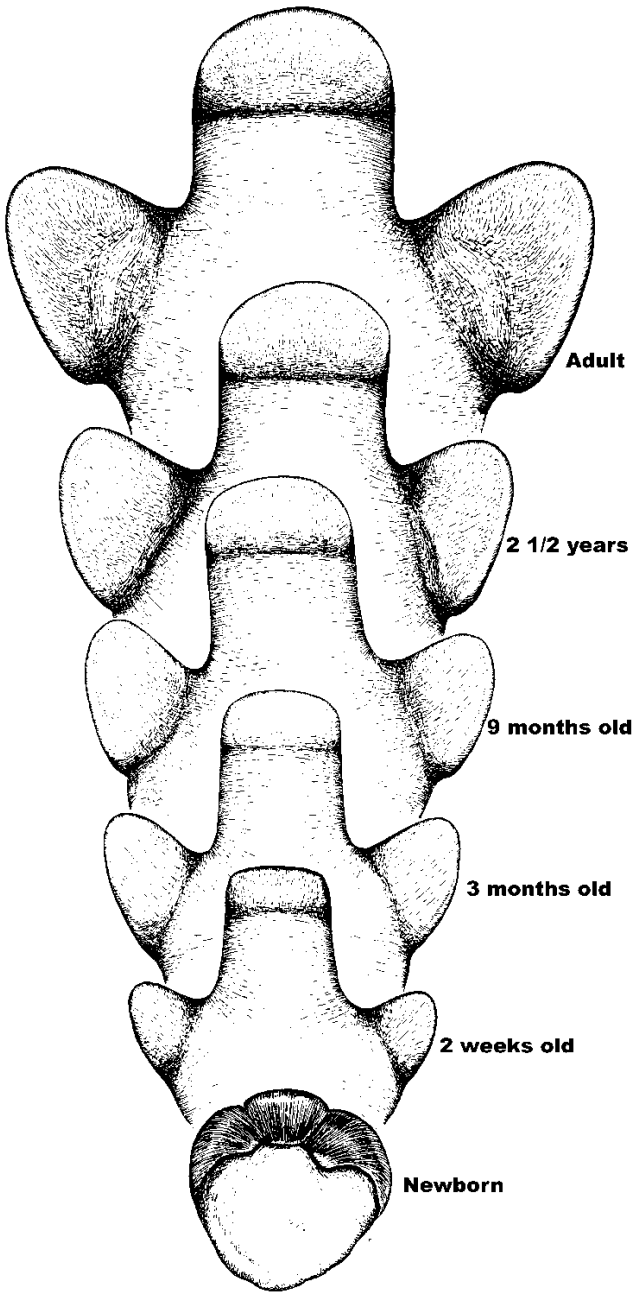
Bukit Barisan Selatan NP
(3500 Km^2)

Way Kambas NP
(1200 Km^2)
Founded 1993.

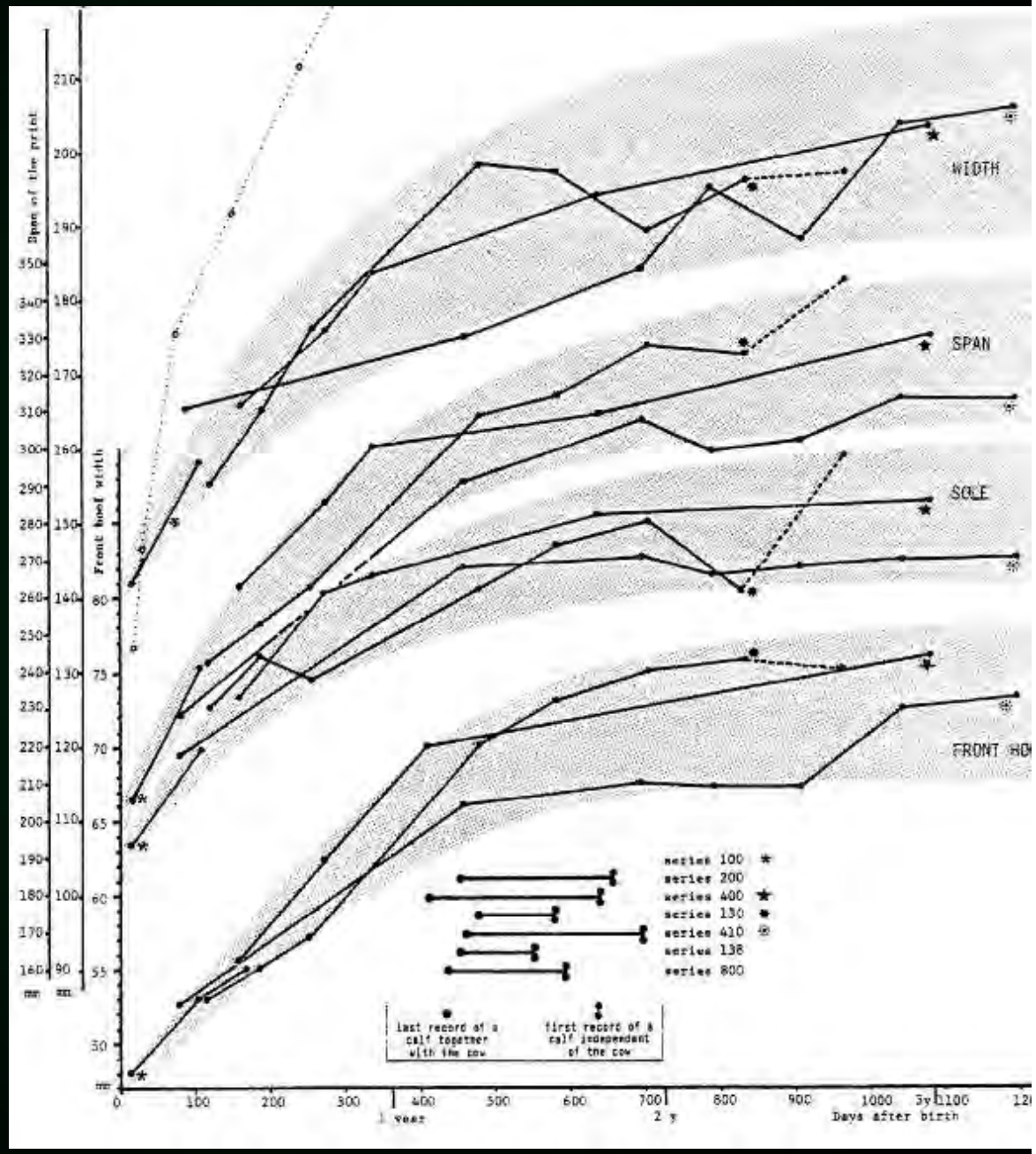
Heterogeneity Royle/Nichols Modeling



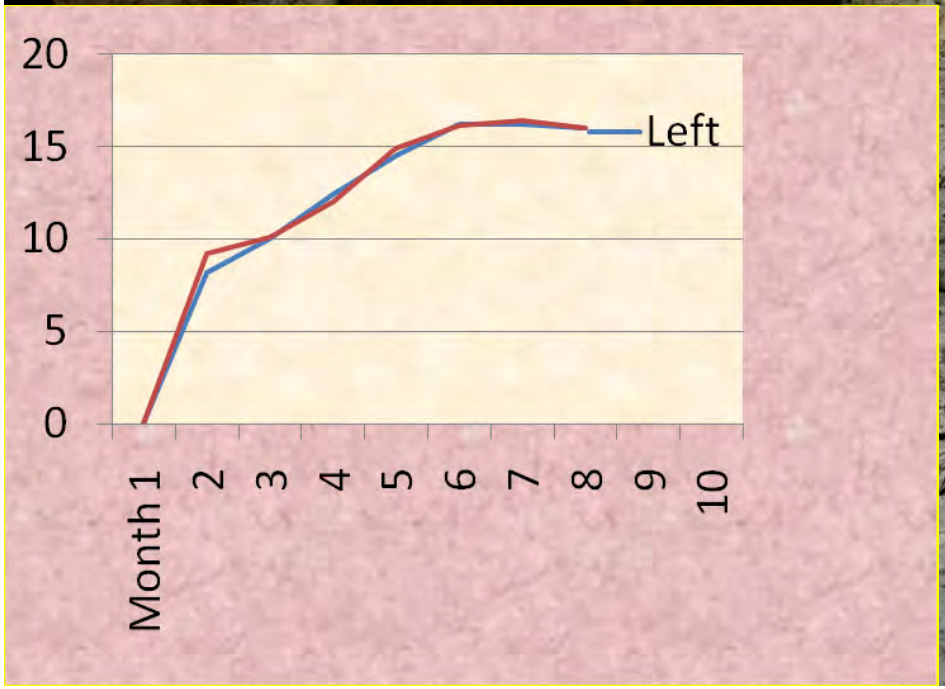
Sumatran rhino occupied 43% of Way Kambas National Park area in 2008



Growth of the foot of the Sumatran Rhino



Andatu Footprint Growth



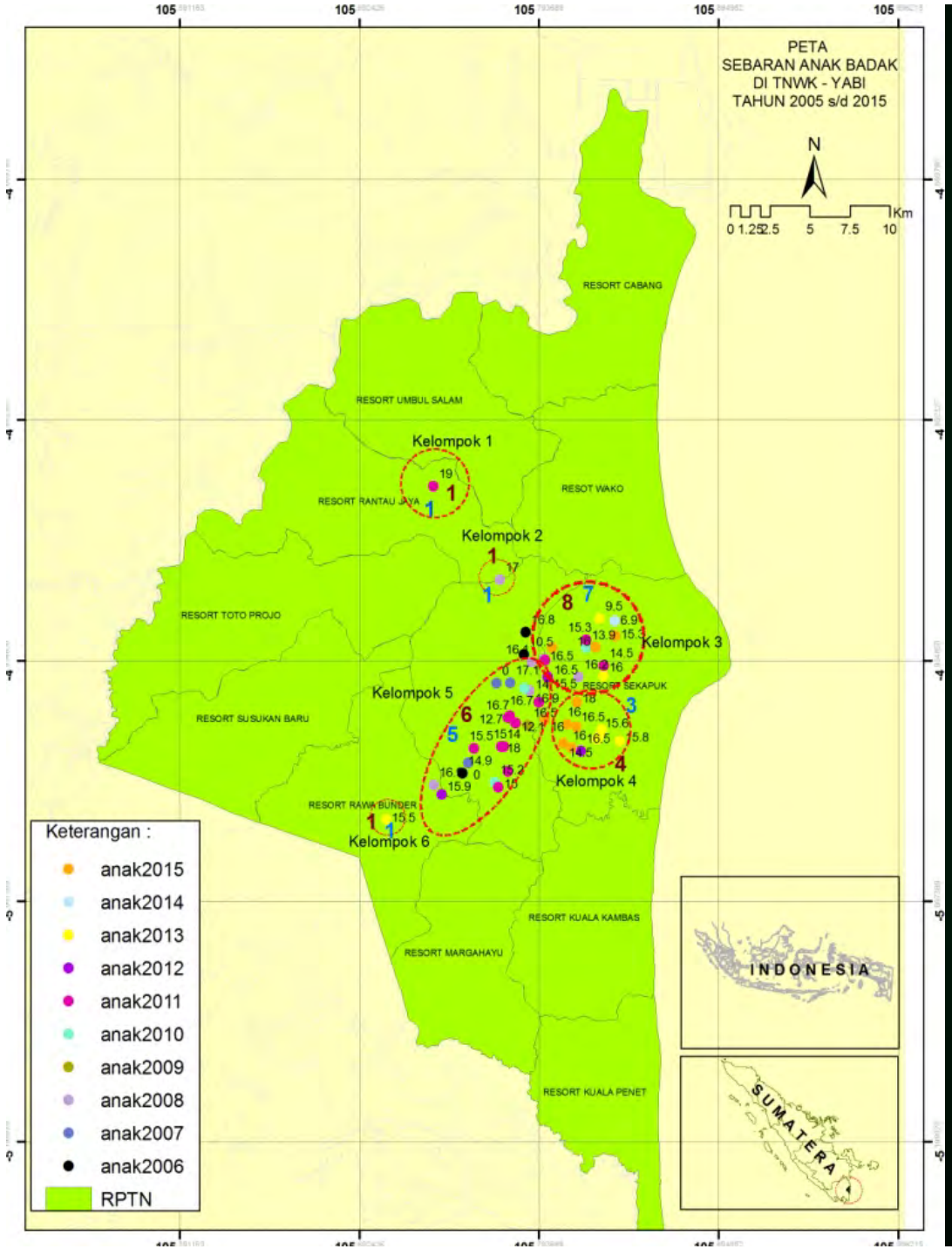




Andatu 1 month

vs

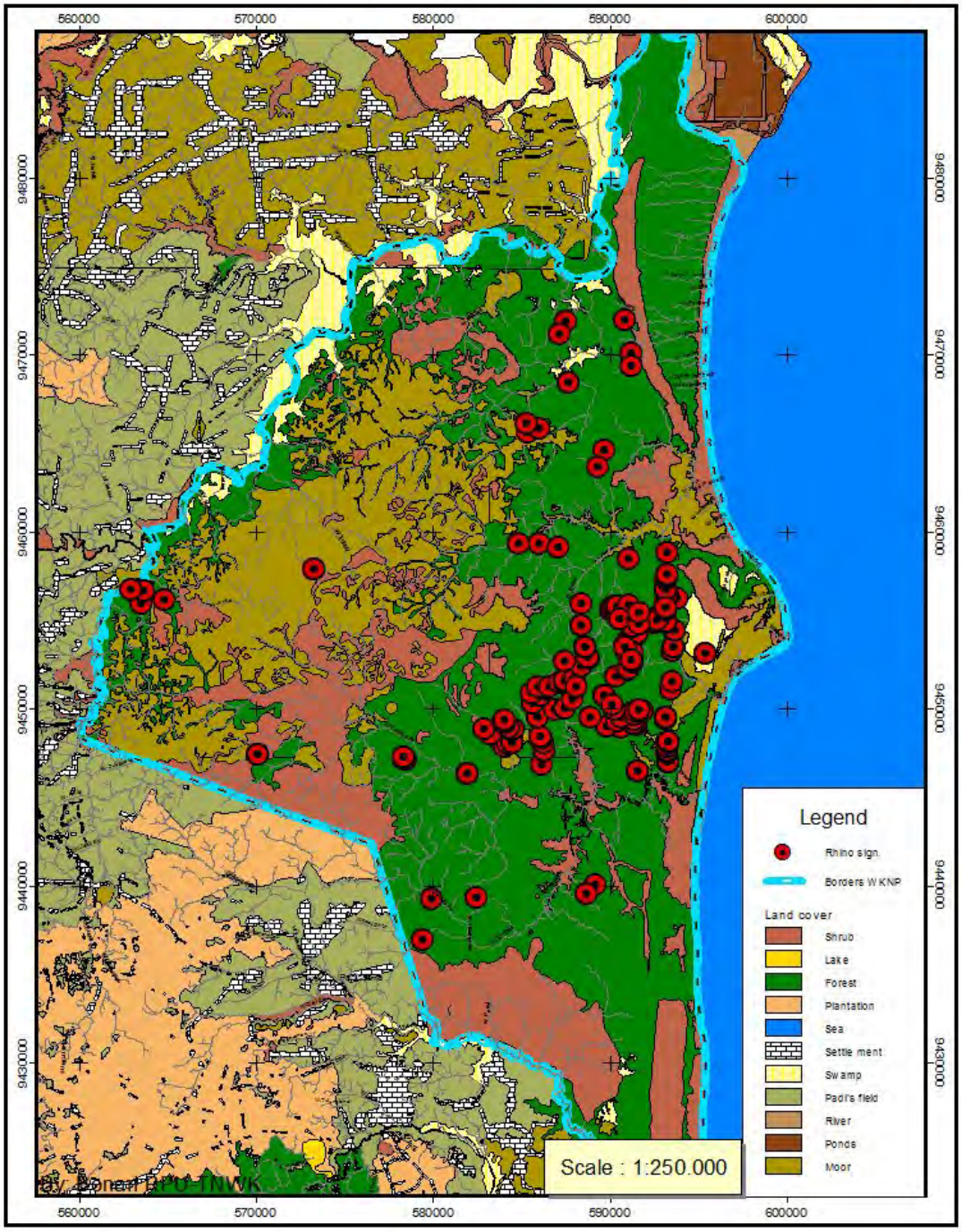
Andatu 1 year



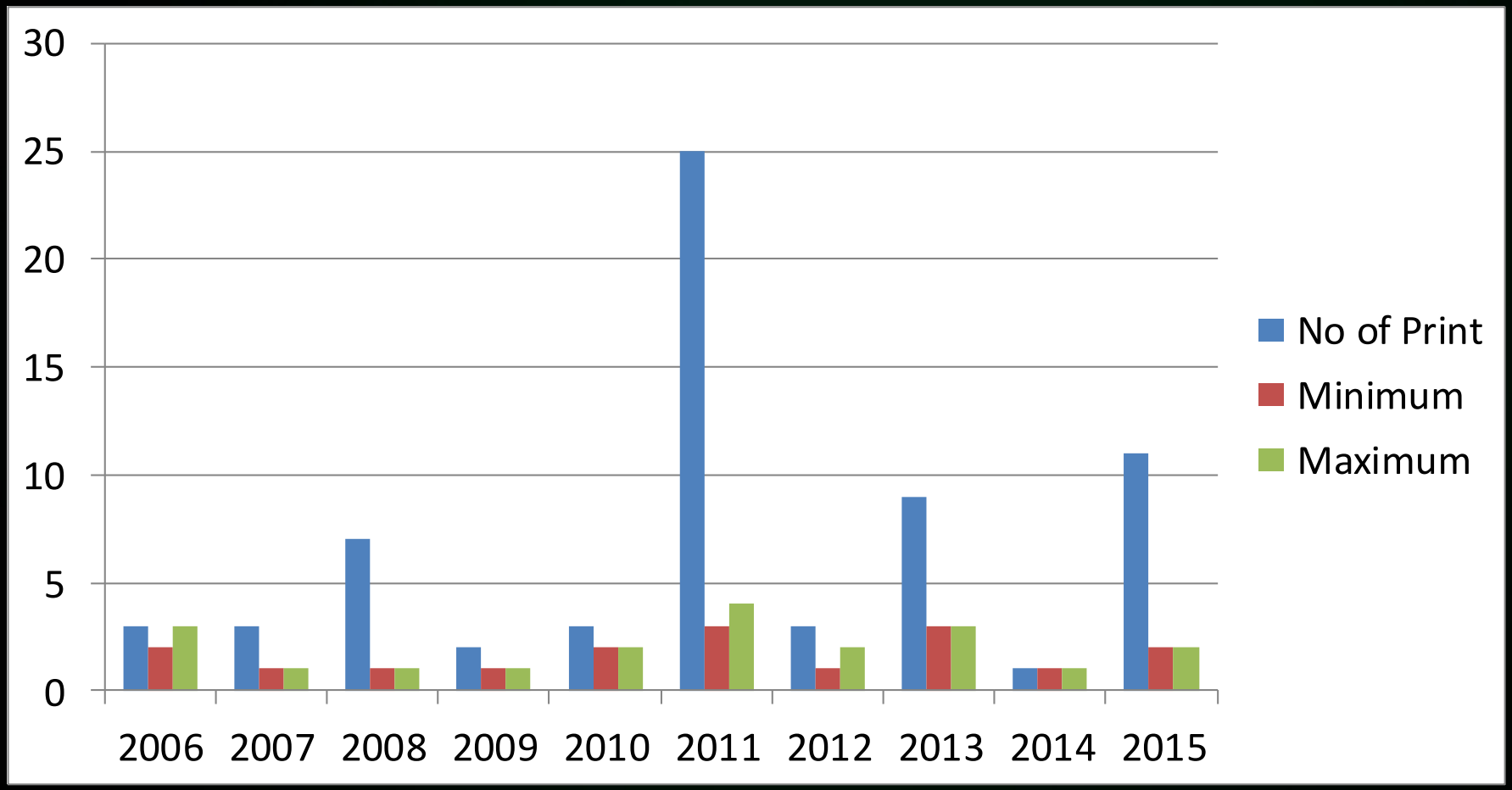
Rhino Calf Distribution in WKNP at 2006-2015

Rhino Distribution in WKNP on 2011

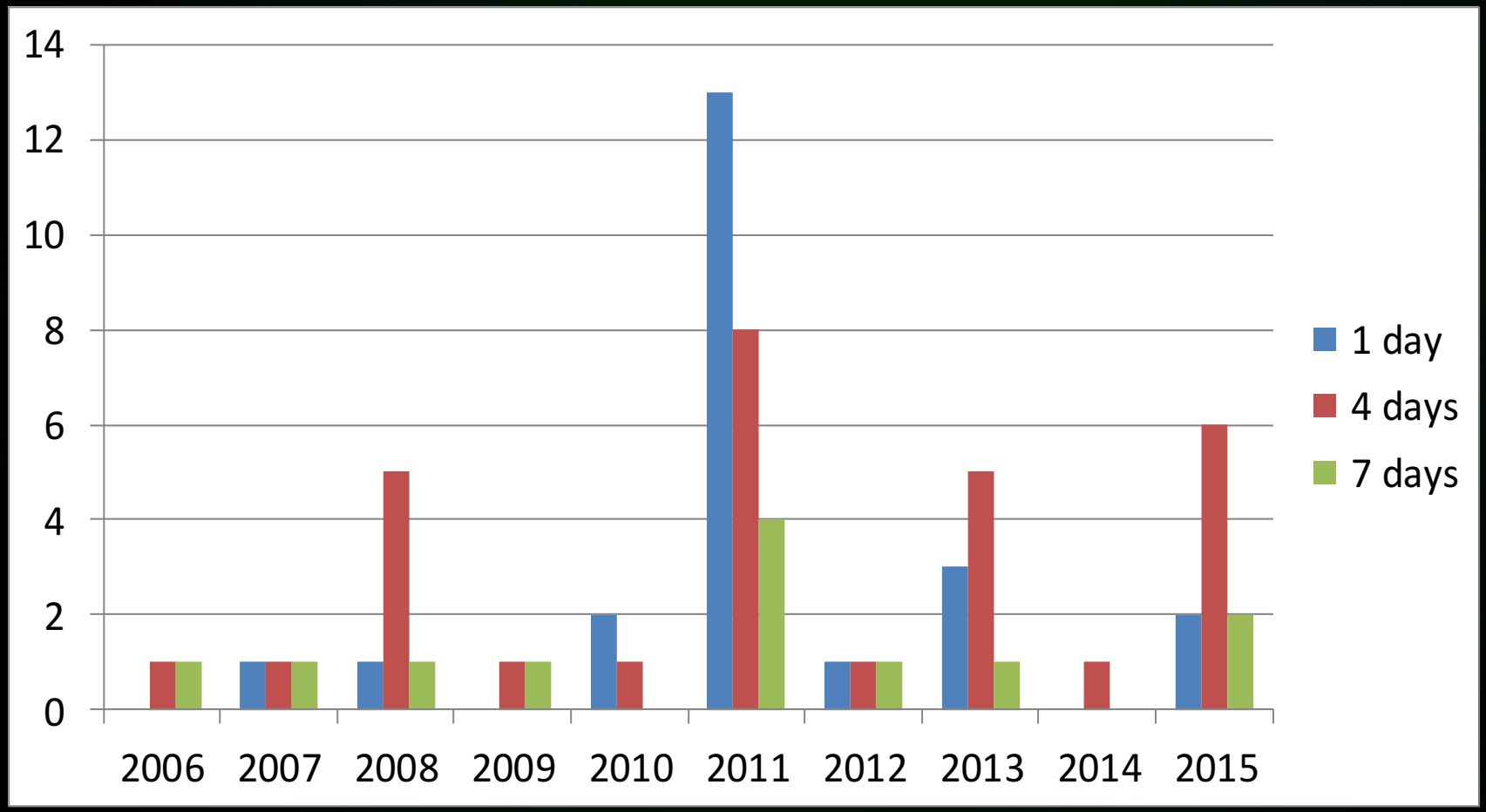
All the calf signs were found under the forest canopy



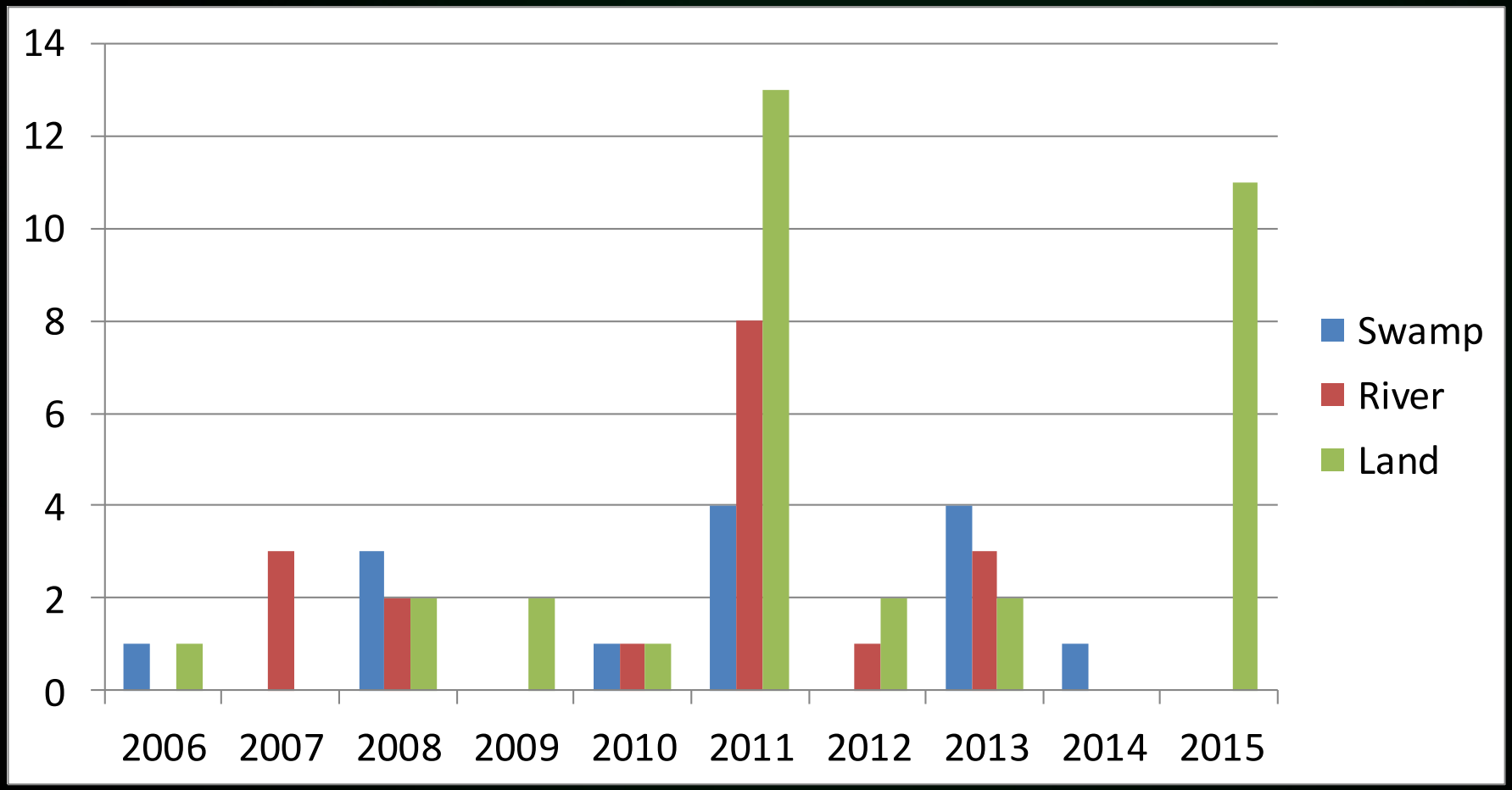
~ 16-20 Calf Estimate



1-7 Days Old


14
12
10
8
6
4
2
0
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
1 day
4 days
7 days

More of the calf sign near the water





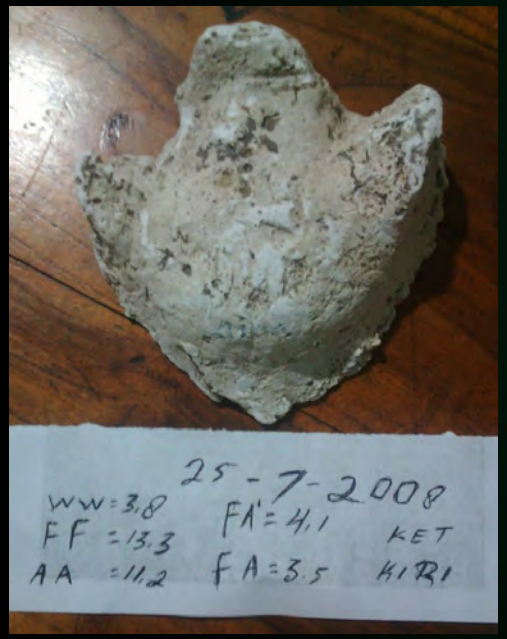
2012, 2013, 2014





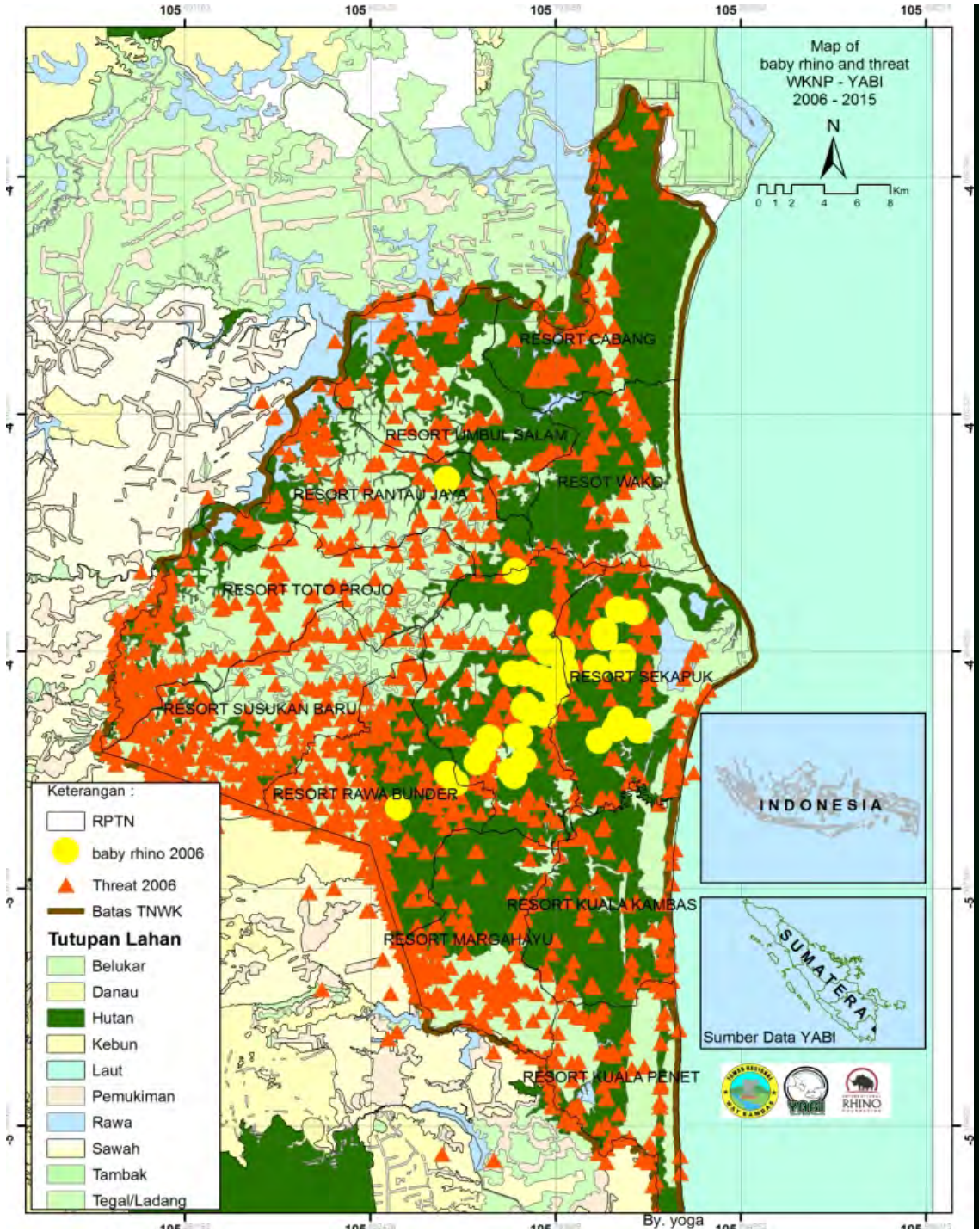


2008, 2009, 2011

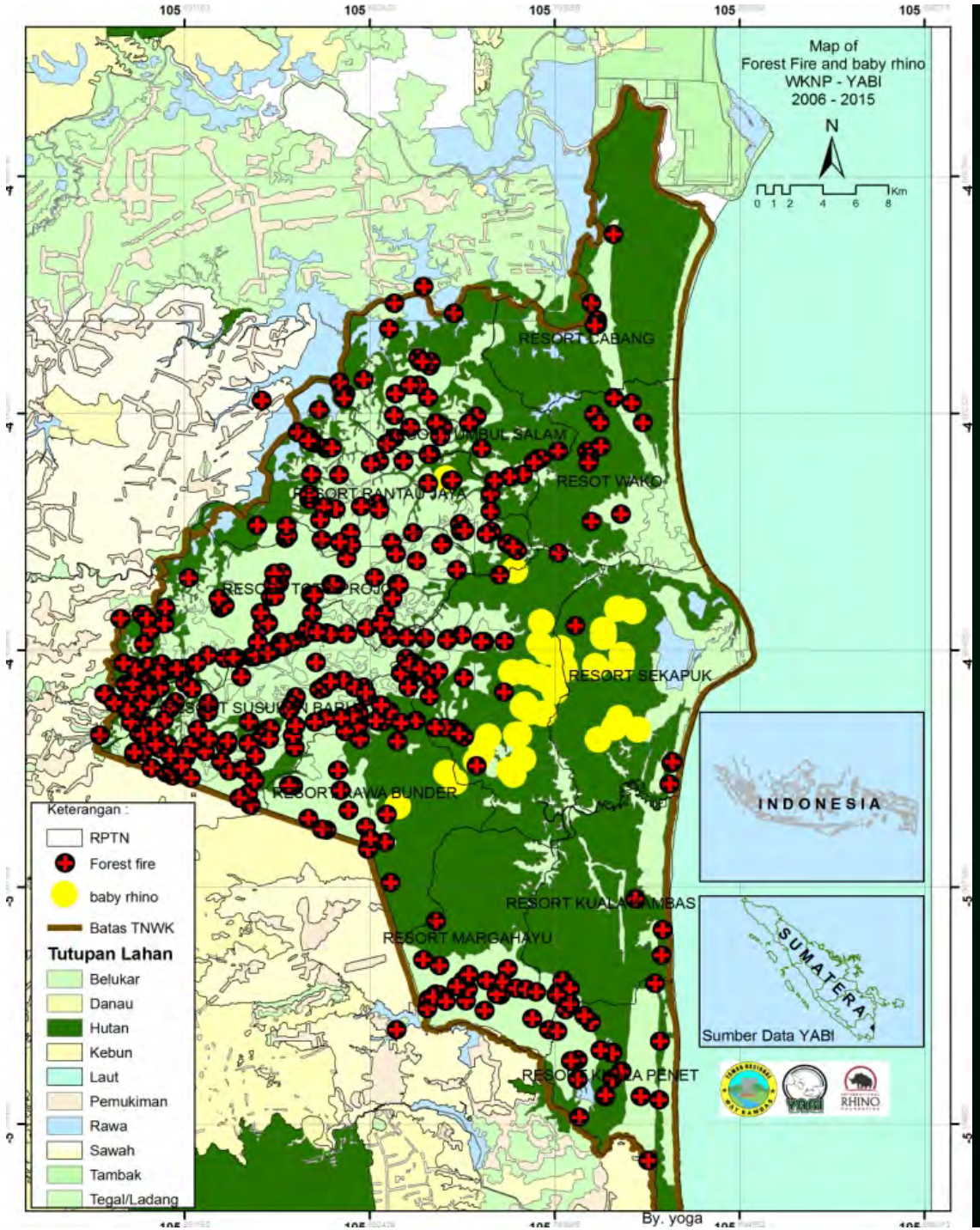






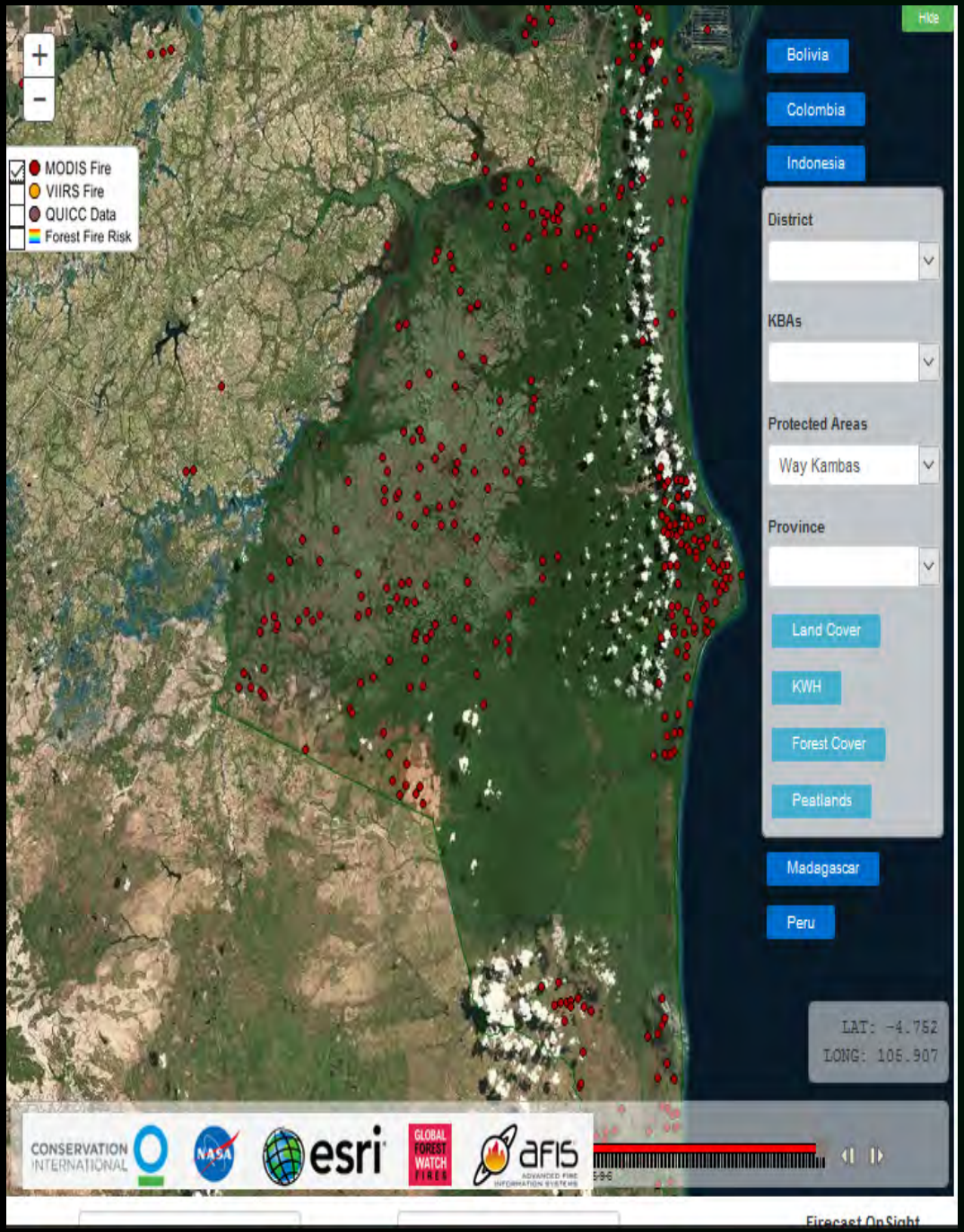


Calf Signs VS Illegal Activities 2006-2015

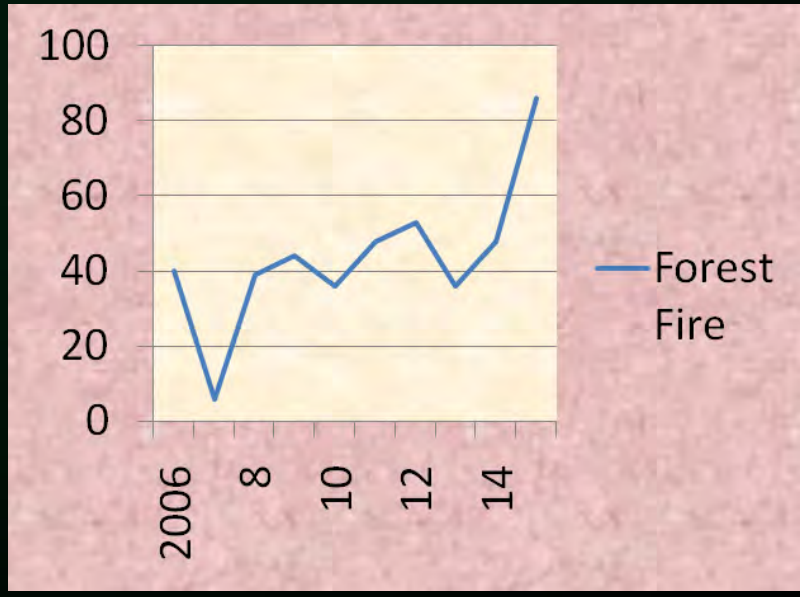


Calf Signs VS Forest Fires 2006-2015

Rhino calf avoid fire zone



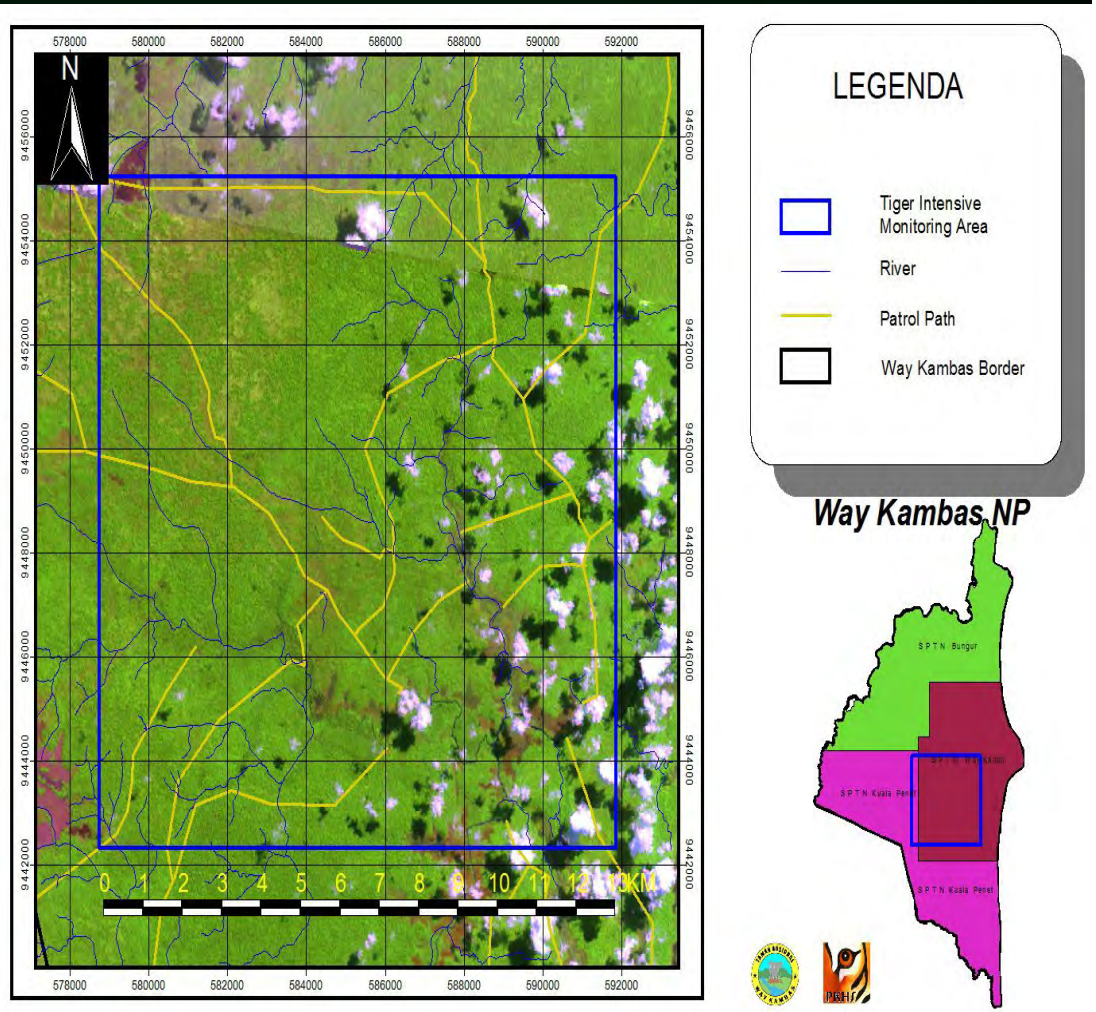
Habitat with forest fire is a factor in limiting in distribution of rhino calves in WKNP



Camera Trap in TERMA

1995-2000= 121
(14-17)

2013-2016= 42
(1 M + 5 F + 1 C)





Concentrated population in WKNP improves breeding potential.

- Numbers of human activities (including WKNP patrols and partners) is a disturbance to the Sumatran rhino.





Recomendations

Total protection to reduce human disturbance to the rhino habitat of Way Kambas NP.

Collaborative survey for key species in TERMA.

Habitat improvement by supressing forest fire.

Genetic controlled.

Thank you



*Rhino Protection Manager Sumatera YABI
**Data base Officer YABI
***DE YABI

THE AFRICAN RHINO CONSERVATION COLLABORATION (ARCC): A STRATEGY TO PROTECT RHINO IN THE EASTERN CAPE OF SOUTH AFRICA



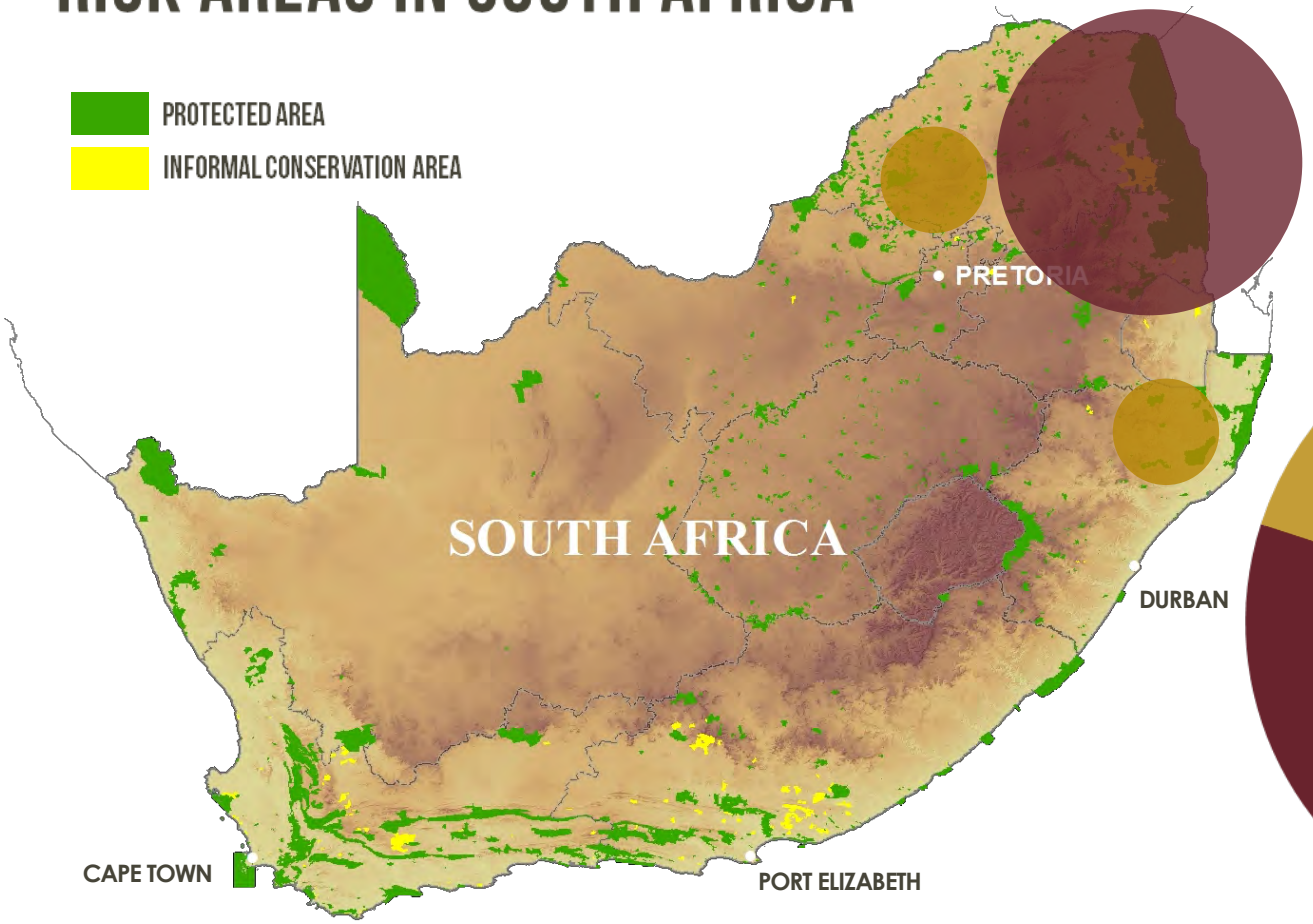
Dr. Mike Slattery
Texas Christian University
Fort Worth, TX USA

Dr. Will Fowlds
Ikhala Vet Services
Grahamstown, SA

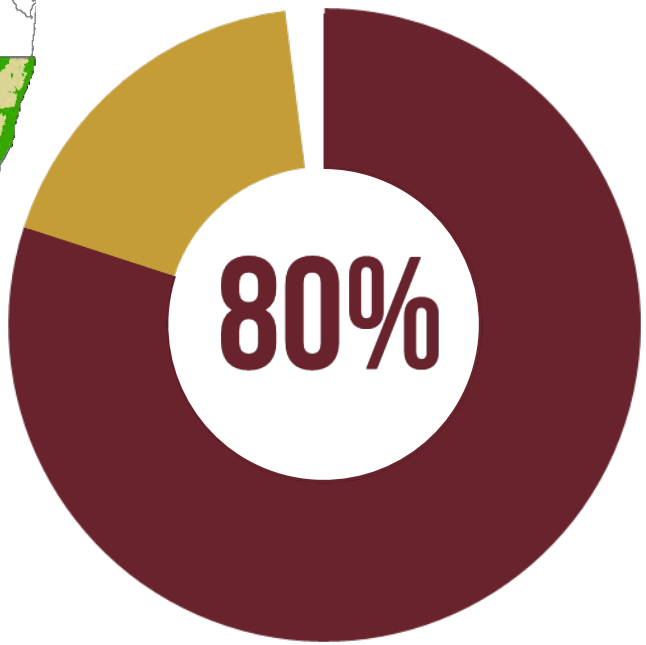
TCU®

IKHALA
VETERINARY WILDLIFE SERVICES

RISK AREAS IN SOUTH AFRICA



RHINO POACHED
2006 – 2015
5,085



KRUGER PARK STATISTICS, 2015

7 INCURSIONS PER DAY

7,500 POACHERS INSIDE PARK

250 CONTACTS WITH POACHERS

600 POACHERS ARRESTED

400 WEAPONS CONFISCATED

711 STAFF INVOLVED IN COMBATTING THE WAR

170 MILLION (USD 11.3 M)PER YEAR BUDGET





Photo: cctv-africa.com

Source: www.environment.gov.za

POTENTIAL REVENUE IN LOCAL TERMS

3 MILLION PEOPLE LIVING NEAR KNP

3,600 RHINO POACHED IN KNP

4KG/RHINO **$50K/KG** CONSUMER **5%** POACHERS $$

---

500 MILLION IN LOCAL CURRENCY

3.85 ANNUAL SALARIES PER DEAD RHINO

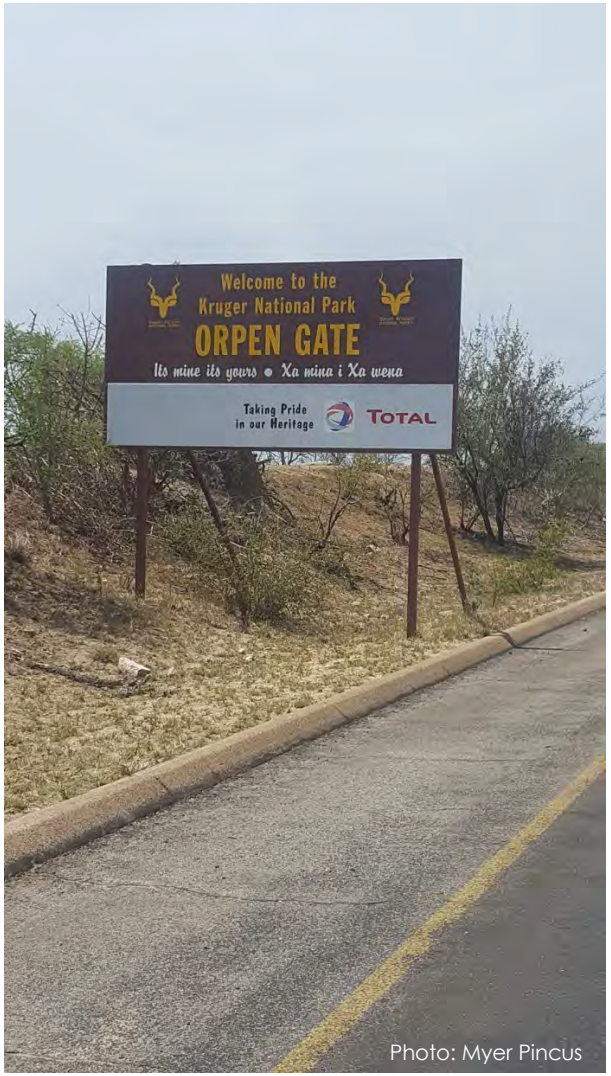


Photo: Myer Pincus

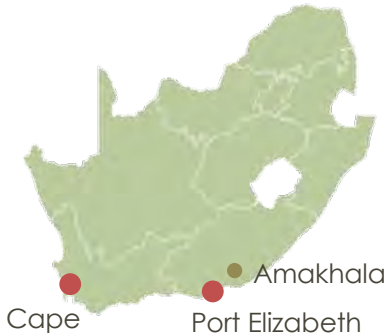
TRANSPLANTING PROTECTION STRATEGIES FROM NORTH TO SOUTH



Photo: Brian Bailey


Photo: Mike Slattery

ARCC LOCATION



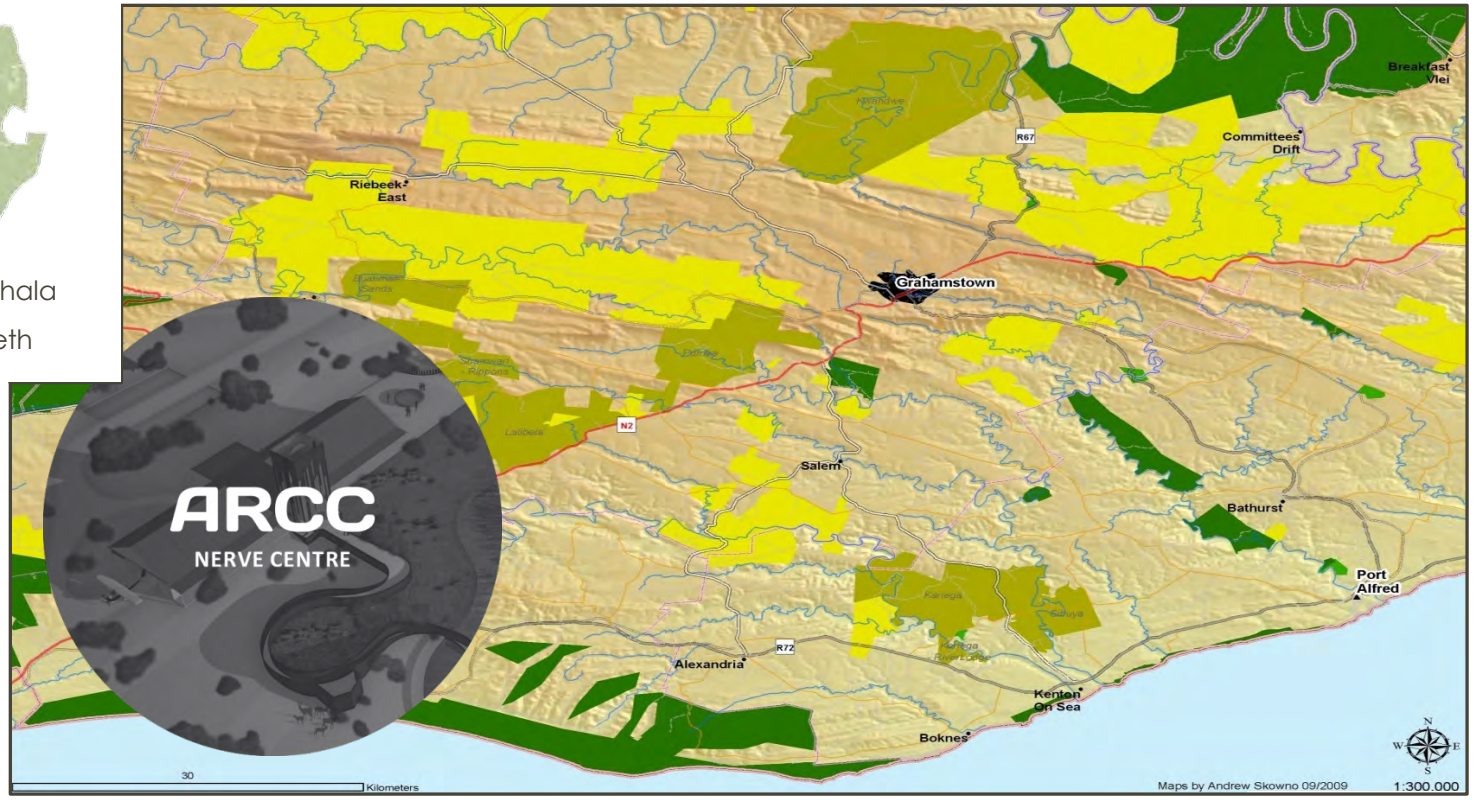
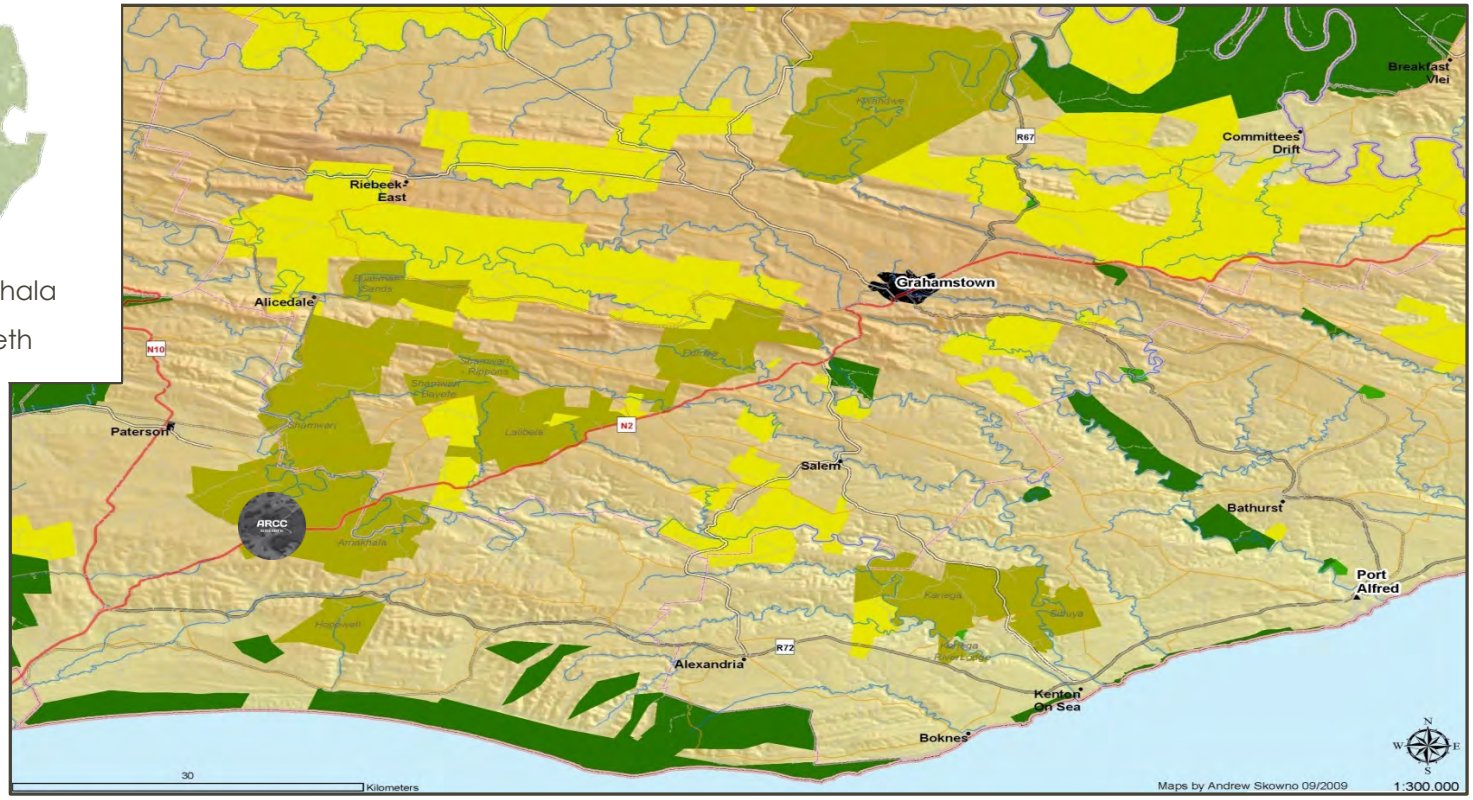



Photo: Mike Slattery

ARCC LOCATION





CONSERVATION INTERNATIONAL SOUTH AFRICA

WILDERNESS FOUNDATION SOUTH AFRICA


TCU


mediVet
THE VETERINARY PARTNERSHIP


ARCC
CONSERVATION
COMMUNITY
PARTNERS


LION ROARS
Humanitarian Award


WILDERNESS
FOUNDATION
FOREVER
WILD
RHINO PROTECTION INITIATIVE


CHIPEMBERE
RHINO
FOUNDATION


HELPING
RHINOS
www.helpingrhinos.org


RHINO ART
LET OUR CHILDREN'S VOICES
BE HEARD


Amakhala
FOUNDATION
COMMUNITY AND CONSERVATION


SAVING
THE SURVIVORS
CREATING HOPE FROM HURT


EASTERN CAPE
PARKS


Province of the
EASTERN CAPE
ECONOMIC DEVELOPMENT AND
ENVIRONMENTAL AFFAIRS


WILDLIFE
OPERATIONS GROUP


Vox Telecom Cloud™


SOUTH AFRICAN
POLICE SERVICE

THE ARCC RESPONSE

RHINO
TRADE

COMMUNITY

PROTECTION



AWARENESS

RHINO
MANAGEMENT

ILLEGAL
WILDLIFE
TRADE

EASTERN CAPE INTENSIVE PROTECTION ZONES (IPZs)

IPZ Amakhala



IPZ Pumba

IPZ Kariega

IPZ Sibuya

IPZ Shamwari

THE ARCC – IMPLEMENTATION AND SUSTAINABILITY



THE ARCC – IMPLEMENTATION AND SUSTAINABILITY



Photo: Courtesy Lion Roars Foundation

THE ARCC – IMPLEMENTATION AND SUSTAINABILITY



THE ARCC – INITIAL BUDGET

R13,185 MILLION CAPITAL

R1,430 MILLION FUNDED TO DATE

R3,520 MILLION OPERATIONS



THE ARCC – ECONOMIC SUSTAINABILITY

A CAPTIVE AUDIENCE

17,520 GUESTS (ANNUAL)

50% VISIT ARCC

R400 FEE (PP)

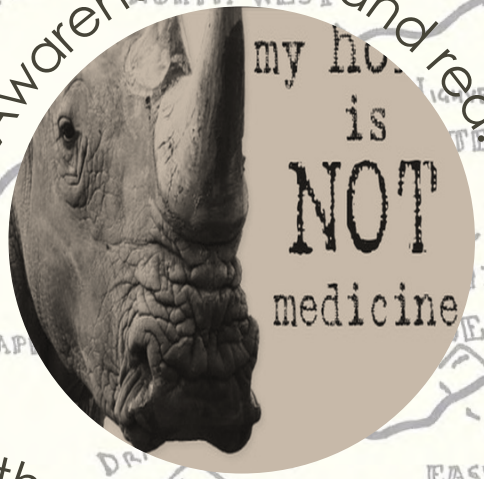
R3.5 M REVENUE (ANNUAL)



Wildlife security



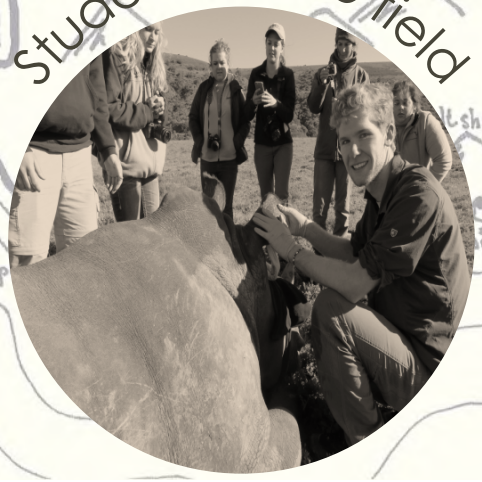
Awareness/demand red.



Community ownership



Students in the field




FIGHTING FROM AFAR,
BUT MY HEART
IS RIGHT THERE!
join the movement | save the rhino


TCU
Photo: Mike Slattery

PLANET RHINO

About Us | Rhino Crisis | Conservation | Protection | Rescue | Community | Awareness | Get Involved





Rhinos and the Environment

The TCU Rhino Initiative was launched in a April 2014 as part of TCU's Global Innovator program. We have teamed up with Dr. Will Fowlds, renowned South African wildlife vet and rhino conservationist, to help save the rhino and ensure its long-term survival. In South Africa, rhino are being brutally poached at a rate of more than three per day. We stand ready to help.

SAVE THE RHINO
Donate Today
Volunteer Your Time | Help Reduce Demand
GET INVOLVED



BLACK RHINO
APPROXIMATE POPULATION
4,240
CRITICALLY ENDANGERED



WHITE RHINO
APPROXIMATE POPULATION
19,000
NEAR THREATENED

BORN WITH HORN

NOVEMBER 1, 2016 | 4-8 PM*
BLUU BALLROOM C-D

* Tours start every 10 minutes.
Please come anytime before 7:30 pm.

Learn about the global crisis

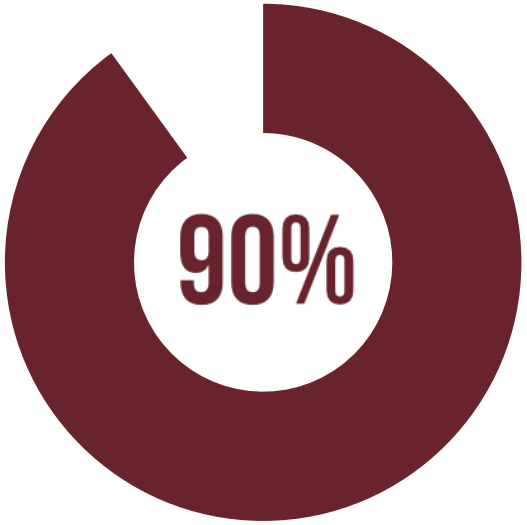
Learn why it matters

Learn how you can make a difference



Vietnamese Student Association | TCU College of Science & Engineering | discovering global citizenship | SGA





OF CHILDREN IN LOCAL COMMUNITIES HAVE NEVER VISITED A GAME RESERVE

Photo: Courtesy of Dr. Will Fowlds

COMMUNITY OWNERSHIP


Photo: Jennifer Gush


Photo: Mike Slattery

MOVING BEYOND CITES



Photo: www.fightforrhinos.com

CITES COP17
JOHANNESBURG 2016
WORLD WILDLIFE CONFERENCE



Photo: Tony Karumba/AFP

THE AFRICAN RHINO CONSERVATION COLLABORATION (ARCC): A STRATEGY TO PROTECT RHINO IN THE EASTERN CAPE OF SOUTH AFRICA



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www.planetRHINO.org
www.environment.tcu.edu

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TCU

IKHALA
VETERINARY WILDLIFE SERVICES



Pointless

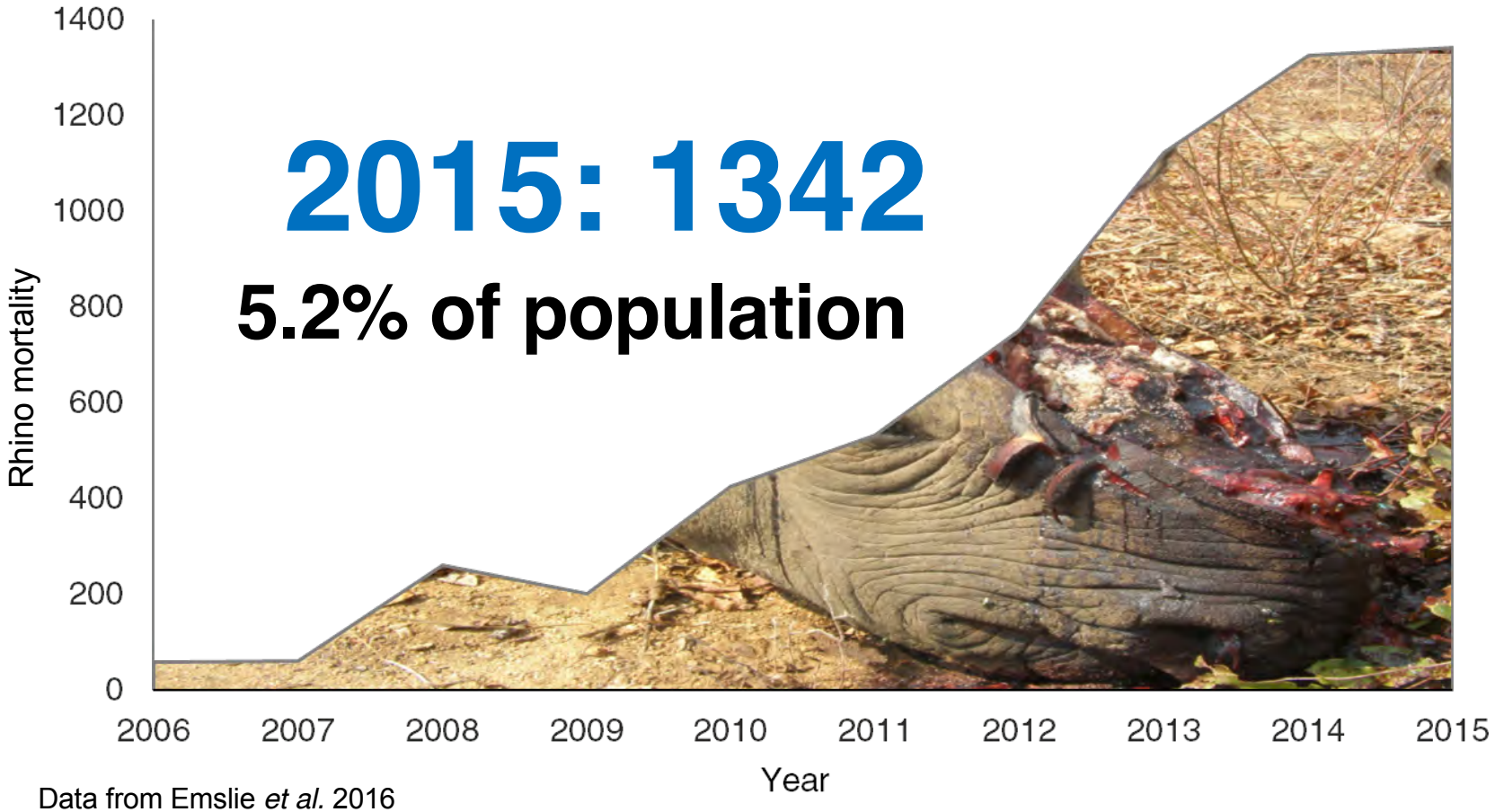
A quantitative assessment of supply and demand in rhino horn

Dr Barbara Maas

Head, International Species Conservation

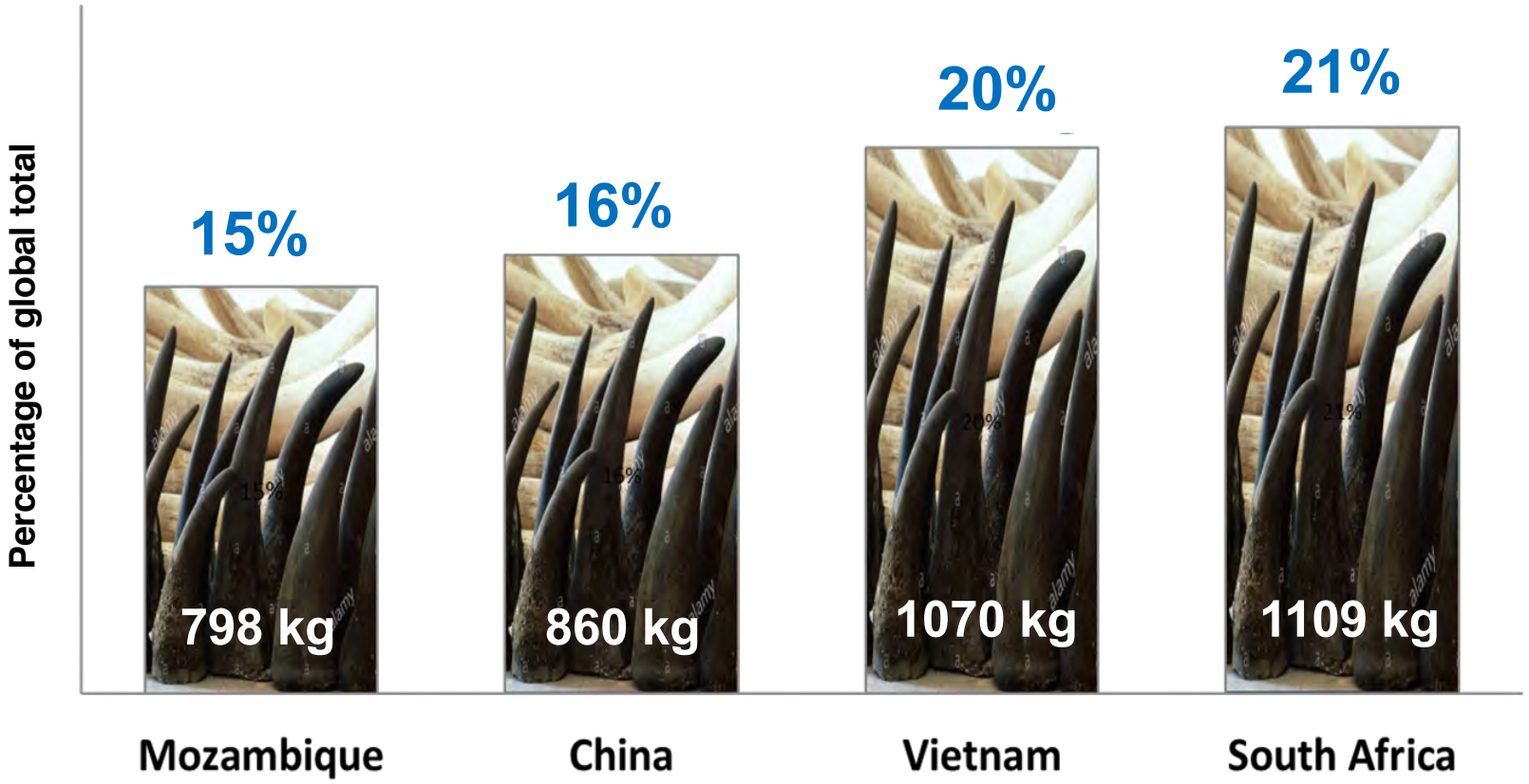
NABU International
Foundation for Nature

Reported poaching mortality in Africa 2006-2015



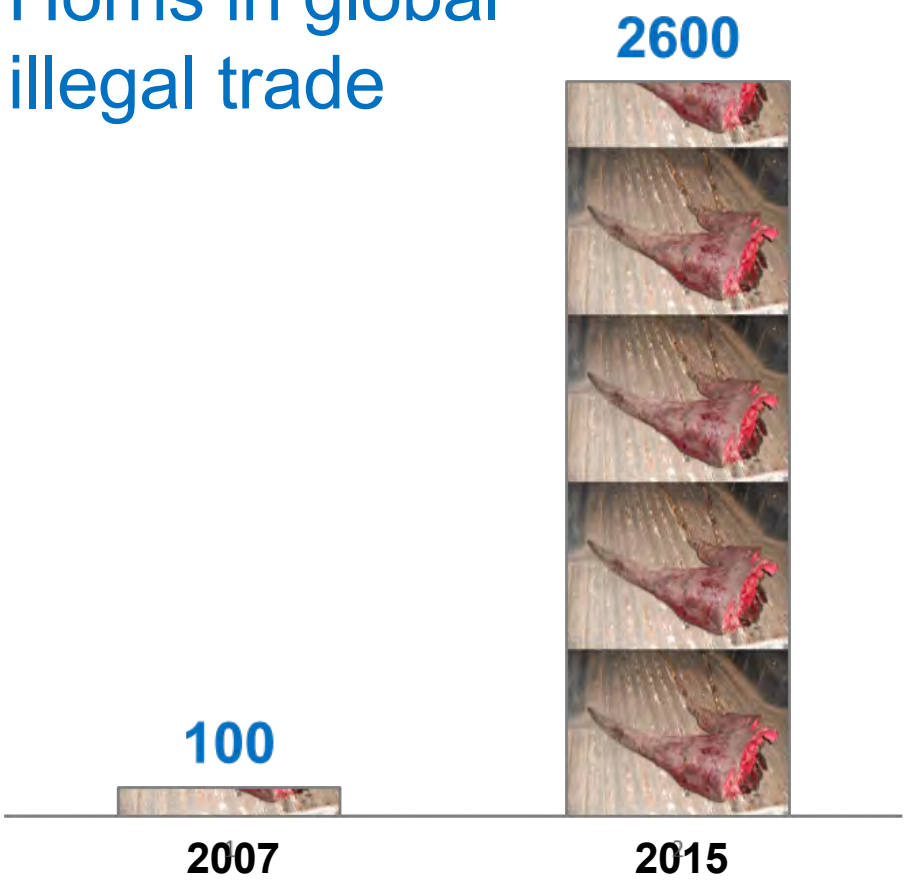
Data from Emslie *et al.* 2016

Horn seizure as percentages of global total: 2010-2015



Data: Emslie *et al.* 2016

Horns in global illegal trade



Data from Emslie *et al.* 2016



Two main markets for rhino horn

VIETNAM

Used to treat a wide range of ailments from hangover to cancer and as a status symbol.

CHINA

TCM application to treat fever and other complaints.



New markets

Jewellery, libation cups and other trinkets



Photo: Environmental Justice Commission

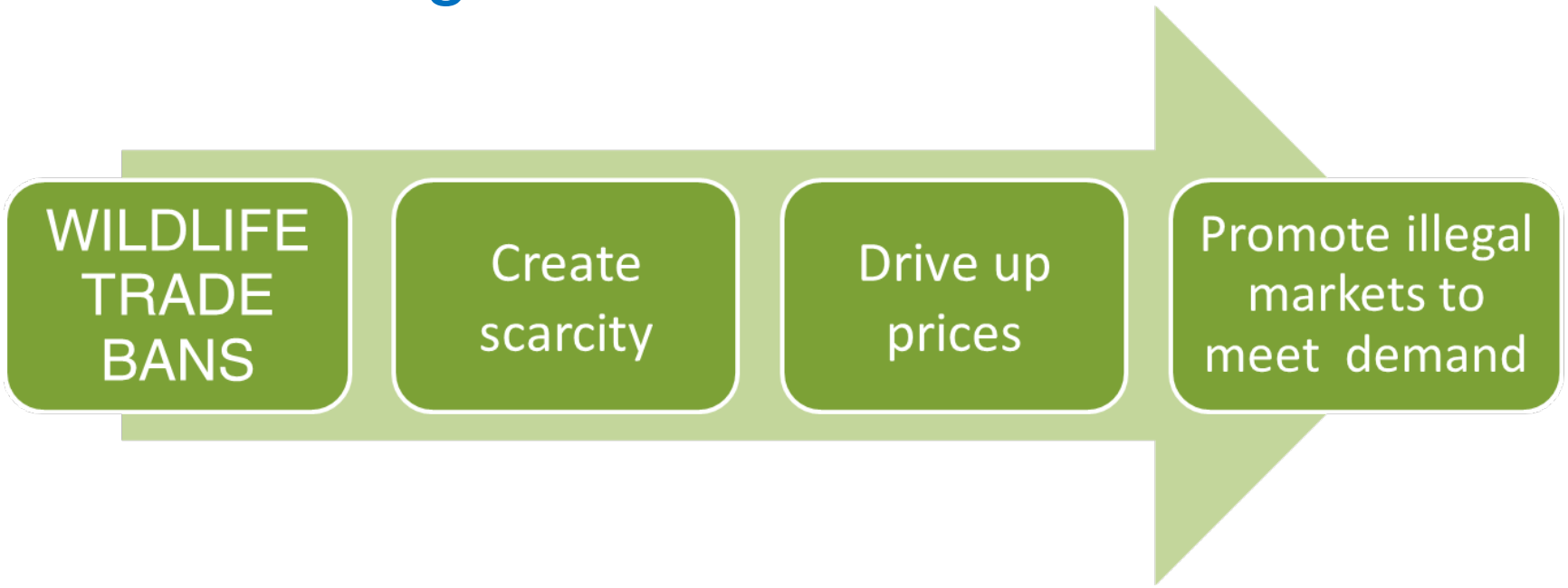
Other new markets

Growing affluence in Vietnam und China as well as criminal operators increasingly use rhino horn as a future-proof investment.

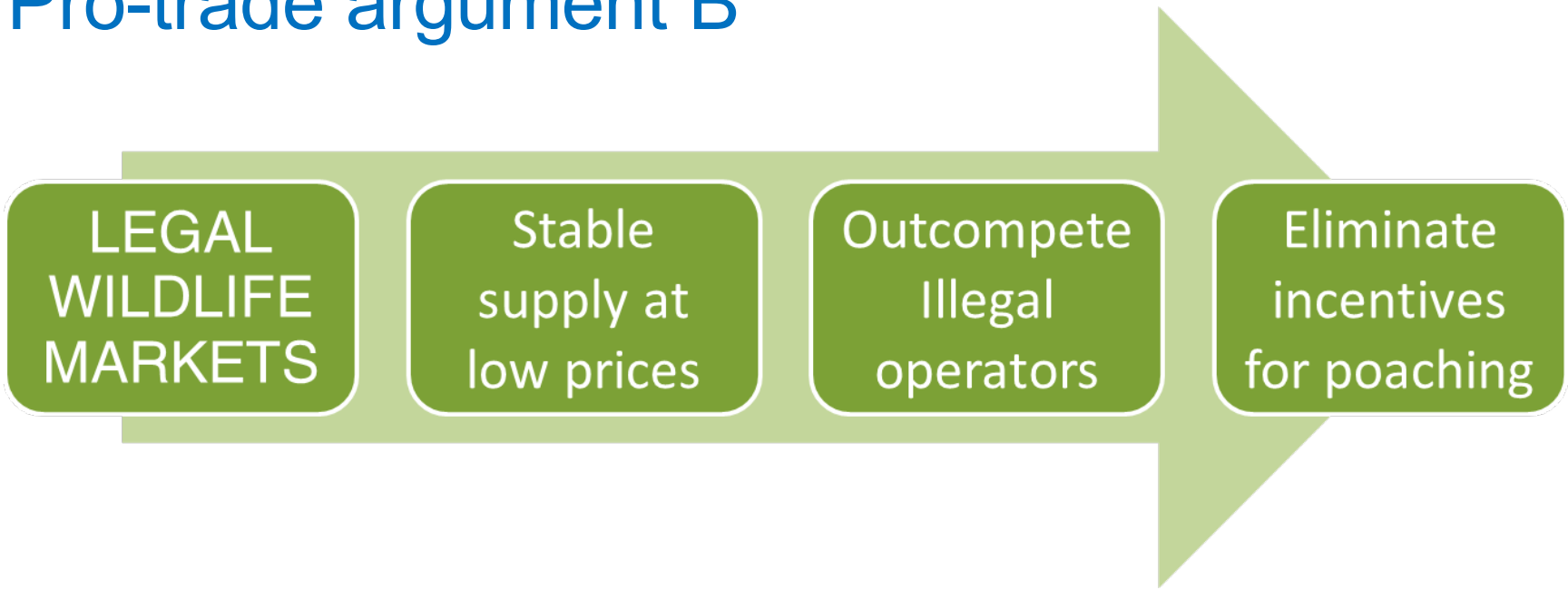



What to do?
TRADE?
NO TRADE?
END DEMAND

Pro-trade argument A



Pro-trade argument B



LEGALISING HORN TRADE
RhinoAlive.com

RhinoAlive.com is an awareness campaign in support of legal trade in rhino horn.

HOME | LEGALISE HORN-TRADE | RHINO FILES PUBLICATION | EXPERTS | FAQ'S

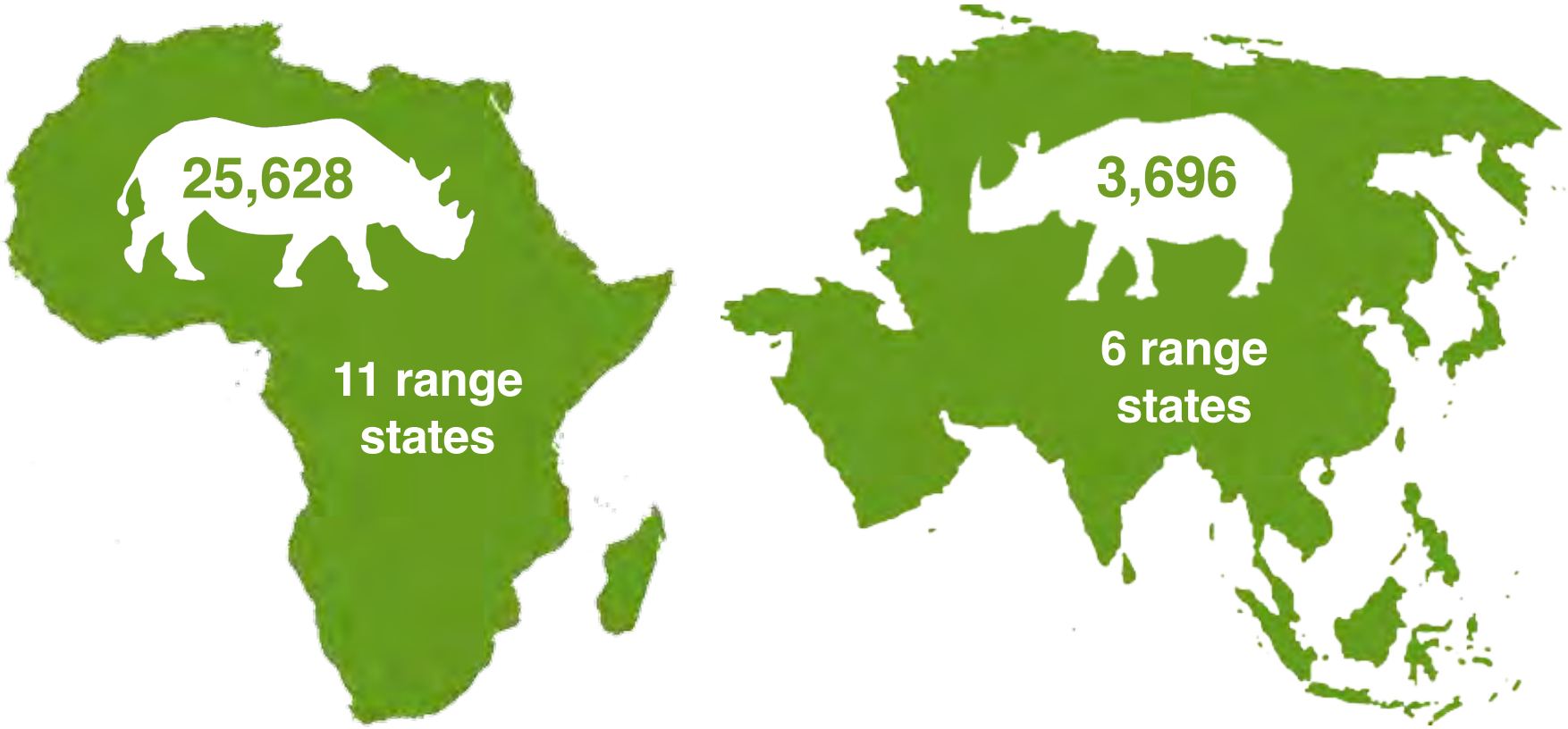
Michael Eustace

Home / Teammate / Michael Eustace

"*SA could satisfy the entire market, at current high prices, without the need to kill one rhino*."



Rhino numbers in Asia and Africa



Data from Emslie *et al.* 2016

Global rhino numbers



Reported rhino poaching mortality in Africa 2006-2015

Species	Horn Weight [g]	Population Size	Horn Mass [g]
White rhino	5,880	20,378	119,822,640
Black rhino	2,655	5,250	13,938,750
Indian rhino	2,000	3557	6,528,000
Javan rhino	550	58	34,650
Sumatran rhino	700	100	53,200
Global total		**29,324**	**140,963,240**

Data: Pienaar *et al.* 1991, Emslie *et al.* 2016, Knight 2016, Bibhab Talukdar pers. comm.

Dosage of rhino horn in traditional Asian medicine

Dosage	Comments	Literature Source
0.05 g/kg	Dependent on patient's body weight	But et al. 1990, Tsai 1995, Liu et al. 2011
0.5 - 1	Daily dose. Vietnam	Do et al. 2006
1 - 2		Jennes F. & Flaws B. 2006
1-3	Daily dose	首页 中医公益学堂 业内相关 中医书籍 图书 中药材 中药方剂 名医 医案心得 专栏 杂集
1.5 – 3		Anonymous 2016b, Chinese Herb Academy, Anonymous 2016a, Jiao Shu-De 3003, Hempen C-H. 2009
1.5 – 6		Anonymous 2012
2 - 6		Anonymous 2016d
2.5 - 10	Asian rhino horn	Anonymous 2016c
2.5 - 10	decocted	Chinese Herb Academy, Anonymous 2016a
3		Liu et al. 2004, Joe Hing kwok 2013, Nowell 2012
3 - 4	Daily dose. Vietnam	Do et al. 2006

Dosage	Comments	Literature Source
3 -5	Daily for two weeks	Hübschle 2016a p 355
3 - 9	decocted	Jiao Shu-De 2003
3 - 9		Liu et al. 2004
6	Twice daily	Joiner 2001
2.5 - 10	Asian rhino horn	Anonymous 2016c
6 - 24		Liu et al. 2004
9	Cancer, 3 x daily	Joiner 2001
9 - 15	decocted	Hempen C-H. 2009
6 - 15	decocted	Gonzalez C.J. 2005
30 - 60	Veterinary use, 2 x daily	Center for Acupuncture and Herbal Medicine, P.A.
5-75		Xie H. 2010
1 - 80	Korea	Song & Milliken 1991
30 - 150		Chinese Acupuncture & Wellness
180		Liu et al. 2004

South Africa's rhino population and associated horn mass estimates

Species	Population Size	Horn Weight [kg]	Horn Mass [kg]
White rhinos	18,413	5,880	108,268.44
Black rhinos	1,893	2,655	5,026.91
Total	**20,306**		**113,294.35**

Data: Pienaar et al. 1991, Knight 2016

Estimated market reach of rhino horn mass amongst adults in China and Vietnam [%]

Amount of rhino horn use [g]	1	3	9	50	100	1000
Global rhino population	11.5	3.86	1.29	0.23	0.12	0.012
South African black + white rhinos	9.31	3.10	1.03	0.19	0.09	0.009
South African white rhinos in private ownership	2.90	0.97	0.32	0.06	0.03	0.003
South African white rhinos in participating private ownership (80%)	2.32	0.77	0.26	0.05	0.02	0.002

Estimated market reach of annual horn regrowth from privately owned rhinos in South Africa amongst adults in China and Vietnam [%]

Amount of rhino horn used	1 g	3 g	9 g	50 g	100 g	1 kg
White rhinos in private ownership in South Africa	**0.4**	**0.12**	**0.04**	**0.007**	**0.004**	**0.0004**
White rhinos in private ownership/ owners interested in trade (80%)	**0.29**	**0.10**	**0.03**	**0.006**	**0.003**	**0.0003**

Independent Economics

Prof Alejandro Nadal

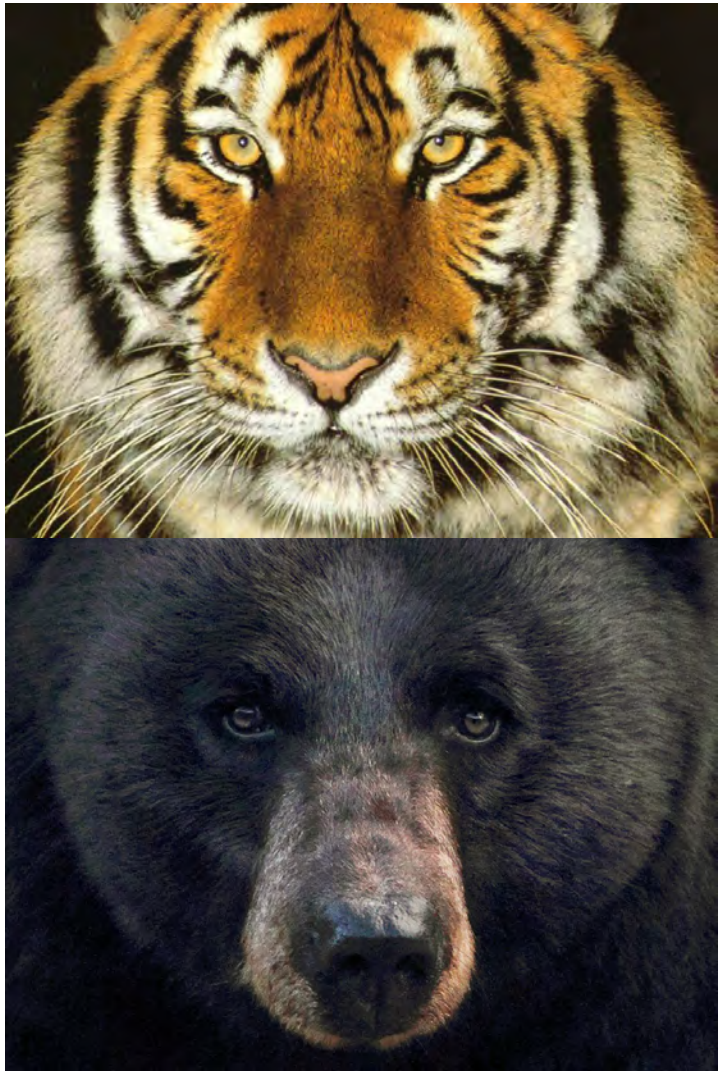
Centre for Economic Studies El Colegio de Mexico, Chair of the Theme on the Environment, Macroeconomics, Trade and Investment (TEMTI) with CEESP-IUCN

Most pro-trade "*claims are restricted to a very small and most likely irrelevant set of possible market configurations," and constitute a "brutal simplification of real-world economics (and) a serious assault on logic*."



WILD vs. FARMED

Preferences amongst TCM and allied medicine users



Bear farming

Strong consumer preference for products originating from WILD individuals.

“the introduction of farmed bear bile has either had little impact on demand for wild bear bile or in some circumstances increased it.”

Dutton *et al.* 2011



Tiger farming

Strong consumer preference for products originating from WILD individuals (71%)

"tiger farming is more likely to increase aggregate demand for tiger products and stimulate higher levels of poaching."

Gratwicke *et al.* 2008





Vicuña

- Cited as a flagship example for sustainable use by rhino horn trade supporters

- Several decades later illegal trade continues to be the primary threat to their survival according to the IUCN SSC Camelid Specialist Group.

Parker & Ying 2009, Nowak 2015



Dr Christian Bonancic

"*The availability and affordability of vicuña wool has ultimately not worked to protect wild populations from poaching. In fact, poaching has even increased.*

The opening of the vicuña wool industry led to market expansion, which we did not anticipate.

Increasing demand led to more poaching, not less. Our worry now is that globalization could increase demand for vicuña wool beyond natural production limits."

Bonacic in Nowak 2015



Drawing parallels…

"When you drive a magnificent animal away from its ecological relationships, you're taking away the whole meaning of wildlife conservation. … There are simply too many of us for trade in wild declining mega-species to be a viable way to keep them with us. Let us spare rhinos the experiment that has been tried with elephants, tigers, bears, and vicuña."





Bonacic in Nowak 2015


Are these wild rhinos?
Is rhino farming “conservation”?

What is CONSERVATION?

“The protection, care, management and maintenance of ecosystems, habitats, wildlife species and populations, within or outside of their natural environments, in order ***to safeguard the natural conditions for their long-term permanence****.”*



"*This is a cattle ranch.“* John Hume

“*The rhino will become the most protected and profitable farm animal in the world*.” Piet Warren 2015



The truth is out there

“In extreme circumstances, law-abiding people may feel that they have no option other than to break the law as an act of civil disobedience. Private rhino ranchers, who are forbidden to sell their horn and whose staff and animals are under threat from poachers, may choose to trade their horn anyway. Black people had to transgress the very law they objected to in order to show it was illegal.”

Hume lawyer, Izak du Toit, in Christy 2016

The Saiga fiasco

- Use of Saiga antelope horns was encouraged as a substitute rhino horn in the 1990s.
- Over 1 million Saiga at the time
- By 2003: 30,000





No man is an island

- Consumer
- Of concern for poaching and transit
- Of concern for transit (including theft)**
- No longer a significant consumer

Environmental Investigation Agency 2016

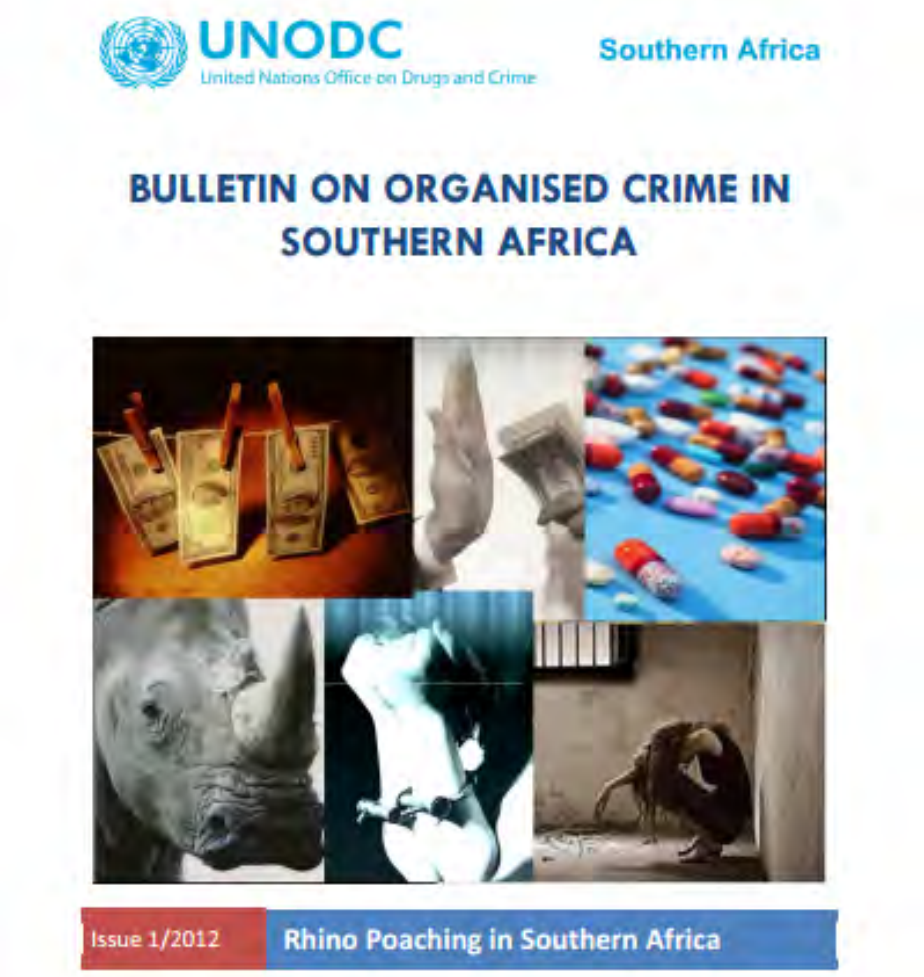


Logic clearly dictates that the needs of the many outweigh the needs of the few.

Who gains?

Rhino horn trade is in the hands of transnational criminal networks of organised crime.

Enforcement is deficient



White mischief

Investigation links South African Minister of State Security and members of a Chinese presidential delegation last December to recent illegal rhino horn trade.

Published: 13 November 2016

http://www.aljazeera.com/news/2016/11/exclusive-african-minister-linked-rhino-poaching-161113071410270.html



NEWS | AFRICA 11 HOURS AGO

South African minister linked to rhino trafficker

Al Jazeera Investigative Unit's exclusive report raises serious questions about South African security chief.

Conclusions

- Not enough rhinos left
- The economical constructs are wrong
- TCM consumers prefer wild products
- It’s not working in other species
- Unnatural farming conditions are not conservation
- Trade is in the hands of professional organised crime
- Poor governance undermines enforcement and compliance

Rhino horn trade will harm, not save wild rhinos.




INTERNATIONAL BUDDHIST CONFEDERATION
Collective Wisdom United Voice
#Buddhists4Rhinos

The International Buddhist Confederation (IBC)

- Global Buddhist umbrella body headquartered in New Delhi
- Founded in 2012
- 320 Buddhist member organizations from 39 countries
- All Buddhist traditions are represented
- Include the Supreme Patriarchs and highest ranking monks of all Buddhist countries
- Other high ranking monks, nuns, leaders and scholars





Sambodh

IBC Newsletter

INTERNATIONAL BUDDHIST CONFEDERATION

Collective Wisdom United Voice

VOLUME 1 • ISSUE 2 • MARCH 2015

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  Jogye Order of Korean Buddhism, South Korea
- His Eminence Khamba Lama Damba Ayusheev
  Supreme Head of Russian Buddhists,
  Buryat Republic, Russian Federation
- His Holiness Sanghanayaka Sudhananda Mahathera
  President, Bangladesh Bauddha Kristi Prachar Sangha and Lord Abbot, Dhammaraja Buddhist Monastery, Bangladesh
- His Eminence Rev Khamba Lama Bakbi Chojamts Dhevkeret
  Supreme Head of Mongolian Buddhists, Mongolia

Prime Minister Narendra Modi meets Richard Gere



Mr Richard Gere, Global Envoy of IBC and Chairman of the Gere Foundation called on Prime Minister Narendra Modi in New Delhi.

Mr Richard Gere, Global Envoy of IBC and Chairman of the Gere Foundation was in New Delhi in December 2014. He was part of a delegation of prominent Indian and global personalities hosted by the IBC to attend a conference in Tawang, Arunachal Pradesh. While in Delhi, Mr Richard Gere called on the Indian Prime Minister Narendra Modi.

Prime Minister Modi has taken a keen interest in the revival of Buddhist heritage and restoration of ancient Buddhist sites in Gujarat. He has often been quoted as saying that this interest stems from the fact that in his village Vadnagar, where he grew up, he was witness to some major excavation work on a Buddhist monastery. The Archaeological Department discovered a Buddhist Monastery in Gujarat's Vadnagar.

According to news reports, the monastery had two votive stupas and an open central court yard. The walls of the monastery were built using bricks. It had around 12 cells for residential purposes with its entrance in the northern direction. This Buddhist monastery probably belongs to the 2nd to 4th century era and it seems it was in use for 300 years, says Gujarat State Archaeology superintendent Yash Singh Rawat.



Excavated ruins of ancient Buddhist Vihara in Vadnagar, Gujarat. Hsuan Tsang, the Chinese monk, traveller and translator, had described the site in his travelogue.

Dialogue on Vinaya between monks of the Theravada and Nalanda traditions

March 18-19, 2015, New Delhi

A high ranking delegation of Sangha Theravada from Sri Lanka, including four Mahanayakas, two Anunayakas and eminent scholars will participate in the historic "Dialogue on Vinaya" with high ranking monks of the Nalanda tradition, including His Holiness the Dalai Lama in New Delhi. The dialogue assumes added significance in the light of the historical, cultural and spiritual linkages between India and Sri Lanka and IBC's core agenda of inter-tradition dialogue and understanding as well as its motto of Collective Wisdom,

For a Buddhist Conservation Awareness Initiative

"Even as a mother protects with her life her child, her only child, so with a boundless heart, should one cherish all living beings."
– The Buddha



Panel in Sanchi

Addressing the esteemed delegates at the meeting of the IBC Governing Council in Rajgir, Bihar in December 2014, Dr Barbara Maas, Secretary, Standing Committee for Environment and Conservation, IBC, put forth the need for a pioneering Buddhist initiative that translates Buddha's teachings of compassion and wisdom into action for the good of all sentient beings. The initiative seeks to discourage the use, ownership and the trade in rhino horn, by engaging existing and prospective consumers of rhino through the supreme leadership of National Vietnam Buddhist Sangha.

This campaign adapts the successful strategies employed by Tibetan Conservation Awareness Campaign (TCAC). Started in 2006 in collaboration with Wildlife Trust of India and blessings of HH the Dalai Lama, the campaign from 2006-08 quickly and lastingly persuaded Tibetans in Tibet and outside as well as other Himalayan communities to abandon the use and trade of tiger skins and other animal furs.

On the similar lines the Buddhist Rhino Conservation Initiative would actively promote agreed guidance and awareness about the illegal and immoral rhino horn usage and trade through Buddhist monasteries and institutions, teachings, and prayer meetings as part of religious and community gatherings as well as in schools and community centres.

Cracking down on poaching and policing the illegal wildlife trade, have long been the main strategies for saving rhinos and other endangered species. But conventional approaches to rhino protection through enforcement and anti-poaching have to be increasingly regarded as ineffective. Recent developments in terms of closer collaboration between South Africa and Vietnam are a positive step, but must be backed by effective initiatives to be successful in curbing demand. New innovative and complimentary initiatives are needed to stop the killing of rhinos. By addressing members of the public through their respected spiritual leaders, this initiative will bypass slow-moving conventional channels and approaches which have so far failed.

Buddhist, monastic, community and contemporary publications, social media channels, podcasts and films are other avenues to spread the

IBC and Environment

According to The Diamond Sutra, it is impossible to distinguish between sentient and non-sentient beings. Every Buddhist should protect the environment.

We should move from Compassion to Action as we are the eyes, heads and arms of the Avalokiteshvara, "the Hearer of the Cries of the World". It manifests in a form that is appropriate to the prevailing circumstances. It is an opportunity for great healing for all sentient beings; an opportunity to show that wisdom and compassion are more than just two words.

There is a role for Buddhists everywhere and we can be a catalyst for change.

The agenda of IBC Standing Committee on Environment and Conservation encompasses global, national and policy issues including climate change, wildlife trade, environmental degradation and nature conservation, plastic pollution and litter to begin with.

HH the 17th Gyalwang Karmapa, Supreme Head, Karma Kagyu tradition and Chairman, IBC Standing Committee on Environment and Conservation:

We should not just always dig and build, but also do something to protect the environment. The sutras and tantras say that keeping the monasteries and sacred places clean has immeasurable benefits. It is the same with the earth: the earth is in great danger and it needs our care, so we should try to help protect the environment for all the beings in the world. Even if we can't do anything else, it is not too difficult to explain the basic things we need to do to protect the world. You should educate people about this and say, "This is how it is." So whether we are members of the sangha or lay people, if we take some interest in protecting the environment every single day, it will be very good.


MỖI NGƯỜI MỖI NƯỚC MỖI NON
BƯỚC VÀO CỬA ĐẠO NHƯ CON MỘT NHÀ .


RNATIONAL BUDDHIST CONFEDERATION
Environment and Conservation
#Buddhists4Rhinos


Thank you for listening!
NABU International
Foundation for Nature

HORNS OF GOLD

Directing rhino metapopulation management 'best practice' during a poaching crisis

Pedersen, G.[1], vonHoldt, B.M.[2], Irons, P.[1]

15th International Elephant and Rhino Conservation and Research Symposium

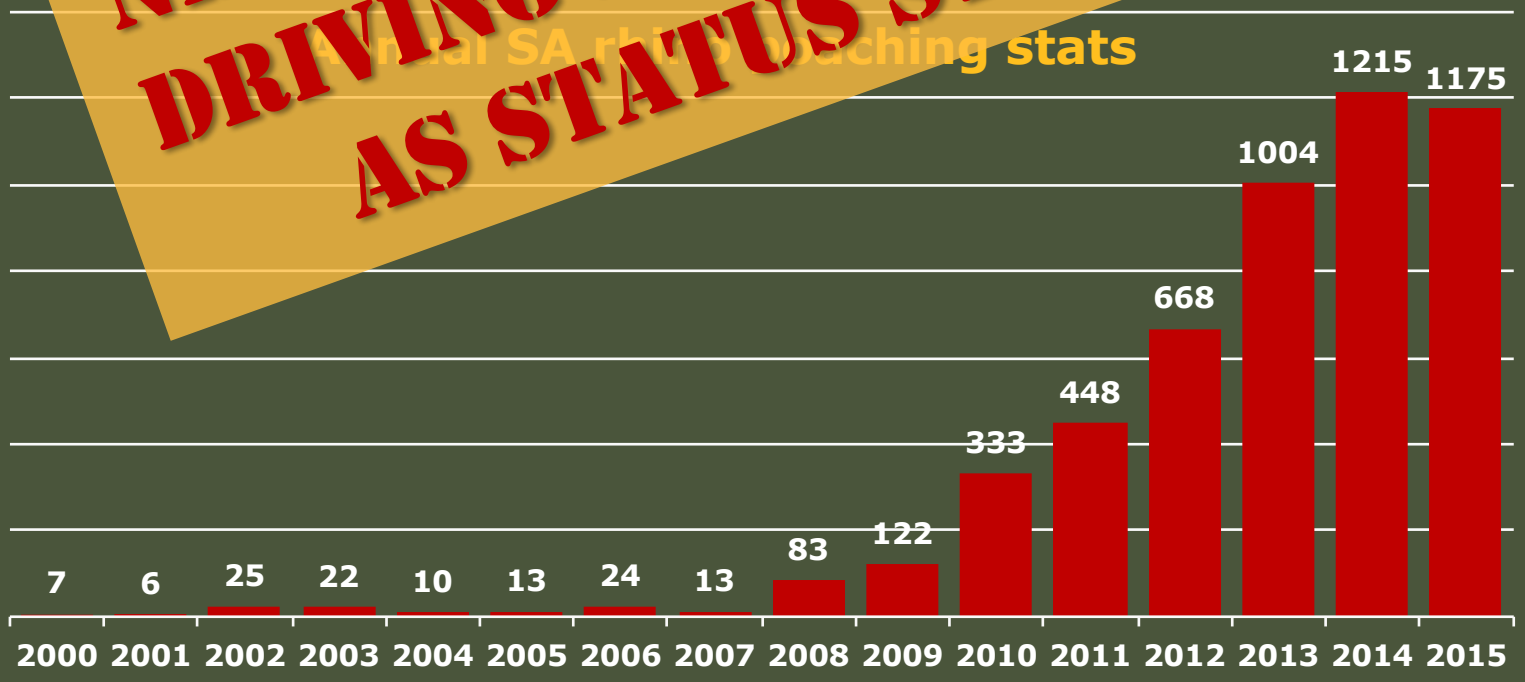
Wildlife Reserves Singapore, 14 – 18 November 2016

[1]University of Pretoria, South Africa; [2]Princeton University, USA

BACKGROUND

- Poached/hunted for centuries for use of horns in TCM and dagger handles
- Claimed to cure many ailments including recent cancer and AIDS links

THE GAME CHANGER….
NEW VIETNAMESE WEALTH DRIVING DEMAND FOR USE AS STATUS SYMBOL!



PROBLEMS



- Traditional demands-though no longer #1 problem
- HIGHLY organised poaching syndicates
- Lack of prosecution as evidence usually lacking
- Benefits of poaching STILL far outweigh the risks, even after 9 years of intensive law enforcement
- CORRUPTION
- Lack of funding for counter measures

MORE PROBLEMS

- Poverty – most species in high demand from illegal wildlife trade exist in developing countries.
- Political ineffectiveness
- Countries divided on solutions and action
- Porous eastern boundary of Kruger with Mozambique



So what is being done?



- Defence force brought in to patrol park fence lines
- Marketing and fundraising to raise awareness and enable increased anti-poaching patrols
- Increase in government and NGO roles focussing on rhino poaching and the wildlife trade
- Microchipping/ Dehorning/ 'treatments'/ alternatives
- Wildlife DNA forensics to increase prosecutions
- Legal trade debate

Moving forward



….conservation is a crisis science* and as is often the case when dealing with a crisis, the solutions tend to be *reactive* and unsustainable.

As long as the demand for the product exists we can't just keep raising endless funds to continually increase security and anti-poaching measures.

What is needed is a long-term, sustainable, *PROactive* solution!! = *BIOLOGICAL MANAGEMENT*

*Linklater, 2003

Objectives

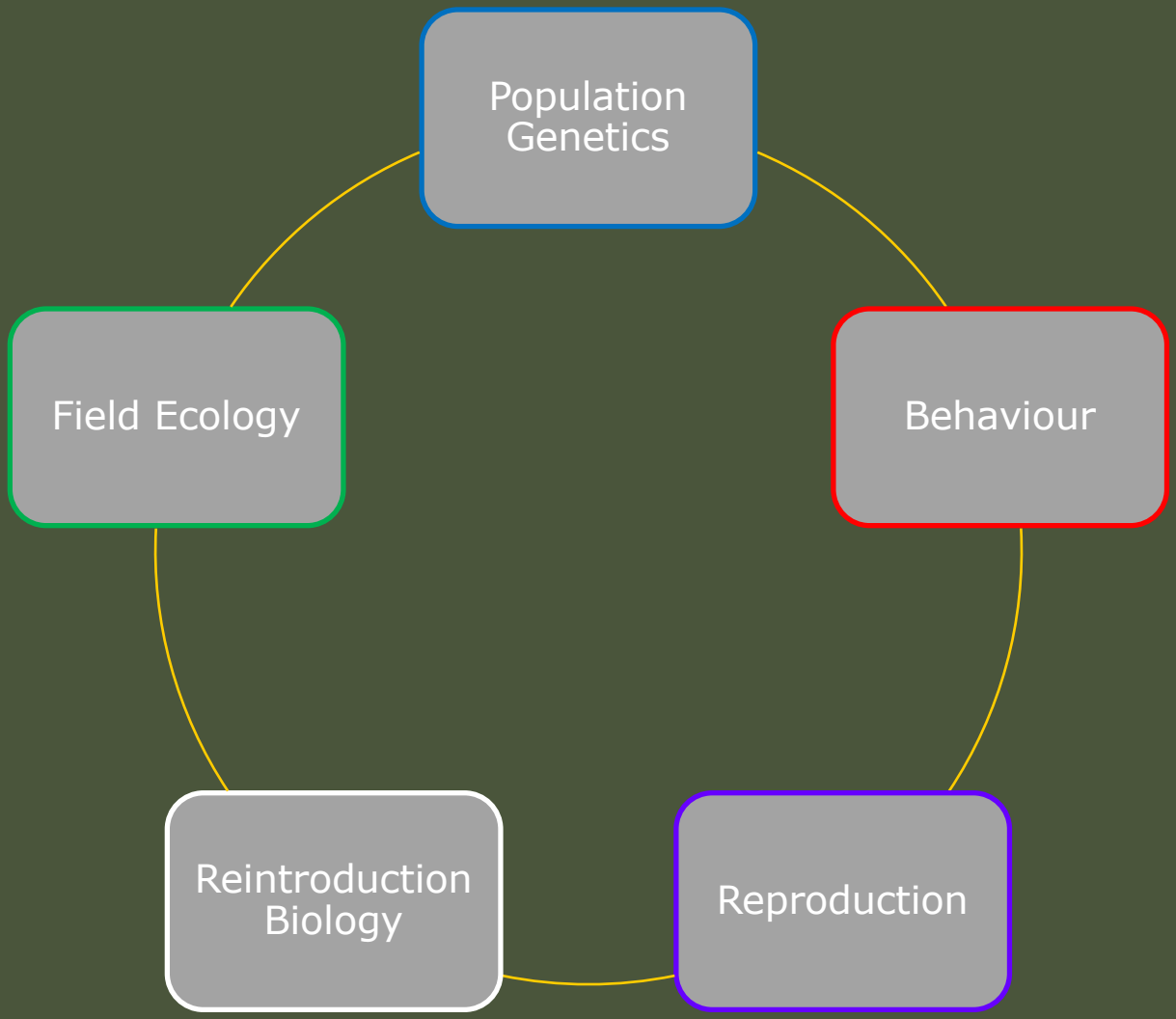
i. Determine whether geographic proximity in social groupings is correlated with genetic relatedness.

ii. Are there any links between genotype and phenotype in relation to dominance of bulls?

iii. Revisit minimum founder size and sex/ age ratios of translocated populations with a focus on recent genetic evidence.

Combine all results into a user-friendly guide for rhino managers and owners on the frontline!

Multidisciplinary approach



Methods



- Well monitored population of white rhinos in a 185km^2 SA Game Reserve, with field data from 10+ years. Microsat data from 125 rhinos and 18 polymorphic markers.
- Parentage and relatedness run in CERVUS v3.0.3 (Kalinowski *etal.*, 2007) & Colony v2.0.1.3 (Jones&Wang, 2010)
- Heterozygosity, allele frequencies, null alleles determined using web version of GENEPOP v3.4 (Raymond&Rousset, 1995) and CERVUS.
- Hardy-Weinberg equilibrium in ML-Relate (Kalinowski *etal.*, 2006). NeEstimator v2.01 for effective population size (Do *etal.*, 2014)

Loci/alleles	Allele freq	Total alleles (max 250)	He (unbiased est of Nei 1978)	Ho	PIC
32A		248	0.52	0.53	0.403
196	0.4677				
198	0.5121				
200	0.0202				
DB44		232	0.31	0.36	0.26
210	0.1897				
218	0.8103				
7B		250	0.57	0.62	0.505
223	0.164				
227	0.584				
229	0.252				
7C		208	0.61	0.63	0.536
142	0.1779				
148	0.3077				
150	0.5144				
BlRh1B		248	0.39	0.38	0.313
240	0.7379				
242	0.2621				
DB66		230	0.64	0.2	0.573
201	0.0478				
202	0.3217				
203	0.1391				
204	0.4913				
DB52		250	0.62	0.67	0.537
217	0.16				
219	0.464				
221	0.376				
BR6		250	0.7	0.73	0.64
132	0.316				
134	0.316				
140	0.048				
150	0.312				
152	0.008				

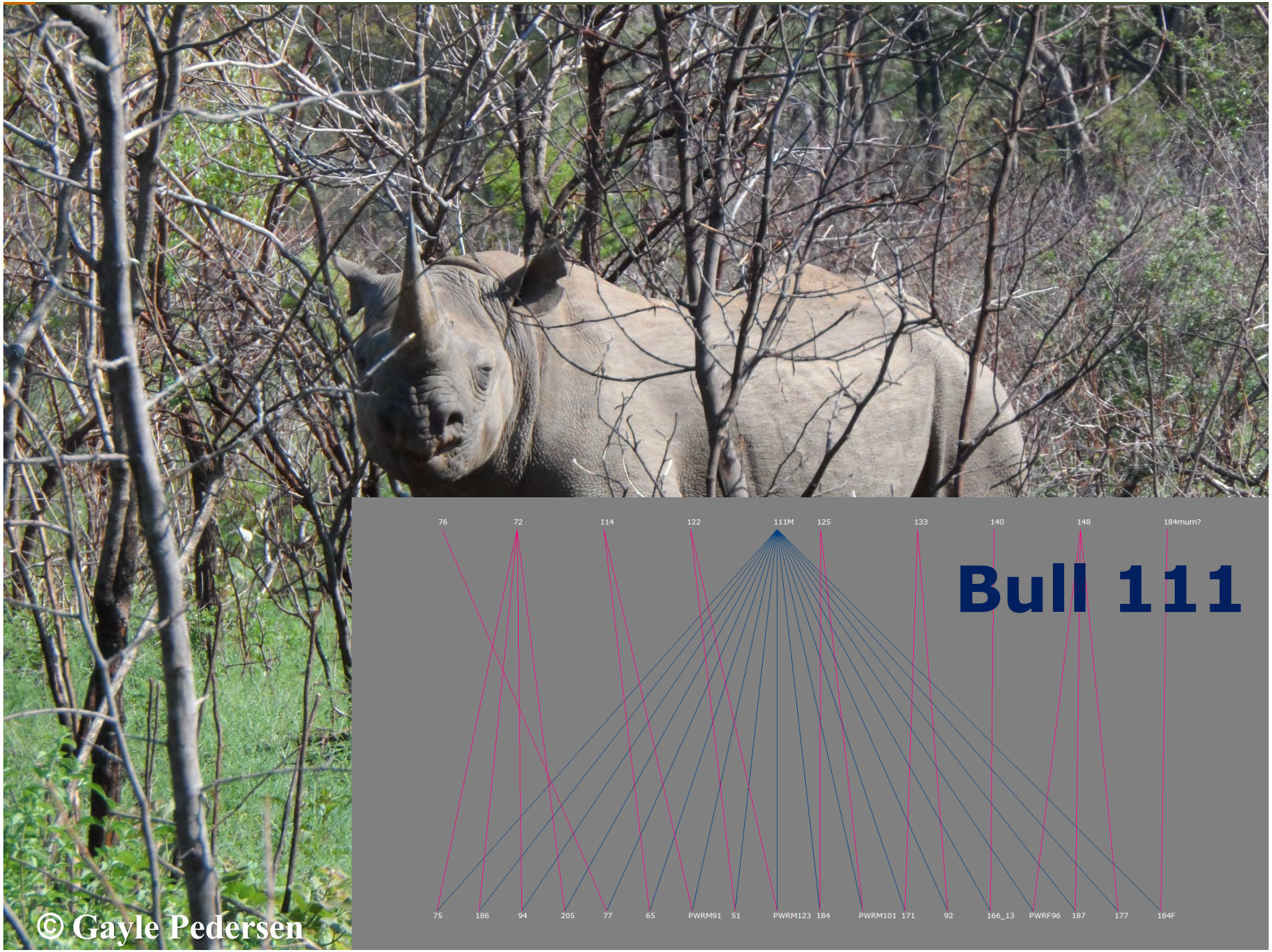
Loci/alleles	Allele freq	Total alleles (max 250)	He (unbiased est of Nei 1978)	Ho	PIC
DB1		250	0.37	0.41	0.3
160	0.76				
162	0.24				
BlRh1C		250	0.46	0.39	0.355
136	0.636				
138	0.364				
12F		222	0.5	0.44	0.375
223	0.4955				
237	0.5045				
32F		250	0.63	0.63	0.549
171	0.364				
175	0.18				
185	0.456				
SR63		248	0.48	0.46	0.365
188	0.3992				
190	0.6008				
IR10		248	0.33	0.33	0.289
132	0.1895				
134	0.7944				
136	0.0161				
IR12		248	0.5	0.18	0.373
174	0.4556				
180	0.5444				
SR262		250	0.45	0.45	0.344
86	0.668				
92	0.332				
SR268		244	0.29	0.29	0.259
176	0.1557				
178	0.0164				
180	0.8279				
SR281		250	0.65	0.63	0.575
222	0.288				
234	0.444				
242	0.268				

CERVUS v3.0.3 - Allele frequencies, Expected/ Observed heterozygosity (He/Ho)&polymorphic information content (PIC) of the 18 microsatellite markers.

Results



Compiled in PEDIGREE VIEWER (Kinghorn, 1994)


76
72
114
122
111M
125
133
140
148
184mum?
Bull 111
75
186
94
205
77
65
PWRM91
51
PWRM123
184
PWRM101
171
92
166_13
PWRF96
187
177
184F
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ID	Loci amp	Loci Het	Het
Barrel	18	10	0.556
189	18	10	0.556
174	17	9	0.529
45	18	9	0.500
184M	16	8	0.500
49	18	8	0.444
107	18	8	0.444
168	18	8	0.444
142	17	7	0.412
109	18	7	0.389
129	18	7	0.389
52	16	5	0.313
59	16	5	0.313
57	17	5	0.294
132	17	5	0.294
58	18	5	0.278
153Zuka	16	4	0.250
111	18	3	0.167




WHAT'S NEXT?
Does geographic proximity automatically assume genetic relatedness?
Samples have been run in STRUCTURE v.2.3.4 (Pritchard *etal*., 2000) to assign individuals to clusters based on relatedness, and then correlate with field data and GPS points.
© Gayle Pedersen


Investigate whether there is any link between bulls levels of heterozygosity, number of offspring and territory size, as has been found in Kenyan black rhinos (Cain *etal.*, 2013).
Preliminary data suggests not but breeding values will be calculated for all reproductive males using pedigree data from the previous chapter.
Run an animal model (linear mixed effect) with breeding value as the random effect, to investigate any link between **heterozygosity, reproductive success** and **territory** (+horn size out of interest).
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In summary…

- Overall aim is to compile these findings into a metapopulation management plan, in accordance with WWF and IUCN/ AfRSG Rhino Action Plans in order to maximise the genetic fitness of a consistently threatened species.

ACKNOWLEDGEMENTS



Prof Bridgett vonHoldt

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- Cilla Pickering &
- Simon Naylor

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– WWF BRREP
Project Leader

Judy Dossett

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UP PG Research Bursary; HWSETA

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THANK YOU!



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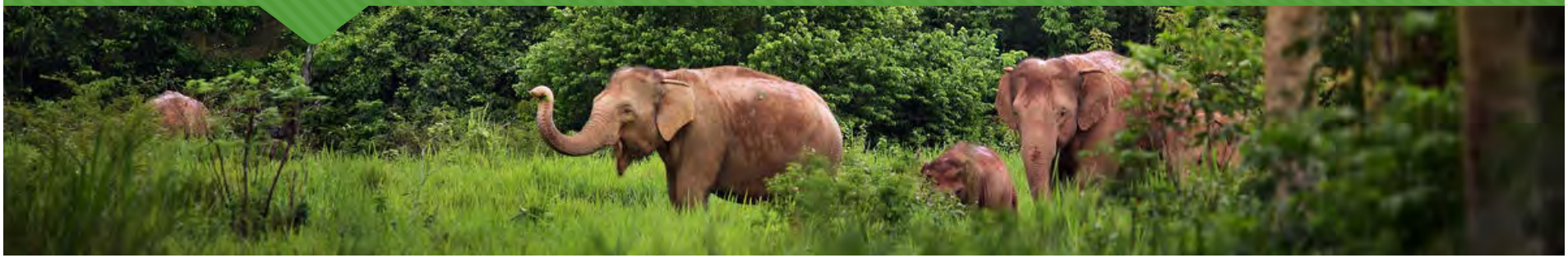
RECURRENT KERATITIS IN CAPTIVE ASIAN ELEPHANTS

Nili Avni-Magen, Gila Kahila-Bar-Gal, Ron Ofri
The Tisch Family Zoological Gardens in Jerusalem
The Koret School of Veterinary Medicine



Jerusalem Zoo Elephant history

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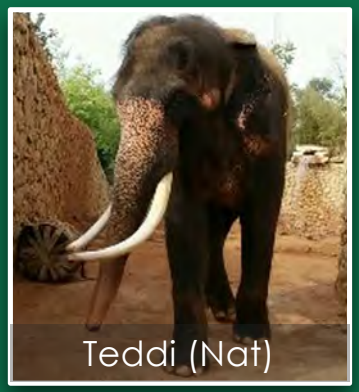
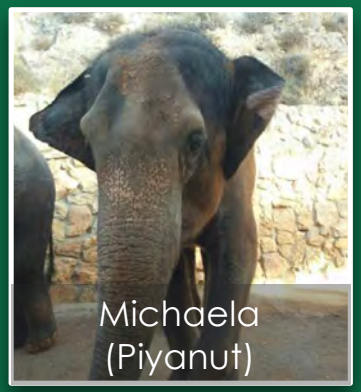
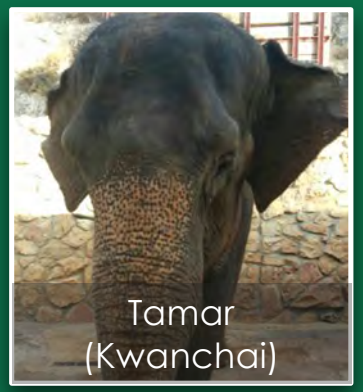
- 4 Asian elephants in residence
- All the females are originally from Thailand arrived in 1995 and 1997
- The bull was born in another Israeli zoo, arrived in 2001



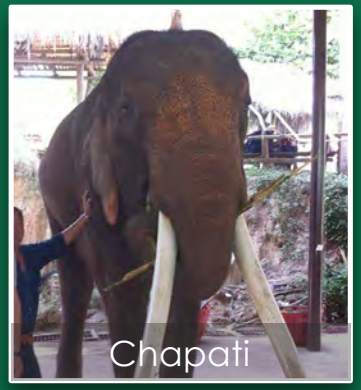

Teddi (Nat)


Michaela (Piyanut)


Susan (Oraphan)


Tamar (Kwanchai)


Champa


Chapati


Bonchu (Gabi)


Avigail (Sunisa)

“Free Contact”



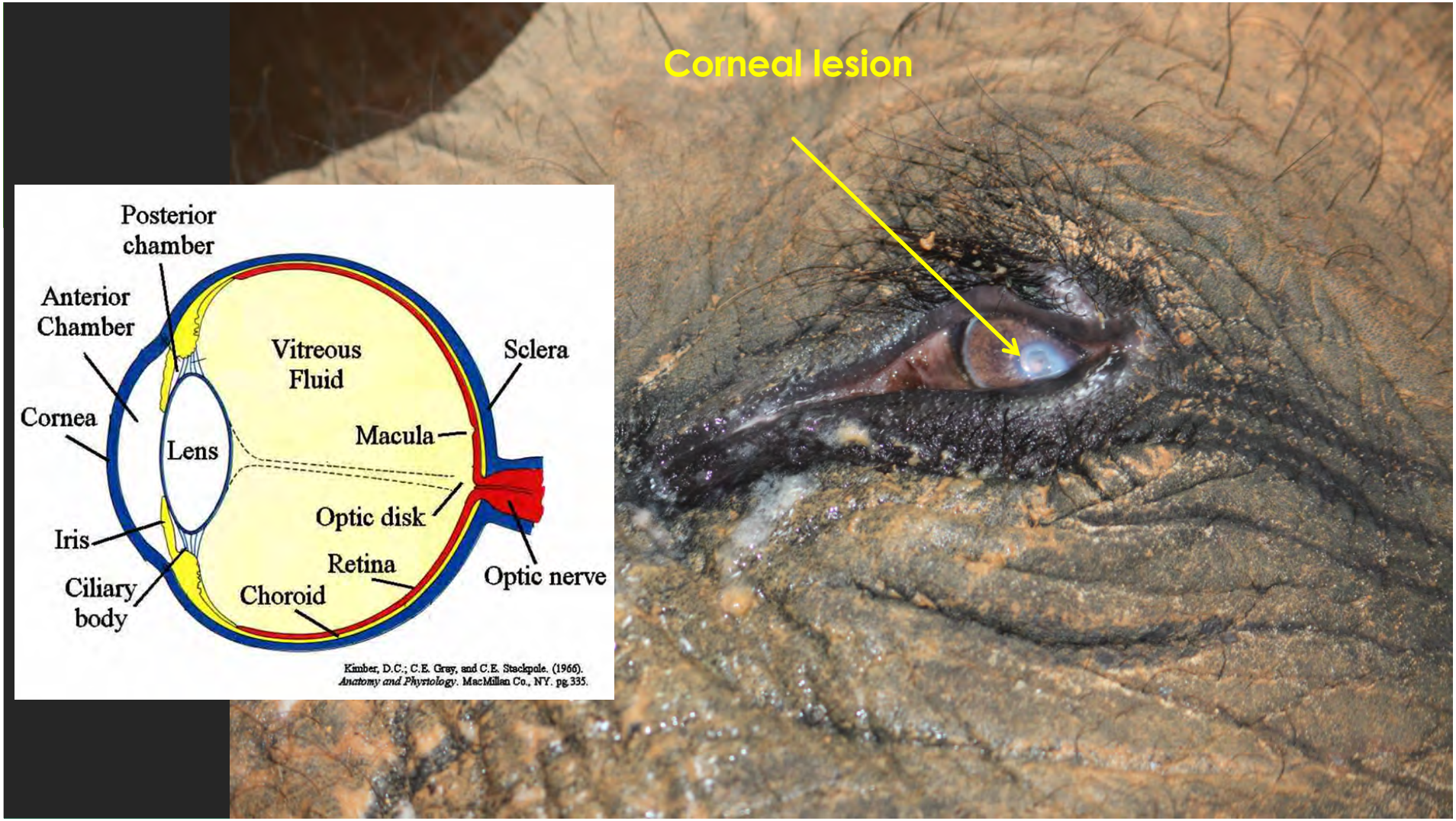
The bull - "Protected Contact"



Keratitis history – some facts

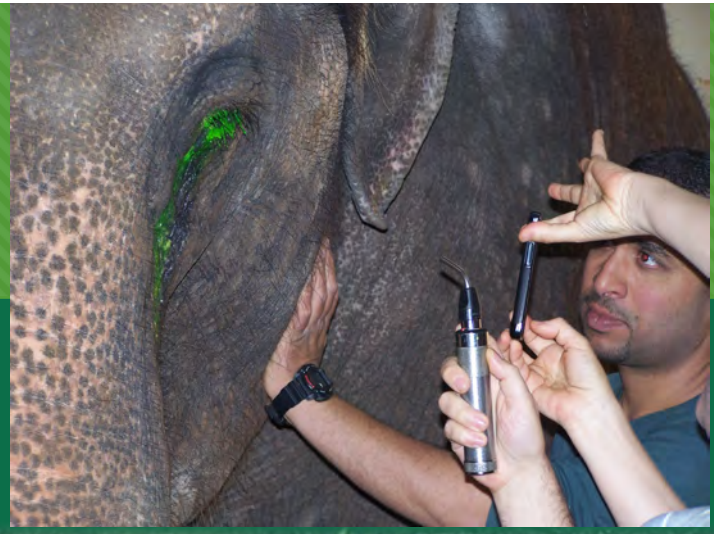


- Two months after their arrival , two of the females (Michaela and Avigail) developed eye problems [1997]
- Six months after the arrival of the bull (Teddi) he showed clinical symptoms [2001]
- Six months after Tamar's successful parturition she showed clinical signs for the first time [2006]
- One elephant (Susan) didn't show any eye clinical signs ever
- Clinical signs always in the same elephants simultaneously


Corneal lesion
Posterior chamber
Anterior Chamber
Cornea
Iris
Ciliary body
Lens
Vitreous Fluid
Choroid
Retina
Macula
Optic disk
Sclera
Optic nerve
Kimber, D.C.; C.E. Gray, and C.E. Stackpole. (1966). Anatomy and Physiology. MacMillan Co., NY. pg 335.

Keratitis - clinical signs

- Bilateral blepharospasm
- Severe photophobia
- Copious sero-mucoid discharge
- Corneal edema leading to loss of vision
- Negative flourescein tests





Keratitis - clinical signs

- 3-4 days to reach the peak ; 2-5 weeks until resolved
- Episodes reoccurred at 3-4 month intervals
- residual pigmentation and infiltration remained in the cornea
- Damage accumulates with every episode.
- Last few years –less frequent but more sever




Tamar
August 2008


Tamar
August
2006


Tamar
July 2006



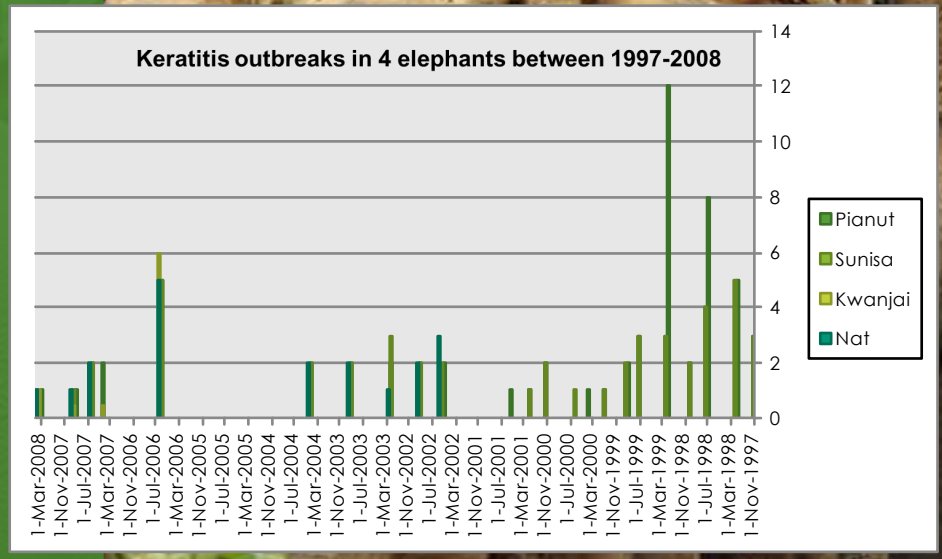
Michaela
Left eye
June 2016

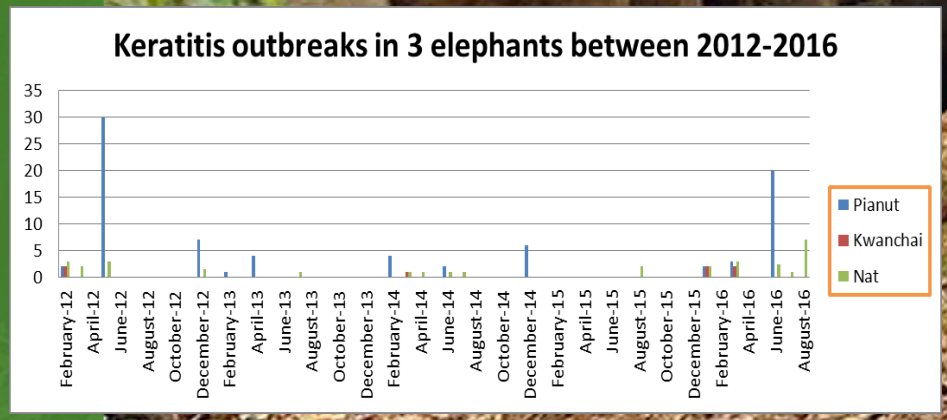


Michaela
Right eye
Sep 2016

Episodes Frequencies

Over the last years there have been 30 outbreaks at increasing intervals





Diagnostics

Diagnostic examinations included –

- Bacteriology culture [staphylococcus spp, Moraxella spp]
- Negative results on virology culture, fungal culture, Mycoplasma spp (culture and PCR), Leptospira spp., Toxoplasma and Chlamydia tests.
- Conjunctival biopsy revealed chronic lymphoplasmatic inflammation of unknown etiology. No evidence of parasites.





Diagnostics

- PCR tests for EEHV - on blood, lymph node biopsy, conjunctival swabs, tears and wart like lesions on the vulva, were all negative including tests for Pan Herpes
- Laboratories:
- "National Elephant Herpesvirus Laboratory" at the Smithsonian National Zoological Park
- IZW – institute for zoo and wildlife research in Berlin





Diagnostics

- Serology for BHV, EHV and WNV and experimental EEHV (Done at Erasmus university, Rotterdam) - negative
- Repeated blood work was consistently normal
- There is no correlation with seasonal, environmental or management changes





Treatments

No significant differences were noted between several treatment regimens including combinations of:

- local antibiotics,
- local and systemic NSAID's,
- local and systemic anti herpes drugs,
- pilocarpine®,
- mydriats.
- Third eyelid flap

Except when using autologous serum which reduced the duration of symptoms.





- During the last outbreaks skin lesions including lichenification, vesicles opened to crusts
- The clinical signs appears first along the lateral edge of both ears then along the along the dorsal trunk.
- No special pathogen isolation
- Clinical signs resolved after local treatment



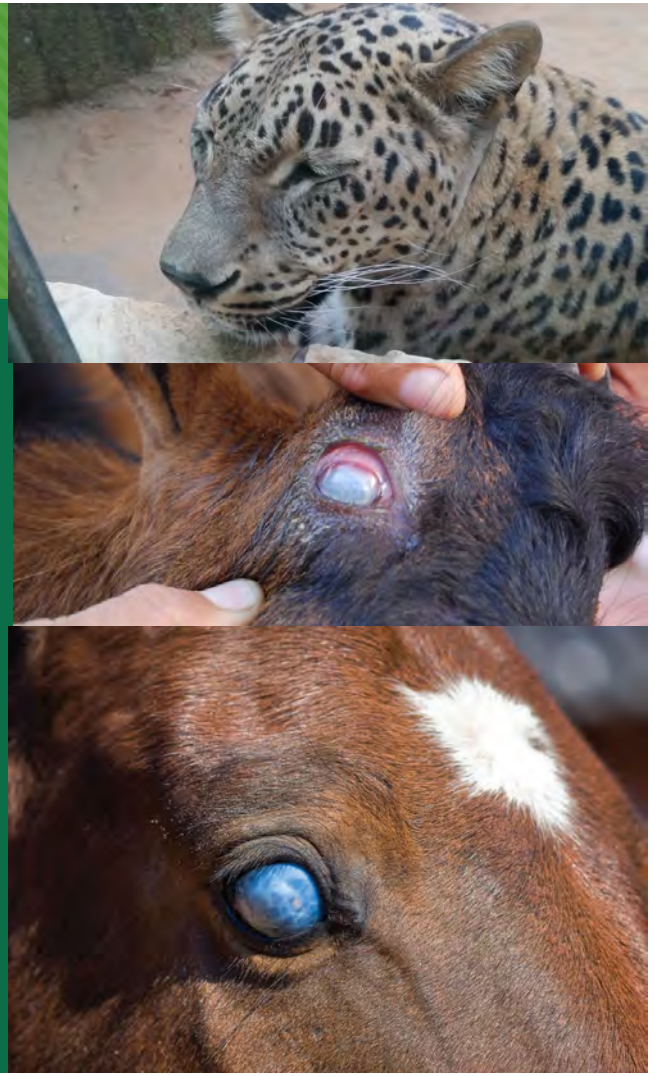


Similar cases

- No reports of **recurrent keratitis** in elephants
- Several ophthalmic reports.
- In the cornea - Corneal ulcers, corneal opacity and stromal abscess.
- etiology - traumatic corneal injuries, foreign bodies, bacterial and fungal isolation or **unknown ethology**.
- In different surveys –Prevalence of eye pathology - 17-25% with 5% blindness. [20% Myanmar , 25.7% Sri Lanka, 25% in Thailand]
- The most common lesions were frothy ocular discharge, corneal edema and conjunctivitis.

Recurrent keratitis

- No reports in elephants
- Recurrent herpetic keratitis has been reported in the cats, cattle, horse and humans.
- Equine Recurrent Uveitis in horses – immune mediated hypersensitivity.



Elephant's eye flora



- Positive EEHV PCR results from conjunctival swabs of healthy elephants reported
- *normal versus abnormal elephant's eye flora.*

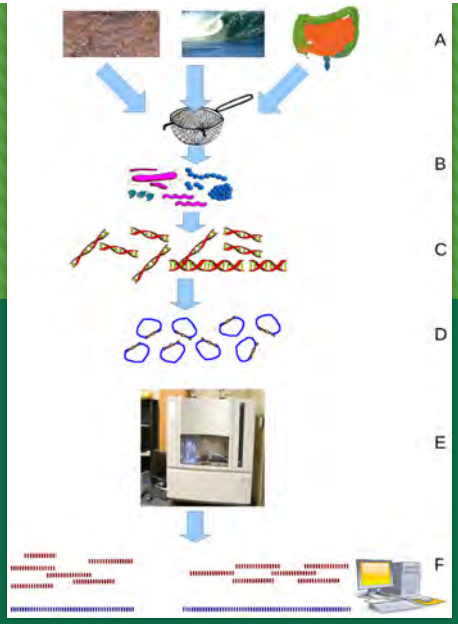
Research plan



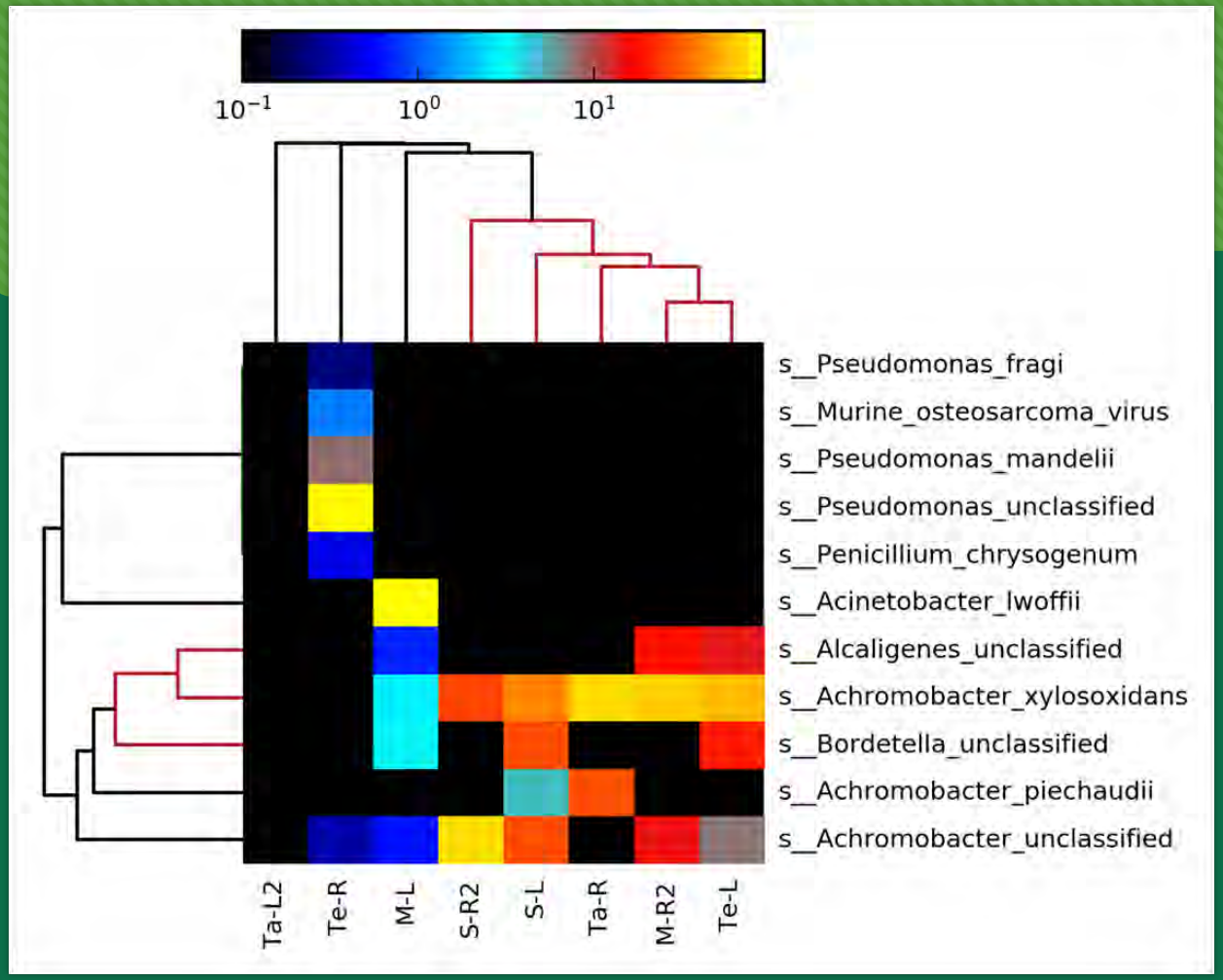
- We evaluated the use of Next Generation Sequencing (MiSeq - Illumina) trying to screen for the pathogens associated with the inflammation.
- Comparison of the flora in the right and left eye of each individual during and after keratitis outbreak
- The analysis included bacterial, fungi and viral pathogens.

Metagenomic identification

- We sampled tears using sterile cotton swabs
- DNA was extracted from the tears
- it was sequenced using Next Generation Sequencing (MiSeq).
- The MiSeq was searching for the pathogens associated with the inflammation.
- The plots were generated by in-house algorithms that are tailored towards **metagenomic screening**.






10^{-1}
10^{0}
10^{1}
s__Pseudomonas_fragi
s__Murine_osteosarcoma_virus
s__Pseudomonas_mandelii
s__Pseudomonas_unclassified
s__Penicillium_chrysogenum
s__Acinetobacter_lwoffii
s__Alcaligenes_unclassified
s__Achromobacter_xylosoxidans
s__Bordetella_unclassified
s__Achromobacter_piechaudii
s__Achromobacter_unclassified
Ta-L2
Te-R
M-L
S-R2
S-L
Ta-R
M-R2
Te-L

- Preliminary results – in the beginning of the process..
- No statistical significance yet..







- Latent pathogen
- Environmental trigger
- Elephant immune resistance
- New approach – metagenomic identification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Thank you!

Periodontal Disease in Black Rhinoceros (*Diceros bicornis)*

Benn Bryant BVSc MVS MANZCVSc
Michelle Campbell-Ward Bsc BVSc DZooMed (Mammalian) MANZCVSc

Taronga Western Plains Zoo

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Farmer at the dentist
Johann Liss
C 1616-1617

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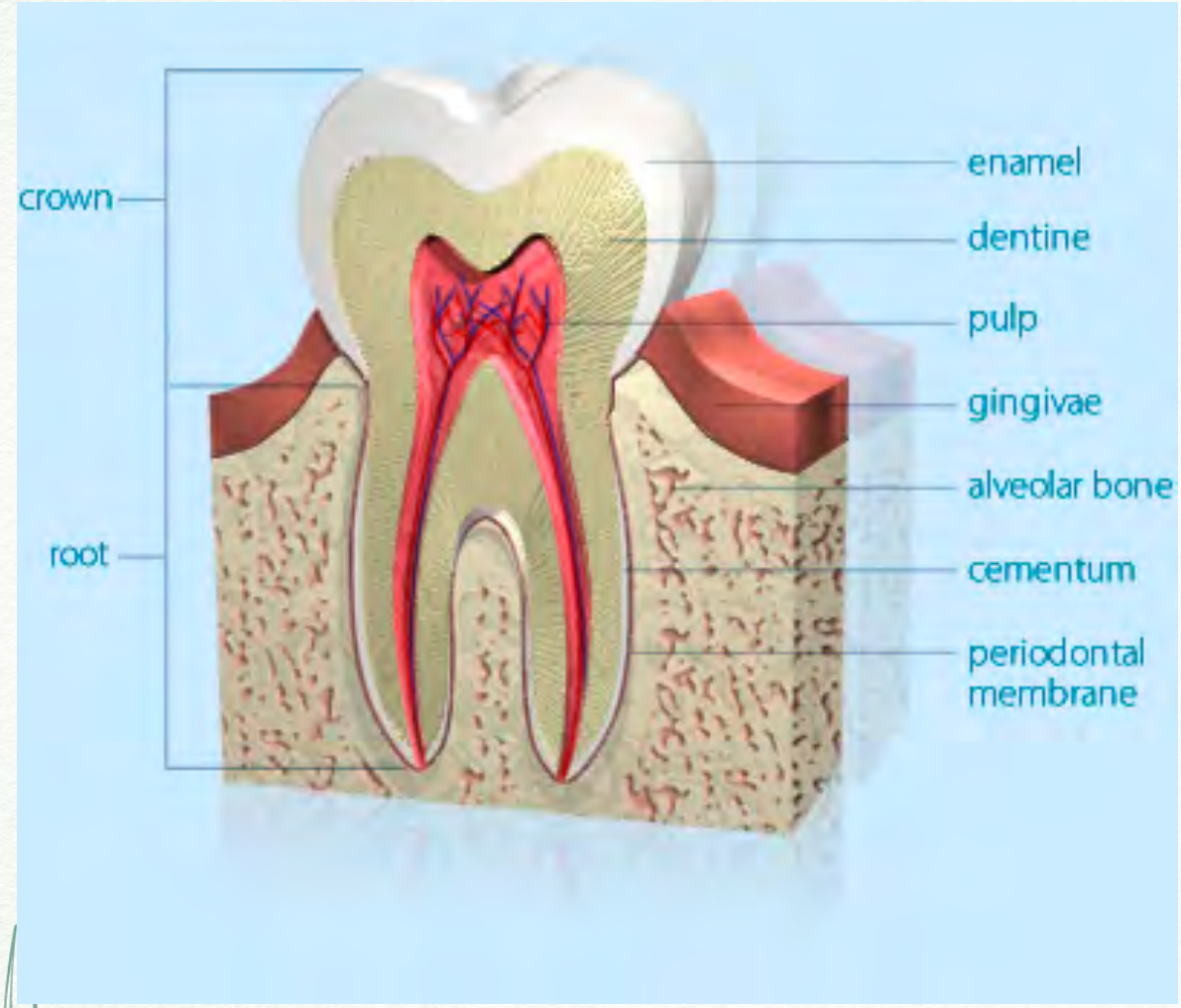
Tooth structure



Periodontia:

- ginigiva
- root
- periodontal ligament
- alveolar bone
- cementum

Source: http://www.toothclub.gov.hk/en/en_teens_02_01_01.html

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Biofilms (plaque)



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Hypsodont teeth (horse)



-continual growth compensates for wear

-extensive surface area for attachment of PD ligament spreads shearing forces

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Irregularities of wear (horse)



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Periodontal disease: diastema



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Coronal reduction/corrective rasping



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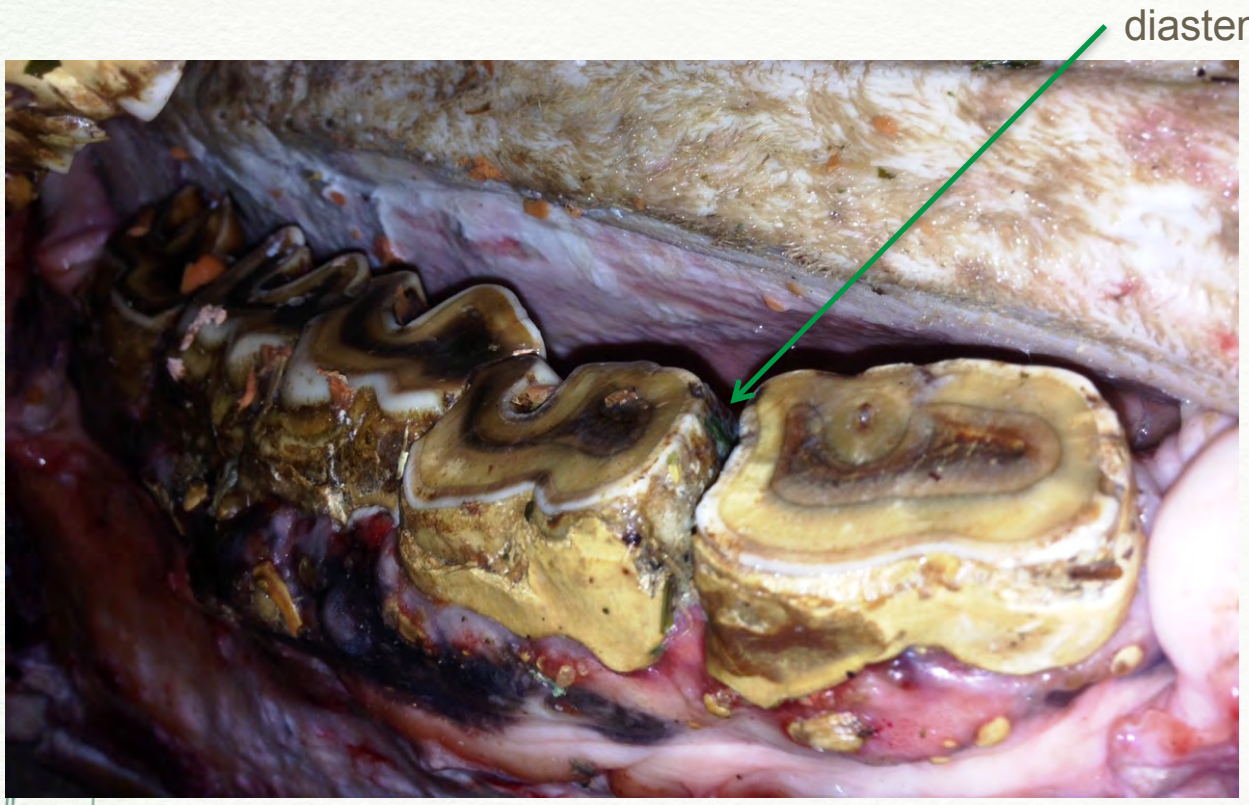
Periodontal disease (black rhino)





- Gingivitis
- Gingival recession
- Diastema
- Hypercementosis

NB: -severe abrasive wear at occlusal surface (lophs are gone)
-only minor irregularities of wear

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Lysis of tooth roots, alveolar crest and perialveolar bone (black rhino)



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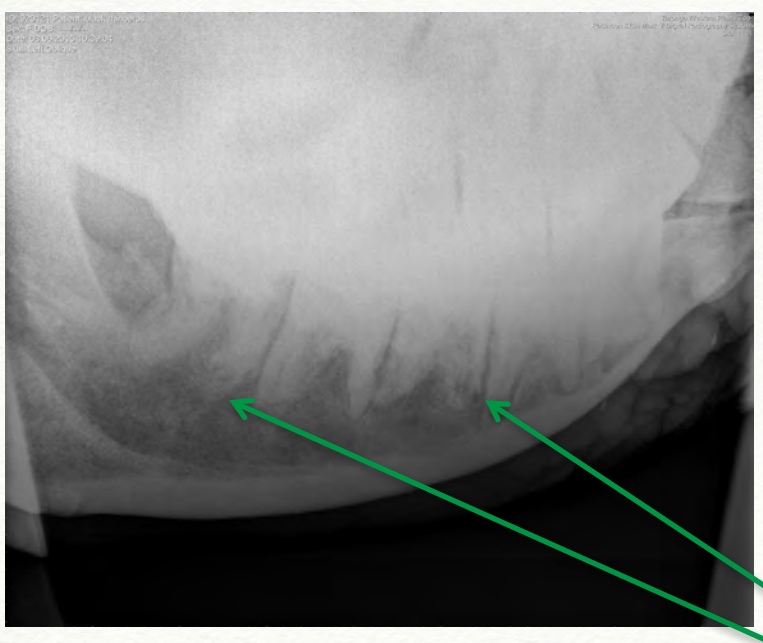
Lysis of tooth roots (black rhino)





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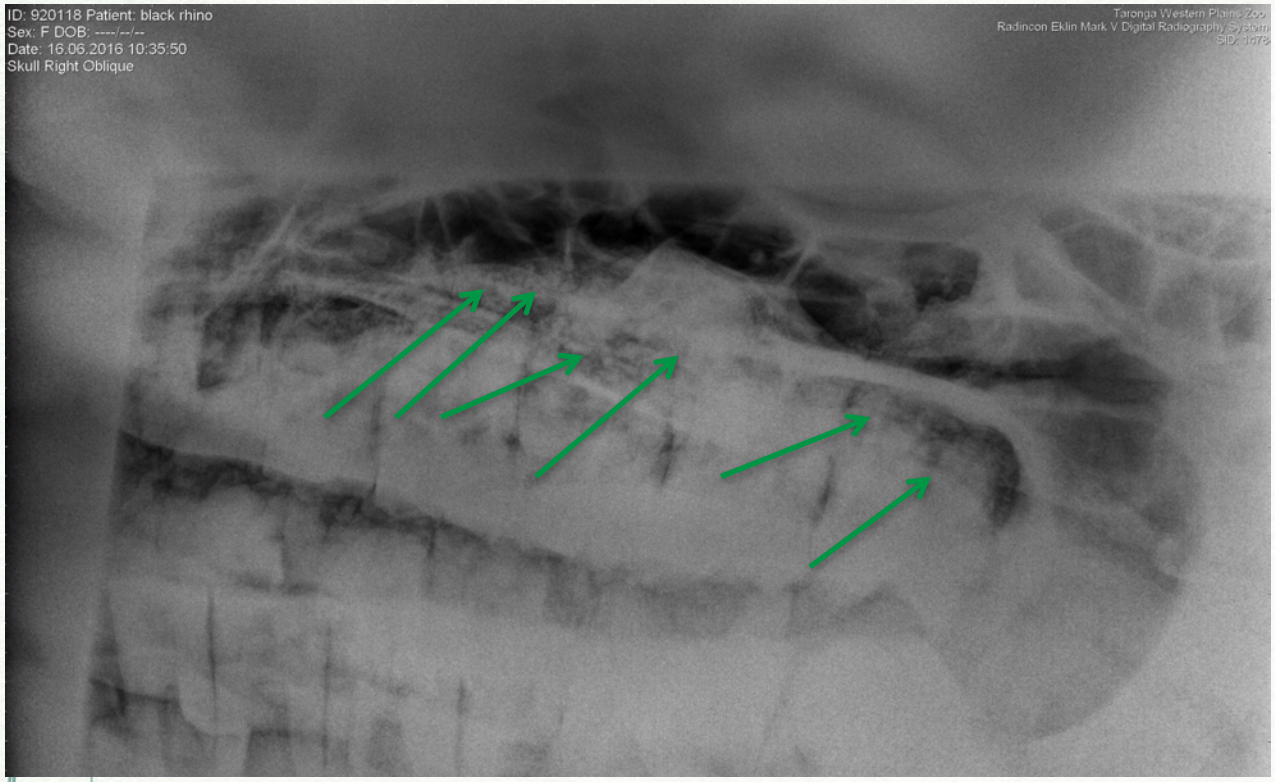
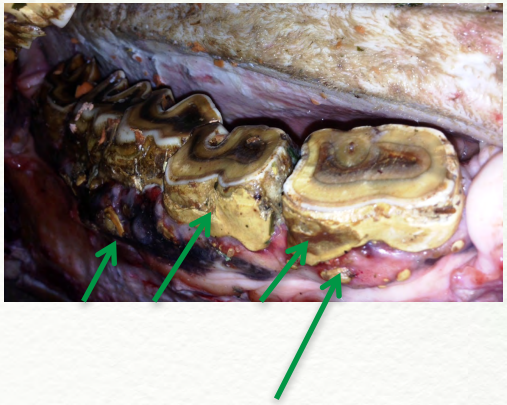
Hypercementosis (black rhino)







Patchy radiodensities overlying and obscuring tooth roots

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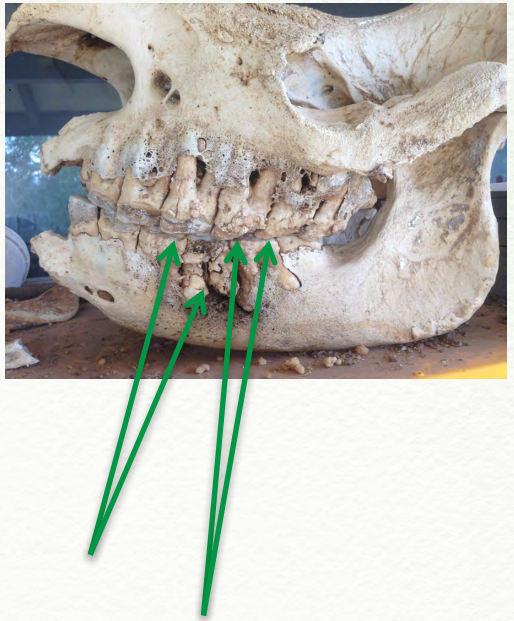
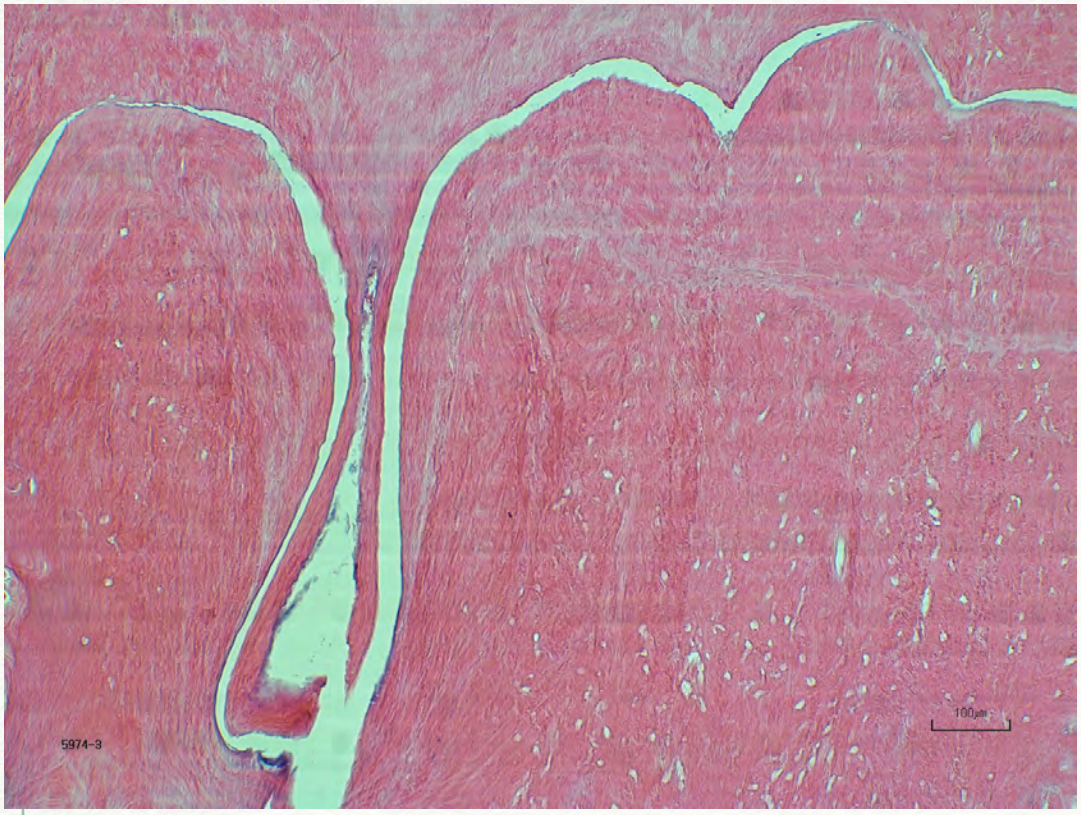
Hypercementosis (black rhino)





Exuberant calcarous material associated with black rhino periodontal disease is histologically consistent with cementum

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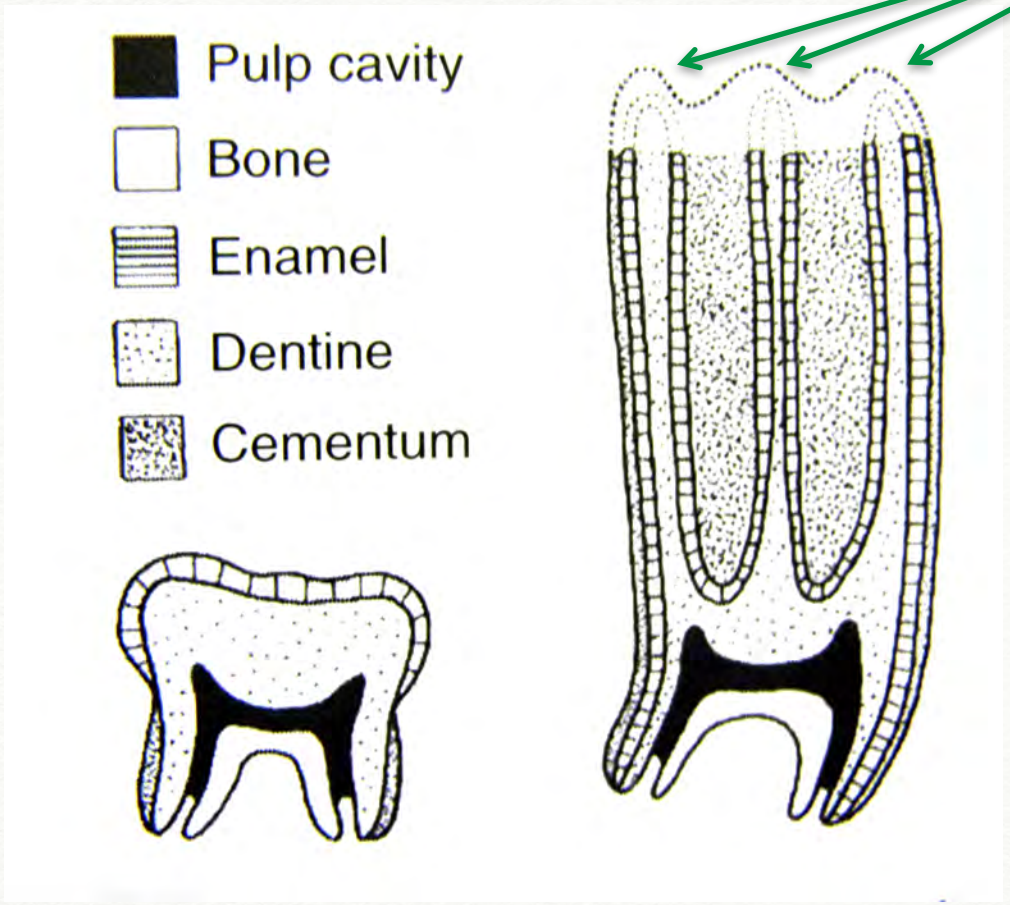
Black rhino teeth are brachydont AND lophodont



Brachydont tooth

Hypsodont tooth

Source: Janis C (2008) in Ecology of Browsing and Grazing , eds Gordon and Prins. Springer-Verlag, Berlin

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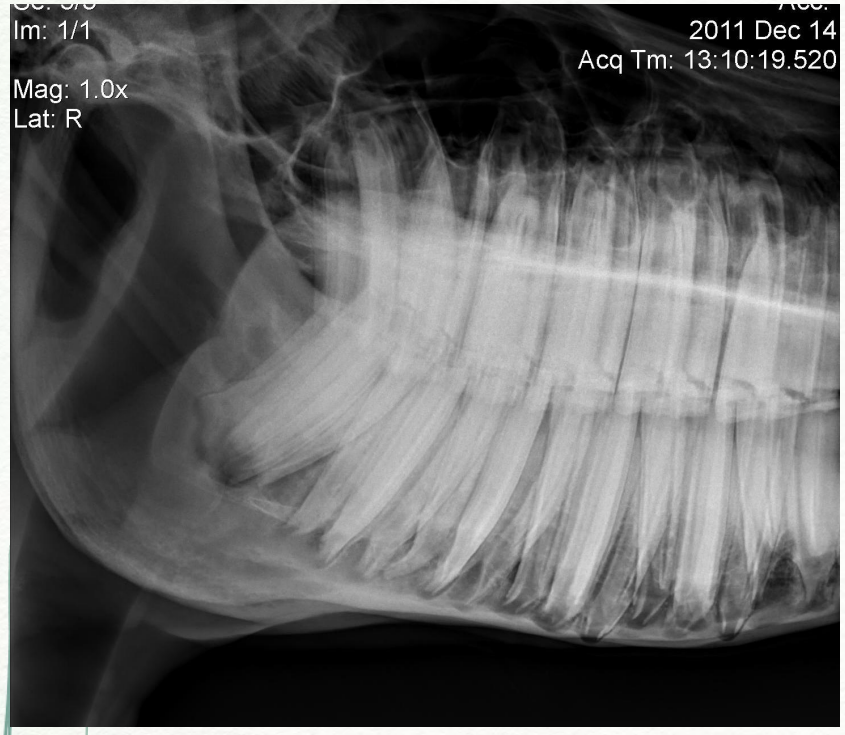
Hypsodont vs brachydont



horse: hypsodont. Long reserve crown



black rhino: brachydont. Short reserve crown

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Grass hay is abrasive



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Black rhino oral examination



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Anaesthesia for oral examination



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Oral cavity access







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Instrumentation





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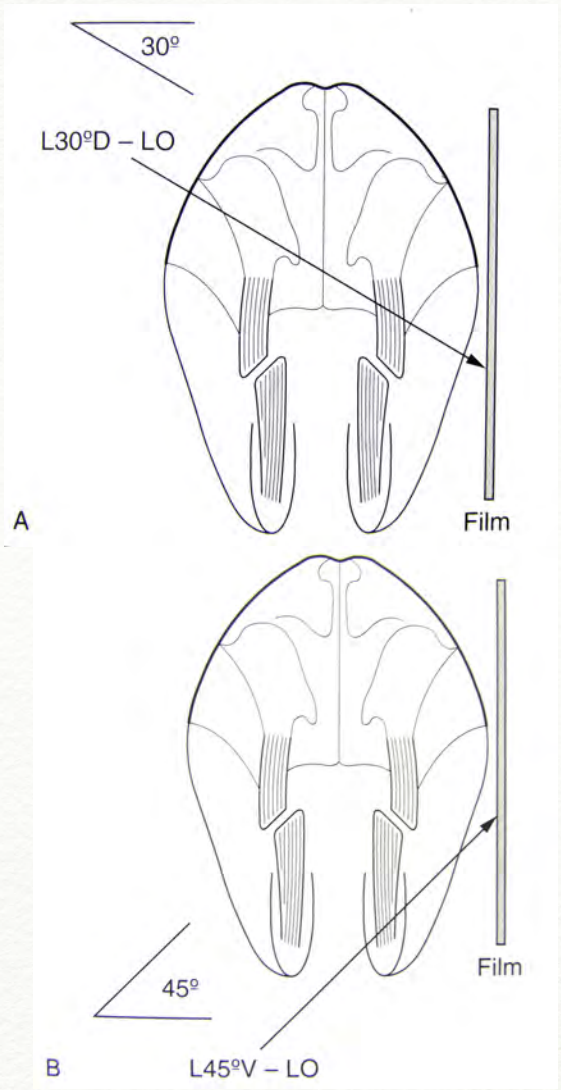
Extra oral radiography (black rhino)





Tooth roots upper arcades

Tooth roots lower arcades

Source: GibbsC (2005) in Equine Dentistry eds Baker & Easley. Elsevier Sanders, Edinburgh.

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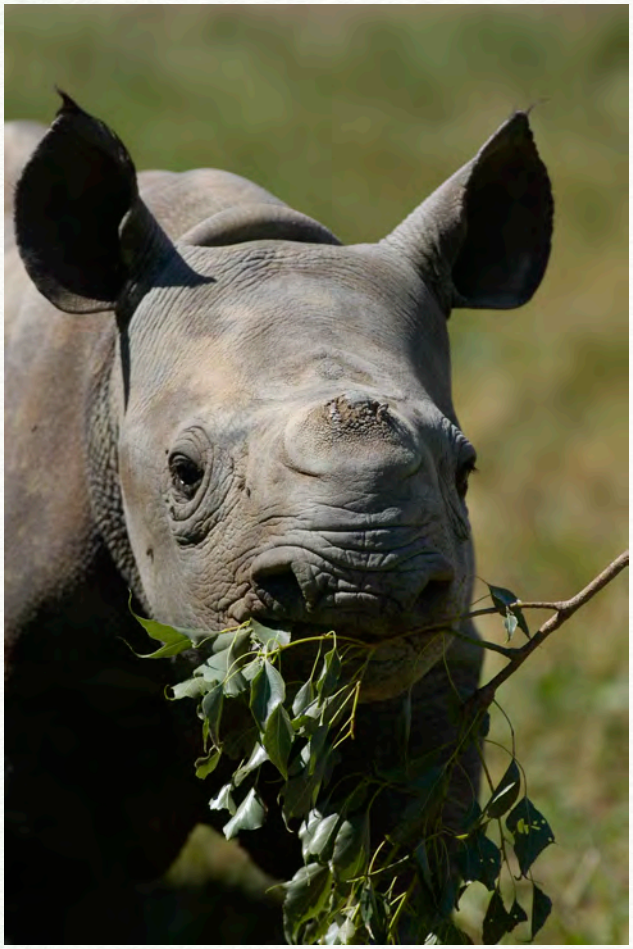
Potential sequelae of periodontal disease in black rhino



- Pain/bad welfare
- Maldigestion
- Bacteraemia and remote abscessation
- Inflammatory mediators
- Subfertility?
- Insulin resistance?
- Iron storage?

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Conclusions:



- Periodontal disease is an important & potentially under-recognised disease of zoo-based black rhinoceros

- Preventative health programs for zoo-based rhinos should include regular, effective dental assessment

- Research into the prevalence and pathophysiology of periodontal disease in black rhino is needed to inform preventative and treatment strategies

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Management of tusk fractures in captive elephants



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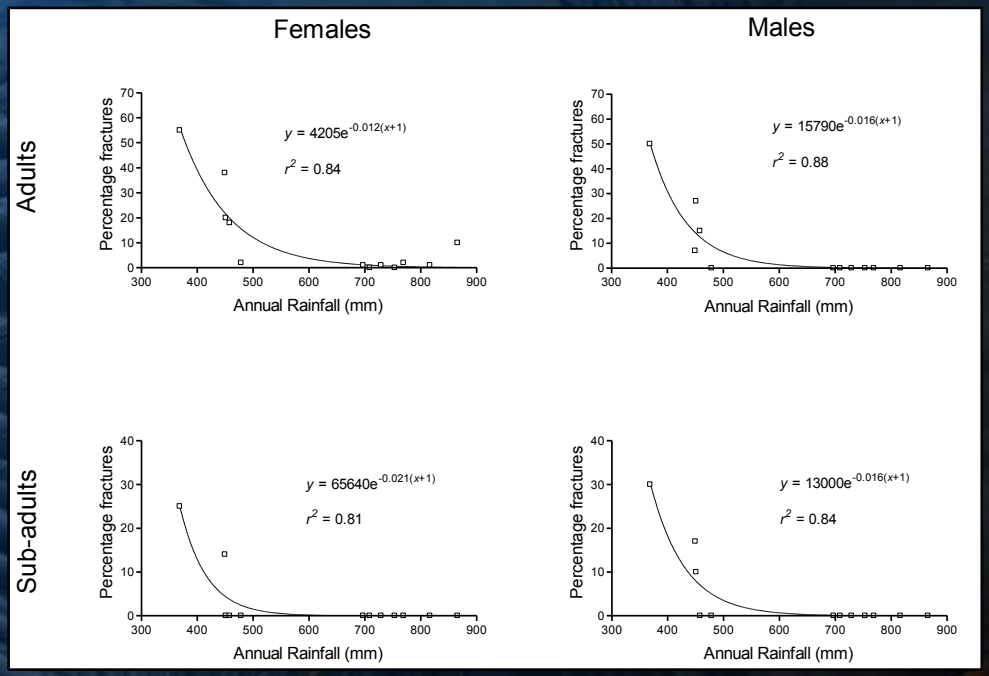
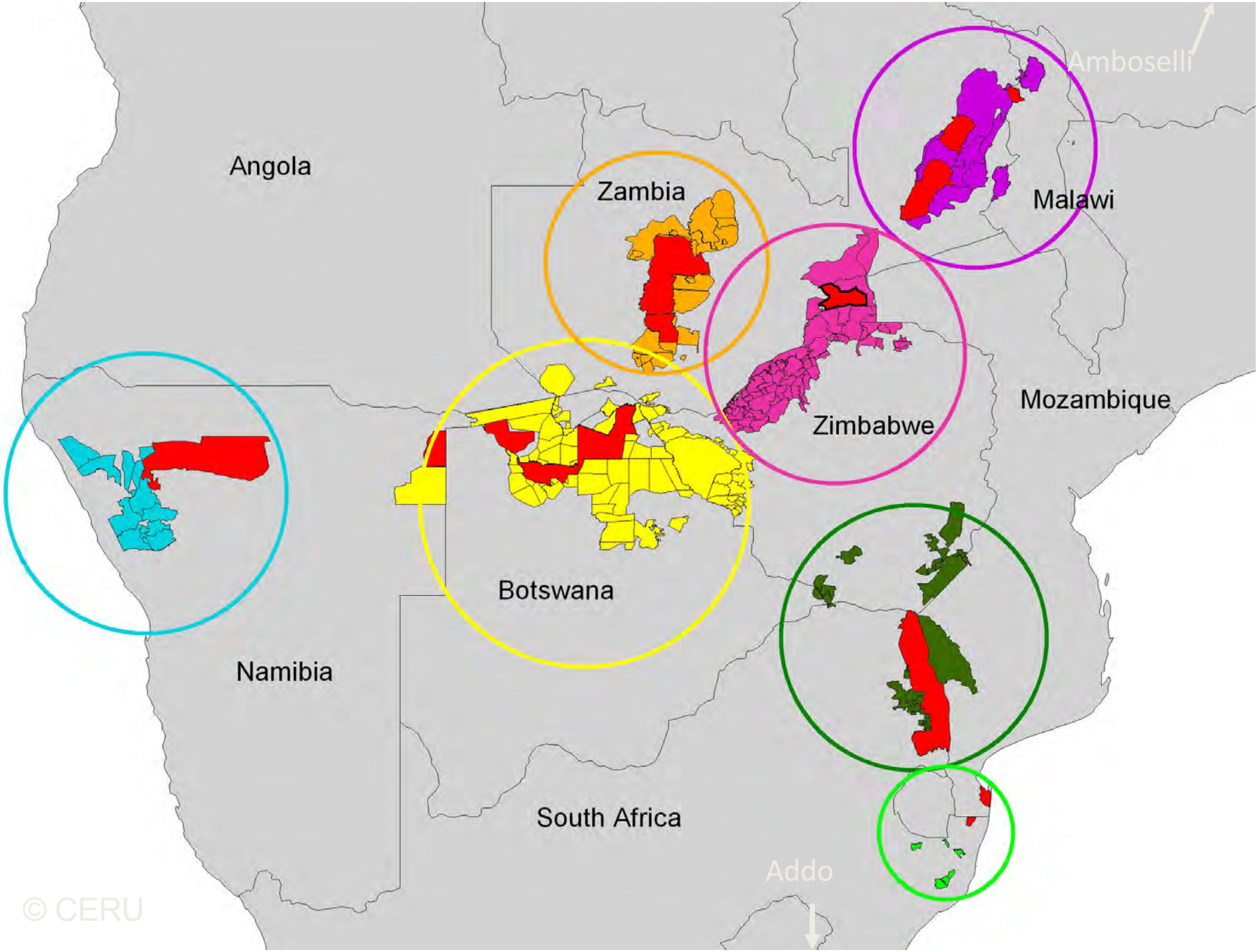
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA
Faculty of Veterinary Science

Tusk fractures

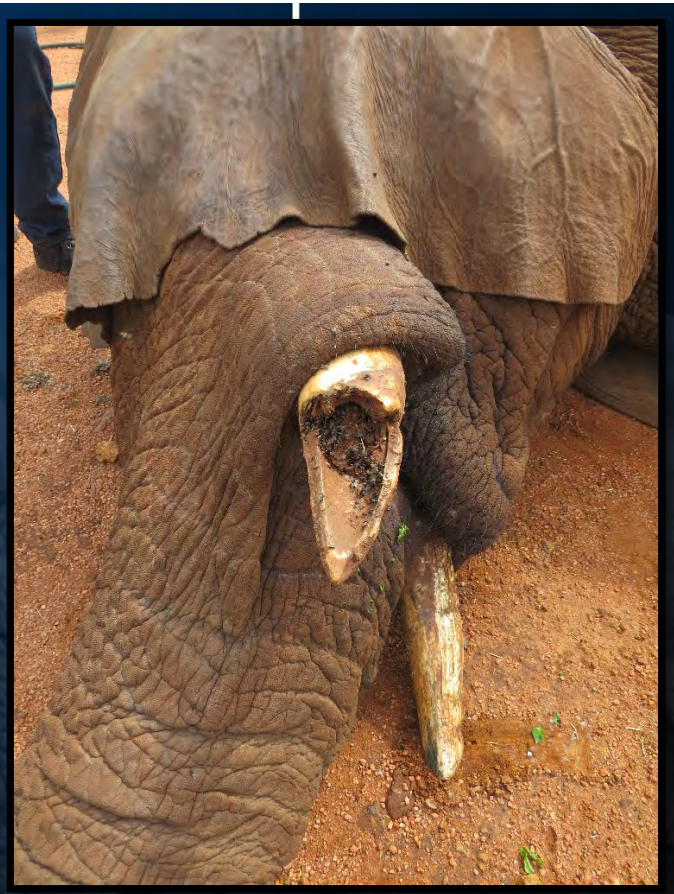
- **Rainfall**
  - Humidity?
  - Nutrients?
  - Behaviour?
- **Captivity**
  - 31%
  - Mikota *et al* 1994 (379)
- **Free ranging**
  - 0 – 55%

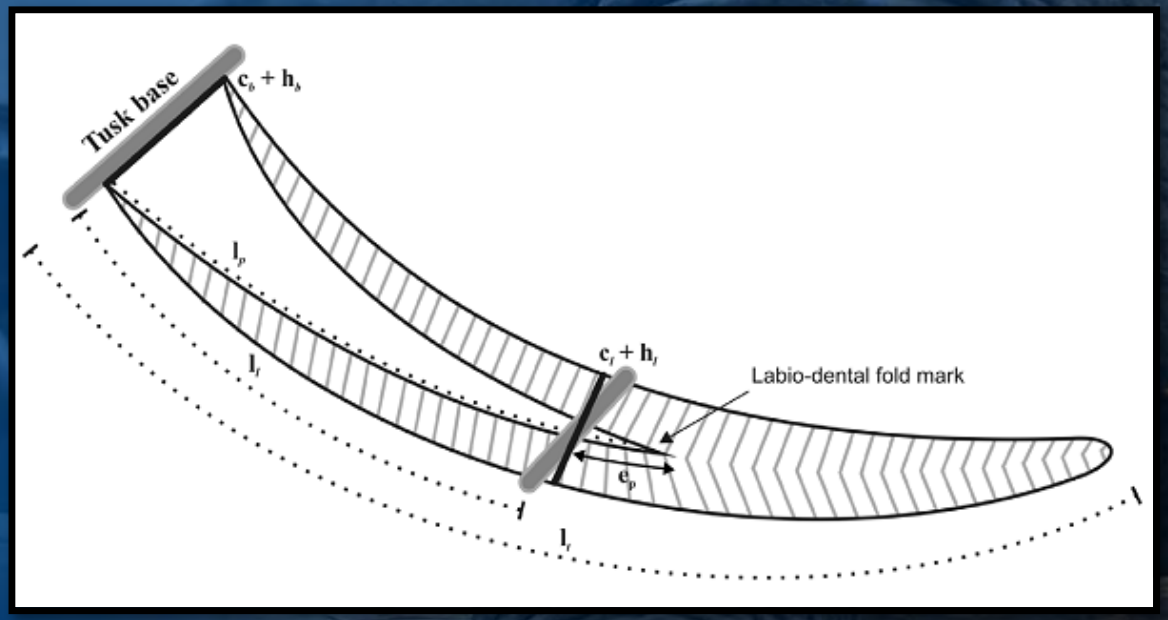


G. Steenkamp *et al.* (2007) Tusklessness and tusk fractures in free-ranging African savanna elephants (Loxodonta africana). JSAVA. 78(2): 75–80


Amboselli
Angola
Zambia
Malawi
Mozambique
Zimbabwe
Botswana
Namibia
South Africa
Addo
© CERU

Pulp exposure

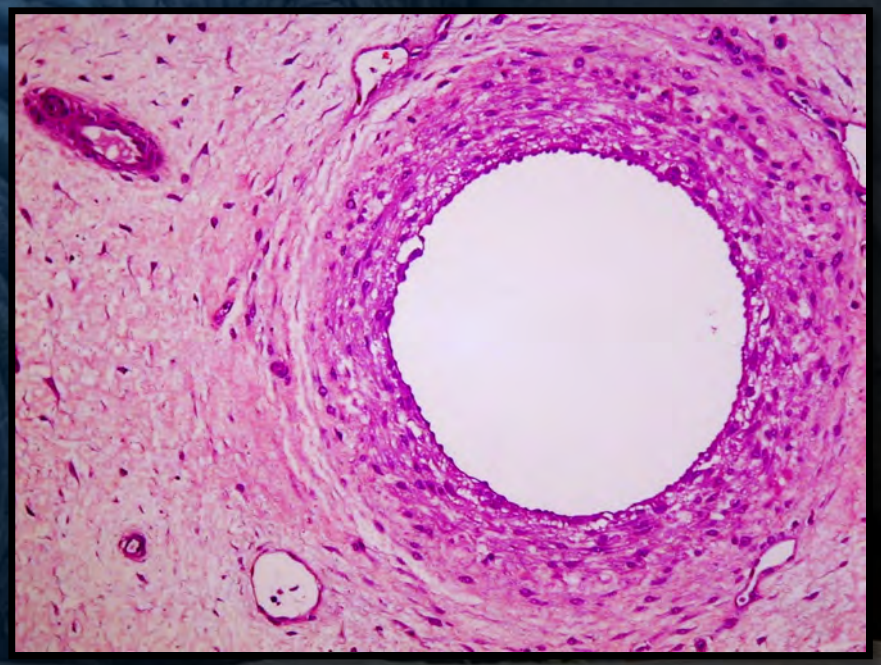




G. Steenkamp *et al*. Estimating exposed pulp lengths of tusks in the African elephant (Lo*xodonta africana africana*). JSAVA. (79(1): 25–30

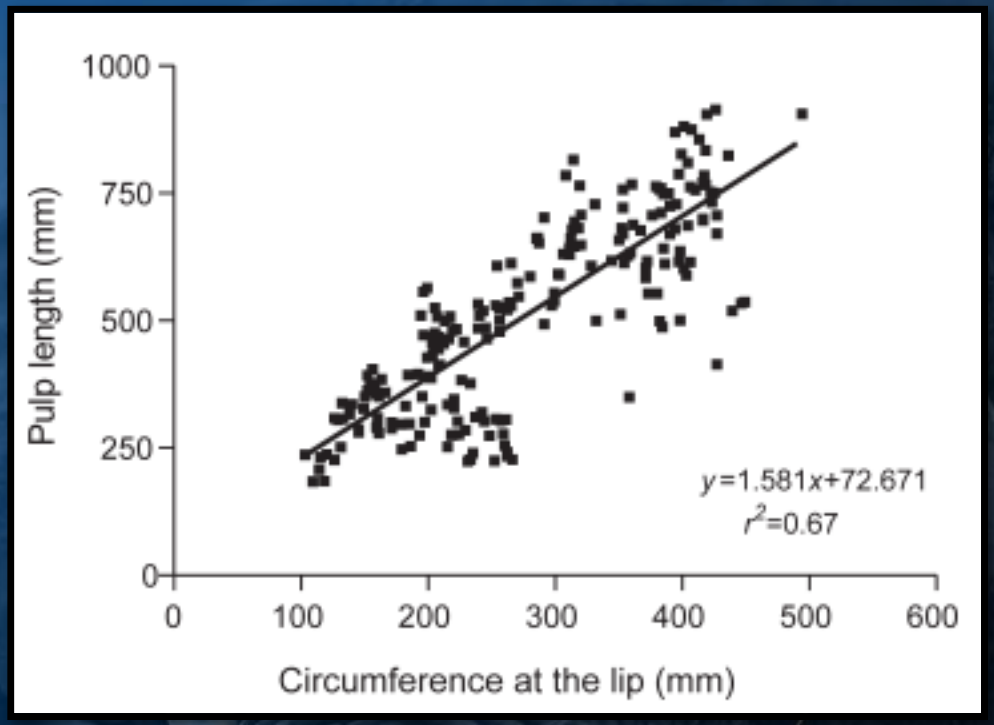
Where are the nerves?

- **Miller 1891**
  - Pain response to sawing
- **Fagan *et al.* 1999, 2001**
  - No nerve supply
  - Painful operation
- **Boy & Steenkamp 2004**
  - Nerve responsible for control



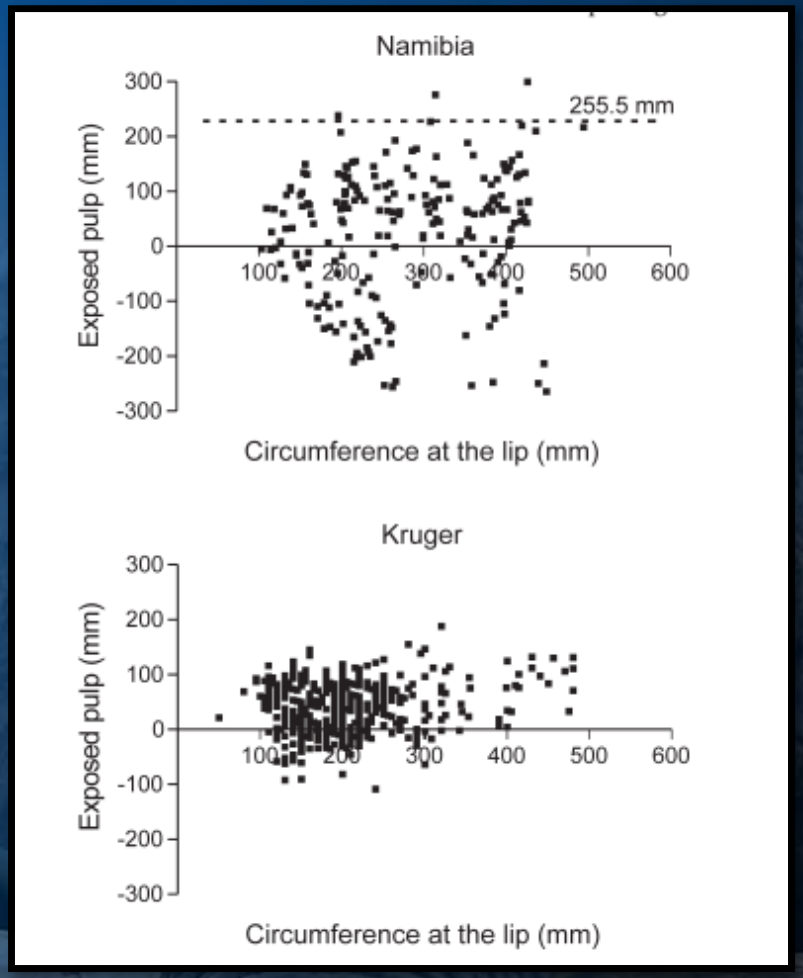
Boy & Steenkamp (2004). Neural innervation of the tusk pulp of the African elephant (*Loxodonta africana*). Vet. Rec. 154(12):372-374

Pulp length



G. Steenkamp *et al*. Estimating exposed pulp lengths of tusks in the African elephant (Lo*xodonta africana africana*). JSAVA. (79(1): 25–30

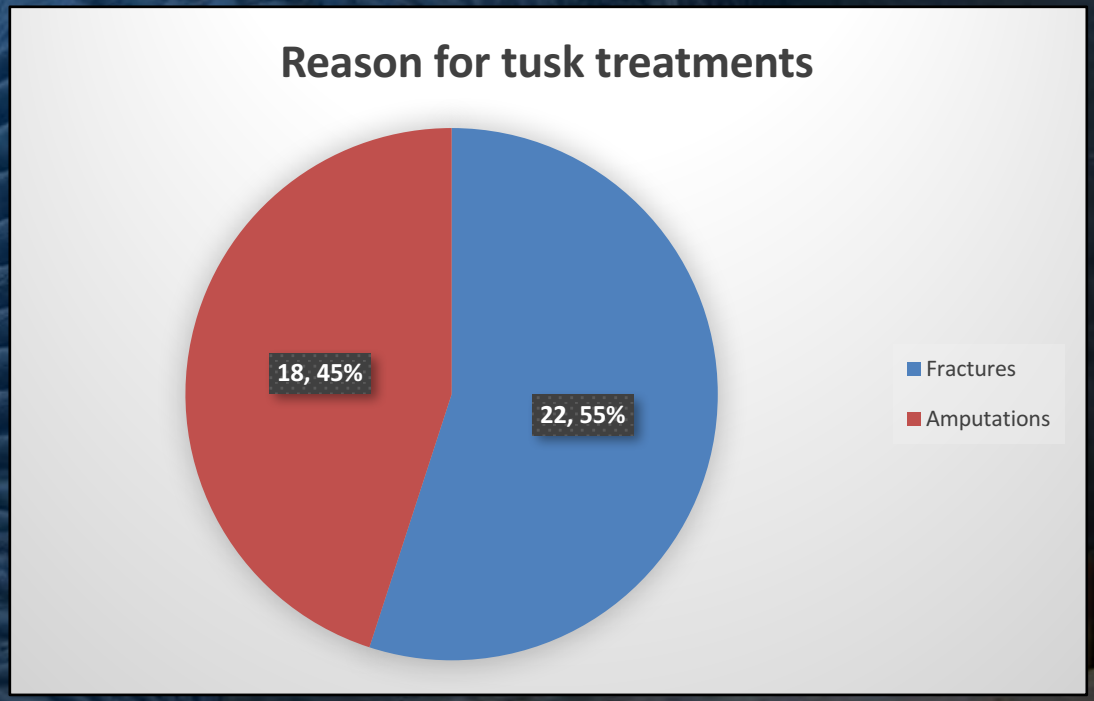
Exposed pulp length

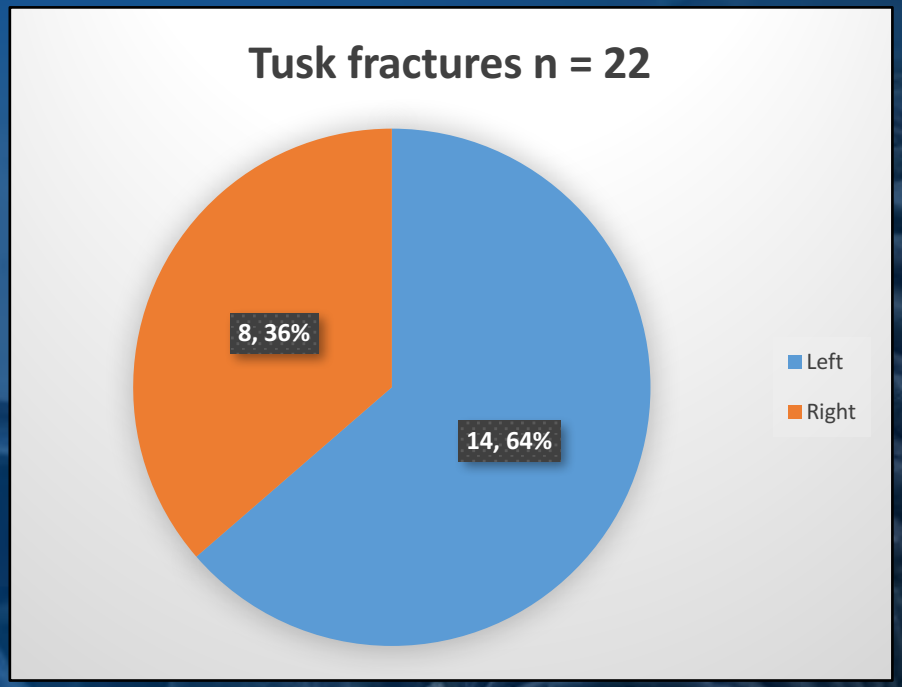


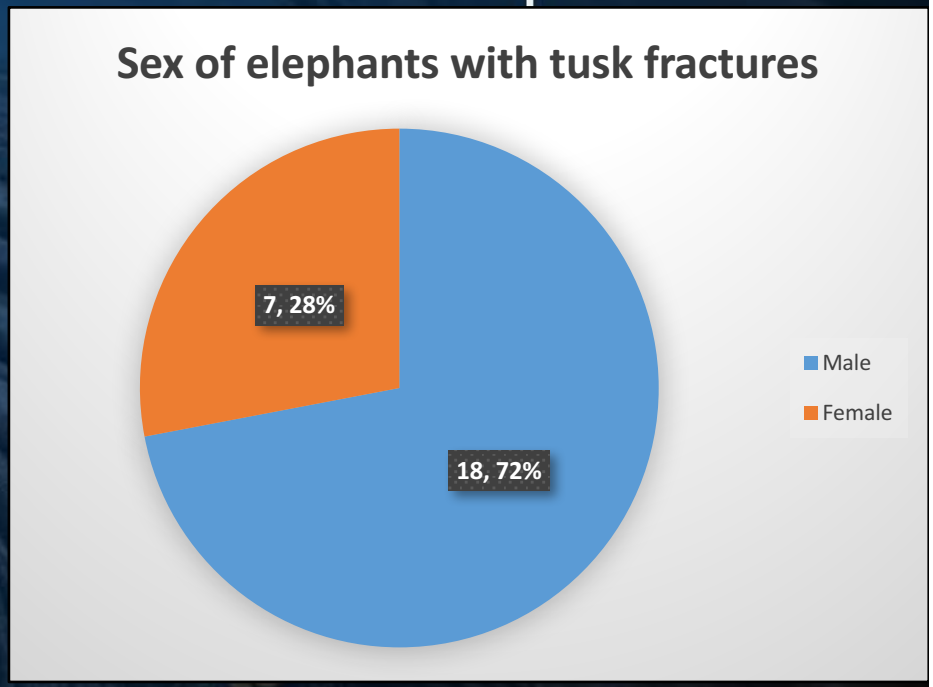
G. Steenkamp *et al*. Estimating exposed pulp lengths of tusks in the African elephant (Lo*xodonta africana africana*). JSAVA. (79(1): 25–30

Indications for treatment

- Tusk fractures
- Tusk cracks
- Amputations?



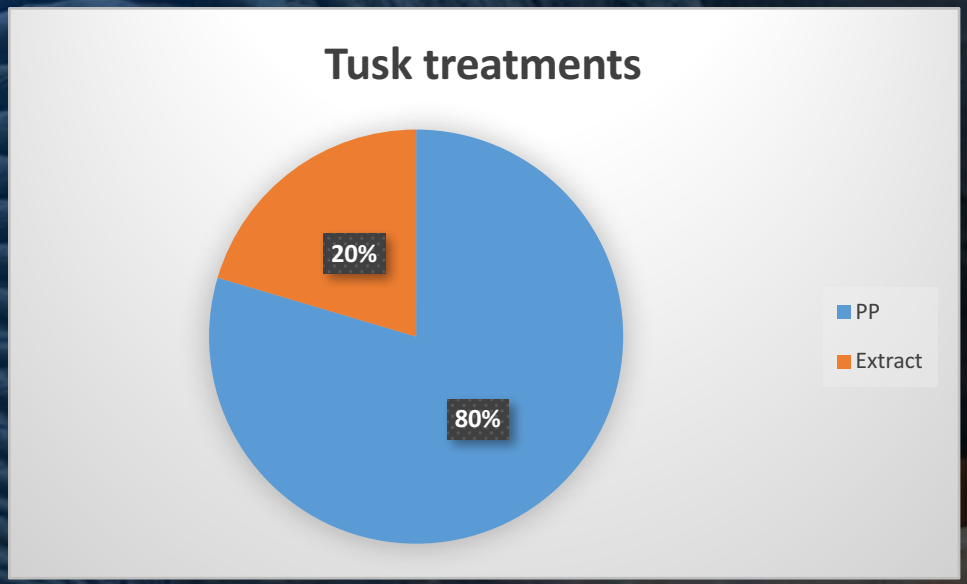

Tusk fractures n = 22
8, 36%
14, 64%
Left
Right


Sex of elephants with tusk fractures
7, 28%
18, 72%
Male
Female

Treatment options

Partial pulpectomy

Extractions



Partial pulpectomy

- Early intervention
- Save the tusk
- Shorter procedure (20-40 min)
- 5% failure (n=2)





Tusk extractions

- Best avoided
- Be sure of your diagnosis
- Length of ‘root’
- Specialised equipment
- May require multiple procedures
- Abnormalities
- Clean alveolus

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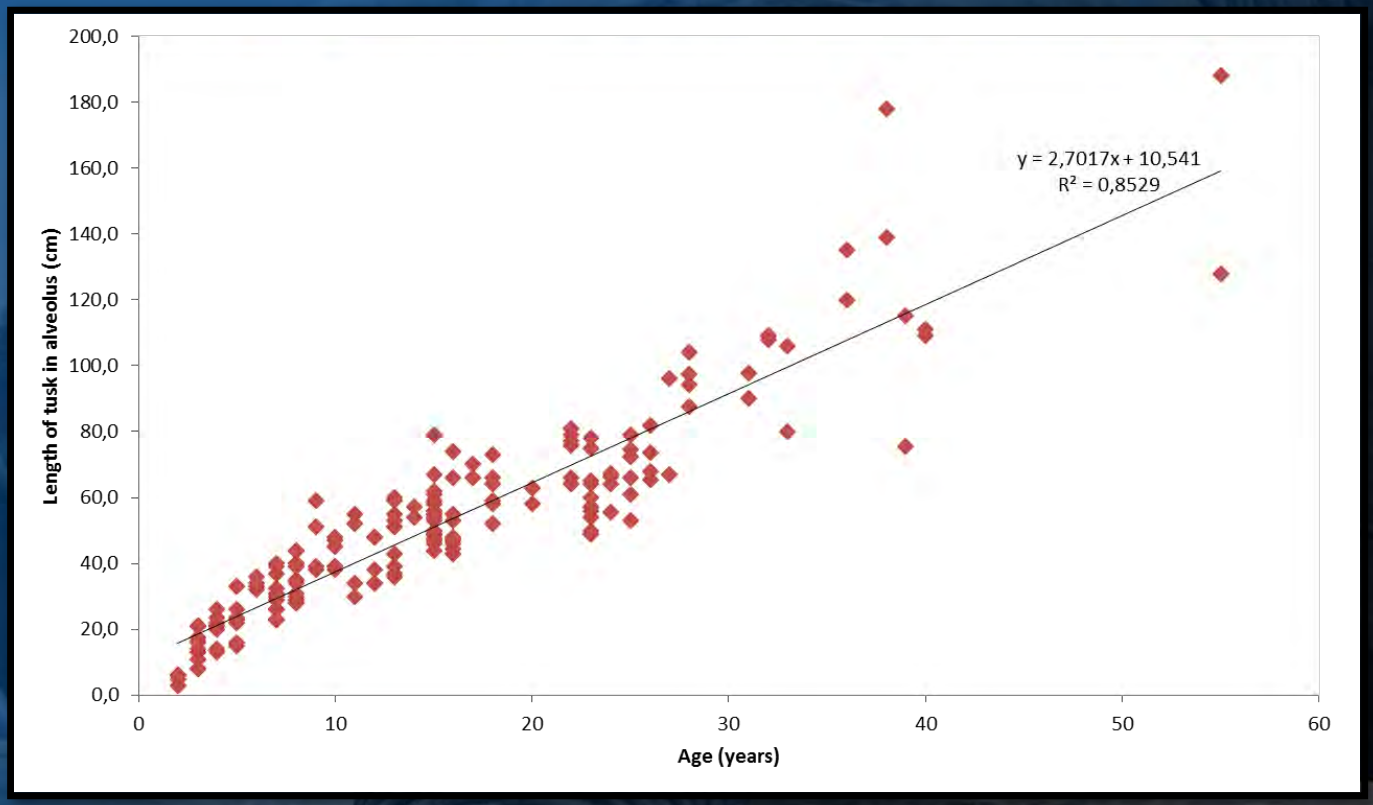
Faculty of Veterinary Science

Length in alveolus









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Acknowledgements

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SOMTA

Dr. Danie Burger

Mr. Louis la Grange



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Thank you





Development of a rhino ferritin specific assay for determining the association between serum ferritin concentrations and hemochromatosis in the Sumatran rhinoceros (*Dicerorhinus sumatrensis*)

Terri L. Roth, Paul R. Reinhart and Jenny L. Kroll

Center for Conservation and Research of Endangered Wildlife, Cincinnati Zoo & Botanical Garden, Cincinnati, OH, 45220, USA

Comparative Serum Ferritin Data

Equine based assay

	Young female	Old male
Serum ferritin	**Last 6 m of illness**	**3 year period**
Mean	1,713±701 ng/ml	1,488±894 ng/ml
Range	740–2,650 ng/ml	382–2,445 ng/ml
Median	1,700 ng/ml	1,700 ng/ml
Hemochromatosis	Yes	No

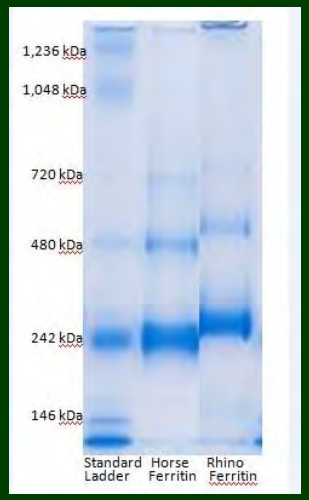
Questions:

1) Is the equine based ferritin assay accurate in monitoring serum ferritin concentrations in Sumatran rhinos?
2) When accurately measured with a rhino ferritin specific assay, will serum ferritin prove to be a useful biomarker for the progression of iron overload disorder in Sumatran rhinos?

I. Develop a Sumatran rhino ferritin specific assay

1.) Isolate ferritin from rhino liver tissue

multi-step process



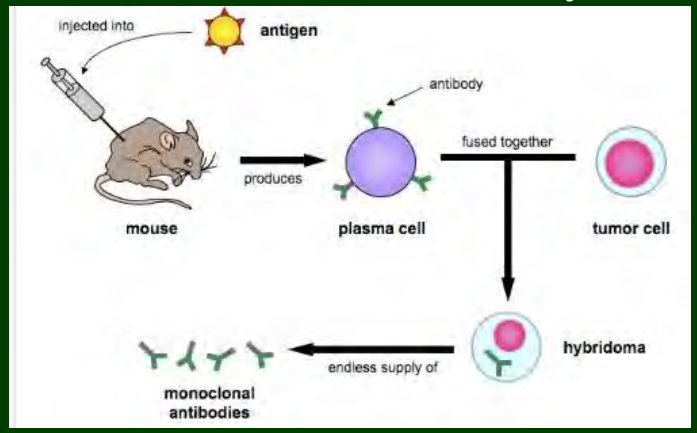
Coomassie blue



Potassium ferricyanide

2.) Produce antibodies to rhino ferritin

University of Georgia, Bioexpression & Fermentation Facility

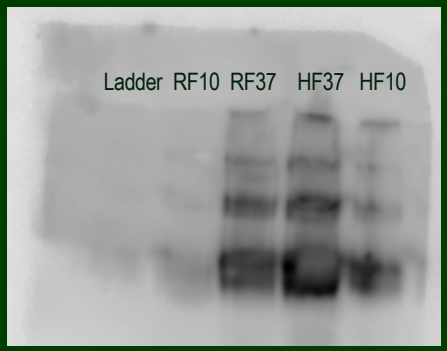






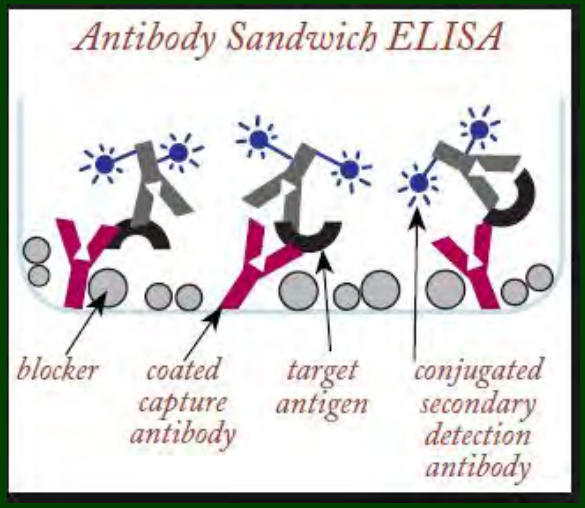
I. Develop a Sumatran rhino ferritin specific assay

3.) Run Western blot to confirm antibody binding to protein





4.) Develop sandwich ferritin EIA



Sandwich EIA

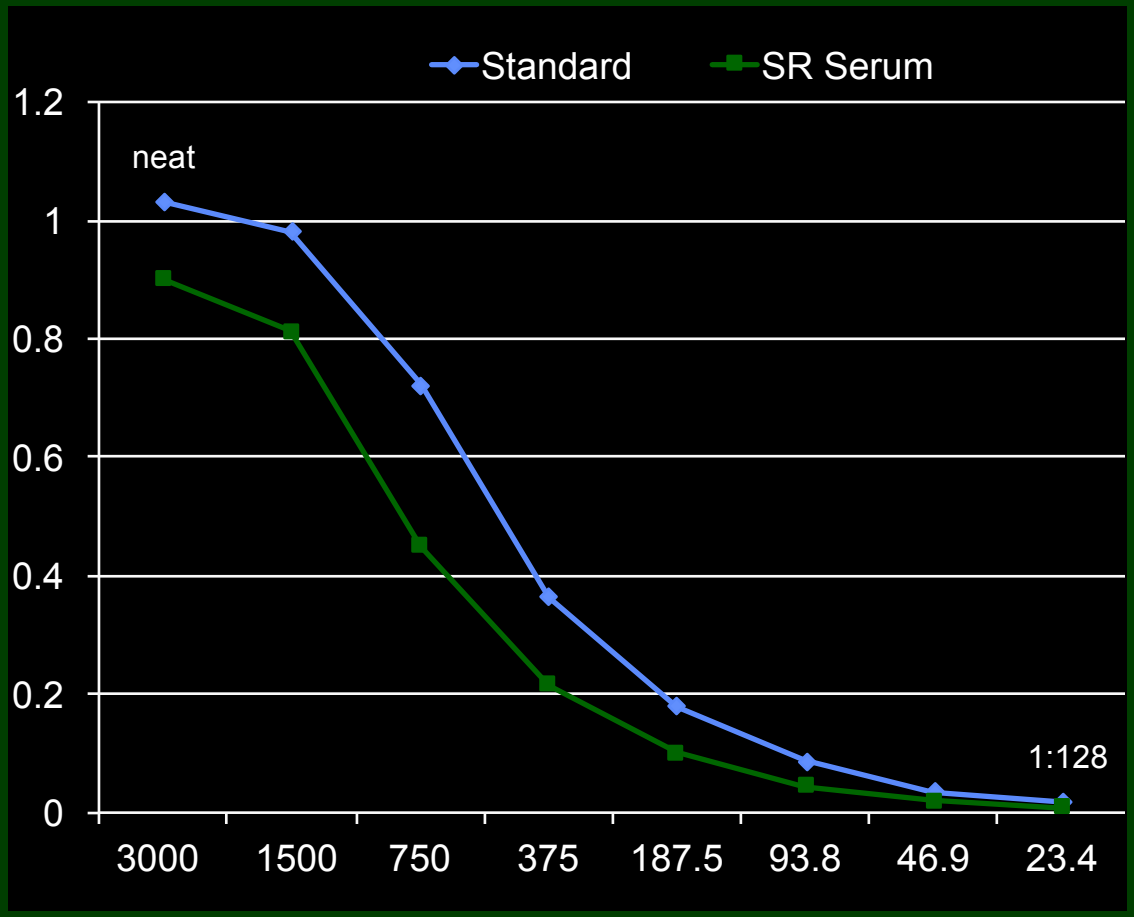


Checkerboard Trials

II. Validate Assay for Rhino Serum

Serum Parallelism Test

r = .986



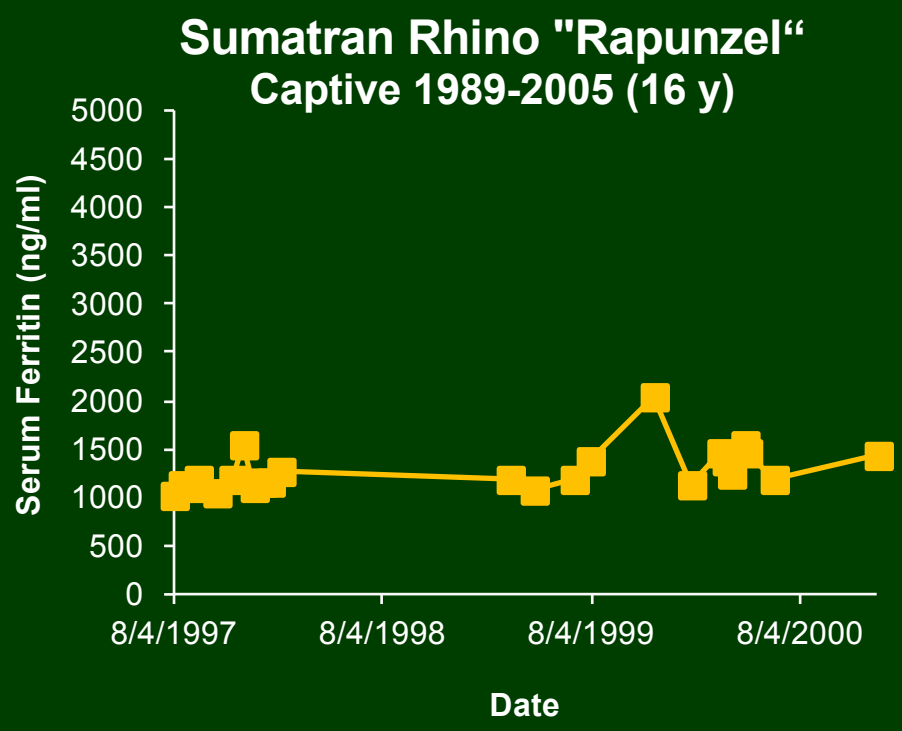
III. Rhinos/samples analyzed for study

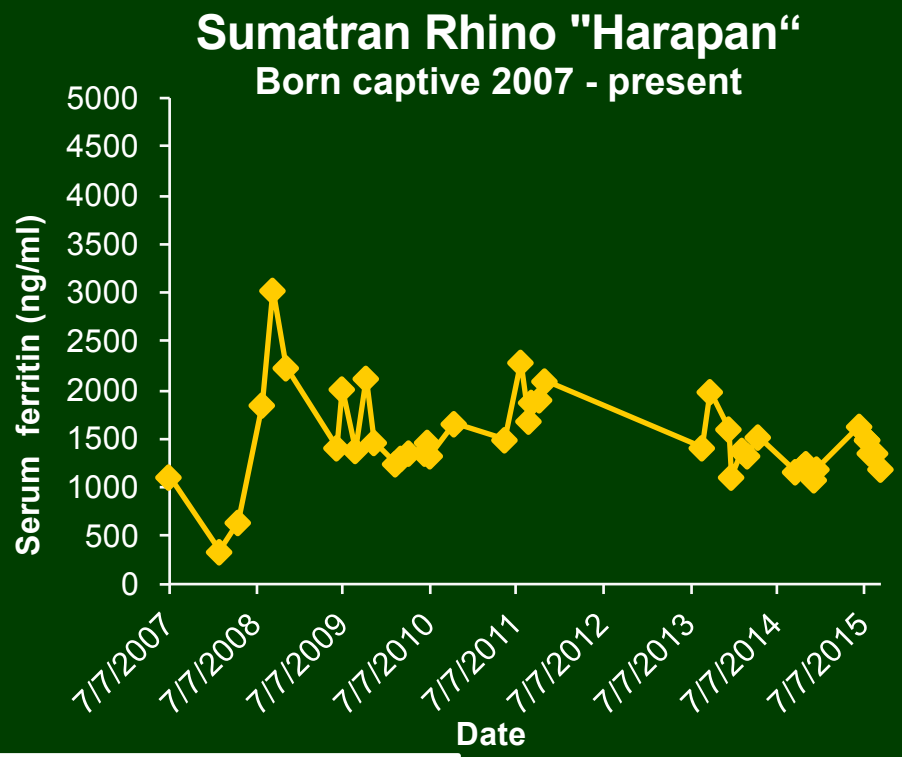
Rhino location	# Rhinos	Samples/ rhino	Sampling interval	Rhino age range	
U.S. Zoos	6	6-128	3-15 y	3 m - 32 y	
S.E. Asia	7	1-2	1-3 d	adults	





Resulting Sumatran Rhino Ferritin Profiles

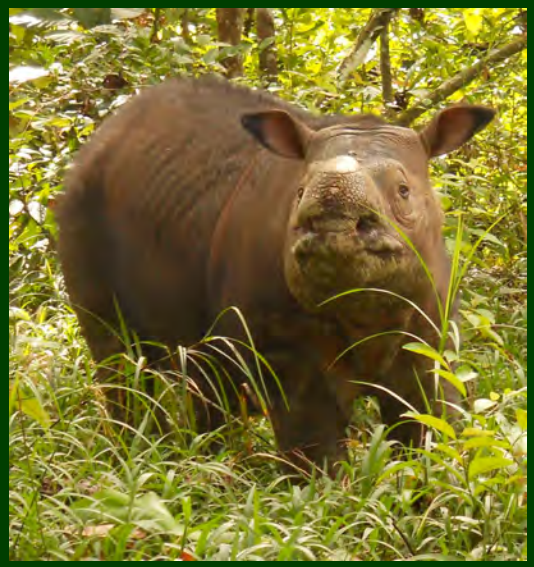




Special thanks to White Oak Conservation Center for providing serum samples from Harapan.

Wild Caught Controls

Two females wild-caught in Sabah, Malaysia



Puntong

~2.5 years in Borneo Rhino Sanctuary
Serum ferritin = 1,062 ng/ml

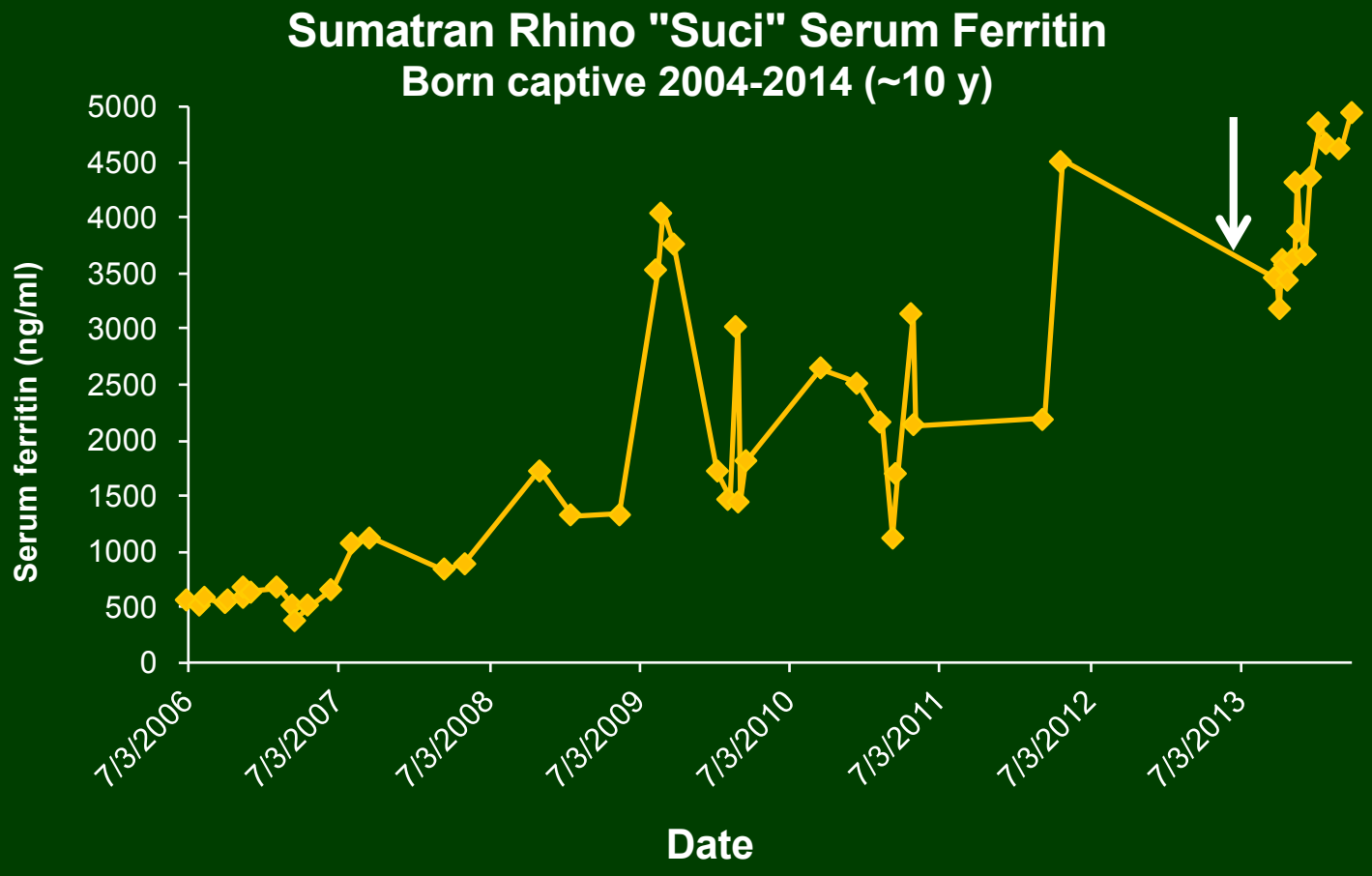


Iman

(50 and 53 days post-capture)
Serum ferritin = 1,117 and 975 ng/ml

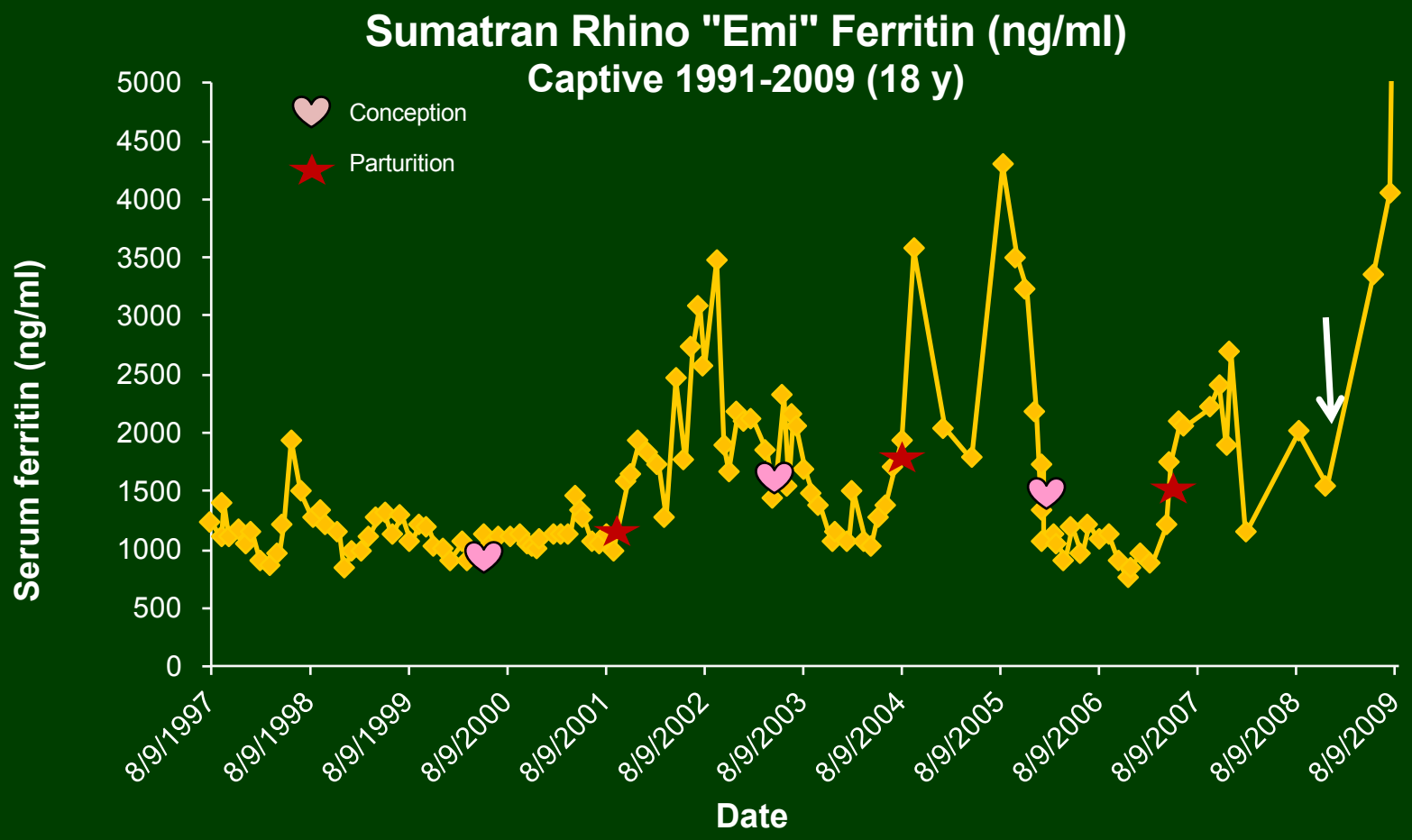
We thank Sabah Wildlife Department for allowing analysis of blood serum samples from Puntong and Iman, and Dr Zainal Zahari Zainuddin for collection of the samples.

Resulting Rhino Profiles



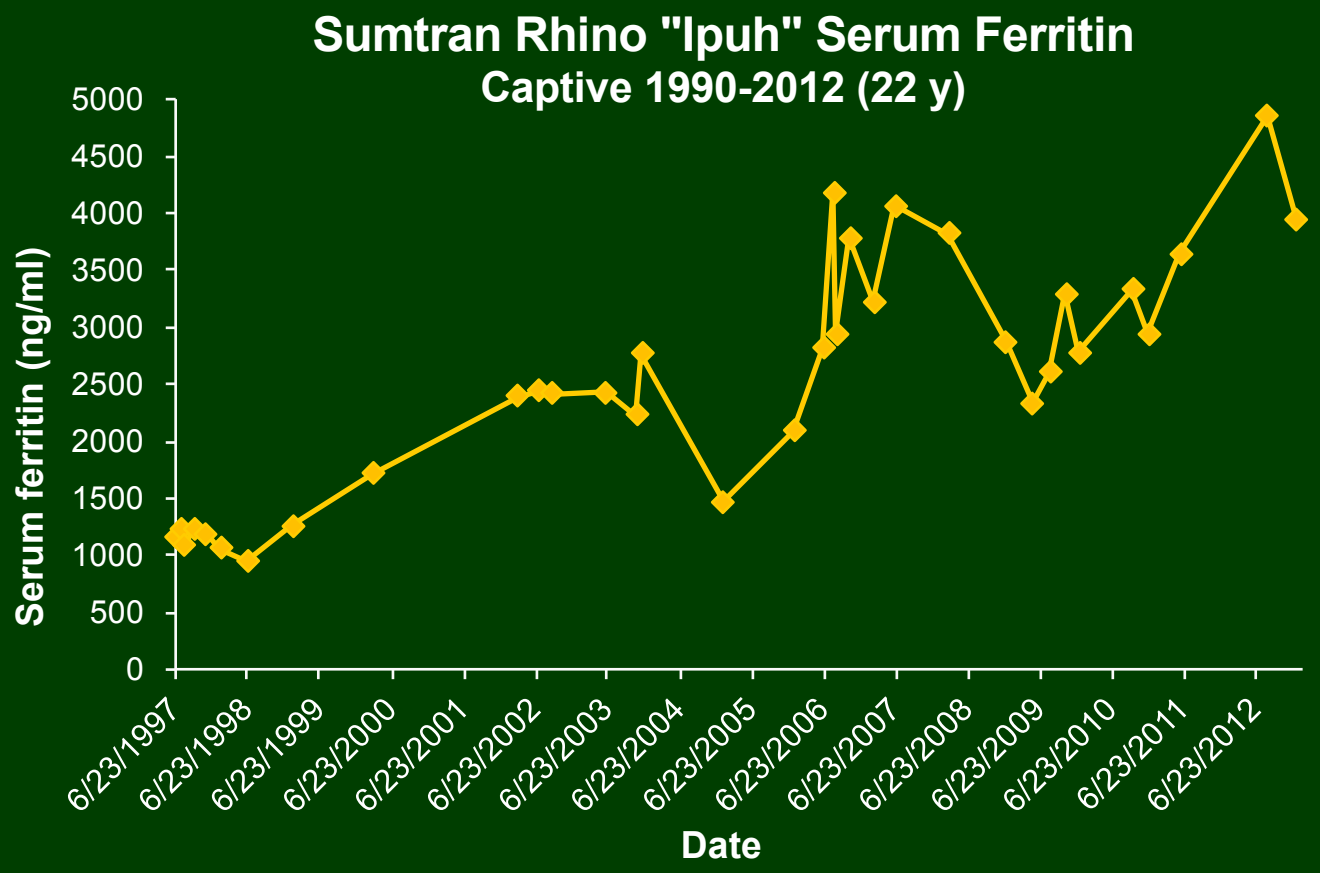
Arrow denotes when clinical symptoms of disease were first noted

Resulting Rhino Profiles



Arrow denotes when clinical symptoms of disease were first noted

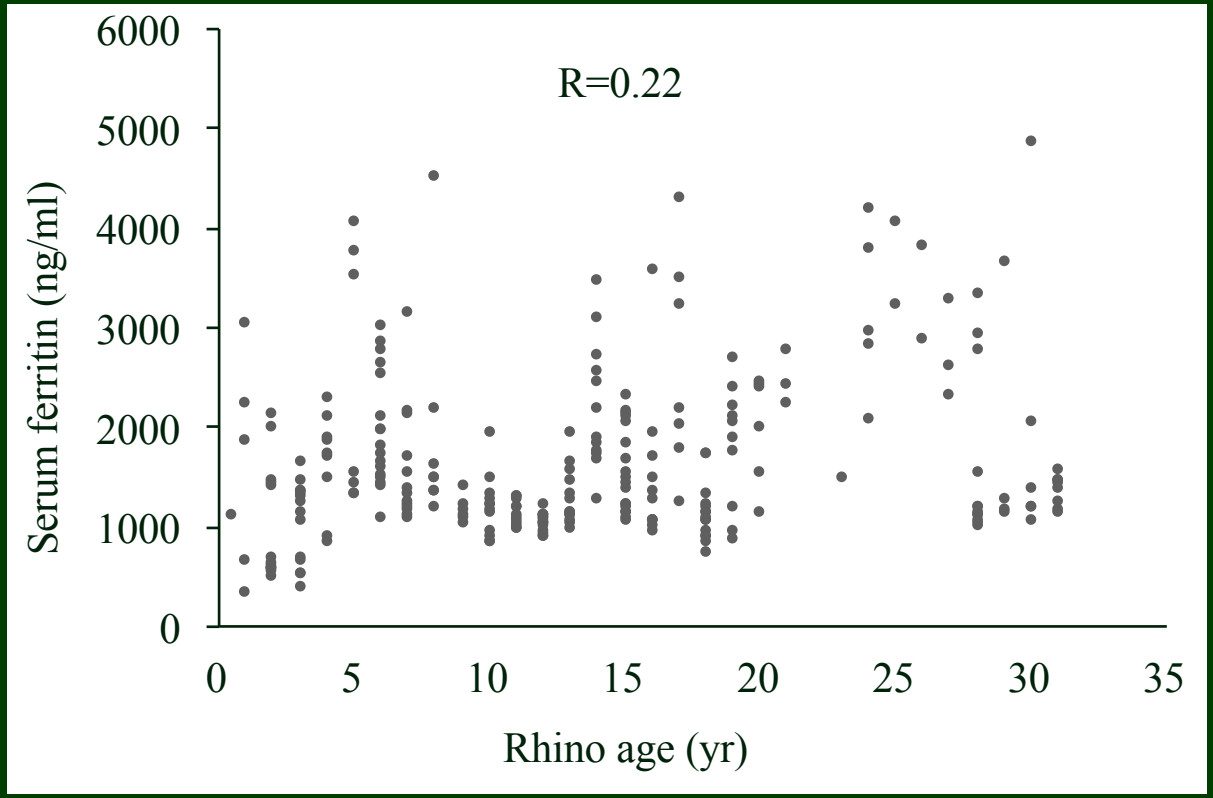
Resulting Rhino Profiles



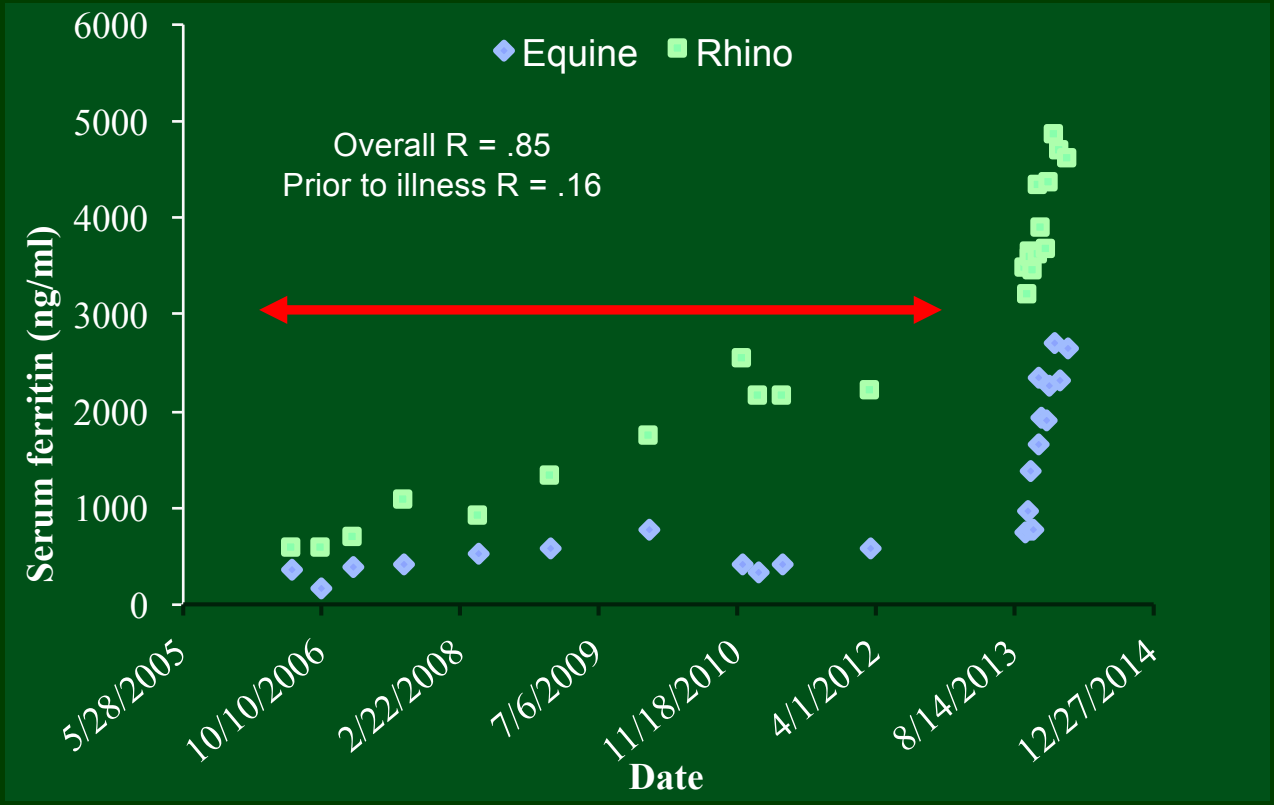
Sumatran rhino serum ferritin and post-mortem liver iron concentrations

Rhino ID (age at death)	Mean Serum Ferritin (ng/ml)	Serum Ferritin (#days) prior to death	Liver iron (ug/gm)	Cause of Death
SB#28 (~32 y)	2,604	5,982 (3)	9,915	Thyroid cancer
SB#29 (21 y)	1,614	7,071 (12)	25,693	Hemochromatosis
SB#43 (9 y)	2,254	4,958 (2)	19,646	Hemochromatosis

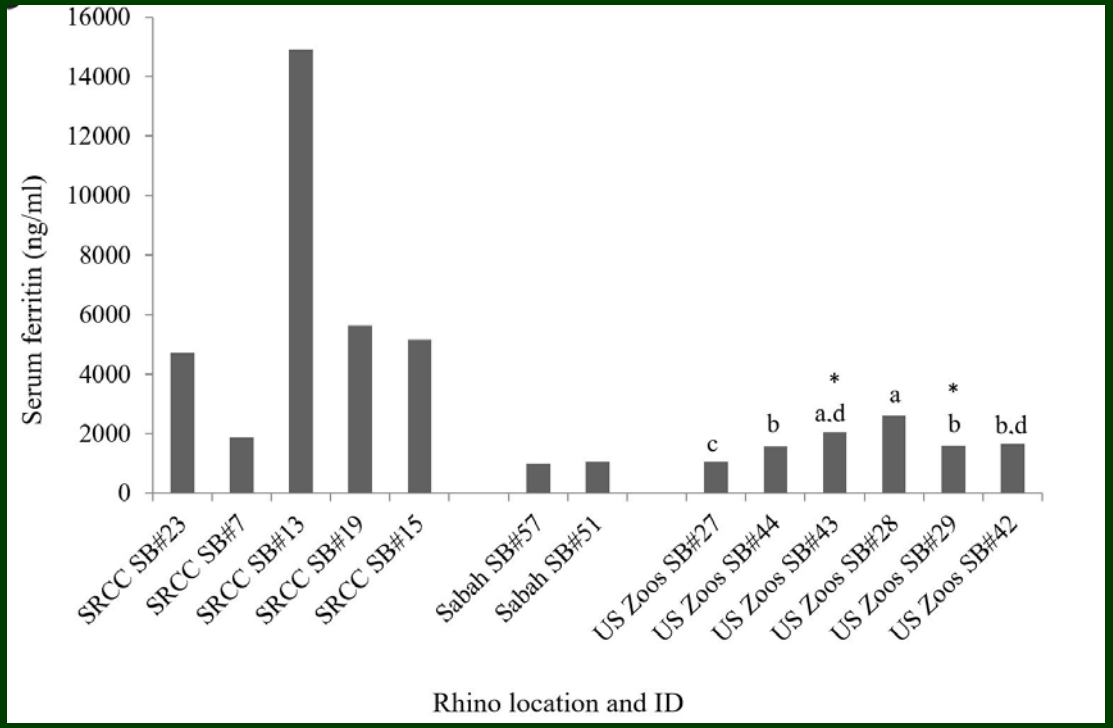
Sumatran rhino serum ferritin concentrations over time in captivity and with increasing age



Equine Assay versus Rhino Assay



Serum Ferritin Concentrations of 13 Sumatran Rhinos in U.S. Zoos and S.E. Asia Sanctuaries



We thank Sabah Wildlife Department for allowing analysis of blood serum samples from SB# 51 and 57, and Dr Zainal Zahari Zainuddin for collection of the samples. Thanks also to the Department of Wildlife and National Parks, Peninsular, Malaysia for permitting our use of samples collected from rhinos previously housed at the Sumatran Rhino Conservation Center (SRCC) and Dr. Aidi Mohamad for collecting those blood samples.

Overall Findings



Sumatran rhino serum ferritin concentrations

1) are dynamic;
2) may decrease during pregnancy;
3) are elevated in rhinos suffering from hemochromatosis; but
4) are also elevated in many rhinos not suffering from hemochromatosis
5) do not increase with time in captivity or rhino age; and
6) may not correlate well with liver iron stores.
7) Rhino ferritin specific EIA and horse ferritin EIA data are not consistently correlated.

Take Home Messages



1) Use caution when interpreting serum ferritin concentrations in relation to iron overload disorder.

2) A better biomarker of IOD is needed to evaluate the effectiveness of treatments on lowering rhino body iron stores and to more accurately monitor IOD progression.

3) There is value in assessing serum ferritin since consistently low values would indicate IOD is not progressing.



Acknowledgment

This research has been generously supported by a gift from Mr. and Mrs. Jeremy S. Hilton and Family with additional support provided by Dr. Thomas and Rita Bell.

Common Foot Disorders Among Captive Asian Elephants in Kerala







Narayanan, M. K.*, Giridas, P.B. and Jayathangaraj, M.G.

*Department of Veterinary Surgery and Radiology
College of Veterinary and Animal Sciences
Kerala Veterinary and Animal Sciences University
INDIA

Background

- Foot disorders in elephants are common in captive conditions (Fowler 2001)
- Many factors contribute to foot disorders
  - Prolonged chaining
  - Poor hygiene
  - Wounds & injuries
  - Inadequate nutrition
- Very few studies in India on foot disorders (Sarma 2011, Giridas 2011)

Goal & Objectives

- Help alleviate foot disorders in captive elephants by adopting suitable husbandry practices
  - Undertake a survey of foot disorders among captive elephants in Thrissur district
  - Document the various types of foot disorders
  - Evaluate the major contributing factors
  - Suggest corrective measures

Study site & animals



- Surveyed 118 captive elephants
  - 115 males & 5 females











Methodology



- Anamnesis
- Foot examination
- Documentation
- Analysis

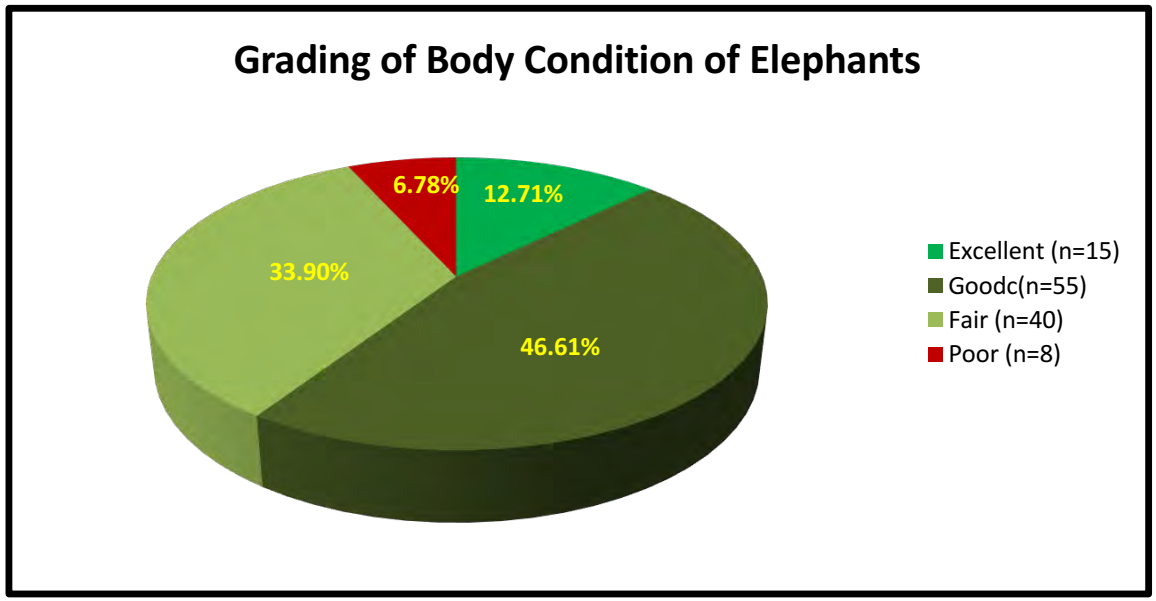
Healthy feet





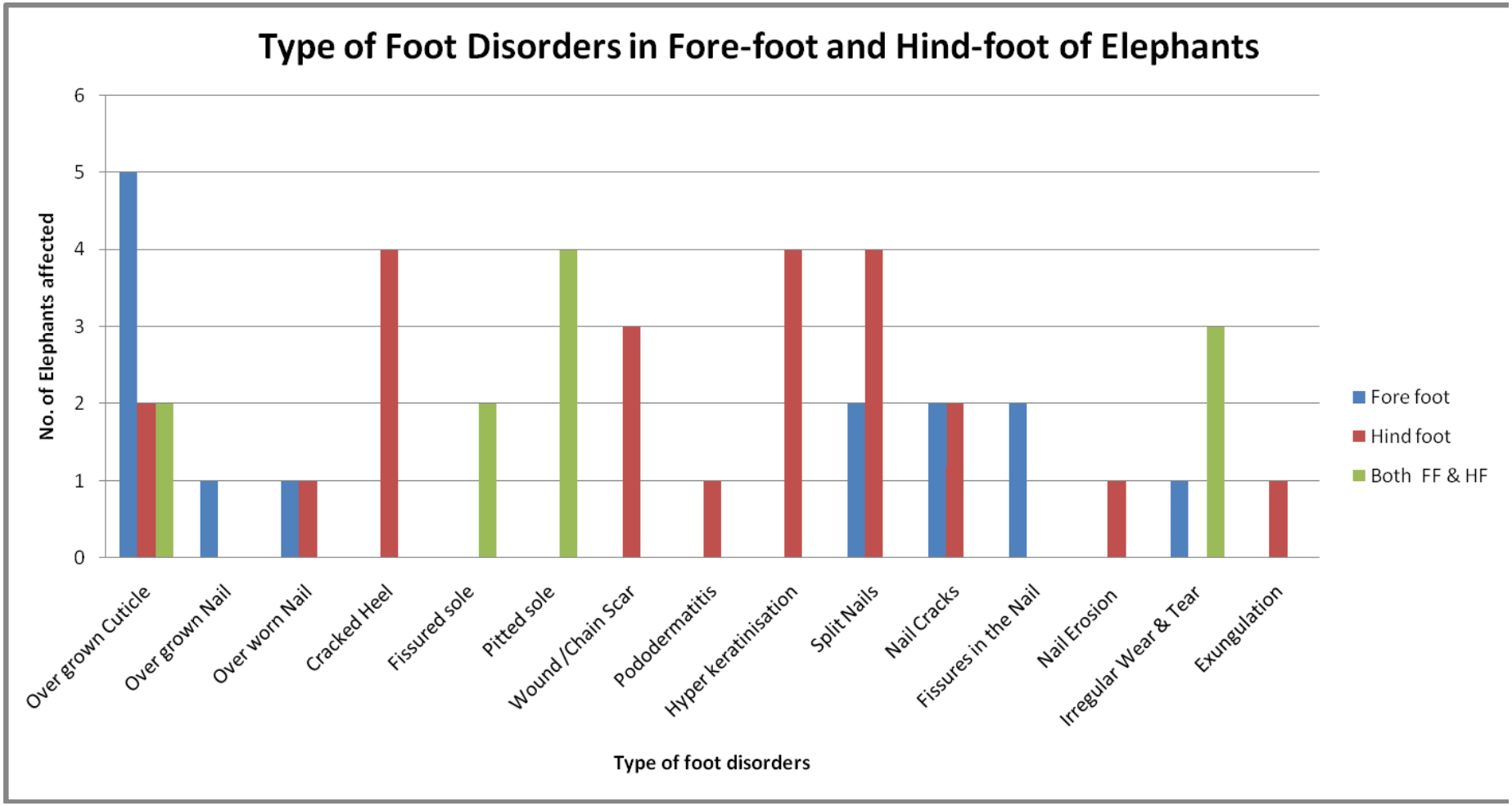
Results

Sex	Elephant #	Foot lesion #	%
Male	113	47	39.83
Female	5	1	0.85
Total	**118**	**48**	**40.68**

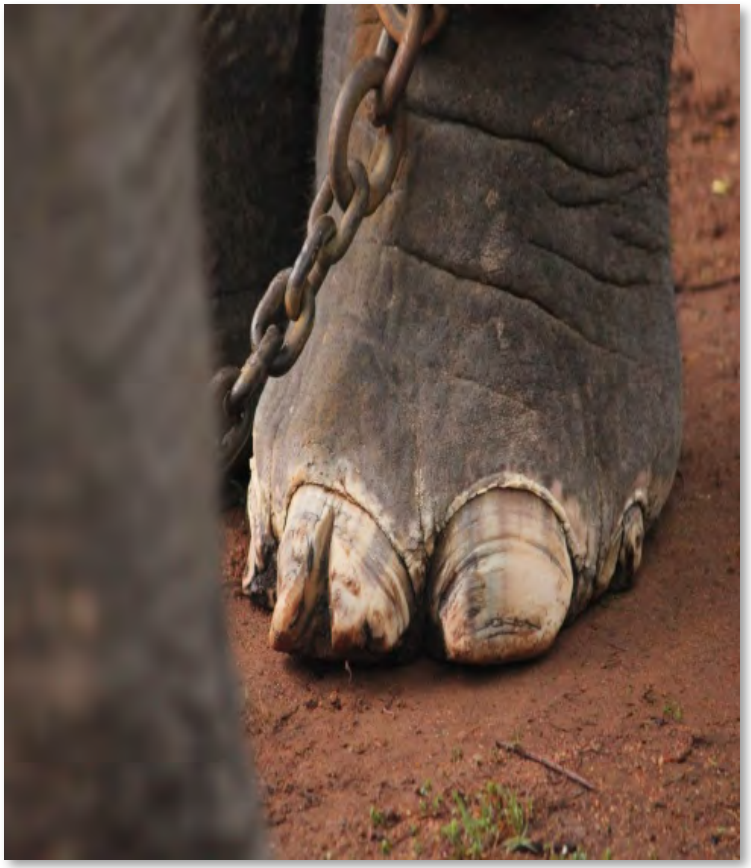


Results …

Figure 3































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Dr. M. G. Jayathangaraj
Chairman
Professor and Head Department of Wildlife Science
Madras Veterinary College, Chennai

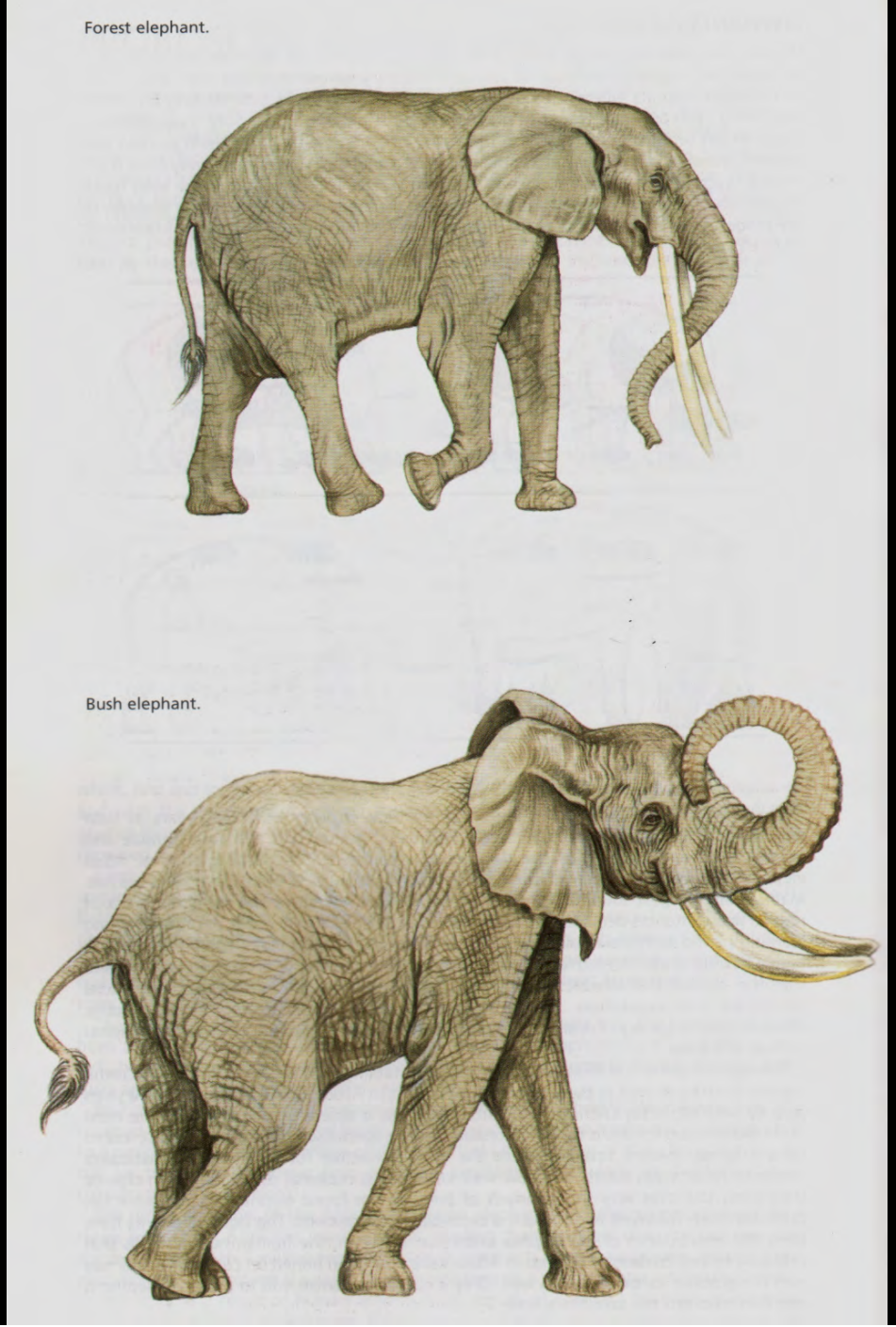
- **Dr. K. Manimaran** **Dr. D. Sumathi**

Members of Advisory Committee

Dean
Director of Distance Education Tamil Nadu Veterinary
Dr. K. Senthilkumar
Dr. A. Prathipa and
Dr. M. Palanivelrajan

THANK YOU



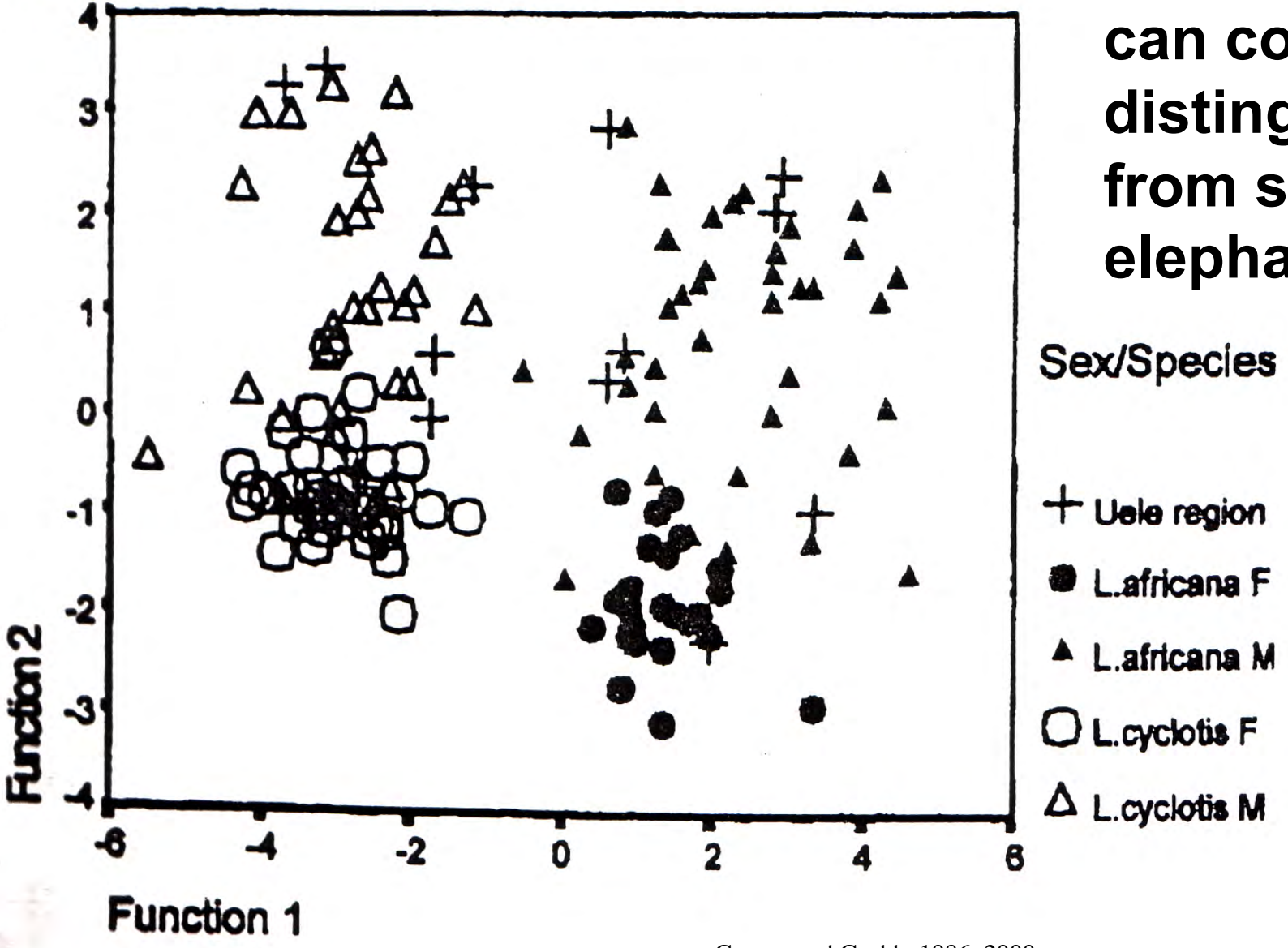


SPECIATION AND HYBRIDIZATION IN AFRICAN ELEPHANTS

Alfred L. Roca

University of Illinois at Urbana-Champaign

⑦ Canonical Discriminant Functions

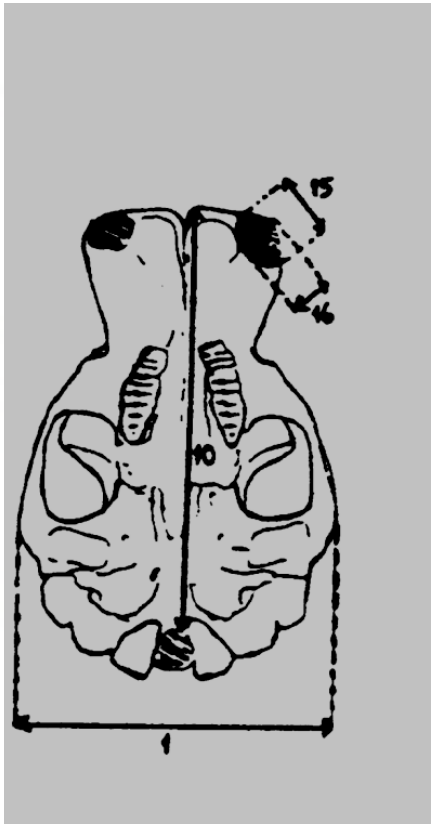


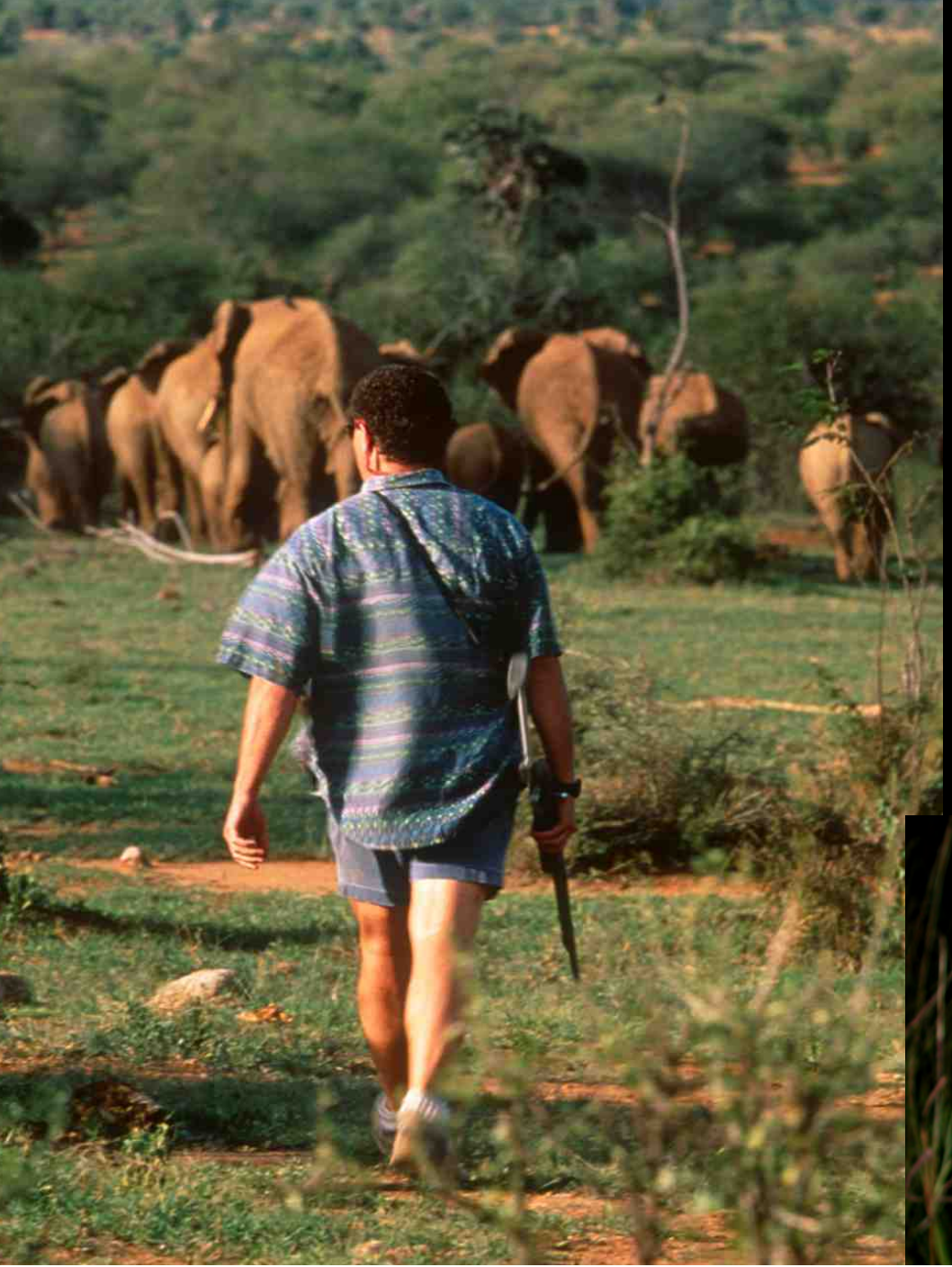
Sex/Species

- Uele region
- L.africana F
- L.africana M
- L.cyclotis F
- L.cyclotis M

Groves and Grubb, 1986, 2000

Morphological measurements can completely distinguish forest from savanna elephants



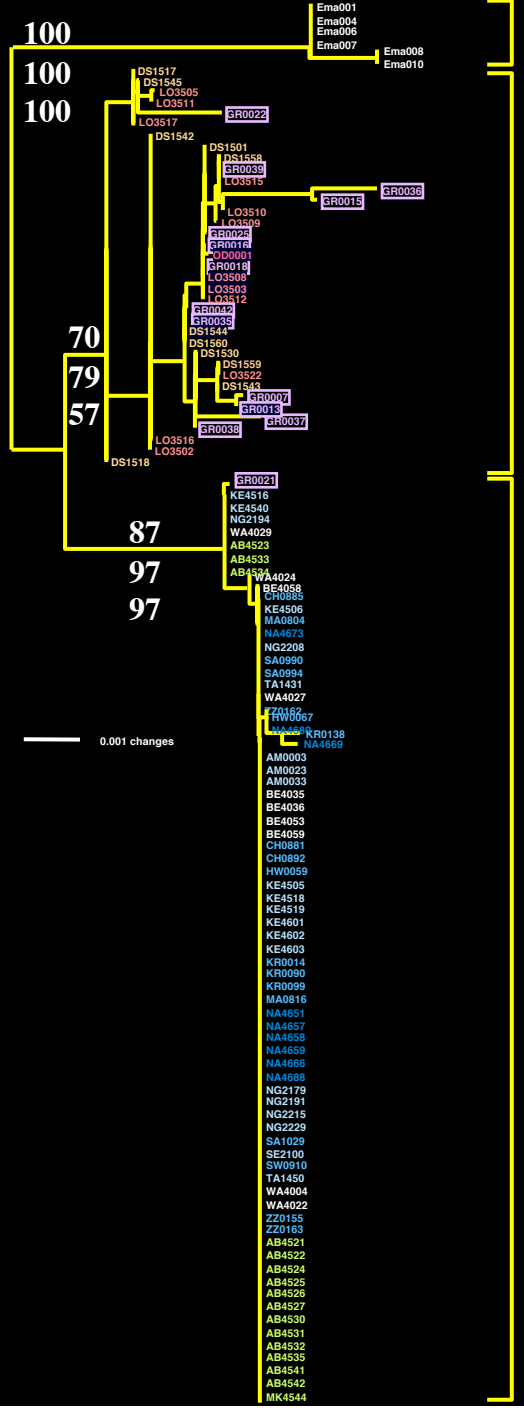


- Biopsy sampling



- Biopsy dart





NJ Tree
1732 bp
4 genes

Roca et al., 2001;
Science 93(5534):1473-7
Genetic evidence for two species of elephant in Africa.

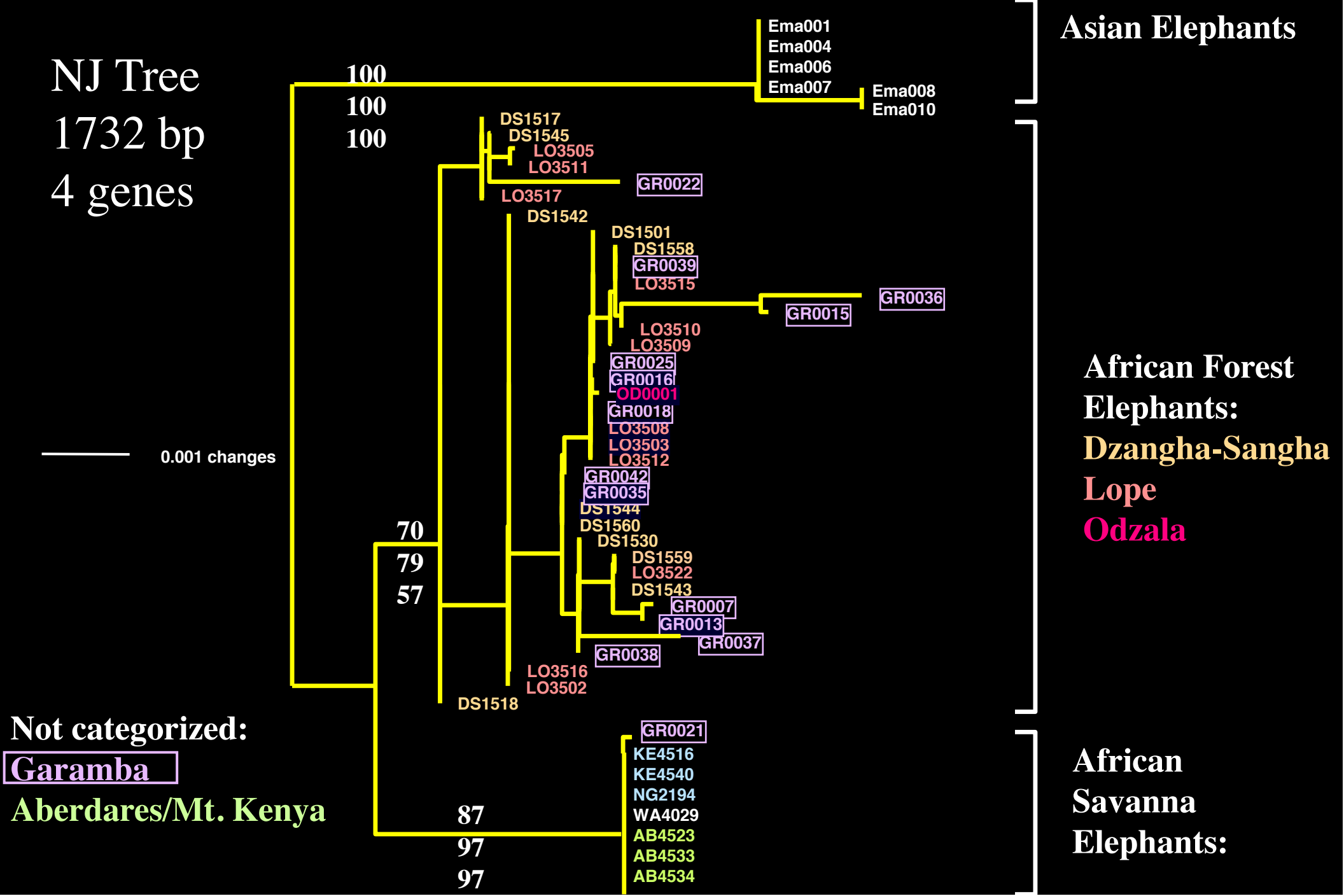
Asian Elephants

African Forest Elephants:
Dzangha-Sangha
Lope
Odzala

Not categorized:
Garamba
Aberdares/Mt. Kenya

African Savanna Elephants:

Cameroon
Eastern Africa
Southern Africa
Namibia


NJ Tree
1732 bp
4 genes
0.001 changes
Ema001
Ema004
Ema006
Ema007
Ema008
Ema010
100
100
100
DS1517
DS1545
LO3505
LO3511
GR0022
LO3517
DS1542
DS1501
DS1558
GR0039
LO3515
GR0036
GR0015
LO3510
LO3509
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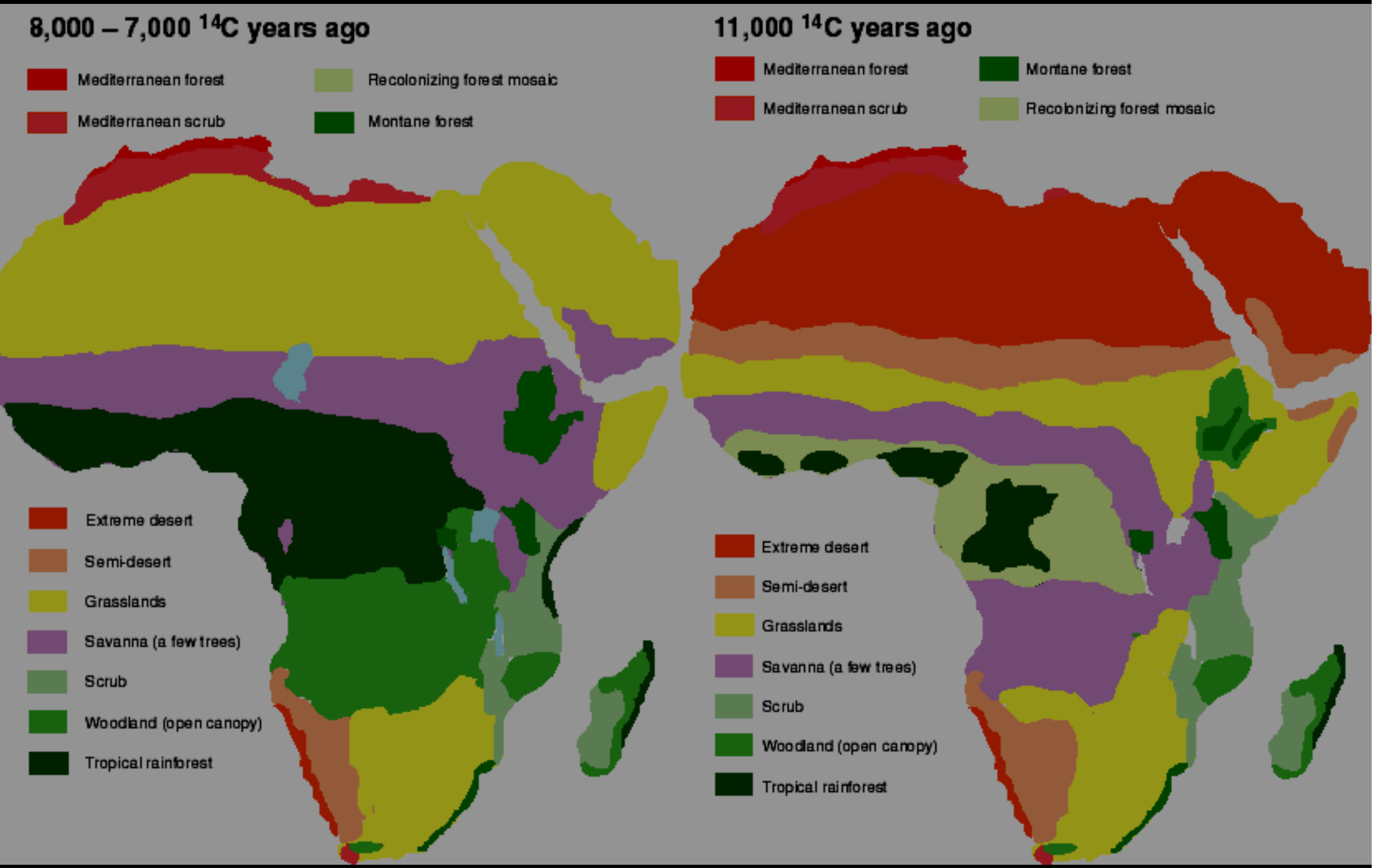
NG2194
WA4029
AB4523
AB4533
AB4534
87
97
97
Asian Elephants
African Forest Elephants:
Dzangha-Sangha
Lope
Odzala
African Savanna Elephants:
Not categorized:
Garamba
Aberdares/Mt. Kenya


8,000 – 7,000 14C years ago
Mediterranean forest
Mediterranean scrub
Recolonizing forest mosaic
Montane forest
Extreme desert
Semi-desert
Grasslands
Savanna (a few trees)
Scrub
Woodland (open canopy)
Tropical rainforest
11,000 14C years ago
Mediterranean forest
Mediterranean scrub
Montane forest
Recolonizing forest mosaic
Extreme desert
Semi-desert
Grasslands
Savanna (a few trees)
Scrub
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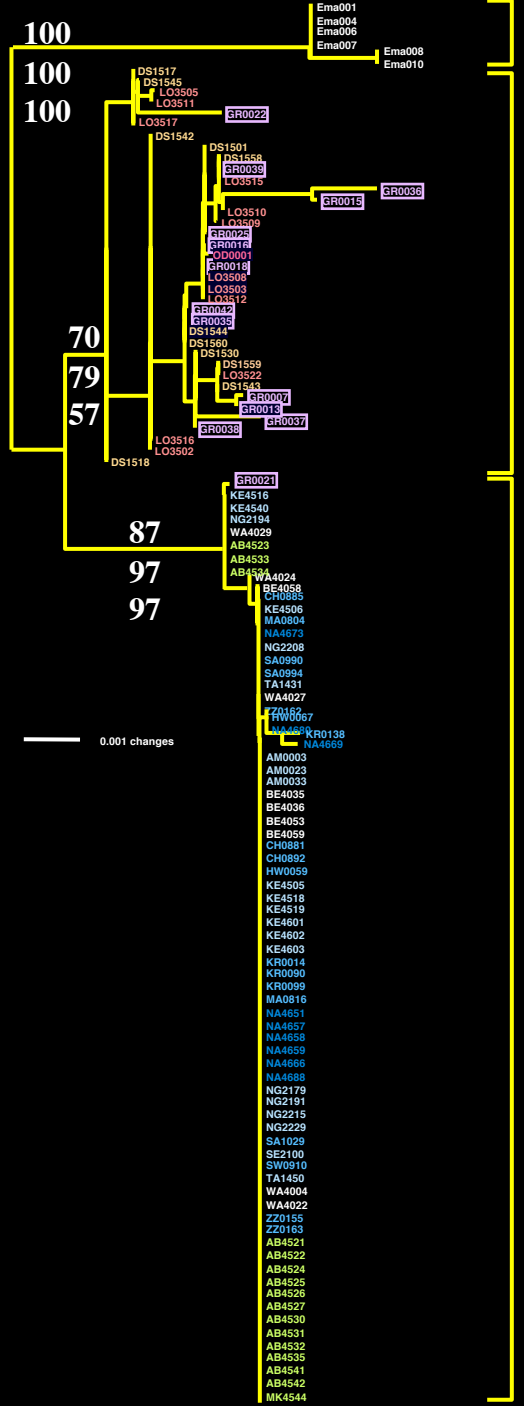
Tropical rainforest



NJ Tree
1732 bp
4 genes

Roca et al., 2001; Science 93(5534):1473-7 Genetic evidence for two species of elephant in Africa.

Asian Elephants

African Forest Elephants:
Dzangha-Sangha
Lope
Odzala

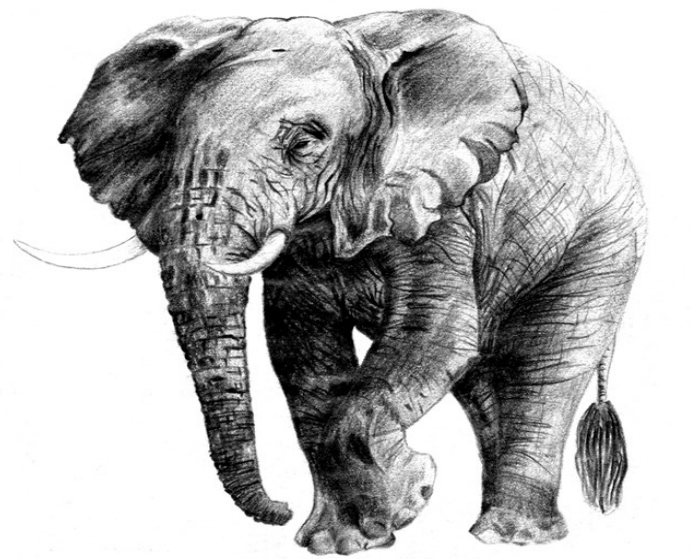
Not categorized:
Garamba
Aberdares/Mt. Kenya

African Savanna Elephants:

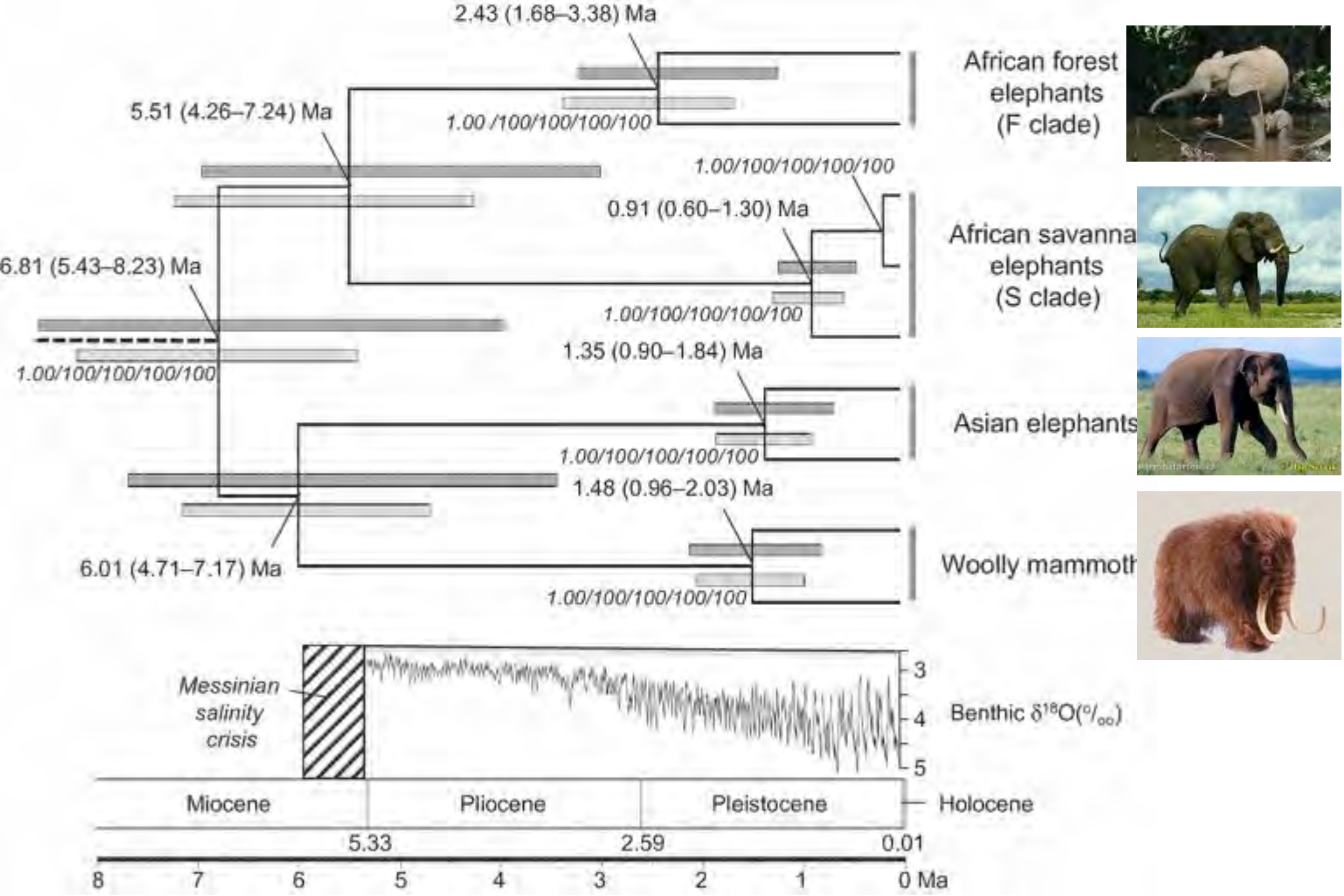
Cameroon
Eastern Africa
Southern Africa
Namibia

Founder effect???: expansion of range of *Loxodonta africana* after *Elephas* (also called *Paleoloxodon*) becomes extinct in the African savannas








2.43 (1.68–3.38) Ma
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1.00 /100/100/100/100
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1.48 (0.96–2.03) Ma
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African forest elephants (F clade)
African savanna elephants (S clade)
Asian elephants
Woolly mammoth
Messinian salinity crisis
3
4
5
Benthic δ18O(‰)
Miocene
Pliocene
Pleistocene
Holocene
5.33
2.59
0.01
8
7
6
5
4
3
2
1
0 Ma

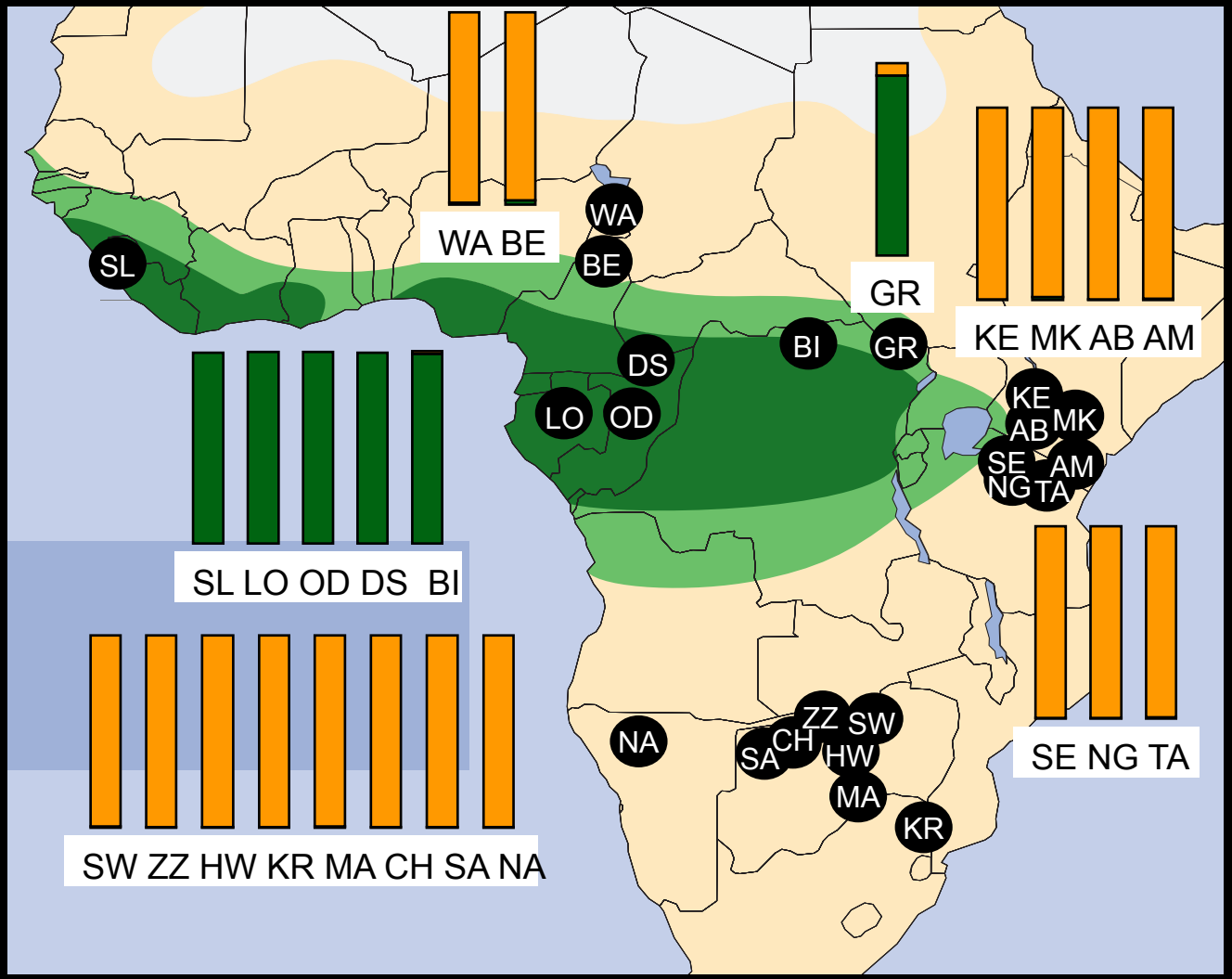
	Asian Elephant	African Elephants			
		Forest	Savanna	Afromontane	Garamba
Asian	-	0.90196**	0.99668**	1.00000*	0.83363*
Forest	13.24997	-	0.93790**	0.88875**	0.07382 NS
Savanna	16.82843	8.09227	-	0.05331 NS	0.91648**
Afromontane	16.79190	7.99836	0.00384	-	0.82970**
Garamba	14.19098	0.16727	8.21162	8.13352	-

Fst mimimum of 0 means no genetic divergence. Fst (above), Average pairwise difference (below)
Fst maximum of 1 means fixation of alternative alleles in different groups.

0.00-0.05	little genetic differentiation
0.05-0.15	moderate genetic differentiation
0.15-0.25	great genetic differentiation
> 0.25	very great genetic differentiation

AMONG AFRICAN ELEPHANTS, 94% OF GENETIC VARIATION IS DUE TO THE DIFFERENCES BETWEEN FOREST AND SAVANNA ELEPHANTS

Structure software: two African elephant species, n=546, K=2 (supported)



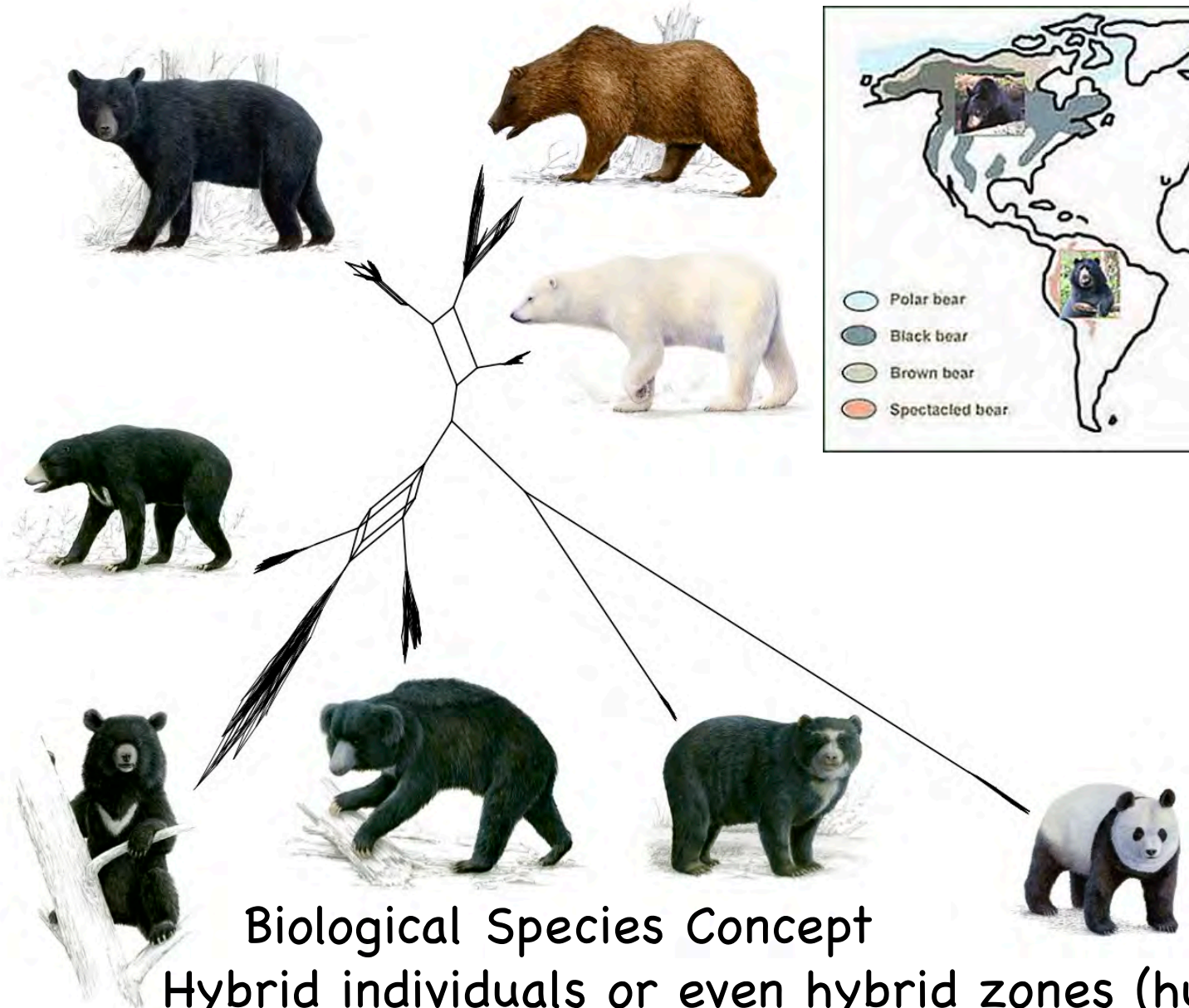
Using a different set of genetic markers, a clustering software identified strong support for two groups. The two groups corresponded to: forest elephants and savanna elephants

Biological Species Concept (BSC), considered the "golden standard" of species concepts

"Species are groups of interbreeding natural populations that are reproductively isolated from other such groups." –Ernst Mayr

What about hybrids?

Hybrid individuals or even hybrid zones (hundreds of described examples) do not violate the BSC if they do not disintegrate the genetic integrity of the species.

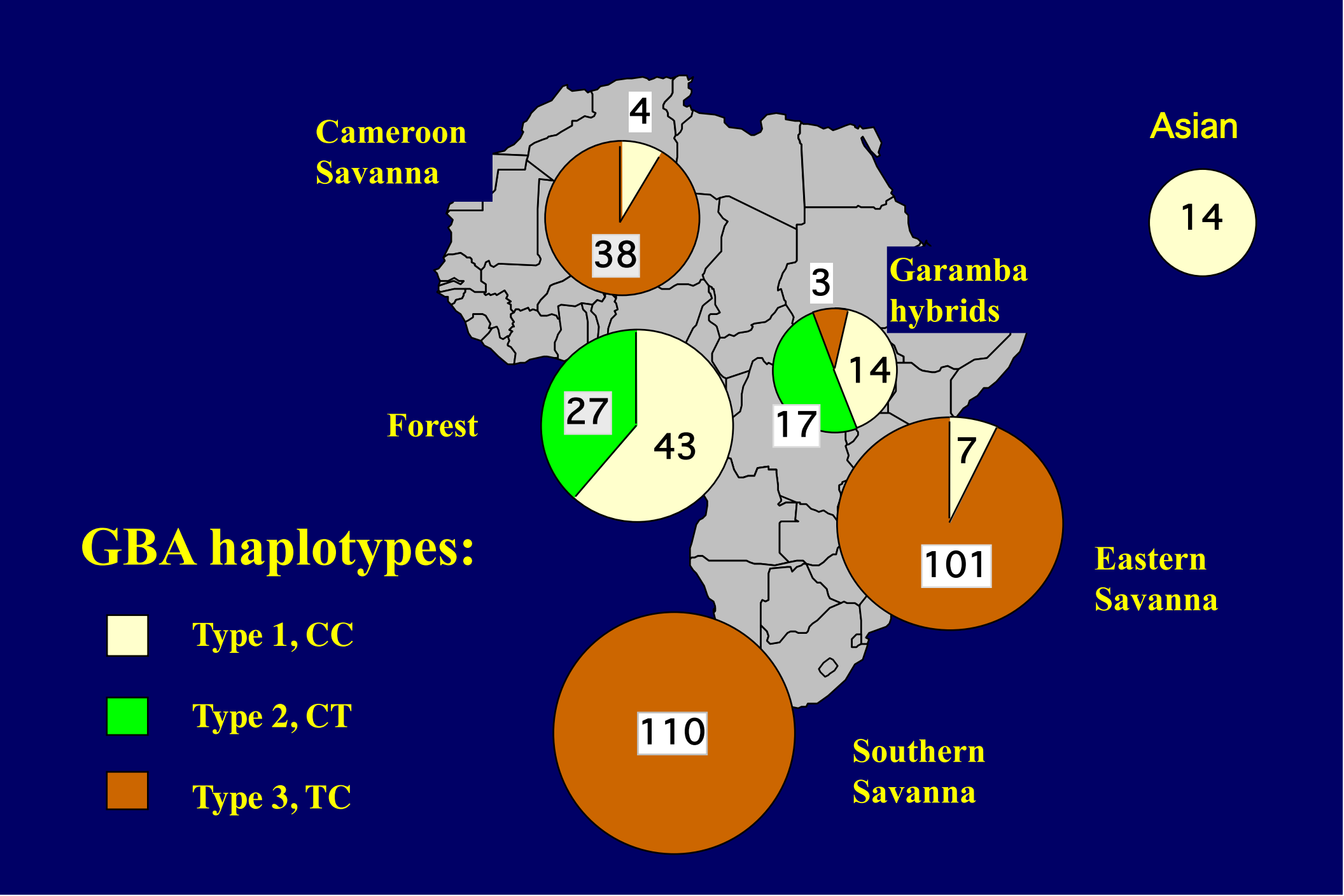






Biological Species Concept

Hybrid individuals or even hybrid zones (hundreds of described examples) do not violate the Biological Species Concept if they do not disintegrate the genetic integrity of the species.


Cameroon Savanna
4
38
Asian
14
Garamba hybrids
3
14
17
Forest
27
43
7
101
Eastern Savanna
110
Southern Savanna
GBA haplotypes:
Type 1, CC
Type 2, CT
Type 3, TC

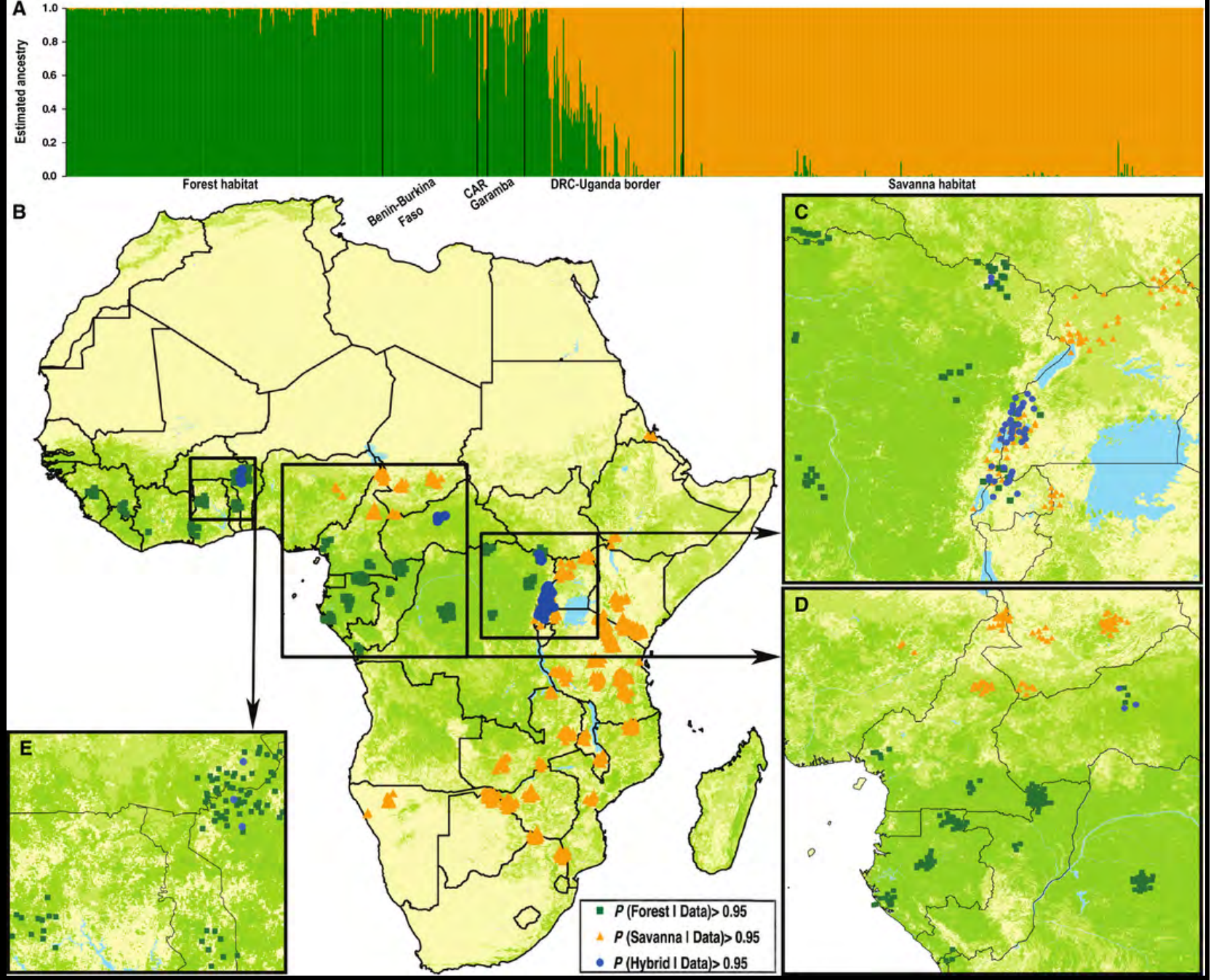

Loxodonta africana


Loxodonta cyclotis

We know where many of the hybrids are located

We know where savanna and forest elephants live

Some hybrid populations appear to be due to human activity.



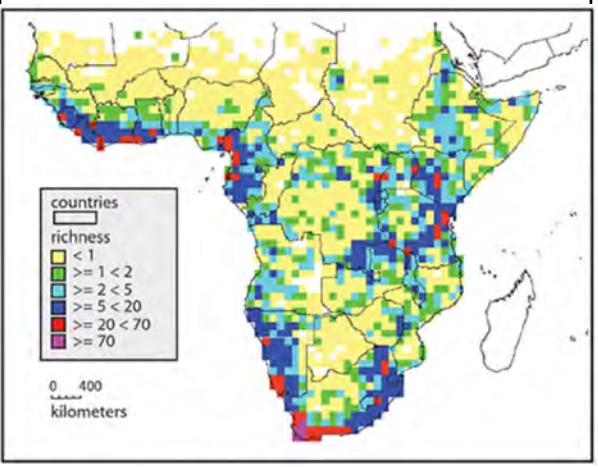
Mondol et al. 2016



CONSERVATION PRIORITIES

For each species

For forest elephants compare to plant endemism x plant dependence on elephants for dispersal, germination.



1

1

2

2

S clade mtDNA:

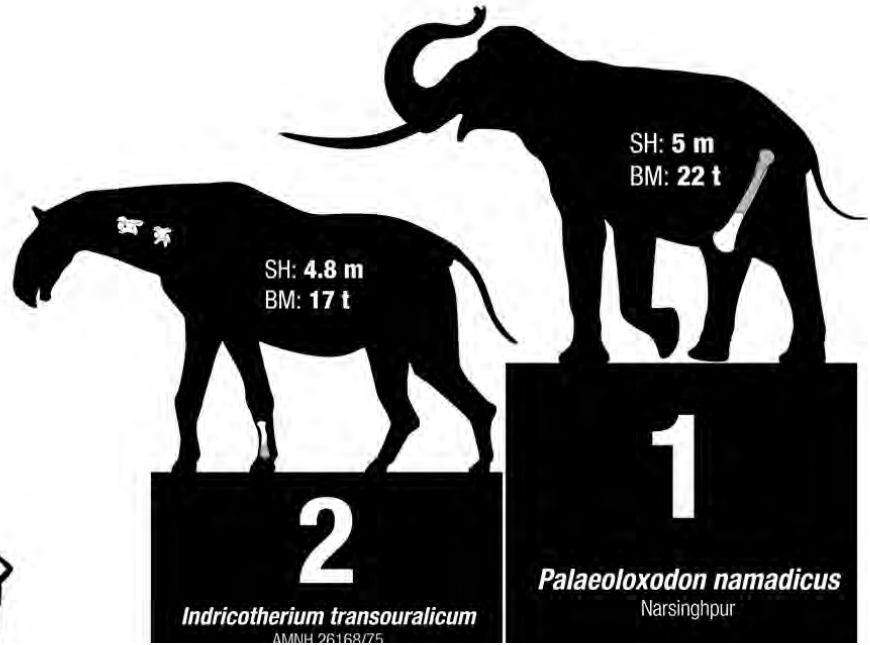
Samples with S clade mtDNA detected

S clade mtDNA not detected in sample (either sample size is too small or S clade is not present)



Paleoloxodon antiquus

The Largest Land Mammal in History



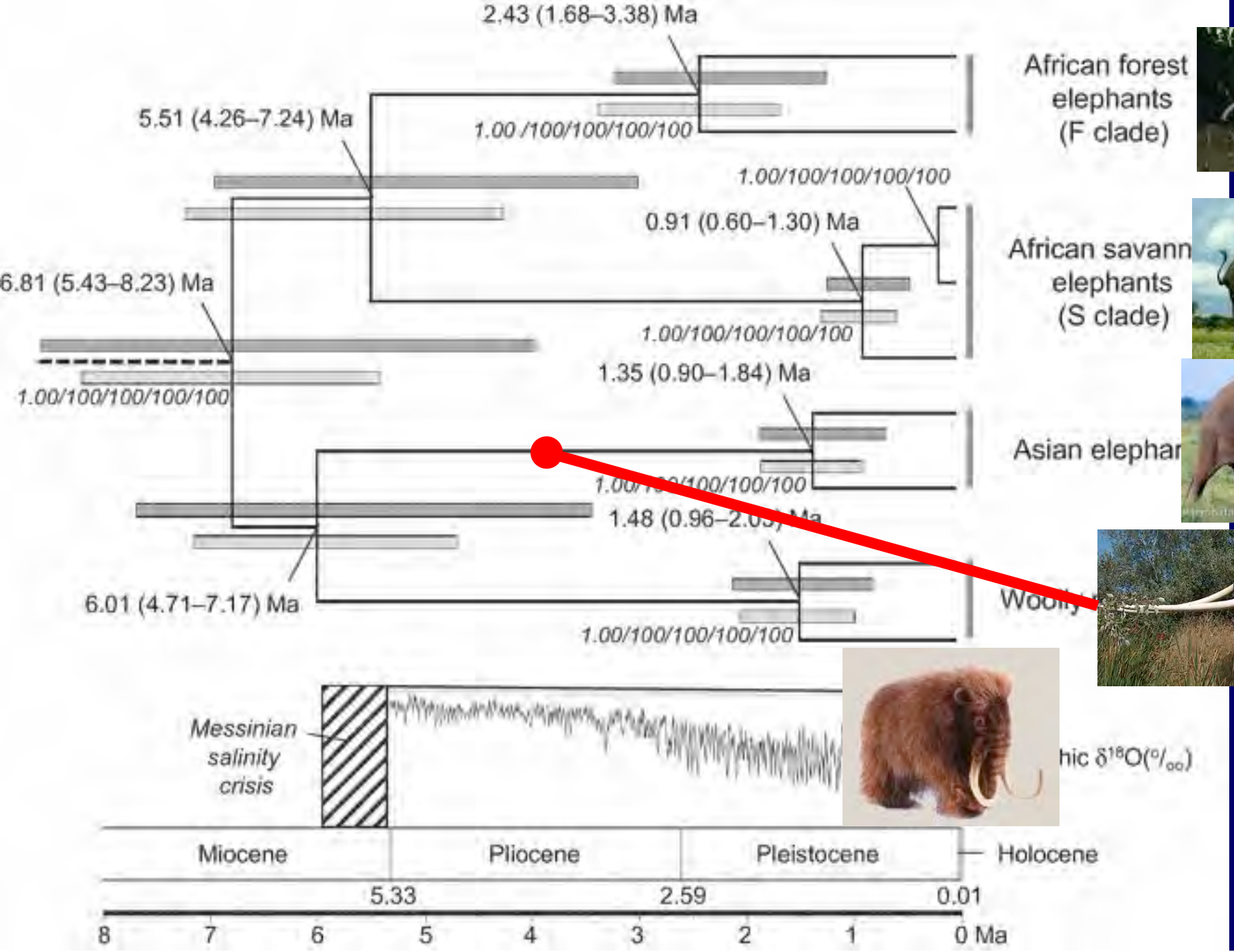
NATURE | NEWS

Elephant history rewritten by ancient genome

DNA from extinct species forces rethink of elephants' family tree.

Ewen Callaway

16 September 2016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Woolly
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hic δ18O(‰)
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Pliocene
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Holocene
5.33
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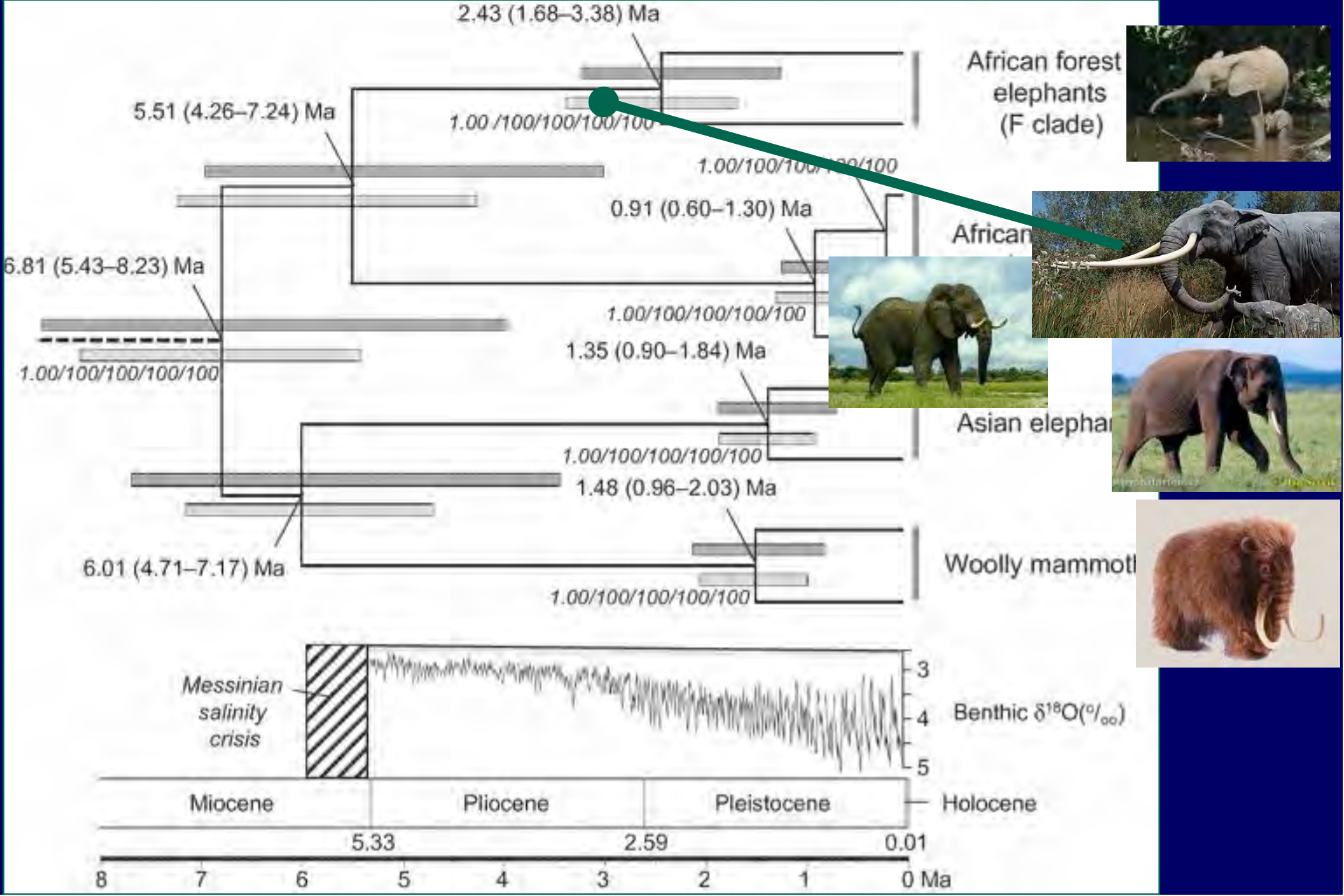
7
6
5
4
3
2
1
0 Ma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Miocene
Pliocene
Pleistocene
Holocene
5.33
2.59
0.01
8
7
6
5
4
3
2
1
0 Ma


Map
Satellite
Algeria
Libya
Egypt
Western Sahara
Mauritania
Mali
Niger
Chad
Saudi A
Mecca
مكة
Red Sea
Dakar
Senegal
The Gambia
Guinea-Bissau
Guinea
Sierra Leo
Liberia
Burkina
Benin
Togo
Nigeria
Lagos
Gulf of Guinea
Central African Republic
South Sudan
Ethiopia
Soma
Uganda
Kenya
Rwanda
Burundi
Nairobi
DR Congo
Kinshasa
Tanzania
Dar es Salaam
Luanda
Angola
Zambia
Malawi
Mozambique
Zimbabwe
Namibia
Botswana
Pretoria
Swaziland
Lesotho
Madag
South Atlantic Ocean
Country: Uganda
Locality: Kidepo Valley NP
GenBank ID: AF106208
Haplotype Designation: H73
Original Designation: KV28
Author: Nyakaana et al. 2002

NATIONAL CANCER INSTITUTE
S. J. O' Brien
J. Arthur
A. Brandt
J. Brown
J. Bruksch
S. Cevario
N. Crumpler
V. David
E. Eizirik
B. Gough
M. P. Gough
R. L. Hill
B. Kessing
M. J. Malasky
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J. Menninger
D. Munroe
W. J. Murphy
W. Nash
G. Nelson
G. K. Pei
M. Raymond
A. Robert
M. Roelke-Parker
J. Sakwa
T. Schroyer
J. P. Slattery
E. Teeling
A. Wilkerson
E. R. Wilson
N. Yuhki

MPALA RESEARCH CENTER
N. Georgiadis

UIUC: Y. Ishida, A. Brandt, K. Zhao

Questions on the two living genera of African elephant: *Loxodonta africana* and *Paleoloxodon cyclotis*

We thank the governments of Botswana, Cameroon, the Central African Republic, Congo (Brazzaville), Congo (Kinshasa), Gabon, Kenya, Namibia, South Africa, Tanzania, and Zimbabwe for permission to collect samples.

We thank the U. S. Fish and Wildlife Service, U. S. National Institutes of Health, National Geographic Society, European Union (through the Wildlife Conservation Society), and U. S. National Science Foundation for funding.

P. Aarhaug
K. Ammann
A. M. Austmyr
Bakari
A. Baker
R. Barnes
M. W. Beskreo
M. Bush
G. Doungoubé
J. M. Fay
M. Fernandez
S. Gartlan
M. Habibou
K. M. Helgen
K. Hillman Smith
Jibrila
W. Karesh
M. Lindeque
A. Mackanga-Missandzou
B. Mwasaga
T. Oleksyk
J. Pelleteret
M. Phillips
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R. Ruggiero
J. Shoshani
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M. Storey
M. Tchamba
A. Turkalo
C. Tutin
W. Versvelt
R. Weladji
L. White
B. York

Range-wide survey of genetic diversity in the black rhino: from DNA profiling to genomics



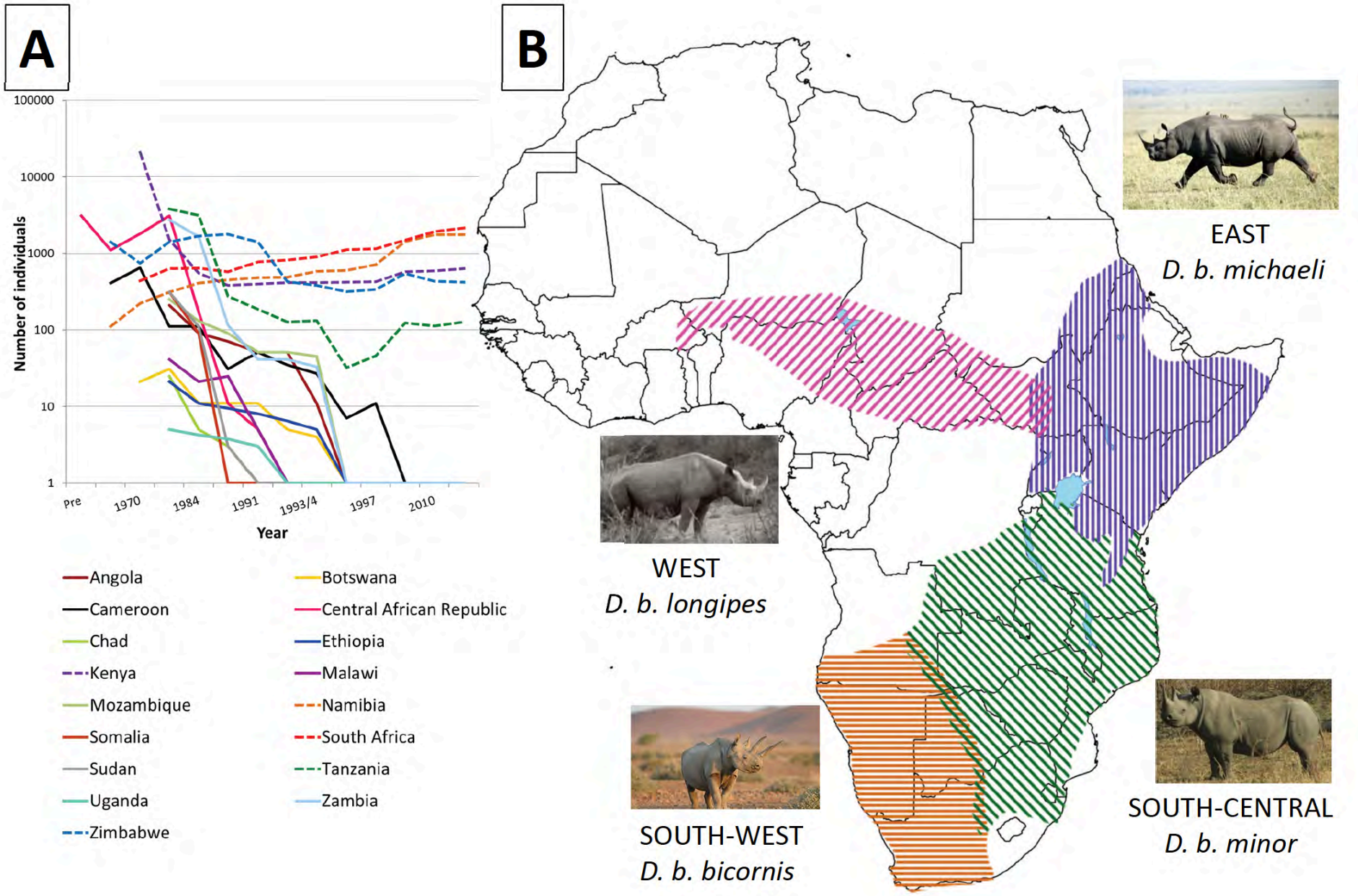
Mike Bruford, Yoshan Moodley, Isa-Rita Russo, Love Dalen

CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD
School of Biosciences
Ysgol y Biowyddorau

University of Venda
Creating Future Leaders

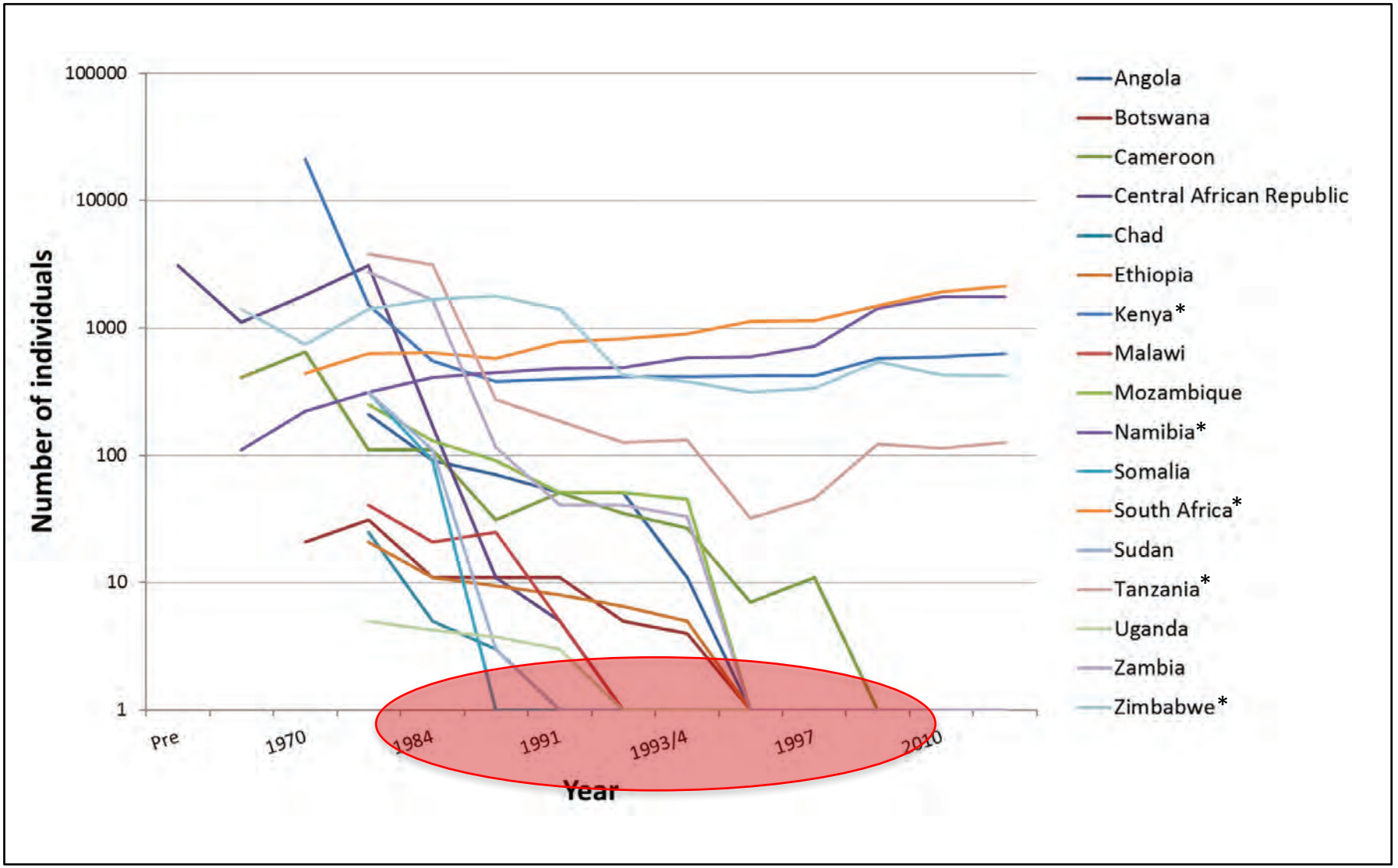
Structure

- Range-wide genetic survey including museum specimens
  - Mitochondrial DNA (maternal evolutionary history)
  - Microsatellites (DNA profiling of mostly modern samples)
- Progress on the southern black rhino genome
  - Current state of knowledge
  - Genome progress (hot off the press..)



Four subspecies/ecotypes recognized by IUCN (from Emslie & Brooks 1999)

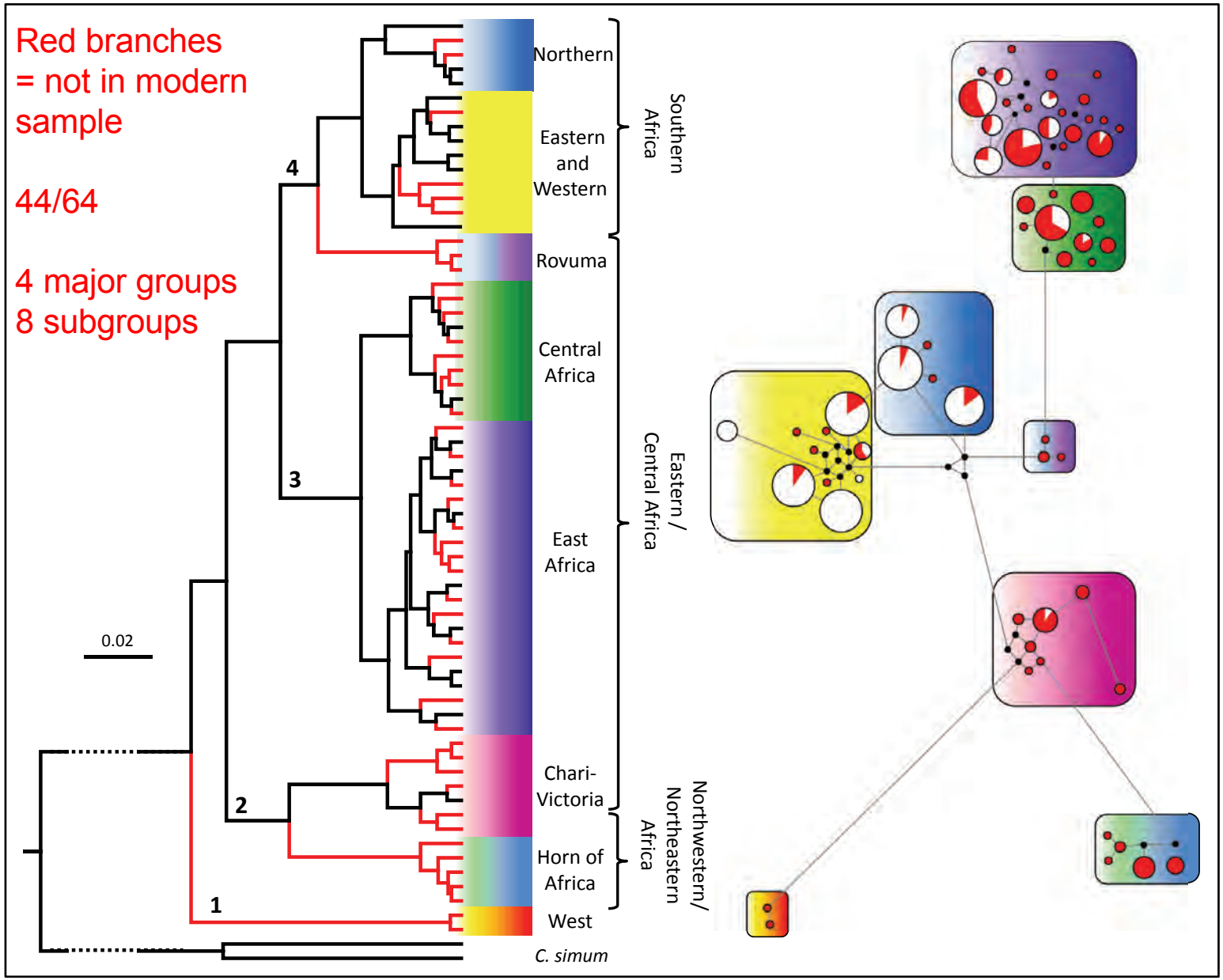
However…

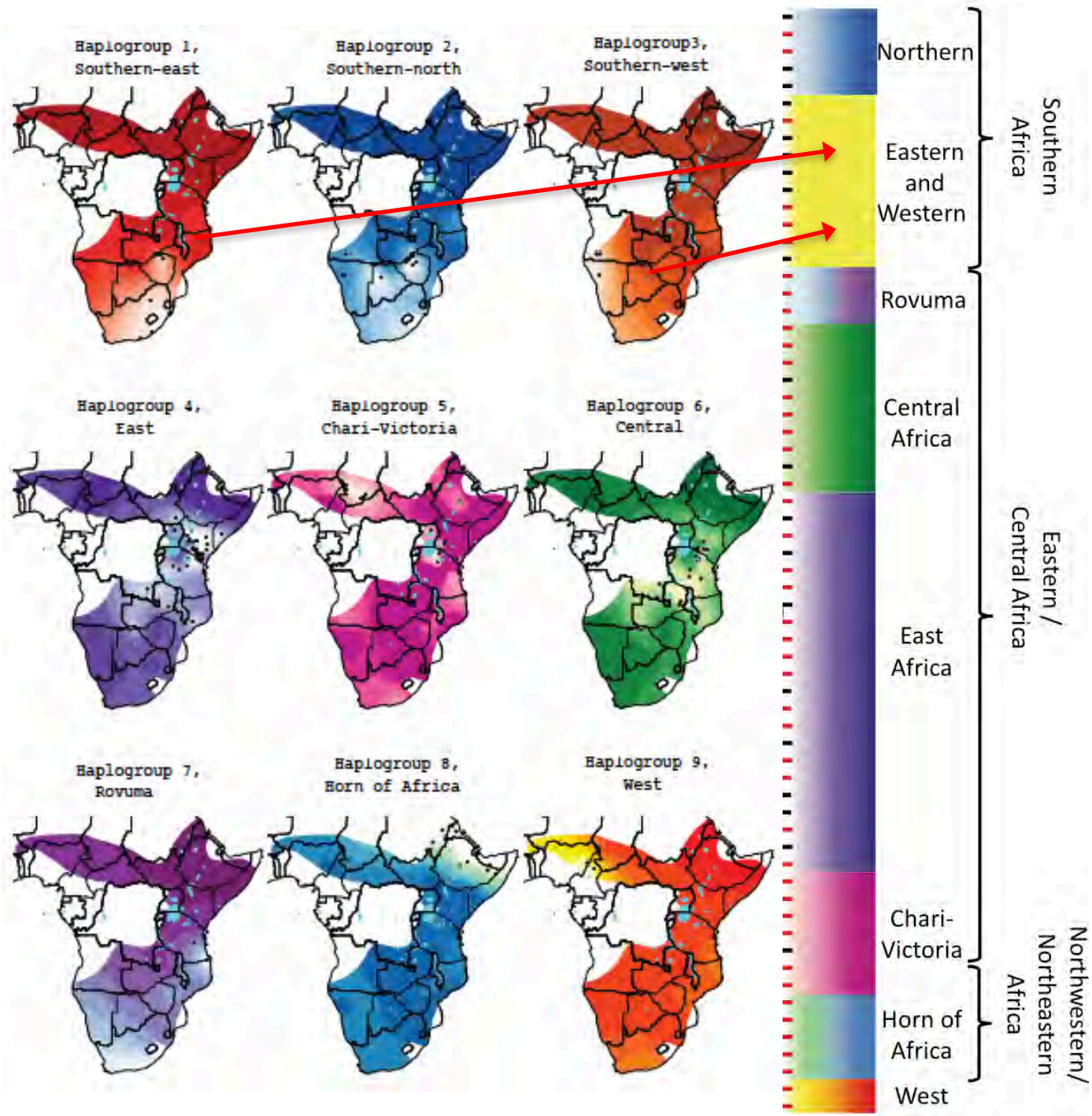

100000
10000
1000
100
10
1
Number of individuals
Pre
1970
1984
1991
1993/4
1997
2010
Year
Angola
Botswana
Cameroon
Central African Republic
Chad
Ethiopia
Kenya*
Malawi
Mozambique
Namibia*
Somalia
South Africa*
Sudan
Tanzania*
Uganda
Zambia
Zimbabwe*

What we did…

- Sequence mitochondrial DNA from both museum and extant samples (402)
- DNA Profiling using 11 microsatellite markers – museum and extant samples (560)
- Includes the entire species range in recorded history..
- MtDNA – maternal evolutionary lineages
- DNA profiling – identification of population clusters

Mitochondrial tree and network



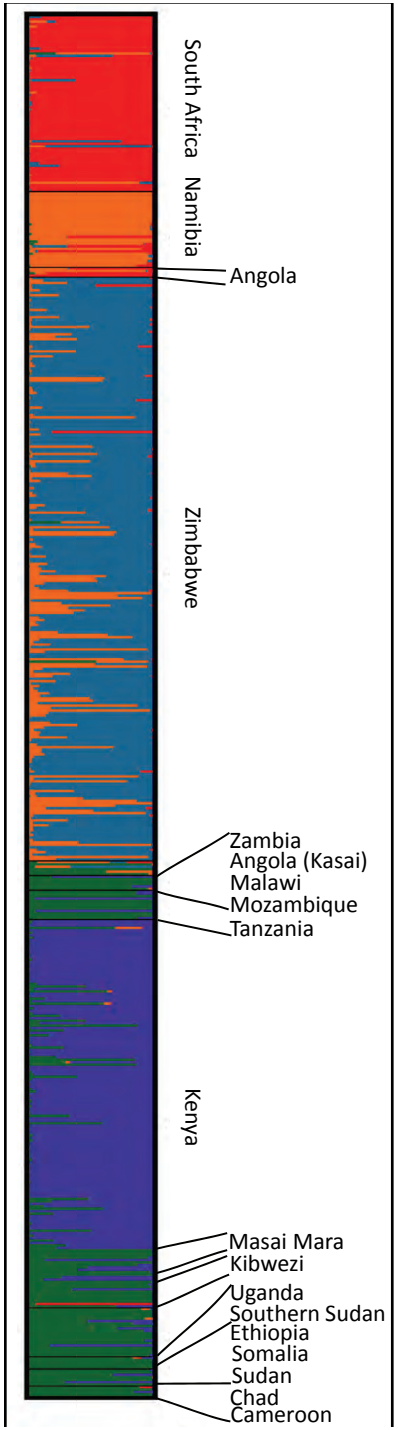


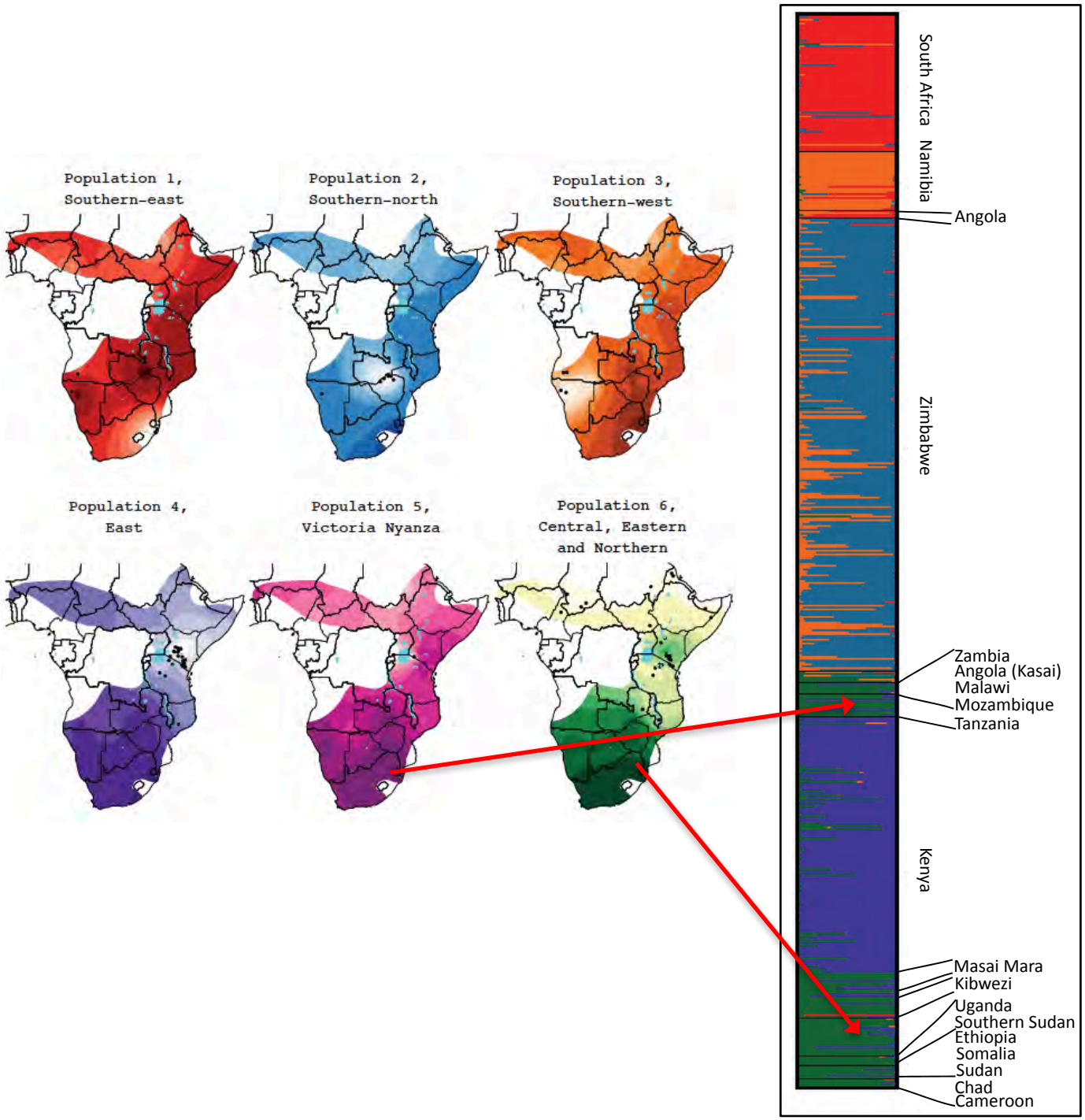
MtDNA on a map..

(black dots, palest contour is the centre of the distribution)

DNA profile clusters

- South Africa
- Namibia/Angola
- Zimbabwe
- East Africa (mainly Kenya)
- CEN (North of Zambezi)





DNA profiles on a map..

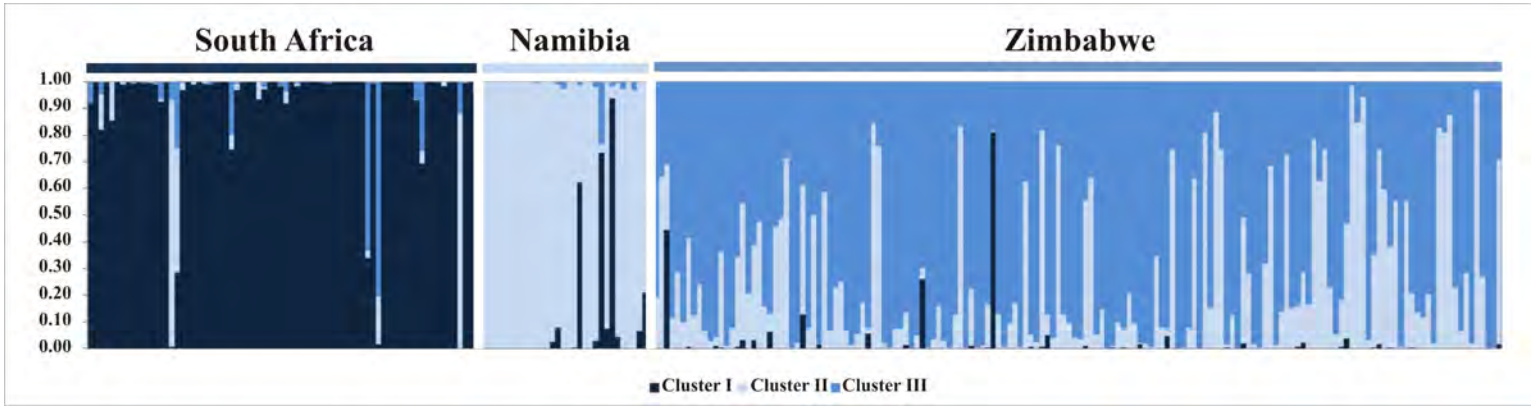
(black dots, palest contour is the centre of the distribution)

Take home

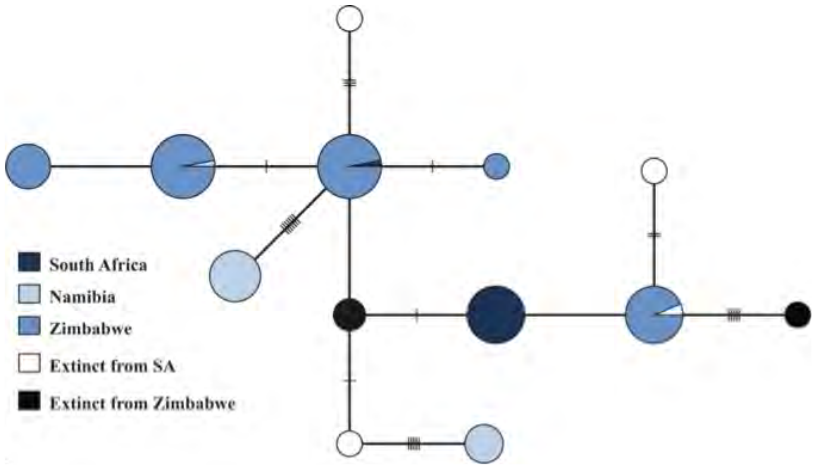
- Only 30% of the pre-hunting mitochondrial diversity in the museum skins remains – 3 lineages disappeared (of 8)…
- Substantial diversity remains in the East..
- Southern African diversity mainly *latitudinal*..
- DNA profiles reveal 6 clusters
- 3 in southern Africa..
- Eastern and Victoria groups same as mtDNA
- The 6 groups could form the basis of management units for now..
- Does not fit exactly onto the AfRSG groups

Southern black rhino genomics

- Three demographically distinct groups at the moment



- But mitochondrial DNA suggests a common evolutionary origin..



Southern black rhino genomics

Table 2: Mitochondrial variation in museum and extant black rhinoceros.

Country	Museum				Extant			
	Samples (n)	***Haplotypes (nhap)***	***Haplotype Diversity (h)***	***Sequence diversity (π)***	***n***	***nhap***	***h***	***π***
S. Africa	36	6	0.31	0.85	31	2	0.06	0.19
Namibia	*No historic data*				31	3	0.41	4.37
Zimbabwe	114	7	0.78	3.32	103	6	0.76	2.89

Table 1: Genetic profiles of southern African black rhinoceros.

Country	***Sample size***	***Mean Heterozygosity***	***Mean no. of alleles (corrected for sample size)***
South Africa	72	0.39	4.27 (3.66)
Namibia	31	0.44	3.73 (3.73)
Zimbabwe	239	0.55	4.82 (3.85)





BUT, very different environments and very different pressures…

Why a genome?

- Better understanding of diversity across the entire genome
- ..including in genes that may be important for survival..
- To detect signatures of local adaptation (eg arid versus savannah versus sub-tropical)
- And to see how distinct from east Africa (also genome sequenced)…

Reference genome (total 50x)

- Sequenced using an Illumina HiSeq platform at the Karolinksa Institute (Stockholm)
- Comprises:
  - High coverage DNA libraries of 180bp and 650bp
  - Low coverage ‘linking’ libraries (3kb, 5kb, 20kb)
- Genome was assembled in October
- Extremely high quality..
- And another assembly is being carried out by Dovetail Genomics

Solving a very large jigsaw puzzle

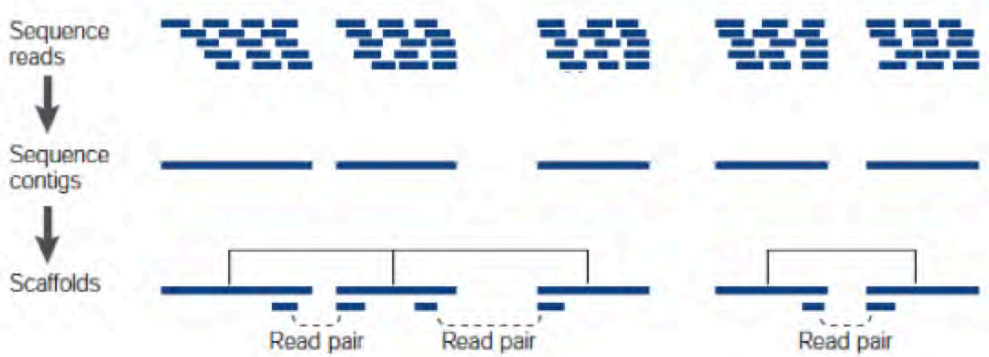
Issues:

- Millions (10 of Millions) of pieces
- Lots of ‘damaged’ pieces
- Missing pieces
- Pieces from other puzzles
- Lots of identical pieces of blue sky

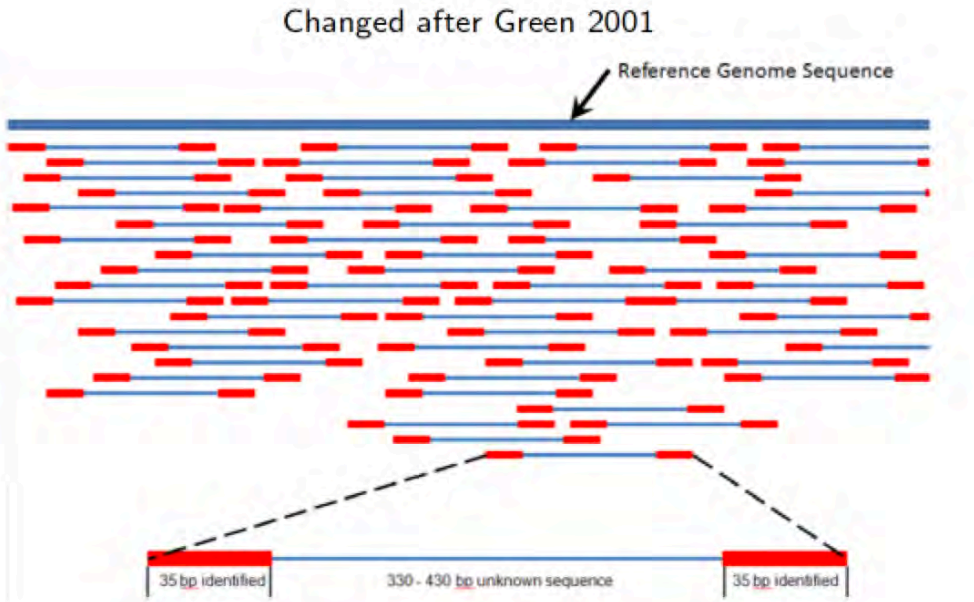


Assembling your genome

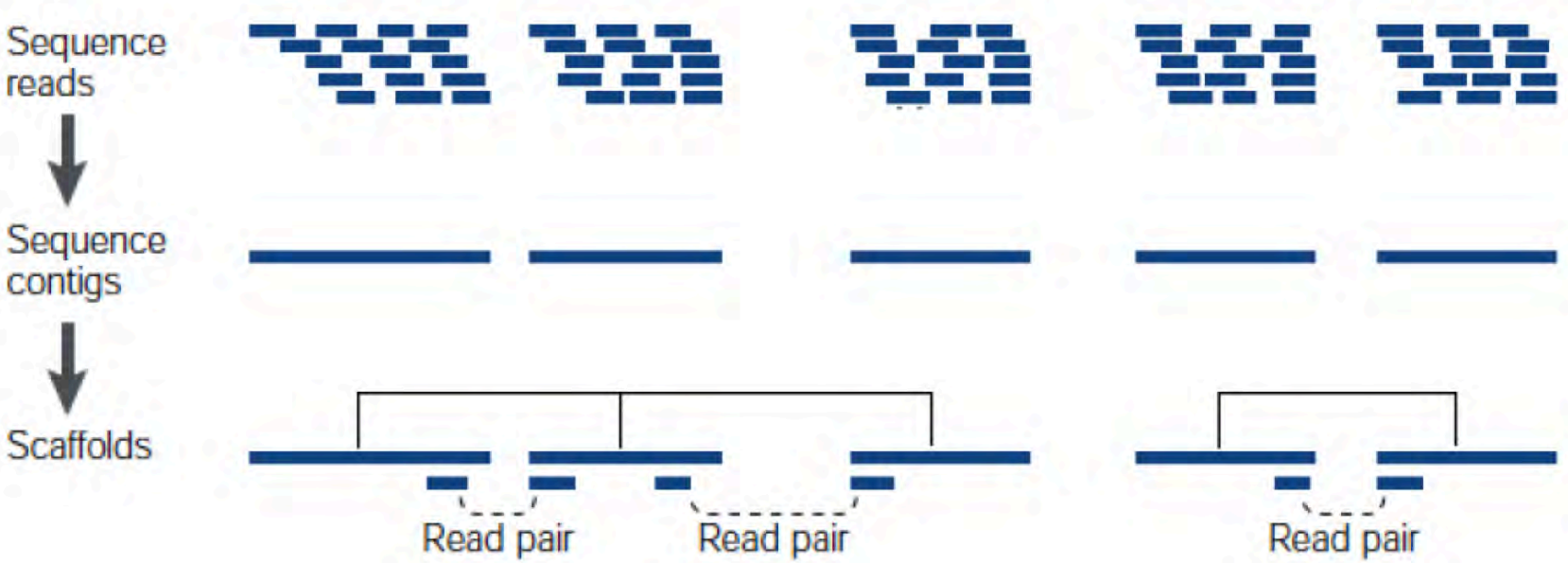
De-novo Assembly



Reference-based Mapping

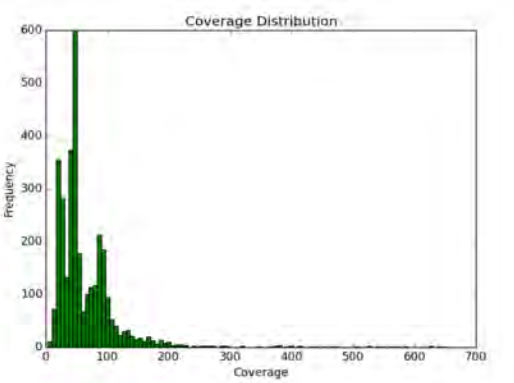


De-novo Assembly



Changed after Green 2001

Reference genome



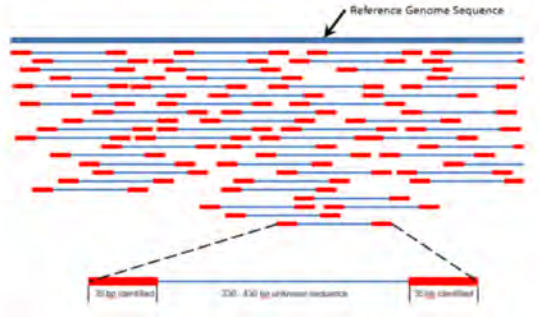
- Assembly (Allpaths)
- Coverage ~50x
- number of scaffolds = 3,736
- total scaffold length, with gaps = 25,651,098 (2.56 Gb)
- Median contig size in kb = 150.6
- Median scaffold size in kb, with gaps = 25,287 (25 Mb)

assembler	n. scaff	n. scaff>1000	NG50	NG80	max_scf_lgth	Ass_lgth	Ass_lgth_scfs>1000
abyss	4940953	46726	470880	155932	4454490	2902409063	2453235414
allpaths	3736	3683	25651098	11690441	86907707	2528787287	2528736099
soapdenovo	2209944	3175	9179357	4278101	61759042	2901161954	2550523377
supernova	88861	88788	1200173	295927	9987581	2488414852	2488341852

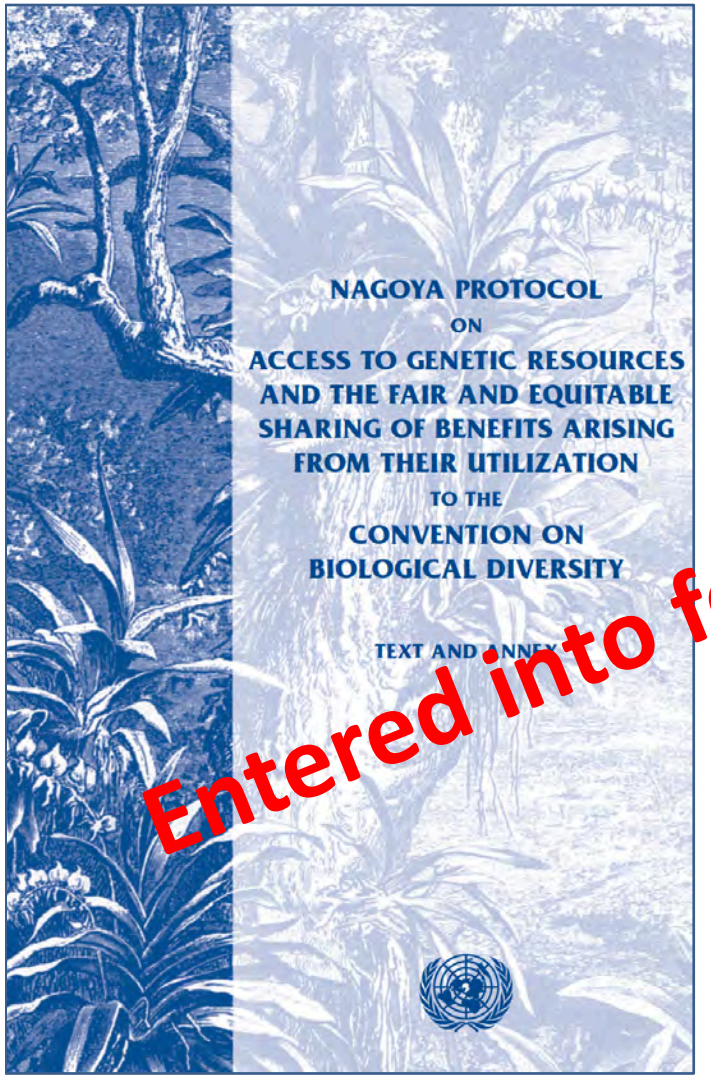

Love Dalén Retweeted
Michelle Vierra @DTGmichelle · Jan 11
Love Dalén-Swedish Museum of Natural History wins the free genome assembly of black rhino! @DTGenomics #PAGXXIV


TAACATAGTCAAAGCATCAGAACTCAA
AGAGTGCATACCTTTGAAATATTCTGA
GTAAGAAACAAAAGCAATTGACAAACC
GTTGAGATGGATTCACTGAGACCGGTA

Resequencing



- Only aiming for 10x coverage
- Align to reference assembly.
- Originally we were going to sequence 9 individuals (3 from each group)
- But sequencing prices are coming down..
- So we hope to do substantially more
- Three individuals ongoing, more in prep



Entered into force on 12 October 2014



Parties

signed, but not ratified

non signatory, but Biological Diversity Convention party

non signatory, non-Biological Diversity Convention party

Besides several member states, the EU is also a party (not on map)

CONSERVATION GENETICS
SPECIALIST GROUP

Formed September 2014

Intentional genetic manipulation, position of hybrids in red lists, genetic trends in red-listing, de-extinction, advice to taxon-based SGs..

Currently upscaling (regional clusters)







SciLifeLab



Isa-Rita Russo

Yoshan Moodley



Paul O'Donoghue



Shadrack Muya



Desire Dalton





Love Dalen

Antoinette Kotze
Kara Dicks
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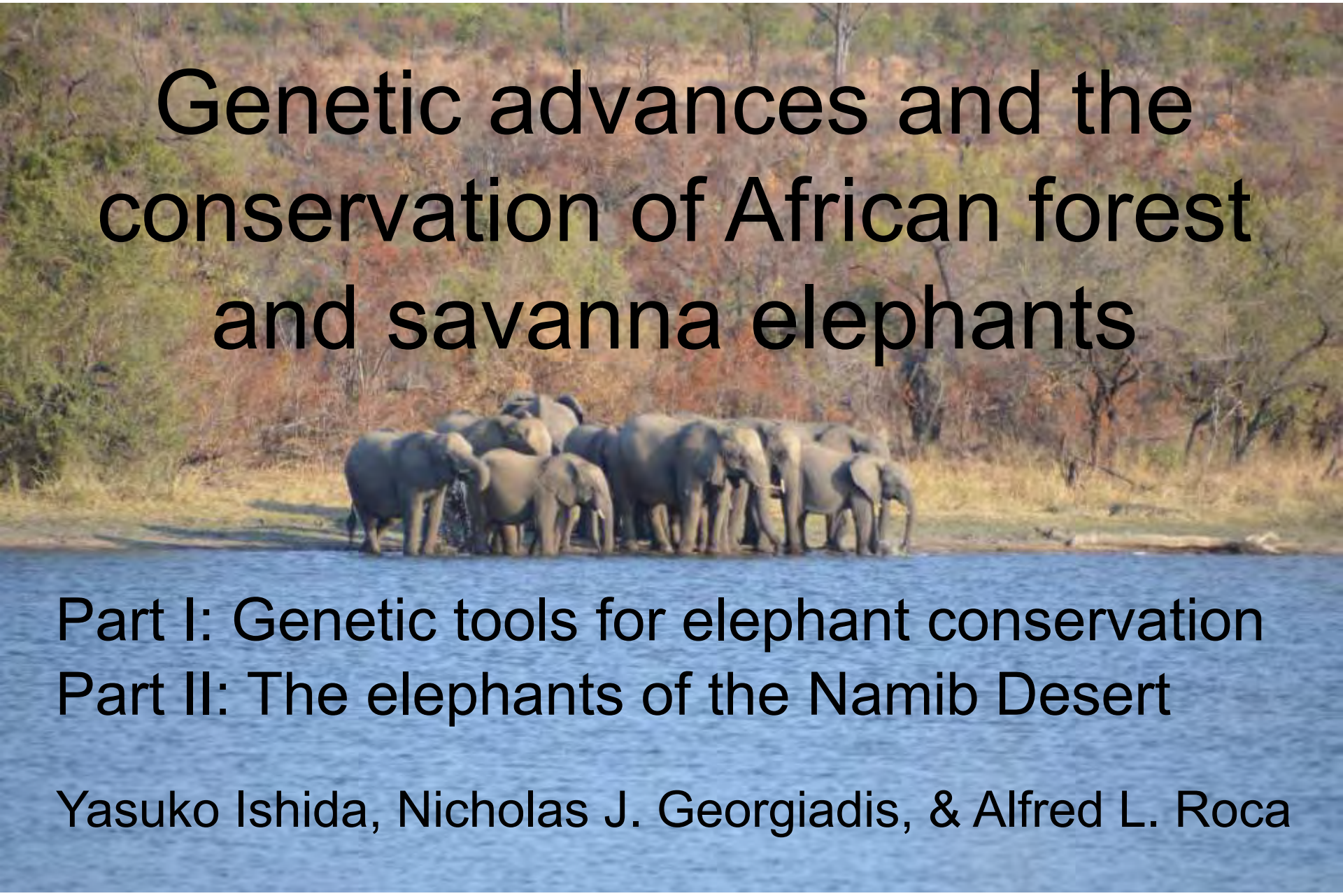
THE FROZEN ARK

U.S. FISH & WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

Dovetail GENOMICS

THE ROYAL SOCIETY

Genetic advances and the conservation of African forest and savanna elephants



Part I: Genetic tools for elephant conservation
Part II: The elephants of the Namib Desert

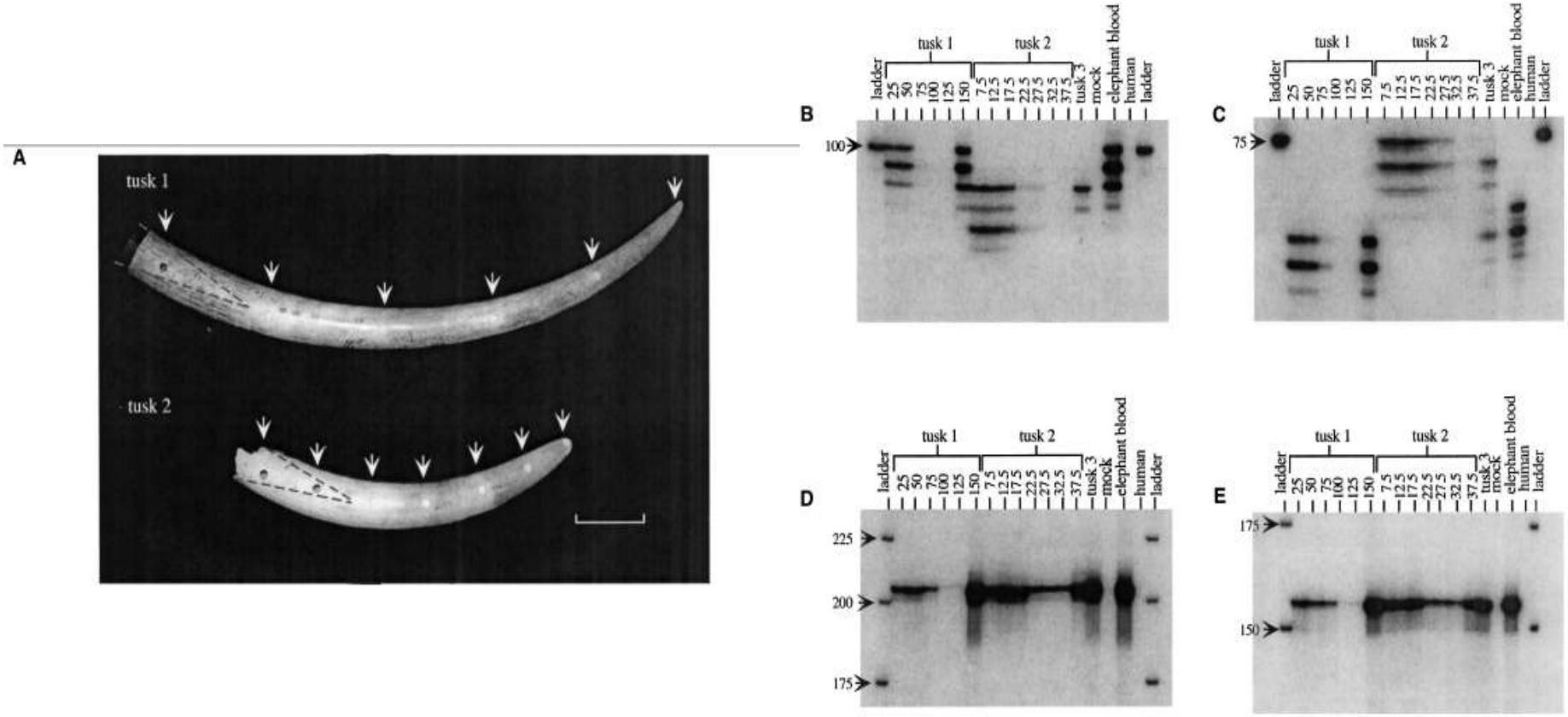
Yasuko Ishida, Nicholas J. Georgiadis, & Alfred L. Roca

Threats to elephants – illegal ivory trade

- Illegal smuggling of ivory is still a major threat to elephant populations, e.g. 13 large-scale ivory seizures in 2011 represented 23 tons of ivory and the deaths of over 2500 elephants.
- Ivory is often seized in markets far from the actual poaching location.
- Inferring the species of the elephant, and geographic origins of ivory would enable law enforcement to be targeted towards poaching "hot spots."



DNA can be isolated from ivory



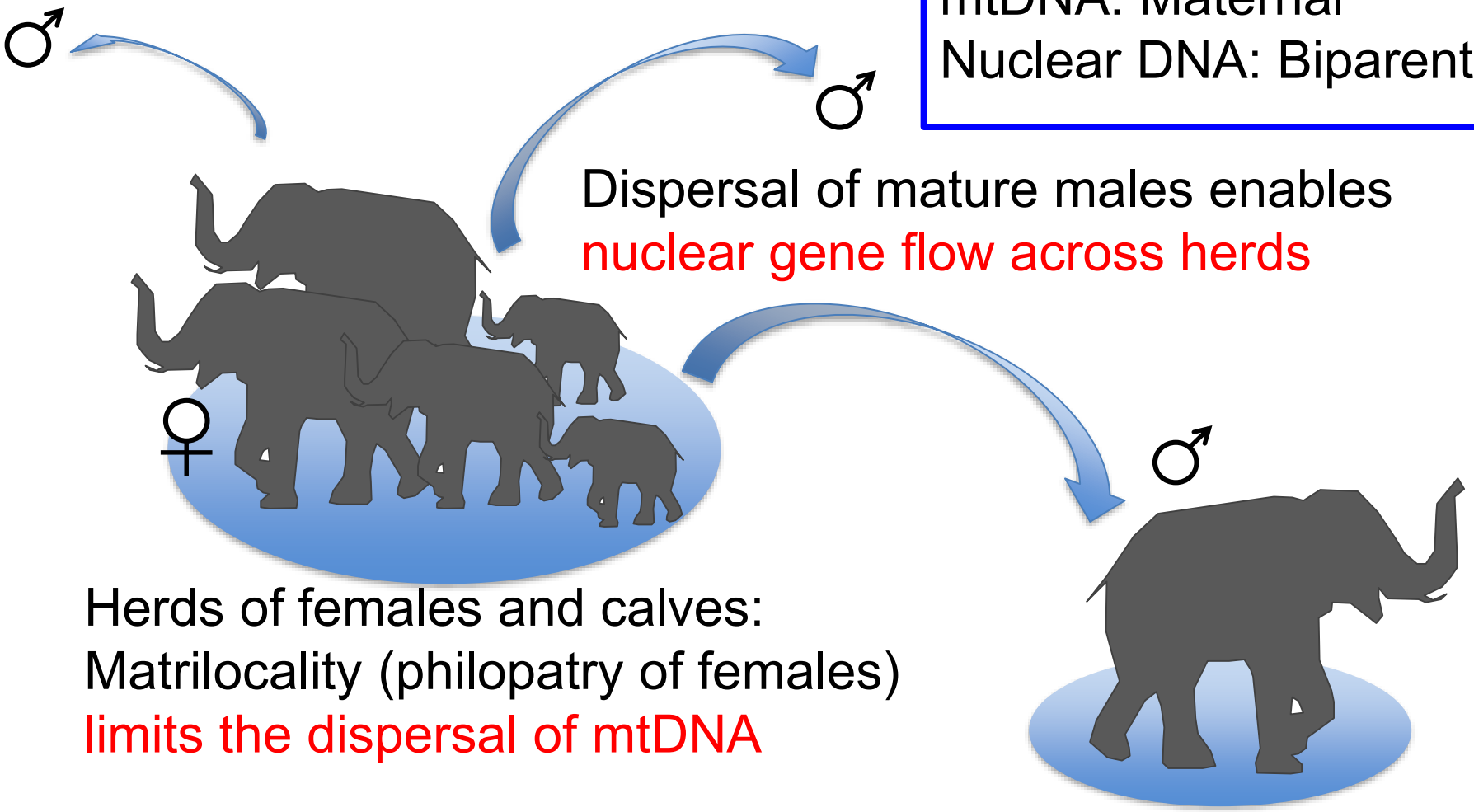
DNA from ivory has been used to infer the geographic origin.

Comstock et al. 2003; Conservation Biology. 1840-1843; Amplifying Nuclear and Mitochondrial DNA from African Elephant Ivory: a Tool for Monitoring the Ivory Trade.
Wasser et al., 2004, 2007, 2008, and 2015.

Elephant social structure and different inheritance patterns of mtDNA and nuclear DNA

Inheritance pattern

mtDNA: Maternal
Nuclear DNA: Biparental

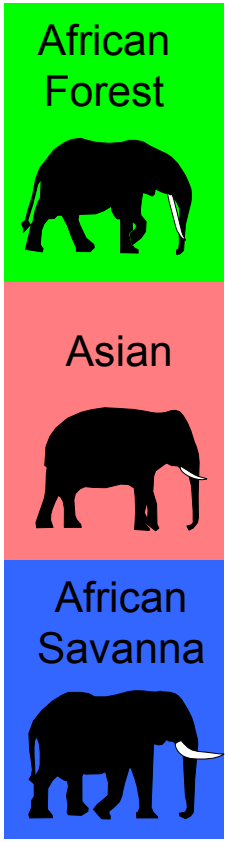


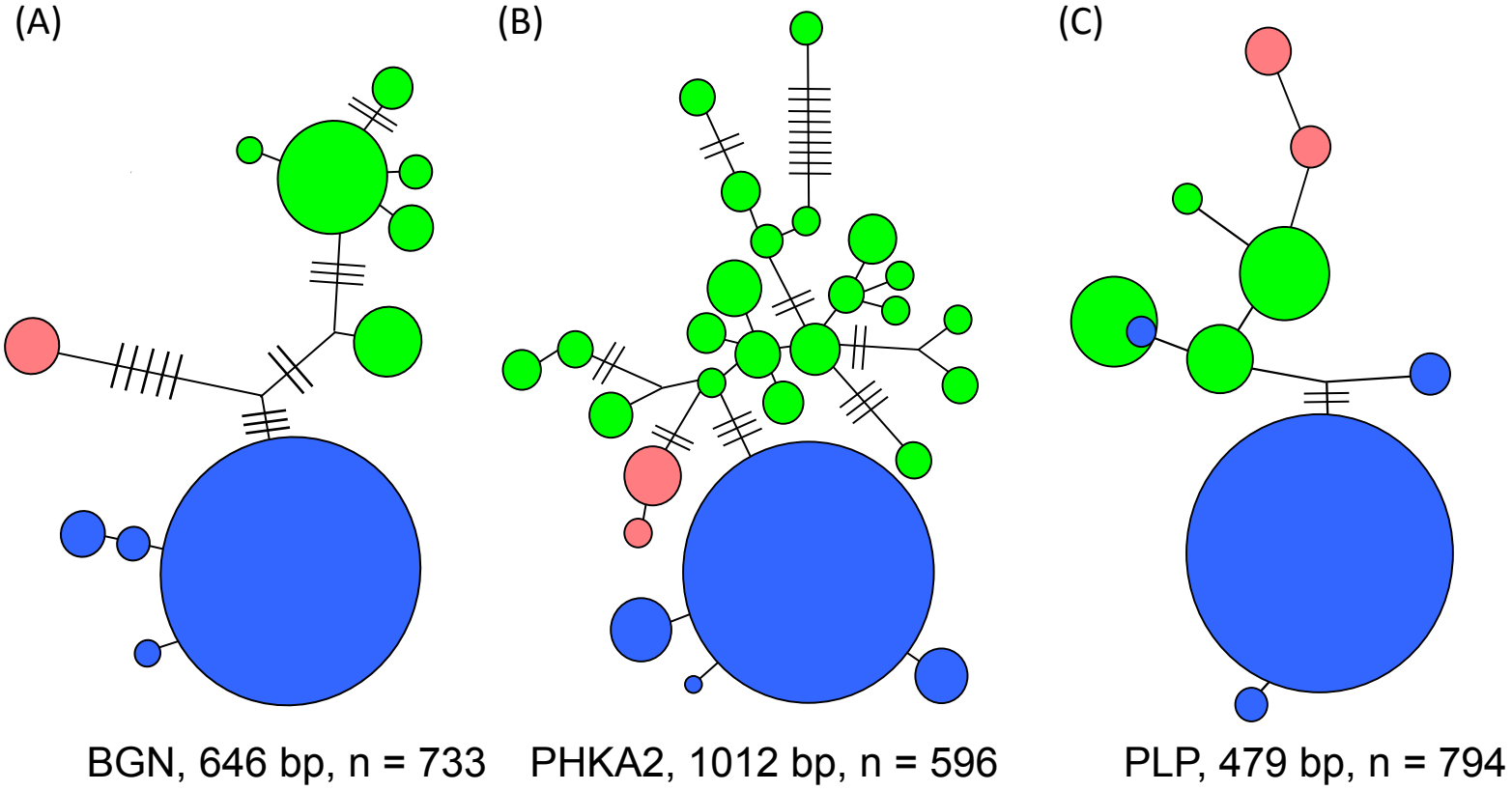
Dispersal of mature males enables nuclear gene flow across herds

Herds of females and calves:
Matrilocality (philopatry of females) limits the dispersal of mtDNA

i) Nuclear DNA markers to distinguish elephant species

Each species has different nuclear DNA patterns





Nuclear DNA can be used to distinguish species.

Roca et al., 2005; Nature Genetics 37:96 Cytonuclear genomic dissociation in African elephant species.

Developing nuclear DNA markers to identify elephant species

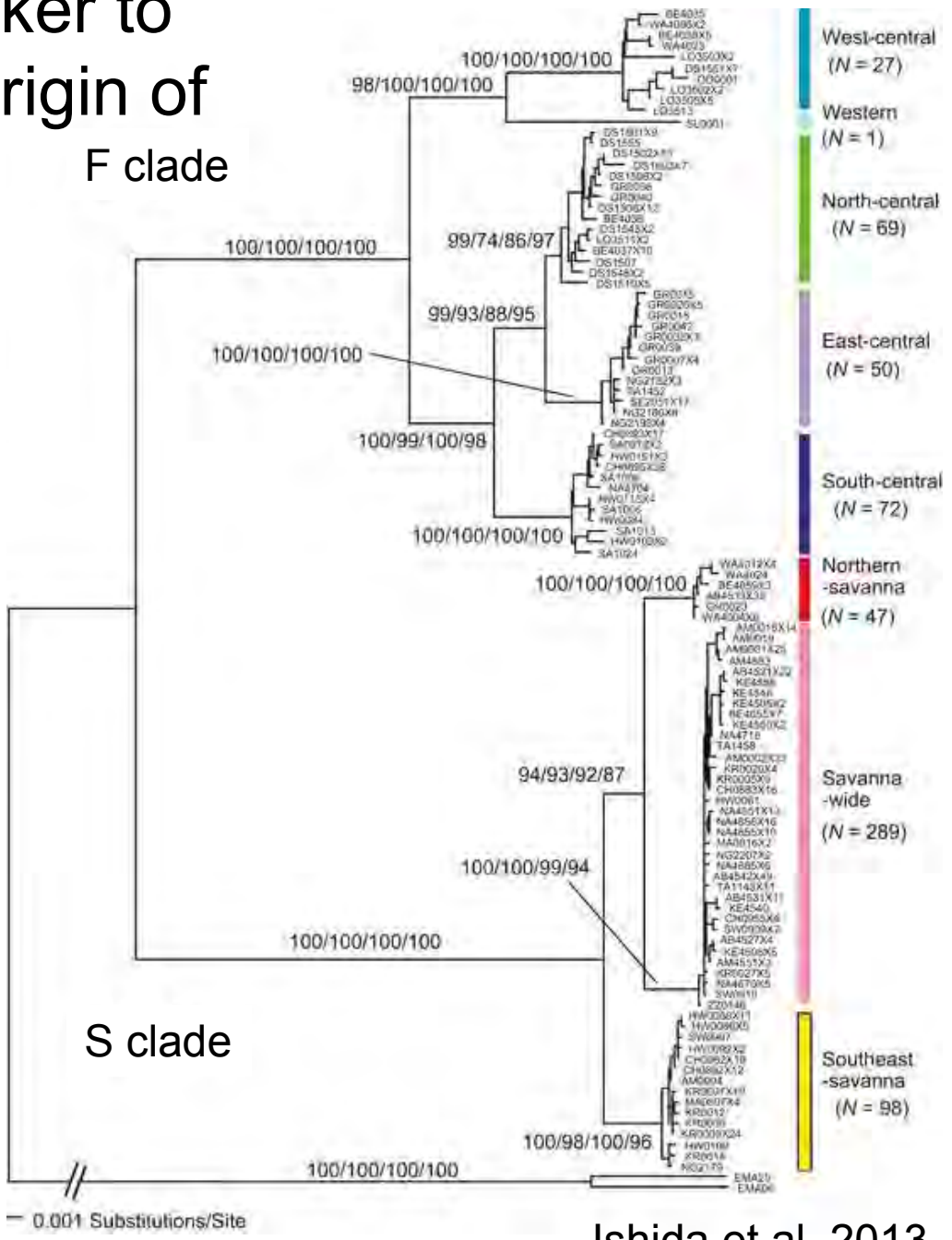
- Primers were designed in the genes that contain fixed nucleotides in each elephant species (Roca et al. 2001, 2005), and to enable to amplify the degraded DNA.

Gene	Primers	Size (bp)	Fixed differences
BGN	BGN-s1	64	1
	BGN-s2	114	4
PHKA2	PHKA2-s1	47	2
	PHKA2-s2	71	1
PLP	PLP-s1	58	2

Ishida et al. 2011

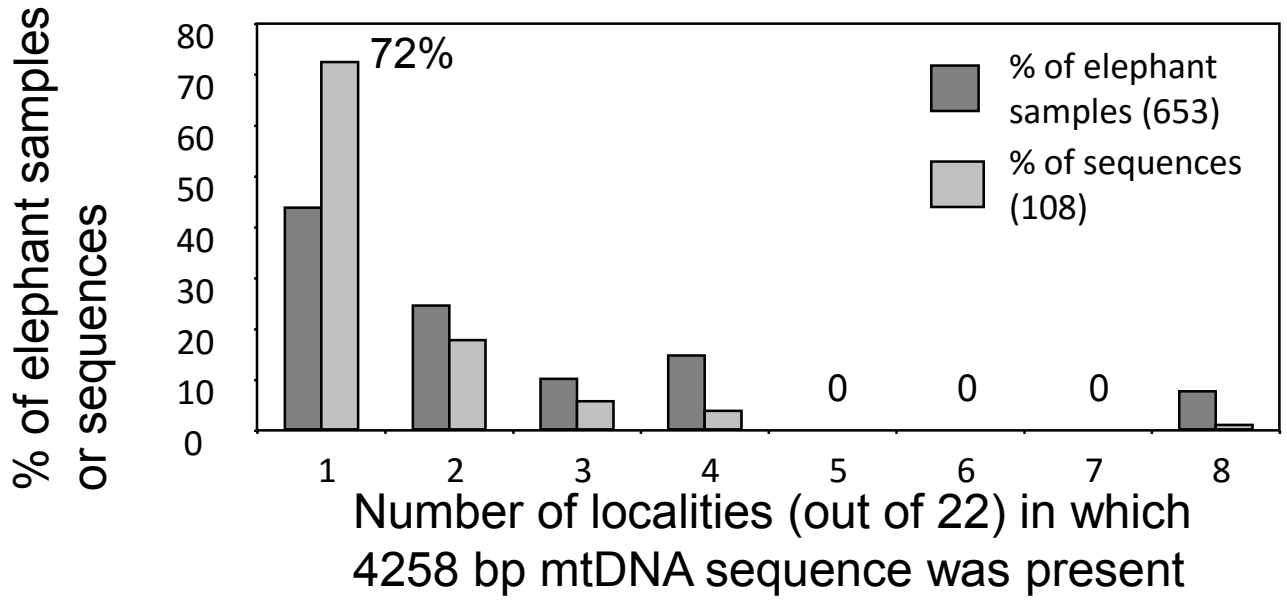
ii) Developing mtDNA marker to estimate the geographic origin of African elephants

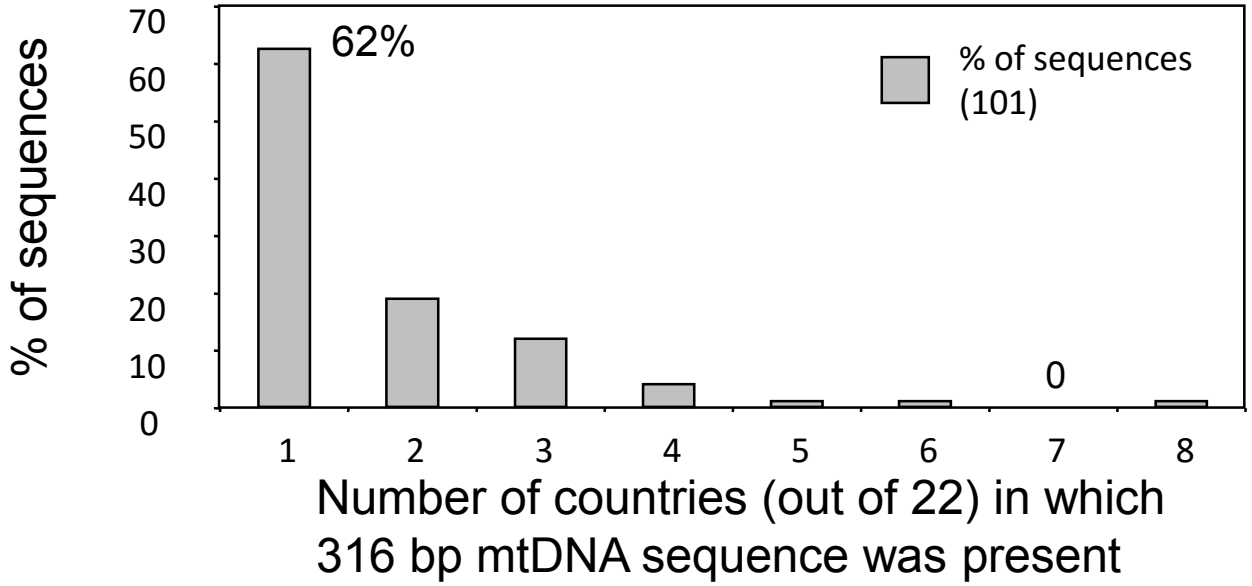
- 4258 bp of mtDNA (MT-ND5 to control region) was Sanger sequenced in 653 wild African elephant samples collected from 22 localities in 13 countries.
- 108 distinct sequences were identified in 653 elephants.



Ishida et al. 2013

Geographic distribution of African elephant mtDNA sequences





(Barriel et al. 1999, Eggert et al. 2002, Debruyne et al. 2003, 2005, and Johnson et al. 2007)

Ishida et al. 2013

Loxodonta Localizer

Designed by Kai Zhao

Introduction

- ***Loxodonta* localizer** maps the localities from which mitochondrial DNA sequences have been reported for African elephants (*Loxodonta africana* and *L. cyclotis*, using the dataset described in Ishida et al., 2012).
- Enter a 316 bp mitochondrial control region sequence from an African elephant sample to display the localities from which elephant samples with similar sequences have been reported.

Input sequences

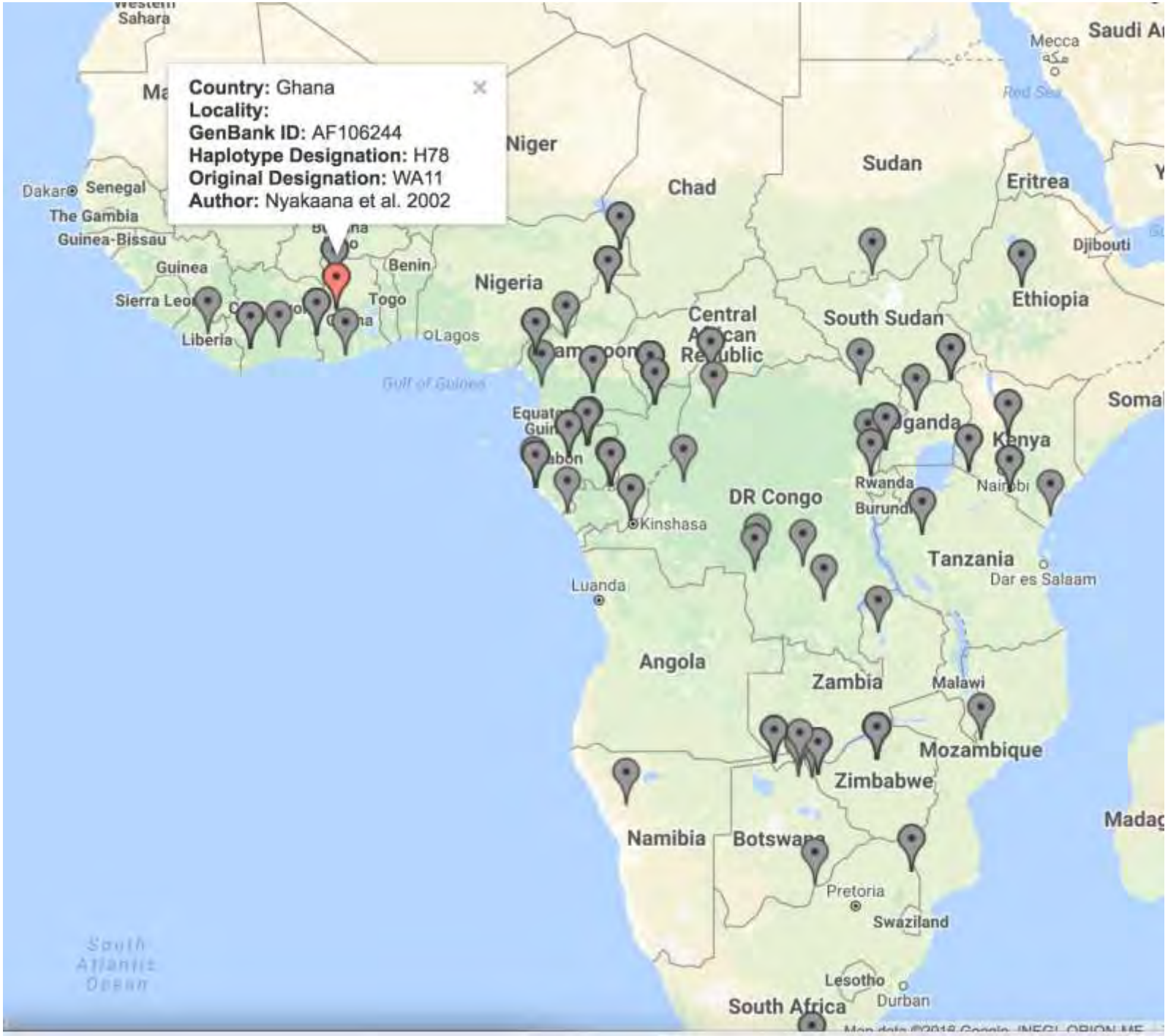
Choose a haplotype in the database to use as an example: Choose an haplotype

Or enter a newly generated mitochondrial sequence below:

Submit! Clear

Map




Country: Ghana
Locality:
GenBank ID: AF106244
Haplotype Designation: H78
Original Designation: WA11
Author: Nyakaana et al. 2002
Western Sahara
Mecca
Saudi A
Red Sea
Niger
Chad
Sudan
Eritrea
Dakar
Senegal
The Gambia
Guinea-Bissau
Guinea
Sierra Leo
Liberia
Benin
Togo
Lagos
Nigeria
Central African Republic
South Sudan
Ethiopia
Djibouti
Gulf of Guinea
Kenya
Rwanda
Burundi
Nairobi
DR Congo
Kinshasa
Tanzania
Dar es Salaam
Luanda
Angola
Zambia
Malawi
Mozambique
Zimbabwe
Namibia
Botswana
Pretoria
Swaziland
Lesotho
Durban
South Africa
South Atlantic Ocean


Country: Cameroon
Locality: Yambong
GenBank ID: AY359267
Haplotype Designation: H08
Original Designation: CA1
Author: Debruyne et al. 2003¶
Mali
Senegal
Gambia
Guinea-Bissau
Guinea
Sierra Leone
Liberia
Burkina
Lagos
Gulf of Guinea
Central African Republic
Sudan
Eritrea
Djibouti
Ethiopia
South Sudan
Somalia
Uganda
Kenya
Nairobi
Rwanda
Burundi
DR Congo
Kinshasa
Tanzania
Dar es Salaam
Luanda
Angola
Zambia
Malawi
Mozambique
Zimbabwe
Namibia
Botswana
Pretoria
Swaziland
Madagascar
South Atlantic


Map
Satellite
Mauritania
Mali
Niger
Chad
Sudan
Eritrea
Yemen
Saudi Arabia
Riyadh
Mecca
Red Sea
Gulf of Aden
Djibouti
Ethiopia
Somalia
Senegal
Dakar
The Gambia
Guinea-Bissau
Guinea
Sierra Leone
Liberia
Burkina
Benin
Togo
Nigeria
Lagos
Gulf of Guinea
Central African Republic
South Sudan
Uganda
Kenya
Rwanda
Burundi
Nairobi
DR Congo
Kinshasa
Luanda
Angola
Zambia
Malawi
Mozambique
Zimbabwe
Namibia
Botswana
Pretoria
Swaziland
Lesotho
Durban
South Africa
Cape Town
Madagascar
South Atlantic Ocean
Country: Zimbabwe
Locality:
GenBank ID: AY741071
Haplotype Designation: H87
Original Designation: ZI6
Author: Debruyne 2005
Google
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Country	Locality	Matching bp	GenBank Accession	Haplotype Designation	Original Designation	Author
Côte d'Ivoire	Tai NP (Ecosystem)	316	AF527670	H49	Tai6	Eggert et al. 2002
Côte d'Ivoire	Tai NP (Ecosystem)	316	AF527671	H49	Tai17	Eggert et al. 2002
Ghana	Bia NP	315	AF527677	H44	Bia3	Eggert et al. 2002
Ghana	Bia NP	315	AF527680	H44	Bia69	Eggert et al. 2002
Liberia		315	AY741079	H44	LI1	Debruyne 2005
Côte d'Ivoire		315	AY741327	H51	IC1	Debruyne 2005
Ghana	Mole NP	314	AF527674	H47	Mole3	Eggert et al. 2002
Mali	Gourma Region	314	AF527668	H47	Mali14	Eggert et al. 2002
DRC	Bosobolo	312	AY359273	H28	DRC6	Debruyne 2005
DRC	Bosobolo	312	AY359274	H28	DRC8	Debruyne 2005
CAR	Dzanga-Sangha NP	312	EU096115	H17	CAR3315	Johnson et al. 2007
CAR	Dzanga-Sangha NP	312	EU096115	H17	CAR381	Johnson et al. 2007

Part II: The elephants of the Namib Desert

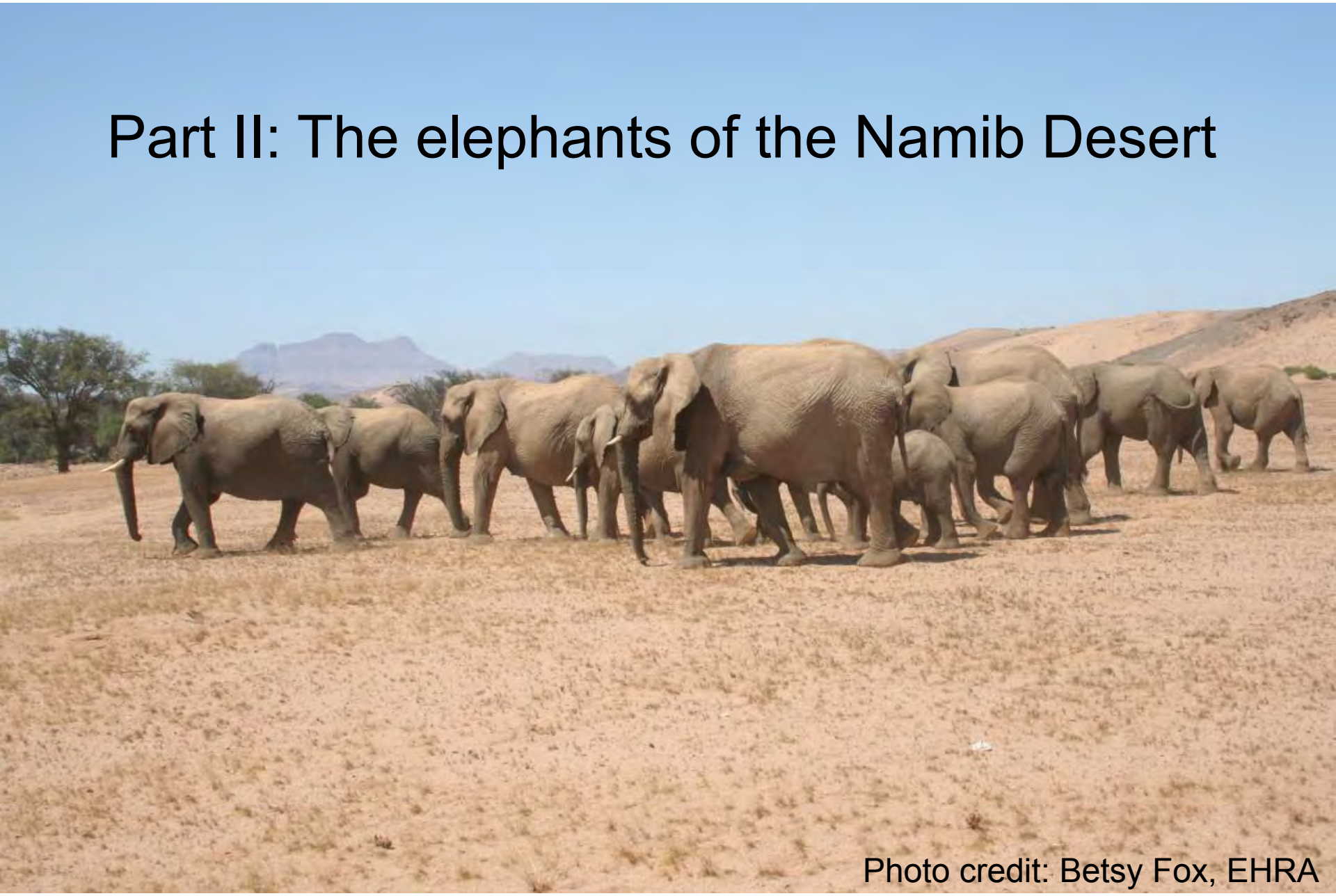
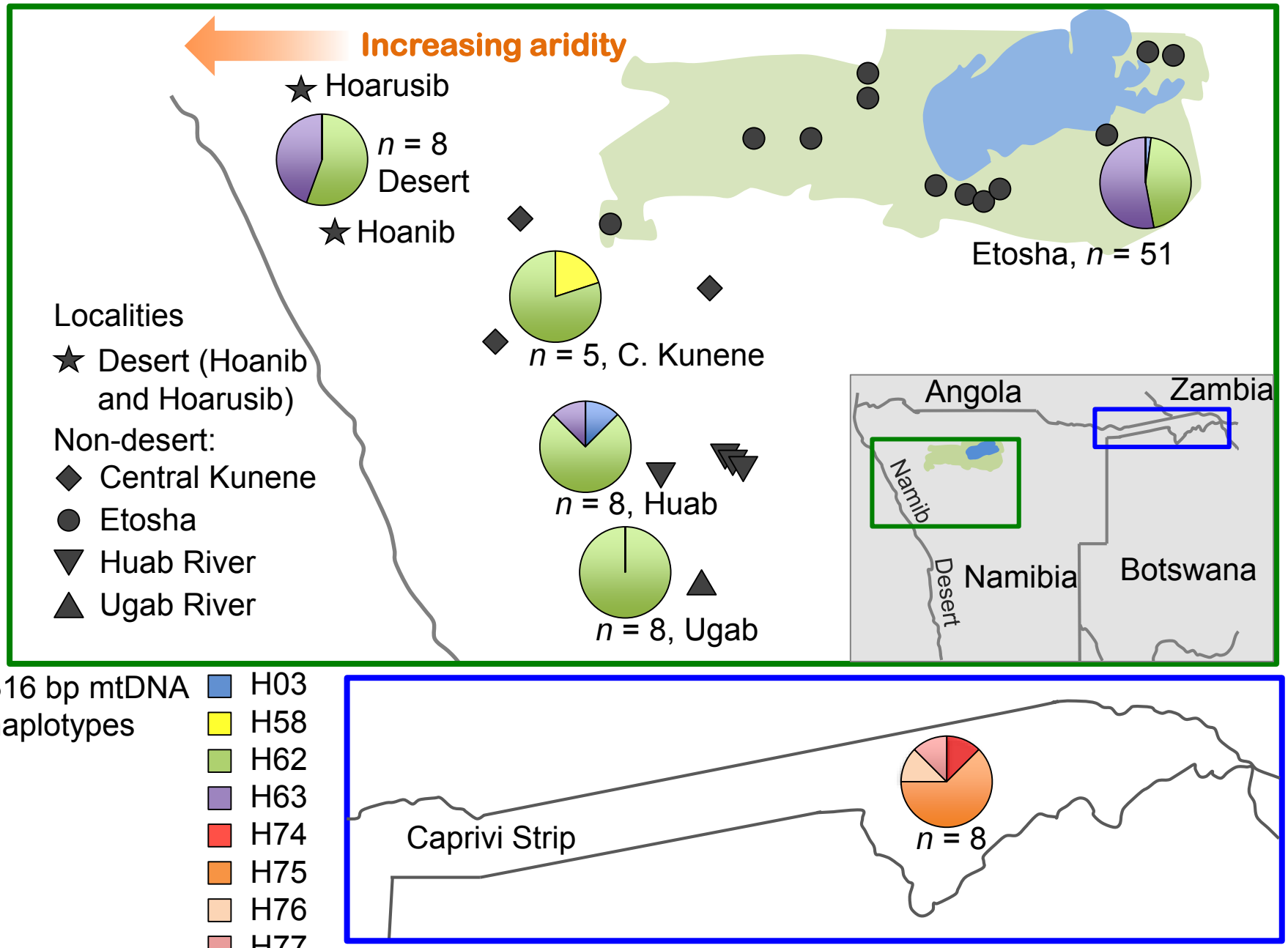


Photo credit: Betsy Fox, EHRA

Elephants of the Namib desert

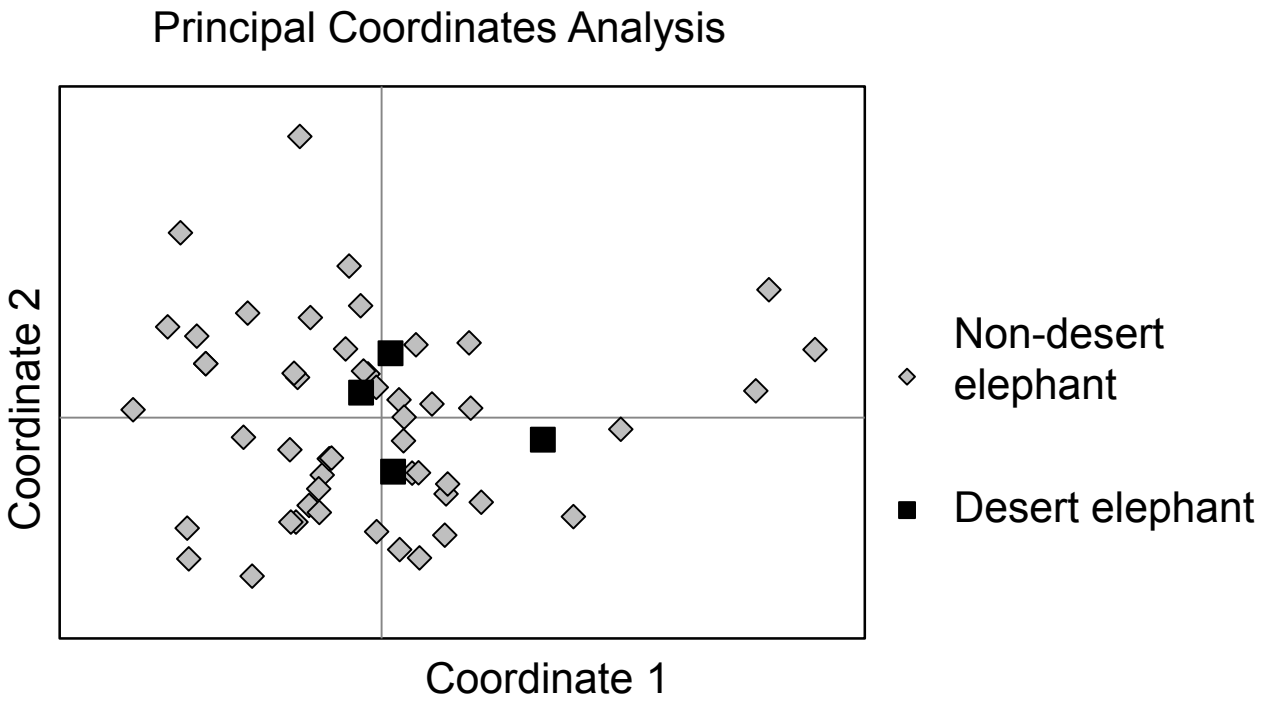
- The existence of elephants in Namib desert was first documented as early as 1793.
- Said to be taller with a leaner build than other savanna elephants, and described as a separate subspecies, Loxodonta africana zukowsky (Strand, 1924).
- Reported to travel for up to 4 days without drinking water to access food sources as far as 70 km from waterholes.
- Are desert elephants genetically isolated from other savanna elephants??

Sampling location and the distribution of 316 bp mtDNA



Ishida et al. 2016

Genetic analyses of Namibian elephants using 17 microsatellite loci



Neither Coordinates 1 nor 2 differentiated desert elephants and non-desert elephants.

Ishida et al. 2016

Conclusions

- There were no genetic differences in either mtDNA or microsatellite (nuclear) DNA between desert-dwelling elephants and savanna elephants in other regions.
- Changes in behavior of desert-dwelling elephants do not represent the genetic adaptation.
- Despite the genetic similarity to other savanna elephants, desert-dwelling elephants play an irreplaceable role in the desert ecosystem.



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Queen's University, Canada
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The Wildlife for Sustainable Development, Ethiopia
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Virginia E. Fox

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Conservation genetics of Greater One-horned Rhinos in India

from identifying individuals to determining conservation priorities

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Member, IUCN SSC AsRSG

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Researcher, Wildlife Genetics Laboratory, Aaranyak

Bibhab Kumar Talukdar
IRF Asia Coordinator & CEO, Aaranyak

Chair, IUCN SSC AsRSG

All Photos © Udayan Borthakur

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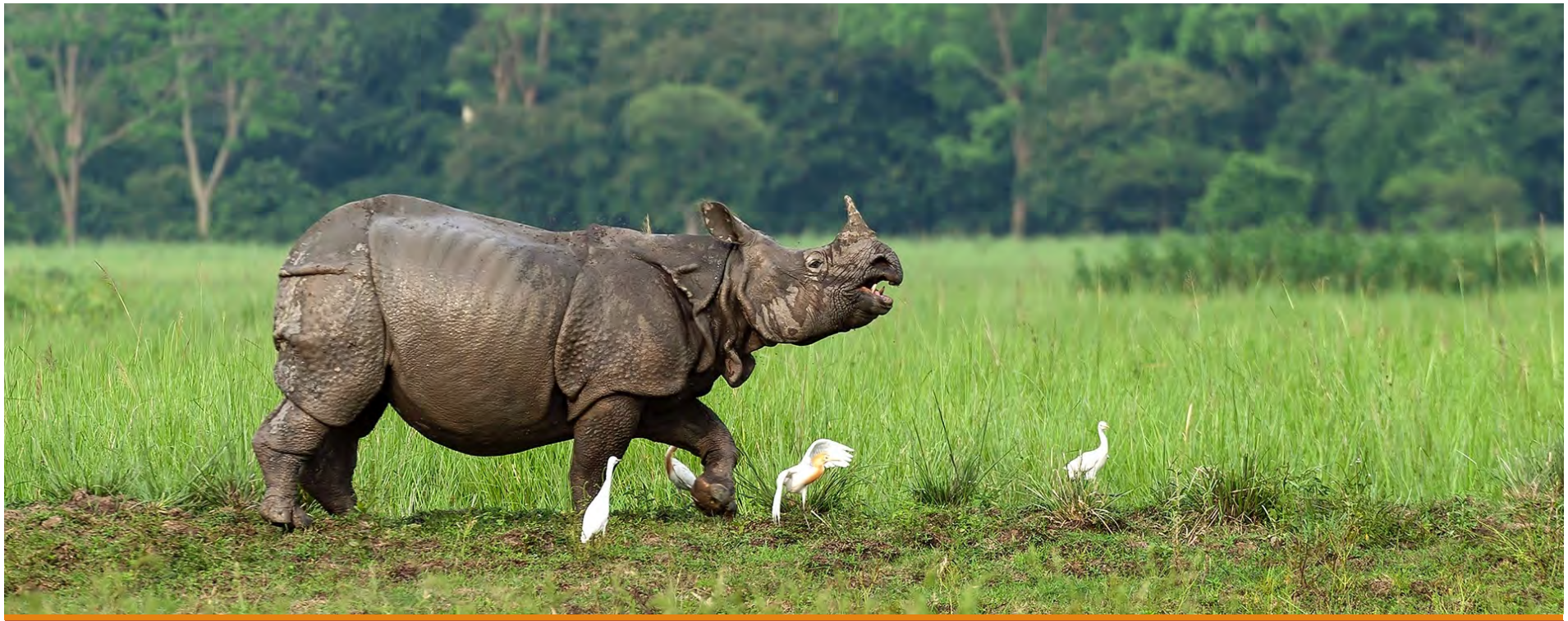
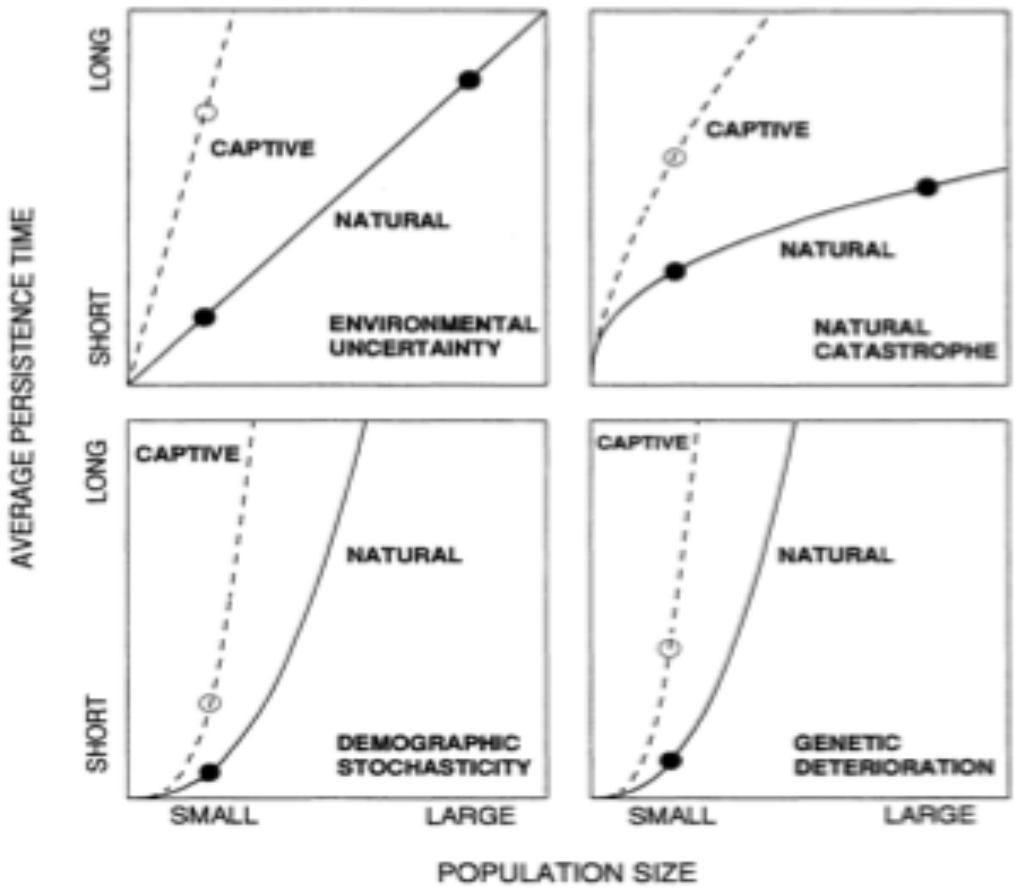
Small isolated populations are often at risk of comeing under the influence of stochastic factors which may eventually lead to decline in population size and extinction



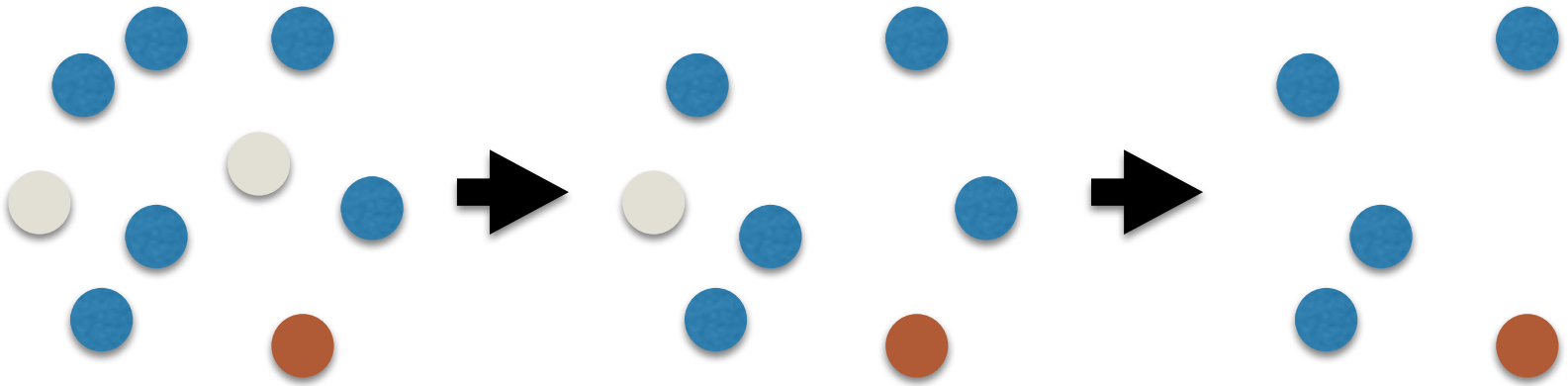


The general expected relationship between population size and the average persistence time for four factors that influence extinction in captive and natural populations

(Hedrick & Miller1992)

What can cause reduction in genetic diversity ?

- Inbreeding
- Genetic drift



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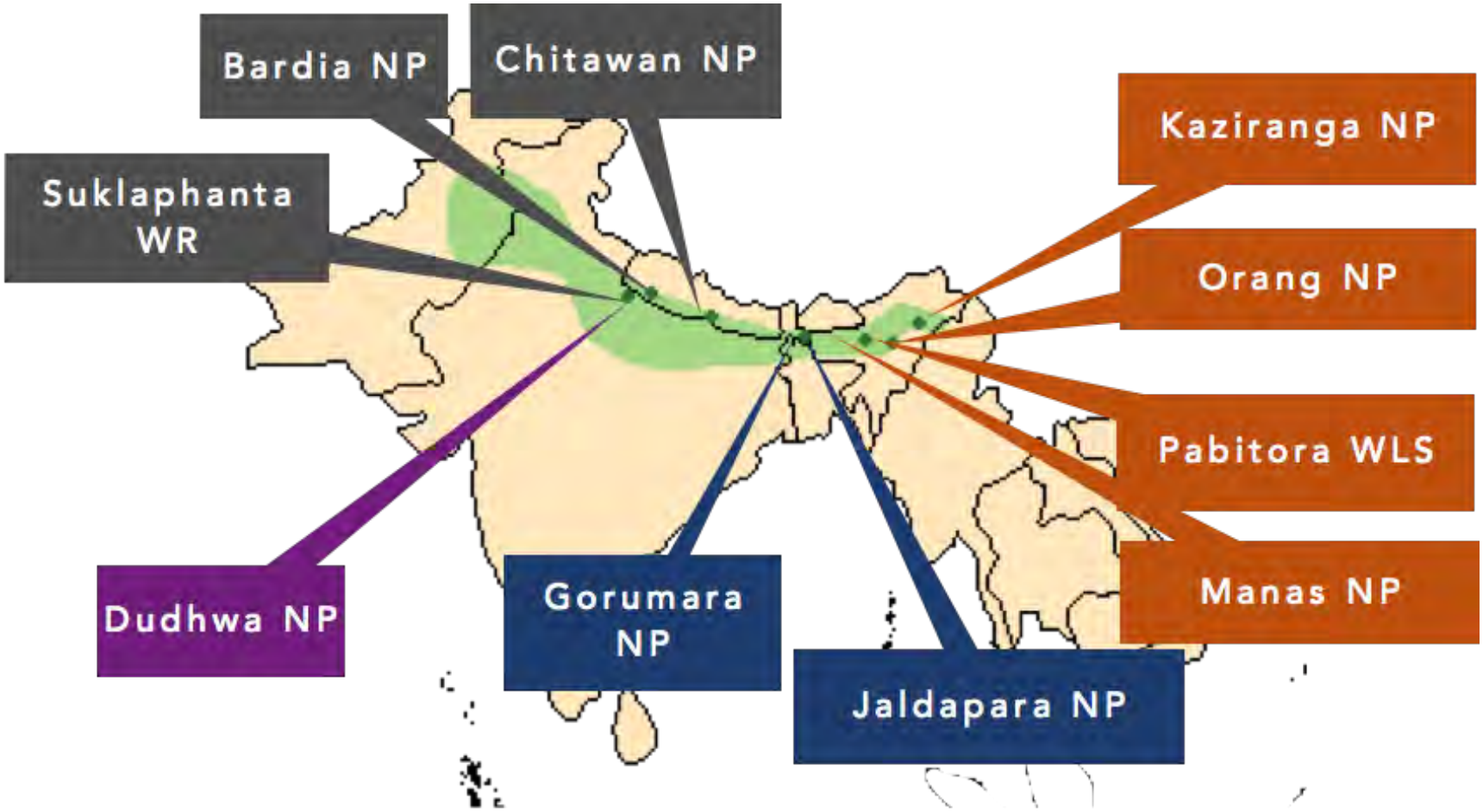
Possible Consequences of Habitat Loss and Fragmentation

- Demographic and genetic isolation of populations that were once connected
- Inbreeding and genetic drift acting on the smaller populations causing reduction in genetic diversity
- The variations between small populations increases due to independent genetic drift, even when diversity within population decreases

Global population of Greater One-horned Rhino



(Map source: Foose and van Strien.

No information on genetic connectivity in the extant population of greater one-horned rhinos thriving in fragmented habitat patches in India was available



Questions

1. What is the contemporary level of genetic diversity in the wild rhino population of India?

2. What is the extent of population genetic structure and gene flow among the rhino bearing protected areas in Eastern India?

Sampling populations for genetic studies – source of DNA





Genetic markers to identify individual rhinos from dung samples

17 microsatellite markers screened on 10 reference tissue samples of greater one-horned rhino



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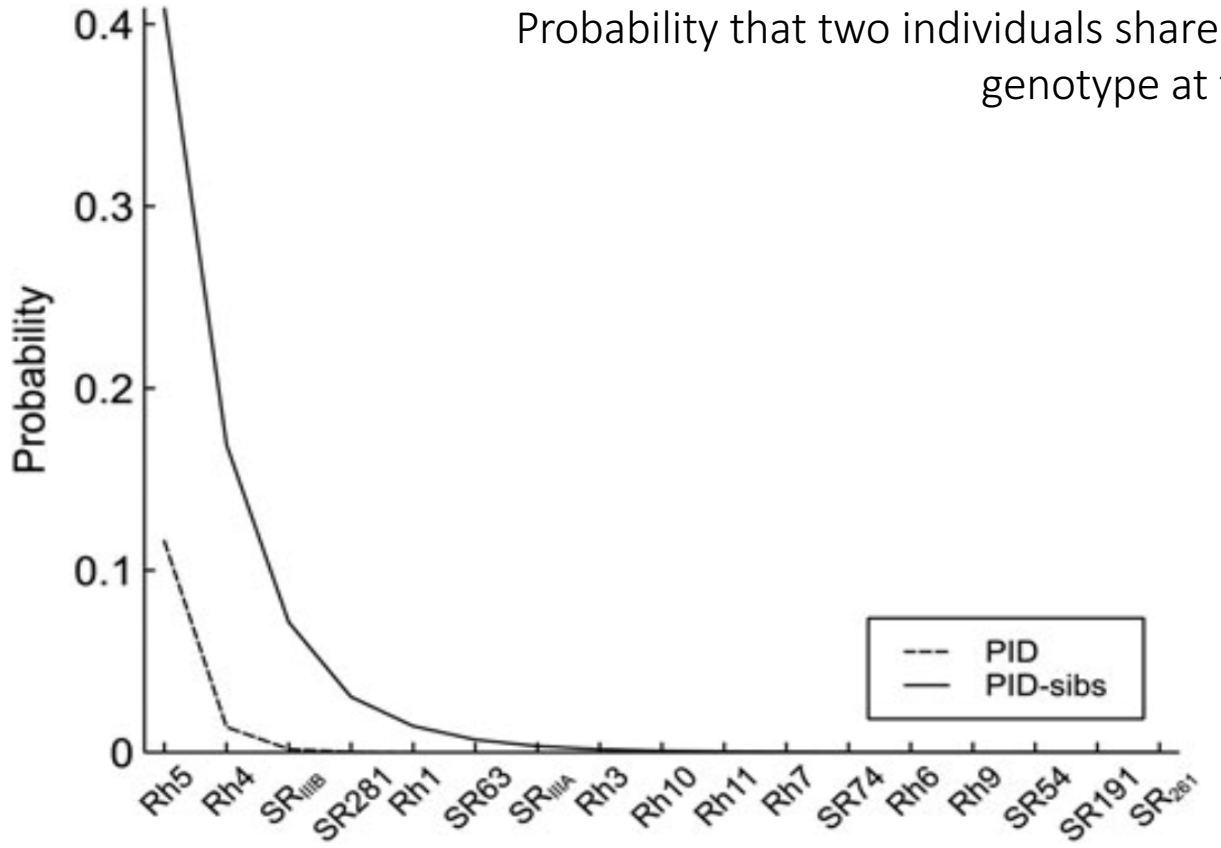
Genetic markers to identify individual rhinos from dung samples

Sample no.	Locus	No. of alleles	Allele range	% PCR success	Allele dropout	False alleles	Expected heterozygosity	Observed heterozygosity	Reference
1	SR54	1	184	100	0	0	0	0	Scott et al. (2004)
2	SR63	4	205–219	100	0	0	0.62	0.5	Scott et al. (2004)
3	SRIIIA	5	100–116	100	0	0	0.63	1	Scott et al. (2004)
4	SRIIIB	5	123–131	100	0	0	0.72	0.8	Scott et al. (2004)
5	SR191	1	178	100	0	0	0	0	Scott et al. (2004)
6	SR261	1	171	100	0	0	0	0	Scott et al. (2004)
7	SR74	2	150–162	100	0	0	0.46	0.7	Scott et al. (2004)
8	SR281	4	216–236	100	0	0	0.72	0.8	Scott et al. (2004)
9	Rh1	3	148–154	100	0	0	0.65	0.8	Zschokke et al. (2003)
10	Rh3	3	116–150	100	0	0	0.62	0.5	Zschokke et al. (2003)
11	Rh4	4	89–101	100	0	0	0.74	0.7	Zschokke et al. (2003)
12	Rh5	4	196–206	100	0	0	0.74	0.9	Zschokke et al. (2003)
13	Rh6	2	120–122	100	0	0	0.38	0.4	Zschokke et al. (2003)
14	Rh7	2	202–204	100	0	0	0.48	0.1	Zschokke et al. (2003)
15	Rh9	2	150–174	100	0	0	0.13	0.1	Zschokke et al. (2003)
16	Rh10	5	138–148	100	0	0	0.58	0.7	Zschokke et al. (2003)
17	Rh11	4	143–155	100	0	0	0.5	0.5	Zschokke et al. (2003)

Genetic markers to identify individual rhinos from dung samples

Probability that two individuals share the same genotype at that locus



Genetic markers to identify individual rhinos from dung samples

12 markers were selected for individual identification of rhinos from dung samples

The efficacy of a selected set of markers in obtaining reliable genetic data from field collected fecal samples needs to be tested prior to any major genetic population monitoring study

Gorumara National Park as a study site for optimization of genetic methodologies

- 80 sq km area
- Relatively small rhino habitat within the PA



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Gorumara National Park as a study site for optimization of genetic methodologies

- Rhino Dung heaps within the rhino habitat were identified
- Dung samples collected over a short period of time during April 2011
- Quality index criteria allowed 93% of samples (n = 56) to be retained for final analysis
- 43 individual rhinos identified

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Gorumara National Park as a study site for optimization of genetic methodologies

- In 2012, West Bengal forest department counted 42 individual rhinos..!
- Demonstrated the feasibility of using a noninvasive genetic approach for genetic census of greater one-horned rhinoceros in the wild

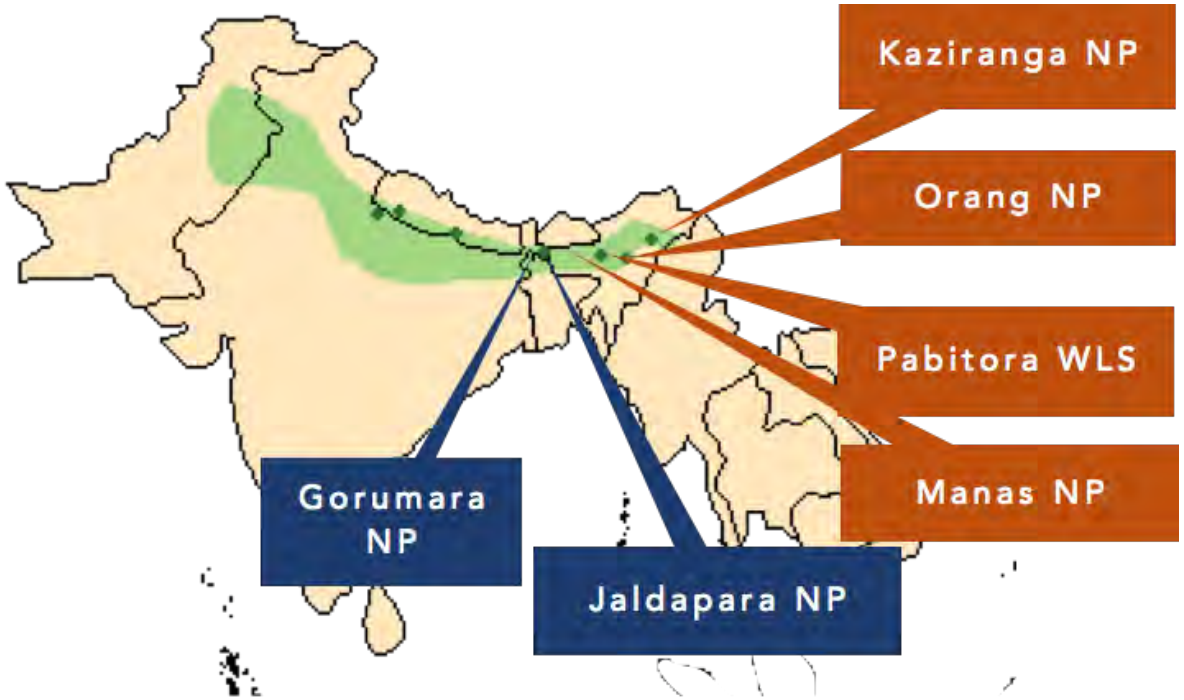


Questions

1. What is the contemporary level of genetic diversity in the wild rhino population of India?

2. What is the extent of population genetic structure and gene flow among the rhino bearing protected areas in Eastern India?

Greater One-horned Rhinos in Eastern India

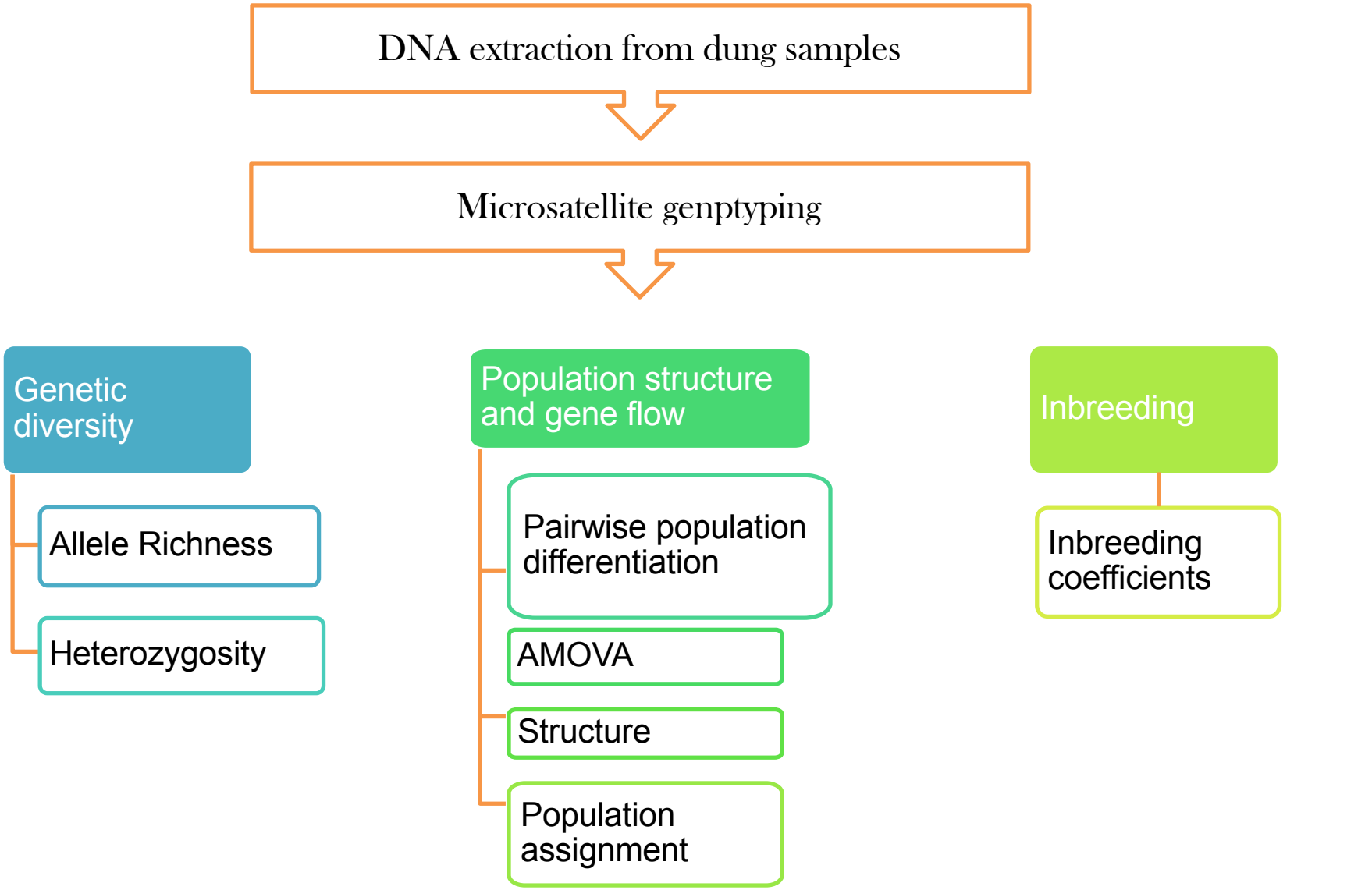


(Map source: Foose and van Strien.

80% of the Global population

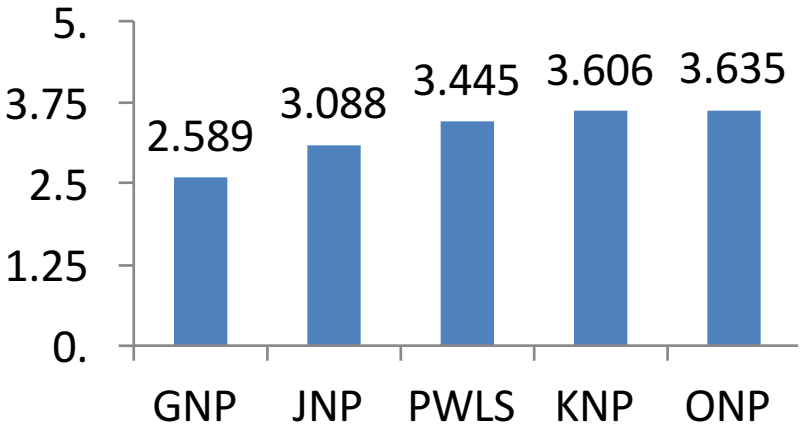
Dung sample = 292/ Individual rhinos = 238

1. Garumara = 60/ 43
2. Jaldapara = 36/ 34
3. Pobitora = 58/45
4. Orang = 54/ 44
5. Kaziranga = 84/ 72

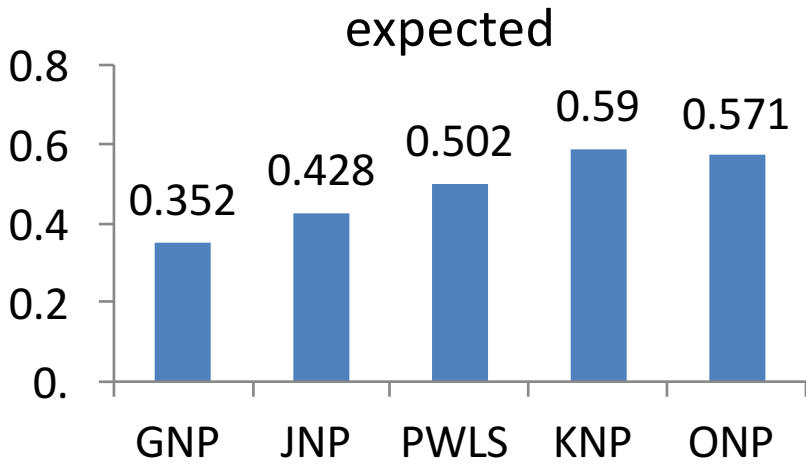

DNA extraction from dung samples
Microsatellite genptyping
Genetic diversity
Allele Richness
Heterozygosity
Population structure and gene flow
Pairwise population differentiation
AMOVA
Structure
Population assignment
Inbreeding
Inbreeding coefficients

Genetic Diversity

1. Allelic Richness



2. Heterozygosity



Population Differentiation

1. Pairwise population differentiation - Fixation Index (F_{ST})

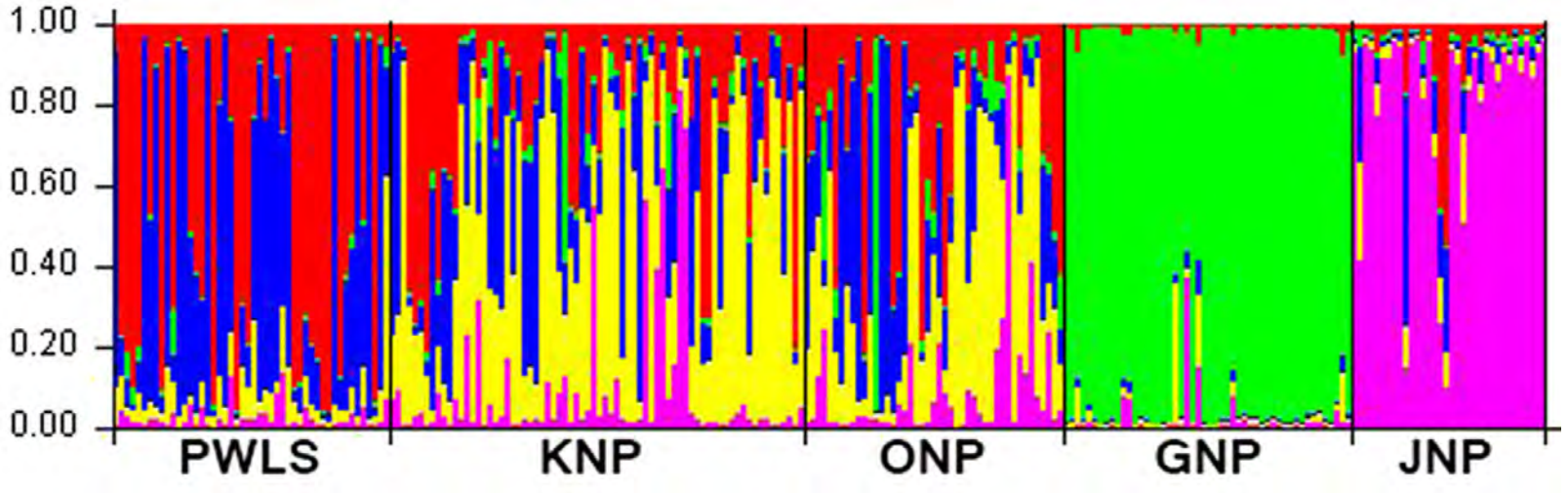
	PWLS	KNP	ONP	GNP	JNP
PWLS	0.00000				
KNP	0.06265	0.00000			
ONP	0.04018	0.02220	0.00000		
GNP	0.38221	0.25040	0.26971	0.00000	
JNP	0.16330	0.11575	0.09543	0.31290	0.00000

	Assam	Nepal
Assam	0	
Nepal	0.22	0

Zschokke et al. (2011)

Population Differentiation

2. STRUCTURE



Conclusions

1. Lower level of genetic diversity in Gorumara and Jaldapara, in comparison to rest of the rhino population in Eastern India

2. Significantly high genetic differentiation within West Bengal as well as from the Assam population

Recommendations

1. Recommend undertaking restocking of West Bengal populations in order to maintain long term genetic viability

2. Create alternate habitat and ensure retaining genetic diversity in multiple satellite populations

Impact of our Research

1. The genetic individual identification methodology optimized by by us has been endorsed by the Ministry of Environment Forest and Climate Change, Govt. of India, for use in developing a forensic DNA database of all the rhino populations in India



Impact of our Research

2. Based on our results, IUCN SSC Asian Rhino Specialist Group meeting held in November 2015 emphasized on undertaking restocking of the greater one-horned rhino population in West Bengal and creating alternative habitats for retaining genetic diversity of the species in the landscape.



Publications

1. Borthakur U, Das PK, alukdar A, Talukdar BK. 2016. Noninvasive genetic census of greater one-horned rhinos in Gorumara National Park, India – A pilot study for population estimation. Oryx, available on CJO2016. doi:10.1017/S0030605314001161.

2. Das PK, Borthakur U, Sarma H, Talukdar BK. 2015. Population genetic assessment of extant populations of greater one-horned rhinoceros (*Rhinoceros unicornis*) in India. European Journal of Wildlife Research. DOI 10.1007/s10344-015-0960-2 .

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- Asian Rhino Project, Australia
- Taiwan Forestry Bureau, CoA
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- Dr. Terri Roth and Dr. Monica Stoops Cincinnati Zoo and Botanical Garden, USA
- All my colleagues at Aaranyak

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Thank You

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Novel microsatellite markers for fecal genotyping of Javan and Sumatran rhinoceros

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Sumatran Rhinoceros (*Dicerorhinus sumatrensis*)



D. s. lasiotis

- Mainland (not shown)
- Declared extinct

D. s. sumatrensis

- Thailand, Peninsular Malaysia, and Sumatra
- Critically endangered

D. s. harrissoni

- Borneo
- Extinct from wild in Malaysian Borneo wild
- Critically endangered in Indonesian Borneo

“Modern” and Museum Specimens

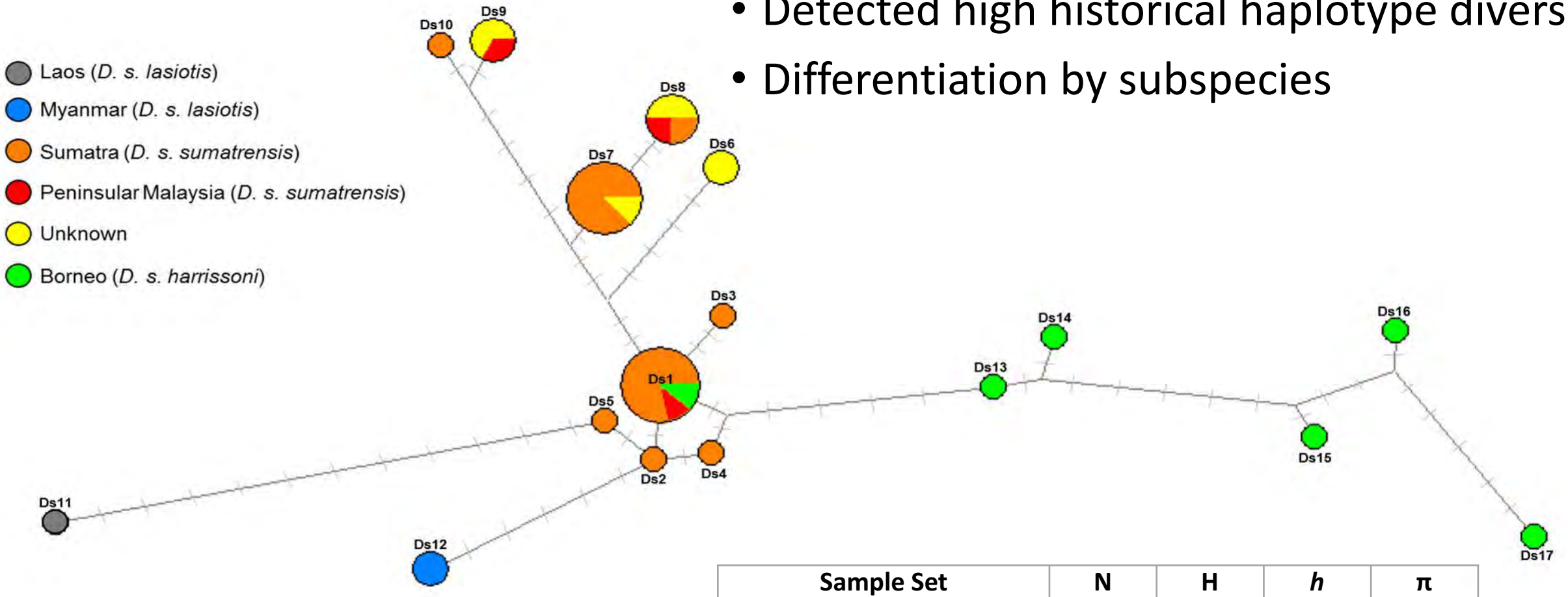
- 15 High quality samples (e.g., blood, tissue)
- From Sumatra and the Malay Peninsula



- 28 museum bone specimens
- Range wide collection locations
  - Myanmar (N = 2)
  - Laos (N = 1)
  - Peninsular Malaysia (N = 1)
  - Sumatra (N = 8)
  - Borneo (N = 7)
  - Unknown (N = 9)
- Collected from 1800s-1940
- Isolations completed in an ancient DNA lab



Mitochondrial sequence network of high quality and museum samples combined

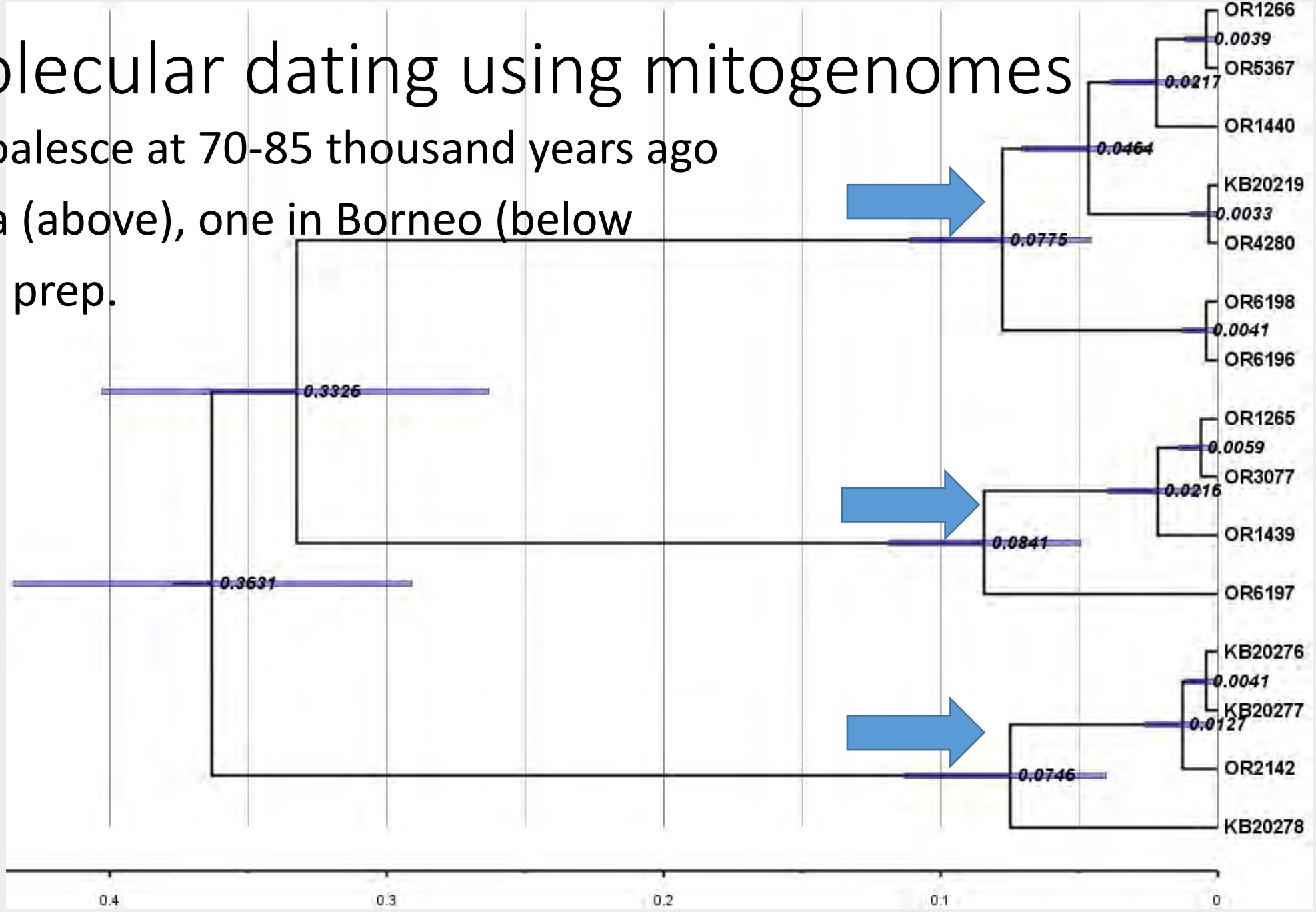


- Detected high historical haplotype diversity
- Differentiation by subspecies

Sample Set	N	H	*h*	π
All	39	17	0.90	0.04

Results: Molecular dating using mitogenomes

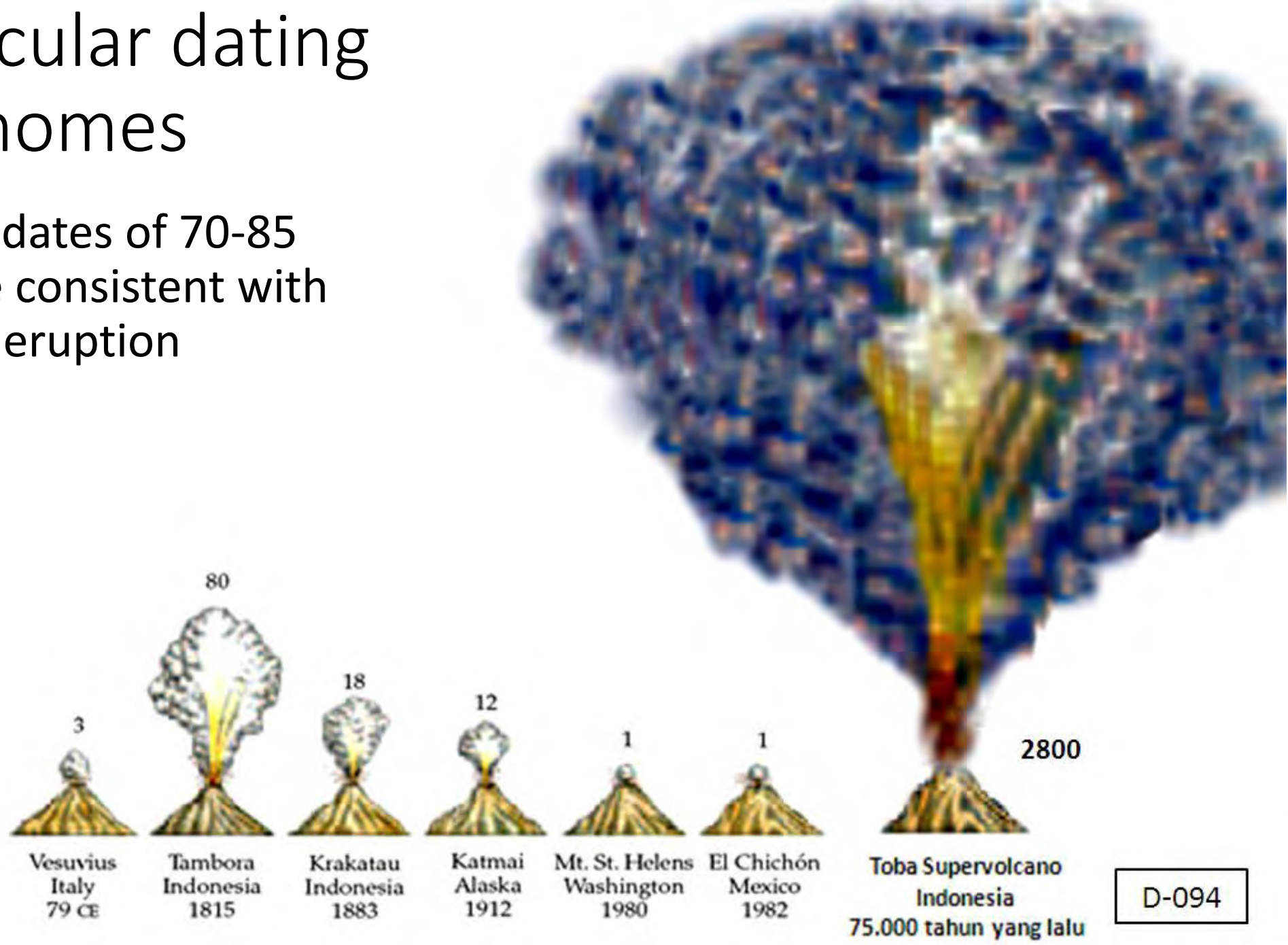
- Three clades coalesce at 70-85 thousand years ago
- Two in Sumatra (above), one in Borneo (below
- Steiner et al. in prep.



Results: Molecular dating using mitogenomes

- Three coalescence dates of 70-85 thousand years are consistent with effects of the Toba eruption





D-094

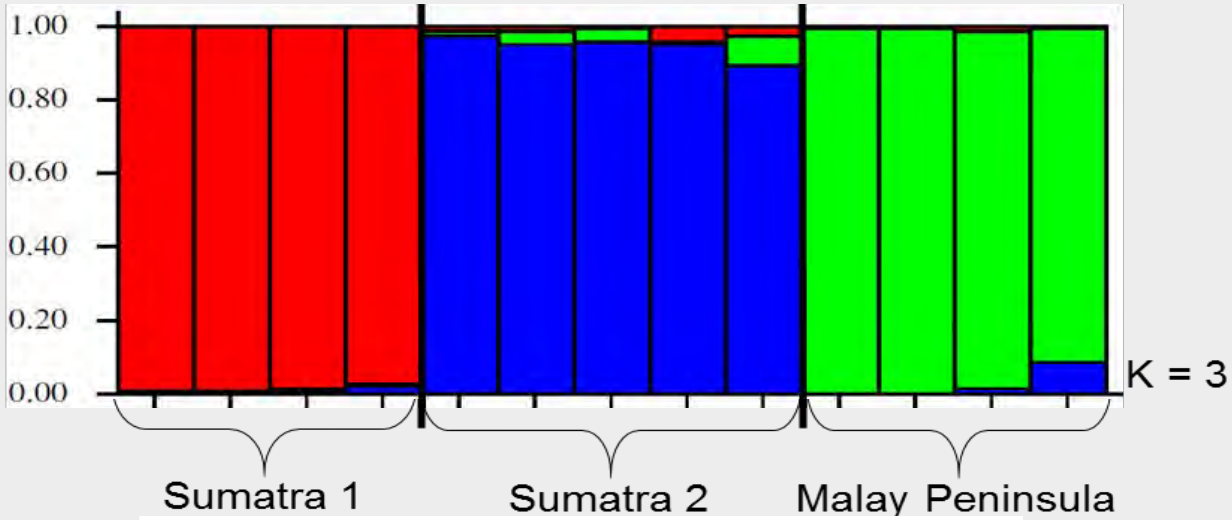
Results: Molecular dating using mitogenomes

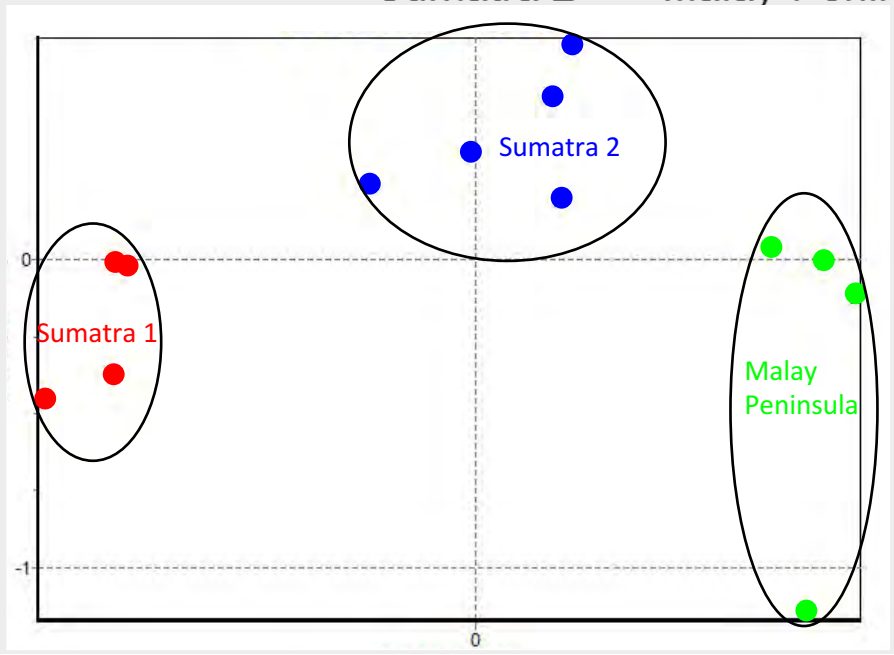
- Two clades in Sumatra diverged
- Two in Sumatra diverged ca 332 thousand years ago (kya)
- Borneo vs. Sumatra, 360 kya
- Outbreeding depression?
- Steiner et al. in prep.

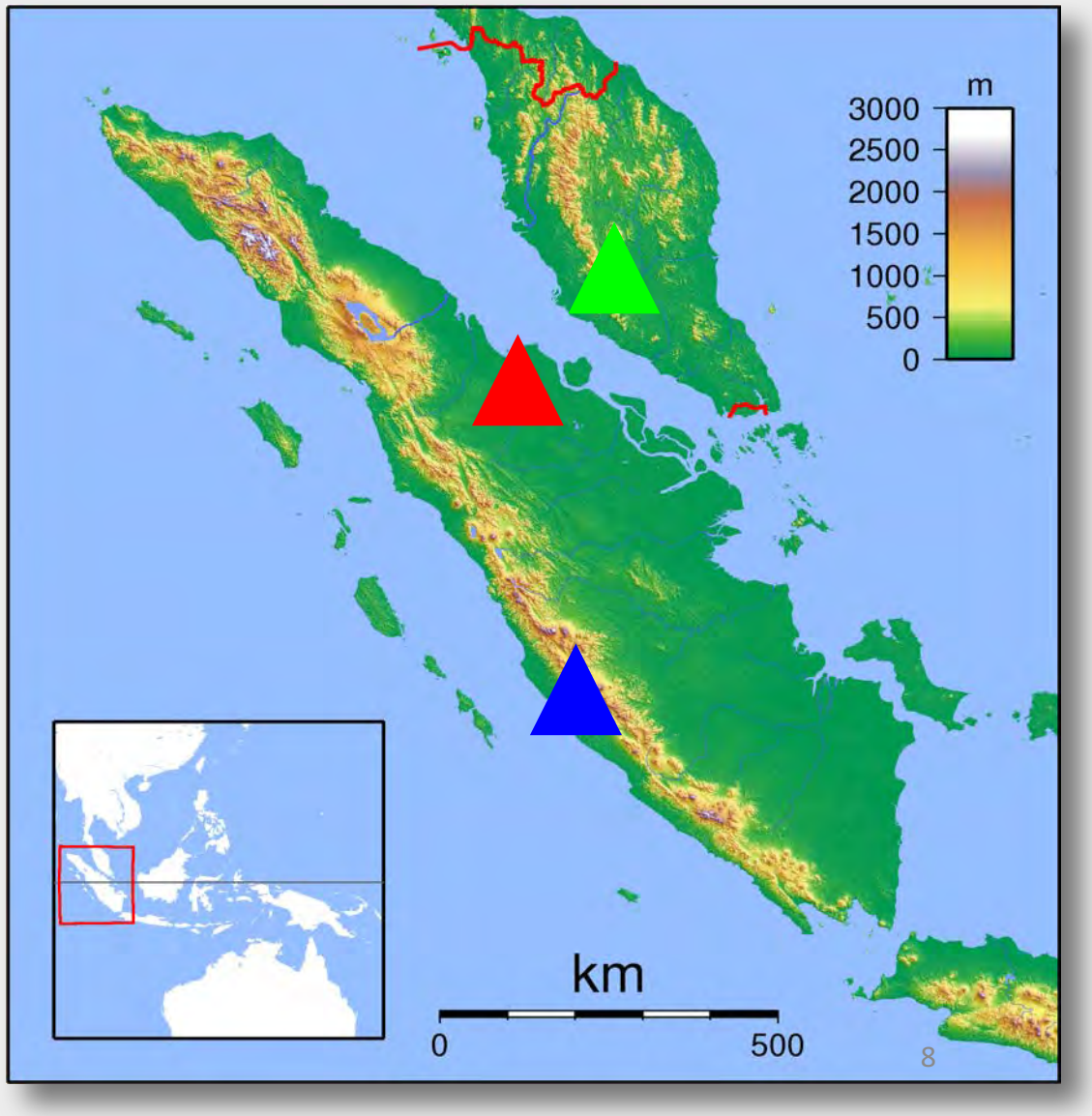




Population structure using nuclear markers

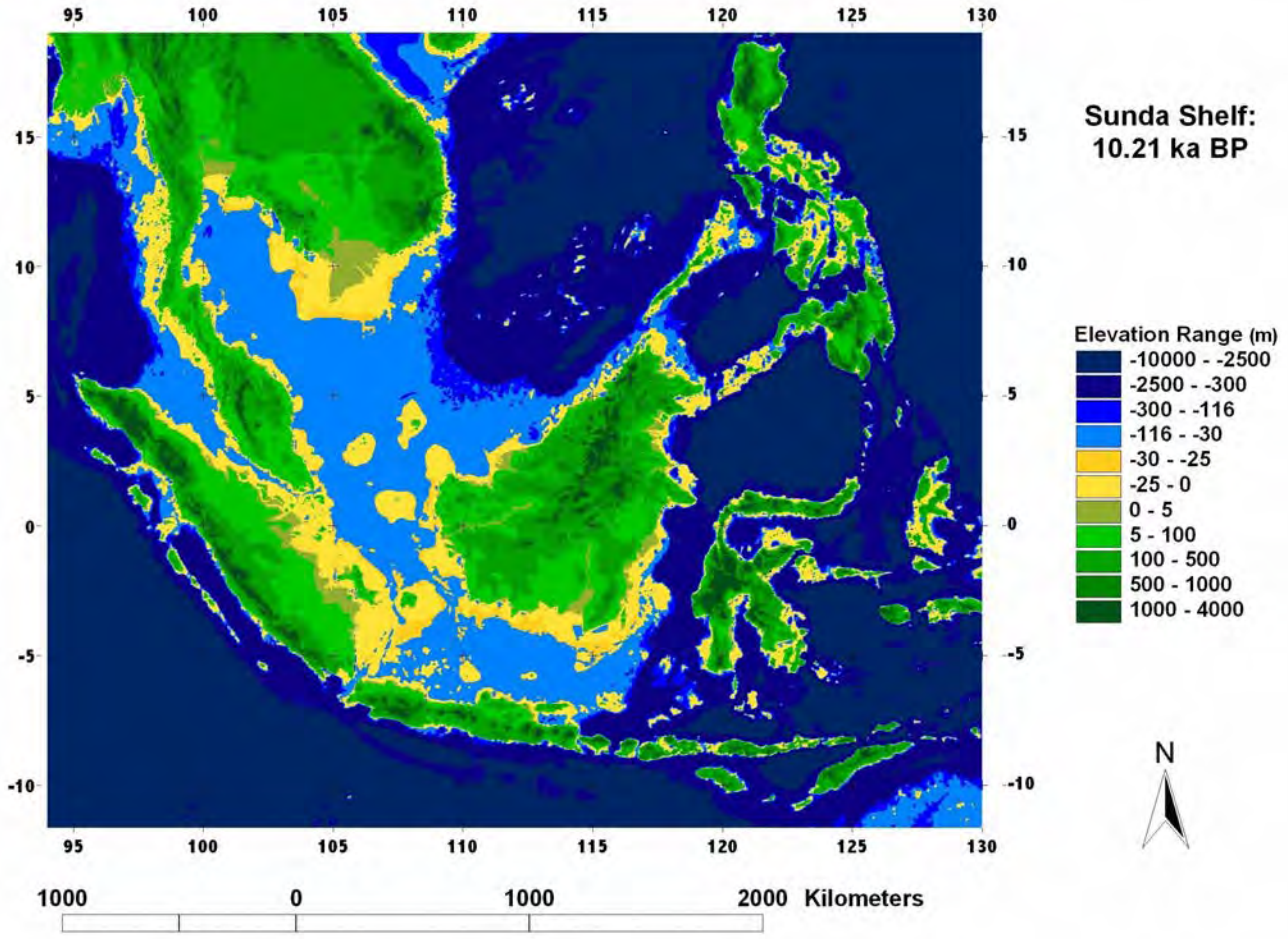






Conclusions: Molecular Patterns and Biogeographic History of Sumatran rhinoceros

- Mitochondrial Haplotypes
  - Geographically differentiated– corresponding to subspecies
  - Potential for outbreeding depression between Borneo and Sumatra, and within Sumatra?
  - Effects of Toba mega-eruption
- Microsatellites
  - Structuring from geographic barriers to gene flow
  - Barisan Mountains and Malacca Straits



DNA from Dung

- DNA from host's epithelial cells

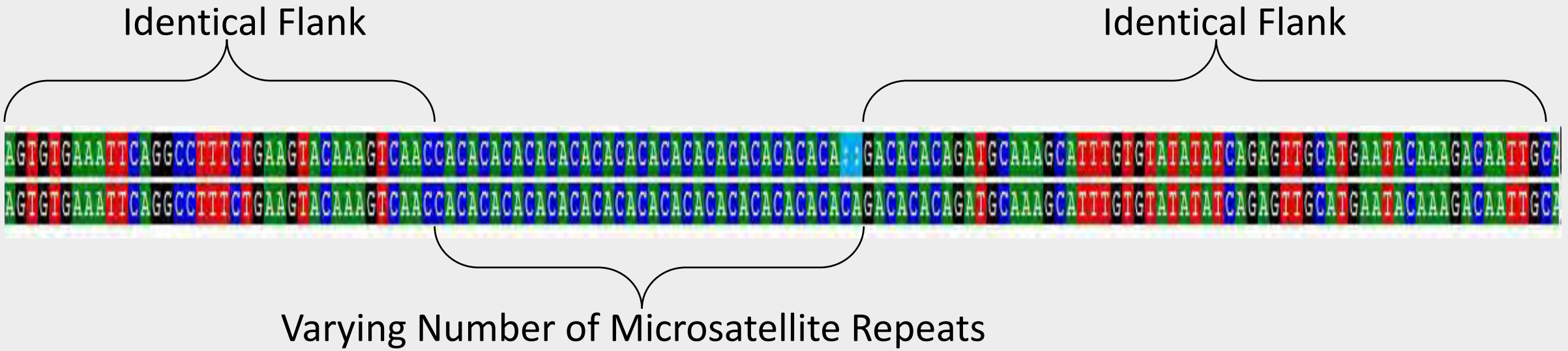
- Technical considerations
  - Collection conditions
    - Freshness
    - Environmental conditions
  - Sampling scheme
  - Quality
    - Degraded DNA
    - Low concentration
  - PCR inhibitors
    - Host diet (plant compounds)
    - Bile salts



Sumatran Rhinos Microsatellite Marker Design

- 2 Sumatran rhino DNA samples for genomic sequencing: Illumina MiSeq

- PolyMsat Precursor (Developed by Dr. Kai Zhao)
  - Uses NGS to automatically identify polymorphic microsatellite loci
  - **Target product size range *75 to 150 bp* (includes primers)**



Sumatran Rhino Markers

- Microsatellite identification
  - Validated novel bioinformatics pipeline (PolyMsat)
  - 344,176 read with microsatellite repeats (6+)
  - 861 potentially polymorphic
  - 55 assessed in lab
  - 29 polymorphic



- Low levels of diversity
  - $A = 2.4$; $H_O = 0.30$
  - High fixation index - $F_{IS} = 0.44$
  - 10 and 17 loci for individual identity ($p < 0.0001$)

- Allow for censusing studies and biological surveys

PCR Optimization for Fecal Samples (Sumatran and black rhinos)

1. PCR Inhibitor Removal: 0, 1, or 2 treatments
2. DNA dilutions: undiluted, 1:2, or 1:10

3. Enzymes: AmpliTaq Gold or AccuPrime Taq
4. Final $MgCl_2$ concentrations: 1.5mM - 4.0mM

5. Annealing Temperatures: 66 – 56°C or 60 – 50°C
6. PCR Elongation Length: 30s, 10s, or 5s
7. Cycle Number
   - Per annealing temp: 3, 4, or 5
   - Total: 45 or 60

8. Reaction Volume: 10, 20, or 40µl
9. DNA Extraction Protocol Modifications

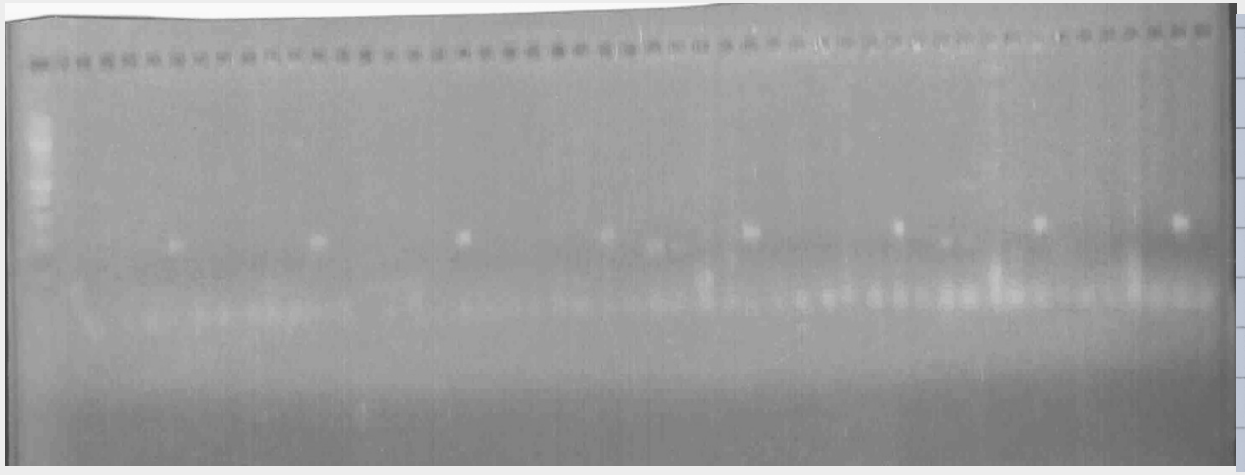
PCR Inhibition

Reagent Specificity

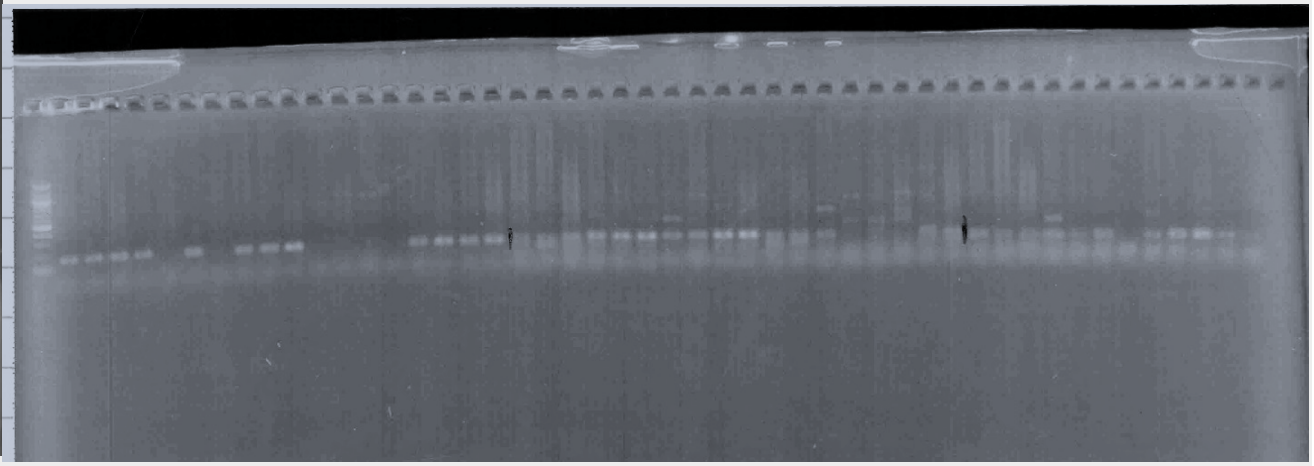
PCR Cycling Conditions

Low Template Concentration

Results. Final Optimized Protocol



Conditions:
Unmodified extraction
AmpliTaq Gold
10ul Reaction volumes
2.0mM $MgCl_2$
Thermal profile
- 2 cycles per annealing temp
- Touchdown 60 – 50C
- 45 second elongation step
- 45 cycles



Conditions:
Modified extraction
Zymo treatment 1x
AmpliTaq Gold
40ul Reaction volumes
Thermal profile
- 4 cycles per annealing temp
- Touchdown 66 – 56C
- 10 second elongation step
- 45 cycles

Varied:
3 $MgCl_2$ concentrations
- 3.0mM
- 2.5mM
- 1.5mM

Genetic diversity of the modern Sumatran rhinoceros individuals at 18 novel microsatellite loci (of 40 developed); *sufficient to distinguish among individuals, including siblings*

Locus	A	F_{IS}	H_E	H_O	P_{ID}	Total P_{ID}	$P_{ID(sib)}$	Total $P_{ID(sib)}$
Disu542	2	-0.091	0.212	0.231	0.65	0.6542	0.81	0.8115
Disu501	2	-0.063	0.508	0.538	0.38	0.2493	0.60	0.4879
Disu556	2	0.529	0.518	0.250	0.38	0.0939	0.60	0.2907
Disu863	3	0.040	0.480	0.462	0.35	0.0326	0.61	0.1762
Disu448	2	0.520	0.471	0.231	0.40	0.0131	0.62	0.1100
Disu201	2	0.842*	0.471	0.077	0.40	0.0053	0.62	0.0687
Disu847	4	0.445	0.545	0.308	0.30	0.0016	0.56	0.0387
Disu393	2	-0.200	0.323	0.385	0.52	0.0008	0.73	0.0281
Disu733	3	1.000*	0.537	0.000	0.31	0.0003	0.57	0.0160
Disu149	4	0.048	0.726	0.692	0.14	<0.0001	0.44	0.0070
Disu783	3	0.318	0.668	0.462	0.20	<0.0001	0.48	0.0033
Disu050	3	0.865*	0.551	0.077	0.33	<0.0001	0.57	0.0019
Disu748	3	0.104	0.428	0.385	0.41	<0.0001	0.65	0.0012
Disu476	3	0.286	0.532	0.385	0.29	<0.0001	0.57	0.0007
Disu151	2	0.442	0.271	0.154	0.58	<0.0001	0.77	0.0005
Disu127	3	0.514*	0.465	0.231	0.38	<0.0001	0.62	0.0003
Disu098	5	0.665*	0.725	0.250	0.14	<0.0001	0.44	0.0001
Disu582	3	1.000*	0.542	0.000	0.31	<0.0001	0.57	0.0001
Overall	2.83	0.440	0.499	0.284	--	--	--	--

Javan Rhinoceros (*Rhinoceros sondaicus*)



ESA: endangered

IUCN: critically endangered

CITES: Appendix I

Indian Rhinoceros (*Rhinoceros unicornis*)



ESA: endangered

IUCN: vulnerable

CITES: Appendix I

Javan rhinoceros microsatellite markers

- No modern nor even fecal samples available
- Collected museum samples: low quality DNA, low target DNA
- Ancient DNA laboratory used to extract DNA
- Mitochondrial DNA used to confirm origin in Java
- “Best” four samples subject to next generation sequencing



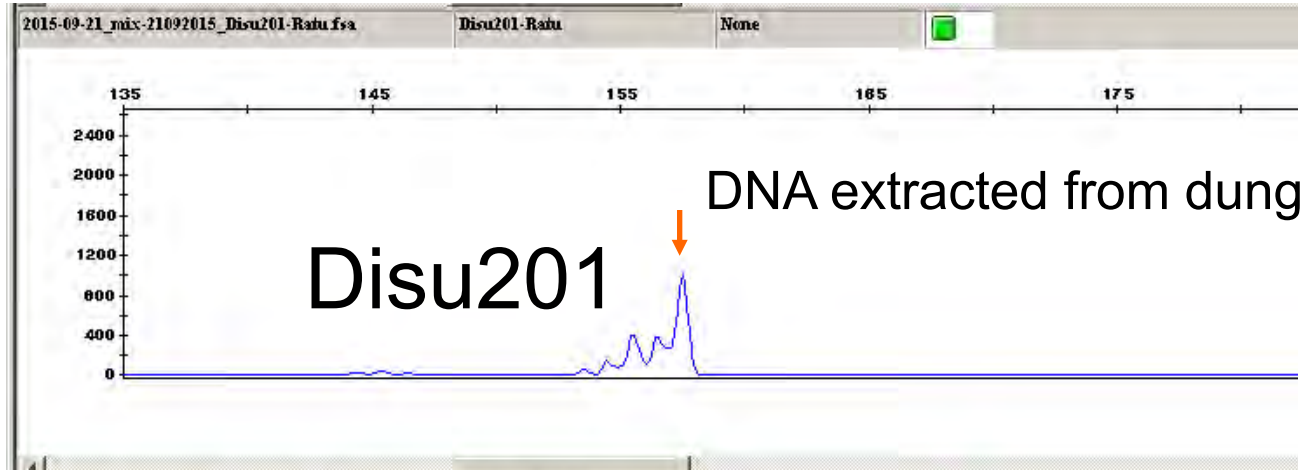
Javan rhinoceros microsatellite markers

- One specimen from Java, 1858, had >40% rhino DNA
- 276 million NGS reads
- 915 potentially polymorphic microsatellites
- >40 tested successfully in Indian rhino dung DNA
- At least 60 successful in Indian rhino will be taken by Y. Ishida to the Eijkman Institute



Molecular Censusing

- Non-invasive sampling
  - No direct observation or handling
  - Fecal material readily available
  - Systematic collection
- Endangered, rare, or elusive species
  - Blood and tissue difficult to obtain
  - Permitting / import restrictions
- Benefits
  - Increased accuracy
  - Study of population dynamics over time
  - Insight into population processes



Sumatran rhino microsatellite fragment, tested on DNA from fecal sample at Eijkman Institute (above)

Javan rhino microsatellite fragment, UIUC, tested on Indian rhino DNA from fecal sample (below)

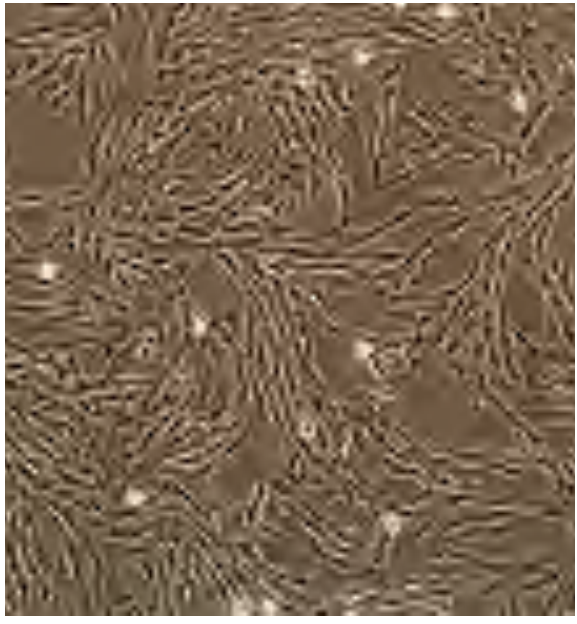


Law of population genetics:

The loss of genetic diversity each generation for a population of size N is 1/(2N)



Javan and Sumatran rhinos lose a few percent of their diversity every generation



There is an urgent need to preserve gametes or cell lines, which can be used (eventually) to reverse deleterious genetic drift…



Thanks to….

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[7]Institute of Conservation Research, San Diego Zoo Global, Escondido, CA, USA
[8]Department of Biology, Queen's University, Kingston, ON, Canada.

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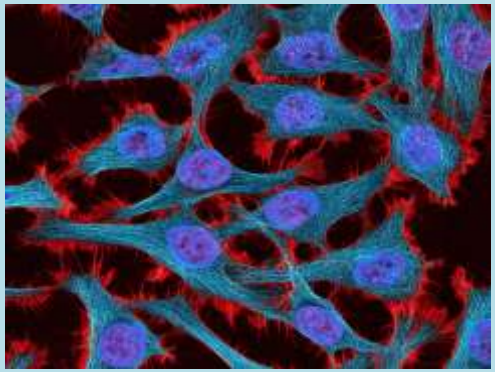
  - Dr. Burton Lim
  - Renata Martin
  - Dr. Oliver Ryder
  - Dr. Cynthia Steiner
  - Dr. Terri Roth
  - National Museum of Natural History of the Netherlands
  - National Museum of Natural History - Smithsonian
  - Palaeontological Museum Munich
  - National Museum of Natural History (Paris)
  - Natural History Museum of Bern
  - Natural History Museum Vienna
  - American Museum of Natural History
  - Indonesian National Government – sample collection permission
  - Malaysian National Government – sample collection permission

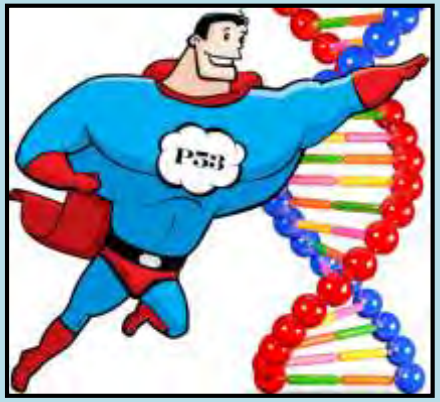
- Import assistance from USFWS – Memphis Wildlife Inspection Office

Elephants and Cancer

Can Elephants Help Us Treat Cancer?







Lisa M. Abegglen, PhD

18 November 2016

UNIVERSITY OF UTAH HEALTH CARE

HUNTSMAN CANCER INSTITUTE UNIVERSITY OF UTAH

THE UNIVERSITY OF UTAH





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Skin Cells (Fibroblasts)





Peto's Paradox

- Observation originally described in 1975 by Sir Richard Peto
- If all cells in the body have equal chance of accumulating cancer causing mutations, then large, long-lived animals should get more cancer
- Cancer incidence does not correlate with the number of cells in an organism



Elephants rarely get cancer!



Review

Cell

Peto's Paradox: evolution's prescription for cancer prevention

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[1] Genomics and Computational Biology Graduate Group, University of Pennsylvania, Philadelphia, PA, USA
[2] Department of Surgery, University of California San Francisco, San Francisco, CA, USA
[3] Helen Diller Family Comprehensive Cancer Center, University of California San Francisco, San Francisco, CA, USA

The evolution of multicellularity required the suppression of cancer. If every cell has some chance of becoming cancerous, large, long-lived organisms should have an increased risk of developing cancer compared with small, short-lived organisms. The lack of correlation between body size and cancer risk is known as Peto's paradox. Animals with 1000 times more cells than humans do not exhibit an increased cancer risk, suggesting that natural mechanisms can suppress cancer 1000 times more effectively than is done in human cells. Because cancer has proven difficult to cure, attention has turned to cancer prevention. In this review, similar to pharmaceutical companies mining natural products, we seek to understand how evolution has suppressed cancer to develop ultimately improved cancer prevention in humans.

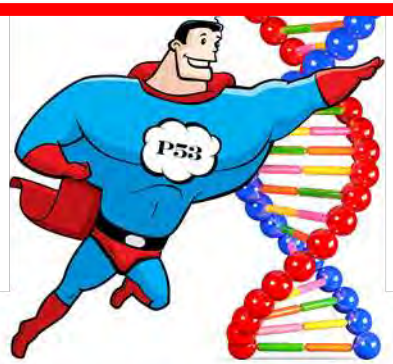
The evolutionary theory of cancer

Cancer (see Glossary) is a consequence of multicellularity and a striking example of multilevel selection. The theory of cancer initiation and progression is deeply rooted in evolutionary and ecological concepts [1]. Cancer develops through somatic evolution, with genetic and epigenetic instability generating fitness variation among the cells in a body (Box 1). Selection at the level of organisms has led to the evolution of tumor suppressor mechanisms, such as cell cycle check genes and apoptosis, which act as safeguards to prevent somatic mutations from propagating in the cell population. Nonetheless, cancer occurs at astonishingly high rates and can be responsible for 20–40% of total deaths in multicellular animals ranging from mice lifetime risk of an organism for developing cancer should also scale with its lifespan. It is well known that larger organisms generally have longer lifespans [4], which exacerbates this problem.

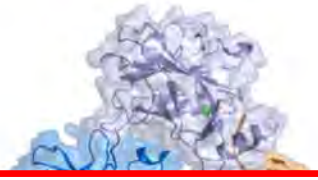
There appears to be no correlation between body size, longevity and cancer across species and the absence of such a relationship is referred to as Peto's paradox [2,5]. Cancer rates across multicellular animals only vary by

Glossary





TP53: The Guardian of the Genome



- **Half of all human tumors**

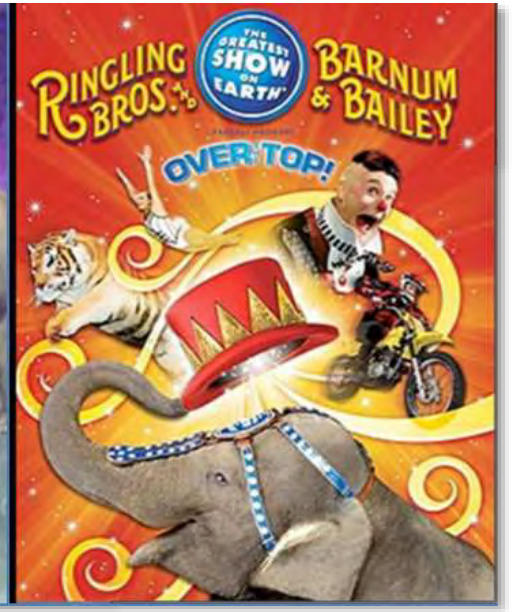
Elephants = 40 copies!!!

- Li-Fraumeni Syndrome = **1 copy (100% risk)**



Utah's HOGLE ZOO





Solving Peto's Paradox

Figure 3. African Elephant and Human Peripheral Blood Lymphocytes and Sensitivity to Ionizing Radiation

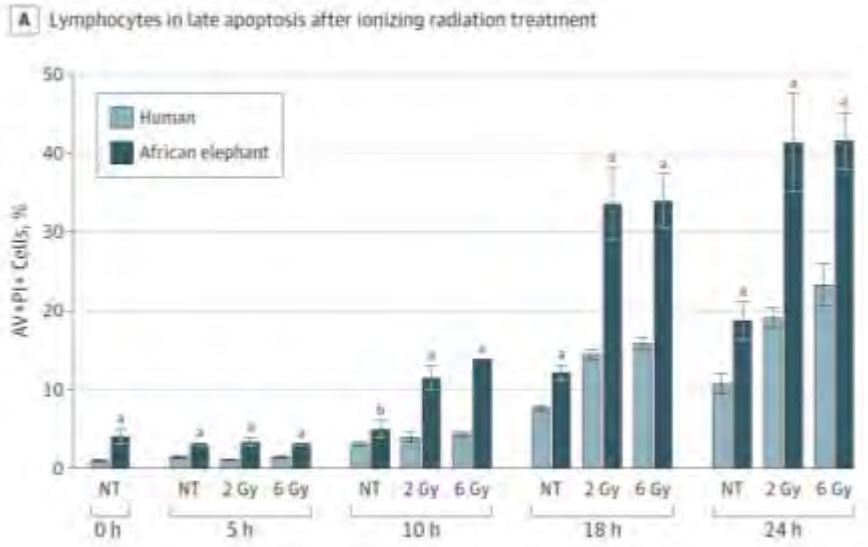
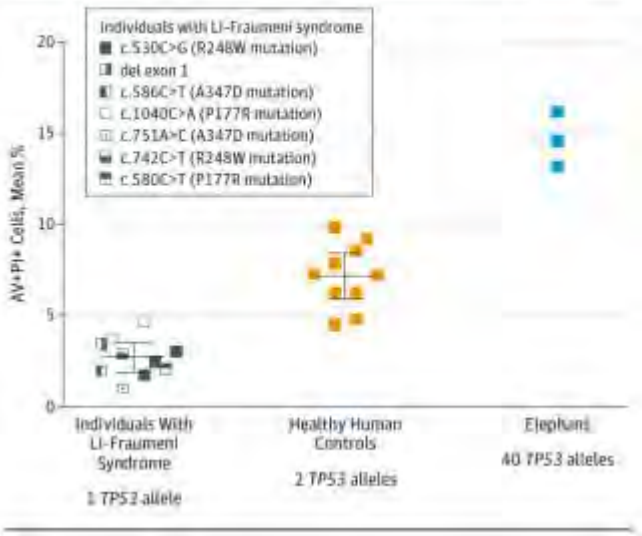
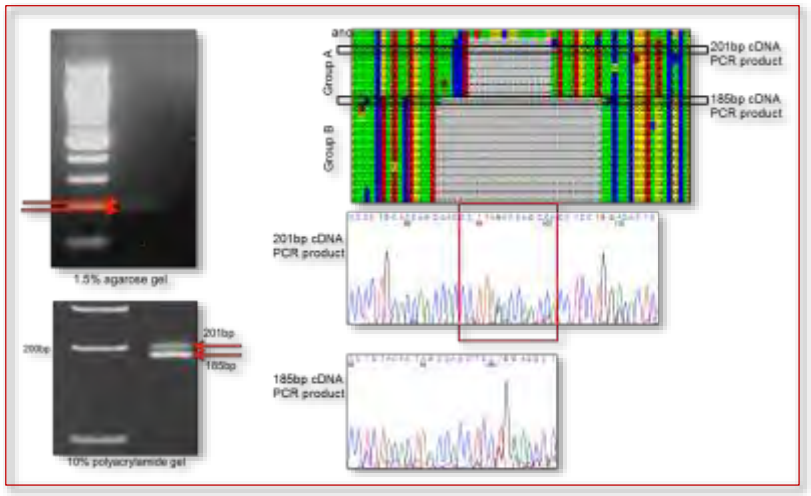
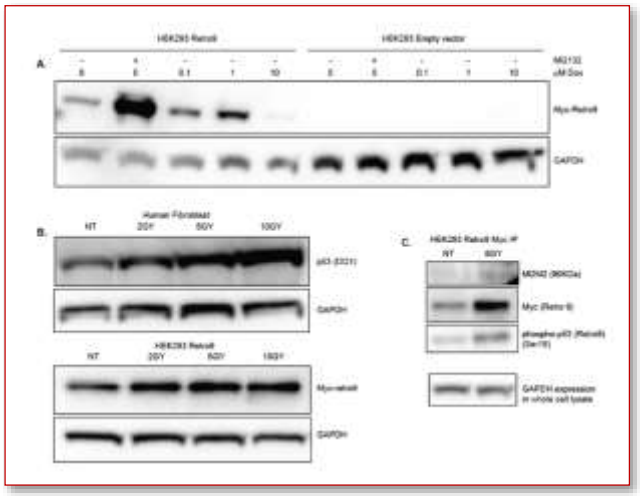


Figure 4. Apoptosis Response Relative to Number of Copies of *TP53*

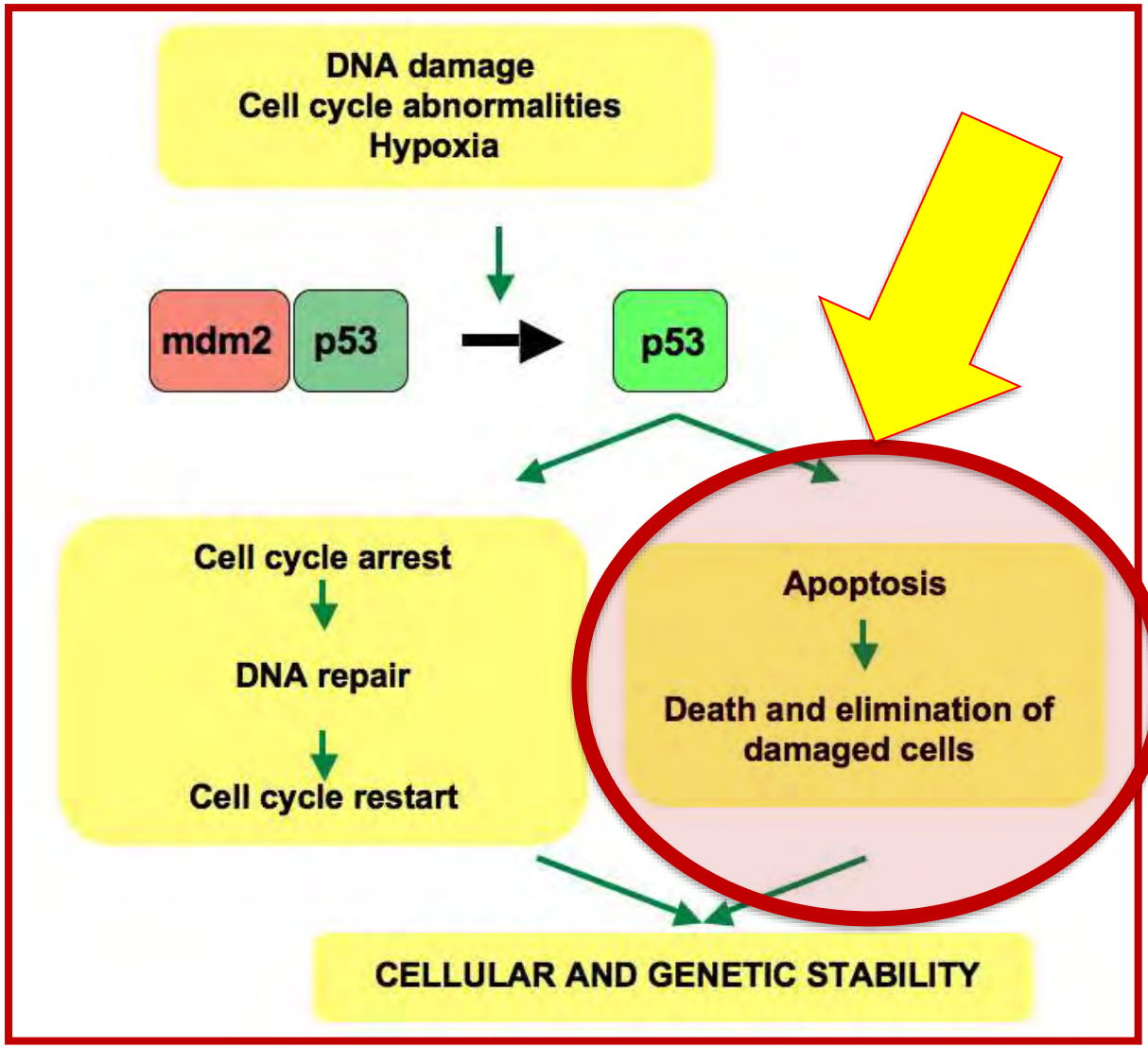






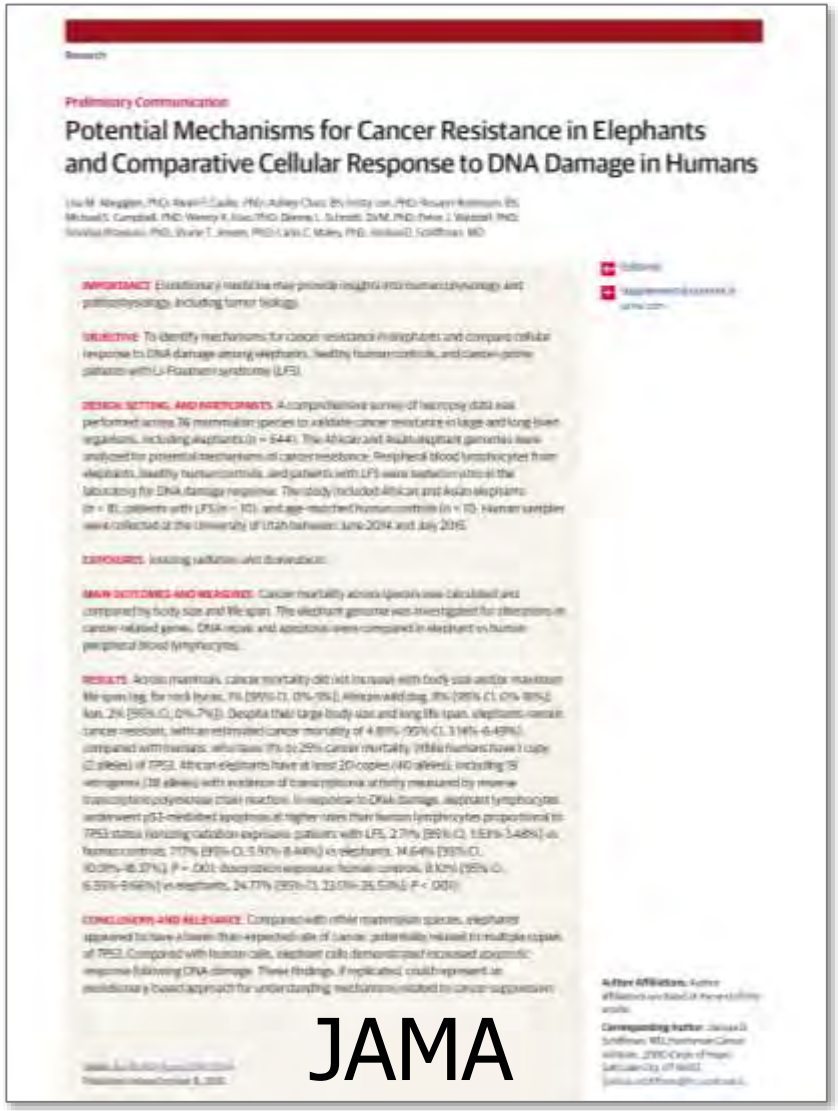
Abegglen et al. JAMA 2015

Solving Peto's Paradox



Peer Read – *and* – Peer Reviewed





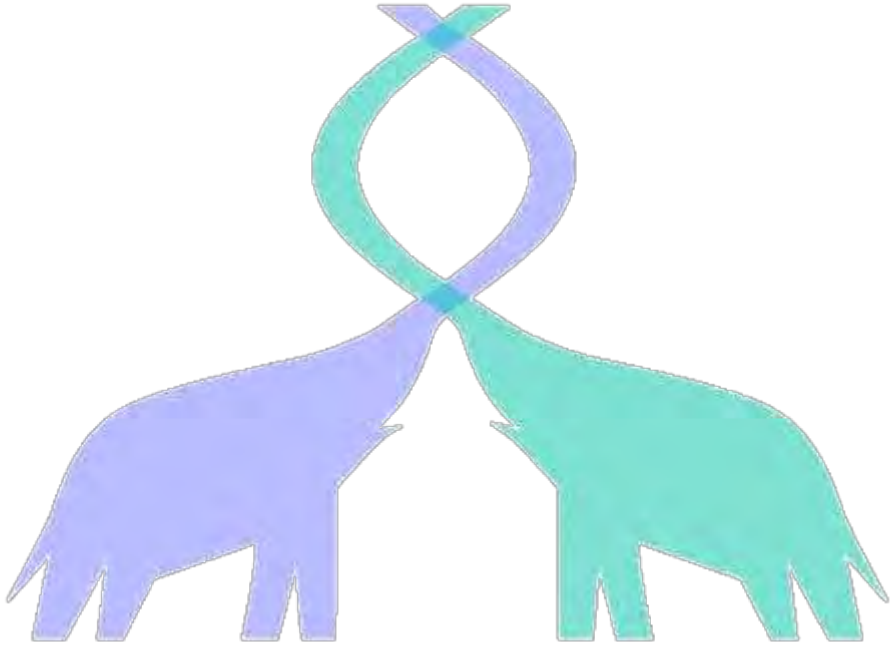






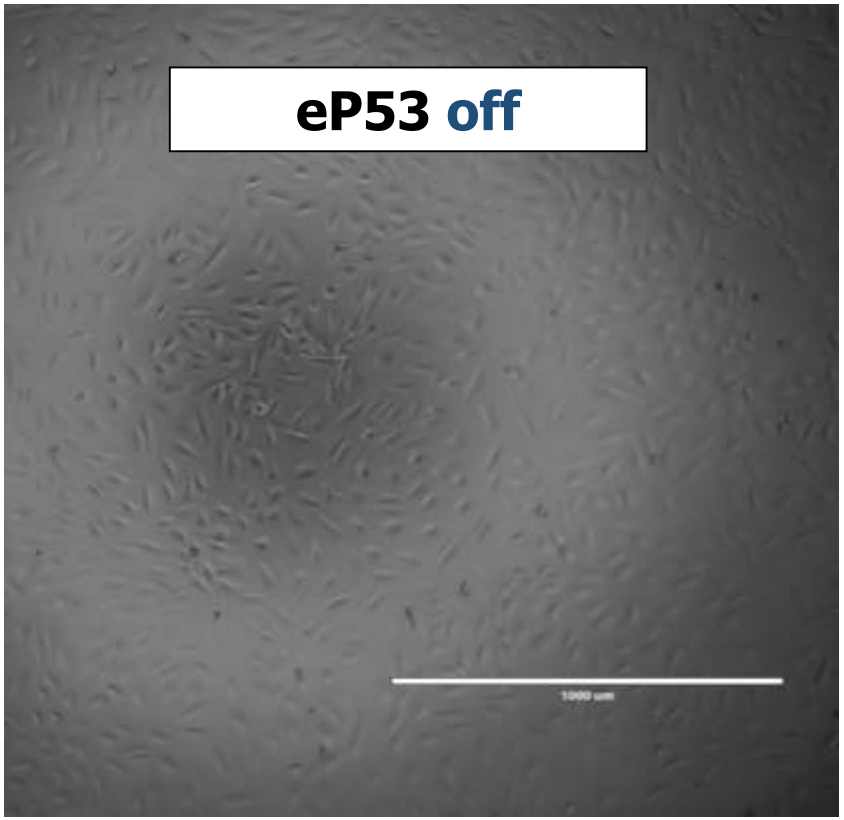


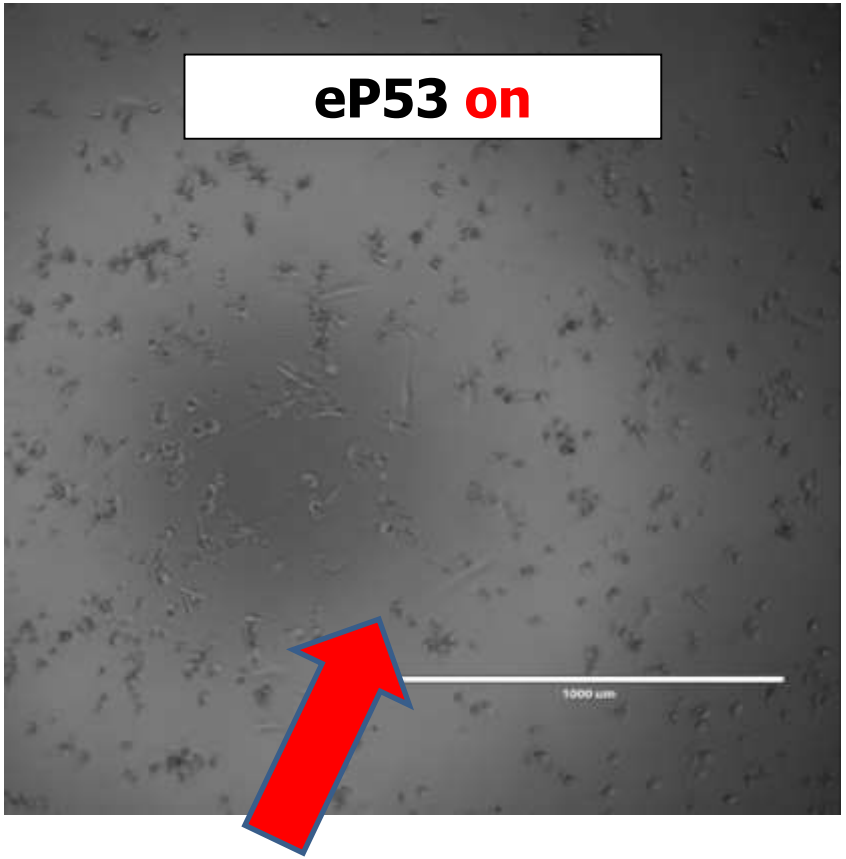
New Elephant Data!



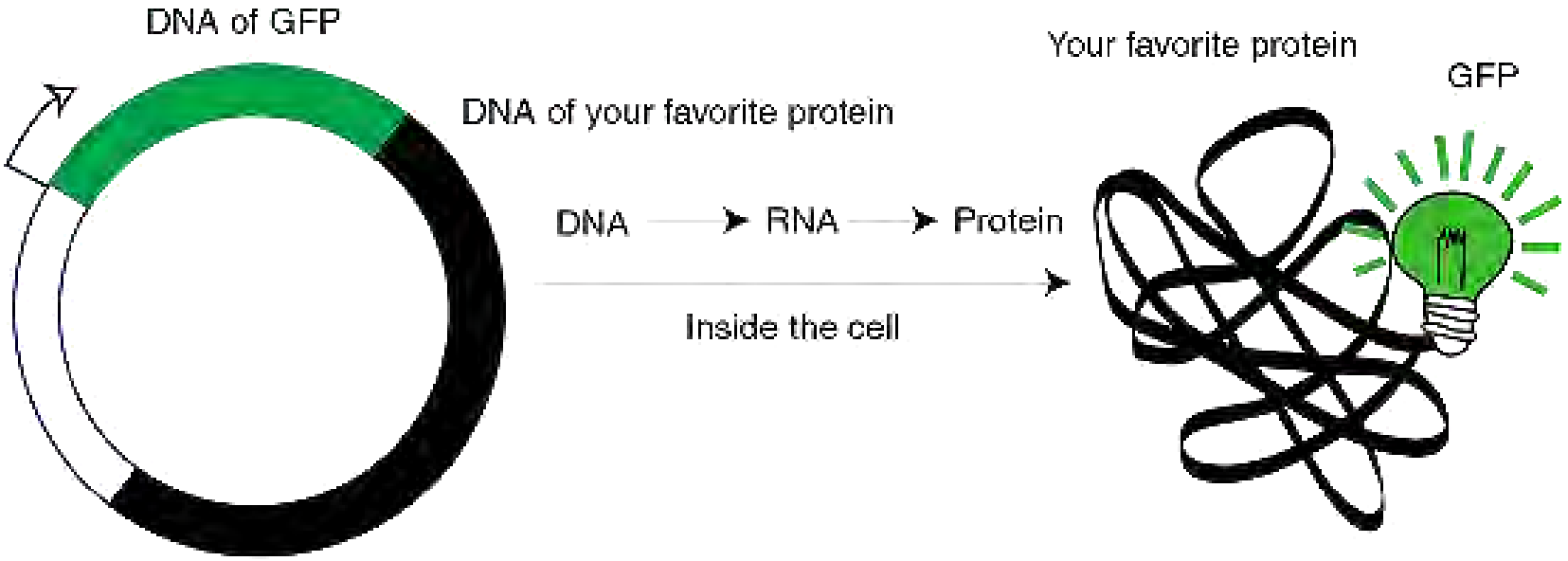


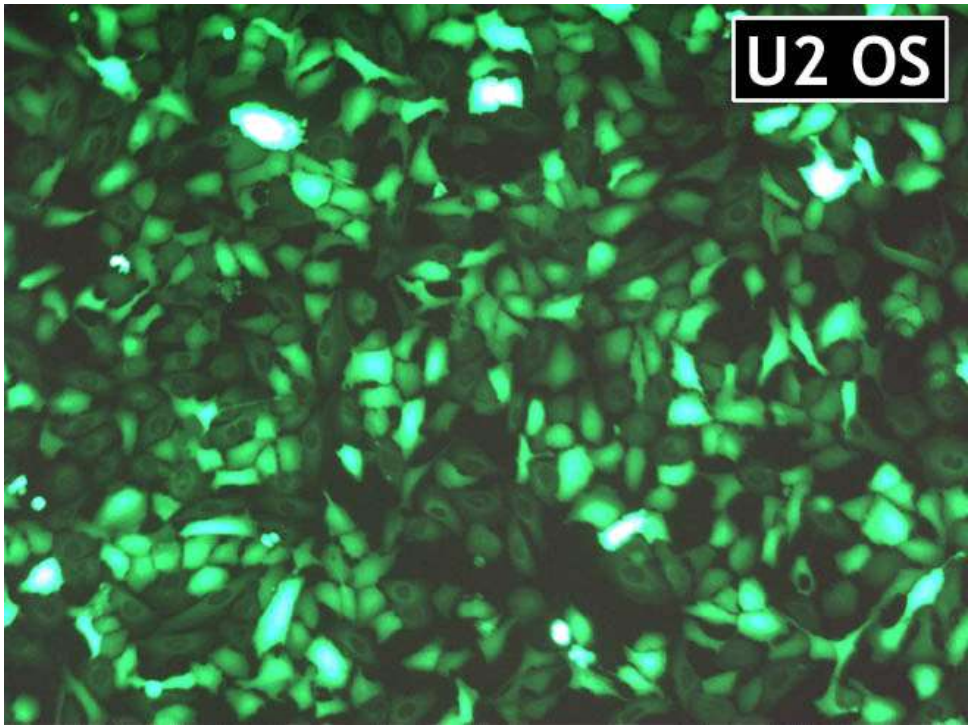
New Data: eP53 in human osteosarcoma (bone tumor)



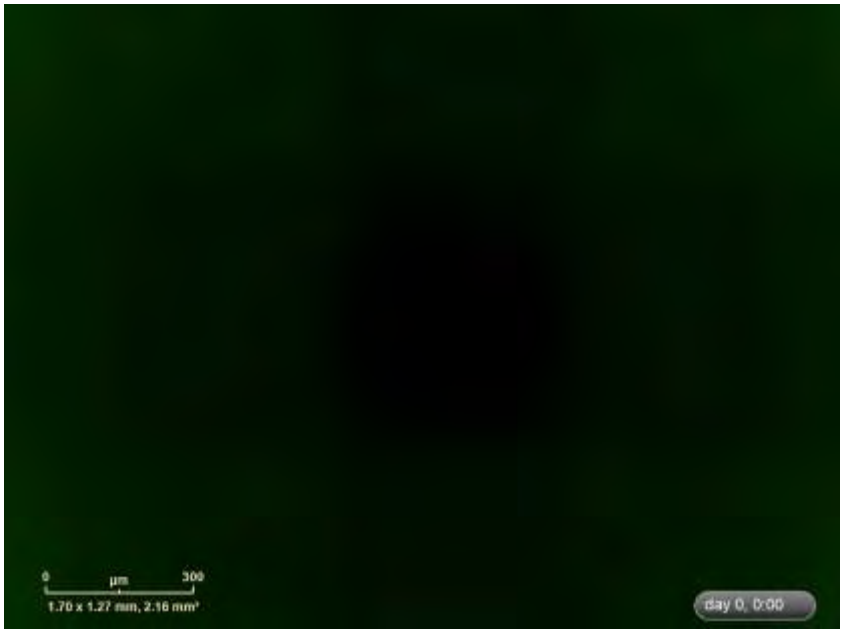
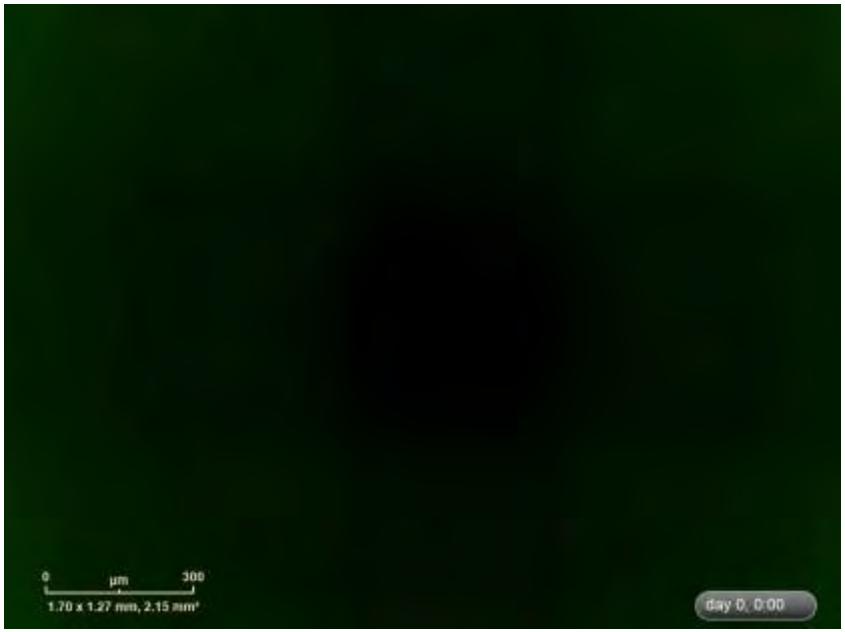


Cancer cells go into death cycle **more than 20 times as much** when elephant p53 is turned on.


DNA of GFP
DNA of your favorite protein
DNA
RNA
Protein
Inside the cell
Your favorite protein
GFP

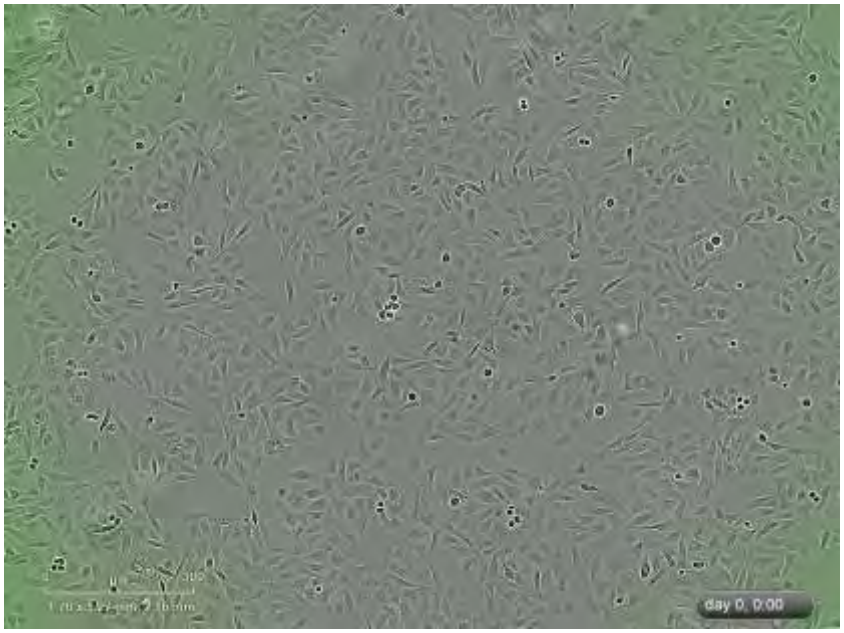

U2 OS

Elephant p53 in human osteosarcoma (bone tumor)

GFP Only	GFP-EP53 Retro 9
	
GFP turns on **(green)** but without EP53 the cancer cells continue to live	Elephant p53 turns on **(green)** and cancer cells shrink and die

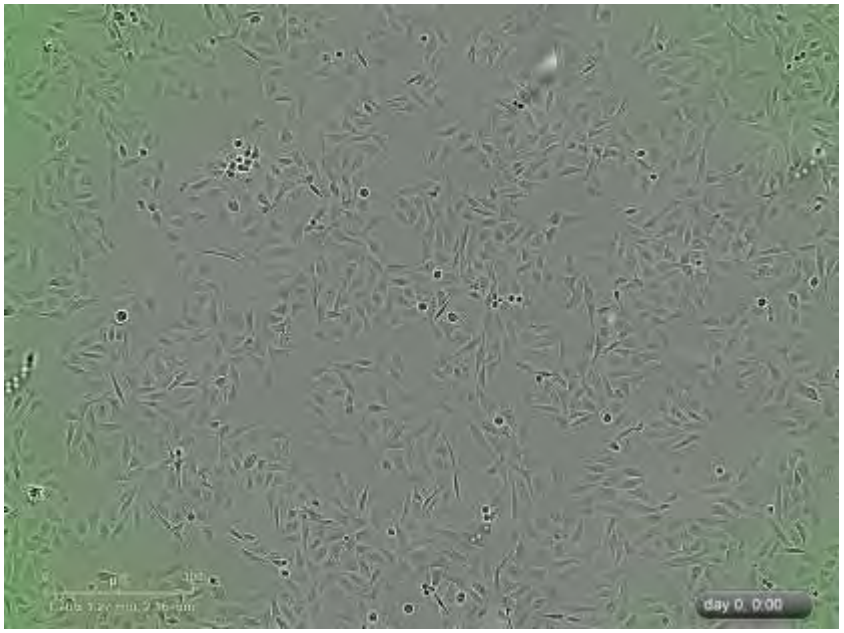
Elephant p53 in human osteosarcoma (bone tumor)

GFP Only



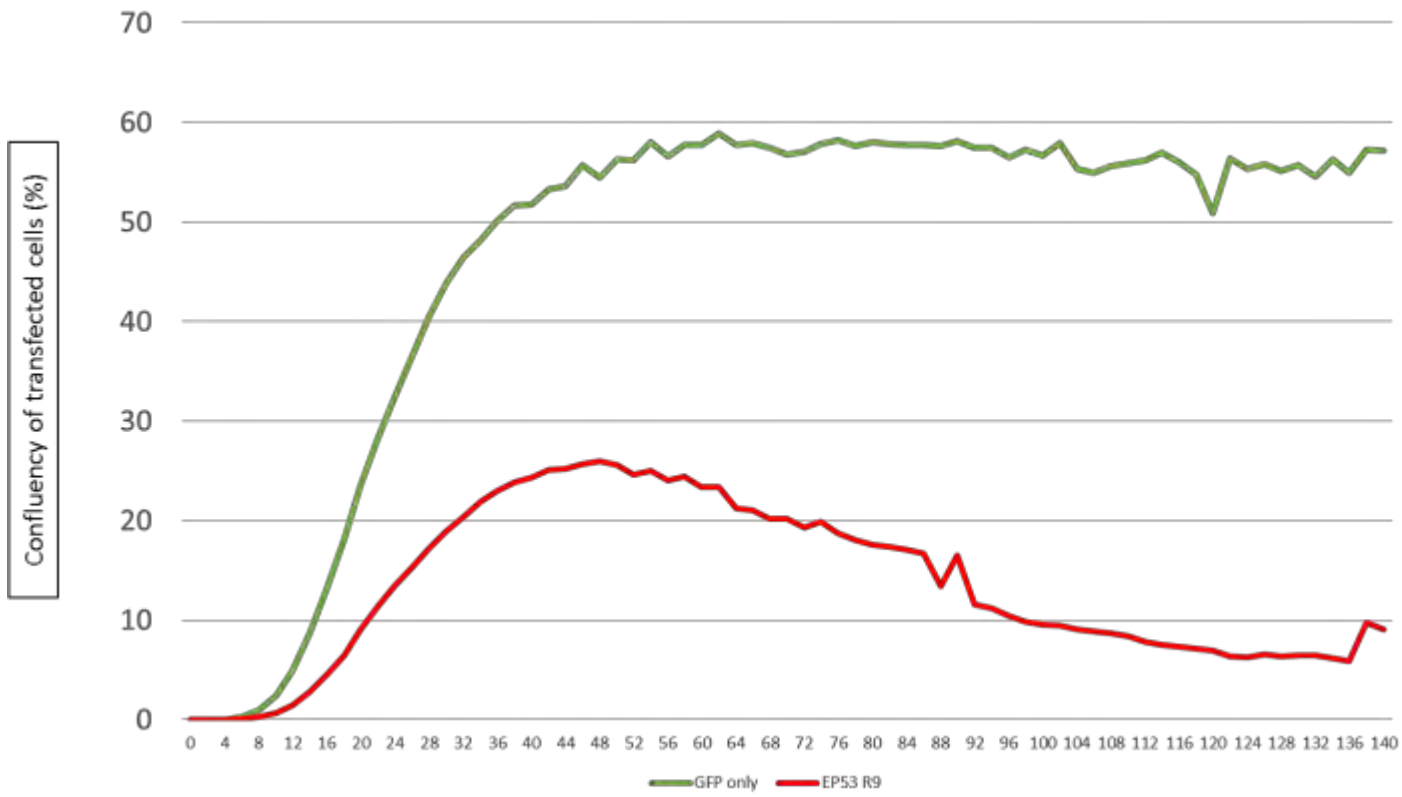
GFP turns on **(green)** but without EP53 the cancer cells continue to live

GFP-EP53 Retro 9



EP53 turns on **(green)** and cancer cells shrink and die

Percentage cancer cells over time



GFP only cells continue to live

EP53 Retro 9 cells die over time (without any chemo)

Hours elapsed since transfection



Elephant p53 in human **prostate cancer** (PC-3 Cell Line)

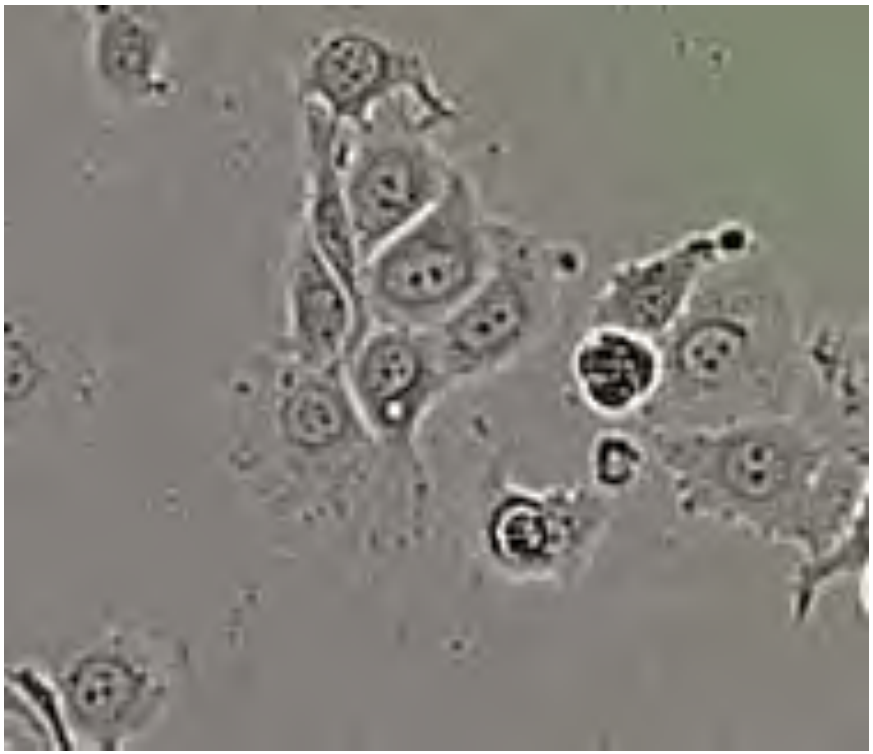
GFP-EP53 Retro 9



EP53 turns on **(green)** and this prostate cancer cell **explodes into pieces !!!!!!**

MCF7 – Breast cancer (human)

GFP + PI



GFP turns on **(green)** but without EP53 the breast cancer cells continue to expand and glow. PI **(red)** is marker of cell death, but does not associate with GFP marker.

GFP-*EP53 Retro9* + PI



EP53 turns on **(green)** and breast cancer stops growing, shrinks, and dies (even faint EP53 triggers cell death). PI **(red)** cell death overlaps with EP53.



Schiffman LAB

Working to understand who develops cancer and why



- **Lab Members**
  - **Joshua Schiffman**
  - **Lauren Donovan ***
  - **Rosann Robinson**
  - **Cristhian Toruno**
  - **Luke Maese**
  - **Trent Fowler**
  - **Kristina Moore**
  - **Genevieve Couldwell**
  - **Kelvin Chang**
  - **Liz Fedak**
  - **Jamie Gardiner**
  - **Schuyler O'Brien**
  - **Kiera Jorgensen**

Intermountain Primary Children's Hospital

Li-Fraumeni Syndrome LFS Association

Huntsman Cancer Institute University of Utah

Kneaders Bakery & Cafe

Titan Tough 21 Foundation

Utah's Hogle Zoo



Ringling Bros. Barnum & Bailey Center for Elephant Conservation

Ringling Bros. Children's Fund

Soccer for Hope

- **Clinical Study Coordinators**
  - **Bella Johnson, Cris Cristenson, Lucy Hayes, Laurel Smith, Janet Jimenez, Branda Quintana, Julie Fernlund**
- **Dennis Schmitt & Wendy Kiso *(Ringling Bros. CEC)*, Eric Peterson *(Hogle Zoo)*, Avi Schroeder & Mor Goldfeder (Technion), Aleah Caulin *(Driver Group)*, Carlo Maley *(ASU)*,**





Lisa.Abegglen@hci.utah.edu

Assessment of Human Elephant Conflicts and mitigating measures taken to resolve the conflict in Dharamapuri Forest Division, Southern India



Presented By

Arivazhagan Chelliah
Indo American Wildlife Society
Chennai, India
www.iaws.in

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Introduction of Study Area

- Dharamapuri is an inland district, lies as the tri-junction of Karanataka, Andhra Pradesh and Tamilnadu state.

- It is located in the north Western portion of Tamilnadu lying between latitudes N11° 47’ - 12° 53’ and longitudes E 77° 28’ – 78° 45’.

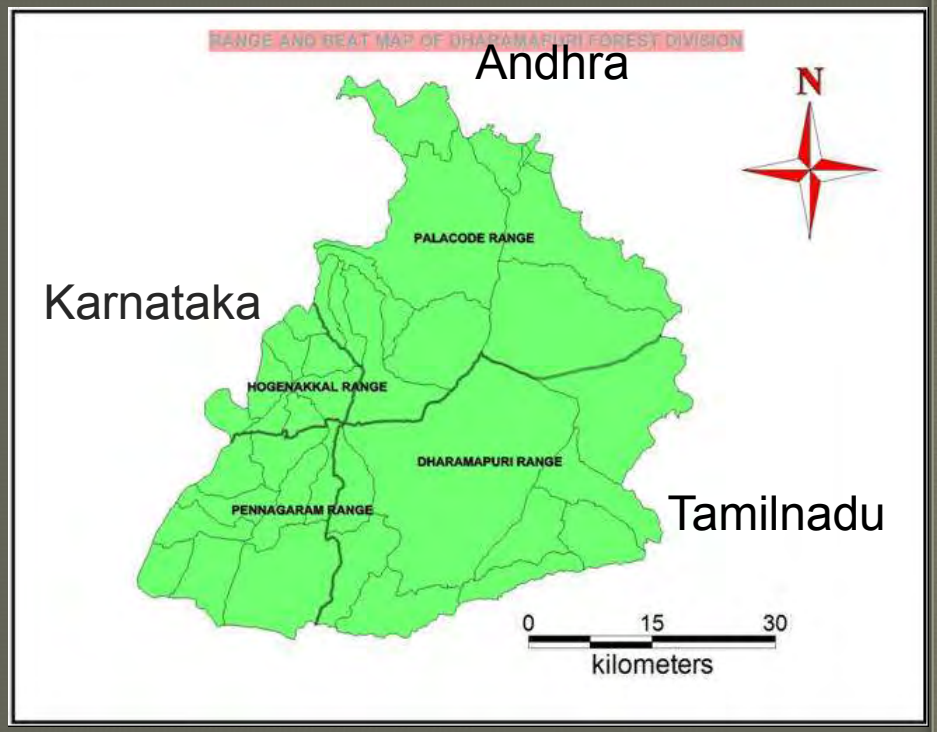
- It has a total area of 961.9km^2 which is divided into three taluks, altitude ranges from 380 to 1395 m above mean sea level.

- The forest of this region is coming as part of Eastern Ghats. Guttirayan is the highest peak in the division (1395.10 m asl).

- The district is surrounded by Vellore, Thiruvannamalai and Villupuram district in the east, Salem district in the south, Karnataka in the west, and Andhra Pradesh in the north.

Introduction cont…

- Dharamapuri forest division is divided into four administrative forest ranges namely Dharamapuri , Pennagaram , Palacode and Hogenakkal forest Range, except Dharamapuri range other three ranges have elephants, from Pennagaram Range Elephants are occasionally visiting the Dharamapuri Range.



Objectives

- To assess the Human – Elephant Conflict situation in the Dharamapuri forest division
- To identify the various mitigating measures being adopted by the department and local villagers
- To evaluate the effectiveness of the mitigating measures in relation to technical features of the barriers
- To assess the people's attitude towards Elephant conservation in the division and
- To suggest management recommendation for conservation of Wildlife in the division

Methodology

- A rapid survey using a questionnaire 139 farmers in 74 villages located across the division were sampled .
- The villages sampled were selected through stratification of conflict level to ensure unbiased sampling.
- Over the last nine years (2006–2014), crop compensation applications were received in total from 74 villages located in and around the forest division was collected .
- The villages were categorized into three conflict zone, viz., low conflict (where the total number of farmers affected ranged 1–10 over one year), medium conflict (10-20 farmers affected) and high conflict (>20 farmers affected)





Methodology Cont..

- The questionnaire was designed to evaluate factors such as frequency of elephant visits and types of mitigating measures being adopted by the farmers.
- Sixty one farmers who had installed electric fences (both solar power fence and AC charged battery fences) and 78 farmers without fencing were interviewed,





Major Crops Cultivated



Ragi



Sugarcane

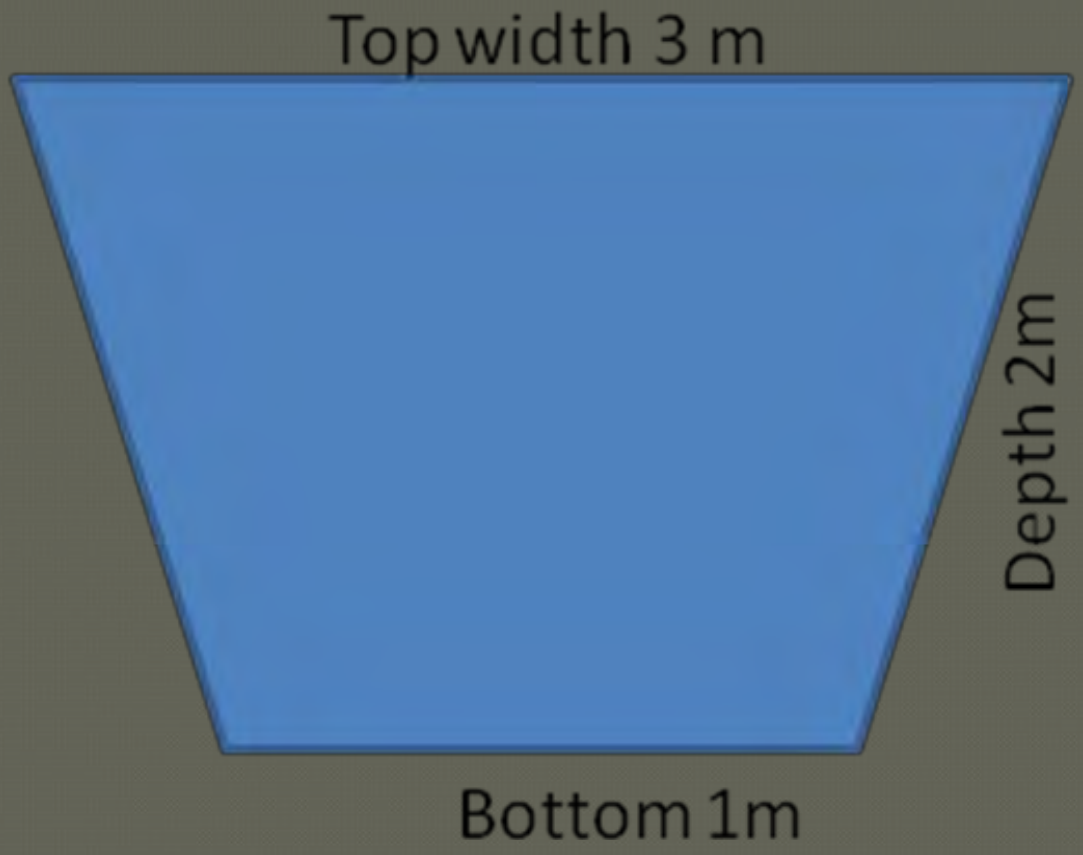


Paddy



Turmeric

Design of EPT



Evaluating EPT in Field







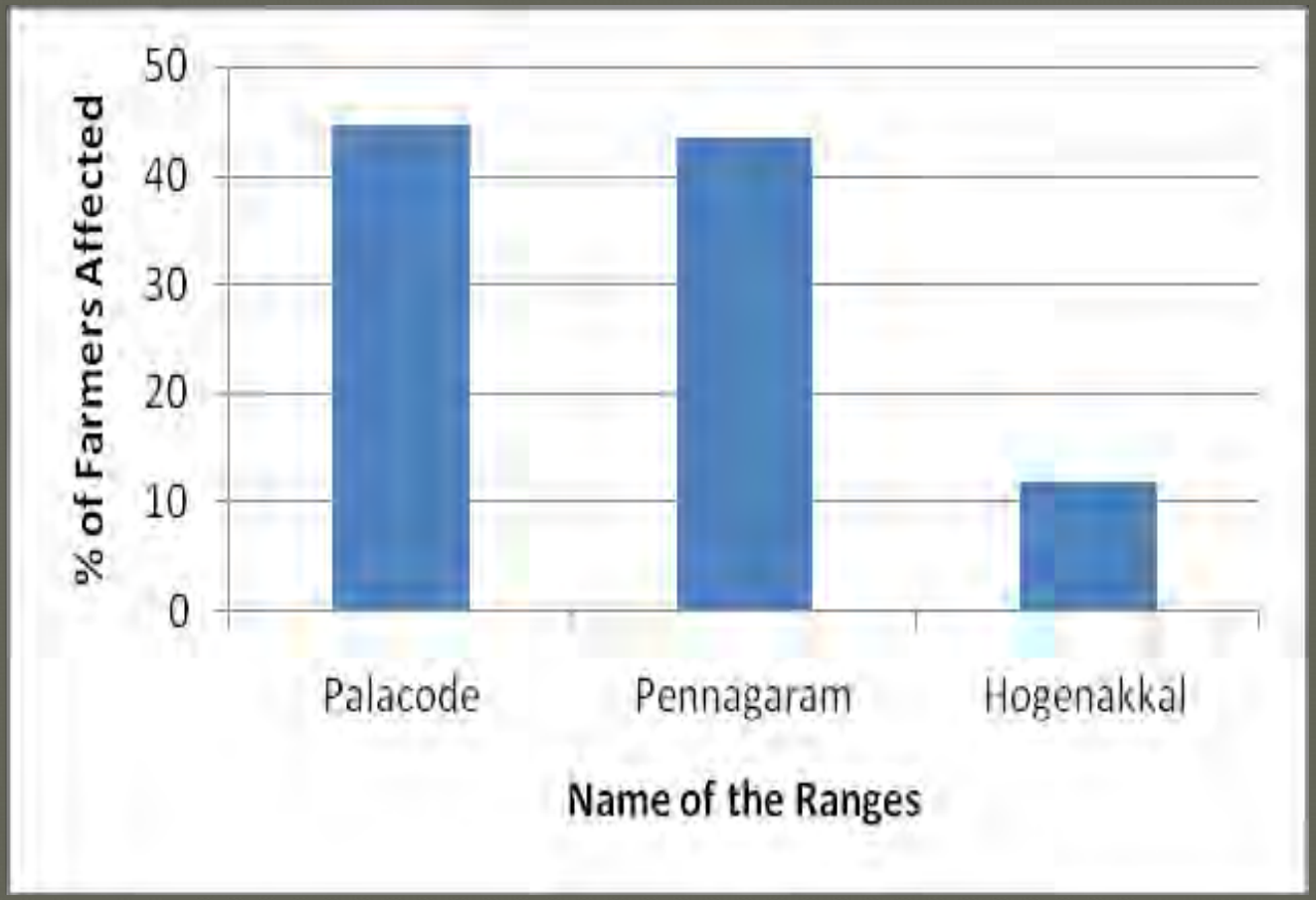


Results

Range Wise Information on Human Elephant Conflict

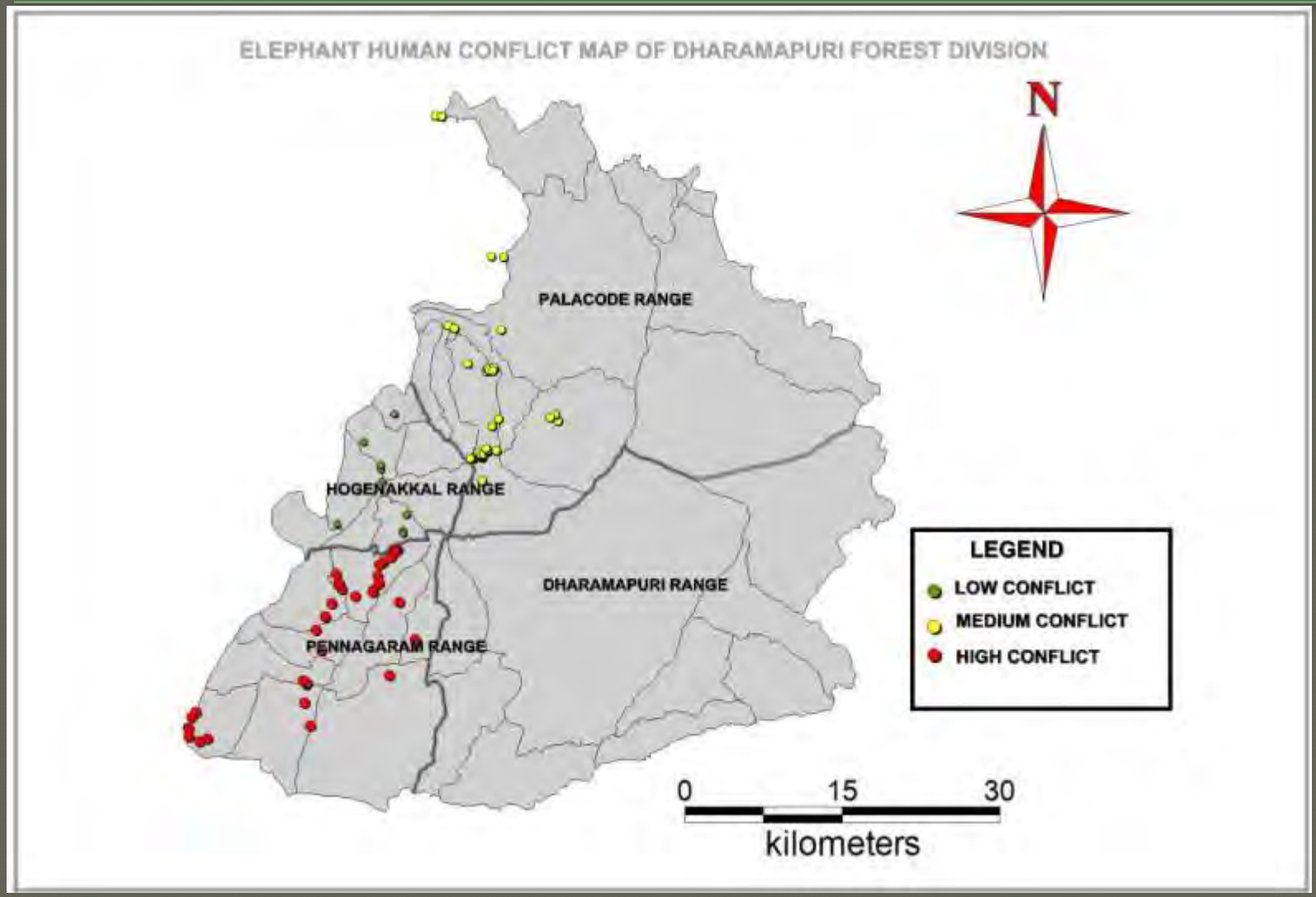
S.No	Name of the Range	No. of Village Visited	No. of Formers affected	Species involved in Conflict
1	Pennagaram	19	33	Elephant
2	Palacode	12	34	Elephant
3	Hogenakkal	8	9	Elephant

Results

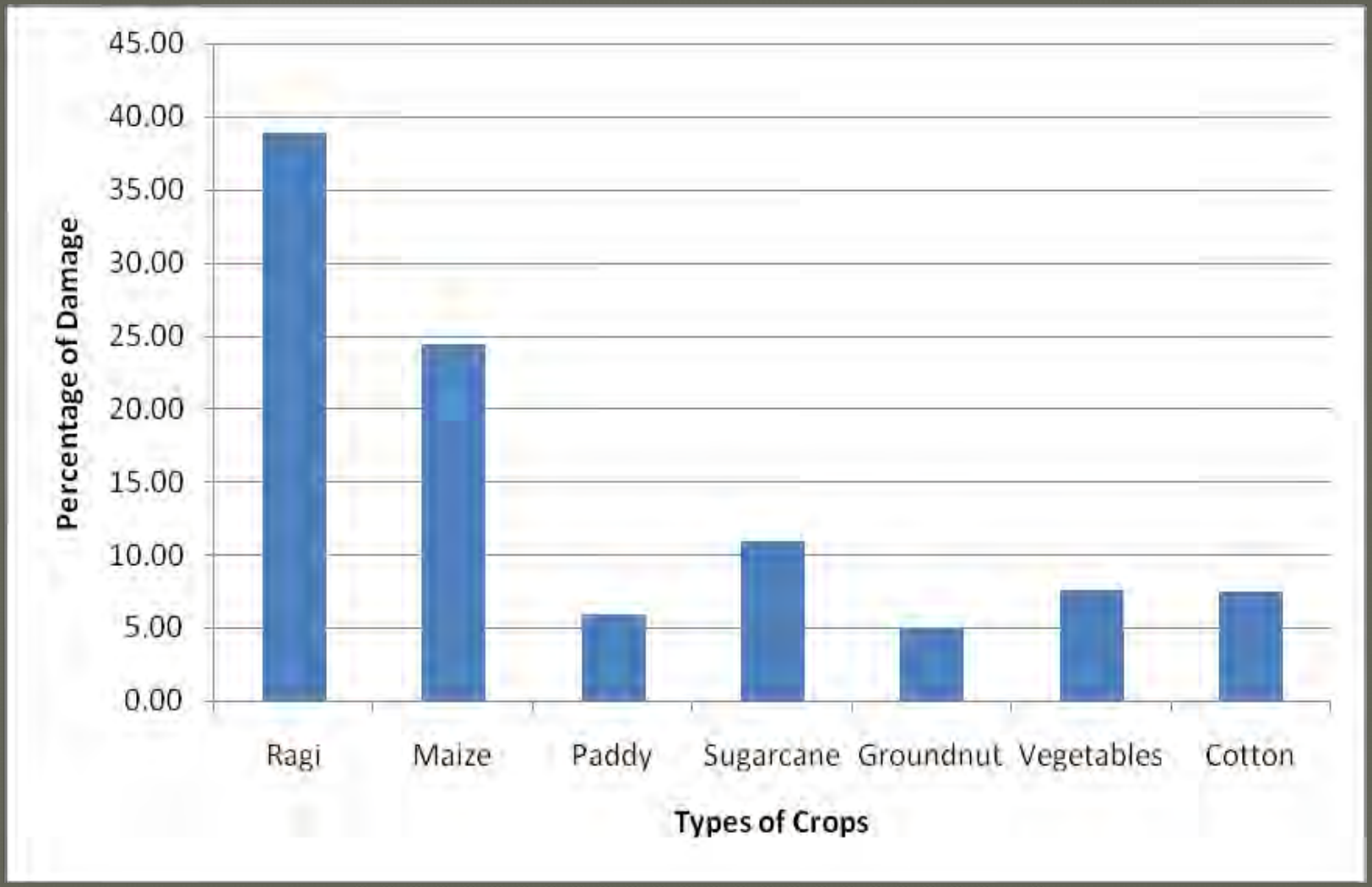

% of Farmers Affected
50
40
30
20
10
0
Palacode
Pennagaram
Hogenakkal
Name of the Ranges



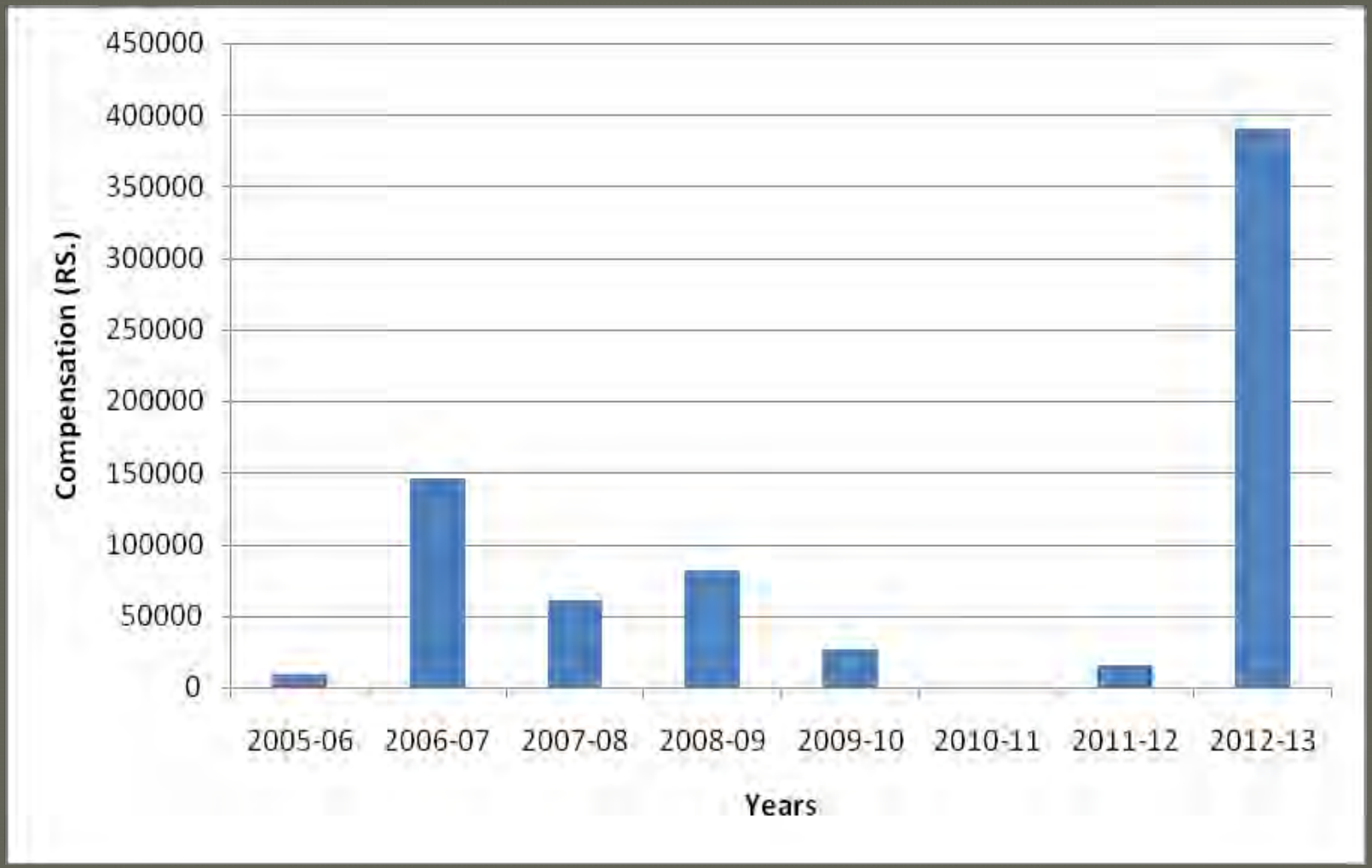
Map showing the Distribution HEC



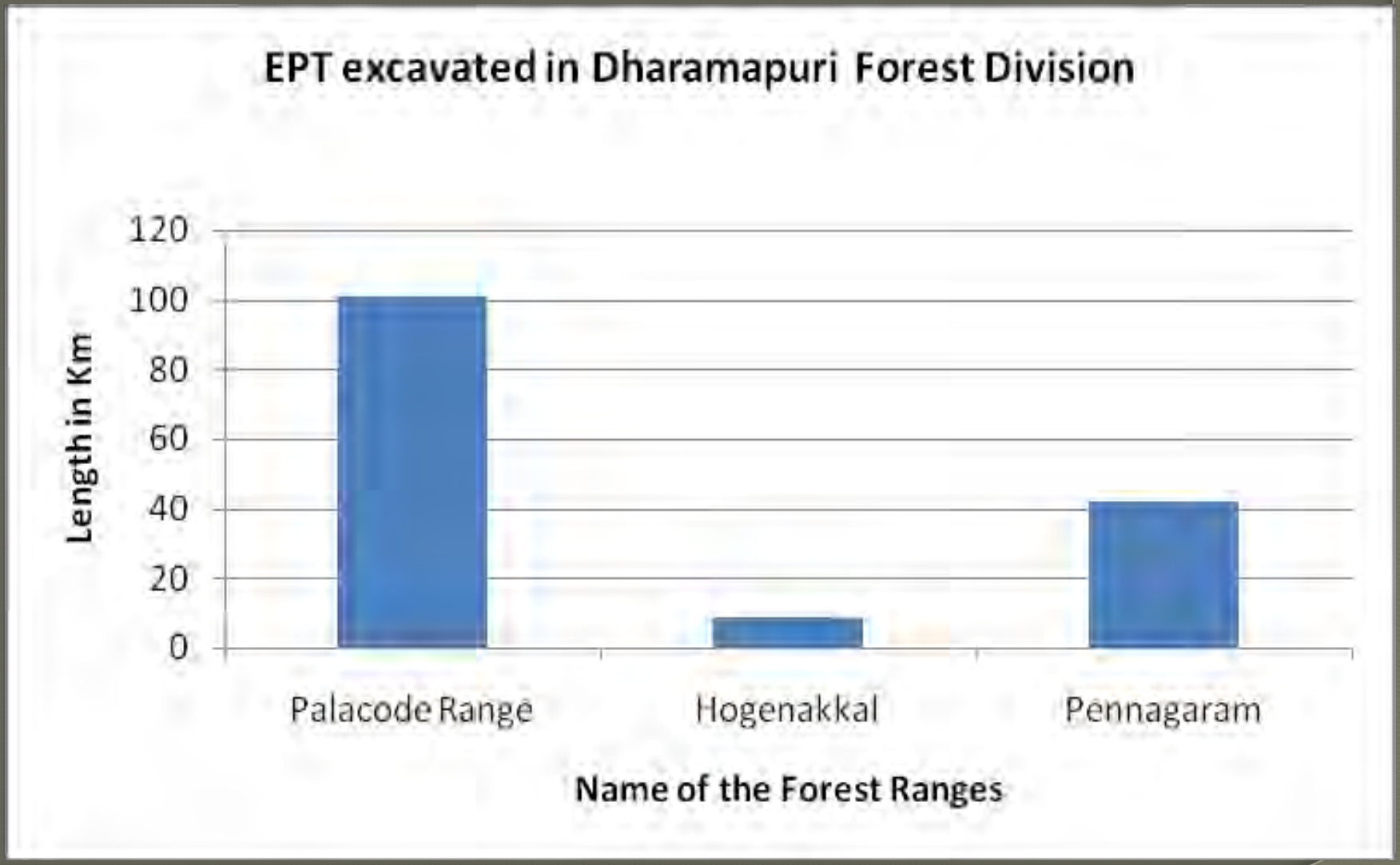
Percent of Crop Damage By Elephants

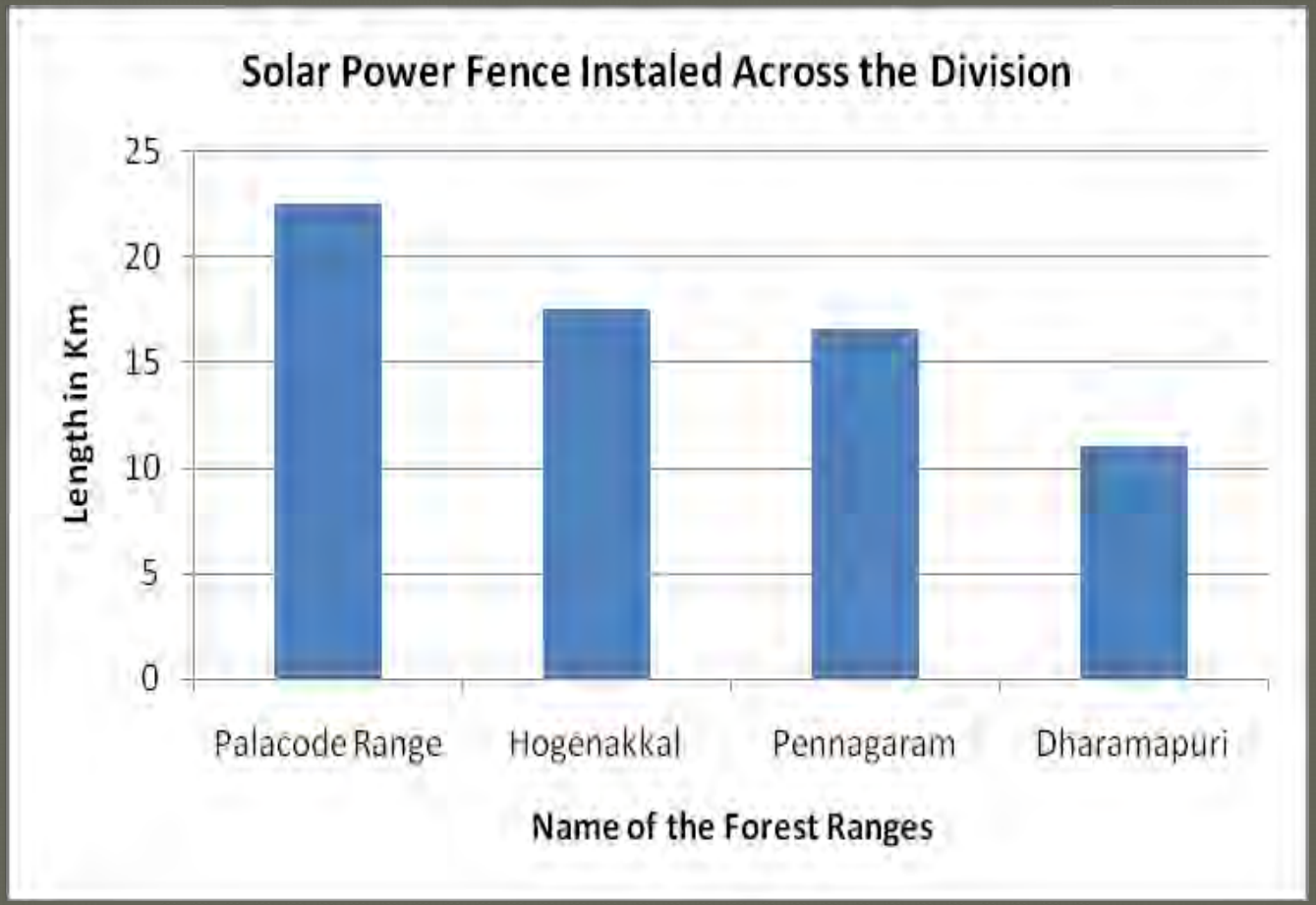


Compensation Paid for HEC



Preventive Measures




Solar Power Fence Instaled Across the Division
25
20
15
10
5
0
Length in Km
Palacode Range
Hogenakkal
Pennagaram
Dharamapuri
Name of the Forest Ranges

Solar Powered Fences Erected

Sl. No	Name of Range	Name of RF	Exact location	Solar fencing erected (in Km)
1	Palacode	Pikkili	Sanjeevarayan koil	4.00
		Pikkili	Malaiyur	3.00
		Pikkili	Reddiyurkottai	3.00
		Pikkili	Kollapatty	2.50
		Pikkili	Kodupatty	2.00
		Pikkili	Podur	2.00
		Keserkuli	Seengadu	3.00
		Thirumalvady	Karikuttanur	3.00
			Total	**22.50**
2	Hogenakkal	Pennagaram	Podur	2.00
		Pennagaram	Poonaikundu kattukottai	2.50
		Pennagaram	Podur	2.00
		Pennagaram	Pannapatty	2.00
		Pennagaram	Neerkundi	3.00
		Woddapatty	Ootamalai	6.00
			Total	**17.50**
3	Pennagaram	Bevanur	Boothipatty	3.00
		Bevanur	Akkalathampatty	2.00
		Bevanur	Godupallam	2.50
		Bevanur	Chinnappanallur	4.00
		Badanavadi	Moolabellur	2.00
		Masakkal	Mudugampatty	3.00
			Total	16.50
4	Dharmapuri	Thoppur	Erumapatty	3.00
		Parigam B	Kammampatty	3.00
		Kalappambady	Kadamadai	5.00
			Total	**11.00**





Conclusions

- The study we found that though there is a conflict in the division, it is very minimal but this will increase in future due to growing human population and elephant population as well.
- Invasive Species such as *Lantana camara* and *Prosophis juliflora* invaded in most of the area in the division, which is affecting elephant forage in the forest, therefore elephants are moving to near by villages to raid crops.
- EPTs are bound to fail as barriers against elephants.
- At the time of excavation, continuity of the trench without any crossing points must be ensured for at least 5-10km. The total length is of no consequences if its integrity cannot be maintained for several km at a stretch.
- In order to achieve the above, agreements between the Forest Department and local people may have to be drawn up regarding joint management of trenches.

Conclusion cont…..

- EPTs are generally unsuitable and impractical in areas of loose sandy or rocky soil, severely undulating topography, high rainfall and high human use of forests.

- Such areas EPT and Solar power fence together may solve the problem

- Elephants being intelligent species, any preventive measure taken by department and local people will not work, elephant will learn easily and destroy it. Therefore proper maintenance of EPT and Solar fence will help to minimise the conflict in the division

Recommendations

- Awareness Programme should be conducted in all the villages one in six months which will help the farmers to understand the importance of elephants and its role in forest ecosystem.
- Good compensation packages paid on time for the affected formers will help to change people attitude towards elephant conservation

- Most of incidents of conflicts occurred, elephants are entering villages for water, they have to walk through crop land, therefore creating more water hole in conflict vulnerable area may help to reduce the conflict.

- People should be appointed in every village to take care of maintenance of fences and EPT. Subsidy for solar fencing to the farmers would help them to protect their crops.

- Management of invasive species in the forest area will help to improve habitat quality
- Curtail the Anthropogenic pressure in the forest area will help to improve the habitat
- Connecting corridors where ever necessary may help to reduce HEC in the elephant range areas

Different Methods Adapted to Prevent Elephant Entering Crop Field







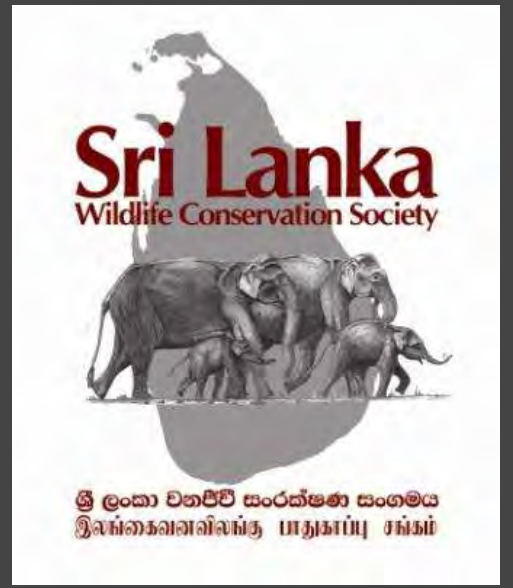





Thank you

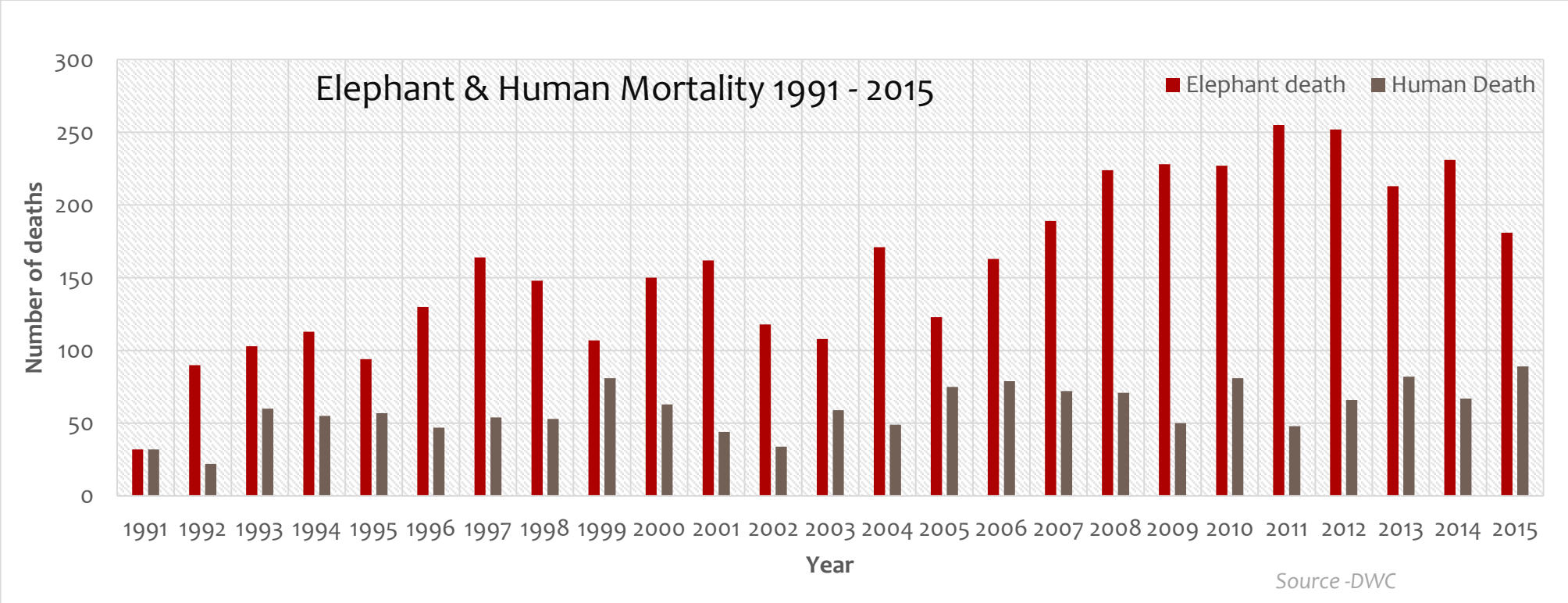
Importance of developing "**Conflict Specific Mitigation (CSM)" Strategies** to mitigate human-elephant conflicts: A case study from Wasgamuwa, Sri Lanka

Ravi Corea, Chandima Fernando, and Chinthaka Weerasinghe
Sri Lanka Wildlife Conservation Society (SLWCS)
www.slwcs.org



HEC biggest socio-economic, environmental & wildlife issue

- *Last 25 years – 3795 elephant deaths and 1490 human deaths*
- *First 15 years average of deaths per year – Elephants - 120 Humans - 52*
- *Last 10 years average of deaths per year – Elephants - 216 Humans - 70*



Root causes?

- *Conflict over agriculture is the leading cause of death*

Land use change





Habitat loss

Competition for land between human and elephants





Current framework & policies to reduce HEC?

- *Mainly focus on implementing broad – scale mitigation measures*



Fencing elephants



Relocating elephants



Elephant drives

Current framework & policies to reduce HEC?

- Still HEC imposes various costs on local communities
- Still HEC threatens elephant populations





Broad mitigation strategies do not recognize SPECIFIC HEC at the LOCAL level

Main reason why the issue remains the same

Developing a Conflict Specific Mitigation (CSM) Strategy

Research

- Identify specific HECs
- Study timing and location of HEC
- Asses socio-economic & wildlife impacts
- Prioritize different HECs
- Identify the most crucial problem

Participatory planning

- Discussion with stakeholders
- Identify joint objectives
- Propose socio-economic benefits to the community
- Mutual agreements for win-win initiatives

Implementation and Monitoring

- 100% involvement of the community
- Equal ownership of the project
- Monitor threats and success

Case study – Weheragala Human Elephant Corridor

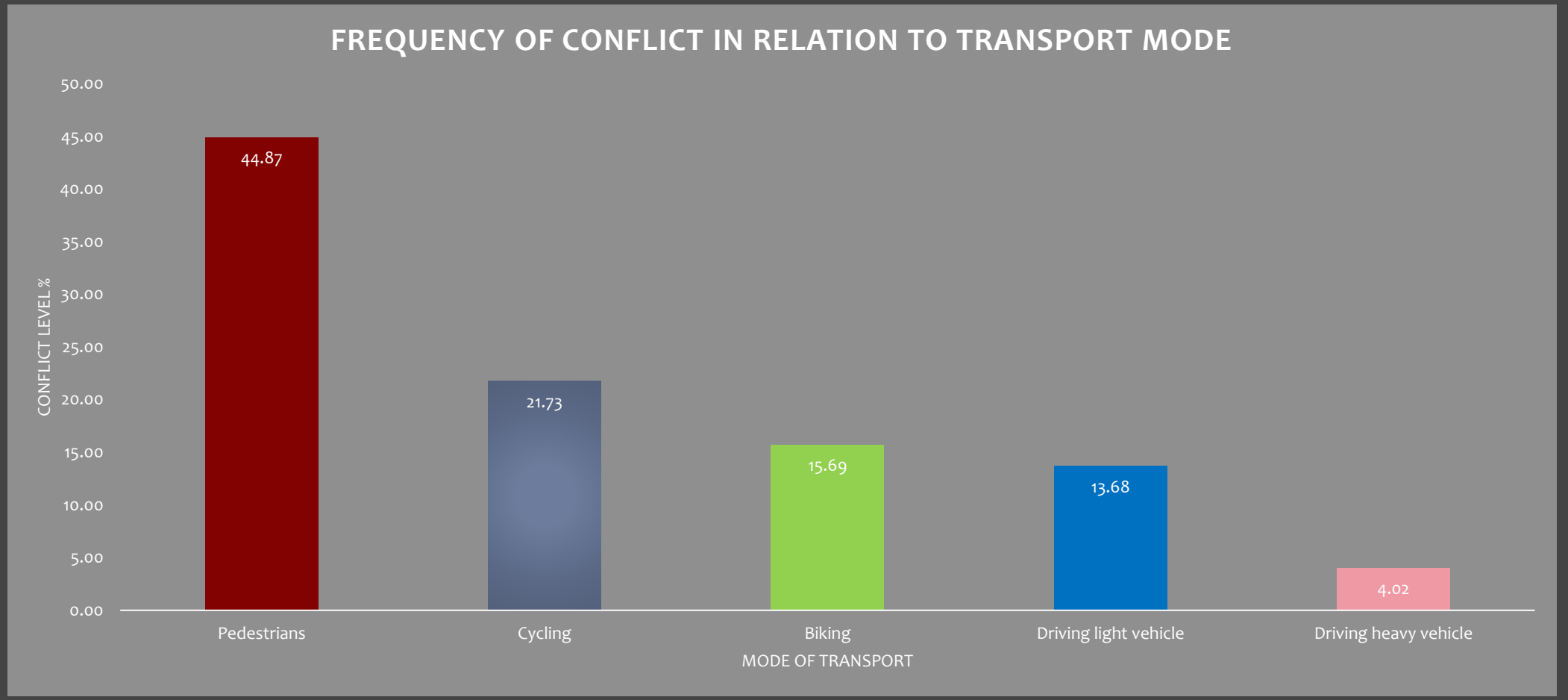
- Unprotected elephant habitat outside Wasgamuwa National Park (WNP)
- Only remaining link for elephants that move to southern forest reserves outside the WNP
- Only road access to two bordering villagers
- Daily encounters between elephants and people
- Elephant presence in the corridor – restricts movement of villagers
- Increased harassment of elephants – make elephants react aggressively toward humans
- Aggressive interactions – increased negative attitude towards elephants
- Negative impact on overall elephant conservation in the area





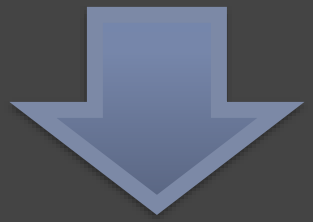
Our research at the corridor

- *Mode of transport - main cause for the conflict*

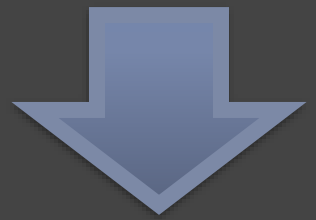


Our approach - Proposed CSM Strategy

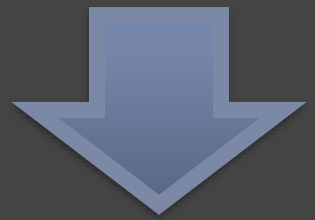
Reduce pedestrians and frequency of travelling



Community consultation - villagers could not afford to change mode of transport



SLWCS – Action



First EleFriendly© Bus service

EleFriendly© Bus Service





- First ever commute to reduce HEC
- Community owned
- Transports school kids for free
- Farmers are able to spend more time farming and less time patrolling
- Brought National and International communities together to support local people and wildlife

Outcome

- Conflict level has decreased for the last three months from 83 to 21 – a 74% decrease in conflicts
- Farmers' attitudes towards elephants have changed significantly
- Farmers are more cooperative – willing to listen & participate
- Elephants are less disturbed in the corridor
- Elephants are able to stay in the corridor for foraging and socializing
- Able to conserve the corridor/habitat for elephants



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



Other SLWCS ongoing & planned CSM Strategies

- Project Orange Elephant: providing a natural deterrent and a sustainable income



- Drone Mitigators: using UAVs to protect villages and fields to minimize human-elephant conflict interactions





ACKNOWLEDGEMENTS

A sincere and grateful thank you from SLWCS and the communities we work with to all who contributed to the EleFriendly© Bus Service Project

- **Adele & Loi Nguyen**

A sincerer thank you to the corporate partners who sponsored us to attend the 2016 International Elephant & Rhino Symposium in Singapore

Integrating teaching and folklore theatre to promote HECx in Tamil Nadu, India



Rengasamy Marimuthu
Zoo Outreach Organisation, India

Human Elephant Conflict

- Relationship between elephant and man is ancient
- No other animal had such a close association
- Part of Indian culture, religion, mythology and politics

Population explosion raised the demand for more land for developmental activities and agriculture.

That pushes wild animal especially elephant close to the human population thus increasing the human-elephant conflict.



Human Elephant Conflict *HEC*

- Burning issue
- Major conservation
- Socio-economic &
- Political issue

A God in distress!!!!



One of the major threats to the survival of Asian elephants.



Human Elephant Conflict *HEC*

Major problems--

Elephant mortality

Human injury and death

Crop damage, loss of property etc.,







Human Elephant Conflict *HEC*

Ministry of Environment, Forests, Climate Change, Govt. of India reports--

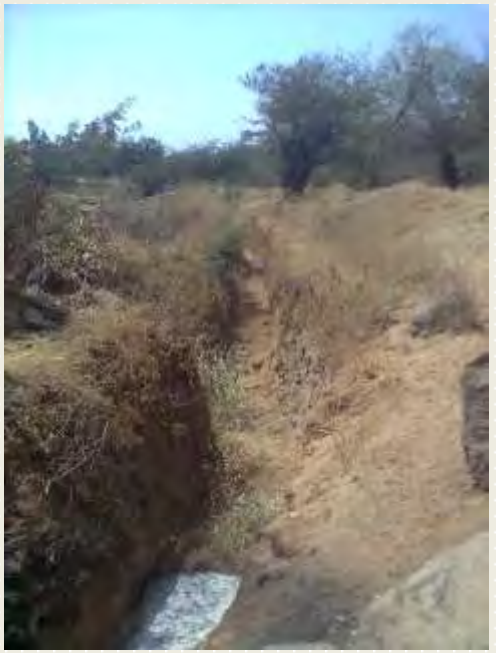
- 2014-15-391 people and 39 elephants died
- 2013-14, 413 human and 72 elephant deaths
- 422 humans and 101 elephants died in 2012-13

Human Elephant Conflict *HEC*

Mitigation Methods

- Beating drums
- Burning fires
- Firing crackers
- Apiculture
- Electric fence
- Elephant Proof Trench (EPT)
- Removal by capturing
- Translocation
- Driving away-using *Kumki* elephants & etc.





Government Initiatives

Project Elephant (PE) was launched by the Government of India in the year 1992

- To protect elephants, their habitat & corridors
- To address issues of man-animal conflict
- Welfare of captive elephants



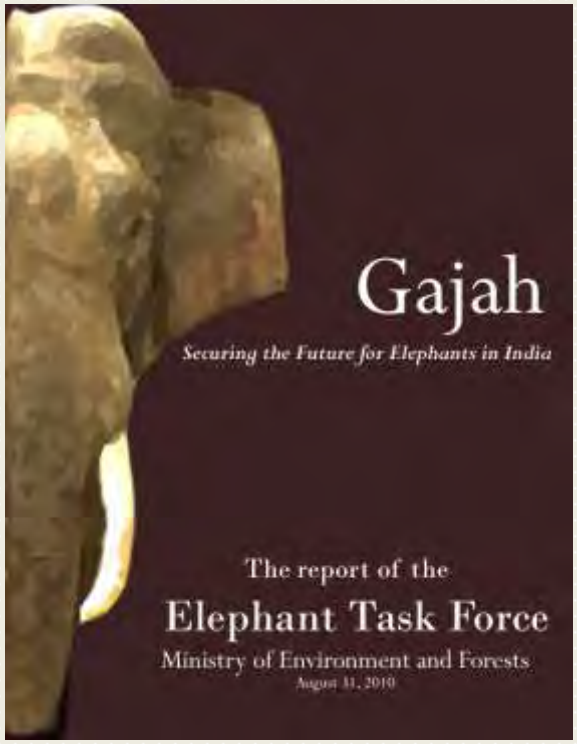
"Public education and awareness programmes"

Government Initiatives

The Report of the Elephant Task Force-2010

Securing the Future for Elephants in India

- Declare National Heritage animal
- Take Gajah to People- Initiate *"Haathi Mere Saathi"* (Elephant My Partner) awareness program
- Regional Gajah Centre



"Public education and awareness programmes on elephants ecology, behaviour, conservation and *HECx*"

Human Elephant Coexistence *HECx*

Zoo Outreach Organization is running *HECx* education programmes since 2008

- Teachers
- School students
- Community







Human Elephant Coexistence *HECx*

International Elephant Foundation IEF Support

2015…

Teacher training & school awareness programme-Wayanad, Kerala-40 teachers & 500 school students





School awareness programmes











School awareness programmes

Human Elephant Coexistence *HECx*

International Elephant Foundation IEF Support

--2015

Street play, Teacher training & school awareness Programmes- Sathyamangalam, Erode Forest Division, TN



Human Elephant Coexistence HECx

Objectives

Make community to aware elephant ecology, behaviour, the importance of its conservation.

To save their life from elephant confrontation by adapting few tips on do's and don't's through street play.

Human Elephant Coexistence *HECx*

Street Play-Therukoothu or Veethi Nadagam

--most popular entertainment forms of Tamil Nadu

--open air theatre/makeshift stage

--stories are from epic, purana and local folklore

Street Play-Process

- Script
- Rehearsal
- Performance



Human Elephant Coexistence HECx

Street Play- *Therukoothu*

Script: On *HEC* and *HECx*

Preparation & Rehearsal: 2 day camp

Selection of villages: pre visits

Performance: 10 HEC villages



Street Play-audiences

500-750 people /village







Worshipping Elephant God



Behaviour of Elephants



Tourist's attitude



Elephant Etiquette



Alternative crops



Do's and Don'ts *FOR* people who lives near Elephant areas

யானைகள் நடமாடும் பகுதிகளில் வசிக்கும் மக்களுக்கான ஆலோசனைகள்

* யானைகள் நடமாட்டம் உள்ள பகுதிகளில் குறிப்பாக இரவு நேரங்களில் யானைகள் அந்தப் பகுதியில் உள்ளது எனக் கேள்விப்பட்டால் வெளியில் செல்வதை தவிர்க்கவும்.
* இரவில் வெளியே செல்லும் போது கை விளக்குகள் அல்லது ஒளிதரும் விளக்குகளை எடுத்துச் செல்லவும்.
* யானை விரும்பாத பயிர்களை பயிர் செய்யவும்.
* யானைகள் தண்ணீரின் வாசனையையும் நுகரும் என்பதால், தண்ணீரை வசிக்கும் இடத்தில் இருந்து தூரத்தில் சேமிக்கவும். கிணறு, குளம் மற்றும் இதர நீர்நிலைகளுக்கு அருகே குடியிருப்பதை தவிர்க்கவும்.
* யானைகள் விரும்பும் உணவுகளான குறிப்பாக பலாப்பழம், புளி, விளாம்பழம், வாழைப்பழம், தேங்காய், சர்க்கரைப்பாகு, வெல்லம், நொதித்த திரவங்கள், சாராயம் போன்றவைகளை வீட்டினுள் வைப்பதை தவிர்க்கவும்.
* காட்டு யானைகளின் அருகில் செல்லாதீர்கள்.
* குடிபோதையில் காட்டிற்குள் நுழையாதீர்கள்.
* யானைகளின் வழித்தடங்களில் நடக்காதீர்கள்.
* காட்டு யானைகளிடம் சவால் விடாதீர்கள்.
* மதம் பிடித்த யானைகளின் அருகில் செல்வதை தவிர்க்கவும்.
* மோதல் வாய்ப்புகளைக் குறைக்க, ஒற்றை ஆண் யானையையும், பெண் யானைகள் குட்டிகளோடு இருக்கும்பொழுதும் தவிர்க்கவும்.
* உங்கள் பகுதிகளில் மின்வேலிகள் அமைக்கப்பட்டு இருக்குமானால் அதை பராமரிக்க உதவி செய்யவும்.
* வனத்துறையினர் காடுகளுக்குள் யானைகளை விரட்டியடிக்கும்போது அவர்களுடன் ஒத்துழைக்கவும்.
* உங்கள் உயிருக்கான உத்திரவாதத்தை நீங்களே எடுத்துக் கொள்ளவும்.



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ZOO OUTREACH ORGANIZATION

விலங்குப் பூங்கா வெளிக்கள அமைப்பு (Zoo Outreach Organization)
96, குமுதம் நகர், வீளாங்குறிச்சி ரோடு, கோயம்புத்தூர் 641 035, தமிழ்நாடு
தொலைபேசி எண் 0422 2665298

Feedback from the villagers



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- Dr. B. Ramakrishnan, Govt. Arts College, Ooty, TN

Thanks for Listening…



Participatory Management of Human–Elephant Interactions in the *Ānamalai* hills, Western Ghats, southern India



nature conservation foundation

Ganesh Raghunathan





Map Source: Western Ghats Portal

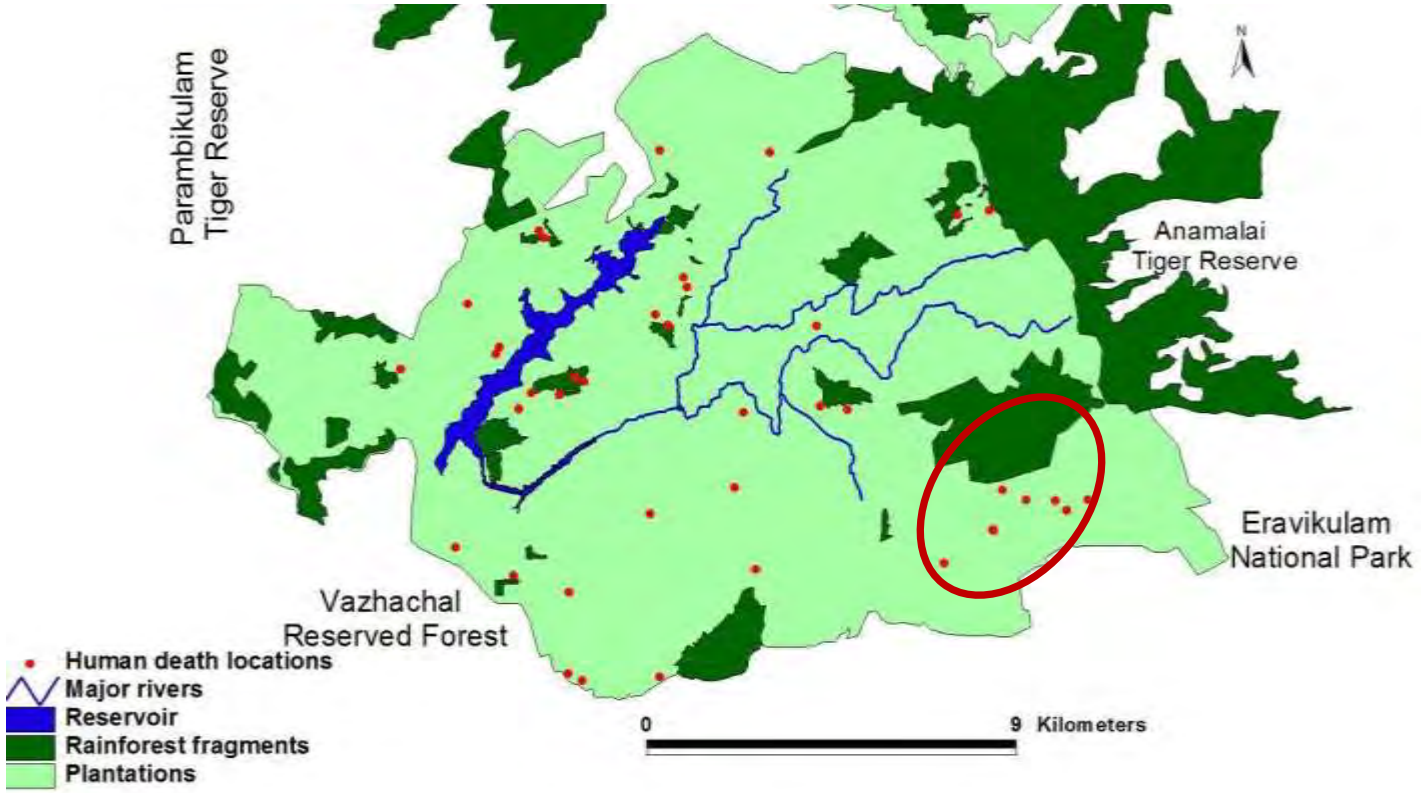



விடி வெள்ளி
மகளிர் சுய உதவிக் குழு



Human deaths: location & habitat

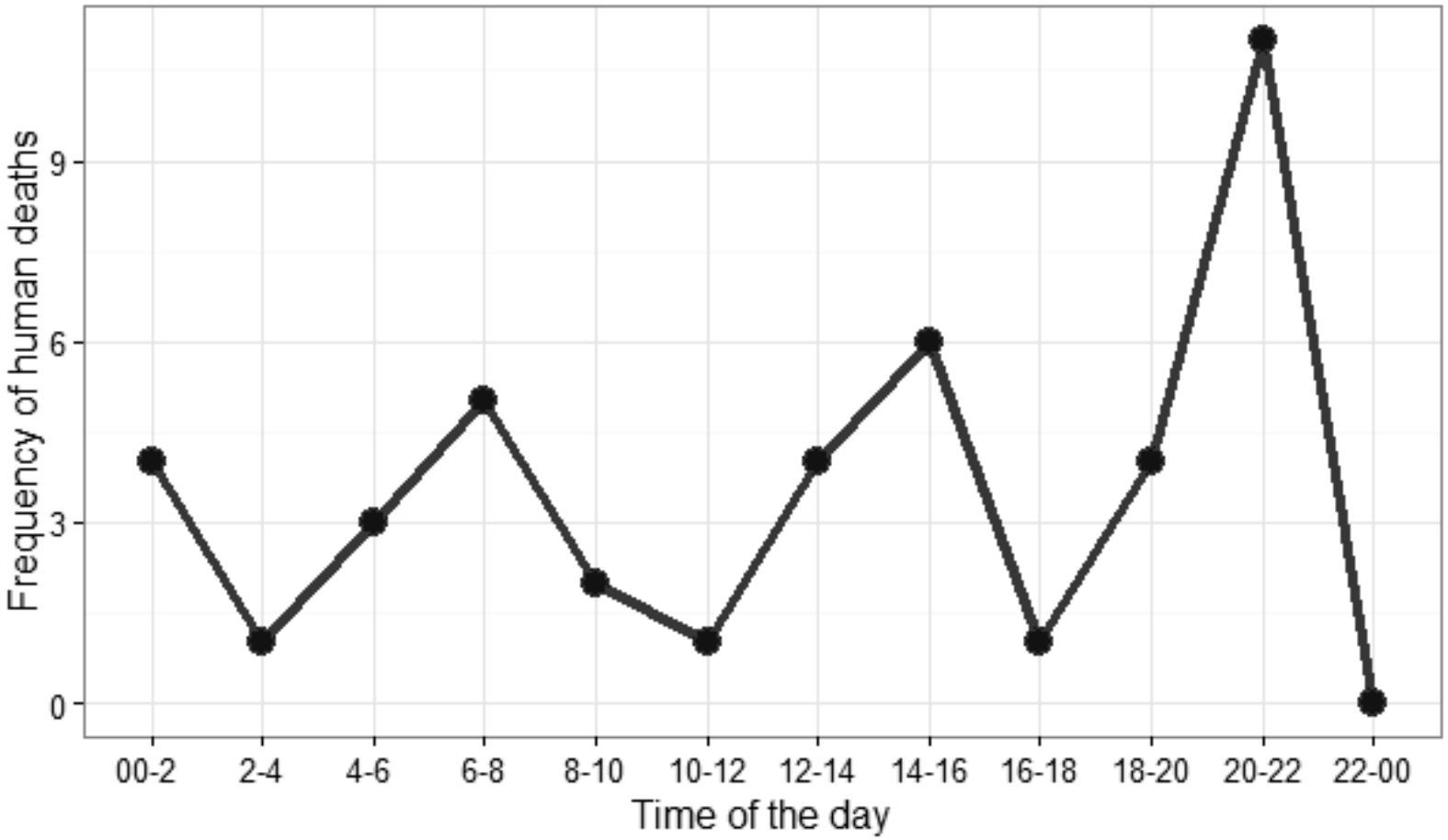
Total human deaths:42



9 deaths in 2% of study area

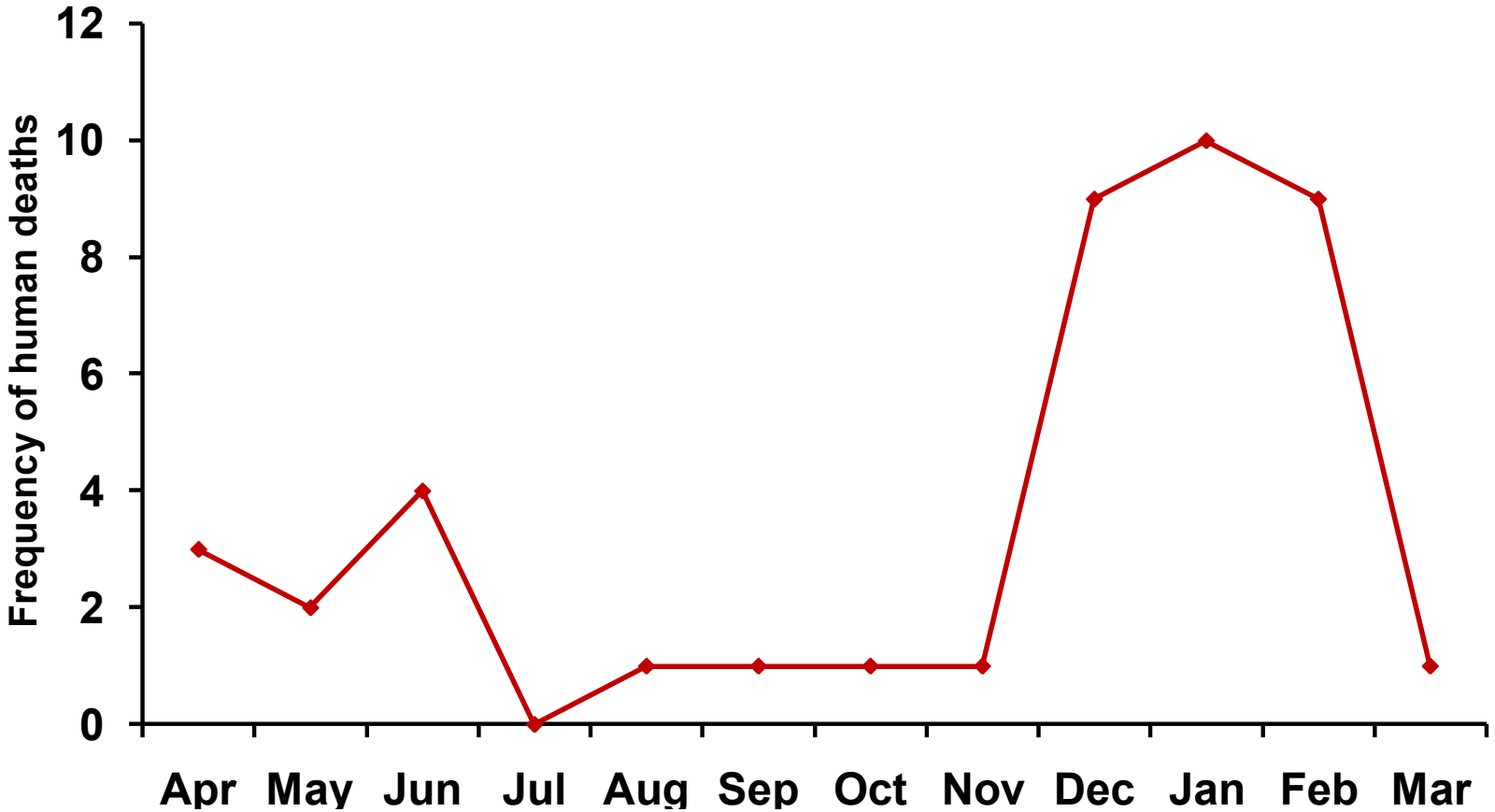
28 deaths along roads in plantations

Human deaths: Temporal distribution (Time)



Valparai plateau
maximum deaths (6pm-9 pm)

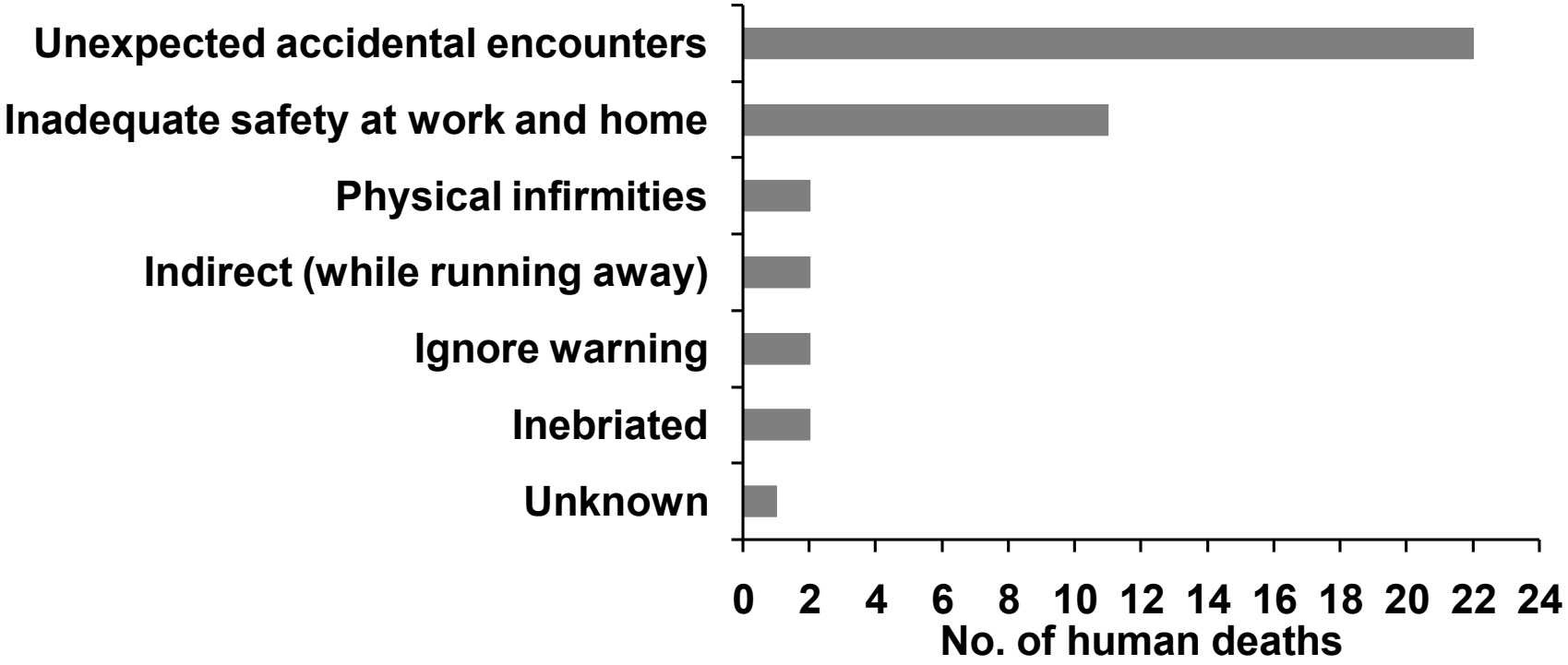
Human deaths: Temporal distribution (months)



Valparai plateau
28 deaths (66.7% between Dec - Feb)

Human deaths: circumstances (Valparai plateau)

35 out of 42 cases were due to unaware of elephants presence



What is required?

- Need for '*early intimation*'
- Requirement of creating a system that is targeted to delivering the information to households and individuals
- *Proactive involvement and sharing responsibility*

Elephant Information Network

Proactive measures: early warning systems





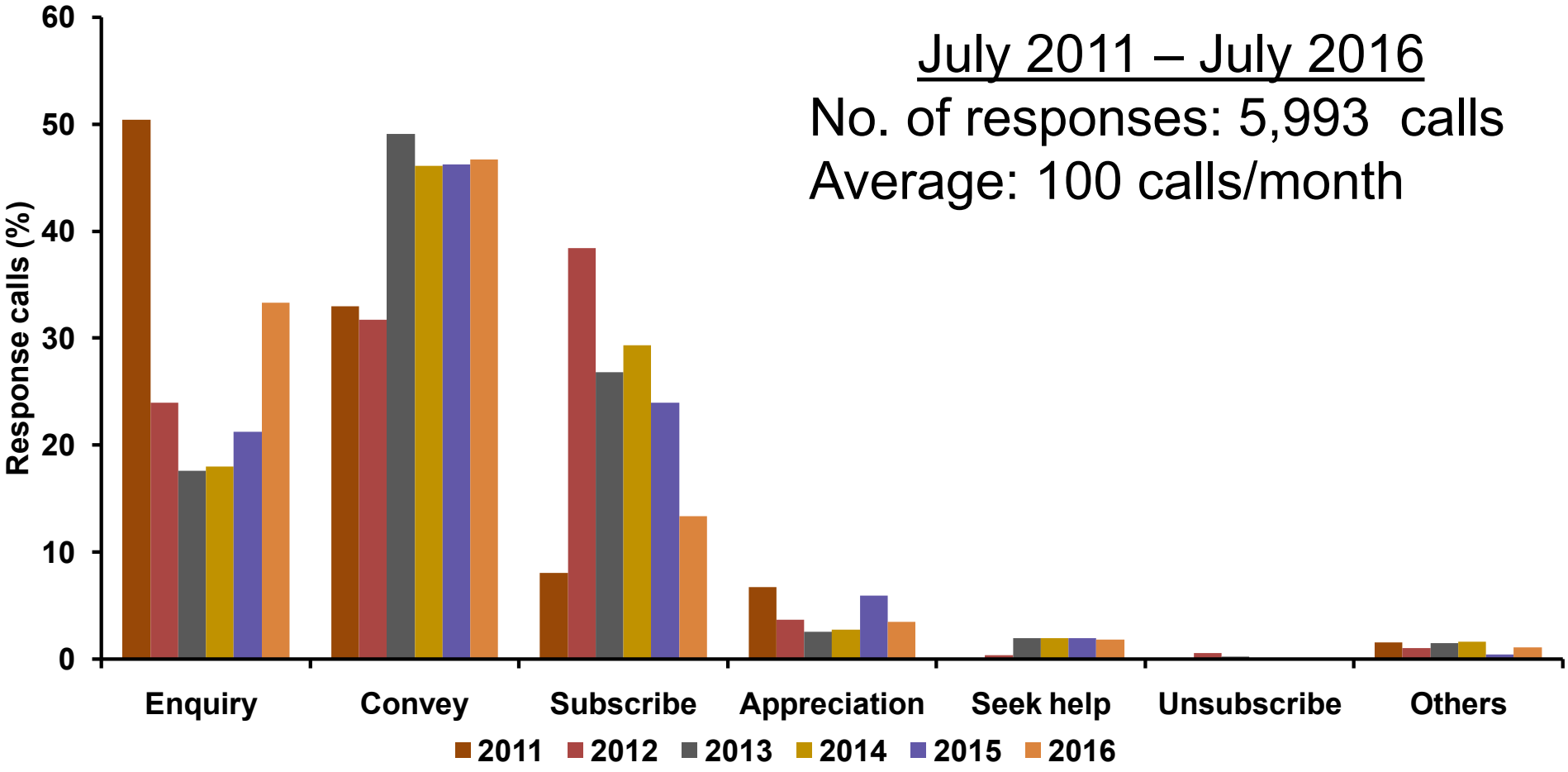



பெண்கள்
ளை வெளியே நீட்டாதீர்கள்

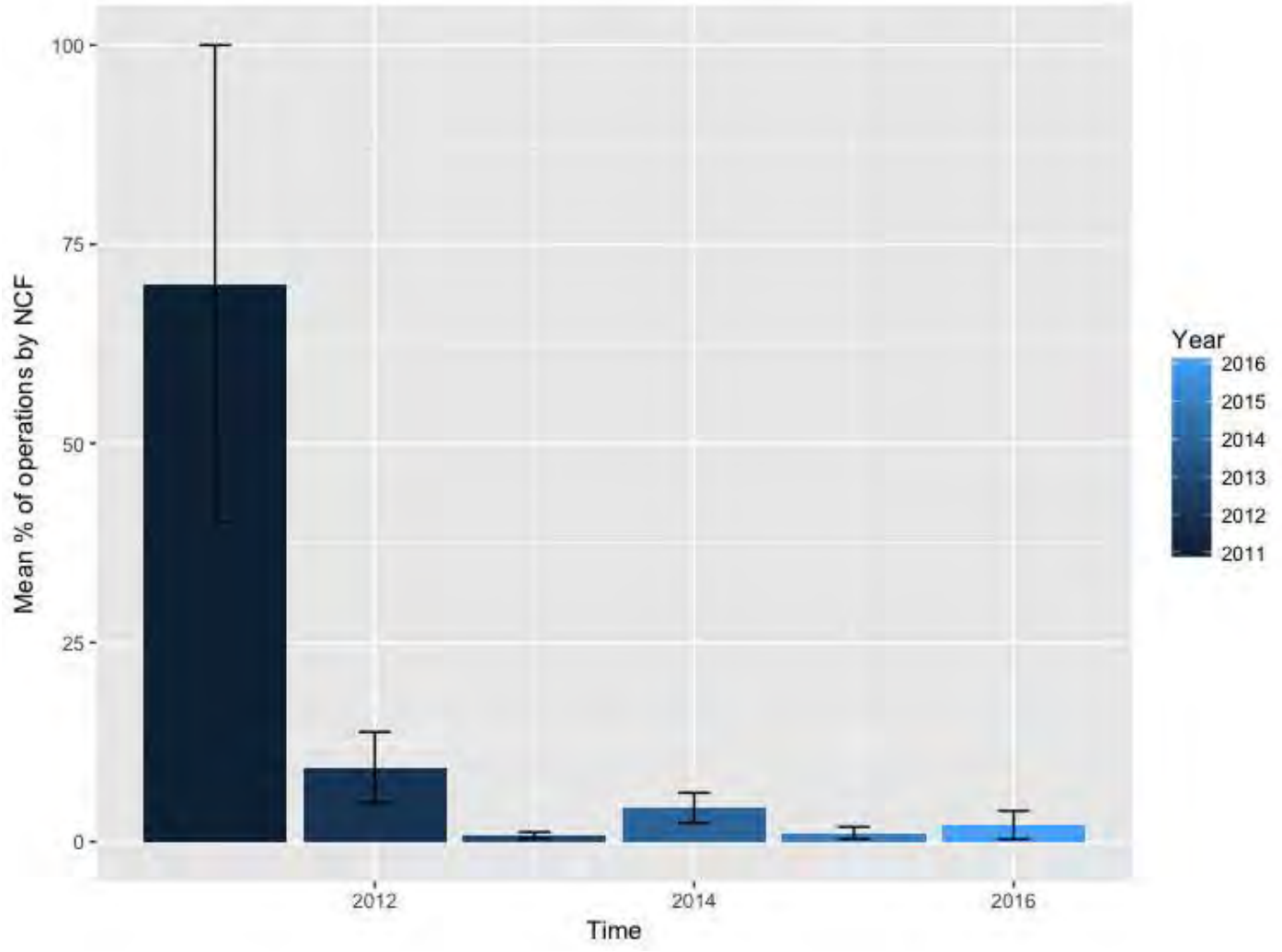
Rapid Response Team & helpline



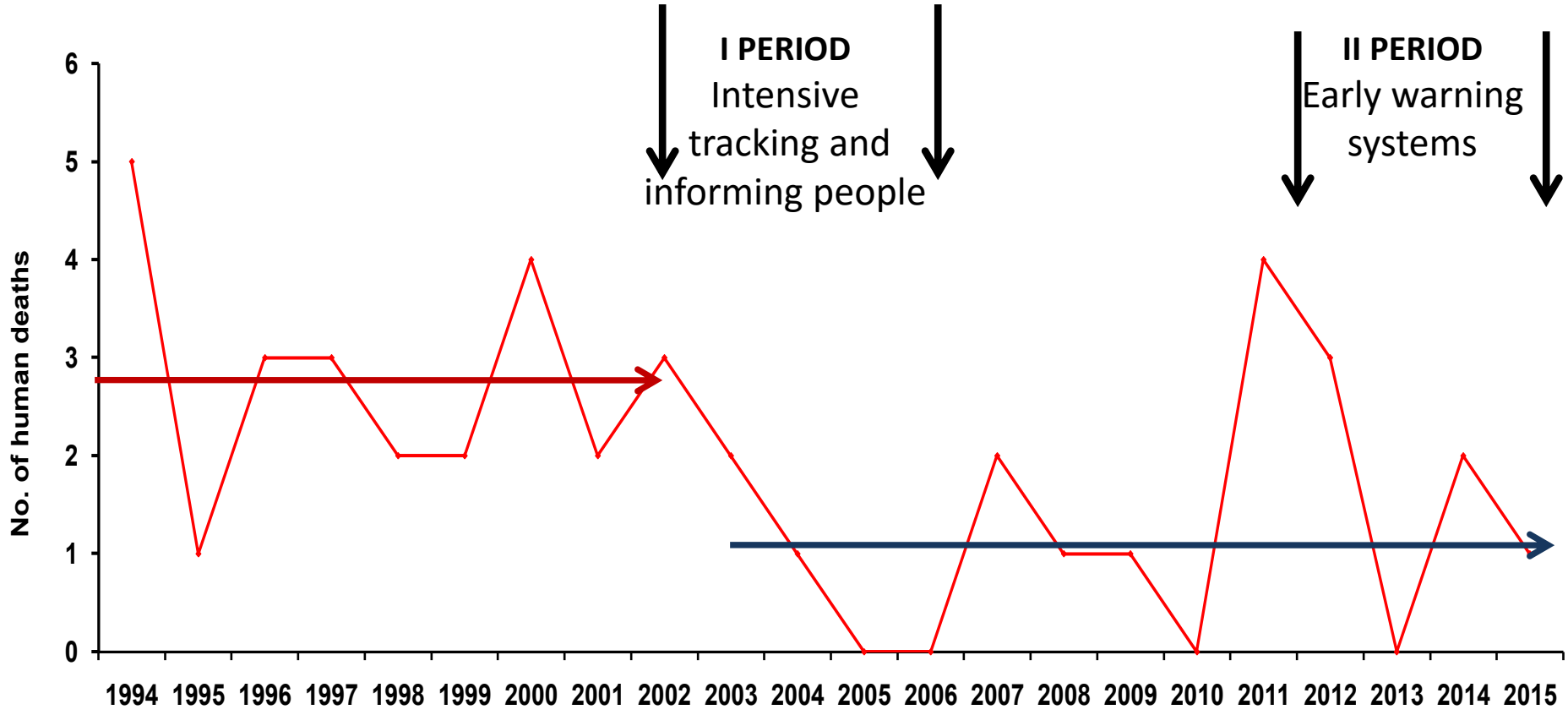
Progression of the EWS: From enquiry to convey



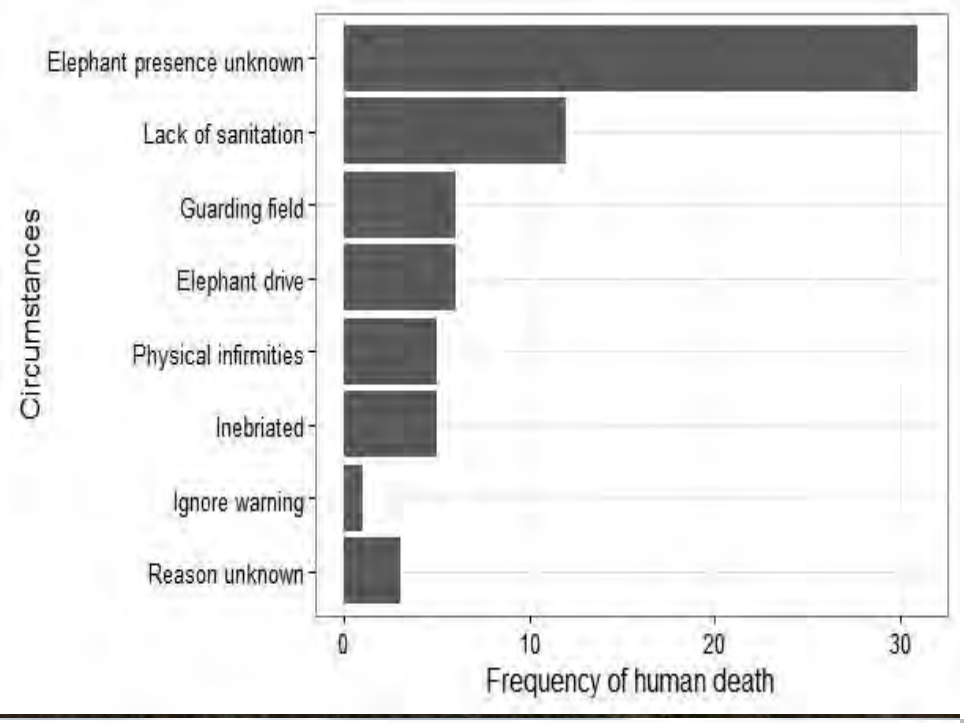
Local Champions: Proactive community involvement



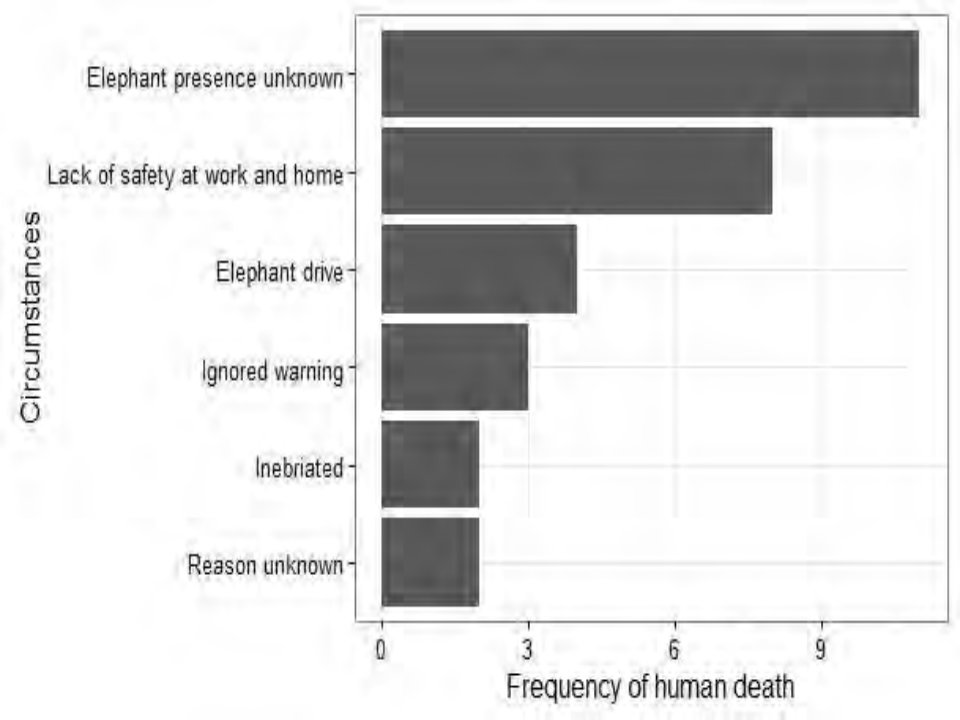
Impact of early warnings on human fatal incidents

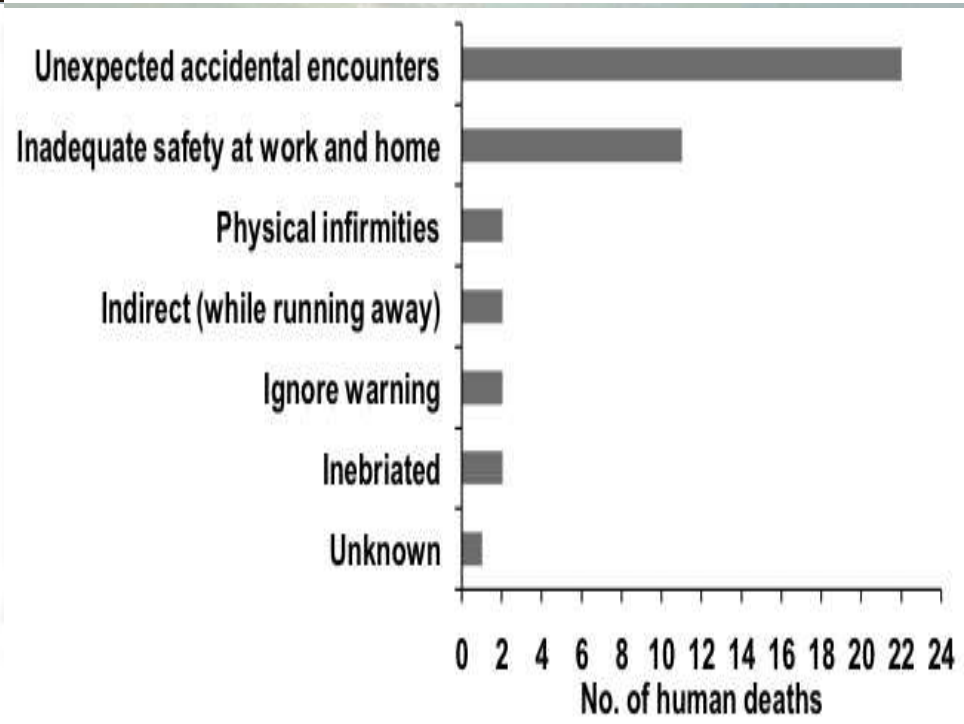


No human deaths between Oct 2004 and Jun 2007 (32 month period)



Land-use mosaics







- Mavatur Ananda Kumar | T R Shankar Raman | Divya Mudappa
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- M D Madhusudan | Kalyan Varma | Stuart Dunn | Ashni Dhawale
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- Niagara Automation | Gupshup Enterprises | Valparai Television
- Anamalai Planters Association
- Praneeth Bodduluri | Media

Cultivating alternative crops reduces crop losses due to elephants

E.M. Gross, R. McRobb, N. Subedi, J. Gross

Crop losses due to elephants

in Africa and Asia



- Elephants can cause massive crop losses and have been defined as crop pests (Schmutterer 1969)
- As massive damages can occure during short time, they are largely seen as catastrophic events (Thirgood et al. 2005)
- Conflicts with elephants resulting from these damages are ranked as threat to species survival (IUCN 2002).

Crop protection against elephants

a constant battle



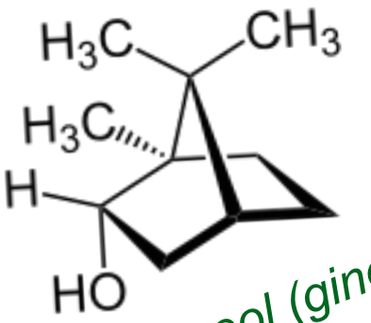
- Guarding of crops: on watchtowers, with scaring devices
- Barriers: Electric Fences, bee hive fences, trenches
- Olfactory repellents: Chilli burning, chilli guns

→ Goal is to deter elephant from highly attractive crops

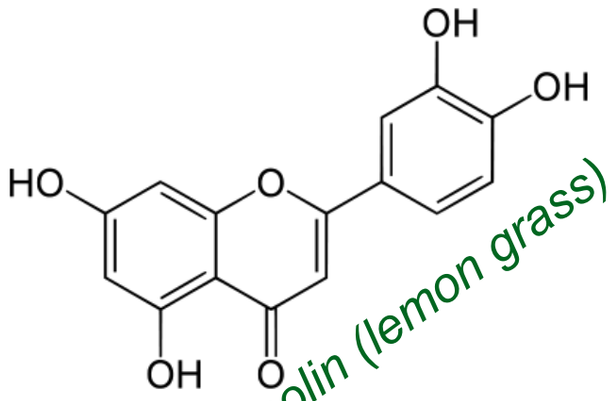
→ Labor and cost intensive

Aromatic crops

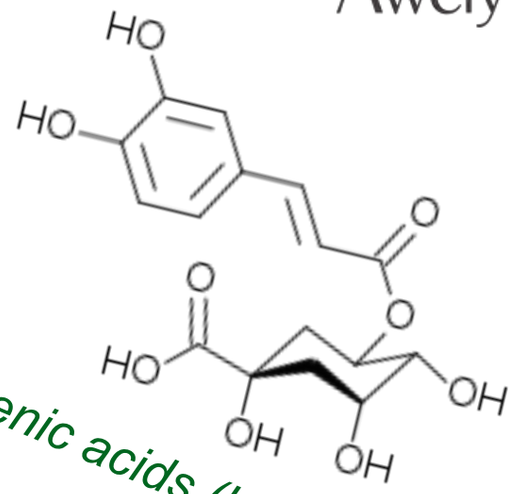
self-defended plants



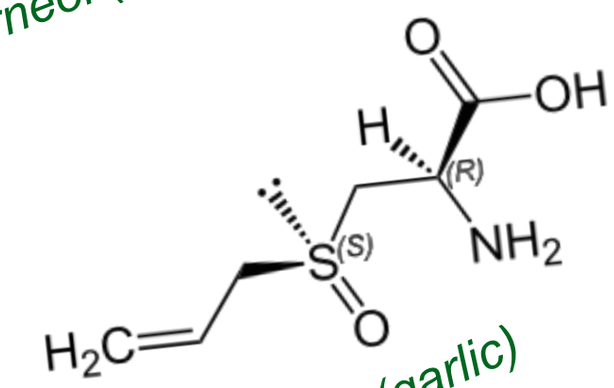
Borneol (ginger)



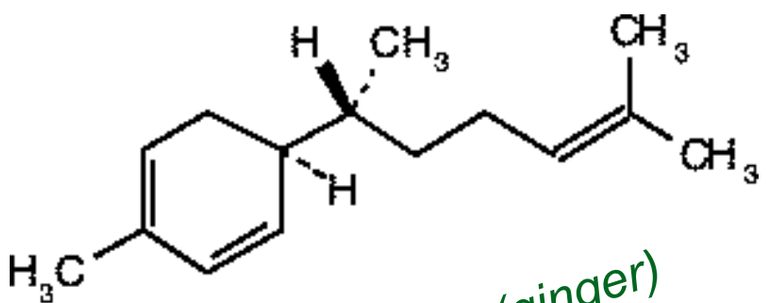
Luteolin (lemon grass)



Chlorogenic acids (lemon grass)



Alliin (garlic)



Zingiberene (ginger)

- Some crop plants are chemically defended through antifeedants
- Detoxification of antifeedants is energy consuming for elephants → unattractive
- Aromatic crops may be an economically viable alternative to traditional crops

Testing the attractiveness of crops

an experimental approach











- Is it true that some crops are not consumed by elephants?
- Are there differences in attractiveness between so called „unpalatable crops“?

Test plots in Zambia and Nepal

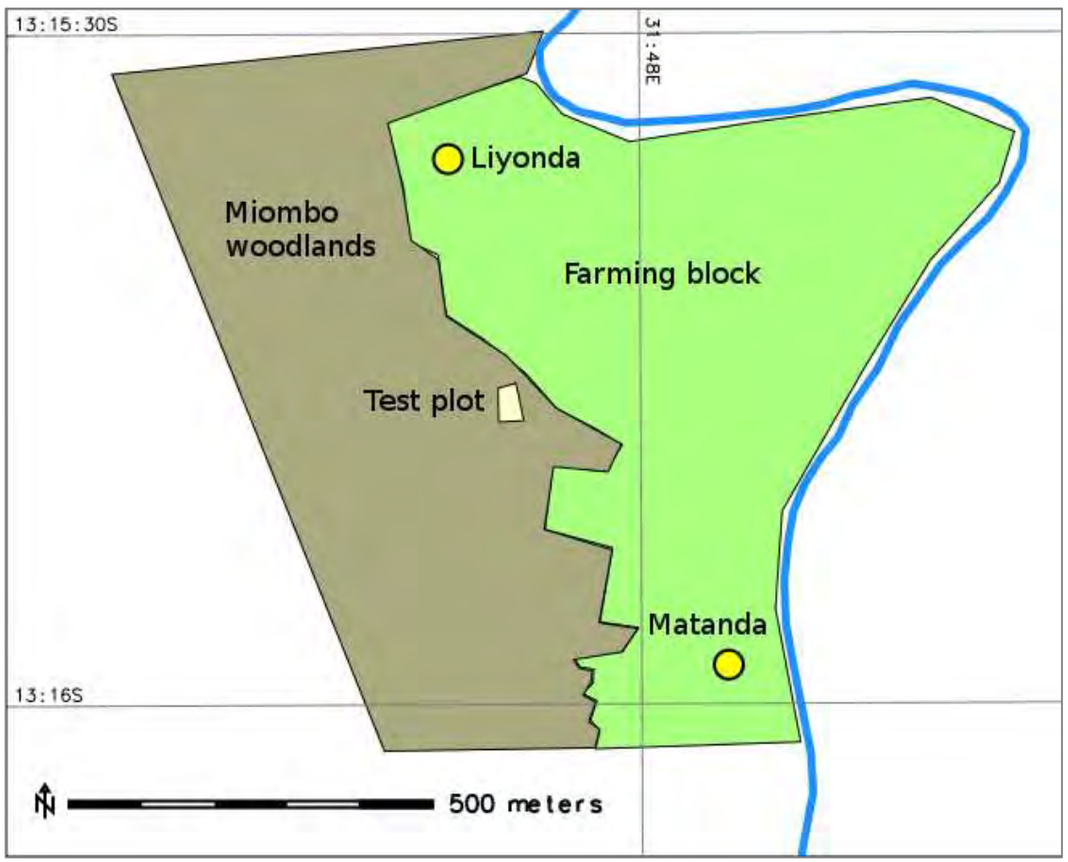
Study areas



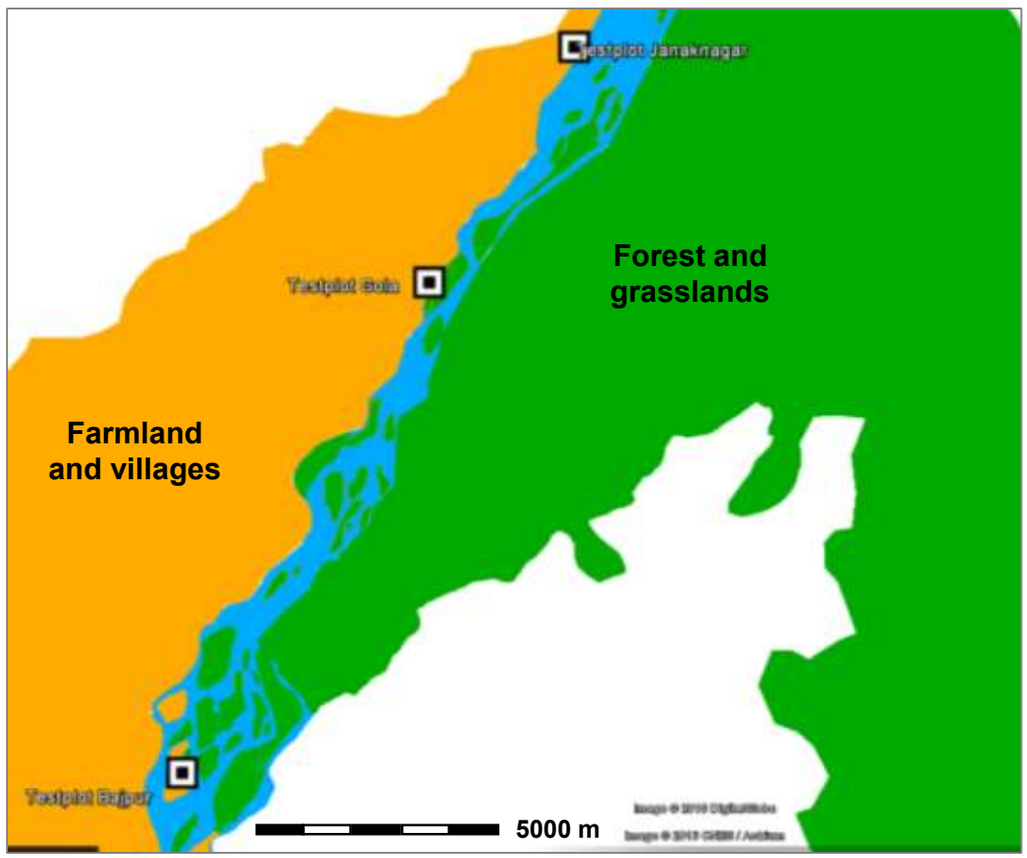








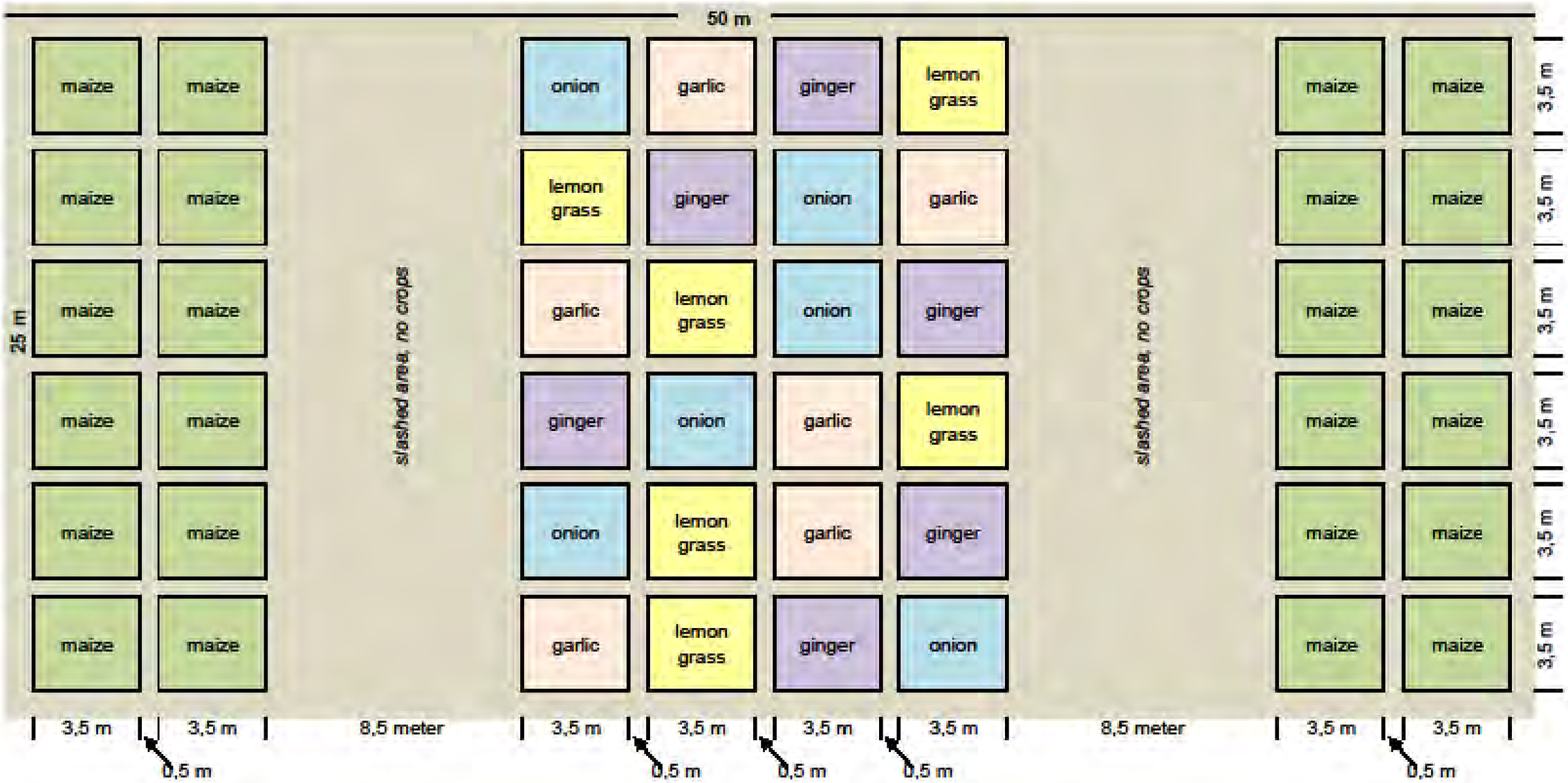
One test plot in 2011



Three test plots in 2013 and 2014

Test plots in Zambia and Nepal

Experimental design



Example: Test plot in South Luangwa/Zambia

Test plots in Zambia and Nepal

Experimental design

Maize as attractive crop (control)



Test crop (ginger)

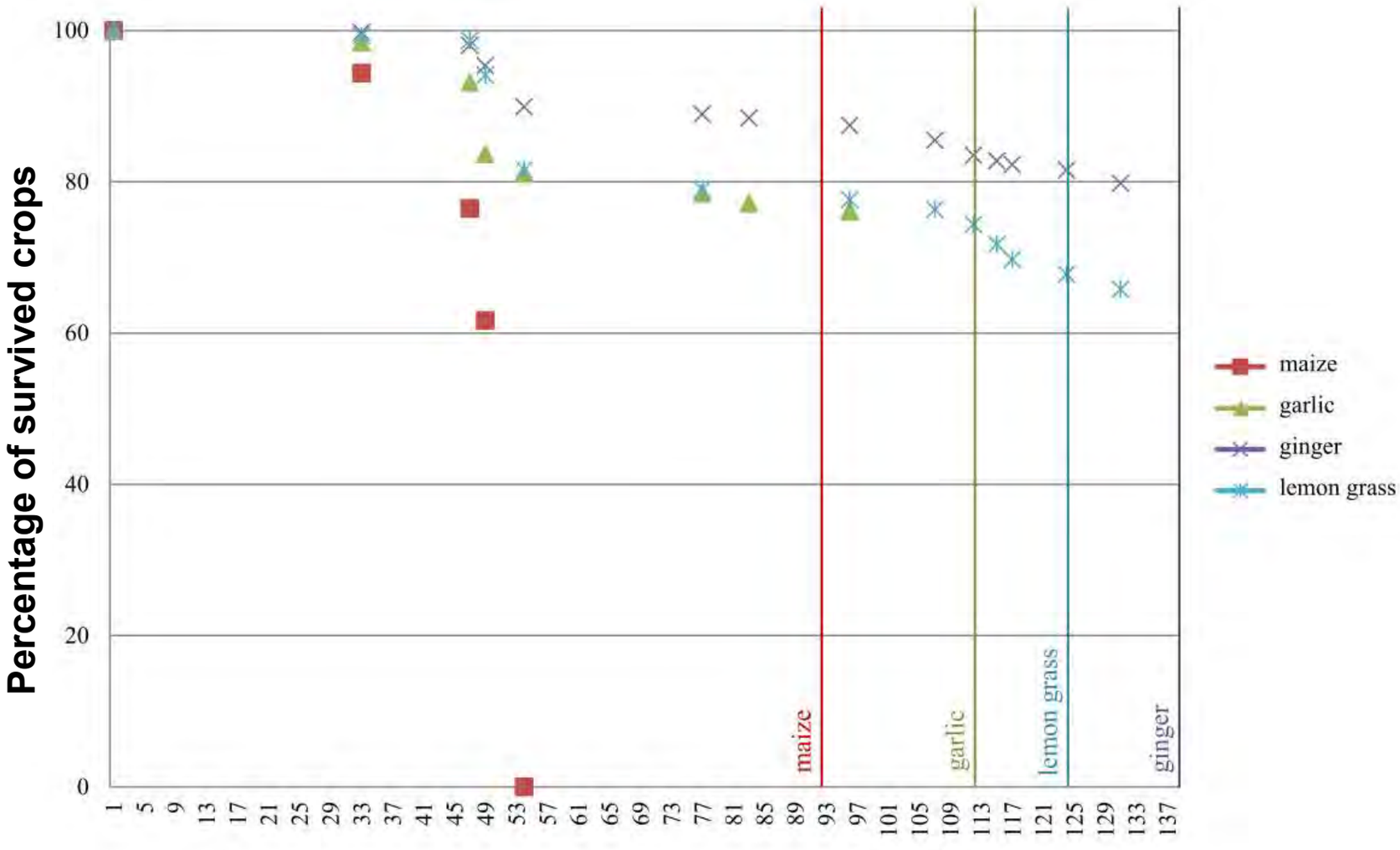
Buffer



Measurement of damage and count of damaged plants

Results Zambia

Monitoring period up to scheduled harvest time February to May 2011





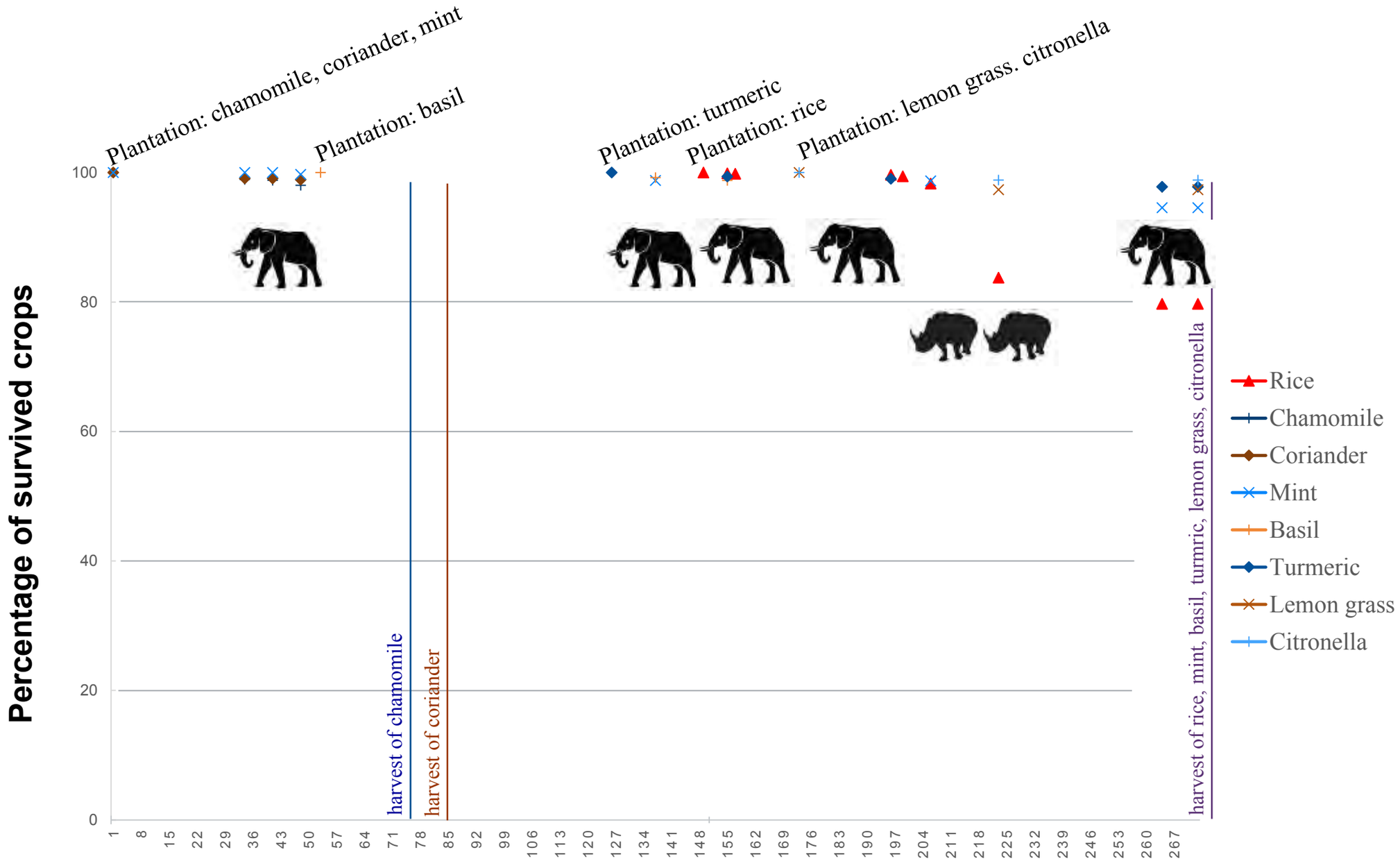


Percentage of survived crops throughout the time (days) of the experiment. Regular harvest dates per crop type are indicated as vertical lines.

13 visits of elephants on testplot within 137 days

Results Nepal

Monitoring period February to October 2013



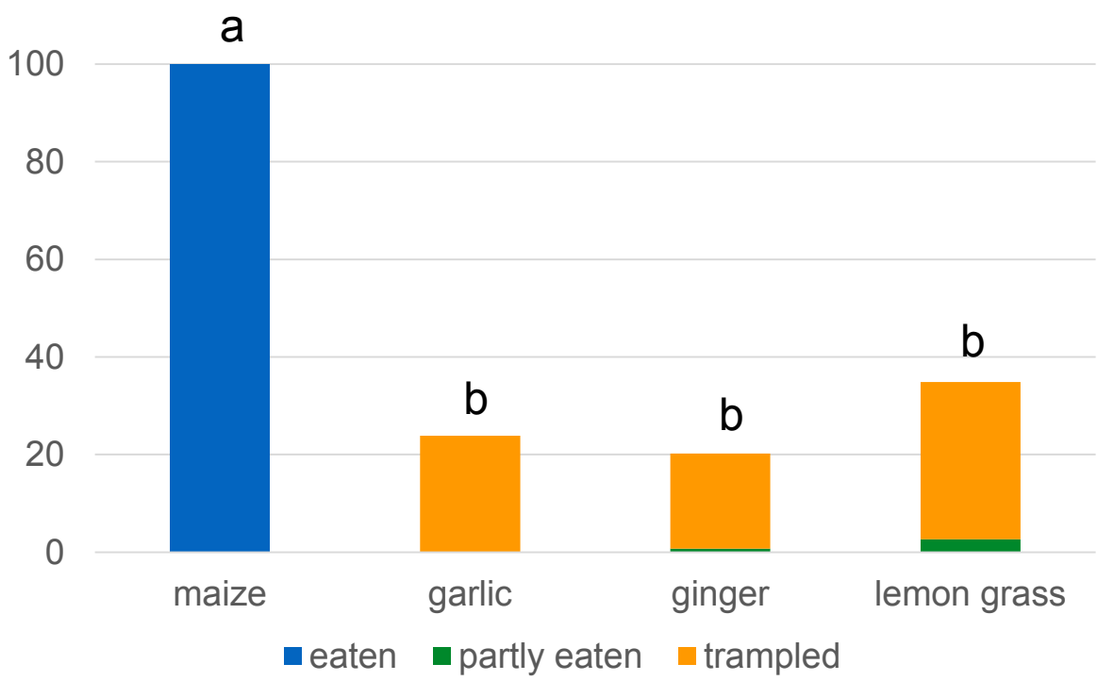
Percentage of survived crops throughout the time (days) of the experiment.
Harvest dates per crop type are indicated as vertical lines.

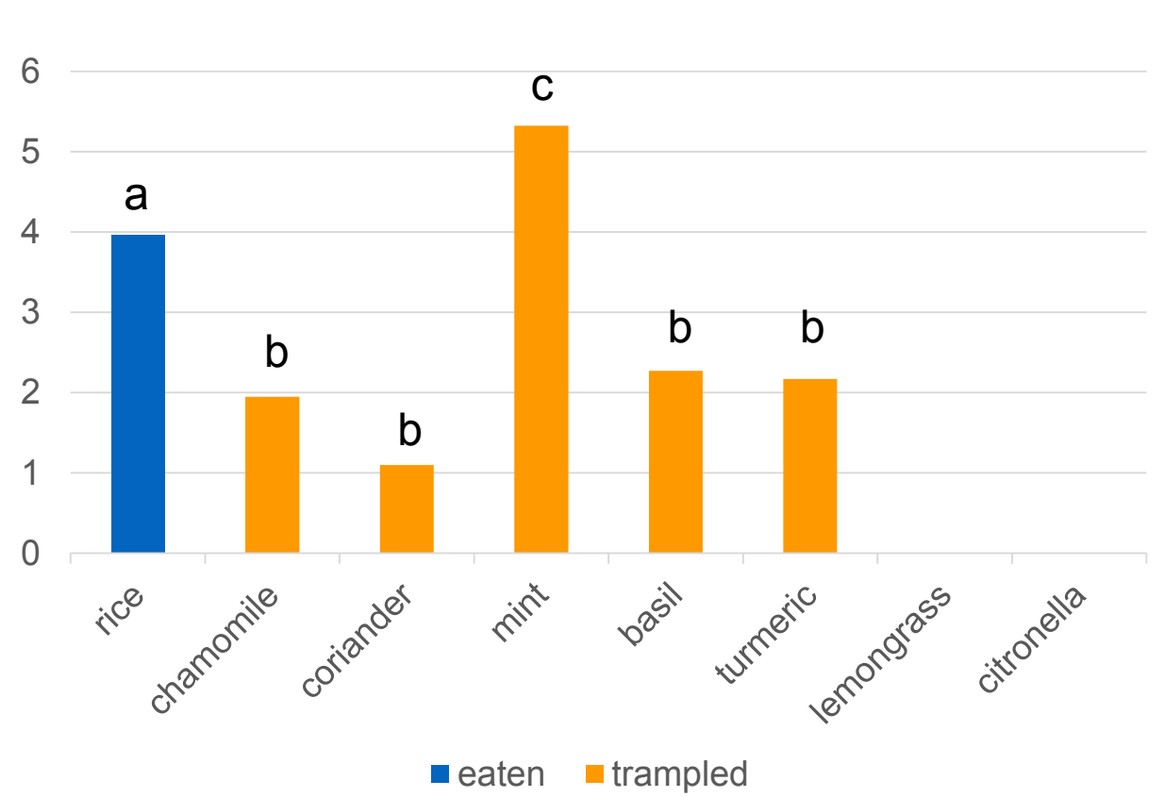
9 visits of elephants and 2 visits of rhinos within 267 days

Results

Damages on testplots

Percentage of plants damaged by **elephants** on testplots





Maize n = 480; garlic n = 771; ginger n = 406; lemon grass n = 152

Rice n = 73728; chamomile n = 5000; coriander n = 10000; mint n = 288; basil n = 1056; turmeric n = 1152; lemon grass/citronella n = 1560

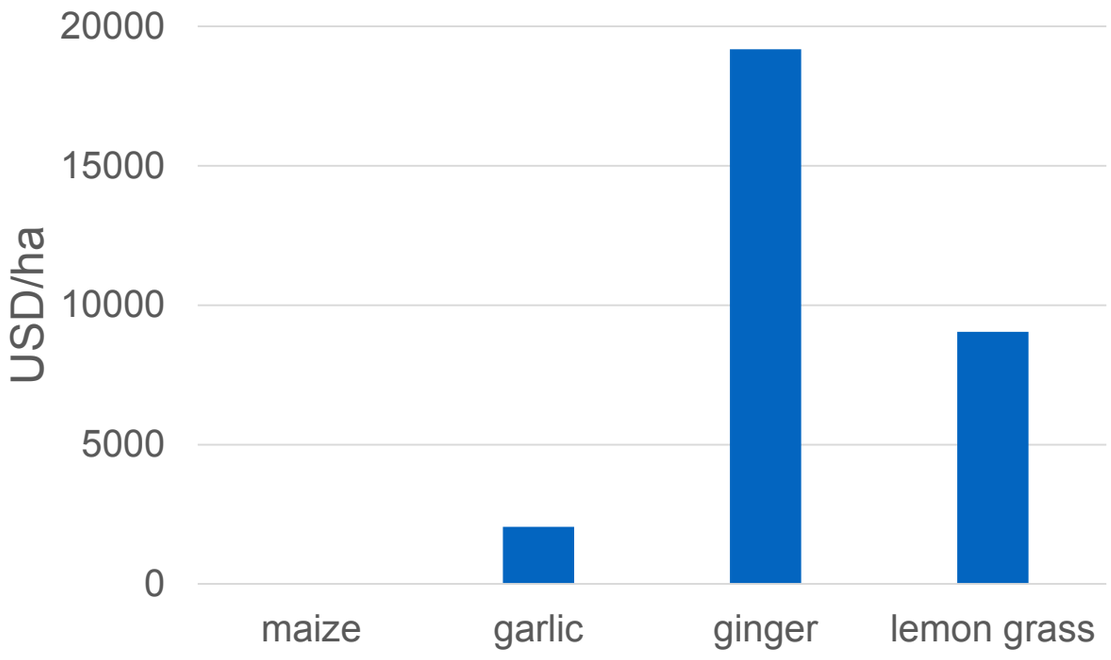
Significant differences in means within elephant damages are indicated with different lowercase letters (Mann-Whitney-U test, p<0,05)

Results

Revenues per crop type

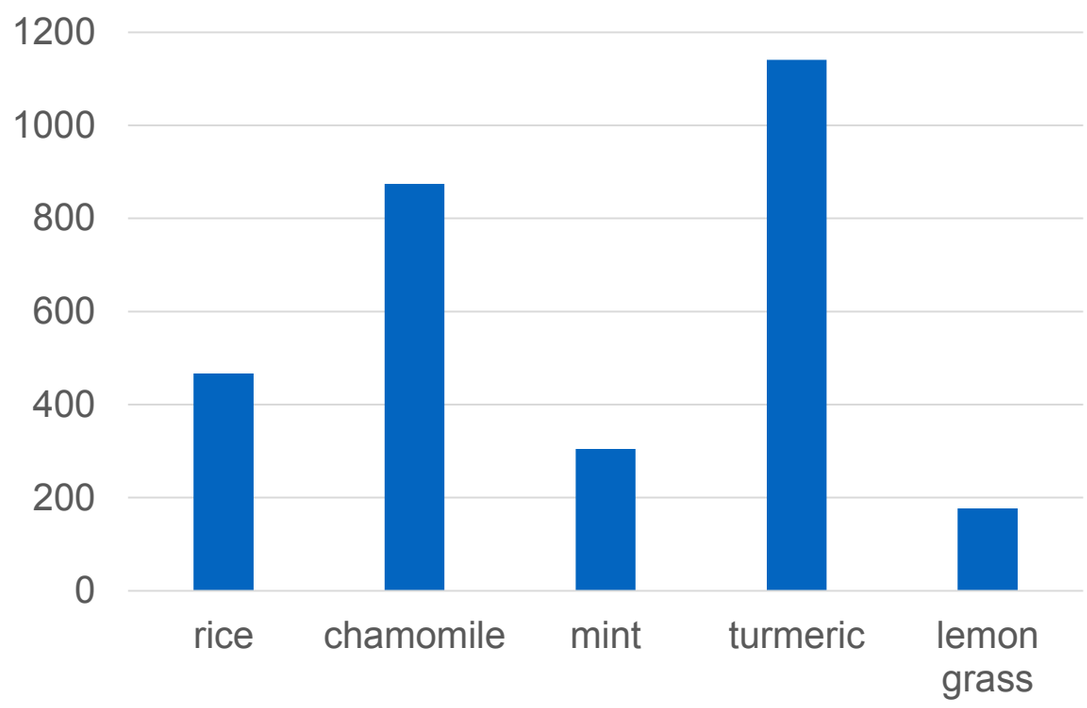
Potential revenues for sale of remaining crops in USD/ha

Zambia



Market price:
maize: 0.54 USD/kg, garlic: 15.05 USD/kg,
ginger/ lemon grass: 3.23 USD/kg

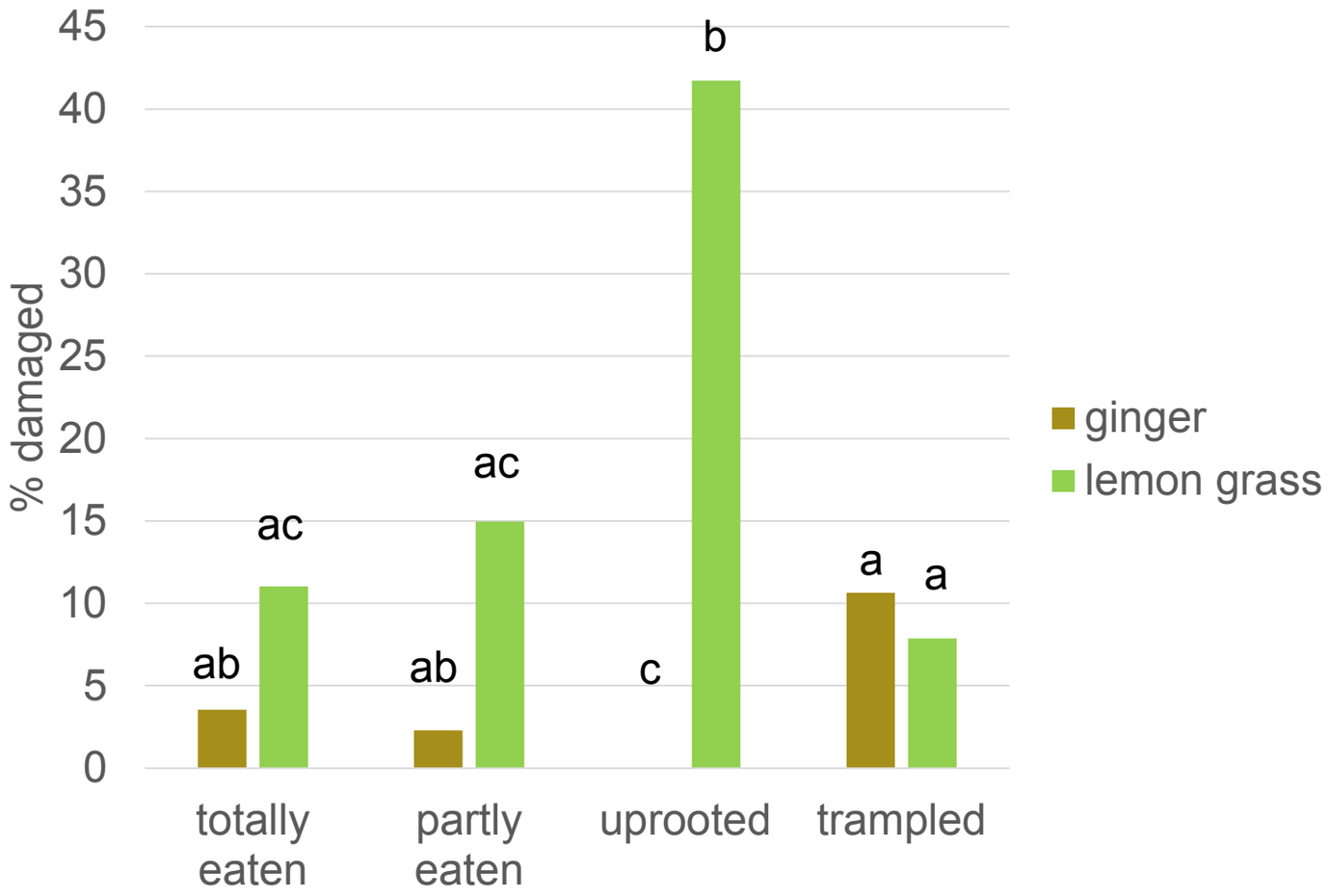
Nepal



Market price:
rice: 0.23 USD/kg, chamomile oil: 215 USD/kg,
mint oil: 15 USD/kg, turmeric: 0.13 USD/kg,
lemon grass: 13.1 USD/kg

Results Zambia

Monitoring after scheduled harvest time (June to September 2011)



- When remaining longer on the fields (after regular harvest time) lemon grass and ginger get prone to damages
- Especially lemon grass gets uprooted
- Lemon grass and ginger are consumed in small quantities



Ginger n = 395, lemon grass n = 127

Significant differences in means within crop damages are indicated with different lowercase letters. Kruskal-Wallis rank sum test within plant species followed by post-hoc test (Wilcoxon, bonferroni corrected).

Lessons learned

African elephants/Zambia

- Maize is more attractive to African elephants than garlic, ginger and lemon grass
- Garlic, ginger and lemon grass are mainly damaged by trampling up to the normal harvest time
- Ginger and lemon grass are NOT unpalatable, but less attractive than maize

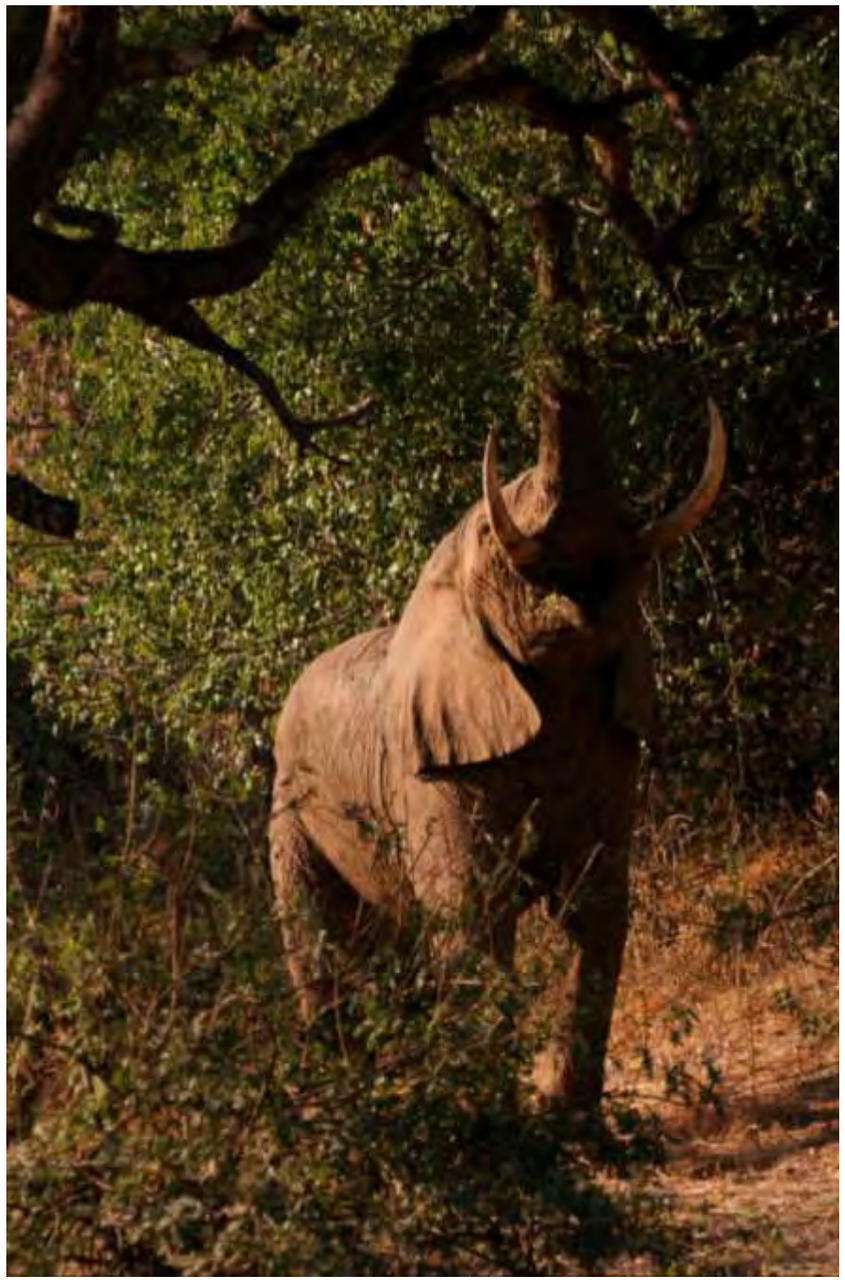
Lessons learned

Asian elephants/Nepal

- Rice is more attractive to Asian elephants than all test crops
- Chamomile, coriander, mint, basil and turmeric are damaged by trampling only
- Lemon grass and citronella were neither damaged through feeding nor trampling
- Lemon grass was consumed by rhino to a small extent – palatability might be given

Management implications

Using unattractive crops for secure income generation



- ✔ More research needed on attractiveness of different crop types
- ✔ Long term (learning) effect needs to be taken into consideration
- ✔ Unattractive crops are an economically reasonable alternative, when market availability is given
- ✔ Cultivation of unattractive crops can turn „fight against elephants“ into a positive approach of development and land-use planning

Thanks to our project partners

and financial supporters

Thank you !

Behaviour and social dynamics of crop-raiding in Asian elephants (*Elephas maximus*): can beehive fencing mitigate human-elephant conflict in a highly crop-raided region of Sri Lanka?





By Kylie M. Butler

University of Newcastle, Australia

Save the Elephants, Kenya

Presentation Overview

- Human-elephant conflict and crop-raiding
- Introduction to Elephants and Bees, Sri Lanka and our project goals
- Behavioural studies of the local elephant population







Human-elephant conflict (HEC)



DEFINITION:

'When the actions of elephants negatively impact human well-being, or when the actions of humans negatively impact the well-being of elephants'







Crop raiding

- a high-risk/high gain foraging strategy

- SL: home to 5879 wild elephants
  - highest density of wild Asian elephants
  - > 10 % global Asian elephant population



Elephants and Bees, Sri Lanka: a PhD and community project

1. Mitigation technique: beehive fencing



2. Elephant demographics and behaviour







Beehive fencing – an elephant deterrent





<u>What is a beehive fence?</u>

• A series of beehives hung from posts and surrounding an area to be protected

• Beehives approx. 10 m apart and connected by wire

• If an elephant tries to walk between hives, it will hit the wire, causing the hives to swing and the bees to swarm

• Effective in Africa

Beehive fencing in Asia

- Different spp. bees and elephants
- Asian honeybee < aggressive
- Has shown promise in Malaysia, Thailand and India
- Yet to be scientifically evaluated in Asia







Elephants and Bees, Sri Lanka: research site





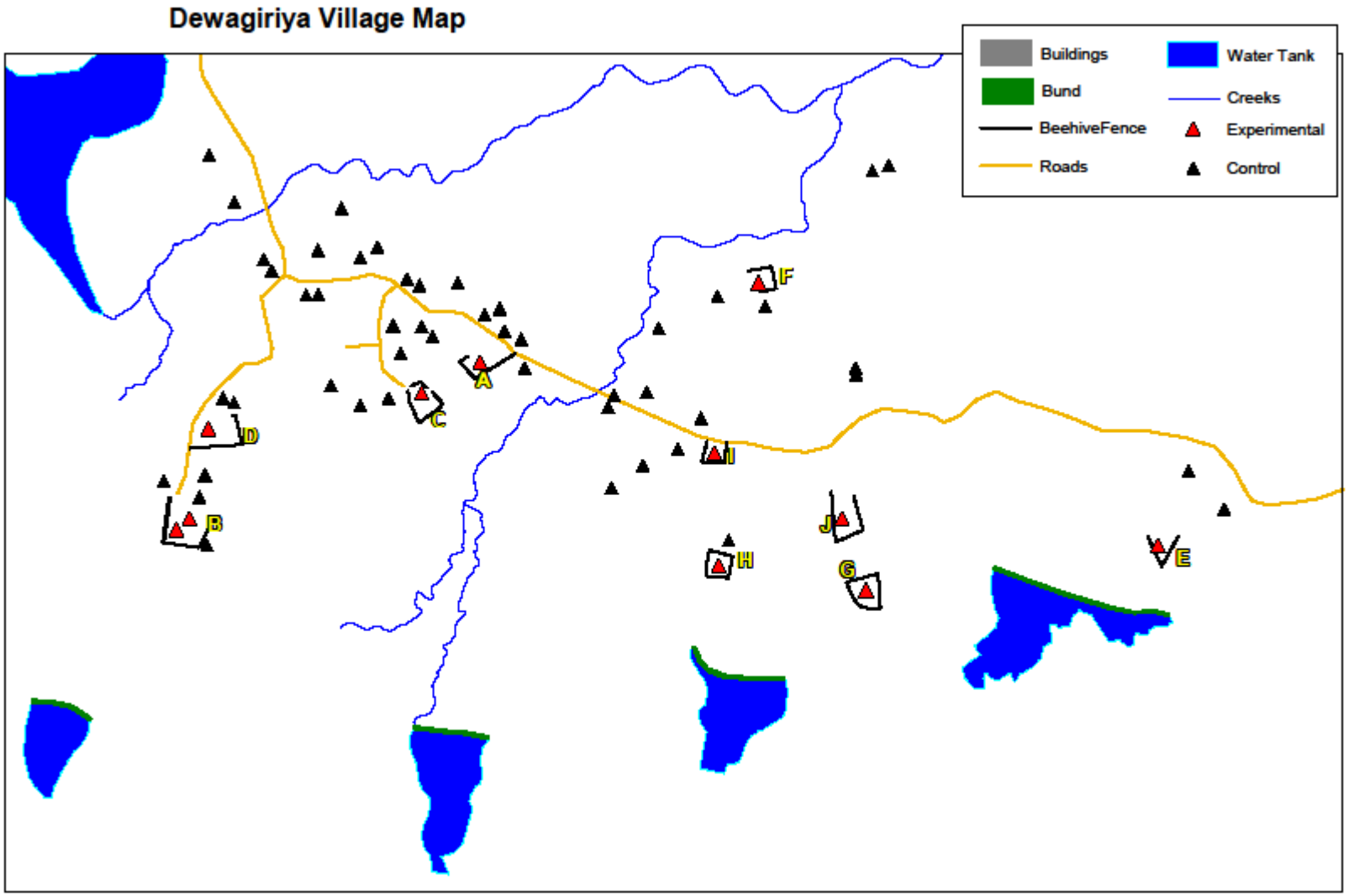
- Beehive fence trial site established in Dewagiriya Village (near Wasgamuwa NP)

- High levels of crop raiding, almost year-round

- No prior beekeeping experience but eager to learn



Beehive fence research site



Beehive fencing – monitoring elephant activity



Elephant events

- # elephant events
- damage incurred
- # elephants crop-raiding
- behaviour near beehives

Beehive fences

- hive occupations
- damage incurred
- break-throughs





Overall evaluation of beehive fencing as a deterrent

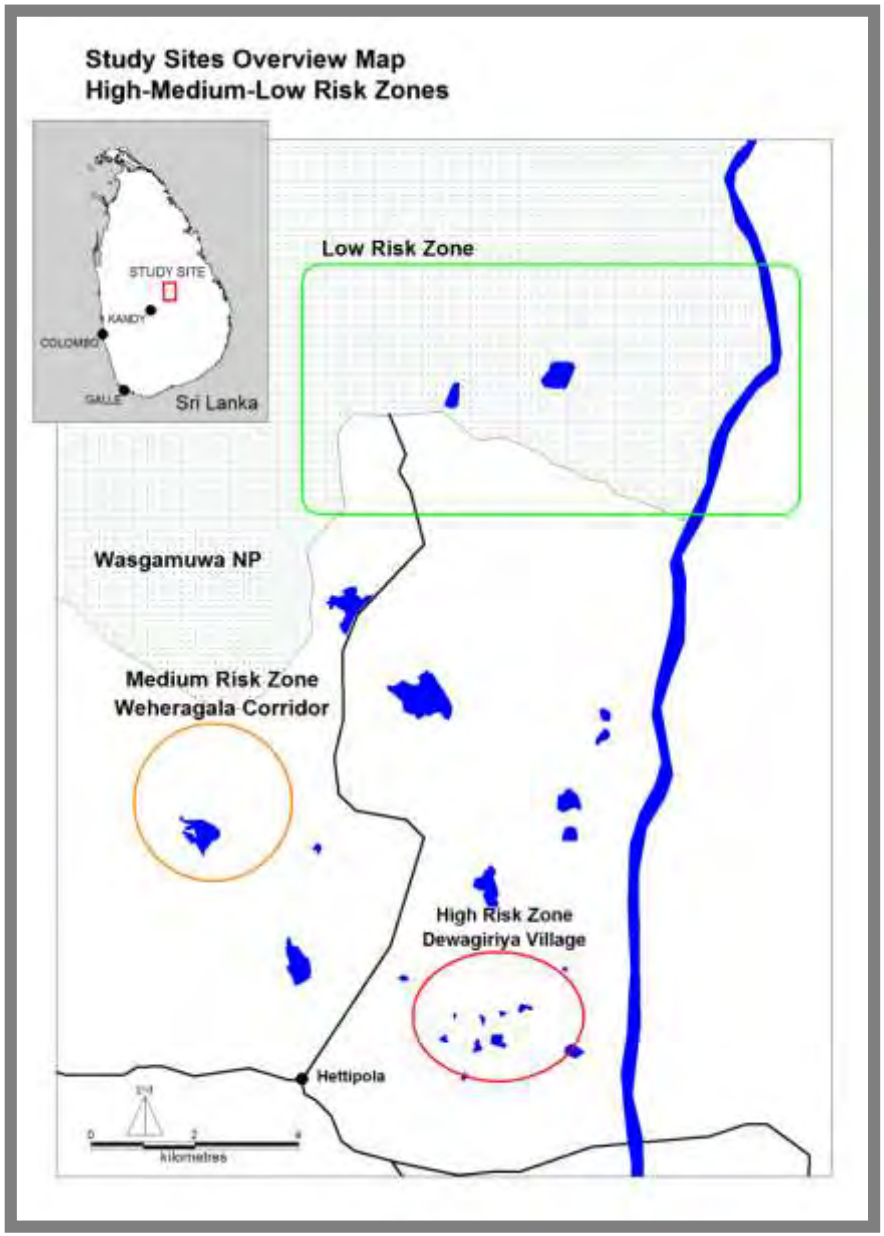
- Has crop raiding decreased?
- Practicality of keeping bees
- Logistics, costs, time, perceptions







Elephant demographics and behaviour



Low risk zone: Wasgamuwa NP

Medium risk zone: Weheragala Corridor

High risk zone: Dewagiriya Village



Elephant demographics and behaviour

- Age, sex, abundance, herd structure, main group activity

- Personality traits: aggressiveness & boldness

- Basic social patterns of male elephants









Preliminary findings

- Male elephants dominant crop raiders

- Female elephants > aggressive traits

- Farmers positive about beehive fencing







Elephant crop-raiding behaviour and mitigation

Information about local elephant population + understanding risk-taking and social behaviour of elephants + researching deterrent effect of beehive fences + farmer attitudes towards elephants and beehive fencing

→ assessment of the potential use of beehive fencing as an Asian elephant crop raiding mitigation tool.





Thank you

THE TRANSPETROL FOUNDATION

The Rufford Foundation
www.rufford.org

Elephant Action League



For the Wild
TARONGA
CONSERVATION SOCIETY AUSTRALIA

CHESTER ZOO
ACT FOR WILDLIFE

ZOOS VICTORIA
WERRIBEE
MELBOURNE
HEALESVILLE



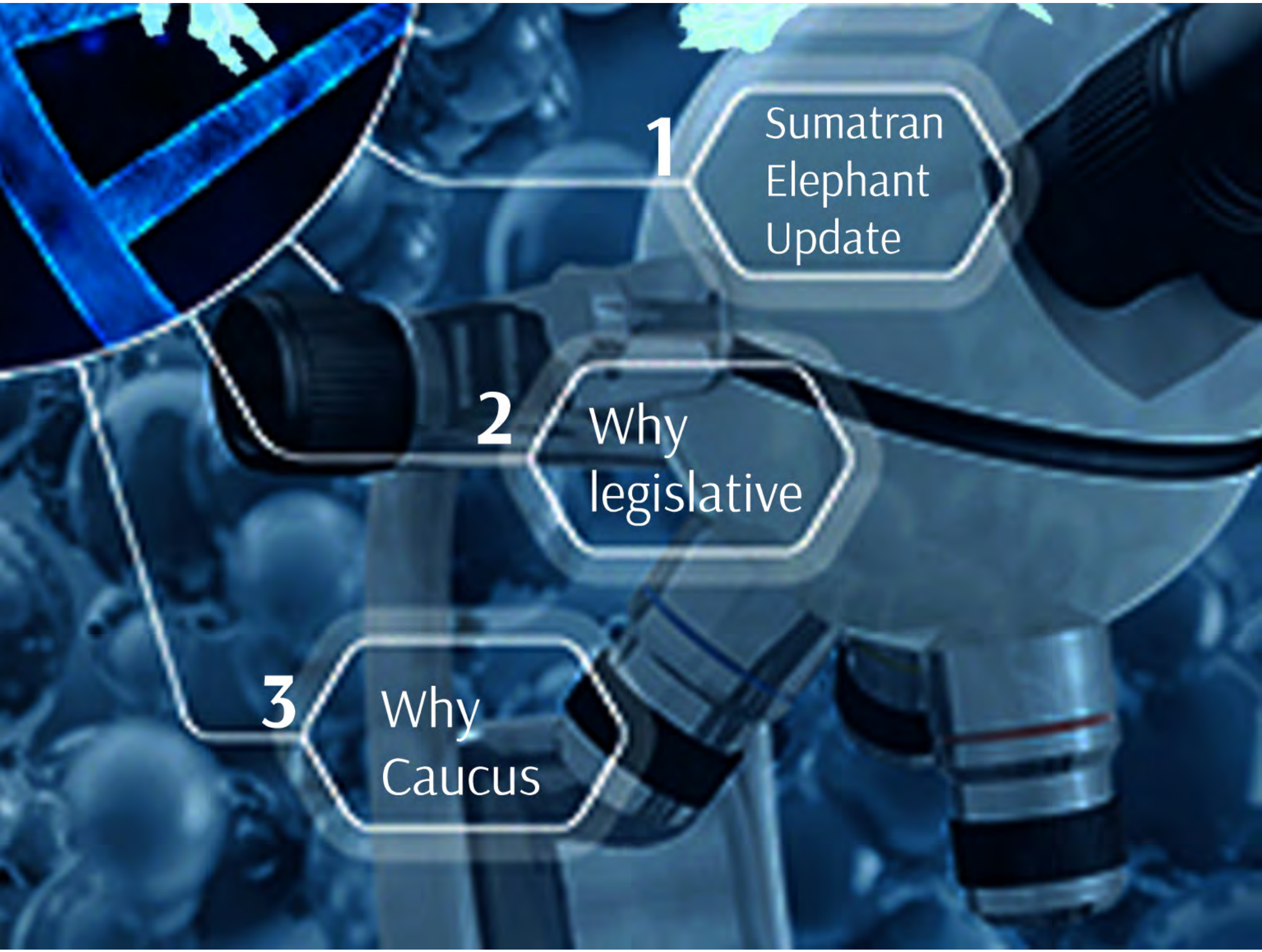
phoenix zoo
ARIZONA CENTER for NATURE CONSERVATION


1. Sumatran Elephant Update
3. Why Caucus
ENGAGING LEGISLATORS IN WILDLIFE CONSERVATION IN ACEH, INDONESIA
By Wahdi Azmi
1 Sumatran Elephant Update
2 Why Legislative
3 Why Caucus

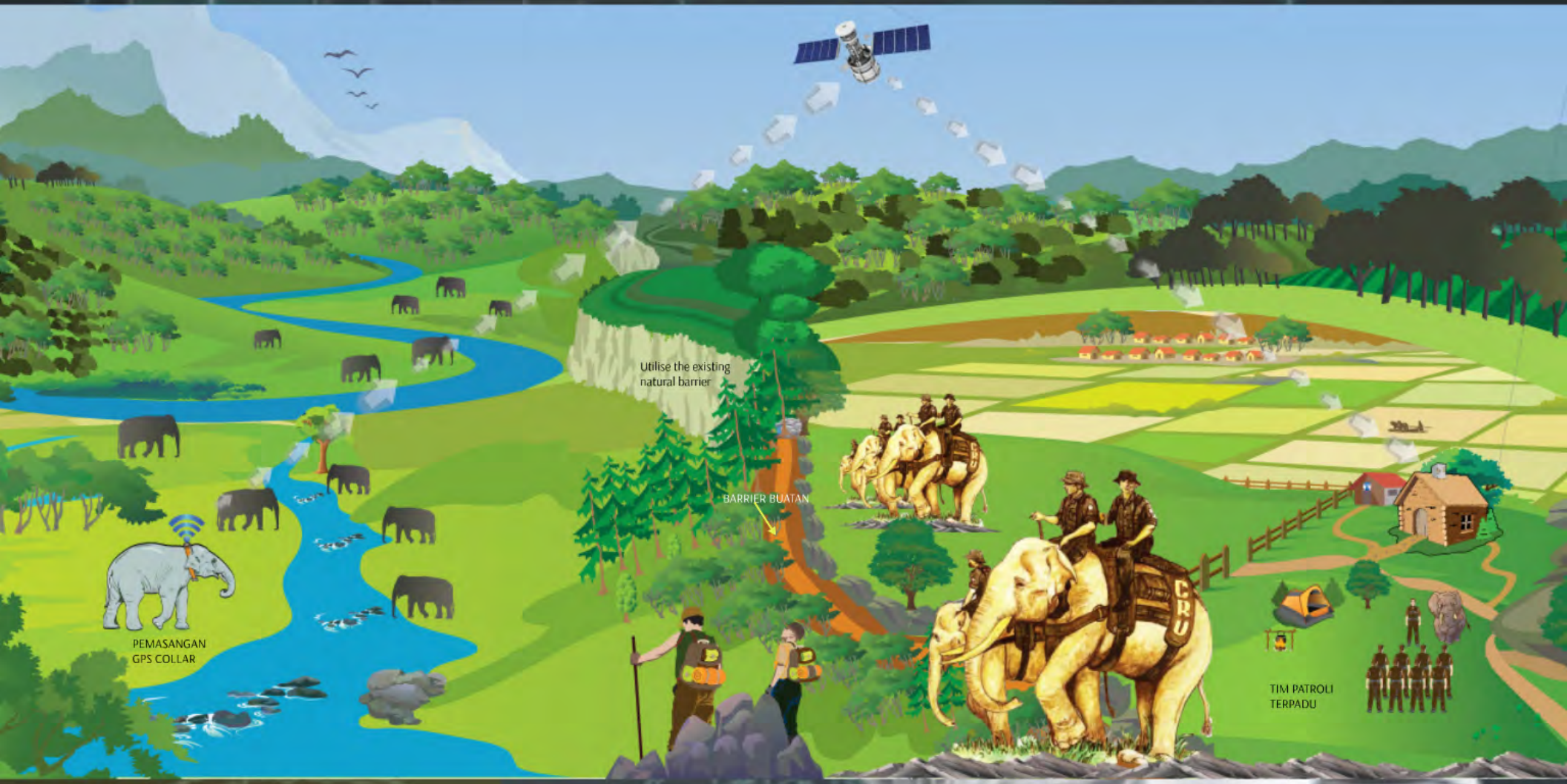
Engaging legislators in wildlife conservation in Aceh, Indonesia

By Wahdi Azmi




1
Sumatran
Elephant
Update
2
Why
legislative
3
Why
Caucus

1. Sumatran Elephant Update



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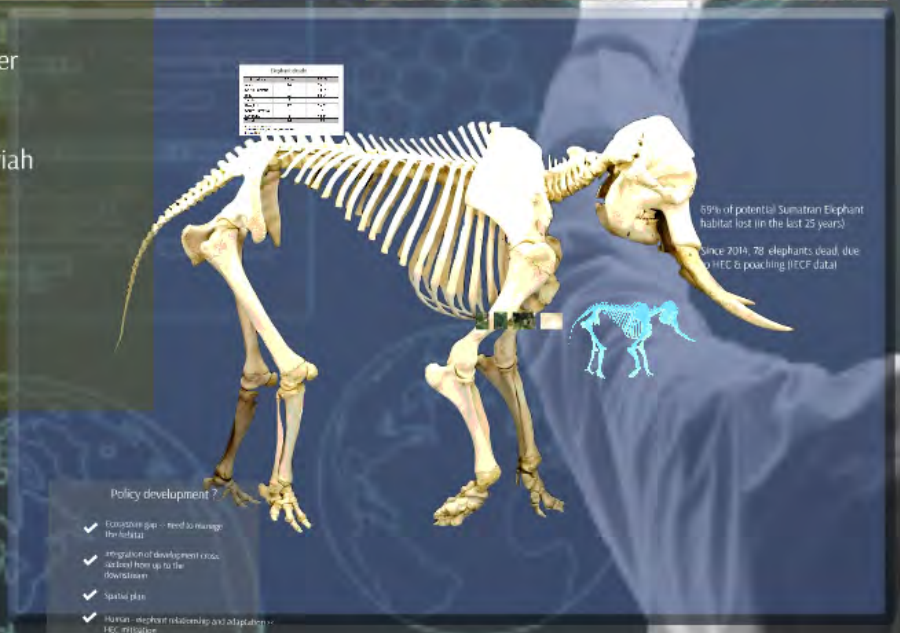


3. Why Cau

Thank You

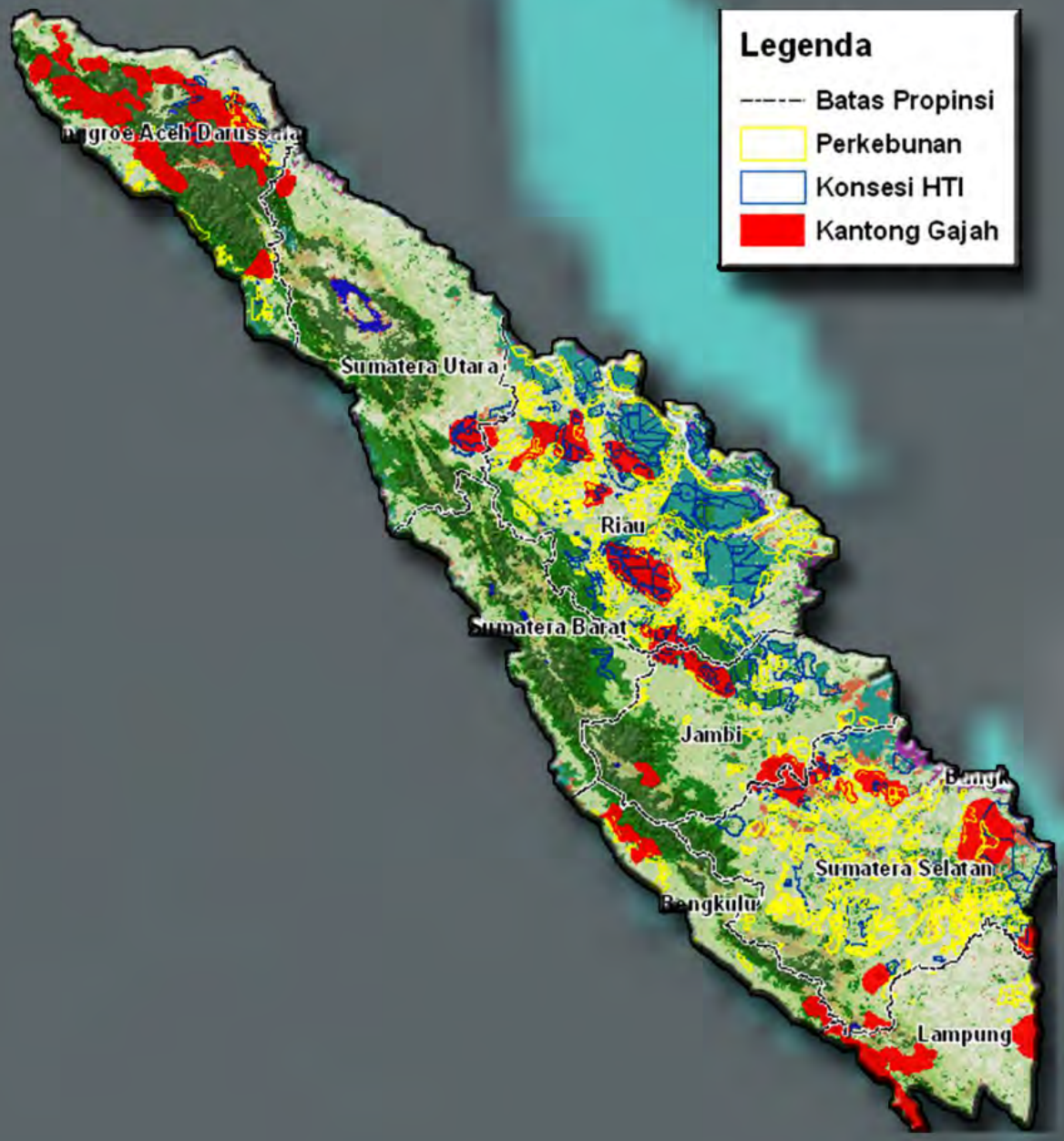


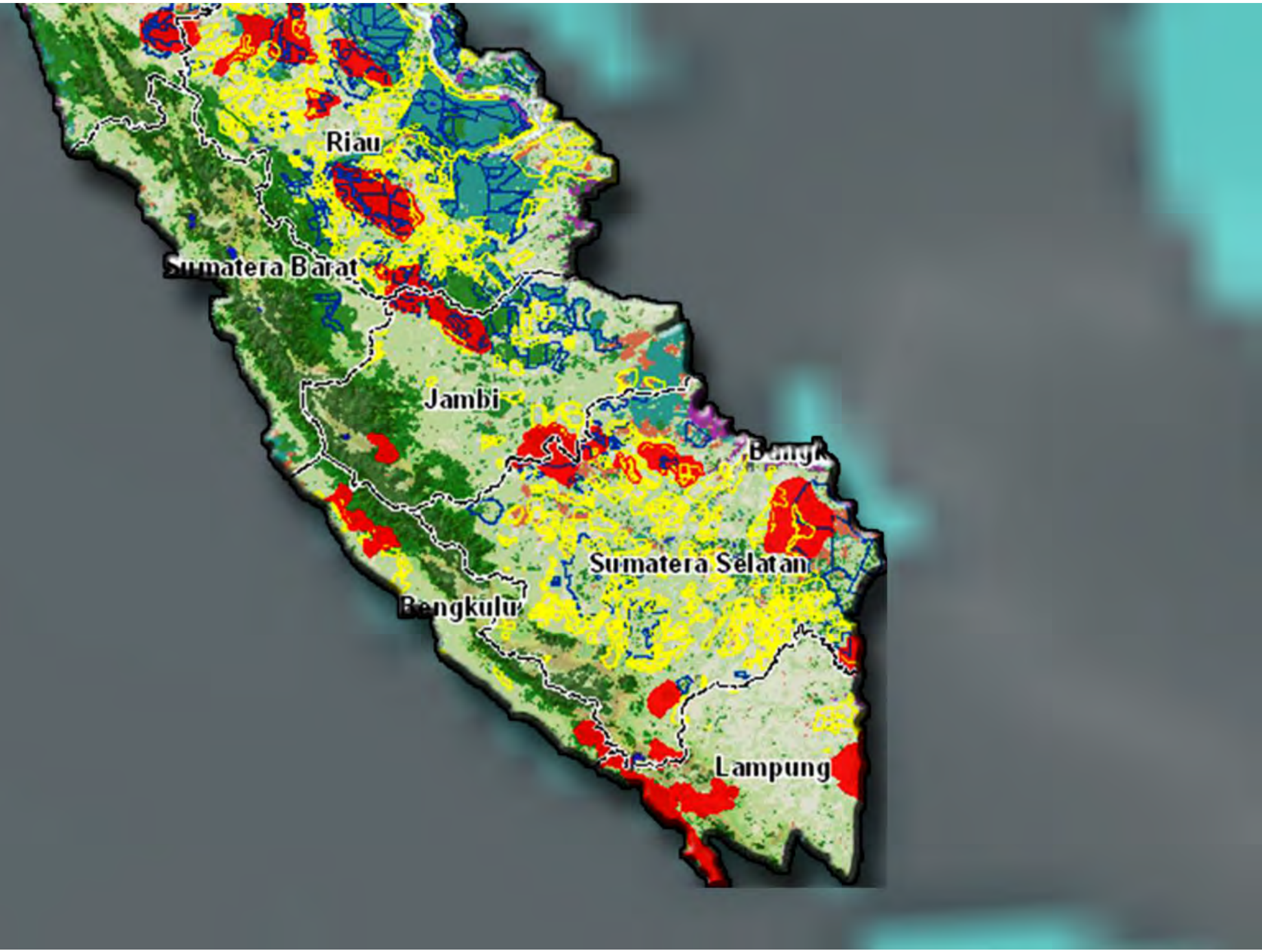





Gap ?
Community
Local NGO
law enforcer
private sector
legislative
Year 1980
Year 2007
Year 2014
1720




Legenda
Batas Propinsi
Perkebunan
Konsesi HTI
Kantong Gajah
Sumatera Utara
Riau
Sumatera Barat
Jambi
Sumatera Selatan
Bengkulu
Lampung


Riau
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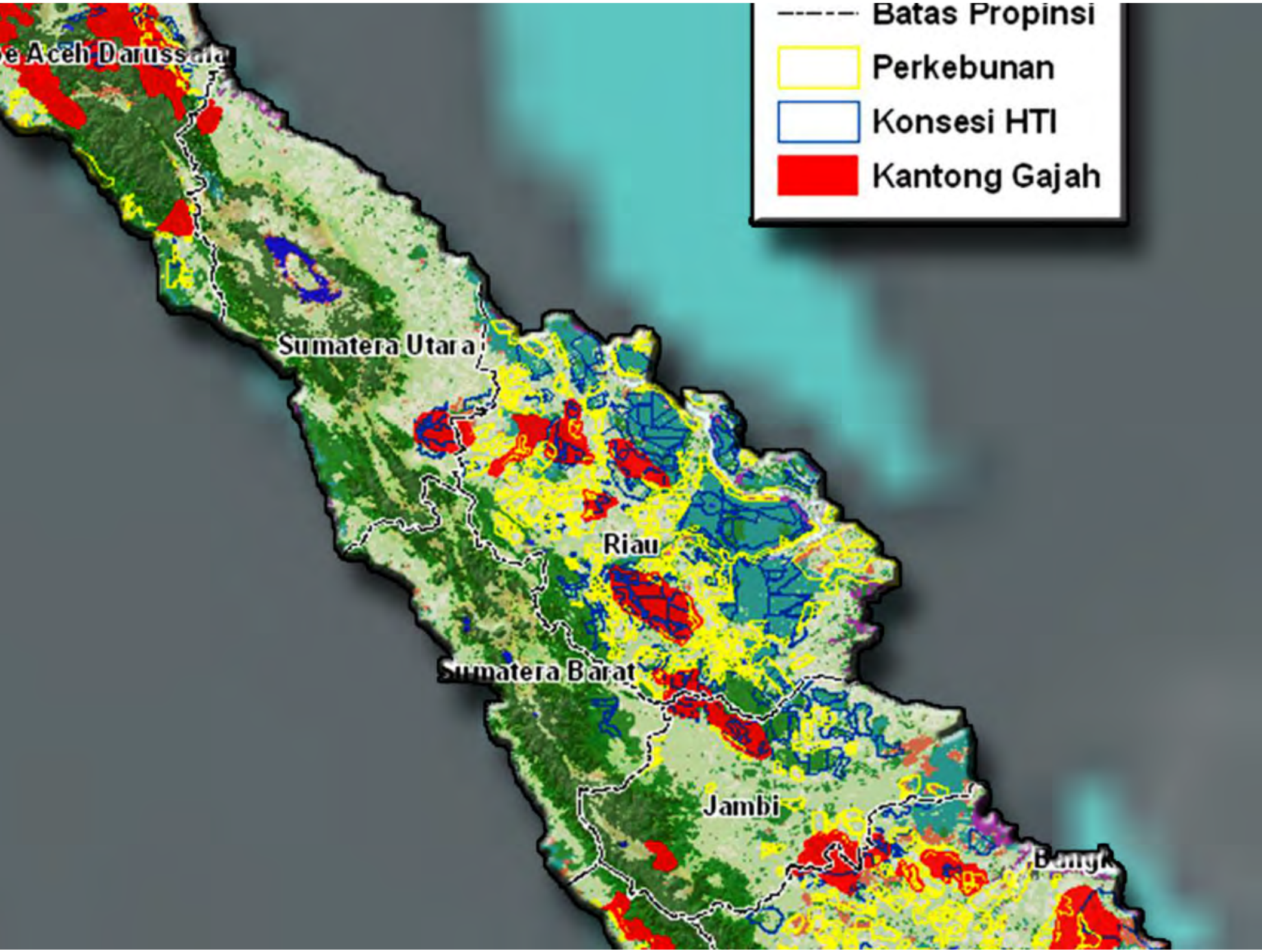
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Riau
Sumatera Barat
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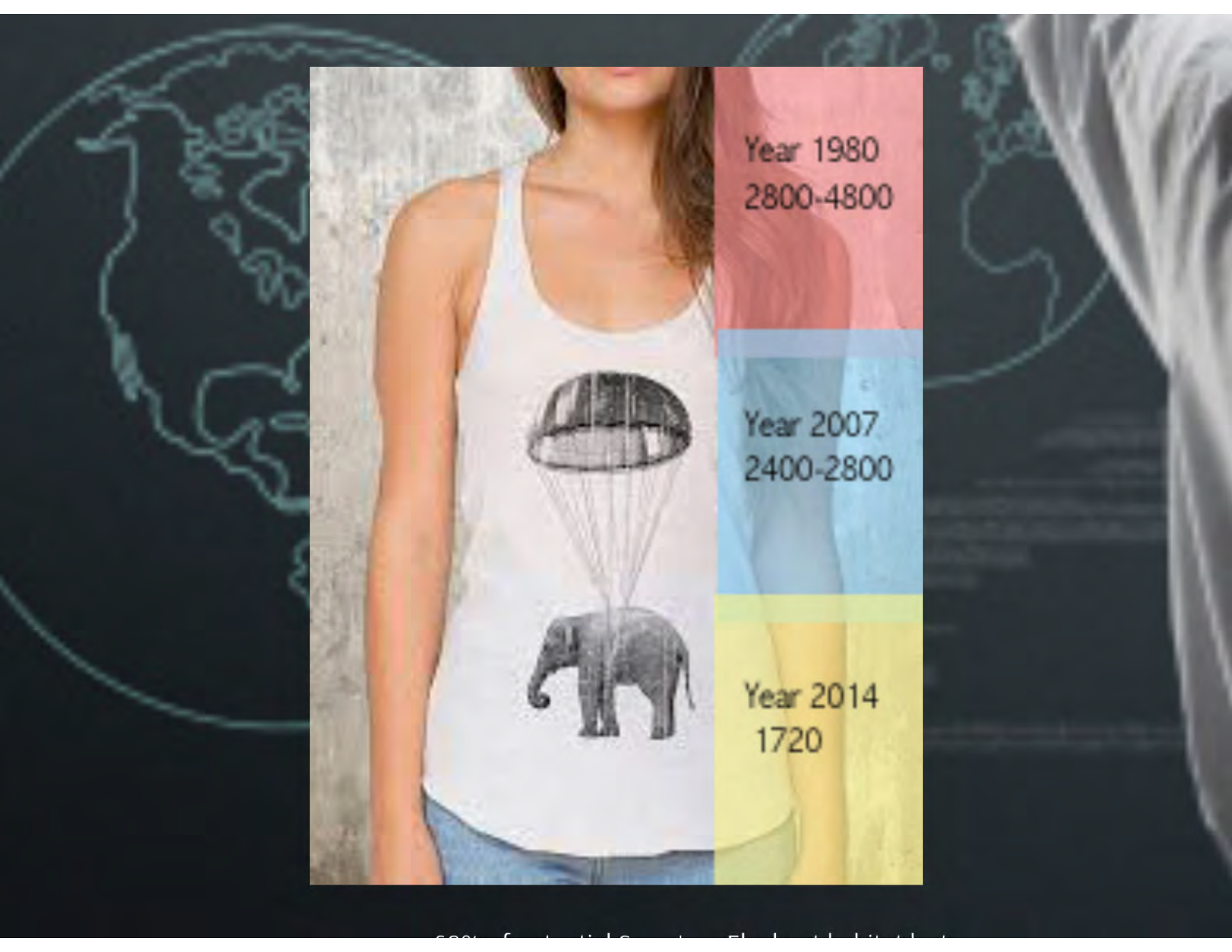
nggroe Aceh Darussala


HUMAN - ELEPHANT CONFLICT
IN AND AROUND ULU MASEN AND LEUSER ECOSYSTEMS
Multi Donor Fund
Malacca Straits
Indian Ocean
Sabang
TWA
BANDA ACEH
Sigli
THR
Jantho
CA
Bireuen
Lhok Seumawe
Lhok Sukon
Idi Rayeuk
Simpang Tiga Redelong
Takengon
Calang
NANGGROE ACEH DARUSSALAM
PROVINCE
TB
Langsa
CA
Kuala Simpang
Jeuram
Meulaboh
Blangkejeren
Blang Pidie
TN
Stabat
Binjai
TN
Kutacane
NORTH SUMATRA
PROVINCE
Tapaktuan
Kabanjahe
Toba Lake
Sidikalang
HSA
Singkil
Tuangku Island
TL
Simeulue Island
Elevation (m)
3.453
0
- 5.500
Depth (m)
LEGEND
Capital City of Province
Capital City of District
Human - Elephant Conflict
Province Boundary
Leuser Ecosystem Boundary
Ulu Masen Ecosystem Boundary
Kawasan Konservasi
TN Taman Nasional
TB Taman Buru
CA Cagar Alam
THR Taman Hutan Raya
HSA Hutan Suaka Alam
TL Taman Laut
TWA Taman Wisata Alam
N
0 40 80
Kilometers
Source :
- Rupabumi Digital Indonesian Map, 1:50.000, BAKOSURTANAL, 1978
- Digital Elevation Model, 25 m, LIF
- Field Survey, FFI and LIF,1985-2002, 2005-2007
Map Catalog : LIF07_NT_512


Year 1980
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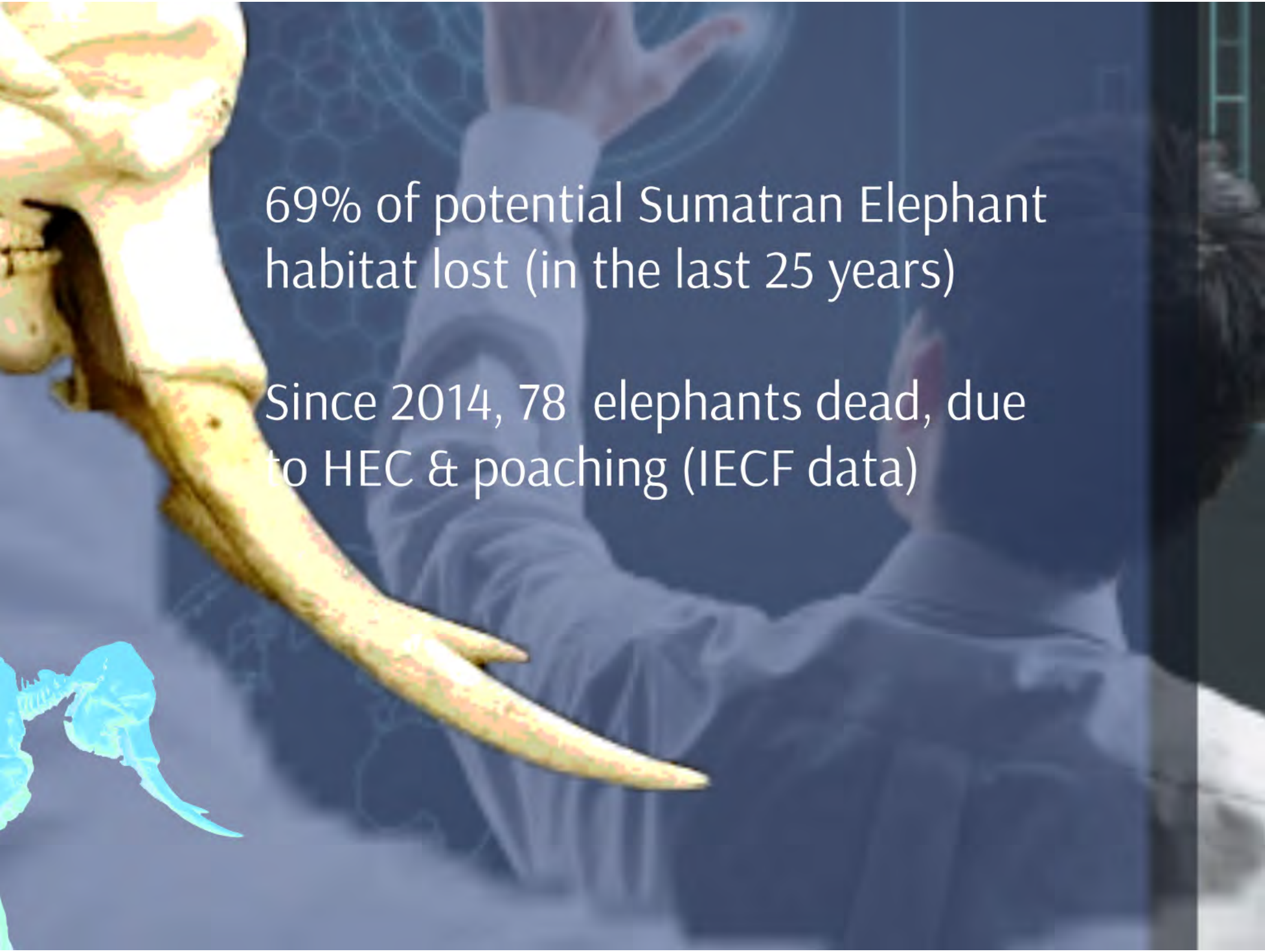
Year 2007
2400-2800
Year 2014
1720

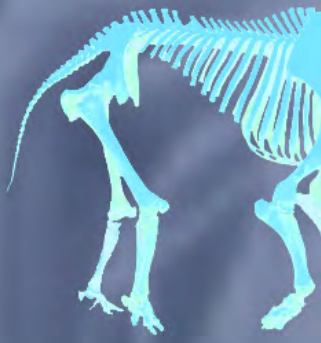

69% of potential Sumatran Elephant habitat lost (in the last 25 years)
Since 2014, 78 elephants dead, due to HEC & poaching (IECF data)

Elephant death

Province	2014	2015
Aceh	14	7+1*
North Sumatra	?	1+1*
Riau	23	5+1*
Jambi	2	1
Bengkulu	1*	5+2*
South Sumatra	?	2
Lampung	6	4+2*
Total	**46**	**32**

Note: *captive elephant
Source: FKGI, WWF, FHK, WCS, FKL, Vesswic
(October 2015)





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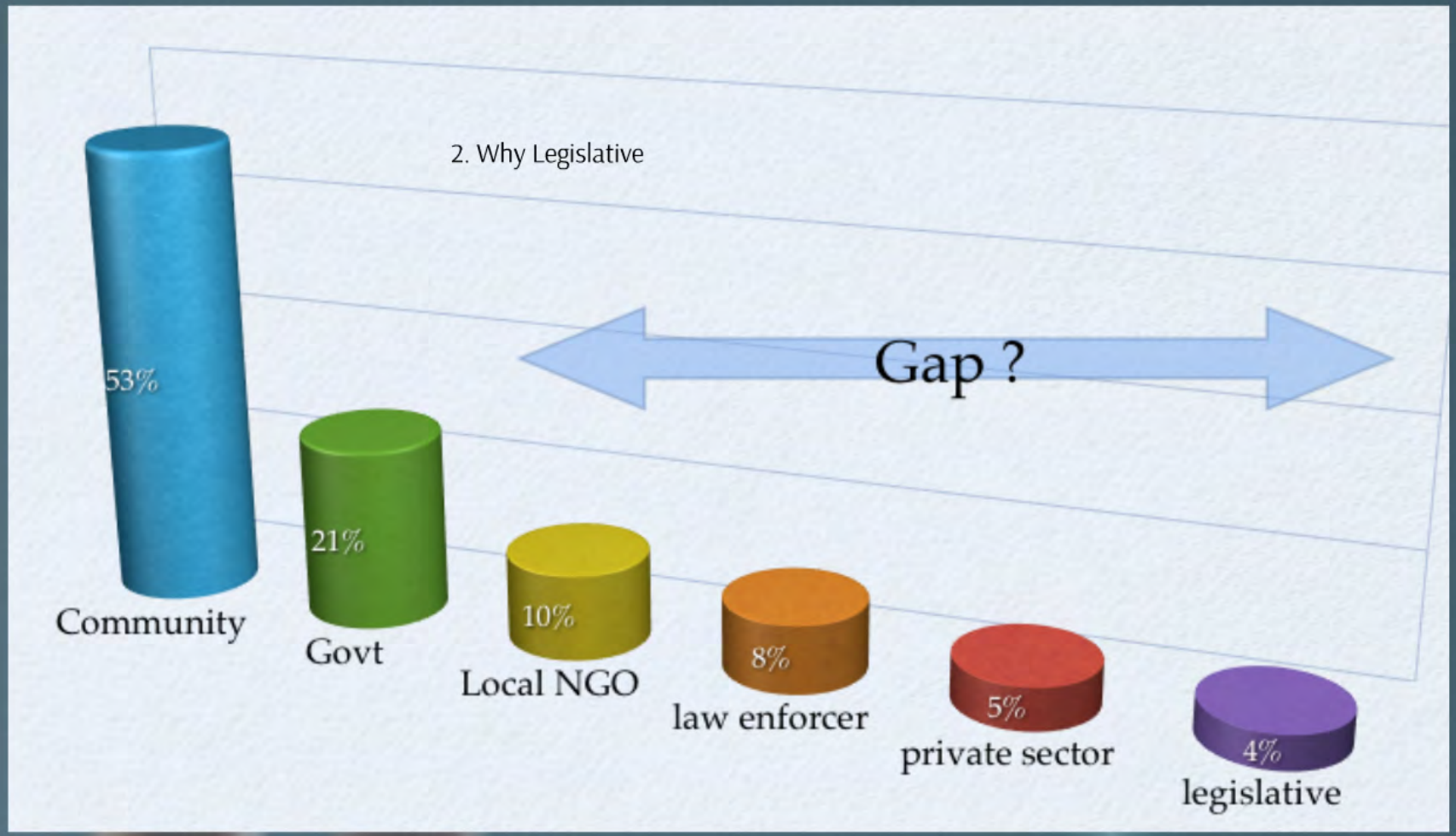
Lampung	6	4+2*
Total	**46**	**32**

Note: *captive elephant
Source: FKGI, WWF, FHK, WCS, FKL, Vesswic
(October 2015)

Policy development ?

- Ecosystem gap -> need to manage the habitat
- integration of development cross sectoral from up to the downstream
- Spatial plan
- Human - elephant relationship and adaptation >< HEC mitigation

2. Why Legislative


2. Why Legislative
53%
Community
21%
Govt
10%
Local NGO
8%
law enforcer
5%
private sector
4%
legislative
Gap ?

3. Why Caucus




Kaukus III
PEMBANGUNAN BERKELANJUTAN ACEH
KAUKUS
PEMBERDAYAAN
HERMES PALACE
Konflik S
Selasa,



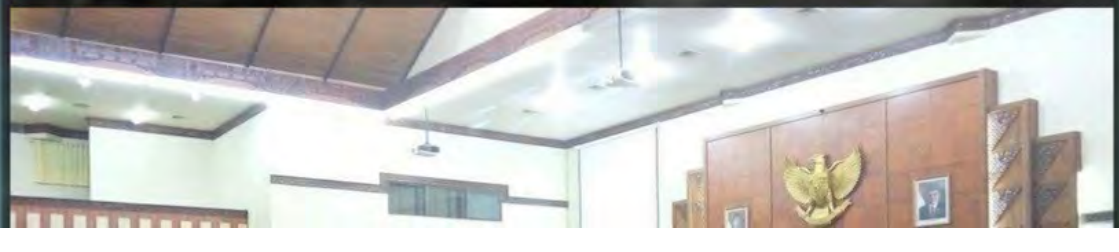


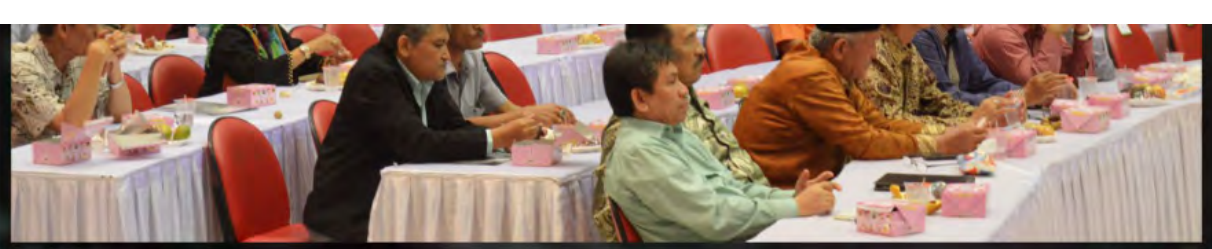












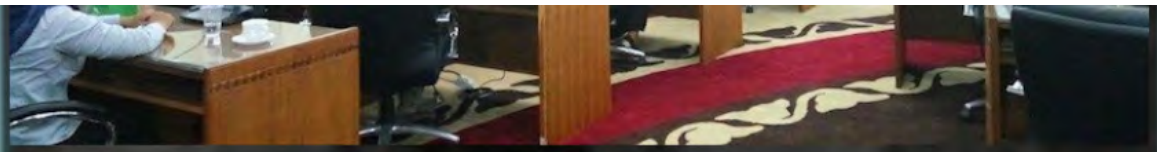














Thanks to

ASIAN ELEPHANT SUPPORT

U.S. Fish & Wildlife Service

WILDLIFE WITHOUT BORDERS

15th international elephant and rhino conservation and research symposium

Singapore

Nov 14th to 18th 2016

Knowledge on Bio diversity, elephant and elephant conservation among the school students of Megamalai, Tamilnadu, India.

Prof. D. Edwin Rajakumar

Prof. Rajesh

Dr. Sivasubramaniyan

Mr. Arasan Saravanan

Mr. Solai Arasu

Tamil Nadu, INDIA

Knowledge on Bio diversity, elephant and elephant conservation among the school students of Megamalai, Tamilnadu, India.

INTRODUCTION

- Meghamalai, is a cool and misty mountain range situated in western ghats, India. It is a virgin forest, hidden paradise, with lot of flora and founa. Many number of elephants are crossing in estates during November every year. So human, elephant conflict management is very important.

- Awareness on bio-diversity is an important socio-scientific issue that is often regard as a pre condition to sustainable eco development. Multi level integrated governance must be strengthen. Education of children and students an elephant conservation is essential. Using traditional methods will help to reduce human-elephant conflicts in the village is essential.

OBJECTIVES

- To understand the knowledge on Bio – Diversity among the school going students.
- To Identify the scientific Knowledge on elephants and its acts in the forest.
- To Identify the students knowledge on elephants conservation
- To understand the knowledge on ecology and its conservation

Design:

- The research design is descriptive in nature,

Sampling:

- There are 50 students have Identified for this study using random sampling technique.

Unit and Universe:

- School going students from tenth standard to higher secondary level in Megamalai and its nearest estates were identified for this study.

RESEARCH FINDINGS:

- 35% of the respondents are saying that knowledge on elephant conservation is essential for the students and remaining 65% of the respondents are saying that it is not necessary for the students.
- 55% of the respondents are saying that knowledge on bio-diversity is essential for the students and remaining 45% of the respondents are saying that it is not essential for the students.

- 62%of the respondents are saying that if they used plastic bags and plastic sheets will give digestive problem to the elephants if they eat in the forest remaining 48% of the respondents are saying that if will not give problem to them.
- 43% of the respondents are saying that elephants can swim in the water, remaining 67% of the respondents are saying that they cannot swim in water.

- 25% of the respondents are saying that elephants will sleep in the forest in night remaining 75% of the respondents are saying that elephants cannot sleep in the forest .
- 27 percentage of respondents are saying that elephant live more than 80 years, 48 percentage of the respondents saying that elephant live 60 years and remaining 25 percentage of the respondents are saying that they live 50 years only.

- 62 percentage of the respondents are saying that Ecology eduction is essentials for the public and remaining 38% percentage respondents are saying that ecology education is not essential for the public.
- 45% of the respondents are saying that conservation effort can start from the school 27% of the respondents are saying that conservation efforts can start from the family remaining 28% of the respondents are saying conservation is Government work.









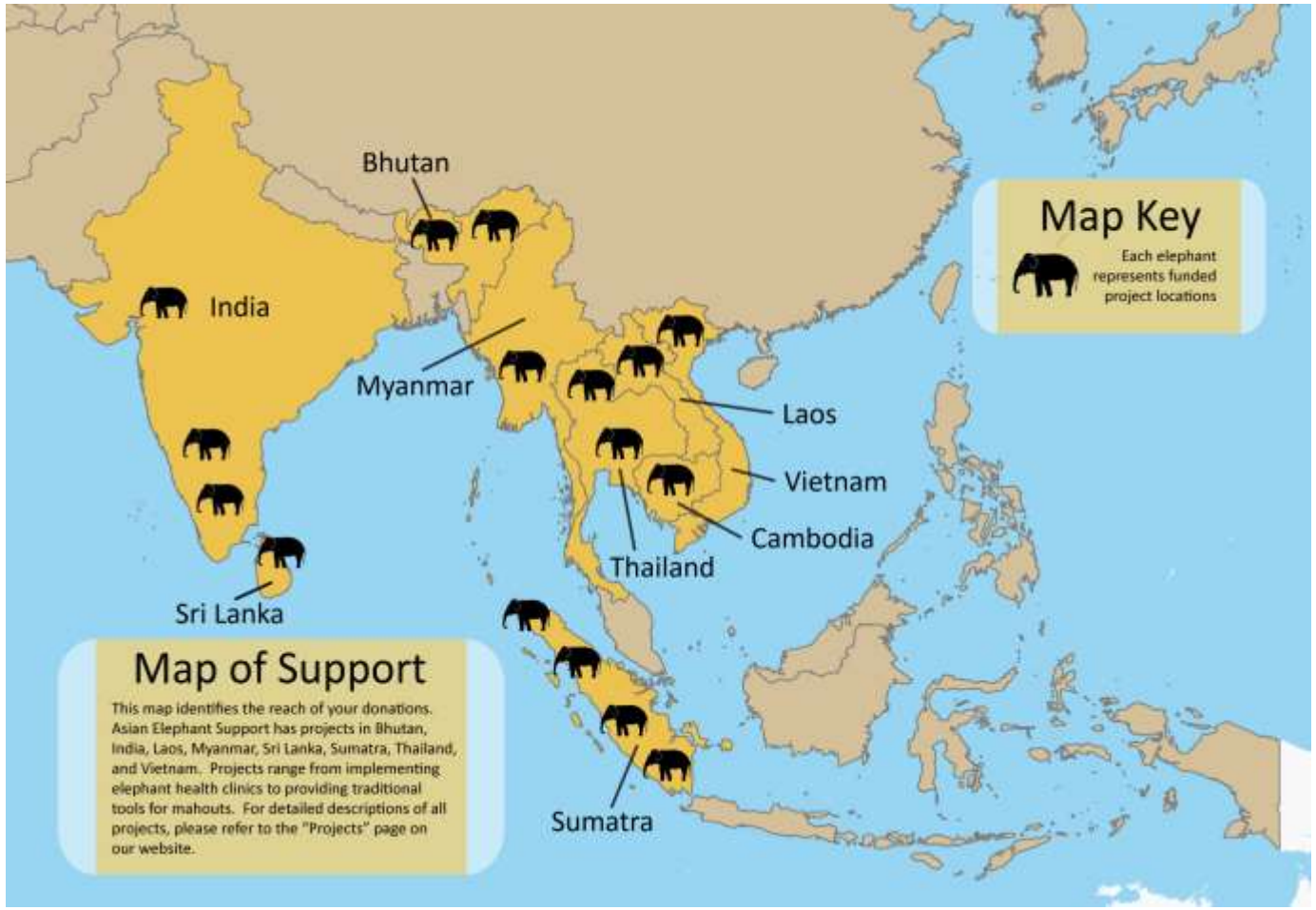

Thank You!

ASIAN ELEPHANT SUPPORT

Supporting the care and conservation of elephants in Asian range countries.

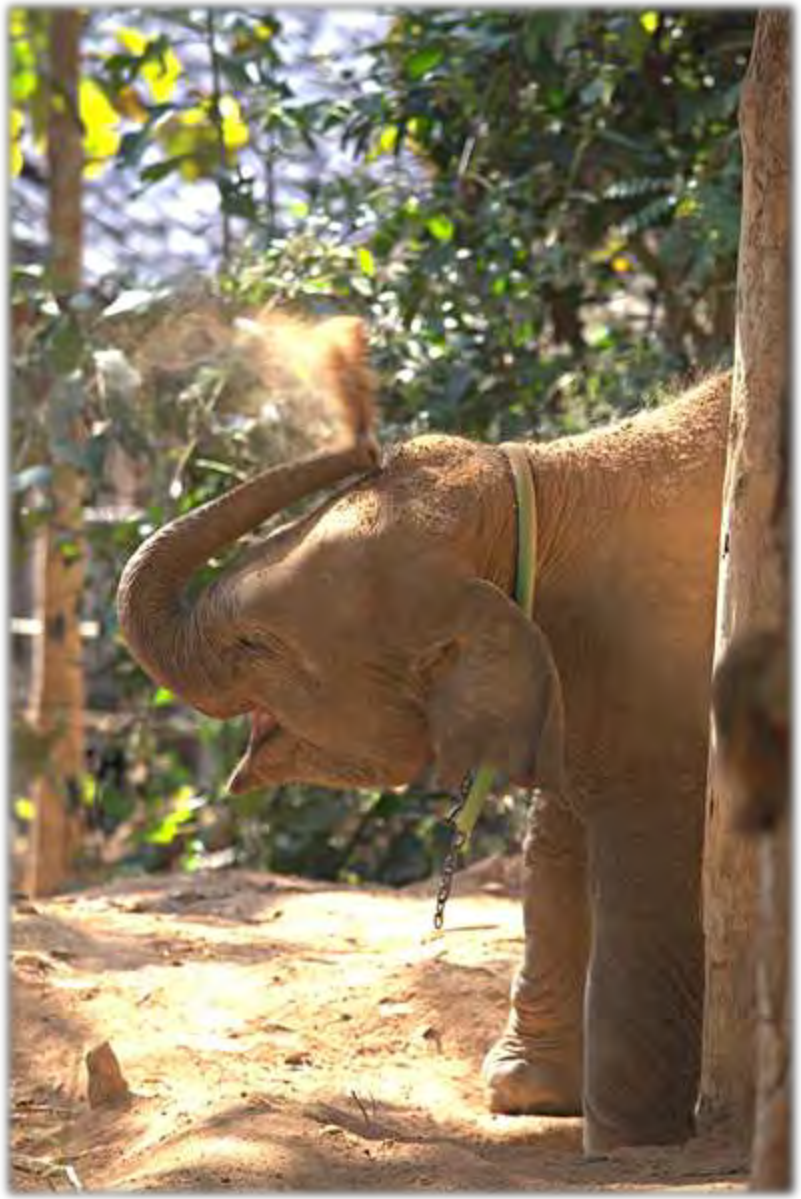


Founded in 2006, Asian Elephant Support (AES) is a U.S. Non-profit foundation dedicated to the care and conservation of Asian elephants in their range countries and to the people whose lives are intertwined with this magnificent and endangered species.



Our Mission:

- Provide financial support for the care and conservation of elephants in Asian range countries that meet our criteria for care of captive elephants and for conservation of the species.
- Increase awareness of the needs and future of the Asian elephant.
- Increase awareness of the humane treatment of elephants living in captivity.
- Provide educational opportunities to those persons who care for captive Asian elephants in range countries.



Educational Opportunities for Individuals



Mamatha Sathyanarayana – International Zoo Educators conference



Sounthone Phitsamone (Kan) – Indonesian Mahout Workshop



Aswin Bangun Master's in Forest Conservation



Mr. Pham Van Thinh, – Asian Elephant Health, Reproduction and Breeding Management

Supporting Educational Workshops



Field Course in Emerging Diseases Kerala, India











Regional Asian Elephant & Tiger Workshop – Kerala, India



Second Regional Asian Elephant Veterinary Workshop Nay Pyi Taw, Myanmar



Mahout workshops – Sumatra, Indonesia











Individuals & Organizations in Range Countries Sharing Knowledge



Dr. Christopher Stremme
Komunitas Untuk Hutan Sumatra







ElefantAsia – Mobile Veterinary Clinic, Laos







Dr. Kushal Sarma



Ms. Hrimati Dasi and Dr. Sarma



Mayapur Temple elephants
Laksmipriya and Bishnupriya









Mamatha Sathyanarayana

Mahout Workshops –India

Yeshey Wangdi

- Royal Manas National Park- Bhutan
- HEC mitigation workshops
- General biology and behavior of elephants
- The do's and don'ts of living with elephants





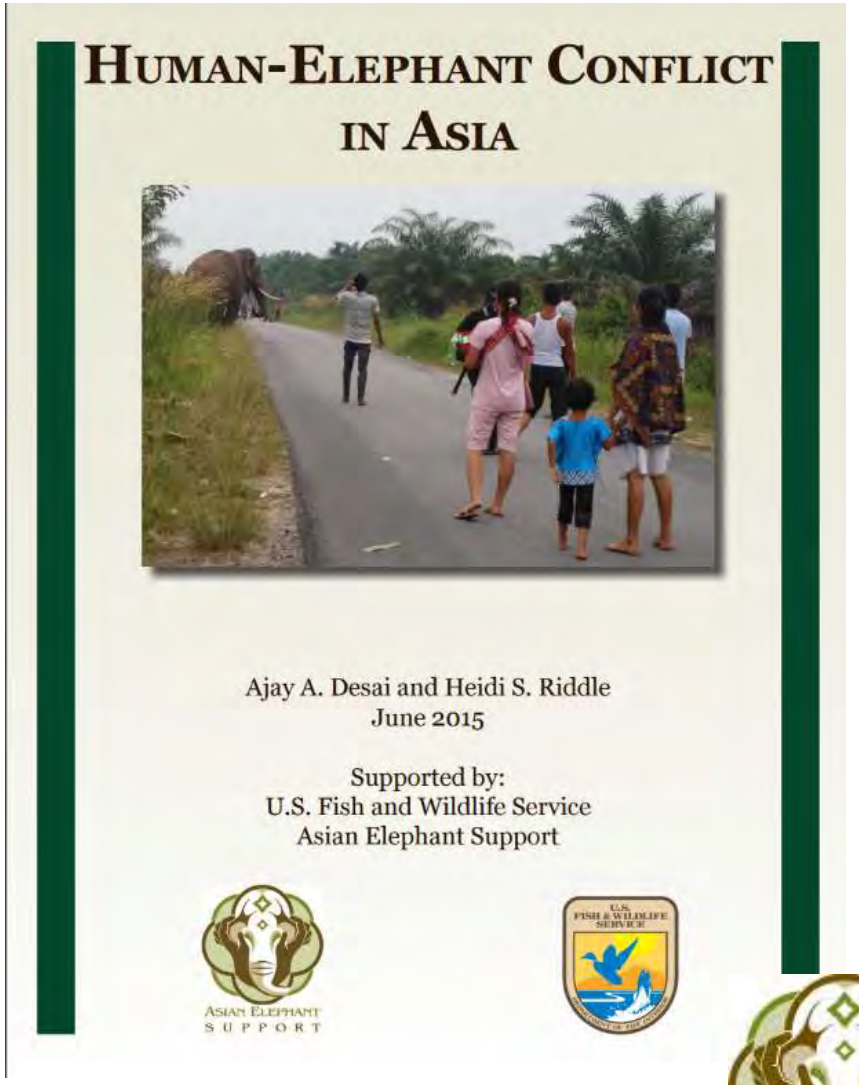
"The current trend of human-elephant conflict in Bhutan is very scary. This is because it involves two important dimensions – the livelihood of the poor farmer and conservation of the endangered Asian elephants.

Ajay A. Desai & Heidi Riddle

“Human-Elephant Conflict in Asia”

The goal was to review existing HEC mitigation efforts in all 13 Asian elephant range countries.

- Review documents, research papers, and meeting reports about HEC
- Synthesize the information
- Prepare a comprehensive guide that identifies the best approaches and methods to mitigating HEC
- Act as the basis for planning and implementing HEC mitigation efforts

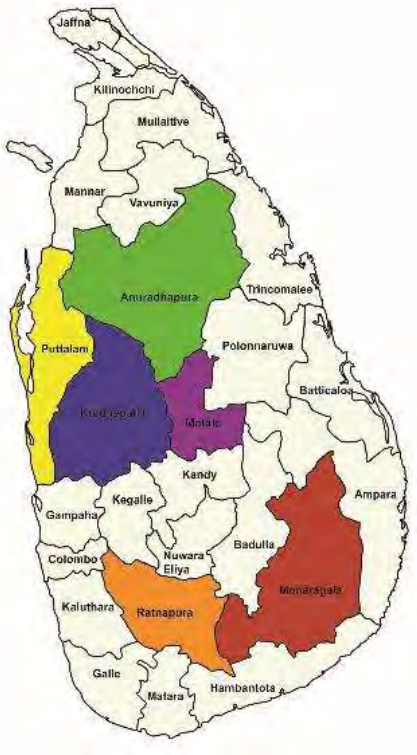


Biodiversity and Elephant Conservation Trust (BECT)



- Schools Awareness Program

This program helps educate children in 150 schools per year on the urgent need to conserve Sri Lanka's wild elephant population.



Asian Elephant Support Outreach



Zoo Outreach



Fresno Chaffee Zoo



Oregon Zoo



Woodland Park Zoo



Santa Barbara Zoo



Las Damas, CA



Asian Festival, Richmond, VA



AAZK Conference St. Louis, MO



Evans Middle School
McKinney, Texas



Earth Day, Norfolk, VA



Perot Science Museum
Dallas, Texas



Buckman Elementary School
Portland, Oregon



"*We are doing this because when they're all gone, they're all gone and there will be no more of that animal left". –*
http://kidsforendangeredanimals.weebly.com/



Travels in India













For More Information

Our website:
www.asianelephantsupport.org

Our email:
Elephants@asianelephantsupport.org

Facebook:
Please “like” us on Facebook for our latest updates, photos, and news about Asian elephants!

Pinterest:
Follow us on Pinterest

Monthly e-newsletter:
Sign up to receive our monthly newsletter, which contains valuable information on how AES contributes to Asian elephant conservation.

Raising Awareness & Funds from the Field: Effective Strategies in the Age of Interconnectivity

Sarah Conley & Nikki Sharp

INTERNATIONAL ELEPHANT FOUNDATION.ORG

WILDLIFE SOS INDIA

Does anybody know who this is?



She takes the stage…



Overnight she became a star



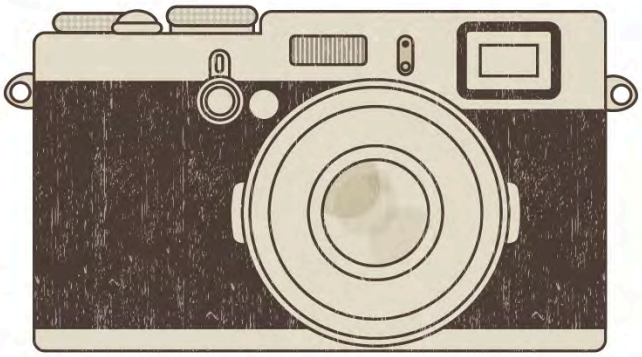
How are they possibly related?





What is a story?

Capture the moment



Get it to a captive audience



Elements to aim for in your story

- People should feel an emotion: joy, compassion, curiosity
- Story should bring hope
- Story should be “share-able” (bonus for a smile)
- Story should promote action (“What can I do?”)
  - Donate, volunteer, sign a petition, etc.

***Shoot for 3 out of 4



Enliven the mundane



Elements to aim for in your story

- What emotion? Concern
- Gives them hope? Yes
- Share the story? Maybe
- Action taken? Donate for her care

I give this a 3 out of 4 stars.

Make the mundane special





Elements to aim for in your story

- What emotion? Joy/amusement
- Gives them hope? Maybe
- Share the story? Yes (made people smile)
- Action taken? Become a monthly donor

This story is a 3 out of 4 stars.

Field people are the celebrities



Think ahead


WILDLIFE SOS
SAVING INDIA'S ELEPHANTS
FREEDOM
PHOTO(C) WILDLIFESOS/SHRESTHA

Show progress



Build your audience: webinars

- Connects you directly with an audience
- Connects you with people all over the world at once
- Supporters feel connected to each other
- Nothing but an internet connection is needed



Remember: Your audience awaits



INTERNATIONAL ELEPHANT FOUNDATION.ORG

Now What?

Communication is Content Driven

- Document your project and experiences as they happen
  - Photos
  - Video
  - Testimonials

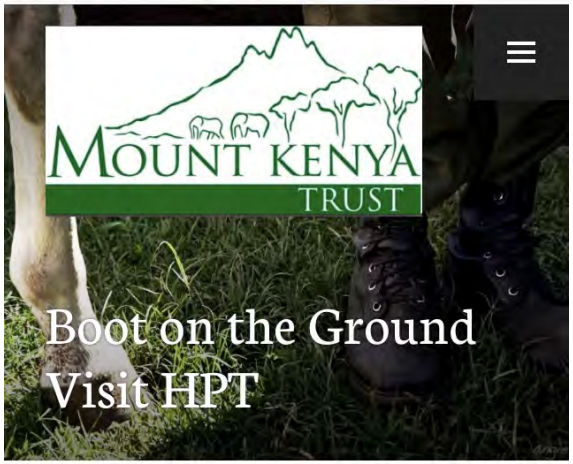


INTERNATIONAL ELEPHANT FOUNDATION.ORG

Raise Your Visibility

Social Media is the dominant form of news & communication for newer generations

- Keep a blog
- Twitter
- Facebook
- YouTube



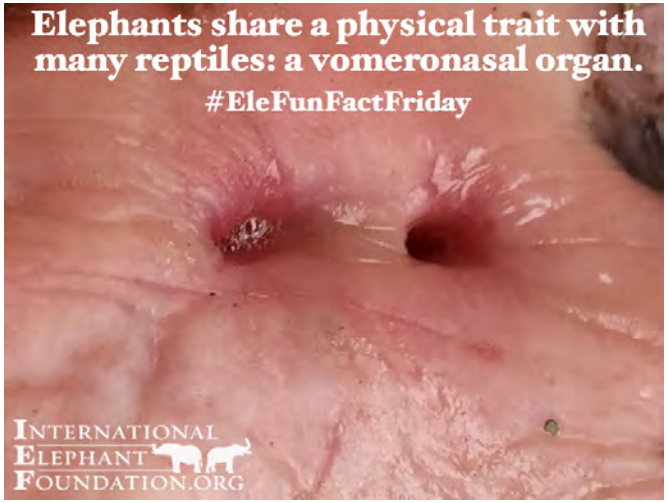
Last week we were lucky to have Boots On The Ground – a film crew travelling the African continent – who are raising awareness of the plight of wildlife and the brave rangers who work tirelessly



BLUE



What's a #Hashtag?



#EleFunFactFriday → RT (Retweet)

Tag Your Donors & Sponsors!

twitter @ElephantsIEF



INTERNATIONAL ELEPHANT FOUNDATION.ORG

Help Your Cause with the Donor

- Good Reports
  - Did you meet all of the deliverables?
  - High resolution/quality

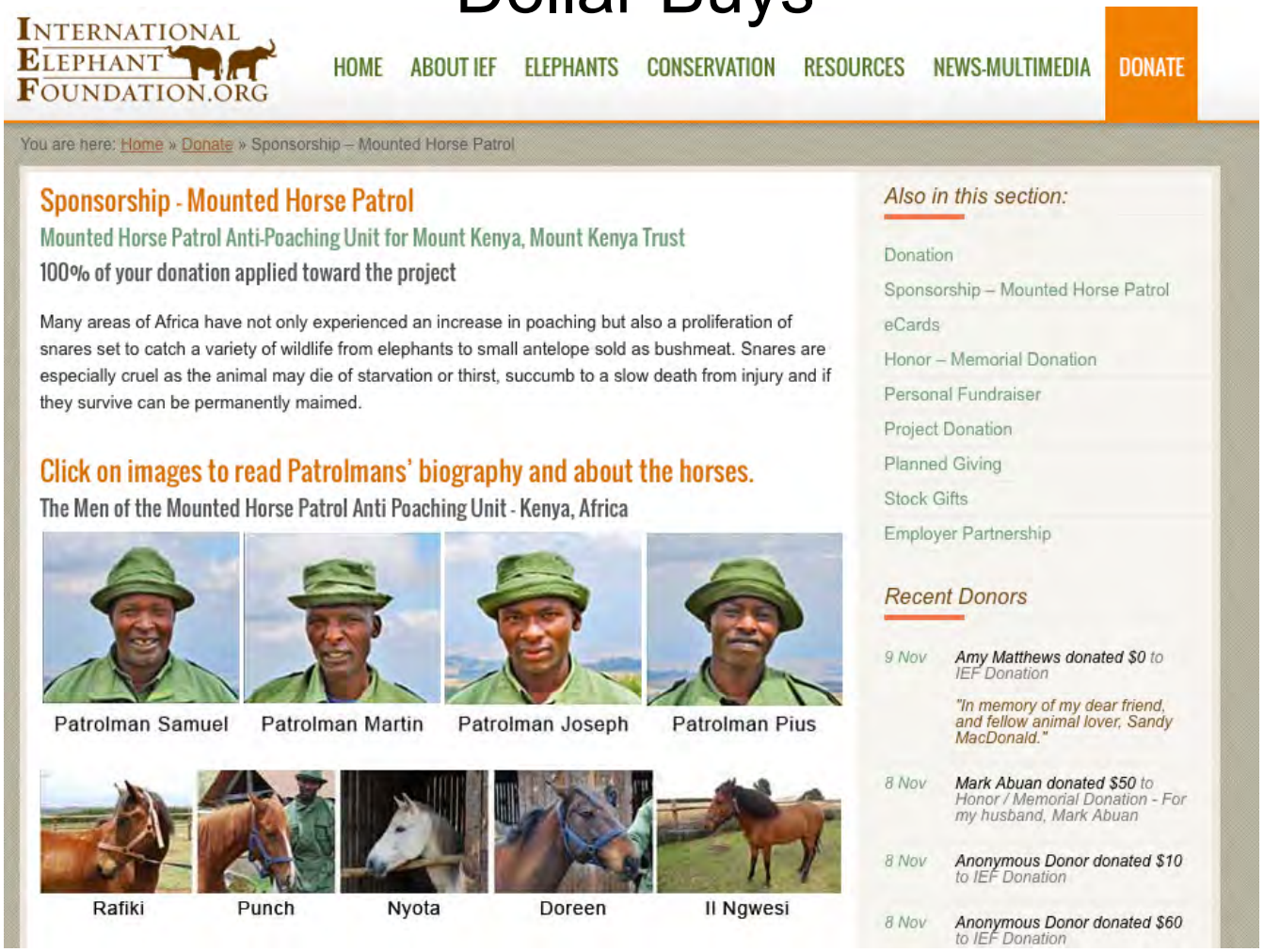


- Communication
  - Updates

Keep them *interested* & *invested*

Diversify Ways of Support

"Dollar Buys"



Making the Shortlist: Grant Writing Best Practices to Improve Funding Success



Deborah Olson and Sarah Conley

Annually, the International Elephant Foundation (IEF) accepts proposals for elephant conservation and research funding support

- Submitted proposals are peer-reviewed by a panel of advisors from the fields of medicine, research, academia, and elephant management.



- Awards typically range about US$10,000 per year.

In this presentation, we will discuss helpful hints for the completion of the funding application to improve the success of a project being selected for funding.



To be chosen for funding, the project should be action-oriented or have a strong component of action and not simply data collection or survey.



- Be grounded in sound scientific methodology, be logistically feasible, and have a high probability of success.
- Must be approved by the appropriate governmental body in the range country or agency at the facility or institution where the study is conducted.



Follow directions closely:

- word and page limits
- submit the proposal as 1 document only
- save the document file as described in the proposal

PROJECT ABSTRACT

USED FOR CATEGORIZING AND IF CHOSEN FOR FUNDING - PROMOTION.



Describe briefly and concisely What, Where, Why, Who, When

- What - The project goals in lay terms and what assistance you are requesting from IEF
- Why - the impact on conservation of elephants.
- The abstract must be specific to your project and should not contain general information about elephants or conservation

ONE-PAGE TECHNICAL SUMMARY INCLUDES:

(recommend that you do this after you write your full proposal)

- Justification - clearly explains the need for the project
- brief description of methodology
- anticipated benefits description of how this project contributes to the long-term conservation of elephants
- description of the personnel and organizations involved



List the project goal(s) and objectives



For Example:

Goal:

Create three elephant corridors through private and community lands from South Sudan to North Murchison Falls National Park

Objectives:

1) Identify location of elephant corridors
2) Identify communities impacted by these corridors
3) Meet with government officials and communities to discuss relocation of communities
4) Identify location of new communities
5) Process of relocation of communities
6) Monitoring and Follow-up

Methodology & work plan is a critical section of the proposal



Use clear and precise language to explain the methods or project design.

List each specific objective of the project and explain in detail how it will be accomplished and who will be responsible for each activity.

Reviewers will judge your proposal on how well you explain your process of accomplishing your goals and objectives.

Explain in depth your methods. For Example:

Objective 1 - Two matriarchs and 2 bulls studied for the last two years with known histories will be radio-collared by Uganda Wildlife Authority (Appendix 1 -letters of support and approved permit for collaring of elephants) using UWA veterinarians and equipment. Animals will be followed by project PI on a daily basis for 2 years by direct observation and download of tracking data. Two research assistants from the university in Kampala will be hired to collect data through transacts and dung counts the first week of each month for twelve weeks total. PI will meet monthly with community leaders and members living in the area to gather information regarding elephant populations, habitat use and history of conflict .

Objective 2 – Using elephant tracking data and information gathered…….

Objective 3 - …..



1) **BUDGET** must itemized and divided into the following categories:

- project personnel (stipends or salary support, number of persons, hours, rate, position),
- travel expenses (number of persons, cost per trip, number of trips),
- lodging and meals (numbers of days x persons),
- equipment (itemize)
- supplies (itemize)
- services (itemize)
- miscellaneous expenses (itemize)

This budget format must be used. All amounts listed must be in US $$$

BUDGET ITEM	AMOUNT REQUESTED FROM IEF	MATCHING FUNDS OR SECURED FROM OTHER PARTNERS	BALANCE REQUIRED (not including funds requested from IEF)	TOTAL PROJECT COSTS
Field Patrol per diem 2 patrols/wk x 21 staff @ $10 ea				
Elephant subsistence 10 elephants x 12 mo @$100/mo				
CRU unit uniforms for 30 staff @$20 ea				
TOTAL				

BUDGET JUSTIFICATION must provide a detailed description of why each line of the budget is necessary and how the costs were determined.



For Example:



The A1 Track Radio collars made in South Africa are considered the best for providing location elephant location data due to their hardiness and battery life. Although 4 collars are required for the study, a fifth collar is requested as a back-up.

UWA charges US$500 per hour for helicopter time for immobilization. Each immobilization and collar placement is estimated by UWA as 5 hours. (Letter of support for UWA listing services and price included)

Research assistants stipend based on …..

LETTERS OF SUPPORT/COOPERATION AND GOVERNMENT ENDORSEMENT

Applicants must include a recent letter of support from the appropriate local, regional, and/or national government wildlife or conservation authority.



Letters of willingness to collaborate from all participating institutions involved in the project are also required.

Endorsement letters should be dated and make specific reference to the project by its title, as submitted on the applicant's proposal.

What about overhead costs?

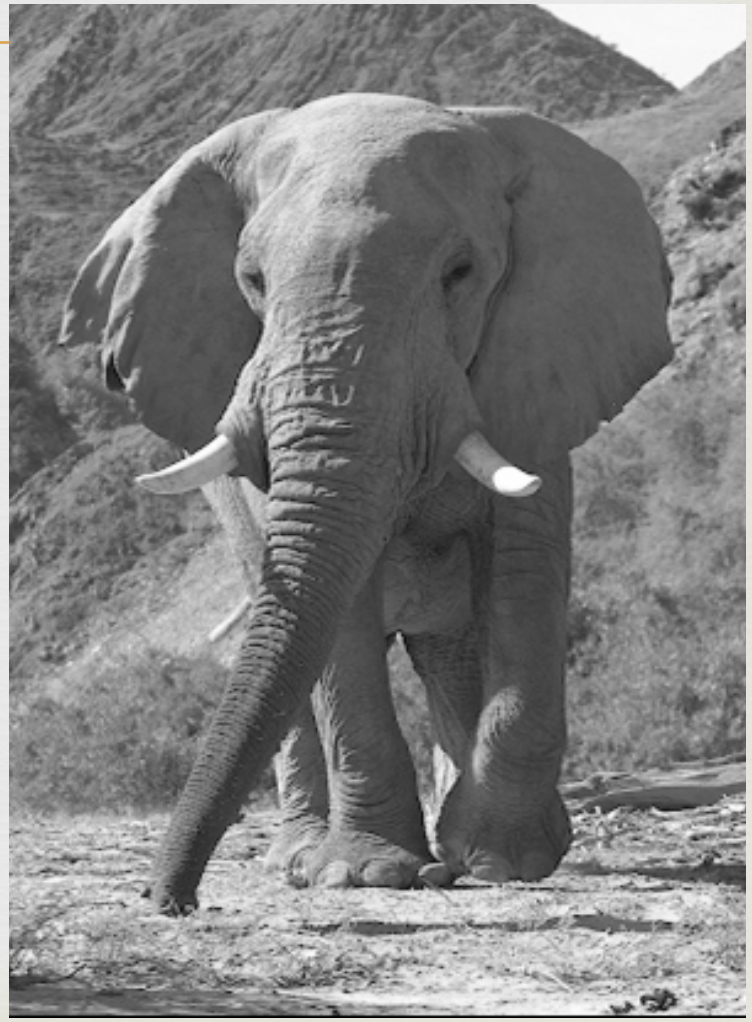
It is our established policy that IEF does not provide miscellaneous expenses, contingency funds or indirect costs (overhead costs) to the recipients of any IEF funded grant or contract.



If I am funded, when are reports due?

Upon signature on the IEF Grant Program Agreement, the 1st installment of funds will be made available to the applicant.

A six-month interim report, including **digital photos and a video**, is required prior to receipt of the second installment of funds.



A final report and budget, including digital photos and a video, is required at the end of the funding year.



The second installment of funds will not be dispersed until the six-month interim report, digital photos and a video have been submitted.

Any future requests for funding will not be given consideration until the final report, digital photos and a video have been submitted

Good Luck!



Electric Poliwire as an Elephant Deterrent



Technical aspects of Installation

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BENEFITS OF POLIWIRE AS A HEC MITIGATION METHOD

- **Low impact** - poliwire is unsuitable for use as a wildlife poaching snare due to its flexibility; thereby eliminating collateral damage seen in other HEC fencing projects
- **Effective deterrent** - shown to deter elephants immediately, with herd members hesitant to challenge the Poliwire again
- **Portable** - easy to erect for a few months during each crop-growing season
  - -> this reduces elephant encounters over time and thus habituation levels
  - -> reduces wear and tear on equipment
- **Low cost** - approx USD $400 per system

Objective: to mitigate the impact of elephants on the livelihoods of small-scale subsistence farmers:
- trial new, farm-based elephant deterrents to reduce crop losses from elephant damage
- focus on low-cost, low-labour solutions that have minimal impact on the environment/ecology

Poliwire electric fencing systems: small, solar-powered farm-based fencing systems:
- to deter elephants from individual fields yet allow them to continue to move through the landscape

Results: Prior to construction of Poliwire electric fencing systems in 2016, approximately 50% of elephant visitations (n=40) over previous months resulted in maize crop-raiding events; after construction, this statistic changed dramatically, with zero out of 13 elephant visitations resulting in crop-raiding events.

Outcome: *Poliwire Electric fencing* provides an additional deterrent method for use in HEC management, especially in areas where elephants may have become habituated to other methods

STEP 1

- Field/Crop circumference ≤ 1 km (~15 acres)
- Bush posts 15 m apart
- Single-strand poliwire to encircle field
- Poliwire on insulators attached to each post 1.5 m above ground
- Flagging between posts for night-time visibility



STEP 2

- Equipment stored in farm building adjacent to field (to prevent theft)
- Poliwire extended 500 m each direction from farm building
- Energizer
- Battery 12V/7ah
- Solar charge regulator



STEP 3

- Connect solar panel to battery
- Install 4 earth rods into the soil & connect to the Energizer
- Connect Energiser to Poliwire
- Voltage runs 500 m each direction away from building to ends of Poliwire



STEP 4

- Farmer training
- Voltmeter to check battery charge
- Fence tester to check poliwire voltage
- Voltage **must** be a minimum of 7.0 kV to deter elephants over time



STEP 5

- Prepare for a bumper harvest



Effects of environmental pressures on gastrointestinal parasitism in black rhinoceros

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Introduction

- Black rhinoceros (rhinos) are critically endangered because of poaching and habitat loss & degradation.
- Habitat loss can result in increased population densities, inter- and intra-specific competition and risk of disease transmission, parasites and stress.
- Natural patterns of parasitism are poorly understood; yet infections can impair health, nutrition, movement patterns and reproduction.
- Knowing what affects black rhino health is vital to its conservation and management.

Objective

- To determine the relationship among gastrointestinal parasites and commensal richness relative to density of competitors, precipitation and fecal glucocorticoid metabolites (FGM) in black rhinos.

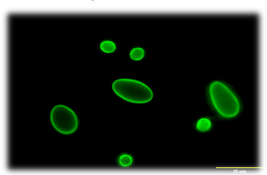
Methods



Camera traps were used to collect fecal samples from known black rhinos in Addo Elephant National Park (AENP), South Africa.

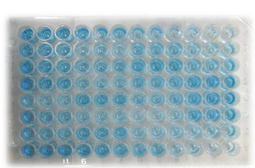


From July 2008 to Nov 2010, 119 samples were collected from 25 rhinos. Fresh feces were stored in 10% formalin and analyzed at Emory University.



Samples were screened for helminths and ciliates using sodium nitrate floatation, fecal sedimentation and Meriflour Direct Immunoflourescent Detection Kits. Parasites were identified on the basis of color, shape, size and contents.

Fecal hormone metabolites were extracted in the field and analyzed at Lincoln Park Zoo for FGM concentrations using a corticosterone (CJM006) EIA.



Results

Table 1. Summary of black rhinos sampled and biotic and abiotic factors that differ between AENP subpopulations

	N of sex (male:female)	Feces/rhino (mean ± SE)	Rhino population sex ratio bias	Elephant Density (ele/km²)	Predators[a]	Vegetation[b]	Tourism intensity
Main Camp	5:5	1.9 ± 1.0	Female	3.58	Present	Limited	High
Nyathi	10:5	5.5 ± 4.1	Male	0.71[c]	Absent	Abundant	Low

[a]Lions were reintroduced into Main Camp in 2003 and hyaenas were reintroduced in 2003 and 2004.
[b]Both sections fall in the Thicket biome of South Africa, represented by the Sundays Thicket and Albany Coastal belt, interspersed with tracts of Coega Bontveld
[c]Elephants were reintroduced into the Nyathi concession in 2003 from the Main Camp population.

- Parasitism rates did not vary (P>0.05) between the sexes or with respect to age category.
- There was a negative relationship between average monthly precipitation and total protozoans (r=-0.20, P= 0.03) and average monthly temperature with total nematode species (r=-0.22, P=0.02).
- A positive relationship existed between FGM concentrations and total protozoans (r=0.21, P=0.02).

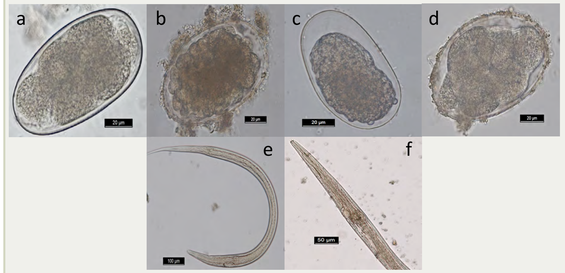


Fig 1.Five nematode species were detected in AENP black rhino feces, including: a) *Necator sp.;* b) *Oesophogotomum sp.;* c) *Trichostrongylus sp.;* d) *Strongyloides sp.*; e-f) Larval nematodes.

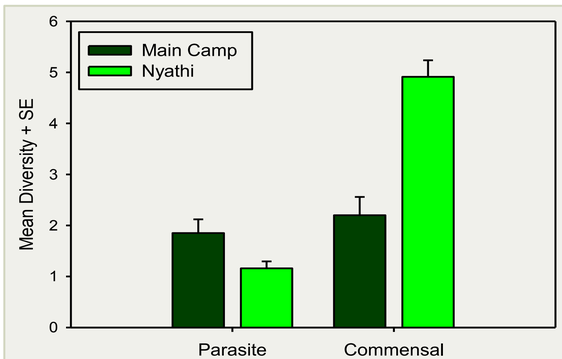


Fig 3. Rhinos in Nyathi had higher (t_{23}=2.51; P=0.02) prevalence and diversity of commensal nematode species and lower diversity (t_{23}=5.48; P<0.001) of protozoan species than rhinos living in Main Camp.

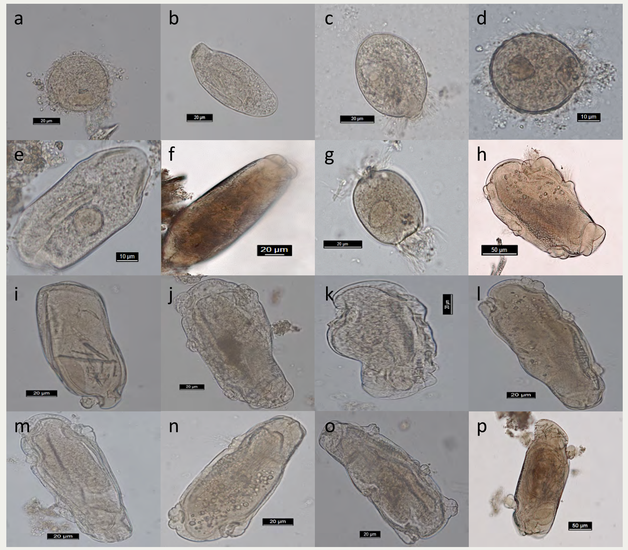


Fig 2. Sixteen protozoan species were detected in AENP black rhino feces, including: a) *Blepharosphaera ceratotherii*; b) *Blepharoconus cervicalis*; c) *Blepharoconus dicerotos*; d) *Blepharosphaera intestinalis*; e) *Charonina odontophora*; f) *Charonina tenius*; g) *Didesmis synciliata*; h) *Gilchristata artemis*; i) *Monoposthiurn vulgaris*; j) *Rhinozeta addonenesis*; k) *Rhinozeta caecalis*; l) *Rhinozeta cristata*; m) *Rhinozeta rhinozeta*; n) *Rhinozeta triciliata*; o) *Rhinozeta unilaminatus*; and, p) *Triplumaria corrugate.* No pathogenic protozoa (i.e., *Cryptosporidium* sp. and *Giardia* sp.) were found in any of the feces examined.

Conclusions

- Results demonstrate patterns of infection and provide an index of rhino population health directly related to habitat quality and usage.
- For AENP rhinos, parasite prevalence and diversity was most strongly affected by location; rhinos in Main camp had fewer positive nematodes (which aid in digestion) and more protozoan parasites.
- These differences suggest that the rhinos in Nyathi had access to higher quality nutrition, perhaps because of less anthropogenic disturbance, competition with elephants and a greater range of forage options, thus facilitating a more diverse *entodiniomorph* and *holotrich* ciliate community.
- Parasites were related to climate; positive nematodes were more common in cooler temperatures and protozoan diversity was greater during the dry season.
- The positive relationship between protozoans and FGM may be further indication of nutritional stress.
- A lack of *Cryptosporidium* and *Giardia* suggest that current land-use patterns in AENP are not exposing their rhinos to zoonotic sources of these pathogens.



Acknowledgments

We wish to thank Thando Mendela, Margaret Hook, Malgorzata Wisniewska, as well as game guide drivers from AENP, and the Gorah, Nguni and Riverbend conservancies for their invaluable assistance gathering fecal samples. We are continually grateful for the support of SANParks, including but not limited to Angela Gaylard, John Adendorff and Zelna Silcock. Our project was approved by the GMU and LPZ IACUC committees as well as SANParks research committee. Funding for the parasite analysis was provided by the James G. Lester Endowment Fund through the Emory University Department of Environmental Studies, and by Emory University SIRE program. Funding for the project was generously provided by the following:

GEORGE MASON UNIVERSITY
Lincoln Park Zoo
EMORY

Effect of the GnRH vaccine Improvac® on testicular size and ultrasonographic appearance in African elephants

Imke Lueders[a,b*], Debbie Young[c], Liana Maree[d,e], Gerhard van der Horst[d,e], Ilse Luther[d,e], Stephan Botha[f], Brendan Tindall[g], Geoff Fosgate[h], André Ganswindt[b], Henk Bertschinger[h]



Study Background: The vaccination with the commercially available GnRH vaccine Improvac® (Zoetis, 200µg GnRH conjugate/ml) was trialled in 13 healthy African elephant (*Loxodonta africana*) bulls located in South Africa in order to investigate the impact on reproductive organs, especially testicular function.

GE lifes
Animal Fertility and Reproductive Research

Prior treatment or up to 2 injections
Mean testicles size:

13.3 ± 2.6 x 15.2 ± 2.8 cm

After >7 vaccinations
Mean testicle size:

7.6 ± 2.1 x 10.2 ± 1.8 cm

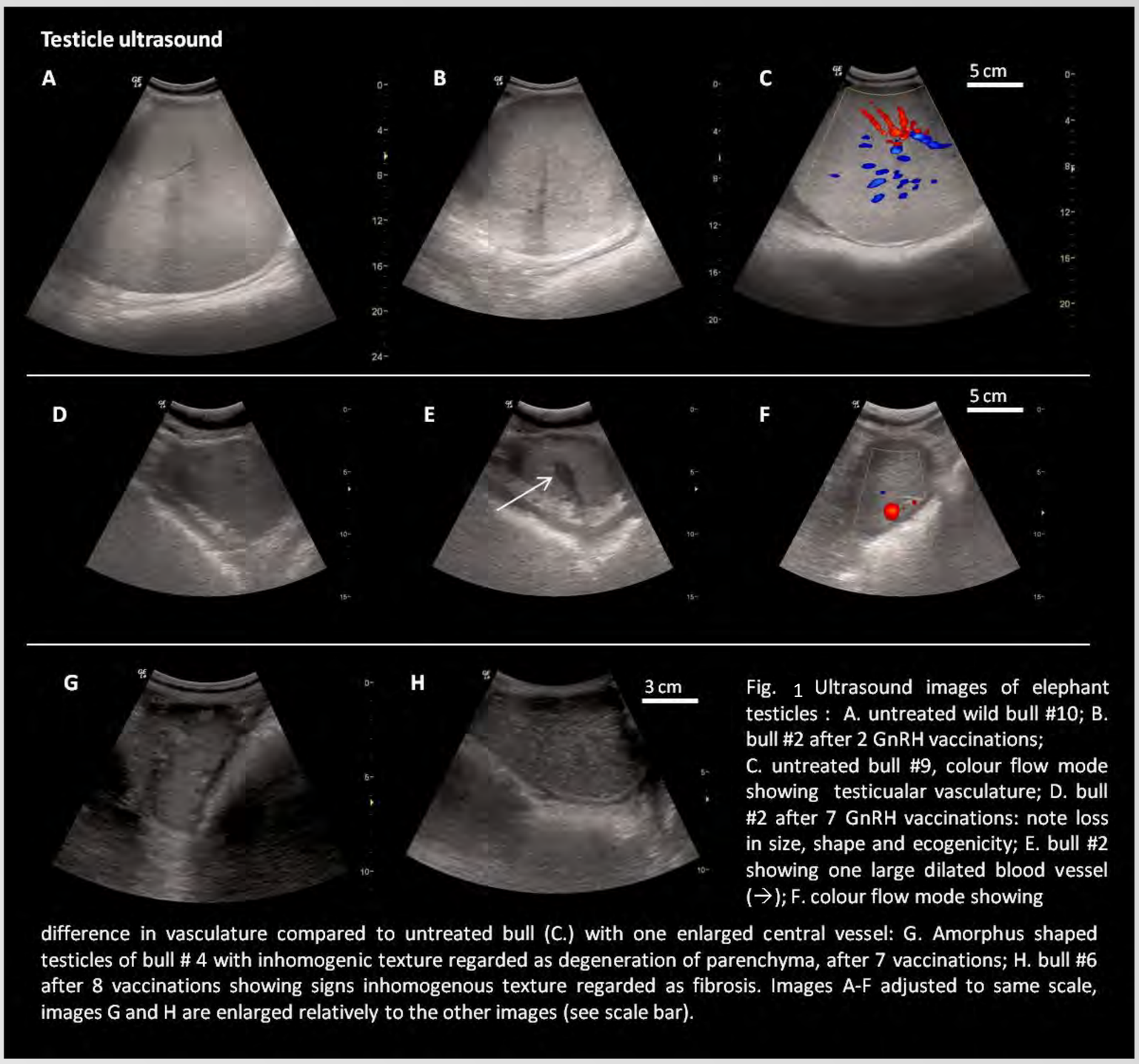
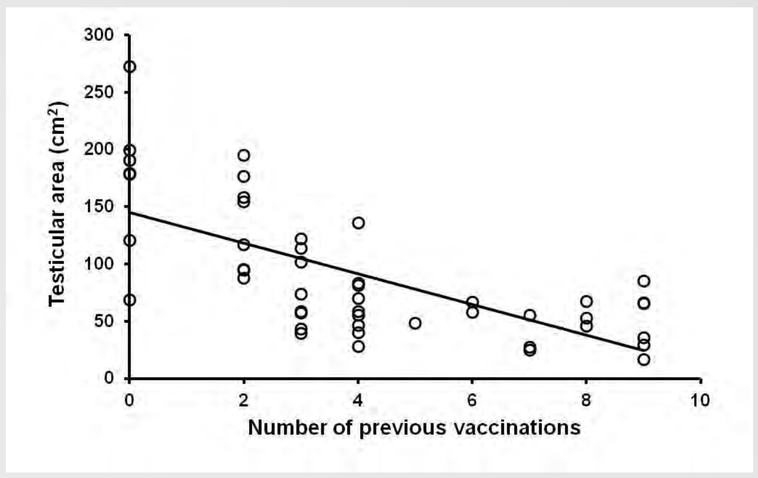


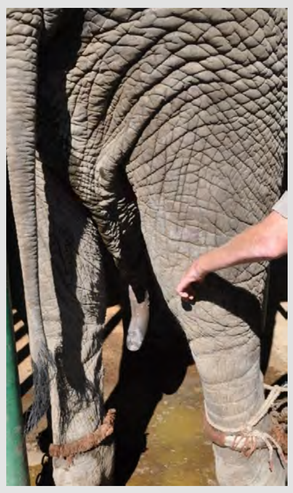
Fig. 1 Ultrasound images of elephant testicles : A. untreated wild bull #10; B. bull #2 after 2 GnRH vaccinations; C. untreated bull #9, colour flow mode showing testicualar vasculature; D. bull #2 after 7 GnRH vaccinations: note loss in size, shape and ecogenicity; E. bull #2 showing one large dilated blood vessel (→); F. colour flow mode showing difference in vasculature compared to untreated bull (C.) with one enlarged central vessel: G. Amorphus shaped testicles of bull # 4 with inhomogenic texture regarded as degeneration of parenchyma, after 7 vaccinations; H. bull #6 after 8 vaccinations showing signs inhomogenous texture regarded as fibrosis. Images A-F adjusted to same scale, images G and H are enlarged relatively to the other images (see scale bar).

Study elephants:

- 13 African elephant bulls (2 wild & 11 captive)
- Age range: 7 and 36 yrs
- GnRH vaccine: Improvac® 5 ml i.m., was given every 5-7 months after initial vaccination and booster after 5 weeks
- Examinations :
  every 5-7 months for 3 years in standing sedation or full immobilization
- including transrectal ultrasound, blood sampling, semen collection and analysis, behavioural evaluation.

Figure 1 shows testicle reference ultrasound images of bulls at the beginning and end of the study.





Graph 1: Testicular size reduction (expressed as area measured from the 2D ultrasound still image) in relation to numbers of vaccinations.

Photo 1: Penis atrophy was seen when males were young at start of vaccination.

Results and Conclusions

Testicle size of the African elephant bulls reduced by 60% (Graph 1) and degenerative signs were noticed after five vaccinations (Fig. 1) suggesting irreversible damage of the organs. The quality and shape of the testicles changed from firm and round to oval or amorphous at the end of the study (Fig.1). The echotexture was echogenic at the beginning, but reduced strongly, likely reflecting the loss in texture and tissue density. A consistent finding with elephants treated >5 times was dilatation of the testicular vein (Fig 1F). Bulls treated >5 times in their life had very small and deformed testicles. In bulls that received >7 vaccinations, we saw inhomogenous testicular tissue with hyperechoic areas which were regarded as signs of parenchymal degeneration and fibrosis.

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INTERNATIONAL ELEPHANT FOUNDATION.ORG

The impacts of dehorning on the southern white rhinoceros (*Ceratotherium simum simum*)

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Introduction

Rhinos in crisis: The greatest threat to rhinoceroses is the poaching they face for their horns.

Why are rhinos dehorned? Dehorning is used as a conservation tool in tandem with anti-poaching security in areas with small rhino populations; it is becoming increasingly common as the cost of effective security rises [1].

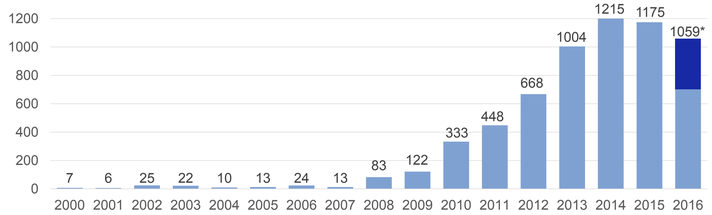

Figure 1. From January 2006 to April 2016, at least 5,460 rhino were killed in South Africa [2]. (*) Projection Aug 2016 [3].

How are rhinos dehorned? The process of dehorning removes around 90% of a rhino's horn mass without causing apparent injury to the animal [4]. The remnant stub then regrows at a rate of around 1 kg / year [5].



Figure 2. **A)** Dehorning a white rhino. **B)** Anterior and posterior horn cut-offs indicating 18 months of regrowth.

How does dehorning affect rhinos? The horns of rhinoceros are important for territorial defence but their evolutionary significance may also relate to foraging behaviour, maternal care and mate choice [6].

The few existing studies to look at horn status have focused on the black rhinoceros (Diceros bicornis). The results have been contradictory, with horn size found to affect male dominance hierarchies in some populations [7] but not others [8].

Aims

To investigate whether a change in horn status will affect either the social behaviour or physiological state of the southern white rhinoceros (*Ceratotherium simum simum*).

Materials and methods

a) To quantify whether horn removal influences sociality through the type and frequency of agonistic interactions.

- Groups of horned and dehorned individuals were observed across two field sites in South Africa.
- All dyadic interactions were recorded, with agonistic interactions scored as either a win or a loss to assess the dynamism of within and between group dominance hierarchies.

b) To assess whether horn removal leads to a temporal change in stress or reproductive hormone levels.

- Hormones can be reliably detected through the analysis of faeces.
- Faecal samples were collected from horned and dehorned rhino.
- Samples collected before or during immobilisation indicate baseline hormone levels, with subsequent samples indicating any consequent changes.

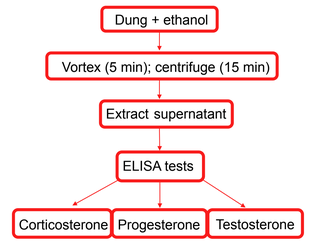

Figure 3: Field extraction of faecal hormone metabolites

Table 1 Hours of behaviour observations before & after a change in horn status. **C.** Change. **N.** No change.

Period	Bulls		Subadult males					Subadult female	Cows				Calves			
Jan-May	67:22	40:17	150:47	159:47	160:27	166:12	159:52	151:02	37:17	44:13	20:37	62:54	37:17	44:13	20:37	12:49
Status	N	C	C	C	C	C	C	C	N	C	N	N	N	N	N	N
Jun-Oct	19:07	42:50	92:56	91:18	80:47	90:26	79:26	90:26	28:47	30:13	11:37	14:59	28:47	30:13	11:37	15:14



Figure 4: Two dehorned males fighting. In this interaction the rhino with the larger horn mass (foreground) proved dominant.

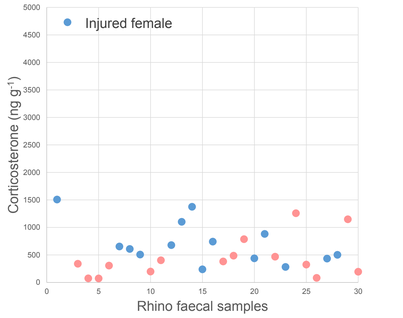

Figure 5: Initial faecal corticoid levels of 30 individual rhino. Blue marker – horned; pink marker – dehorned. Faeces collected from an injured female shortly before death produced the highest value, at 4729 ng g^{-1}.

b) Preliminary analyses indicate that hormone levels can be reliably detected following storage for a number of months. Initial corticoid levels averaged 778 ± 876 ng g^{-1} (n = 30), across a number of different age groups and horn statuses.

Next steps: Faecal samples were collected over an 8 week period, these will be grouped for comparison into three time periods as sampling constraints mean they're unequal and uncoordinated. Trends will be investigated using a multivariate repeated measures ANOVA. Behavioural data will be collected from additional field sites, and then input into a GLMM for analysis, with gender and age factored into the model.

It is hoped that findings will aid future conservation policy and management techniques, as well informing the debate around the horn trade.

Preliminary results

a) Rhinos from one field site were followed for a 6 month period. Half of the dehorned group underwent further dehorning during the experiment, creating asymmetries in horn-size. No major changes in dominance or territory were observed during the course of the experiment. A change in horn mass did not appear to influence existing trends in dominance.

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