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Address all correspondences, including enquiries about subscription, to

The Managing Editor, *Pachyderm*
PO Box 68200–00200
Nairobi, Kenya
Email: pachydermeditor@gmail.com
Website: http://www.iucn.org/african_elephant
http://pachydermjournal.org

Cover caption: A greater one-horned rhino wallowing in Kaziranga National Park, March 2022.

The new logo for the 'Estate of Esmond Bradley Martin' was especially designed by Roshni Peshavaria for *Pachyderm*, the images were provided by © Warren Samuels (black rhino), and © Storm Stanley (elephant).

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CHAIR REPORTS

African Elephant Specialist Group Chair report
Rapport du Groupe de Spécialistes de l'Eléphant d'Afrique

Benson Okita-Ouma[1] and Rob Slotow[2], co-Chairs/Présidents

[1]Director, Wyss Academy for Nature, East Africa Hub, PO Box 18, Nanyuki, 10400, Kenya
[2]Oppenheimer Fellow in Functional Biodiversity, School of Life Sciences, University of Kwazulu-Natal, Pietermaritzburg, 3209 South Africa

email contacts: okitaben@gmail.com; slotow@ukzn.ac.za

Introduction

During the period of June 2022 to July 2023, the African Elephant Specialist Group (AfESG) focused on the production of African forest and savannah elephant reports, conducted its ninth membership meeting virtually, and participated in the CITES CoP19 meeting in Panama in November 2022 and in the CITES Animal Committee, which recently took place in June 2023. The highlight of the achievements is that the African forest elephant report is under review and the savannah elephant report is underway. The latter received a major boost with the release of the results of the KAZA survey, as KAZA covers the largest component of the global population of savannah elephants. The African Elephant Database (AED) is going through changes in terms of making it easier for data entry and verification, streamlining calculations, and developing output tables to accommodate a new statistical way of reporting numbers, data quality, and confidence limits. The details of these activities are highlighted in the main text. The AfESG has also made significant progress in approaching organizations and institutions that could be part of its funders' circle initiative to ensure financial stability for the Group's activities.

Introduction

De juin 2022 à juillet 2023, le Groupe de Spécialistes de l'Éléphant d'Afrique (GSEAf) a axé son travail sur la production de rapports de situation de l'éléphant de forêt et de l'éléphant de savane d'Afrique, a conduit sa neuvième réunion des membres en ligne et a participé à la 19e CdP de la CITES au Panama (en novembre 2022) ainsi qu'au Comité pour les animaux de la CITES (en juin 2023). En ce qui concerne les progrès effectués, le rapport sur les éléphants de forêt était à l'étape de relecture et celui relatif aux éléphants de savane était en cours. Ce dernier a connu une impulsion majeure grâce à l'arrivée des résultats de l'évaluation de KAZA (Zone de conservation transfrontalière du Kavango-Zambèze), qui comprend la plus grande population d'éléphants de savane au monde. La BDEA (Base de Données sur l'Éléphant d'Afrique) est en phase de transformation afin de faciliter la saisie et la vérification des données, la rationalisation des calculs et le développement de tableaux d'affichage des résultats, dans le but d'ajuster le processus à une nouvelle technique statistique pour présenter les chiffres, la qualité des données et les limites de confiance. Les détails de ce projet sont fournis plus loin dans le texte. Le GSEAf a également montré des progrès significatifs dans son rapprochement avec des institutions et organisations pouvant, à terme, intégrer son cercle de donateurs de manière à assurer la stabilité financière des activités du groupe.

Reporting of forest and savannah elephant status reports

The AfESG recognized African elephants as two species in 2021 after research into their genetics (Wilson and Reeder 2005[1], Kingdon et al. 2013[2]; Hart et al. 2021[3]). This is reflected in the ongoing update of the status reports for 2023 and also in the recently published IUCN Red List reassessments, in which the African forest elephant (*Loxodonta cyclotis*) was listed as Critically Endangered (Gobush et al. 2021a[4]) and the African savannah elephant (*Loxodonta africana*) was listed as Endangered (Gobush et al. 2022b[5]).

Prior to the recognition of two species, it was challenging to assess the practical implications for the conservation of African forest and savannah elephants. Accordingly, producing two separate Red List assessments and two separate status reports will provide opportunities at the national, regional, and global levels to prioritize specific actions to each species and its unique circumstances. As reported in CITES SC74, this distinct treatment will refocus and renew attention on the plight and conservation challenges of each species.

The African Forest Elephant Status Report (AFESR) 2023 and the African Savannah Elephant

[1]Wilson DE and Reeder DM. (Eds.). 2005. *Mammal species of the world: a taxonomic and geographic reference* (Vol. 1). JHU press.

[2]Kingdon J, Happold D, Hoffman M, Butynski T, Happold M, Kalina J. (Eds.). 2013. *Mammals of Africa* Vol. I: Introductory chapters and Afrotheria. Page 351 *in* Kingdon J, Happold D, Hoffman M, Butynski T, Happold M, Kalina J. editor. *Mammals of Africa*. Bloomsbury Publishing, London, New Delhi, New York, Sydney.

[3]Hart J, Gobush K, Maisels F, Wasser S, Okita-Ouma B, Slotow R. 2021. African forest and savannah elephants treated as separate species. *Oryx* 55 (2): 170–171.

[4]Gobush KS, Edwards CTT, Maisels F, Wittemyer G, Balfour D, Taylor RD. 2021a; *Loxodonta cyclotis* (errata version published in 2021). The IUCN Red List of Threatened Species 2021: e.T181007989A204404464. https://dx.doi.org/10.2305/IUCN.UK.2021-1.RLTS.T181007989A204404464.en. [Accessed 25 September 2022]

[5]Gobush KS, Edwards CTT, Balfour D, Wittemyer G, Maisels F, Taylor RD. 2021b; *Loxodonta africana* (amended version of 2021 assessment). The IUCN Red List of Threatened Species 2021: e.T181008073A204401095. https://dx.doi.org/10.2305/IUCN.UK.2021-2.RLTS.T181008073A204401095.en. [Accessed 25 September 2022]

Rapports sur le statut de l'éléphant de savane d'Afrique

Depuis 2021, les éléphants d'Afrique sont classés par le GSEAf en deux espèces distinctes, après des recherches en génétique effectuées dans leurs populations (Wilson and Reeder 2005[1], Kingdon et al. 2013[2], Hart et al. 2021[3]). Cette décision transparaît dans l'actuelle mise à jour des rapports de situation des éléphants pour 2023, ainsi que dans la réévaluation de la Liste rouge de l'UICN dans laquelle l'éléphant de forêt d'Afrique (*Loxodonta cyclotis*) apparaît comme « en danger critique d'extinction » (Gobush et al. 2021a[4]) et l'éléphant de savane d'Afrique (*Loxodonta Africana*) est « menacé » (Gobush et al. 2022b[5]).

Avant cette reconnaissance des deux espèces, il était difficile de mesurer les implications concrètes pour la conservation des éléphants de savane et de forêt. Par conséquent, l'élaboration de deux Listes rouges et de deux rapports de situation distincts offre l'opportunité à l'échelle nationale, régionale et internationale de déployer des actions précises pour chaque espèce, en prenant en compte leurs caractéristiques respectives. Comme indiqué lors de la 74e session du Comité permanent de la CITES (SC74), cette décision permettra de renouveler l'attention sur la situation préoccupante de chaque groupe et leur conservation.

Le rapport de situation de l'éléphant de forêt d'Afrique (AFESR) 2023 et le rapport de situation de l'éléphant de savane d'Afrique (ASESR) 2024 seront

[1]Wilson DE and Reeder DM. (Eds.). 2005. *Mammal species of the world: a taxonomic and geographic reference* (Vol. 1). JHU press.

[2]Kingdon J, Happold D, Hoffman M, Butynski T, Happold M, Kalina J. (Eds.). 2013. *Mammals of Africa* Vol. I: Introductory chapters and Afrotheria. Page 351 *in* Kingdon J, Happold D, Hoffman M, Butynski T, Happold M, Kalina J. editor. *Mammals of Africa*. Bloomsbury Publishing, London, New Delhi, New York, Sydney.

[3]Hart J, Gobush K, Maisels F, Wasser S, Okita-Ouma B, Slotow R. 2021. Éléphants de forêt et de savane considérés comme des espèces distinctes. *Oryx* 55 (2): 170–171.

[4]Gobush KS, Edwards CTT, Maisels F, Wittemyer G, Balfour D, Taylor RD. 2021a; *Loxodonta cyclotis* (errata version published in 2021). Liste rouge des espèces menacées de l'UICN 2021: e.T181007989A204404464. https://dx.doi.org/10.2305/IUCN.UK.2021-1.RLTS.T181007989A204404464.en. [Accessed 25 September 2022]

[5]Gobush KS, Edwards CTT, Balfour D, Wittemyer G, Maisels F, Taylor RD. 2021b; *Loxodonta africana* (amended version of 2021 assessment). The IUCN Red List of Threatened Species 2021: e.T181008073A204401095. https://dx.doi.org/10.2305/IUCN.UK.2021-2.RLTS.T181008073A204401095.en. [Accessed 25 September 2022]

Status Report (ASESR) 2024 will be the fifth and sixth AESRs produced by the AfESG. Like their predecessors, the objective is to provide the most authoritative, comprehensive, and up-to-date information on the numbers and distribution of the two species of African elephants at the national, regional, and continental levels.

The assessment of the two reports indicates that future surveys should prioritize specific West African and East African countries and countries with small elephant populations, as many of the numbers are categorised as *guesses* as opposed to *estimates*. These small populations may be very important from a species-conservation perspective.

Redesigning the African Elephant Database

With the transition to an online database in 2007 and the important use of the African Elephant Database (AED) platform for the production of elephant status reports, the AED underwent a very significant change in 2016 and this continues. The redesign of the AED is to identify the primary and secondary users of the AED, align the AED with the goals and desired outcomes of the user community, and add new survey methods and procedures to classify and calculate the size of an elephant population and its confidence limits. Future AED development will include building visualisation and analytical tools to map and plot elephant distribution and range changes, and elephant trends at national, regional and continental levels. In coming years, we hope to demonstrate meaningful advances in the analytical potential of the AED to provide a strong and relevant evidence base for the management and conservation of African elephants.

Sustainability and governance of AED

In addition to the production of status reports and revamping of the AED, the AfESG is working towards technical, functional, data, and financial sustainability through the targeted identification of partners and funders who align with its mission of promoting long-term conservation of Africa's two elephant species, the critically endangered African forest elephant (*Loxodonta cyclotis*)

les sixièmes comptes-rendus produits par le GSEAf. Comme les précédents, leur but est de fournir les informations les plus fiables, actualisées et complètes sur le nombre d'éléphants d'Afrique et leur répartition à l'échelle nationale, régionale et continentale.

L'examen des deux documents a souligné la nécessité d'axer les prochaines études sur les pays d'Afrique de l'Ouest et d'Afrique de l'Est, ainsi que sur les États comptant de petites populations d'éléphants, étant donné que la plupart des chiffres issus de ces régions sont catégorisés comme des «*suppositions*» plutôt que comme des «*estimations*». Ces faibles populations sont potentiellement d'une grande importance dans les perspectives de conservation des espèces.

Reconfiguration de la Base de Données sur l'Éléphant d'Afrique (BDEA)

Après la numérisation de la BDEA en 2007 et compte tenu de l'usage important qui est fait de sa plateforme pour la production des rapports de situation de l'éléphant, une évolution significative a été entreprise en 2016 et se poursuit aujourd'hui. La reconfiguration de la BDEA consiste à identifier les utilisateurs primaires et secondaires, à faire que l'outil soit en cohérence avec les objectifs et les résultats attendus par la communauté des utilisateurs et à ajouter les nouvelles méthodes d'étude et les procédures permettant de classifier et de calculer la taille d'une population d'éléphants et ses limites de confiance. Les futurs développements incluront des ressources analytiques et de visualisation dans le but de cartographier la distribution des éléphants et de tracer les changements d'aires de répartition, ainsi que de répertorier les évolutions à l'échelle régionale, nationale et continentale. Nous espérons montrer dans les prochaines années des avancées significatives dans le potentiel analytique de la BDEA, afin de fournir une base de preuves solide et pertinente pour la gestion et la conservation des éléphants d'Afrique.

Pérennité et gouvernance de la BDEA

Au-delà de la production de rapports de situation et de la réorganisation de la BDEA, le GSEAf travaille actuellement à la pérennisation technique, fonctionnelle, financière et à la durabilité des données par le biais de l'identification ciblée de partenaires et de donateurs en cohérence avec la mission et les

and the endangered African savannah elephant (*Loxodonta africana*) through their range. This aims to establish long-term relationships and funding sources while establishing a governance structure around its agreements that streamlines administrative activities and maximizes opportunities for impact.

Ninth AfESG members meeting

The Communication task force organized and facilitated a virtual meeting for the AfESG members in September and October 2022. The theme of the meeting was 'Forest and savannah elephant conservation and emerging challenges'. The aim of the ninth members meeting of the AfESG was to update the membership on the activities of the group and exchange scientific and technical information on selected aspects of elephant research, conservation, planning development, management, extension, education, and training. This was to help members become more aware of global and regional policy processes, events, and new opportunities for the AfESG to participate in activities. The ninth members meeting of the AfESG focused on the conservation and management of the Critically Endangered forest elephant (*Loxodonta cyclotis*) and emerging challenges such as human-elephant conflict and coexistence, and the effects of climate change, for the savannah elephant (*Loxodonta africana*).

During this meeting, the AfESG paid tribute to Diane Skinner, who passed away on 10 August 2022. Diane was a highly respected and admired colleague and friend to many. Her work lives on and we express our sincere gratitude for all of Diana's contributions not only to elephant conservation, but also to enriching our lives with her sparkle and positive approach to getting work done. The winner of the inaugural Diane Skinner 'Unsung Hero in Conservation Award' this year, is Norah Njiraini from the Amboseli Trust for Elephants, for her dedication to elephants.

Participation in international conferences

The International Conference on *Human-Wildlife Conflict and Coexistence* took place from 30 March

objectifs du GSEAf. Cet effort vise à établir des relations de long terme et des sources de financement durables, tout en construisant autour de ces accords une structure de gouvernance qui rationalise les activités administratives et crée un maximum d'opportunités d'impact pour le Groupe.

Neuvième réunion des membres du GSEAf

La cellule opérationnelle *Communication* a organisé une réunion en ligne à destination des membres du GSEAf en septembre et octobre 2022. Le thème proposé s'intitulait « La conservation des éléphants de savane et de forêt et les défis émergents ». L'objectif était d'informer les membres du travail récent effectué par le Groupe et d'échanger des données techniques sur certains aspects précis : recherche, conservation, planification, gestion, processus d'extension, éducation et formation. Les enjeux de décisions politiques à l'échelle mondiale et régionale, les événements et les nouvelles opportunités pour le GSEAf de participer à des activités étaient autant de sujets abordés pour une meilleure prise de conscience de la part des membres. Les discussions relatives à l'éléphant de forêt (*Loxodonta cyclotis*), en danger critique d'extinction, se sont concentrées sur la conservation et la gestion de l'espèce ainsi que sur les défis émergents tels que la coexistence et les conflits entre humains et éléphants. En ce qui concerne l'éléphant de savane (*Loxodonta africana*), ce sont les effets du changement climatique qui ont été examinés.

Un hommage a été rendu à feue Diane Skinner, décédée le 10 août 2022. Diane était une collègue hautement respectée et admirée, et nous lui exprimons notre sincère gratitude pour toutes ses contributions à la conservation de l'éléphant, mais également pour ce qu'elle a apporté de lumineux et de positif dans notre travail et nos vies. Pour sa première édition, le prix Diane Skinner "Unsung Hero in Conservation" ("héros de l'ombre de la conservation") a été décerné à Norah Njiraini de l'Amboseli Trust for Éléphants, pour son dévouement à la cause des éléphants.

Participation aux conférences internationales

La Conférence internationale sur *La coexistence et les conflits entre animaux sauvages et humains* s'est tenue du 30 mars au 1er avril 2023 à Oxford (Royaume-Uni).

to 1 April 2023 in Oxford, UK. It was organized by the IUCN SSC Human-Wildlife Conflict and Coexistence Specialist Group and co-hosted by the GEF-funded and World Bank-led Global Wildlife Programme, and WildCRU of Oxford University. Several members of the AfESG including Duan Biggs, Lucy King, Anna Songhurst, Loki Osborne, Richard Hoare, Lydia Tiller and Audrey Delsink attended the conference and presented papers, posters and a toolbox on topics related to human wildlife conflict and coexistence. The AfESG established a Human-elephant coexistence task force in 2022 which is convened by Loki Osborne, and which has initiated a number of processes following this conference.

Summary of the outcome of CITES CoP19 meeting in Panama held in November 2022, and relevance to African elephants

A team of seven AfESG members participated in CITES CoP19 as part of the IUCN delegation. Parties agreed on their perspectives on the effects of recognizing forest elephants as a separate species. IUCN AfESG is to work with the Animals Committee to review the taxonomic-nomenclatural history of the African elephant. TRAFFIC will work to see if an analysis of ivory seizures connected to each Party with a legal domestic ivory market could be undertaken and if possible, include results in its ETIS report for CoP20. Input will continue to be gathered from Parties related to the non-binding guidance on how to determine whether live trade of African elephants promotes in situ conservation and whether recipients are suitably equipped to house and care for specimens.

A Decision was adopted that a "Dialogue Meeting" among the African elephant range States and other Parties, the CITES Secretariat and technical experts should be held to come to a consensus on a clear legal framework for live trade. A moratorium on live trade will occur during this dialogue process. Parties called on IUCN AfESG to be part of the 'technical experts' to this dialogue which IUCN acknowledged.

At the time of writing this report, the CITES Secretariat had posted on its website a document of the African elephants dialogue[6] meeting for its

Elle était organisée par le Groupe de spécialistes de la coexistence et les conflits entre animaux sauvages et humains de la CSE de l'UICN, en collaboration avec le Programme mondial pour la vie sauvage (GWP) – financé par le GEF (Global Environment Facility) et piloté par la Banque mondiale – et l'unité de recherche sur la conservation de la vie sauvage WildCRU de l'université d'Oxford. Plusieurs membres du GSEAf, dont Duan Biggs, Lucy King, Anna Songhurst, Loki Osborne, Richard Hoare, Lydia Tiller and Audrey Delsink, ont assisté à l'événement et ont présenté des articles, des affiches et une boîte à outils sur le sujet de la coexistence et les conflits entre animaux sauvages et humains. En 2022, le GSEAf a mis en place une cellule opérationnelle convoquée par Loki Osborne et nommée *Coexistence et conflits entre animaux sauvages et humains*, qui s'est attelée à diverses tâches à l'issue de cette conférence.

19e CdP de la CITES au Panama en novembre 2022 : bilan des conclusions et pertinence pour l'éléphant d'Afrique

Une équipe de sept membres du GSEAf participaient à la CdP19 en tant que délégation de l'UICN. Les Parties se sont accordées sur les effets induits par le fait de considérer les éléphants de forêt comme une espèce distincte. Le GSEAf travaillera, conjointement avec le Comité pour les animaux de la CITES, à la révision de la nomenclature taxonomique de l'éléphant d'Afrique. TRAFFIC envisagera la faisabilité d'effectuer une analyse des saisies d'ivoires pour chaque Partie disposant d'un marché légal d'ivoire, et, si possible, inclura les résultats dans son rapport ETIS (Système d'information sur le commerce des éléphants) pour la CdP20. Quant aux préconisations visant à déterminer si le commerce d'éléphants vivants favorise une conservation in situ et si les destinataires possèdent les infrastructures adaptées pour accueillir et s'occuper de tels animaux, leur impact continuera à être étudié, selon les données compilées.

Il a été décidé qu'une réunion de dialogue devait se tenir entre les pays de l'aire de répartition de l'éléphant d'Afrique et autres Parties, le secrétariat de la CITES et des experts techniques, afin d'atteindre un consensus sur un cadre légal clair pour le commerce d'éléphants vivants. Un moratoire sur ce sujet sera organisé pendant cette rencontre d'échange. L'UICN/le GSEAf ont été sollicités par les Parties pour agir en tant qu'experts

77th Standing Committee meeting in November 2023, [the relevant section]:

> Decision for the Secretariat to seek perspectives of Parties and others on effects of recognizing forest elephants as separate from savannah elephants; develop a list of Resolutions and Decisions that would be impacted, collate, review and report these; and for the Animals Commitee to include IUCN AFESG to review the taxonomic-nomenclatural history of the African elephant, was adopted. The Standing Committee will then review and advise CoP20 on this. The progress made on this decision is reported in the section that highlights the outcome of the Animals Committee 32.

The CITES Secretariat on behalf of the AfESG submitted CoP19 Inf. 64[7] in relation to CoP19 Proposals 4 & 5, CoP19 Doc. 84.1 and CoP19 Inf. 4. The document highlighted issues related to CITES, including the status of forest and savannah elephants, Red List assessment results, future plans for the AED, and highlighted range States that require updating their elephant population surveys.

Engagement and relationship building with range States on general elephant conservation issues, including CITES issues

The AfESG hosted and/or co-hosted four side events. Two AfESG-led events were: i) an updated view of the status and distribution of the African forest elephant and the implications for species conservation, management, and related policies; and ii) the special meeting between the AfESG and African elephant ranges States from Central and West Africa under the auspices of the African Elephant Coalition (AEC), where representatives from 22 range States participated. The latter meeting focused on the status of forest and savannah elephants in these two techniques, et l'UICN a donné son accord.

À l'heure où nous écrivons ce rapport, le secrétariat de la CITES a publié sur son site Internet un document[6] au sujet de cette réunion de dialogue, devant être examiné lors de sa 77e réunion du comité permanent en novembre 2023 [section correspondante]:

> Ont été adoptées les directives suivantes : il incombe au secrétariat de recueillir les avis des Parties et des autres participants sur les effets induits par la reconnaissance de l'éléphant de forêt et l'éléphant de savane comme deux espèces distinctes ; le secrétariat se doit également de développer une liste de résolutions et de décisions qui seraient impactées, puis de les compiler, les analyser et d'en faire un rapport. En outre, le Comité pour les animaux devra intégrer le GSEAf de l'UICN afin d'étudier l'histoire de la taxonomie et de la nomenclature de l'éléphant d'Afrique. Le comité permanent fera alors son travail de révision et informera la CdP20 sur le sujet. L'avancée des progrès en la matière est détaillée plus bas, dans le paragraphe indiquant les résultats de la 32e réunion du comité pour les animaux.

Le secrétariat de la CITES, au nom du GSEAf, a présenté le document CdP19 Inf. 64[7] relatif aux propositions 4 & 5 de la CdP19, aux documents CoP19 Doc. 84.1 et CoP19 Inf. 4. Le texte met en exergue les problématiques liées à la CITES, notamment la situation de l'éléphant de forêt et de savane, les résultats de l'évaluation de la Liste rouge et les projets de la BDEA. Les États de l'aire de répartition devant mettre à jour leurs estimations de populations d'éléphants sont également cités.

Engagement et développement de relations avec les États de l'aire de répartition sur les différents sujets relatifs à la conservation de l'éléphant, dont des problématiques de la CITES

Le GSEAf a organisé et/ou accueilli quatre événements, et a dirigé deux d'entre eux, dont: 1)

[6] https://cites.org/sites/default/files/documents/SC/77/agenda/E-SC77-55.pdf
[7] https://cites.org/sites/default/files/documents/E-CoP19-Inf-64-R1_0.pdf

[6] https://cites.org/sites/default/files/documents/SC/77/agenda/E-SC77-55.pdf
[7] https://cites.org/sites/default/files/documents/E-CoP19-Inf-64-R1_0.pdf

regions; the development and implementation of national elephant action plans; collaboration and partnerships to refine the classification of forest/savannah/hybrid elephant populations and the Human-elephant Coexistence Toolkit. A representative of the Convention on Migratory Species (CMS) participated by presenting a paper on the progress of implementation of a Memorandum of Understanding (MOU) between CMS and West African range States, to which the AfESG is a technical partner.

To further enhance collaboration between the AfESG and range States, Rose Mayienda, the AED manager, and Rachel Sharon Ouma, the new office administration assistant, visited Tanzania, Ethiopia, Malawi and Zambia between June and July 2023. To strengthen the relationships, MOUs and Letter of Agreements (LOAs) on data sharing with a number of countries, are being drafted. All these countries have shared their updated elephant data—population and range—for the purpose of updating the AED, to be used in the upcoming status reports.

Summary of the outcome of CITES 32nd meeting of the Animals Committee, 19–23 June 2023, Geneva Switzerland, concerning African elephants

The AfESG was represented by its CITES focal point, Kathleen Gobush, at the 32nd meeting of the CITES Animals Committee (AC32) on 19–23 June 2023 in Geneva, Switzerland, to engage in a number of agenda items relevant to African elephants. The main item on the agenda at AC32 concerning elephants, related to the possible future recognition by the CITES CoP of there being two distinct African elephant species and the specific steps outlined in a set of CoP19 decisions on this (Decisions 19.275–19.277). IUCN and AfESG recognized both species for the first time in 2021 (Hart et al. 2021), and the Animals Committee (CoP19 decision 19.276) was directed to consult with the Specialist Group to review the taxonomic nomenclature, and, if appropriate, make a recommendation on adopting a new standard nomenclature reference for African elephants, for final decision at CoP20.

une vue d'ensemble actualisée de la situation et de la distribution de l'éléphant de forêt d'Afrique et les implications pour la conservation et la gestion de l'espèce, ainsi que pour les politiques afférentes ; et 2) une réunion spéciale entre le GSEAf et les pays de l'aire de répartition de l'Afrique centrale et de l'Afrique de l'Ouest, sous l'égide la Coalition pour l'éléphant d'Afrique (AEC), à laquelle participaient les représentants de 22 États. Cette dernière rencontre était axée sur la situation des éléphants de forêt et de savane au sein de ces deux régions, le développement et la mise en œuvre de plans d'action nationaux, l'établissement de collaborations et de partenariats afin d'affiner la classification des populations d'éléphants de forêt, de savane et hybrides et, enfin, la boîte à outils pour la coexistence humain-éléphant. Un représentant de la Convention sur la conservation d'espèces migratrices (CMS) a apporté sa pierre à l'édifice en présentant un document sur les progrès effectués dans la création d'un Mémorandum d'entente (MoU) entre le CMS et les États de l'aire de répartition ouest-africains, dont le GSEAf est un partenaire technique.

Afin de renforcer la collaboration entre le GSEAf et les États de l'aire de répartition, Rose Mayienda, responsable de la BDEA et Rachel Sharon Ouma, nouvelle adjointe administrative, se sont rendues en Tanzanie, en Éthiopie, au Malawi et en Zambie sur la période juin-juillet 2023. En outre, des Mémorandums ainsi que des lettres d'entente (LOA) sur le partage de données entre pays sont en cours d'élaboration. Tous ont communiqué leurs informations mises à jour – populations et aires de répartition des éléphants – dans l'objectif d'actualiser la BDEA et de les intégrer dans les rapports de situation à venir.

Synthèse des conclusions relatives aux éléphants de la 32e réunion du Comité pour les animaux de la CITES, du 19 au 23 juin 2023 à Genève (Suisse)

Le GSEAf, représenté par son point focal à la CITES Kathleen Gobush, participait à la 32e réunion du Comité pour les animaux de la CITES (AC32) qui s'est tenue à Genève du 19 au 23 juin 2023, afin d'aborder certains thèmes de l'ordre du jour relatifs aux éléphants d'Afrique. L'un des sujets principaux concernait la possibilité d'une future reconnaissance par la CdP de la CITES de deux espèces distinctes

At the time of writing this report, the CITES Secretariat had posted on its website a document on this issue[8] to be discussed at its 77th Standing Committee meeting in November 2023. The process is expected to occur over several years, culminating at CoP20 which is planned for 2025.

AC32, Doc 46 (i.e. items 6–12)[9] was briefly discussed in plenary and an in-session working group was created with the mandate to "consider the scientific merit of the CITES recognition of two species of African elephants, and, as appropriate, recommend the retention or an appropriate replacement nomenclature standard reference for these animals".

The working group, chaired by the CITES nomenclature specialist met and made the recommendations which were accepted as follows: [the AC] "acknowledges the scientific merit of recognizing the two species of African elephants, recognizing that hybrids and mixed-species groupings occur, and notes that a relevant nomenclature standard reference for these animals be further deliberated inter-sessionally, with the outcomes of deliberations reported back to AC33." The nomenclature specialist will set up the intersessional working group via email and virtual meetings and will include the AfESG focal point in this discussion going forward.

The AfESG focal point also worked with the CITES nomenclature specialist to understand the requirements for a standard nomenclature reference to be from a book or peer-reviewed article that states the basic taxonomy of the species, a description of each, and a list of countries where each is found, with a map depicting this ideally included. Plans are being considered within AfESG to generate an article with this information by AC33.

Process launched to transform conflict over the sustainable use of Africa's elephants

Long-standing polarized debates about the management and acceptability of sustainable use of African elephants have undermined

[8]https://cites.org/sites/default/files/documents/E-SC77-74.pdf
[9]https://cites.org/sites/default/files/documents/E-AC32-46.pdf

d'éléphants d'Afrique et les étapes spécifiques pour y parvenir, décrites dans un ensemble de décisions issues de la CdP19 (décisions 19.275–19.277). L'UICN et le GSEAf sont convenus de l'existence des deux espèces pour la première fois en 2021 (Hart et al. 2021) et le Comité pour les animaux (CdP19, décision 19.276) a été chargé de consulter le groupe de spécialistes afin de revoir la nomenclature taxonomique et, le cas échéant, d'effectuer une recommandation quant à l'adoption d'un nouveau standard de nomenclature pour les éléphants d'Afrique. Une réponse sera donnée lors de la 20e réunion de la CdP. À l'heure où nous écrivons ce rapport, le secrétariat de la CITES a publié sur son site Internet un document à ce sujet[8], qui sera discuté dans le cadre de la 77e réunion du Comité permanent en novembre 2023. Le processus devrait se poursuivre sur plusieurs années et voir son issue à l'occasion de la CdP20, prévue pour 2025.

Le document AC32, Doc 46 (articles 6 à 12)[9] a été rapidement parcouru en session plénière et un groupe de travail a été créé pendant la réunion, avec les prérogatives de « considérer l'intérêt scientifique de la reconnaissance par la CITES de deux espèces d'éléphants d'Afrique, et, le cas échéant, de recommander le maintien du standard de nomenclature actuel ou son remplacement par une norme de référence appropriée pour ces animaux. »

Le groupe de travail, dirigé par le spécialiste en nomenclature de la CITES, s'est réuni et a produit les recommandations suivantes : [le Comité pour les animaux] « a établi l'intérêt scientifique de la reconnaissance de deux espèces d'éléphants d'Afrique et d'un consensus autour de l'existence de groupements hybrides ou interespèces. De plus amples délibérations entre les sessions quant à la pertinence d'un standard de nomenclature pour ces animaux sont requises, dont les conclusions seront rapportées lors de l'AC 33. » Le spécialiste en nomenclature créera le groupe de travail intersession par email et au cours de de réunions en ligne, et le point focal du GSEAf sera inclus dans cette discussion.

Kathleen Gobush a également collaboré avec le spécialiste en nomenclature de la CITES afin de déterminer si la meilleure méthode consiste à faire apparaître le standard de référence dans un ouvrage,

[8]https://cites.org/sites/default/files/documents/E-SC77-74.pdf
[9]https://cites.org/sites/default/files/documents/E-AC32-46.pdf

collaboration for the conservation of elephants and their habitats in Africa as well as globally. Central to this debate are disagreements over the risks versus the benefits of sustainable use, and the inequitable distribution of costs and benefits stemming from elephant conservation. Differences in values about the moral acceptability of different forms of sustainable use complicate decision-making processes. Due to differences in moral values, the debate over sustainable use of elephants cannot be solved with science alone. Instead, like debates over other contentious issues such as gun control and abortion in the United States, scientific evidence needs to be incorporated in a process together with considerations of moral values, attitudes, and perspectives, and how different individuals and the associated inherent assumptions of stakeholders will perceive that certain actions will lead to different outcomes.

Duan Biggs is leading a process in the AfESG, with the support of a team with conflict facilitation expertise to explore potential areas of common ground, and evidence required to address remaining gaps and areas of disagreement. The process was launched with a meeting of the AfESG in July 2023 and incorporates using mental models (the frameworks, and underlying assumptions individuals hold of how actions lead to outcomes), and perceptions regarding the levels of risk and threats to elephants, and different moral values over the types of actions that are considered acceptable.

In this issue

The research section of Issue 64 leads with Poole et al.'s substantive manuscript, *A culture of aggression: the Gorongosa elephants enduring legacy of war*, which examines the prevalence of aggressive behaviour in a population of elephants socially disrupted by civil war in eastern Mozambique. The results show that the Gorongosa population is indeed relatively hostile compared to other populations, that aggressive behaviours follow learned patterns and idiosyncrasies, and that it has given rise to a culturally learned behavioural variant that has persisted over time and generations. Culture is a field not yet greatly explored in elephants and

ou dans un article revu par les pairs, décrivant chacune des deux espèces et présentant une liste de pays dans lesquelles elles se trouvent, idéalement accompagnée d'une carte. Cette dernière option est envisagée au sein du GSEAf, avec une échéance prévue pour AC33.

Désaccords relatifs à l'utilisation durable des éléphants d'Afrique : le processus de travail est lancé

Les controverses de longue date quant à la gestion et l'acceptabilité d'une utilisation durable des éléphants ont affaibli la collaboration pour la conservation des éléphants et de leurs habitats, en Afrique comme à l'échelle mondiale. Les désaccords concernant les risques et les bénéfices de ce type de pratique – et le manque d'équité dans la répartition des coûts et des profits qui découlent de la conservation des éléphants – sont au cœur de ces discussions. Les différences de valeurs à propos de l'acceptabilité morale des diverses formes d'utilisation durable compliquent le processus de décision. Face à ces divergences, la science ne peut pas à elle seule clore le débat. Mais, à l'instar d'autres controverses telles que le contrôle des armes ou l'avortement aux États-Unis, les preuves scientifiques doivent être intégrées dans la réflexion, tout comme la prise en considération des valeurs morales, des postures et des points de vue. Il faut également tenir compte des différentes perceptions selon les individus et les parties prenantes – et les hypothèses inhérentes qui y sont associées – quant aux conséquences de certaines actions.

Duan Biggs dirige actuellement une opération au sein du GSEAf, avec le soutien d'une équipe possédant une expertise en résolution des conflits, afin d'identifier de potentiels terrains d'entente et les preuves nécessaires pour combler les lacunes et atténuer les désaccords. Le processus a été lancé en juillet 2023 durant une réunion du GSEAf et il comprend l'utilisation de modèles mentaux (cadres de pensée et hypothèses intégrés par les individus définissant la façon dont des actions conduisent à des résultats), la prise en compte des perceptions du niveau de risque et de menace pour les éléphants et des différentes valeurs morales associées à des types d'actions considérées comme acceptables.

Dans ce numéro

Le copieux manuscrit *A culture of aggression: the Gorongosa elephants enduring legacy of war* («Une

still not accepted by many scientists however, *Pachyderm* is the ideal publication to introduce novel ideas that may influence elephant conservation strategies. (See pp. 37–62).

In Songhurst et al.'s manuscript entitled: *All aboard 'the Elephant Express'—a practical solution for human-elephant coexistence*, the authors describe their inspirational project from concept to implementation. Beneficiaries are mainly rural children and medical staff and their patients who use the same space as elephants, to reach schools and health clinics in the eastern Okavango Panhandle. Transport has been provided thanks to a private sector partnership established by EcoTrust. Formerly at risk from elephants, and living in fear, school attendance is up, and more patients are being treated with a noticeable positive shift in mindsets about elephants. (See pp. 63–77).

Tracking is an important tool for elephant conservationists in a wide variety of environments throughout Africa (and increasingly in Asia). A case study by Friswold et al. looks at a 'twisting' problem that occurred with LoRa tracking collars. Twisting occasionally occurs with larger, more substantial iridium-type collars, but not at the rate seen in this study. LoRa collars are currently still a small use case, but should expand as the availability of these low-cost networks increases. Sharing information when problems occur with collars is the best way to modify design issues and to encourage manufacturers to address them; awareness and refinement of the collars is an important issue. (See pp. 78–91).

After the collar deployment of a male elephant in Amboseli NP, Kenya, in 2019, the elephant remained primarily in northern Amboseli NP. From September 2022 he began 'an incredible journey', covering 1,780 km over 28 weeks. The elephant's movements show that he travelled from Amboseli NP in a southerly direction, walking to the base of the Ngurumen Escarpment, between the South Rift Valley and the extreme east of the Maasai Mara ecosystem. The elephant returned to Amboseli NP on 27 June 2023, and the authors were able to recollar him on 1 July, with support from the Kenya Wildlife Service and the NGO Save The Elephants. With this new collar, the authors expect to be able to confirm any repeat journeys to the Mara. This case may be a rare or

culture de l'agression : les éléphants de Gorongosa et l'héritage de la guerre ») de Poole et al. ouvre la section recherche de ce numéro 64 de *Pachyderm*. On y examine la prévalence d'attitudes agressives dans une population d'éléphants socialement déstabilisée par le conflit dans l'est du Mozambique. Les résultats montrent en effet que les éléphants du Gorongosa sont relativement plus hostiles que d'autres populations, et que leur comportement suit des schémas caractéristiques acquis, ayant créé au fil du temps des variantes culturelles intégrées par les récentes générations. L'aspect culturel chez les éléphants n'est pas un domaine très bien étudié ni accepté par la majorité des scientifiques. Cependant, *Pachyderm* est la publication idéale pour introduire de nouvelles idées pouvant influencer les stratégies de conservation de l'éléphant. (voir pages 37–62).

Dans l'étude de Songhurst et al. intitulée *All aboard the Elephant Express – a practical solution for human-elephant coexistence* (« Embarquons à bord de l'Elephant Express ou une solution concrète pour la coexistence humain-éléphant »), les auteurs décrivent leur projet – une initiative source d'inspiration – du concept jusqu'à la mise en œuvre. Les bénéficiaires sont principalement des enfants ainsi que le personnel soignant et les patients de zones rurales utilisant le même espace que les éléphants sur leur trajet en direction des écoles et des centres de santé dans la partie Est de l'Okavango Panhandle. Leurs déplacements sont désormais assurés en bus grâce à un partenariat privé mis en place par EcoTrust. Les habitants, auparavant exposés au danger des éléphants et vivant dans la peur, sont aujourd'hui plus présents à l'école et sont mieux pris en charge par le personnel médical. En outre, on constate une évolution positive des états d'esprit envers les éléphants. (voir pages 63–77).

Le suivi des éléphants est un outil d'importance pour les acteurs de la conservation dans de nombreux environnements d'Afrique, et représente une tendance croissante en Asie. Une étude de cas de Friswold et al. s'attarde sur un problème de « torsion » des colliers reposant sur le protocole LoRa. Ce type d'incident est ponctuellement rapporté avec des colliers « iridium » plus larges, mais jamais à un taux aussi élevé que ce qui est décrit dans cette recherche. Les colliers LoRa sont actuellement peu fréquents, mais l'on peut s'attendre à une hausse des utilisations du fait de l'augmentation de la disponibilité de ces dispositifs peu coûteux. Faire part des problèmes identifiés avec ces colliers est la meilleure façon d'amener les fabricants à en modifier

unique movement nowadays, but at a time of fast changing land use and land ownership structures (Tyrrell et al. 2022a,b), it is both encouraging to see large mammal connectivity on this scale and an urgent reminder of what is at stake if conservation policies are allowed to fail. (See Fishlock et al. pp. 107–111).

A possible case of congenital tusklessness in a male African savannah elephant, a study by D'Ammando et al. describes what is, to our knowledge, the first documented occurrence of a potentially congenital tuskless male African elephant–with tusklessness present from birth, probably due to genetic causes. The authors substantiate their claims with photographic evidence and long-term observations, while discussing possible hypotheses to explain such a unique phenomenon. (See pp. 112–119).

The combination of local and scientific knowledge in data gathering and analysis is a potentially effective tool to improve our knowledge of tropical forest species, such as *Loxodonta cyclotis*, and foster the development of effective strategies to meet biodiversity conservation goals. Mubalama et al. have used social surveys to gather information about the status of *L. cyclotis* in eastern DRC in their study: *Integrating local and scientific ecological knowledge to assess African forest elephant (Loxodonta cyclotis) populations in a data-deficient region, eastern DR Congo*. (See pp. 120–129).

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la conception : la sensibilisation et le perfectionnement de cette technologie sont des questions importantes. (voir pages 78–91).

Après le déploiement d'un collier sur un éléphant mâle dans le parc national d'Amboseli au Kenya en 2019, on a constaté dans un premier temps que ses déplacements se limitaient à la partie nord du parc. À partir de septembre 2022, il a commencé un « périple incroyable », couvrant 1780 km en 28 semaines. Ses mouvements ont montré qu'il a voyagé vers le sud depuis le parc national d'Amboseli, en direction de la base de Ngurumens, entre la Valléee de South Rift et l'extrême est de l'écosystème du Maasai Mara. Suite à son retour à Amboseli le 27 juin 2023, les auteurs ont été en mesure de remplacer son collier le 1er juillet, avec le soutien des services de protection de la vie sauvage kenyans et de l'ONG Save The Elephants. Grâce à ce nouveau dispositif, les auteurs espèrent être à même de confirmer d'éventuels déplacements répétés vers le Maasai Mara. Ce déplacement peut constituer un cas rare ou unique, mais en ces temps de mutations rapides dans l'utilisation des terres et dans les structures de propriétés terriennes (Tyrrell et al. 2022 a, b), il est à la fois encourageant d'assister à des connexions d'une telle échelle de la part de grands mammifères, et urgent de rappeler ce qui pourrait être perdu si l'on laisse les politiques de conservation échouer. (voir Fishlock et al. pages 107–111).

L'étude *A possible case of congenital tusklessness in a male African elephant* (« Cas potentiel d'absence congénitale de défenses chez un éléphant d'Afrique mâle ») par D'Ammando et al. décrit ce qui représente, à notre connaissance, la première occurrence documentée d'absence de défenses vraisemblablement congénitale chez un éléphant mâle d'Afrique (une absence de défense constatée dès la naissance, probablement due à des causes génétiques). Les auteurs étayent leur postulat grâce à des photos et des observations au long cours, tout en explorant les hypothèses possibles à même d'expliquer ce phénomène unique. (voir pages 112–119).

La combinaison des savoirs scientifiques et de terrain dans la collecte de données est un outil potentiellement efficace pour approfondir notre compréhension des espèces de forêt tropicale telle que *Loxodonta cyclotis* et de promouvoir le développement de stratégies performantes permettant d'atteindre les objectifs de conservation de la biodiversité. Dans leur manuscrit *Intégrer les connaissances écologiques locales et scientifiques pour évaluer les populations*

forces, and especially the Data Review working group, and Boo Maisels, Chris Thouless, John Hart, Howard Fredrick, and Colin Craig, who are working on the African forest and savannah elephant status reports. We also thank Lucy Vigne, Lydia Tiller, and Shifra Goldenberg of the Communications team for organizing the ninth AfESG meeting and supporting all members in attending the meeting. Finally, we thank Kathleen Gobush for representing the AfESG at the 32nd CITES Animal's Committee meeting.

d'éléphants de forêt d'Afrique (*Loxodonta cyclotis*) *dans une région où les données sont insuffisantes (Est de la République du Congo)*, Mubalama et al. ont utilisé des enquêtes sociales afin de réunir des informations sur le statut de *L. cyclotis* à l'est de la République du Congo (voir pages 120–129).

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African Rhino Specialist Group Chair report
Rapport du Groupe de Spécialistes du Rhinocéros d'Afrique

Mike Knight[1], Chair/Président, Keit Mosweu[2] (Programme Officer) and Sam M Ferreira[3] (Scientific Officer)*

[1]IUCN SSC AfRSG; WWF KAZA Lead, WWF in Namibia, Windhoek, Namibia; Nelson Mandela University, Port Elizabeth, South Africa 6031
[2]IUCN SSC AfRSG; Programme Officer, Gaborone, Botswana
[3]IUCN SSC AfRSG; Scientific Services, SANParks, Skukuza, South Africa; Department of Conservation and Marine Sciences, Cape Peninsula University of Technology, South Africa

*corresponding email: mknight@wwf.na

Introduction

Africa's large animals including rhinos, are important biodiversity for future global restoration and rewilding options. The African Rhino Specialist Group (AfRSG) of the IUCN SSC envisages thriving wild African rhinoceroses (rhinos) valued by and contributing to the well-being of people. Here, we report on guiding and facilitating the conservation of viable African rhino populations across their natural range that contribute primarily to the well-being of local people We reflect on progress towards achieving the objectives of the AfRSG.

The status of rhinos—looking up!

Across the continent, poaching pressure updated to the end of 2022, generally declined from 2015 onwards (Table 1). Yet, at least 551 rhinos were poached in Africa with a poaching rate of 2.49% recorded in 2022, similar to the 2.44% recorded in 2021. These are lower than the 3.4% threshold, above which populations will decline (Ferreira et al. 2022).

Within South Africa, the range State that experienced the bulk of poaching previously, the Kruger National Park (KNP); poaching has now shifted from this hotspot (124 poached rhinos were detected during 2022) to the province of Kwazulu-Natal (with 228 poached rhino). An additional 16 rhinos were poached in South African State reserves and private properties, with

Introduction

Les grands animaux d'Afrique, dont les rhinocéros, représentent une biodiversité importante dans les projections de restauration globale des écosystèmes et de réensauvagement. Le Groupe de Spécialistes du Rhinocéros d'Afrique (GSRAf) de la CSE de l'UICN espère voir à l'avenir des populations de rhinocéros d'Afrique florissantes et participant au bien-être d'habitants qui les apprécient à leur juste valeur. Nous rapportons ici les démarches qui guideront et faciliteront la conservation des populations de rhinocéros sauvages d'Afrique sur leurs aires de répartition naturelles, un atout pour les communautés locales. Nous faisons également le bilan des avancées du GSRAf.

Le statut du rhinocéros s'améliore !

Entre 2015 et 2022, la pression du braconnage sur le continent africain est globalement en baisse (tableau n° 1). Pour autant, au moins 551 rhinocéros d'Afrique ont été victimes de braconniers, avec un taux de braconnage de 2,49 % en 2022, similaire aux 2,44 % enregistrés en 2021. Ces chiffres sont en deçà des 3,4 %, seuil sous lequel les populations sont en déclin (Ferreira et al. 2022).

En Afrique du Sud, État de l'aire de répartition qui concentrait la majorité des cas de braconnage, on assiste à un déplacement de la zone d'action principale des braconniers, depuis le parc national de Kruger (124 rhinocéros détectés en 2022) vers la province du Kwazulu-Natal (228 rhinocéros détectés en 2022). Seize rhinocéros supplémentaires ont été abattus dans des réserves nationales et privées, auxquels il faut

Table 1. Detected African rhino poaching mortalities by range States since 2006 (Ferreira et al. 2022) updated for Botswana (Department of Wildlife and National Parks 2023) and Namibia (Government of the Republic of Namibia 2023). Also added are the poaching reports for 2022. Zeros reflect reports of no detected poached carcasses by a range State, na—not available at the time

Tableau 1. Mortalité causée par le braconnage chez les rhinocéros d'Afrique, par État de l'aire de répartition depuis 2006 (Ferreira et al. 2022). Chiffres mis à jour pour le Botswana (Service de protection de la nature et des parcs nationaux, 2023) et pour la Namibie (Gouvernement de la République de Namibie, 2023). Les rapports de braconnage pour l'année 2022 ont été ajoutés. «0» indique l'absence de carcasses braconnées dans les rapports des États de l'aire de répartition, «na» signifie que le rapport n'est pas disponible

Range State	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Botswana	0	0	0	0	0	0	0	1	0	0	1	0	7	32	62	33	6
Chad	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	na
DR Congo	0	0	2	2	-	-	-	-	-	-	-	-	2	0	0	0	na
Côte d'Ivoire	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0
Eswatini	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	na
Kenya	3	1	6	21	22	27	29	59	35	11	10	9	4	4	0	6	1
Malawi	0	0	0	0	0	0	2	1	1	1	1	1	0	0	0	0	1[1]
Mozambique	0	9	5	15	16	10	16	15	19	13	5	5	8	6	2	0	na
Namibia	0	0	0	2	2	1	1	4	30	97	66	57	84	62	43	47	93
Rwanda	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0
Senegal	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0
South Africa	36	13	83	122	333	448	668	1004	1215	1175	1054	1028	769	594	394	451	438
Tanzania	0	0	2	0	1	2	2	0	5	5	0	2	0	0	0	0	na
Uganda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	na
Zambia	0	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1
Zimbabwe	21	38	164	39	52	42	31	38	20	50	35	36	34	82	12	4	11
Total	**60**	**62**	**262**	**201**	**426**	**532**	**751**	**1123**	**1324**	**1349**	**1167**	**1125**	**930**	**773**	**503**	**501**	**551***

* Minimum number

* Nombre minimum

a further 70 poached rhinos detected elsewhere in South Africa. Within most other range States, poaching abated, with the exception of Namibia. A total of 93 poached rhinos were detected in 2022, substantially higher than the 47 noted in 2021 (Government of the Republic of Namibia 2023).

With a decrease in the number of poaching incidents in most range States since 2015 and the overall continental poaching rate below the 3.4% threshold, it is reasonable to assume that rhino numbers should increase in various range States and throughout Africa. The latest available numbers noted 23,171 rhinos, an increase of 5.2% from what was reported by the end of 2021 (Ferreira et al. 2022) (Fig. 1). This comprised 6,468 black rhinos (*Diceros bicornis*)

ajouter 70 sujets visés ailleurs dans le territoire. À l'exception de la Namibie, où 93 rhinocéros ont été retrouvés mutilés – un chiffre considérablement plus élevé que les 47 relevés en 2021 (Gouvernement de la République de Namibie, 2023) – le braconnage est généralement en baisse dans les autres États de l'aire de répartition.

Avec des faits de braconnage en recul dans la plupart des pays de l'aire de répartition depuis 2015 et un taux sous la barre des 3,4 % à l'échelle du continent, on peut raisonnablement conclure à un accroissement de la population de rhinocéros dans cette région du monde. Les dernières estimations décomptent 23 171 rhinocéros, soit une progression de 5,2 % par rapport aux données de fin 2021 (Ferreira et al. 2022) (cf. graphique n° 1). Ces chiffres comprennent 6 468

[1]Note, this was a death resulting from a snaring, and not necessarily targeted rhino poaching.

[1]Notons que ce rhinocéros a été retrouvé dans un piège et n'est peut-être pas le résultat d'un braconnage ciblé.

(which increased by 3.9% from 2021 to 2022) and 16,801 white rhinos (*Ceratotherium simum*) (which increased by 5.6%). It is the first time since 2012 that white rhinos have increased on the continental scale.

Including the 391 black (345 *D. b. michaeli*, 32 *D. b. minor* and 14 *D. bicornis* of unknown subspecies) and 1,241 white (2 *C. s. cottoni* and 1,239 *C. s. simum*) rhinos in ex situ collections takes the world population to 24,905 African rhinos as of the end of 2022.

Achieving global rhino conservation

The AfRSG received numerous proposals for introductions of rhinos and expansion of the species' ranges. These included Southern white rhino translocations to Kidepo Valley NP in Uganda and Ngorogoro Conservation Area in

rhinocéros noirs (*Diceros bicornis*), en augmentation de 3,9 % entre 2021 et 2022, et 16 801 rhinocéros blancs (*Ceratotherium simum*), qui ont connu une hausse de 5,6 %. C'est la première fois depuis 2012 que l'on assiste à une croissance de la population de rhinocéros blancs à l'échelle du continent.

En incluant les lieux de conservation ex situ comprenant 391 rhinocéros noirs (dont 345 *D. b. michaeli*, 32 *D. b. minor* et 14 *D. bicornis* de sous-espèces inconnues) et 1 241 rhinocéros blancs (dont 2 *C. s. cottoni* et 1 239 *C. s. simum*), la population mondiale de rhinocéros d'Afrique s'élève à 24 905 individus fin 2022.

Pour une conservation du rhinocéros à l'échelle mondiale

Le GSRAf a reçu de nombreuses propositions d'introductions de rhinocéros et d'expansions d'aires d'habitat : transferts de rhinocéros blancs du Sud

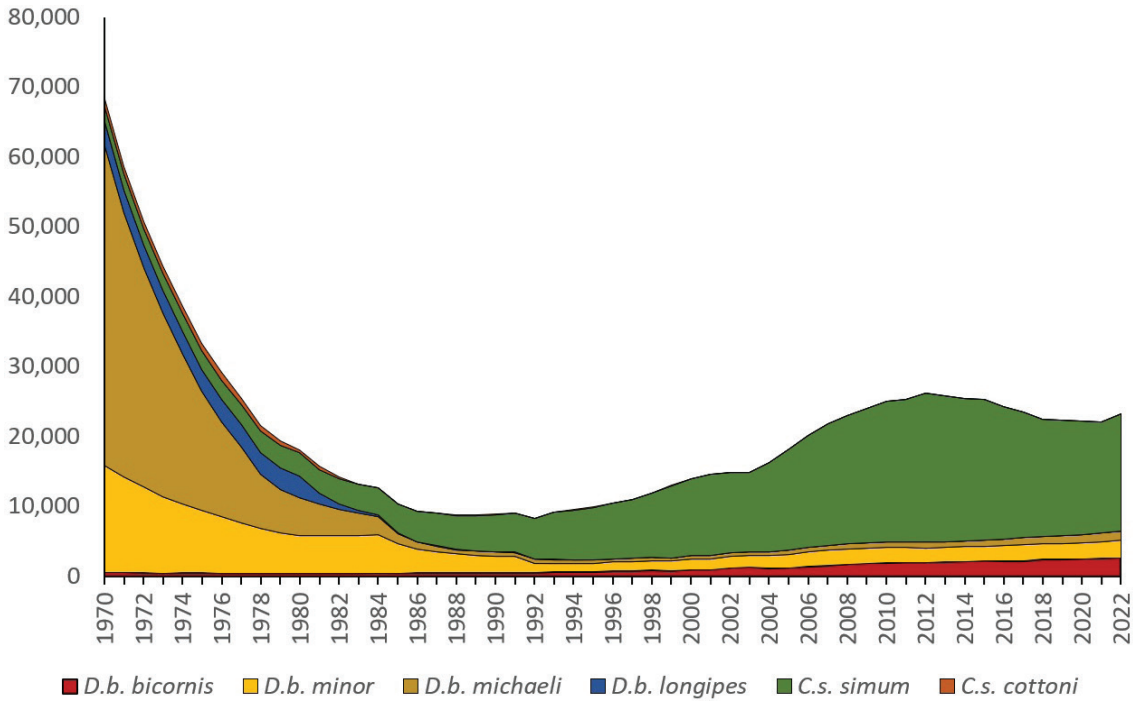

Figure 1. African black and white rhino populations since 1970 to 2022 updated with the latest estimates available from range States. Latest available estimates for 2022: Botswana, Cote d'Ivoire, Kenya, Malawi, Namibia, Rwanda, Senegal, South Africa, Zambia and Zimbabwe. Latest estimates available for 2021: Chad, Democratic Republic of Congo, Eswatini, Mozambique, Tanzania and Uganda.

Graphique 1. Évolution des populations de rhinocéros noirs et de rhinocéros blancs entre 1970 et 2022 intégrant les dernières estimations des pays de l'aire de répartition. Estimations disponibles pour 2022: Botswana, Côte d'Ivoire, Kenya, Malawi, Namibie, Rwanda, Sénégal, Afrique du Sud, Zambie et Zimbabwe. Estimations disponibles pour 2021: Tchad, République Démocratique du Congo, Eswatini, Mozambique, Tanzanie et Ouganda.

Tanzania, re-establishing Eastern black rhinos in Kidepo Valley NP in Uganda, and the translocation of South-central black rhinos (*D. b. minor*) to Karingani Game Reserve in Mozambique.

In response to a request from donors and queries on the initial information provided, the AfRSG revised its audit of rhino numbers in the Savé Conservancy, Zimbabwe. An independent firm conducted a security audit of the same property.

A key feature of these proposals is considerations of ecological equivalent sub-species for local sub-species that have gone extinct, as well as introducing rhinos as a novel species (Nogués-Bravo et al. 2016) often for purposes such as tourist experiences. A key consideration is how such proposals comply with CITES decisions that restrict exports for in situ conservation purposes (CITES 2022) that is, targeted areas within the natural range of a species. Uncertainty, however, abounds about what constitutes suitable and appropriate destinations for species in this context, as the definition of the natural range is problematic—it depends on the timeframe of a historical range and the poor written record for some areas. The AfRSG make use of recent genetic work on black rhinos (Moodley et al. 2017) and white rhinos (Sánchez-Barreiro et al. 2021) to define a contemporary distribution and is developing a guiding document on the interpretation of suitable and appropriate destinations and the applicability of that for commercial versus non-commercial exports.

Linked to the expanding scope of rhinos being introduced into historic ranges, as ecological equivalents as well as novel species outside contemporary ranges, are various concepts of translocation. Translocation sources and target areas can be within or beyond the natural or historical range of a species or sub-species. The AfRSG developed guiding concepts resulting in four translocation types: (1) introduction—ex situ to ex situ; (2) reintroduction—in situ to in situ; (3) expatriation—in situ to ex situ; and (4) repatriation—ex situ to in situ. Tactics linked to translocations, however, also vary depending on the management approach (Leader-Williams et al. 1997) within source and target areas, and require at times, removal from the wild, conservation husbandry, and rewilding. It is envisaged that these concepts can help inform interventions that

vers le parc national de Kidepo Valley en Ouganda et la réserve naturelle de Ngorogoro en Tanzanie, réintroduction de rhinocéros noirs de l'Est dans le même parc national de Kidepo Valley et translocation de rhinocéros noirs du Centre-Sud (*Diceros. b. minor*) vers la réserve de Karingani Game au Mozambique.

En réponse à la demande de donateurs et à des interrogations émises sur les informations fournies initialement, le GSRAf a révisé son audit des rhinocéros vivant dans la Réserve de la vallée de Savé au Zimbabwe. Une société indépendante y a également mené un audit de sécurité.

L'une des caractéristiques principales de ces propositions est l'introduction de sous-espèces dont l'impact écologique est équivalent à celui de sous-espèces locales désormais éteintes, ainsi que l'introduction de rhinocéros en tant que nouvelle espèce (Nogués-Bravo et al. 2016), souvent dans le cadre d'initiatives touristiques. Il est essentiel d'analyser dans quelle mesure de tels projets sont conformes aux décisions de la CITES, qui restreignent le transfert d'animaux à des fins de conservation in situ (CITES 2022), soit des zones ciblées au sein de l'aire de répartition naturelle d'une espèce. L'incertitude est de taille quant à ce qui constitue une destination appropriée dans un tel contexte, étant donné que la définition même de l'aire de répartition naturelle pose question, car elle dépend de la période choisie pour délimiter une zone de répartition historique. Il faut également prendre en compte le manque d'archives écrites dans certains cas. Le GSRAf utilise de récentes recherches en génétique menées sur le rhinocéros noir (Moodley et al. 2017) et le rhinocéros blanc (Sánchez-Barreiro et al. 2021) afin de déterminer la distribution contemporaine de ces animaux, et développe un document de référence pour définir ce qui caractérise une destination appropriée et adaptée, ainsi que la pertinence de tels critères pour des transferts commerciaux et non commerciaux.

Le cadre toujours plus vaste de rhinocéros introduits dans des zones d'habitat historiques, en tant qu'équivalents écologiques autant que comme nouvelles espèces hors de leurs zones contemporaines, évolue selon différents concepts de translocations. Les lieux de départ des transferts ainsi que les zones cibles peuvent se trouver au sein des aires naturelles (ou historiques) d'une espèce ou d'une sous-espèce, ou au-delà de ces espaces. Le GSRAf a développé des concepts de référence qui se traduisent par quatre types de transferts : (1) introduction ex situ/ex situ ; (2) réintroduction in situ/in situ ; (3) expatriation in situ/

mitigate diet and disease adaptations, as well as expectations of people, including the risks and benefits of rhino conservation.

The developing African Rhino Conservation Framework seeks to address the emerging social context and changing expectations related to rhinos. This highlights that rhino conservation in Africa is no longer just about rhino numbers. Rhinos play key ecological roles (Waldram et al. 2008) and contribute to the well-being of people when rhinos are present (Morais et al. 2018). Six key themes (ecological roles, safety and security, organized crime, rhino markets, inequity, and values of rhinos), supported by enabling flexible funding, technical capacity, as well as rights and laws provide the strategic direction.

Fostering values for rhinos

Several rhinos reside in semi-wild and captive conditions. For instance, as of the end of 2021, 0.2% and 37.0% of Southern white rhinos lived in intensive[2] and semi-wild[3] conditions respectively in a sample of 127 populations (Ferreira et al. 2022) from South Africa. At that time, 1.5% and 0.5% of Southern white rhinos lived in intensive and semi-wild conditions respectively in other range States. By the end of 2022, 6.9% of the global Southern white rhinos were in ex situ collections outside Africa.

South-western black rhinos (*D. b. bicornis*) lived exclusively in wild ranging conditions in Africa, although a small fraction (0.6%) lived in ex situ collections outside Africa as of the end of 2022. Eastern black rhinos (*D. b. michaeli*) had 100 individuals living in semi-wild conditions outside their historic range in South Africa at the end of 2022, down from 115 in 2021 (Ferreira et al. 2022). Ex situ collections outside Africa,

[2]"Rhinos, usually in small (<10km^2) to very small areas, either in or out of the historic range of the taxon, living at compressed density and spacing, with partial or full food supplementation, with frequent levels of husbandry and veterinary intervention, and a manipulated breeding system." Leader-Williams et al. 1997.

[3]"Rhinos, usually in small (<10km^2) areas, either in or out of the historic range of the taxon, living at compressed density and spacing, with routine partial food supplementation, with a high management intensity, but with a natural breeding system." Leader-Williams et al. 1997.

ex situ ; (4) rapatriement ex situ/in situ. Les stratégies inhérentes aux translocations varient cependant selon l'approche de gestion privilégiée (Leader-Williams et al. 1997) dans les zones d'origines et les zones cibles et requièrent parfois des prélèvements dans la nature, suivis de mises en élevage puis de réintroductions à l'état sauvage. Ces concepts devraient permettre d'orienter les interventions visant à atténuer les besoins d'adaptation en termes de régime alimentaire et de maladies, et d'ajuster les attentes liées à de tels transferts, dont les risques et bénéfices de la conservation du rhinocéros.

Le plan de conservation du rhinocéros d'Afrique, en cours d'élaboration, a pour objectif d'analyser le contexte social et les nouvelles perspectives en ce qui concerne les rhinocéros. Cela illustre combien le sujet de la conservation en Afrique dépasse la seule notion du nombre de rhinocéros : ils ont un rôle essentiel sur le plan écologique (Waldram et al. 2008) et, dans les zones où ils sont présents, ils contribuent au bien-être des habitants (Morais et al. 2018). Six thèmes clefs (rôle écologique, sécurité, crime organisé, le rhinocéros sur le marché noir, inégalités, valeur du rhinocéros), qui s'appuient sur un financement flexible, des capacités techniques ainsi que les droits et les lois en vigueur, définissent l'orientation stratégique.

Promouvoir la valeur des rhinocéros

Plusieurs rhinocéros sont actuellement en captivité et à l'état semi-sauvage. Fin 2021, par exemple, sur un échantillon de 127 populations (Ferreira et al. 2022) d'Afrique du Sud, 0,2 % des rhinocéros blancs du Sud vivaient en élevages intensifs[2] et 37 % en conditions semi-sauvages[3]. Dans les autres États de l'aire de répartition, on constatait un taux de 1,5 % de rhinocéros en élevages intensifs et de 0,5 %

[2]« Rhinocéros vivant généralement sur des zones d'un périmètre réduit (<10km^2), voire très faible, sur l'aire d'habitat historique du taxon ou en dehors de celle-ci, dans un espace comprimé avec une densité importante, connaissant une supplémentation partielle ou totale en nourriture, des interventions d'élevage et vétérinaires fréquentes et un système de reproduction assistée. » Leader-Williams et al. 1997.

[3]« Rhinocéros vivant généralement sur des zones d'un périmètre réduit (<10km^2), sur l'aire d'habitat historique du taxon ou en dehors de celle-ci, dans un espace comprimé avec une densité importante, connaissant une supplémentation partielle mais systématique en nourriture et un niveau de gestion élevé, mais un système de reproduction naturelle ». Leader-Williams et al. 1997.

however, held 20.9% of the global Eastern black rhinos. South Africa and Zimbabwe reported few localities where South-central black rhino (*D. b. minor*) individuals lived in semi-wild conditions. At the end of 2022, 1.2% of the global South-central black rhinos were in ex situ collections outside Africa.

This reflection highlights the relative importance and potential contribution of rhinos living in semi-wild and captive conditions to achieve continental rhino outcomes, particularly for Eastern black rhinos, the least abundant black rhino sub-species with a "Critically Endangered" conservation status (Emslie 2020a). Discussions with the European Association of Zoos and Aquariums focus on approaches to integrate Eastern black rhinos bred and or held by zoos into free-ranging populations. A particular challenge is varying zoo conditions and naivety towards natural diseases that later place constraints on the adaptive capacity of individual rhinos when they arrive at targeted localities.

In contrast, Southern white rhinos are the most abundant rhino sub-species (Ferreira et al. 2022). The large fraction of individuals in semi-wild conditions in South Africa primarily link to approximately 2,000 residing at the Platinum Rhino Captive Breeding Organization situated in South Africa. The facility acquired between 27 and 157 Southern white rhinos annually from 2008 to 2016, sourced from 98 different sites in South Africa. Of the total 957 introductions, 299 were male and 658 were female. The population increased at 8.7% per annum (Adcock et al. 2018). Recently, the growth declined slightly, to 7.5% per annum (Furstenburg et al. 2022).

The AfRSG developed a framework for evaluating the conservation need and contribution of captive breeding operations (AfRSG 2023a). International guidelines for captive, semi-captive or semi-wild breeding projects identify intensive breeding as an important tool when a species is highly threatened. Southern white rhinos have an IUCN Red List "Near Threatened" conservation status (Emslie 2020b), and the lowest risk of extinction of the five extant rhino species. Thus Southern white rhinos have a relatively low urgency for captive breeding approaches. However, Platinum Rhino is making useful contributions to education, awareness,

en conditions semi-sauvages. Fin 2022, 6,9 % de la population mondiale de rhinocéros blancs du Sud se trouvaient dans des lieux de conservation ex situ en dehors de l'Afrique Sud.

Le rhinocéros noir du Sud-Ouest (*D. b. bicornis*) vivait exclusivement en liberté en Afrique, à l'exception d'un petit nombre (0,6 %) relevé dans des lieux de conservation ex situ en dehors du continent africain. La population de rhinocéros noirs de l'Est (*D. b. michaeli*) était composée de 100 sujets en semi-liberté hors de leur zone d'habitat historique en Afrique du Sud – un chiffre en baisse par rapport aux 115 individus répertoriés en 2021 (Ferreira et al. 2022). Les lieux de conservation ex situ hors d'Afrique comptaient cependant 20,9 % de la population mondiale de rhinocéros noirs de l'Est. Quelques rhinocéros noirs du Sud-Ouest (*D. b. minor*) dans des conditions de semi-liberté ont été signalés en Afrique du Sud et au Zimbabwe. Enfin, 1,2 % de la population mondiale de rhinocéros du Centre-Sud était présent dans des lieux de conservation ex situ en dehors du continent africain.

Ces chiffres soulignent la relative importance des rhinocéros vivant en semi-liberté ou en captivité et leur contribution potentielle à l'atteinte des objectifs de croissance de population à l'échelle du continent, tout particulièrement en ce qui concerne le rhinocéros noir de l'Est, sous-espèce du rhinocéros noir comprenant le plus faible nombre d'individus, en « danger critique d'extinction » (Emslie 2020a). Des discussions sont en cours avec l'Association européenne des zoos et aquariums, axées sur des approches visant à intégrer dans les populations en liberté les rhinocéros noirs de l'Est nés ou vivant en zoos. Une des difficultés majeures réside dans l'hétérogénéité des conditions de vie au sein des zoos et dans le manque de réalisme quant aux maladies naturelles pouvant affecter les rhinocéros lors de leur arrivée dans les zones cibles, mettant à l'épreuve leurs capacités d'adaptation.

À l'inverse, le rhinocéros blanc du Sud représente la sous-espèce la plus abondante de rhinocéros (Ferreira et al. 2022). Le grand nombre de rhinocéros à l'état semi-sauvage en Afrique du Sud est avant tout lié aux 2 000 sujets vivant sur les terres de l'organisme Platinum Rhino Captive Breeding Organization, qui a accueilli, chaque année sur la période 2008 à 2016, entre 27 et 157 rhinocéros blancs du Sud venus de 98 sites sud-africains différents. Sur un total de 957 animaux introduits, on compte 299 mâles et 658 femelles. La population a augmenté de 8,7 % par an

and research, while increasing the numbers of Southern white rhinos and maintaining genetic diversity. Want of a clear conservation needs analysis, low benefits for other species; and limited benefits for broader ecosystems detract from the conservation contribution.

Maintaining the varied conservation outcomes of captive breeding approaches such as those of Platinum Rhino requires a substantial investment that is no longer sustainable as a private business venture. As a result, the entire initiative went to auction, but did not receive an offer. The Secretariat and some members engaged with the African Parks Network, the Peace Parks Foundation, Endangered Wildlife Trust, and Rhinomics on request. The African Parks Network recently announced the purchase of the operation[4]. This was done with the full support of the South African Government. It offers an ideal opportunity to rewild this large population of Southern white rhinos.

These discussions highlighted four strategic aspects of importance: 1) value-based policies that incentivize rhino conservation may also lead to unintended consequences with policies that do not provide guidance on how to respond in such instances; 2) government support (in South Africa) cannot carry risks and responsibility for failed business models linked to rhinos; 3) short-term responses to rewilding all rhinos "as soon as possible" encounter a key challenge of finding safe rhino habitat; 4) various discussions and reflections often conclude that breeding at Platinum Rhino should be slowed or stopped and rewilding should be gradual over a period of 10 to 15 years. In this context, the AfRSG provided a brief predictive model of the needs to the Rhino Management Group of South Africa linked to Platinum Rhino.

Task forces and working groups

Communicating about rhinos

The AfRSG's *Communication and Public Support* working group responded to various media requests. These included a press release on the

[4]https://www.africanparks.org/2000-southern-white-rhino-be-released-wild-over-next-10-years

(Adcock et al. 2018). Récemment, cette croissance a connu une légère baisse (7,5 % par an) (Furstenburg et al. 2022).

Le GSRAf a mis en œuvre un plan visant à évaluer les besoins des initiatives d'élevage en termes de conservation et leur contribution à la préservation des espèces (GSRAf 2023a). Les recommandations internationales en ce qui concerne les projets d'élevage en captivité, en semi-captivité ou semi-sauvage, identifient l'élevage intensif comme un outil précieux dans le cas d'espèces fortement menacées. Les rhinocéros blancs du Sud entrent dans la catégorie « quasi menacés » dans la Liste rouge de l'UICN (Emslie 2020b) et représentent la population connaissant le risque d'extinction le plus bas parmi les cinq espèces de rhinocéros encore existantes. Une approche d'élevage en captivité est par conséquent moins vitale pour ce groupe. Cependant, Platinum Rhino est à l'origine de contributions utiles dans les domaines de l'éducation, de la sensibilisation et de la recherche, tout en collaborant à l'augmentation du nombre de rhinocéros blancs du Sud et en maintenant leur diversité génétique. En matière de conservation, l'absence d'analyse claire des besoins et des bénéfices – faibles pour d'autres espèces, limités pour des écosystèmes plus vastes – nuit à la contribution initialement envisagée.

Le maintien des différents objectifs de conservation dans une approche d'élevage en captivité, telle que celle de Platinum Rhino, nécessite un investissement considérable qui n'est plus viable dans un contexte d'entrepreneuriat privé. Par conséquent, l'intégralité du projet a dû être mise aux enchères, mais n'a pas trouvé de repreneur. Répondant à la demande qui leur a été faite, le secrétariat et quelques membres du GSRAf, aux côtés des initiatives African Parks Network, Peace Parks Foundation, Endangered Wildlife Trust et Rhinomics, ont confirmé leur engagement. African Parks Networks a récemment annoncé le rachat de Platinum Rhino[4]. Cette décision a reçu l'aval du Gouvernement sud-africain – une opportunité idéale pour un retour à l'état sauvage de cette population de rhinocéros blancs du Sud.

Ces discussions ont permis de mettre en exergue quatre aspects stratégiques de taille : (1) des politiques qui encouragent la conservation des rhinocéros et sont

[4]https://www.africanparks.org/2000-southern-white-rhino-be-released-wild-over-next-10-years

latest status and trends in rhino populations in commemoration of World Rhino Day (AfRSG 2022); submission of a rebuttal paper to *People and Nature* on a published paper that reported reductions in rhino horn sizes due to trophy hunting; a statement on the conservation contribution of the Platinum Rhino white rhino captive breeding organization, including media responses. The working group also published a conservation news item titled the 'Future of African Rhinos' in the journal *Oryx* (AfRSG 2023b). A key output included organizing a series of one-and-a-half-hour update meetings for the membership. As part of developing a communication strategy, the working group embarked on a stakeholder analysis. The analysis highlighted a diverse and extensive list of stakeholders and key players linked to African rhinos. A key concern is that, at present, stakeholder participation may result in degraded rhino outcomes—most stakeholders are in the outer circle of influence and interest, while many take a limited or misinformed part in decision-making. Communication aimed at correcting these shortcomings would require varied responses.

The Secretariat provided inputs and comments on several media releases, such as the new report by the IUCN SSC African and Asian Rhino Specialist Groups and TRAFFIC for the 19th meeting of the Conference of Parties to CITES (IUCN 2022). The Secretariat also responded to journalist requests from *Science, New York Times, Mail & Guardian, Daily Maverick* and *Media24*, to name a few.

Guiding rhino conservation initiatives

The AfRSG completed three online meetings for members in June 2023. Working groups and task forces reported various key initiatives. The completion and revision of tasks resulted in five task forces and 10 working groups continuing with guiding conservation initiatives to enhance rhino conservation. The *Rewilding Rhinos* task force provided the guidance on rewilding (see above). The *Data Access and Use* task force concluded the drafting of a Data Access and Use Policy that links with the *African Rhino Data Management* working group in developing a data management system that focuses on both site-level and national-level data sources. Most

fondées sur des valeurs peuvent également entraîner des conséquences fortuites lorsque l'absence de directives se traduit par un manque de solutions dans ce type de situation ; (2) le Gouvernement (d'Afrique du Sud), malgré son soutien, ne peut pas assumer les risques ni les responsabilités de l'échec de modèles d'entreprises en lien avec la conservation des rhinocéros ; (3) les réponses à court terme visant à un retour à l'état sauvage de tous les rhinocéros « le plus vite possible » se heurtent au défi majeur de leur trouver des habitats sûrs ; (4) les divers débats et échanges parviennent souvent à la conclusion que l'élevage de Platinum Rhino doit être ralenti ou stoppé, et que le retour à l'état sauvage doit se faire de manière graduelle sur une période de 10 à 15 ans. Dans ce contexte, le GSRAf a fourni un modèle prédictif des besoins au Groupe de gestion du rhinocéros en Afrique du Sud, lié à Platinum Rhino.

Cellules opérationnelles et groupes de travail

La communication autour du rhinocéros

Le groupe de travail *Communication and Public Support* (« Communication et soutien du public ») du GSRAf a répondu à plusieurs demandes de la part des médias : un communiqué de presse sur l'état du rhinocéros et les évolutions récentes de populations, à l'occasion de la Journée mondiale du rhinocéros (GSRAf 2022) ; un article dans le magazine *People and Nature* afin de démentir une publication précédente dans laquelle on imputait la diminution de la taille des cornes de rhinocéros à la chasse aux trophées ; une déclaration au sujet de la contribution de l'élevage de rhinocéros blancs Platinum Rhino à la conservation de l'espèce, accompagnée des réactions médiatiques. Le groupe a également publié dans la revue *Oryx* un article intitulé « Future of African Rhinos » (« l'avenir du rhinocéros d'Afrique ») traitant de l'actualité de la conservation (GSRAf 2023b). L'un des aboutissements majeurs a consisté en l'organisation de plusieurs réunions informatives de 90 minutes à destination des membres. Dans le cadre du développement d'une stratégie de communication, le groupe de travail a entrepris une analyse des parties prenantes, qui a permis de faire ressortir les divers acteurs gravitant autour du rhinocéros d'Afrique. L'une des principales préoccupations est qu'à l'heure actuelle, la contribution de ces parties prenantes peut entraîner des résultats défavorables pour le

IUCN-sanctioned functions involve information at the population and security summary level per site, and national summaries when the focus is on trade data. Efficiency in data collation is a key requirement supporting a developing priority assessment process using a system of scoring rhino populations based on size and recent population growth that predicts a future value calibrated for the reliability of data, expansion potential, and genetic health of the population guided by the *Population Rating Systems* working group. The approach needs further review to incorporate meta-population concepts (Hanski 1998) and connectivity (Baguette et al. 2013), as well as a consideration of 'green scoring' (Grace et al. 2021) as a complementary method to other tactics such as the existing Red Listing of both black (Emslie 2020a) and white rhino species (Emslie 2020b).

The *African Rhino Conservation Framework* task force produced the first draft (see details above) that identified key requirements which complement the traditional strengths of technical support provided by the AfRSG. Although the *Biological Management* working group responded to various reviews and requests for input into rhino proposals and management initiatives (see above for details), the AfRSG has been reactive to requests, as opposed to being more proactive based upon a robust strategic outcome and framework. It is envisaged that the African Rhino Conservation Framework would provide a uniform rationale for the strategic evaluation of proposed conservation interventions, both internal and external. The *Technical Mediation and Facilitation of important Processes and Actions* working group was subsumed into these structures because the tasks are similar.

The security of rhinos, benefits from understanding and best practice. The *Protection, Law Enforcement, Investigations, and Intelligence* working group identified two key challenges to rhino conservation—fast evolving organized crime and non-functional security agencies. The AfRSG could play a key role in trends analyses while engaging with other IUCN SSC specialist groups with security aspects as part of their focus, as well as providing platforms where members can share their various experiences.

Participation in rhino conservation at a local scale emerged as a key theme of the developing

rhinocéros, la plupart de ces personnes se situant dans le cercle extérieur d'influence et d'intérêt. En outre, nombreuses sont celles dont la participation dans la prise de décision est limitée, ou repose sur de mauvaises informations. La communication visant à corriger ces défaillances appelle différentes réponses.

Le secrétariat a fourni des données et commentaires à plusieurs médias, tel le nouveau rapport issu du travail des Groupes de Spécialistes du Rhinocéros d'Afrique et du Rhinocéros asiatique de la CSE de L'UICN et de TRAFFIC, lors de la 19e réunion de la Conférence des Parties à la CITES (UICN 2022). Le secrétariat a également répondu à la demande des journaux *Science, New York Times, Mail & Guardian, Daily Maverick* et *Media24*, entre autres.

Orienter les initiatives de conservation du rhinocéros

En juin de cette année, le GSRAf a organisé trois réunions en ligne à destination de ses membres. Les groupes de travail et les cellules opérationnelles ont exposé plusieurs initiatives majeures. L'atteinte de certains objectifs et la révision des tâches à accomplir ont conduit à la formation de cinq cellules opérationnelles et dix groupes de travail, qui continueront d'orienter les projets visant à développer la conservation du rhinocéros.

La cellule opérationnelle *Rewilding Rhinos* a fourni la marche à suivre pour accompagner le retour des rhinocéros à l'état sauvage. La cellule opérationnelle *Data Access and Use* a achevé la première version de sa politique d'accès et d'utilisation des données, qui vient soutenir le groupe de travail *African Rhino Data Management* (« Gestion des données du rhinocéros d'Afrique ») dans la conception d'un système de gestion ciblé sur les sources de données à l'échelle locale comme nationale. La plupart des fonctions approuvées par l'UICN impliquent des informations par site, au niveau de la population et de la sécurité, ainsi que des synthèses nationales lorsque l'accent est porté sur les données commerciales. L'efficacité de la collecte de données est cruciale pour la mise en place d'un processus d'analyse des priorités, grâce à l'utilisation d'un système de notation selon la taille et la croissance récente des populations. Ce dispositif permet de prévoir une valeur future calibrée pour la fiabilité des données, le potentiel d'expansion et la santé génétique des sujets, avec l'appui du groupe de travail *Population Rating Systems* (« Système d'évaluation des populations »). Cette approche demande à être

African Rhino Conservation Framework. The *Community Participation* working group identified that a summary of all kinds of engagement tools with local people can provide the basis for developing guidelines that can be used at local site level.

The *Value of Rhinos* working group integrated with the working group on *Adequate Financing* suggested a focus on improving livelihoods and empowering local people through the promotion of benefits derived from various values of wildlife resources. A centralized system for collating all relevant socio-economic data and considering other means, can also help to achieve objectives. These approaches can help provide a framework for financing and supporting rhino conservation, separate from adequately financing the operations of the AfRSG.

The mandated functions of the AfRSG are embedded in the IUCN SCC processes. The *Governance* working group provided a clear guiding process of succession of the Chair of the AfRSG required to step down after two terms. Linked to these processes was the restructuring of members advised by the *AfRSG Membership* working group. Less than 50% of the members actively participate in AfRSG activities. Furthermore, the relevance of the AfRSG may diminish if translocations continue to take place in the absence of specialist considerations. A skills audit in 2019 highlighted that the AfRSG needs a set of mixed skills. Guidance focused on new members linked to identified functionality gaps. Part of this links to the *Capacity* working group that shares capacity building opportunities, identifies young rhino specialists, and incorporates them into the AfRSG sphere.

Range State representatives play a key role in helping the AfRSG achieve its internationally mandated requirements, particularly in reporting back to Parties at CITES. The Secretariat, as part of outputs for the *Range State Representatives and AfRSG Activities* task force, conducted a survey with range State representatives. Representatives may underestimate the contributions they make. Often mandated activities are seen as a top-down task, and not felt as an individual contribution, and/or representatives simply oblige by what their employees require. Some representatives went beyond what they perceived as country-focused expectations. Online meetings prove challenging,

revue plus précisément afin d'y intégrer des concepts de métapopulation (Hanski 1998) et de connexion (Baguette et al. 2013), ainsi que la notion de « score écologique » (Grace et al. 2021) comme méthodes complémentaires à des stratégies telles que l'actuelle Liste rouge des espèces de rhinocéros noirs (Emslie 2020a) et de rhinocéros blancs (Emslie 2020b).

La cellule opérationnelle *African Rhino Conservation Framework* (« Plan de conservation du rhinocéros d'Afrique ») a produit une première version du document (voir détails plus haut) qui identifie les besoins principaux, en complément des efforts traditionnels du GRSAf en termes de soutien technique. Bien que le groupe de travail *Biological Management* (« Gestion biologique ») ait répondu aux diverses analyses et demandes de contribution en ce qui concerne les propositions et initiatives de gestion du rhinocéros (voir détails plus haut), le GSRAf souligne l'absence d'un cadre stratégique solide sur lequel se baser. Le Plan de conservation du rhinocéros d'Afrique devrait fournir un ensemble de critères pour l'évaluation stratégique des interventions de gestion suggérées, qu'elles soient proposées en interne ou qu'elles viennent de l'extérieur. Le groupe de travail *Technical Mediation and Facilitation of important Processes and Actions* (« Médiation technique et facilitation des processus et des actions d'importance ») a été intégré dans les dernières structures citées, car leurs tâches sont similaires.

Une compréhension solide entre les différents acteurs et de bonnes pratiques définies sont des atouts pour la sécurité des rhinocéros. Le groupe de travail *Protection, Law Enforcement, Investigations, and Intelligence* (« Protection, application de la loi, investigations et renseignement ») a identifié deux défis majeurs pour la conservation du rhinocéros : les mutations rapides du crime organisé et les dysfonctionnements des organismes de sécurité. Le GSRAf pourrait jouer un rôle clef dans les analyses des évolutions tout en prenant part à d'autres groupes de spécialistes de la CSE de l'UICN traitant le sujet de la sécurité, tout en créant des plateformes sur lesquelles les membres puissent partager leurs diverses expériences.

La participation à la conservation du rhinocéros à l'échelle locale s'est imposée comme un thème central du Plan de conservation du rhinocéros d'Afrique. Le groupe de travail *Community Participation* (« Communautés engagées ») a identifié qu'une synthèse de toutes les approches permettant d'intégrer

along with restrictions placed on them with regards to information that representatives can share or participate in sensitive topics, such as trade, population and poaching numbers. Motivation for more personal involvement could be divided into individual enrichment versus desire to contribute to rhino outcomes. A key concern was that some range State representatives felt that their views have low value compared to other non-State representatives on the Group.

The Secretariat virtually attended the National Rhino Meeting of Zimbabwe and provided clarification when requested. Contributions by the Scientific Officer summarizing the key continental trends extracted from the report to CITES (Ferreira et al. 2022) helped in reflections of rhino performances in the Marakele cluster of rhino populations in the Limpopo province of South Africa. Here, a focus on regional safety and security for people and property resulted in no rhinos being poached in the cluster during 2022. A similar reflection by Rademeyer (2023) of the declining safety and security situation in the Greater Kruger in South Africa suggests the need for innovative approaches to address challenges that people face.

According to the annual reporting requirements of the IUCN SSC 2022 (Grace and Long 2023) for the 2021–2025 quadrennium, the AfRSG had set 31 targets. These targets are lumped into the Assess (7), Plan (7), Act (2), Network (4) and Communicate (4) thematic areas. In 2022, the AfRSG had fully completed 10% of the targets which included: the submission of a joint IUCN/TRAFFIC report for CoP19; the review of range State proposals for IUCN TRAFFIC Analyses in preparation for CITES COP19 in 2022; the review of at least two scientific papers per year until 2024. A total of 13% of the targets had not been initiated such as: publish at least two articles in SPECIES by 2024; attend the next IUCN SSC Leaders meeting; develop a strategy for capacity building of young rhino conservationists in 2021. However, the remaining 24 (or 77%) of targets are on track.

Improving knowledge and understanding

The AfRSG continued to engage in scientific understanding to inform rhino conservation. les habitants dans la conservation du rhinocéros pourrait fournir une base sur laquelle développer des recommandations utilisables sur le plan local.

Le groupe de travail *Value of Rhinos* (« Valeur du rhinocéros ») allié au groupe *Adequate Financing* (« Financement approprié »), ont suggéré de mettre l'accent sur l'amélioration des niveaux de vie et sur l'autonomisation des habitants locaux, grâce à la promotion des avantages pouvant découler des différentes ressources qu'offrent les espèces sauvages. Un système de collecte de toutes les données socio-économiques pertinentes et la prise en considération d'autres leviers sont également des façons d'atteindre ces objectifs. Ces approches peuvent aider à fournir un cadre de financement et de soutien à la conservation du rhinocéros, qui soit distinct d'un financement adéquat des initiatives du GSRAf.

Les fonctions qui sont confiées au GSRAf sont inscrites au cœur des processus de la CSE de l'UICN. Le groupe de travail *Governance* (« Gouvernance ») a produit une procédure claire permettant de désigner la nouvelle présidence du GSRAf après deux mandats effectués par la même personne. Par ailleurs, la restructuration de l'équipe, conseillée par le groupe de travail *AfRSG Membership* (« Membres du GSRAf »), a été abordée. Moins de 50 % des membres sont actifs au sein du Groupe, dont l'existence pourrait perdre en pertinence si des translocations continuent d'être organisées sans examen de la situation par des spécialistes. En 2019, un audit a souligné la nécessité pour le GSRAf de se pourvoir d'un ensemble de compétences variées, et ses conclusions ont montré le besoin d'accueillir de nouveaux membres pouvant combler certaines lacunes en matière de fonctionnalité. Sur le même thème, le groupe *Capacity* (« Compétences ») travaille sur les opportunités de renforcement des compétences, identifie les jeunes spécialistes du rhinocéros et les intègre dans la sphère du GSRAf.

Les représentants des États de l'aire de répartition sont d'un grand soutien au GSRAf pour l'exercice de ses prérogatives internationales, notamment en ce qui concerne ses rapports à destination des Parties à la CITES. Le secrétariat, dans le cadre de la cellule opérationnelle *Range State Representatives and AfRSG Activities* (« Représentants des États de l'aire de répartition et activités du GSRAf »), a conduit une enquête auprès des représentants des États de l'aire de répartition, qui a mis en évidence les problématiques suivantes : les représentants sous-estiment sans

Expanding on what was mentioned above, a collective rebuttal paper from the membership followed the publication of a recent manuscript implying selective hunting as a driver of reducing horn size (Wilson et al. 2022). The membership's rebuttal highlighted the many ways wild rhinos use their horns, refuting the sample of mostly zoo animals to conclude that wild rhino horn sizes had become smaller in response to selective pressure of hunting. Public debate, scientific evidence, policy-making, and management, should instead, focus on the causal reasons for poaching and horn trafficking to make and implement plans to reduce rhino crimes (Ferreira et al. 2023).

AfRSG members produced several scientific outputs under the auspices of the variety of institutions that provided important insights and reflections. Insights focused on various influences on accounting trends in rhinos. The dehorning of black rhinos in Namibia, for example, had no effect on age at first reproduction, inter-calving intervals, birth sex ratios, calf survival, or lifespan in South-western black rhinos, reaffirming the continued use of dehorning as a complementary deterrent for poachers (Chimes et al. 2022).

South-western black rhinos in Namibia also experienced very little density-dependent effects on reproduction. Although in the short term, browse quality could have a greater impact spanning multiple years, rainfall has a key influence. For example, conceptions were synchronized in the rainy season (Muntifering et al. 2023).

Surprisingly, poaching did not seem to induce stress for Southern white rhinos in general, instead, weather conditions were more impactful. (There is no data either for stress in calves having observed the loss of their mother, or pain registered during/following horn removal). Concentrations of faecal glucocorticoid metabolites (fGCM) increased by 42% in the dry compared to the wet season. Furthermore, fGCM concentrations were 38% and 42% higher in the dry and wet season, respectively, in small reserves, compared to large reserves. Authorities could mitigate stress associated with reduced access to resources and spatial constraints to promote the viability of rhinos in small reserves (Nhleko et al. 2022).

Social stresses also play a role in influencing reproductive output and population viability in

doute leur propre contribution ; les activités qui leur incombent sont souvent perçues comme des tâches très hiérarchisées et non pas comme des contributions individuelles, et/ou les représentants se limitent aux demandes de leurs collaborateurs ; quelques-uns des représentants sont pour autant allés au-delà d'attentes qui leur semblaient centrées sur leur pays ; les réunions en ligne s'avèrent exigeantes, ainsi que les contraintes relatives aux informations qu'ils sont en droit de partager sur certains sujets sensibles tels que le commerce ou les chiffres des populations et du braconnage ; les motivations susceptibles de mener à un plus grand engagement de leur part pourraient être classées entre épanouissement personnel et désir de contribuer aux objectifs en lien avec le rhinocéros ; l'une des préoccupations principales concerne le ressenti de certains représentants quant à la valeur de leurs opinions, qui leur paraît moins prise en considération que celle d'autres participants non représentants des États de l'aire de répartition dans le groupe.

Le secrétariat a assisté en visioconférence à la réunion nationale du Zimbabwe sur le rhinocéros et a fourni des clarifications lorsqu'elles les lui étaient demandées. La synthèse des évolutions clefs à l'échelle du continent, effectuée par le responsable scientifique à partir du rapport à la CITES (Ferreira et al. 2022), a contribué aux réflexions sur les performances des populations de rhinocéros dans le parc national de Marakele (province du Limpopo en Afrique du Sud). L'accent mis sur la sécurité régionale et la protection des biens et des personnes a montré son efficacité : aucun fait de braconnage sur les rhinocéros n'a été relevé sur l'année 2022. Dans le même temps, les observations de Rademeyer (2023) concernant la détérioration de la sécurité sur le territoire du Greater Kruger (Afrique du Sud) concluent sur le besoin d'approches innovantes afin de répondre aux défis rencontrés par les habitants.

Selon les exigences pour l'année 2022 en matière de rapports (Grace and Long 2023) dans le cadre du quadriennat 2021-2025, le GSRAf avait identifié 31 enjeux, réunis dans les thématiques suivantes : évaluation (7), planification (7), action (2), réseau (4) et communication (4). En 2022, le GSRAf avait atteint 10 % des objectifs, dont : la soumission d'un rapport conjoint de l'UICN et de TRAFFIC pour la CdP19, l'examen des propositions des États de l'aire de répartition pour les analyses TRAFFIC de l'UICN en vue de la CdP19 de la CITES en 2022, et l'étude

captive Southern white rhinos. The population of captive European Southern white rhinos is declining at 2% annually with only 10% of females calving each year, much lower than the almost 40% across wild populations. Institutions housing larger groups, however, had proportionally higher breeding success, and females were more likely to copulate if housed with another breeding female, and be more receptive to bulls if housed in a group with a lower mean age (Scott et al. 2022). Worth noting that the zoo community has limited space and may not want them breeding at higher rates.

Poaching pressures remain a significant threat to wild rhinos. Forensic evidence continues to play a key role in obtaining convictions. This provides the foundation for future application to disrupt criminal networks (Harper 2023).

The various influences on rhino reproduction and mortality require authorities to be accountable when considering trends in rhinos, especially in Kruger NP, South Africa, the population that has experienced the highest poaching pressure since 2007 (Ferreira et al. 2021). Progressively modelling influences of management introductions and removals, effects of environmental variation and rhino density, direct impacts of poaching, consequences of imperfect carcass detection, and indirect impacts of deaths of dependent calves accounted for 93% of Southern white and 83% of South-central black rhino trends in populations (Ferreira and Dziba 2023). Authorities require innovative approaches within and beyond Kruger NP to help reignite rhino conservation.

In Namibia, innovative approaches are strongly linked to local stewardship with associated economic opportunities. A case study in north-western Namibia noted more than USD 1,000,000 revenue generated from rhinoceros viewing encounters which were ranger-based during a six-year period which led to a 340% increase in the employment of local 'Rhino Rangers' during the same period. Communities that benefited more from rhinoceros-based tourism demonstrated higher levels of stewardship which contributed to the reduction in illegal killing (Muntifering et al. 2023a). In India, the participation of local people in wildlife conservation is also a major element for the successful restoration of key habitats in Pobitora Wildlife Sanctuary in

d'au minimum deux documents scientifiques par an jusqu'à 2024. Au total, 13 % des missions n'avaient pas débuté : la publication de deux articles dans la revue SPECIES à l'orée 2024 ; la présence à la réunion « IUCN SSC Leaders » ; le développement en 2021 d'une stratégie de renforcement des compétences pour les jeunes impliqués dans la conservation du rhinocéros. Les 24 thématiques restantes (soit 77 % du total) sont néanmoins en cours de réalisation.

Pour une connaissance et une compréhension plus vastes

Le GSRAf n'a de cesse de promouvoir la connaissance scientifique comme levier de la conservation du rhinocéros. Nous avons mentionné plus haut l'écriture d'un article collectif par les membres afin de démentir une publication précédente dans laquelle on imputait à la chasse aux trophées la diminution de la taille des cornes de rhinocéros (Wilson et al. 2022). Dans leur texte, les membres se sont attachés à démontrer les nombreux usages qu'ont les rhinocéros de leur corne, réfutant par là même les conclusions indiquant que la taille des cornes des rhinocéros à l'état sauvage était plus courte du fait de la pression de la chasse sélective alors que l'échantillon choisi comportait majoritairement des sujets de zoos. Le débat public, les preuves scientifiques, l'élaboration des politiques et la gestion en général devraient plutôt cibler les raisons fondamentales à la base du braconnage et du trafic de cornes afin de créer et de mettre en place des plans de réduction de la criminalité liée au rhinocéros (Ferreira et al. 2023).

Les membres du GSRAf ont produit plusieurs résultats d'études scientifiques sous l'égide des différentes institutions à l'origine d'éclairages déterminants, notamment sur les divers facteurs pouvant affecter les évolutions de populations de rhinocéros. Le décornage des rhinocéros noirs en Namibie, par exemple, n'a engendré aucun effet sur l'âge de la première reproduction, l'intervalle entre les naissances, le ratio mâle-femelle à la naissance, le taux de survie des petits ou la durée de vie chez les rhinocéros noirs du Sud-Ouest. Ces données vont dans le sens de la politique utilisant le décornage comme l'un des moyens de dissuasion des braconniers (Chimes et al. 2022).

Les rhinocéros noirs du Sud-Ouest en Namibie ont également montré que la densité de population avait peu de conséquences sur leur reproduction. Bien

Assam, where 102 greater one-horned rhinos reside, to mitigate the anthropogenic pressure and initiate sustainable development approaches in the area (Sarma et al. 2023).

The importance of private and communal lands was highlighted, such as those in South Africa, the global rhino stronghold. Private and community rhino custodians conserve >50% of South Africa's rhinos enabled by a supportive policy and economic environment. Private and community custodian contributions are increasingly more difficult with rising protection costs and diminishing revenue-generating options. Strengthening the resilience of private and community custodianship is central to the protection of Africa's remaining rhinos (Clements et al. 2023).

Part of the diminishing revenue is due to increasing objections being voiced against the recreational practice of trophy hunting. Legal trophy hunting of African rhinos has been sustainable, with small proportions of populations hunted each year. There are greater numbers of both species today in countries with controlled trophy hunting. Terminating this management option and significant funding source could have negative consequences at a time when rhinos in these countries are being increasingly viewed as liabilities (‘t Sas-Rolfes et al. 2022).

Strengthening resilience is particularly important given that rhino horn products continue to appear on markets such as at the Myanmar–Thailand–China border where horn tips went for USD 10,770 and bracelets at USD 5,385. In this case study, mobile phones and online trading allow customers to order items without having to cross borders (Vigne and Nijman 2022).

These insights provide additional guidance to continue with the restoration of rhinos and grow African legacies left by predecessors like Tony Fitzjohn 1945–2022, determined conservationists who sought to restore degraded habitat for Eastern black rhinos (Vigne 2022).

Acknowledgements

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qu’à court terme, la qualité du fourrage puisse avoir un plus grand impact sur plusieurs années, ce sont les précipitations qui ont une influence capitale. À titre d’illustration, les conceptions étaient synchronisées pendant la saison des pluies (Muntifering et al. 2023).

Contre toute attente, le braconnage ne semblait pas induire de stress chez le rhinocéros blanc du Sud en général, mais les conditions météorologiques, elles, avaient une incidence plus importante. (Il n'y a pas de données non plus dans l'étude concernant le stress éventuel ressenti par les petits ayant perdu leur mère, ou chez ceux ayant observé la douleur des rhinocéros, pendant ou après le décornage). La concentration de métabolites fécaux des glucocorticoïdes (fGCM) a augmenté de 42 % pendant la saison sèche par rapport à la saison des pluies. De plus, la concentration de fGCM était respectivement 38 % et 42 % plus élevée pendant la saison sèche et la saison des pluies, dans les réserves de petite surface. Les autorités pourraient travailler à l’atténuation du stress lié aux contraintes d’espaces et d’accès aux ressources dans le but de promouvoir la viabilité des rhinocéros dans de petites réserves (Nhleko et al. 2022).

Le stress social peut également avoir une influence sur l’efficacité de la reproduction et la pérennité de la population chez les rhinocéros blancs du Sud. La population de rhinocéros blancs en captivité en Europe décline actuellement de 2 % chaque année, avec seulement 10 % des femelles donnant naissance à un petit, chiffre bien inférieur aux presque 40 % parmi les populations à l’état sauvage. En revanche, dans les institutions accueillant un plus grand nombre de sujets, on relève un taux de reproduction proportionnellement plus élevé et des femelles plus susceptibles de s’accoupler si elles comptent une autre femelle reproductrice à leurs côtés. En outre, elles sont plus réceptives à l’approche d’un mâle si elles se trouvent dans un groupe d’une moyenne d’âge plus jeune (Scott et al. 2022).

La pression du braconnage reste une menace significative pour les rhinocéros à l’état sauvage. Les preuves médico-légales représentent toujours un élément clef pour obtenir des condamnations, ce qui fournit les bases permettant, à l’avenir, de déstabiliser les réseaux criminels.

Les diverses influences sur la reproduction et la mortalité du rhinocéros exigent des autorités qu’elles rendent des comptes lors de l’étude des évolutions de populations, notamment celles du parc national de Kruger (Afrique du Sud), groupe qui a le plus subi

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Kees Rookmaaker will be stepping down as the rhino Section Editor on the completion of volume 64. The AfRSG and AsRSG are extremely appreciative to Kees for dedicating 12 years of service (from Vol. 47 to Vol. 64) to the editorial board of *Pachyderm*, overseeing the publication of 69 papers on rhinos as well as contributing 32 manuscripts and 12 reviews.

Kees will continue to manage the invaluable Rhino Resource Center: http://www.rhinoresourcecenter.com/.

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la pression du braconnage depuis 2007 (Ferreira et al. 2021). Les facteurs qui modèlent progressivement la gestion des introductions et des retraits de rhinocéros, les effets de la variation environnementale et de la densité de sujets, les incidences directes du braconnage, les conséquences d'une détection imparfaite des carcasses et les impacts indirects de la mort de petits dépendants de leur mère constituent 93 % des évolutions de populations chez le rhinocéros blanc et 83 % chez le rhinocéros noir du Centre-Sud (Ferreira and Dziba 2023). Les autorités ont besoin d'approches novatrices au sein – et au-delà – du parc national de Kruger afin de relancer la conservation du rhinocéros.

En Namibie, les démarches innovantes sont fortement liées aux initiatives communautaires, avec les opportunités économiques qui en découlent. Une étude de cas effectuée au nord-ouest du pays a relevé que plus d'un million de dollars (USD) de revenus avaient été générés par des visites d'observation de rhinocéros organisées par les gardes locaux («rangers») sur une période de six ans, entraînant une augmentation des créations d'emplois de «Rhino Rangers» de 340 % pendant ces mêmes années. Les communautés qui bénéficient le plus du tourisme lié au rhinocéros ont montré de plus hauts niveaux d'initiatives locales, ce qui contribue à la réduction du braconnage (Muntifering et al. 2023a). En Inde, la participation des habitants à la conservation des espèces sauvages est également un élément majeur de la restauration réussie d'habitats clefs dans la réserve Pobitora Wildlife Sanctuary (État de l'Assam), où vivent 102 rhinocéros indiens, ce qui permet d'atténuer la pression anthropique et d'adopter des approches de développement durable dans la région (Sarma et al. 2023).

Il faut souligner ici l'importance des terres communautaires et privées, tel que celles existant en Afrique du Sud, place forte des rhinocéros à l'échelle mondiale : elles y accueillent plus de 50 % de la population sud-africaine de rhinocéros, une situation rendue possible grâce à un environnement politique et économique favorable. Cette forme de contribution devient de plus en plus difficile du fait des coûts croissants liés à la protection des animaux et de la diminution des opportunités d'en tirer un revenu. Renforcer la résilience des initiatives privées et communautaires est au cœur de la sauvegarde des rhinocéros d'Afrique (Clements et al. 2023).

La baisse des ressources financières en lien avec le rhinocéros s'explique notamment par les objections

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toujours plus fortes envers la chasse au trophée. La pratique légale de ce type de chasse est durable, avec de faibles proportions de populations concernées chaque année. Aujourd'hui, le nombre de sujets des deux espèces est en hausse dans les pays autorisant une chasse au trophée contrôlée. Sonner le glas de cette option de gestion, source significative de financement, pourrait avoir des conséquences négatives alors que les rhinocéros sont de plus en plus considérés comme une charge dans ces pays ('t Sas-Rolfes et al. 2022).

Renforcer la résilience est crucial du fait que les produits dérivés du rhinocéros sont toujours présents sur les marchés tels que ceux installés à la frontière Myanmar–Thaïlande–Chine, dans lesquels des extrémités de cornes se sont vendues jusqu'à 10 770 USD et des bracelets en corne 5 385 USD. Dans ce cas précis, l'usage de téléphones mobiles et le système d'achats en ligne permettent aux clients de commander des articles sans avoir à traverser de frontières (Vigne and Nijman 2022).

Ces exemples montrent d'autant plus la direction à prendre afin de poursuivre la réhabilitation des populations de rhinocéros et de voir prospérer l'héritage des Africains, tel notre prédécesseur Tony Fitzjohn (1945–2022). Grand défenseur de l'environnement, il n'a eu de cesse d'œuvrer à la restauration des habitats dégradés du rhinocéros noir de l'Est (Vigne 2022).

Remerciements

Nous remercions les États de l'aire de répartition du rhinocéros d'Afrique pour leur contribution continue d'informations au secrétariat. Le GSRAf est également reconnaissant à Save the Rhino International (SRI), à International Rhino Foundation (IRF), au fonds pour la conservation du rhinocéros et du tigre du département américain US Fish and Wildlife (USFWS RTC), au fonds pour les espèces sauvages menacées (EWT) et à la fondation Oak pour leur soutien au responsable scientifique (SO), au responsable du programme (PO) et au Président, et pour leur permettre de rendre ce service inestimable au groupe. Merci à WWF Namibie pour son soutien au Président. Nous remercions nos fidèles donateurs pour leur généreux soutien à la publication de ce numéro : la fondation Oak, Save the Elephants et le legs Esmond B. Martin par le biais de la Royal Geographic Society.

Kees Rookmaaker quittera sa fonction de rédacteur de la section rhinocéros à l'issue de la publication de ce numéro 64 de Pachyderm. Le GSRAf et le GSRAs

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sont extrêmement reconnaissants à Kees pour son engagement durant 12 années dans le comité éditorial de *Pachyderm* (du n° 47 au n° 63), pour sa supervision de la publication de 69 articles traitant des rhinocéros et pour sa contribution à 32 manuscrits et 12 comptes-rendus.

Kees continuera son travail de gestion de l'inestimable Centre de ressources du rhinocéros («Rhino Resource Center»): http://www.rhinoresourcecenter.com/

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Asian Rhino Specialist Group Chair report
Rapport du Groupe de Spécialistes du Rhinocéros d'Asie

Bibhab Kumar Talukdar, Chair/Président

Aaranyak, 50 Samanwoy Path (Survey), PO Beltola, Guwahati—781 028, Assam, India
email: bibhab@aaranyak.org

Current state of the greater one-horned rhinos in India and Nepal

Currently, there are about 4,018 greater one-horned rhinos (GOH) in India and Nepal according to population estimates carried out in 2022. Of these, 752 are found in four rhino-bearing areas in Nepal and 3,266, and in seven rhino-bearing areas in three provinces of India.

In 2023 (up to the end of August), Assam had lost four rhinos to poaching in three rhino-bearing areas. In January 2023, two rhinos were killed in Chitwan National Park (NP); while only two rhinos were poached in Nepal throughout the seven-year period preceding (2016–2022).

Assam, which has more than 70% of the global wild population of GOH rhino, is still aiming for "zero rhino poaching" recognising that the measures put in place from 2013 onwards, are working well.

To secure the future of rhinos in Assam, the connectivity from Orang NP, in the central western part of Assam, to Kaziranga NP in the central eastern part of Assam, is being established through the extension of areas contiguous with the neighbouring Laokhowa and Burhachapori Wildlife Sanctuary (WLS). As part of the Indian Rhino Vision 2020 being implemented by the Government of Assam an additional 200 km^2 has been added to Orang NP which holds 125 GOH rhinos. With this expansion, the Park's capability to house more rhinos has been ensured and it is hoped will improve the gene flow in the coming years.

In collaboration with Aaranyak, donor partners International Rhino Foundation and Save the Rhino International, continue to clear and control invasive plant species in the Park which are choking the preferred grasses

État actuel du rhinocéros indien en Inde et au Népal

Selon les estimations menées en 2022, la population actuelle de rhinocéros indiens en Inde et au Népal s'élève à 4 018 individus environ, dont 752 se trouvent au Népal dans quatre zones d'habitat différentes et 3 266 en Inde dans sept zones d'habitat réparties sur quatre régions.

De janvier à fin août 2023, l'état de l'Assam (Inde) a perdu quatre rhinocéros du fait du braconnage, dans trois zones d'habitat différentes. En janvier 2023, deux sujets ont été tués dans le parc national de Chitwan (Népal) alors que sur la période 2016-2022, seules deux victimes de braconnage avaient été recensées.

L'état de l'Assam, qui compte plus de 70 % de la population mondiale de rhinocéros indiens sauvages, maintient son objectif « zéro braconnage » et reconnaît que les mesures mises en œuvre depuis 2013 sont efficaces.

Afin de sécuriser l'avenir des rhinocéros dans l'état de l'Assam, une connexion est en train d'être créée (du centre ouest au centre est de l'état) entre les parcs nationaux d'Orang et de Kaziranga, grâce à l'extension de zones contiguës aux réserves naturelles voisines de Laokhowa et de Burhachapori. Dans le cadre du plan Indian Rhino Vision 2020 mis en place par le gouvernement de l'Assam, le parc national d'Oran a été doté de 200 km^2 supplémentaires pour les 125 rhinocéros indiens qui le peuplent. Cette mesure, qui permet de pourvoir le parc d'une capacité d'accueil plus importante afin d'abriter un plus grand nombre d'individus, donne des raisons d'espérer une amélioration du flux génétique dans les années à venir.

Les partenaires-donateurs International Rhino Foundation et Save The Rhino International, en collaboration avec l'ONG Aaranyak, continuent leur travail de régulation des plantes invasives dans le parc, qui étouffent les végétaux prisés des rhinocéros. Le

of the rhinos. The project employs locals to manually remove alien species such as American rope (*Mikania micrantha*) and Siam weed (*Chromolaena odorata*) and plant native grasses that are palatable for the rhinos to feed on, thus increasing suitable rhino fodder.

The front cover of this issue of *Pachyderm* is of a GOH rhino scenting the air while wading in the Brahmaputra River, in Kaziranga NP. The photo was taken by Anwaruddin Choudhury, with kind permission to use it in this issue.

Current state of Javan rhino

In Indonesia, the populations of both Javan and Sumatran rhinos remain perilously low. Due to successful breeding in recent years, Javan rhino numbers are increasing slowly. According to official figures, as of mid-2022, the current population estimate is 76 Javan rhino. However, all Javan rhinos live in Ujung Kulon NP, their last stronghold, and without any new habitat to move into, they are at enormous risk of disease and natural disasters. Additionally, there are reports of some individuals killed by poachers in the Park.

Current state of the Sumatran rhino

Declining Sumatran rhino numbers are of even greater concern. While official figures from the Indonesian government estimate fewer than 80 remaining animals, the new estimate and information compiled by the Asian Rhino Specialist Group (AsRSG), the African Rhino Specialist Group (AfRSG) and the wildlife trade watchdog TRAFFIC, conclude that the actual number of Sumatran rhinos is just 34–47. The concerning estimate was submitted to CITES as part of the IUCN SSC AfRSG and AsRSG and TRAFFIC report on the Status of African and Asian Rhinoceros.

Sumatran rhinos are spread out in fragmented patches of forest, making it almost impossible for them to find each other and breed successfully. Ex situ/captive breeding projects are being implemented, but these projects take time and the species is being pushed to the edge of extinction. See the action plan below.

projet emploie des habitants locaux afin de supprimer manuellement les espèces non endémiques (telles que la liane américaine *Mikania micrantha* et l'herbe du Laos *Chromolaena odorata*), puis d'introduire des plantes endémiques appréciées des rhinocéros, augmentant par là même leur quantité de fourrage disponible.

La photo de couverture illustrant cette édition de *Pachyderm* montre un rhinocéros indien humant l'air tout en pataugeant dans le fleuve Brahmapoutre, dans le parc national de Kaziranga (Inde). Le cliché a été pris par Anwaruddin Choudhury, qui nous a gracieusement autorisés à l'utiliser pour ce numéro.

État actuel du rhinocéros de Java

En Indonésie, les populations du rhinocéros de Java et du rhinocéros de Sumatra restent dangereusement basses. Néanmoins, ces dernières années, le nombre de rhinocéros de Java connaît une légère hausse grâce à quelques naissances répertoriées. La population actuelle est estimée à 76 individus, selon les chiffres de 2022. Cependant, l'intégralité des rhinocéros de Java vit dans le parc national de Ujung Kulon sans aucune zone alternative d'habitat. Ils sont par conséquent très vulnérables au risque de maladies et de catastrophes naturelles. En outre, des rapports indiquent que plusieurs sujets ont été tués par des braconniers dans le parc.

État actuel du rhinocéros de Sumatra

Le déclin du rhinocéros de Sumatra est plus préoccupant encore. Alors que les données officielles du gouvernement indonésien n'indiquent qu'un chiffre « inférieur à 80 animaux », la nouvelle estimation et les informations collectées par le Groupe de Spécialistes du Rhinocéros d'Asie (GSRAs), le Groupe de Spécialistes du Rhinocéros d'Afrique (GSRAf) et l'organisme de surveillance du commerce d'espèces sauvages TRAFFIC, concluent à un nombre réel se situant entre 34 et 47 individus. Cette estimation a été soumise à la CITES par la CSE de l'UICN, le GSRAf, le GSRAs et TRAFFIC dans leur rapport sur l'état du rhinocéros africain et asiatique.

Les rhinocéros de Sumatra sont dispersés dans des secteurs de la forêt isolés les uns des autres, ce qui rend leur rencontre et leur accouplement quasiment impossible. Des projets de reproduction ex-situ ou en captivité sont en cours, mais leur mise en place prend

Third Asian Rhino range States meeting

The Third Asian Rhino Range States meeting was held in Chitwan NP, Nepal, from 3 to 5 February 2023, where 116 participants took part including government officials from the five Asian rhino range states: India, Nepal, Indonesia, Bhutan, and Malaysia. Following three days of discussions and negotiations on various aspects of Asian rhino conservation, the Asian range states issued the following Chitwan declaration.

Chitwan Declaration for Asian Rhino Conservation, 2023

Based on three days of deliberations, during the Third Asian Rhino Range countries meeting held in Chitwan NP, Nepal, the delegates from Bhutan, India, Indonesia, Malaysia, and Nepal recognized the various challenges facing Asian rhinos and agreed on:

"Protection

- Strengthen protection regime, intelligence gathering, and real-time sharing of intelligence information on Rhino crime and its illegal horn trade.
- Use of advanced technology, including the use of forensic science to aid ongoing protection and surveillance to prevent illegal hunting of Rhinos.
- Enhance 'boots on the ground' for regular field vigil to detect and deter wildlife offences in Rhino-bearing areas, with special emphasis on strategic locations.
- Upkeep high morale of frontline staff through improved field facilities and incentive packages.
- Enhancement of skills and capacity building of frontline staff including wildlife crime investigations.
- Provide alternative livelihoods to increase local economic growth and community development programmes around Rhino-bearing Protected Areas.
- Mobilization and empowerment of local communities for community-based conservation activities.

du temps et les espèces continuent d'être fragilisées et de friser l'extinction. Un plan d'action, détaillé ci-dessous, a été défini.

Troisième réunion des États de l'aire de répartition du rhinocéros d'Asie

Cette réunion s'est tenue dans le parc national de Chitwan au Népal, du 3 au 5 février 2023. Cent seize participants y ont assisté, parmi eux des représentants des gouvernements des cinq pays de l'aire de répartition du rhinocéros d'Asie : Inde, Népal, Indonésie, Bhoutan et Malaisie. Après trois jours de discussions et de négociations sur la conservation du rhinocéros d'Asie et ses différents aspects, les États ont rédigé la déclaration suivante.

Déclaration de Chitwan 2023 pour la conservation du rhinocéros d'Asie

Dans le cadre de la troisième réunion des États de l'aire de répartition du rhinocéros d'Asie dans le parc national de Chitwan (Népal), les représentants du Bhoutan, de l'Inde, de l'Indonésie, de la Malaisie et du Népal ont, après trois jours de délibération, identifié les différents défis auxquels sont confrontés les rhinocéros d'Asie et se sont entendus sur les mesures suivantes :

« Protection

- Renforcer le régime de protection, la collecte de données et le partage d'informations en temps réel sur les crimes relatifs au rhinocéros et au commerce illégal de corne.
- Intégrer les technologies de pointe, y compris l'utilisation de la science médico-légale, dans la protection et la surveillance quotidienne contre la chasse illégale des rhinocéros.
- Augmenter les ressources sur le terrain pour la mise en place de veilles régulières visant à détecter et à prévenir les infractions relatives aux espèces sauvages dans les zones d'habitat du rhinocéros, avec un dispositif renforcé dans certains secteurs stratégiques.
- Encourager un investissement continu des agents sur le terrain grâce à l'amélioration des infrastructures et à des mesures incitatives.
- Développer et renforcer les compétences du personnel sur le terrain, y compris en ce qui

- Strengthening and harmonizing the legal framework and regulations to combat wildlife crime.

Population management

- Establish the National Conservation Breeding Programme for Sumatran rhino in Indonesia, to direct the management of all Sumatran Rhinos under human care as a single population and manage for optimal growth. Use multiple approaches to accurately detect and save isolated Sumatran Rhino populations in the wild, then consolidate them into a sanctuary for breeding purposes as part of the national breeding programme.
- Support the movement of Sumatran Rhinos amongst the breeding centres under the National Conservation Breeding Programme to optimize breeding opportunities, genetic diversity and population growth.
- Establish and operate the Javan Rhino Study and Conservation Area (JRSCA) Management System as a management centre for the Javan Rhinoceros population.
- Establish a second habitat to secure the population of the Javan Rhino outside of the Ujung Kulon National Park.
- Encourage the exchange of rhinos between populations of the same species to improve genetic health.
- Explore possibilities of expanding rhino ranges within country or between rhino range States for optimal population management.
- Share technologies and scientific knowledge to restore the species and ecosystems, including Assisted Reproduction Technology (ART).

Habitat management

- Improve habitat management techniques in Rhino-bearing areas to maximise habitat suitability and expansion of its range.
- Develop and implement rhino habitat management guidelines to ensure continuous availability of food, water, and space for rhinos.
- Minimize the threats to Rhino habitats including invasive alien species.

concerne les enquêtes relatives aux crimes contre les espèces sauvages.

- Diversifier les moyens de subsistance des habitants afin de soutenir la croissance économique locale et créer des programmes de développement au sein des communautés autour des zones d'habitat protégé des rhinocéros.
- Mobiliser et autonomiser les habitants autour d'activités de conservation menées par les communautés locales.
- Renforcer et harmoniser le cadre juridique et la réglementation pour combattre la criminalité liée aux espèces sauvages.

Gestion de la population

- Établir le Programme national de conservation et d'élevage du rhinocéros de Sumatra en Indonésie, afin que tous les rhinocéros de Sumatra actuellement sous la responsabilité de l'homme soient considérés comme une seule et même population, pour une gestion et une croissance optimales du nombre d'individus. De multiples approches pourront être utilisées afin de détecter de manière précise les rhinocéros de Sumatra isolés dans la nature, les sauver puis les consolider dans un sanctuaire, dans le cadre du Programme national d'élevage.
- Appuyer les efforts de déplacement des rhinocéros de Sumatra entre les différents centres dans le cadre du Programme national de conservation et d'élevage, afin d'optimiser les opportunités de reproduction, la diversité génétique et la croissance de la population.
- Définir et organiser le système de gestion de la Zone d'Étude et de Conservation des Rhinocéros de Java (JRSCA) comme centre de gestion pour tous les rhinocéros de Java.
- Établir un deuxième habitat afin de sécuriser la population de rhinocéros de Java hors du parc national de Ujung Kulon.
- Encourager les échanges entre individus de la même espèce afin d'améliorer la santé génétique de la population.
- Explorer les possibilités d'expansion des zones d'habitat des rhinocéros au sein des pays ou entre États de l'aire de répartition pour une gestion optimale des populations.
- Partager les technologies et les connaissances

- Adopting wildlife-friendly measures in developmental projects to minimize adverse effects on rhino habitat and prevent fragmentation and degradation of Rhino range.

Research, monitoring, and information sharing

- Conduct/promote long-term research on various aspects related to rhino conservation, including population and habitat management, captive breeding potential, the human-rhino interface, genetic health, and control of invasive species.
- Establish routine-based rhino population monitoring systems in rhino-bearing areas and conduct rhino population surveys every four years.
- Promote studies on potential impacts of climate change on species and habitats.
- Undertake studies on Rhino health issues and potential diseases, and take necessary steps for management intervention according to One Health principles.
- Conduct water health assessment and availability in Rhino habitats periodically.
- Identify potential areas and conduct feasibility studies for reintroduction.
- Share studies, research outcomes, and best practices among range countries.

Coordination and cooperation

- Strengthen transboundary collaboration among Asian Rhino range countries.
- Strengthen cooperation and engagement between Bhutan, Nepal, and India, sharing contiguous habitats and connecting corridors.
- Regularly carry-out cross-learning visits among managers and front-line staff of Rhino range countries.
- Increase the engagement of local communities as stewards to secure the future of Rhinos in range countries and promote co-existence."

The Asian Rhino range countries unanimously agreed to launch a dedicated rhino conservation programme focusing on community-based initiatives in the vicinity of their Rhino-bearing areas.

scientifiques afin de restaurer les espèces et les écosystèmes, dont les techniques de procréation assistée (ART).

Gestion de l'habitat

- Améliorer les techniques de gestion de l'habitat dans les zones où vivent les rhinocéros afin d'augmenter la qualité de leurs milieux de vie et de favoriser l'expansion de leur périmètre de déplacement.
- Définir et appliquer les lignes directrices de la gestion de l'habitat des rhinocéros afin de leur assurer une disponibilité constante de nourriture, d'eau et d'espace.
- Réduire les menaces envers les habitats des rhinocéros, dont les espèces invasives non endémiques.
- Adopter des mesures respectueuses des espèces sauvages dans les projets de développement afin d'en atténuer les effets négatifs sur l'habitat des rhinocéros et d'éviter la fragmentation et la dégradation de leurs espaces de vie.

Recherche, surveillance et partage d'informations

- Conduire ou promouvoir des recherches à long terme sur les différentes dimensions de la conservation du rhinocéros, dont la gestion des populations et de l'habitat, le potentiel de reproduction en captivité, les relations humains-rhinocéros, la santé génétique et le contrôle des espèces invasives non endémiques.
- Mettre en place des dispositifs de surveillance systématique des populations de rhinocéros dans les zones d'habitat et réaliser des études de population tous les quatre ans.
- Promouvoir des études interrogeant les impacts du changement climatique sur les espèces et les habitats.
- Mener des études sur les problèmes de santé et les maladies potentielles des rhinocéros, puis prendre les mesures nécessaires d'intervention de gestion selon les principes One Health.
- Procéder à des évaluations régulières de salubrité et de disponibilité de l'eau dans les habitats des rhinocéros.
- Identifier des zones propices à une réintroduction de rhinocéros et réaliser des études de faisabilité.

The member countries also agreed that the critically endangered Sumatran Rhino needs time-bound recovery measures in range countries and appeals to the global community to complement the effort, technically and financially, to secure the species.

The member countries additionally agreed to review the status of the three species of Asian rhinos every four years to reassess the need for joint actions to secure their future.

The five Asian Rhino Range countries; Bhutan, India, Indonesia, Malaysia, and Nepal; hereby commit to managing the populations of the GOH, Javan and Sumatran rhinos with the intention of achieving at least 3% annual growth rate in their populations for these rhino-bearing countries, through the implementation of the strategic actions outlined in this Declaration.

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- Partager les études, les résultats de recherche et les bonnes pratiques entre pays de l'aire de répartition.

Coordination et coopération

- Renforcer la collaboration transfrontalière entre les pays de l'aire de répartition du rhinocéros asiatique.
- Consolider la coopération et l'engagement des pays frontaliers partageant des habitats et des corridors biologiques (Bhoutan, Népal et Inde).
- Organiser régulièrement des visites d'échange à destination des responsables et des équipes sur le terrain afin de favoriser l'apprentissage mutuel entre pays de l'aire de répartition.
- Encourager les communautés locales des pays de l'aire de répartition à s'engager pour l'avenir des rhinocéros et à promouvoir la coexistence avec les humains. »

Les pays de l'aire de répartition du rhinocéros asiatique ont décidé à l'unanimité de lancer un programme de conservation qui met l'accent sur les initiatives des communautés locales dans les zones proches des habitats de rhinocéros.

Les pays membres sont également convenus du fait que le rhinocéros de Sumatra, en danger critique d'extinction, devait bénéficier de mesures de rétablissement appliquées selon un échéancier précis et appelle la communauté internationale à soutenir cet effort, à la fois financièrement et techniquement, afin d'assurer la survie de l'espèce.

En outre, il a été décidé que l'état des trois espèces du rhinocéros asiatique serait revu tous les quatre ans afin de réévaluer la nécessité d'entreprendre des actions communes pour leur pérennité.

Les cinq pays de l'aire de répartition du rhinocéros asiatique (Bhoutan, Inde, Indonésie, Malaisie et Népal) s'engagent, par le présent document, à s'associer dans leur gestion du rhinocéros indien, du rhinocéros de Java et du rhinocéros de Sumatra, afin d'atteindre une croissance de ces populations d'au moins 3 % chaque année, grâce à la mise en œuvre d'actions stratégiques détaillées dans cette Déclaration.

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RESEARCH

A culture of aggression: the Gorongosa elephants' enduring legacy of war

Joyce Poole[1],Jason Denlinger[2], Dominique Gonçalves[3,4], Petter Granli[1]*

[1]ElephantVoices, Buskhellinga 3, 3236 Sandefjord, Norway
[2]Dubuque County Conservation, 13606 Swiss Valley Road, Peosta, IA, USA
[3]Durrell Institute of Conservation and Ecology, School of Anthropology and Conservation, Marlowe Building, University of Kent, Canterbury, Kent, CT2 7NR, UK
[4]Scientific Services, Gorongosa National Park, Avenida Mártires da Revolução Nº 1452, Edifício CPMZ – 1º Andar, Bairro do Macuti, PO Box 1983, Beira, Moçambique

*corresponding author: jpoole@elephantvoices.org

Abstract

Humans have hunted elephants since the Palaeolithic era and, as cunning predators, have likely helped shape the animals' sophisticated defensive behaviour. In recent centuries, the use of modern weapons in targeted mass killings has resulted in signs of post-traumatic stress disorder (PTSD) in elephants, including heightened aggression and impaired decision-making. During Mozambique's long civil war (1977–1992), 90% of the elephants of Gorongosa National Park were killed. More than a quarter of a century after the end of hostilities aggression towards vehicles by elephant families is an enduring legacy. This study found that females and entire families were more likely to charge when vehicles were in close proximity (<~80 m) and on, rather than off, the roads. Although aggression was primarily initiated and led by older adult females, most charges involved mobbing by entire families, including calves. Some individuals engaged in idiosyncratic defensive behaviours, while some families exhibited distinctive group manoeuvres that appeared to form traditions, indicating that young elephants were acquiring their defensive responses within this social context. We argue that the aggressive behaviour of the Gorongosa elephants is a response to the traumatic events of the civil war and that the observed patterns of behaviour are transmitted within and across groups, giving rise to a culturally learned behavioural variant that has persisted over time and generations. Given rapid environmental change, increasing contact between elephants and people, and the extreme losses caused by poaching and armed conflict, a better understanding of the role that culture plays in the response of elephants to people is urgently needed. Conservation and management strategies may have to be adapted to meet the changing cultures of specific elephant populations.

Résumé

Nous, humains, chassons l'éléphant depuis le Paléolithique et en tant que prédateurs astucieux, nous avons probablement contribué à façonner le comportement défensif sophistiqué dont ils font preuve. Depuis quelques centaines d'années, le recours aux armes modernes pour procéder à des tueries de masse ciblées a provoqué chez les éléphants des manifestations de stress post-traumatique, notamment une augmentation

du taux d'agression envers les humains et une altération des prises de décision. Pendant les longues années de guerre civile au Mozambique (1977 à 1992), 90 % des éléphants du parc national de Gorongosa ont été abattus. Les attaques de véhicules par des familles entières d'éléphants sont des marqueurs hérités de ces années de conflit. La présente étude a permis d'identifier que, non seulement les femelles, mais également des familles entières d'éléphants, sont plus susceptibles de charger des véhicules se trouvant à proximité (moins de 80 mètres). En outre, ces altercations ont lieu sur les routes plutôt qu'en dehors de celles-ci. Bien que les femelles plus âgées amorcent et mènent ces agressions, la plupart des heurts impliquent des familles entières, dont des juvéniles. Certains individus montrent des comportements de protection caractéristiques et connus, tandis que plusieurs clans identifiés présentent des manœuvres spécifiques effectuées en groupe et qui semblent former un ensemble de « traditions ». Cela donne à penser que les éléphants juvéniles acquièrent leurs réactions défensives dans ce contexte social. Nous attribuons l'attitude agressive des éléphants de Gorongosa aux événements traumatiques de la guerre civile, et nous avançons l'hypothèse selon laquelle les schémas comportementaux observés se transmettent au sein des groupes et entre eux, créant au fil du temps des variantes culturelles intégrées par les nouvelles générations. Du fait des rapides changements environnementaux, de l'augmentation des contacts entre éléphants et humains et des pertes extrêmes causées par le braconnage et les conflits armés, une meilleure compréhension de l'aspect culturel dans la réponse des éléphants en présence d'humains est vitale. Il sera peut-être nécessaire d'ajuster les stratégies de conservation et de gestion face à certaines populations spécifiques d'éléphants montrant des transformations culturelles.

Introduction

In 1915 WB Canon used the phrase "fight or flight" to describe the immediate, transitory response of animals to threat. We now know that life-threatening events can have enduring consequences for the brain and behaviour, this being most clearly demonstrated by post-traumatic stress disorder (PTSD). Zanette et al. (2019) argue that predator-induced fear can have lasting effects on the brain and behaviour of wild animals and maintain that these meet the criteria to be a non-human form of PTSD. They contend that PTSD is neither unnatural nor maladaptive; rather, the lasting effects of predator-induced fear are a natural phenomenon serving an adaptive, evolutionarily purpose, even though it may be associated with costs such as hypervigilance. But what if such trauma is caused by human predators engaged in targeted, often prolonged mass killing events that cause dramatic declines in populations and are associated with enduring changes to the behaviour of individuals, the traditions of particular groups or, indeed, the culture of an entire population?

Culture in animals has been defined by Brakes et al. (2021) as information or behaviours shared within a group and acquired from conspecifics through some form of social learning. Individual responses to anthropogenic threats combined with social learning can lead to distinct cultures, which can be important conservation indicators, as well as a resource for resilience in the face of rapid anthropogenic change (Brakes et al. 2021). In this study we distinguish between the terms *tradition* and *culture*. Following Fragaszy and Perry (2003) and Whiten (2005, 2017) we define a *tradition* as a "distinctive behaviour pattern shared by two or more individuals in a social unit [in this case within an elephant family unit], which persists over time and that new practitioners acquire in part through socially aided learning" (Whiten 2017). We define *culture* as the distinctive patterning at population level or the array of traditions across families, which are also presumably acquired from conspecifics through some form of social learning.

Like humans, elephants are known for their close, complex, and enduring social relationships (Moss and Poole 1983; Archie et al. 2006) that develop over long lifespans and are assumed to involve social transmission of knowledge between generations (McComb et al. 2001, 2011; Shannon et al. 2013). Elephant society is highly adaptable and flexible (Moss and Lee 2011), and elephants' behaviour and communication are malleable; with many social, behavioural and communication traits presumed to be acquired through social learning (Poole et al. 2005; Bates et al. 2010; Chiyo et al. 2012). Elephants also adopt novel and idiosyncratic behaviour that may

Table 1. Examples of some elephant culling programmes in Africa

Country	Location	Years	Number killed	Source
Kenya	Tsavo NP	1966	300	Parker and McCullagh 2021
Namibia	Etosha NP	1983–85	570	reported in Slotow et al. 2008
South Africa	Kruger NP	1967–97	14,629	Slotow et al 2008, Whyte 2007
Tanzania	Mkomazi NR	1968–69	600	Parker and McCullagh 2021
Uganda	Murchison Falls (Kabalega) NP	1965–67	2,000	Parker and McCullagh 2021
Uganda	Budongo Forest	1965–67	269	Parker and McCullagh 2021
Zambia	Luangwa Valley NP	1965–69	1,453	Astle 1971
Zimbabwe	Hwange NP (mostly)	1960–91	~50,000	Martin et al. 1996 cited in Slotow et al. 2008

be learned or imitated by others (Poole et al. 2005; Poole and Granli 2021), making them ideal candidates for examining whether and how the culture of populations might be shaped by anthropogenic threats.

Humans have likely been hunting elephants for meat since the Palaeolithic era (Agam and Barkai 2018). Hunting expeditions for ivory have been documented as far back as 1500 BC (Wilson and Ayerst 1976; Meredith 2001). Demand for ivory caused the extinction of elephants in the Middle East by 500 BC, and by the end of the 4th century AD, there were no elephants remaining in North Africa. Europeans began collecting ivory south of the Sahara in the mid-1400s, and in and around what is now Gorongosa National Park (NP), Mozambique, in the late 1500s, though considerable amounts of ivory were already being exported there to the Arabian Peninsula and India (Meredith 2001). Since the 1600s demand for ivory has been responsible for catastrophic declines in populations across Africa (Meredith 2001). During the last half century sophisticated weapons and other resources (e.g. automatic rifles, machine guns, vehicles, and helicopters) have been used to hunt elephants on a massive scale.

It is impossible to give an accurate figure of the number of elephants killed for ivory, which varies enormously among time periods, regions and populations. For example, Thouless et al. (2016) estimate that between 2007 and 2015 illegal hunting (poaching) was the primary cause for the loss of some 114,000 elephants continent-wide (~21% of the total population). During the same period, East Africa's elephants as a whole declined by 50%, while Tanzania's population declined by 60% (Thouless et al. 2016) and the Selous population, specifically, fell by 74% from 50,000 to 13,000 individuals (Kyando 2014). Between 1946 and 2010, armed conflicts occurred in 71% of Africa's protected areas (PA) (Daskin and Pringle 2018); and many were associated with catastrophic local declines in elephant populations of up to 90% (Beyers et al. 2011; Bouché et al. 2010, 2011, 2012). The appalling loss of elephants during the Mozambican civil war is well documented (Campbell-Staton et al. 2021; Poole and Granli 2022) and is the subject of this paper.

While demand for ivory has by far caused the largest number of elephant deaths, the impact of targeted mass killings on the behaviour of elephants is best documented by studies of the survivors of culling operations (systematic killing to control elephant numbers). From 1960–1997, at least nine populations across Africa experienced large-scale culls during which more than 66,000 elephants were killed (Table 1). Such operations involved rounding up groups of elephants, sometimes immobilising adults from helicopters, before shooting them at close range and, in some cases, capturing calves for sale or reintroductions.

Such killings have both short- and longer-term effects on elephant behaviour (Slotow et al. 2008). As Martin et al. (1996) observed, "it is naïve to believe that, if an entire herd is killed, the remainder of the population knows nothing about the event." In the shorter term, elephants may spend less time in places where they feel vulnerable, such as waterholes (Martin et al. 1996), or may disappear from the area where the killing occurred (Whyte 1993). Anecdotal reports suggested that in the long term, in areas of Kruger

NP where culling occurred, elephants were more aggressive (Whyte 2001), acted in a "secretive and skittish manner" (Slotow et al. 2008), and were easily disturbed by vehicles (Slotow et al. 2007).

Anthropogenic disturbances that cause significant deaths or separation of bonded individuals, such as culling programmes, legal and illegal hunting, translocation, and capture for captivity, can fragment patterns of social attachment by eliminating the supportive stratum offered by family members. Severely disturbed populations may experience both initial trauma associated with the disruptive event and loss of opportunities for interacting and learning from older group members who could act as role models or repositories of knowledge (Slotow et al. 2000; McComb et al. 2001, 2011; Shannon et al. 2013).

Studies also indicate that such disruption appears capable of driving aberrant behaviours (e.g. impaired decision making and hyper-aggression) in elephants that are akin to PTSD experienced by humans following traumatic events (Bradshaw et al. 2005). Examples include the killing of rhinoceroses by male elephants (Slotow et al. 2000) and reduced ability of family groups to respond appropriately to social threats (Shannon et al. 2013) in populations that were established from translocated survivors of culls.

Psychological trauma in humans is often encountered as a legacy of war and/or disruptions of a socio-ecological nature (Bradshaw et al. 2005). Long-term studies have found that survivors of severely traumatic events may face a lifelong struggle with sometimes debilitating behavioural dysfunctions (i.e. PTSD). Furthermore, their children and families can exhibit similar symptoms, such that an entire society can be affected: directly through an individual's experience and indirectly, through social transmission and the breakdown of conventional social structures (Leiner 2009). Indeed, trauma can define a culture (Bradshaw et al. 2005). Since neuroscience has demonstrated that all mammals share common stress-regulating neurophysiology and developmental attachment mechanisms, we should not be surprised to find that elephant survivors of war, poaching and culling have been observed displaying symptoms similar to those of human PTSD (Bradshaw et al. 2005). Might such traumas experienced by elephants have also shaped their cultures?

Patterns of fear and aggression in response to human-induced trauma can vary significantly among elephant populations, suggesting cultural variants. As described above, a behavioural variant of aggression towards rhinos was observed in several disturbed populations in South Africa, with the majority of events perpetrated by young males in musth (Slotow et al. 2000). Furthermore, provisional analysis from an ongoing study of videos posted online showing aggressive acts by elephants towards vehicles found that the vast majority were of males, often in musth, filmed in South African PAs (Sidhu et al. in prep.). While it is tempting to blame aggression on musth, or poorly behaved drivers, these traits also exist elsewhere. However, reports of musth males attacking vehicles in Kenya, for example, are extremely rare. In 50 years of study in Amboseli there has only been one instance of a musth male tusking a tourist vehicle. We suggest that the elevated frequency of aggressive behaviour in South Africa may indicate a cultural variant.

In Tsavo East and Tsavo West NPs, Kenya, where ivory poaching caused an 85% decline in elephant numbers between 1976 and 1989, a study carried out towards the end of this period found that elephants often fled from vehicles several hundred metres away, once human presence was noticed (Poole 1989b).

In Queen Elizabeth NP, Uganda, the elephant population declined by almost 95% between 1973 and 1980 (Douglas-Hamilton et al. 1980). Here, the remaining elephants permitted vehicles to approach in open habitat but moved together in one tight-knit semi-permanent aggregation of 170 elephants (Poole 1989b). In Mikumi NP, Tanzania (part of the Selous ecosystem), where the population declined by an estimated 75% during the same period (Balozi 1989), many of the survivors sought safety in small, fragmented and, often, orphan groups, near the lodge and park headquarters (Poole 1989b).

In the Maasai Mara ecosystem, Kenya, between 2011–2016, we experienced neither aggressive nor fearful behaviour during vehicle encounters with 286 groups in the Maasai Mara National Reserve (NR) and neighbouring conservancies (Poole et al. 2016; Poole and Granli 2022) despite very significant poaching in the ecosystem during this period. Elephants were, however, wary of Maasai and their livestock and, in neighbouring Naimina Enkiyo Forest, where poaching

was heaviest, elephants were extremely skittish.

Studies in relatively undisturbed Amboseli NP, Kenya, found that elephants were calm around vehicles, yet reacted fearfully if a Maasai man in traditional dress was, or had been, in the vehicle (Joyce Poole (JP), pers. obs., 1980s), as well as to garments worn by Maasai men (Bates et al. 2007) or to Maasai male voices (McComb et al. 2014). On occasion, Maasai warriors spear elephants, in some instances in retaliation, when some Amboseli elephants have killed livestock (Sayialel and Moss 2011). Thus, this population considers Maasai men a threat, but not women and children, nor members of other ethnic groups, nor tourists in vehicles.

Studies indicate that populations of elephants understand not only specifically *who* (which class of people) represents a threat, but also *where* and *when* they are safe, based on specific knowledge about the characteristics and behavioural patterns of their human predators. Satellite tracking in Samburu NR, Kenya, revealed that elephants "streak" through unsafe habitat at night and avoid areas where they are more likely to meet people (Douglas-Hamilton et al. 2005). Around Mikumi NP, crop raiding occurred less frequently on full moon nights, a period associated with greater visibility and greater human activity (Gunn et al. 2013), suggesting again that elephants use knowledge of human behaviour to try to minimize contact with them.

In Amboseli NP, elephants were more vigilant when they were outside the Park boundaries, when we carried strangers in our car, or when vehicles did not conform to their expectation of being on the road within the protected area boundary (JP pers. obs.). In Gorongosa NP, trail camera data revealed that there, too, elephants had expectations about the movement of vehicles, avoiding roads during hours when they were more likely to be present (Gaynor et al. 2018). Video footage of elephants charging after our vehicle (Poole and Granli 2021) also indicates that they understood that vehicles use roads, as they anticipated our movements, using short cuts in attempts to cut us off.

In the Mara ecosystem, we filmed young elephants repeatedly rumbling "Let's–Go" (based on classification in Poole 2011 and *The Elephant Ethogram*) as they waited for their matriarch to initiate movement out of the Conservancy, which she did only at dusk once she had determined that the sounds of Maasai herders (cowbells and voices) had moved back to their settlement. Through such daily demonstrations, young elephants likely learn from older family members to navigate their increasingly human-populated world, leading to behavioural variants in which some humans, are tolerated and others not.

While elephant populations may exhibit particular responses to humans, these may change over time if individuals learn that all or certain groups of humans are no longer a threat. In Amboseli NP, we were charged by immigrant families on initial encounters with them (JP, pers. obs., 1980s). Thereafter, they learned, presumably by watching resident herds, to respond to vehicles as members of their adopted population did. In Manyara, Tanzania, Douglas-Hamilton (1972) observed that many families were initially unapproachable, either charging or running away when hearing his Land Rover engine, but over time most became habituated.

The elephants of Gorongosa NP offer an opportunity to examine the embedded behavioural reactions to humans in a population that has suffered extreme disruption and trauma caused by the mass killing of elephants during a civil war. In 1972 Gorongosa NP held ~2,200 elephants ranging across 3,674 km^2 of protected habitat (Tinley 1977). In the greater Gorongosa ecosystem, including the surrounding area and the Marromeu area of Zambezi River delta, there were an estimated 6,000 elephants (Tinley 1977). In 1977 a 15-year civil war began, during which hostilities raged in and around Gorongosa NP and >90% of the elephant population was extirpated. Elephants were shot and killed for meat and ivory by both FRELIMO[1] and RENAMO[2] forces, and large quantities of ivory were exported from the area. Animals were particularly affected around areas where forces were stationed for long periods, such as the Park headquarters at Chitengo, from where the core tourist road network stems (Hatton et al. 2001). By 1994 it was estimated that <200 elephants remained (Cumming et al. 1994; Poole and Granli 2022).

In 2004 a public–private partnership was established between the government (Republic of Mozambique) and the Greg Carr Foundation to restore GNP and began to provide elephants and other wildlife with protection and stability. Almost three decades after the war elephant numbers are now beginning to recover (Poole and Granli 2022), but the enduring

consequences of the violence perpetrated are still visible in the markedly changed distribution of elephants (Stalmans and Peel 2020), the prevalence of tusklessness and its' genetic markers (Campbell-Staton et al. 2021), avoidance of roads by elephants during peak game drive hours (Gaynor et al. 2018), and markedly changed behaviour toward vehicles.

Prior to the war, visitors to the Park described the elephants of Gorongosa as "wonderfully relaxed ... absolutely friendly, no fear, no aggression whatsoever" (Jens M. Lucke, pers. comm., January 2018). The Park ecologist, Dr Kenneth Tinley and Lynne Tinley, who lived in Gorongosa NP from 1967 to 1973, reported that they never encountered any untoward aggression by elephants, nor did they hear of any overt aggression (Lynne Tinley, pers. comm., October 2013). Yet, 19 years after the end of the war, when we were invited to Gorongosa NP to gather baseline data on the population, the elephants had a reputation of threatening and charging vehicles. It was generally believed that the dramatic change in behaviour was a consequence of the atrocities that the elephant survivors of the war had experienced.

In this research paper, we suggest that elephant aggression towards vehicles is another legacy of the war. We further argue that the behavioural variants observed in population responses to humans represent different elephant cultures acquired through social learning.

Between 2011 and 2019, authors JP and PG carried out nine field trips to document the status of the Gorongosa NP elephants, to better understand the lasting physical and behavioural scars inflicted by civil conflict, and to provide scientific data to ensure the strategic protection, management, and recovery of the Gorongosa NP elephant population (Poole and Granli 2022). In this study we examined the responses of the Gorongosa NP elephants toward vehicles. We wanted to understand: 1) how context (distance to the elephants, vehicle location on or off the road) influenced the reaction of elephants; 2) whether those who were aggressive were more likely to belong to a particular sex or age class, or were specific individuals; 3) whether particular patterns of aggressive behaviour were exhibited by specific individuals or families; 4) whether there was evidence of behaviour being acquired by younger elephants; 5) whether the number and intensity of aggressive events declined over time; and 6) if the behavioural response of GNP elephants to vehicles was distinct from those of other heavily poached populations. All named behaviours are capitalised and are described in *The Elephant Ethogram* (https://www.elephantvoices.org/elephant-ethogram.html).

Methodology

Study site

Gorongosa NP covers 3,674 km^2 of Sofala Province, Mozambique. Elephants historically ranged throughout Gorongosa NP and the Marromeu area of the Zambezi River delta to the east. After the civil war, the range of the surviving elephants in GNP contracted to the area south of Lake Urema (Fig. 1) in the vicinity of the Urema River and Pungue River, with some venturing into human settlements south of the Pungue.

Within Gorongosa NP, 15 landscape types are recognized, with floodplain grasslands and Acacia–Combretum savannah predominating in the Rift Valley and miombo woodlands occurring at higher elevations to the east and west (Stalmans and Beilfuss 2008). The mean annual rainfall is 700–900 mm, with peak rain falling in December–February, when the floodplains around Lake Urema are inundated (Stalmans et al. 2019). As the dry season progresses, elephants begin to concentrate near two primary permanent water sources: (a) around Lake Urema and along the upper Urema River; and (b) along the lower Urema River and the Pungue River (Fig. 1).

Number of visitors and vehicles in Gorongosa NP

Due to seasonal flooding, Gorongosa NP is typically closed to tourists between December and late March. The road network around the floodplains, the core elephant habitat, usually does not open again for vehicle access until April.

Vasco Galante, the Communications Director of Gorongosa NP, provided us with visitor records from 2006 to 2017. Data for earlier years are estimates as precise figures were not available. Since 2012 tourists have only been allowed to enter the Park in Land Cruisers driven by guides. Test Malunga, the Tourism Manager provided records of the number of tourist vehicles entering the Park for game drives in 2018 and 2019.

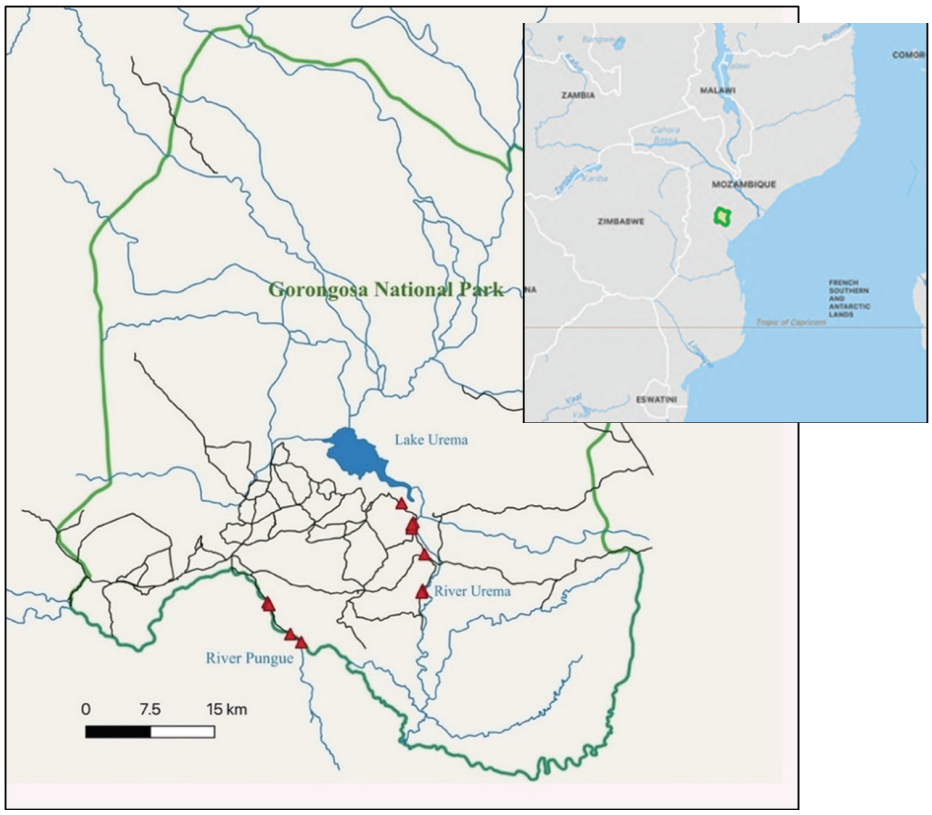

Figure 1. Gorongosa NP [Key: green-Park boundary; blue-Lake Urema, permanent rivers (Urema and Pungue) and seasonal waterways; black-murram roads; red triangles-positions of trail cameras].

While the number of vehicles given in the results do not include those used by NP rangers, management, and researchers, it offers a picture of the seasonal level of activity on the NP road network. The lower numbers in March, April, and May 2019 correspond to Cyclone Idai, which caused the closure of Gorongosa NP for longer than usual.

Sightings, registration and re-identification of elephants and assigning family membership

We searched for elephants as we drove on the network of roads in the south-central section of GNP (Fig. 1). We occasionally drove off-road to observe elephants spotted from the road. The collection of elephant sightings data, registration, re-identification of individuals, and assigning of family membership are described in detail in Poole and Granli (2022). We collected sightings data via the Gorongosa *EleApp* and uploaded the information to the *Gorongosa Elephants Who's Who & Whereabouts Database* (Granli and Poole 2022). The database contains 879 sightings records, collected by the authors (487 records), other scientists (67), park management officers (112), experienced guides (207) and tourists (6). We specify when we relied on subsets of these data. Authors JP and Peter Granli (PG) collected 392 records during nine field trips (between 2011 and 2019), while Jason Denlinger (JD) (2016–2018) and Dominique Gonçalves (DG) (2016–2021) collected data opportunistically as they carried out other duties.

Elephants were grouped according to methods developed in Amboseli (Moss 1996) into the following age classes (estimated years): 0A (0–4.9), 0B (5–9.9), 1A (10–14.9), 1B (15–19.9), 2 (20–24.9), 3 (25–34.9), 4 (35–49.9) and 5 (50+). We refer to individuals aged 0–1 year as infants; 0–4.9 years as calves; 5–9.9 years as juveniles; and 10–14.9 years (or until they gave birth if female or became independent if male) as adolescents.

Scoring vehicle distance and location and elephants' behavioural responses

For each group observed we aimed to note: 1) the group type, family name, and adult individuals identified; 2) whether our vehicle was on or off the road; 3) the estimated distance (metres) we were from the elephants when they reacted and/or we turned off the engine; 4) the behavioural response of the elephants. We used an iPhone Voice Memos app to record the behavioural response of the elephants (Table 2 below). Often the response escalated, e.g. from Vigilance to Advancing–Toward or Charging our vehicle. In these cases, the score used in analyses was the maximum level of either attack or retreat. We had a complete set of these records for 174 encounters.

Since many encounters culminated in elephants charging, the collection of data was often challenging. We have photographic records of most encounters, and many were also filmed. No method is completely accurate, however, when up to 40 elephants are mobbing the vehicle. It is simply not possible to record all behaviour, nor to film or photograph the behaviour of each individual in a big group.

We scored the responses of elephant(s) based on behaviours observed (Table 2) and noted the identity of individuals who instigated or took the lead in a charge. According to convention (Poole and Granli 2021) behaviour names are capitalized and hyphenated if they contain more than one word. Full written descriptions and video examples of all behaviours mentioned and some of the encounters described can be found in *The Elephant Ethogram* (https://www.elephantvoices.org/elephant-ethogram.html) (Poole and Granli 2021).

We stopped the vehicle and turned off the engine as soon as the elephants indicated by their behaviour that they were reacting to our presence. Our aim was to show them that we understood and respected their signals. Exceptions included instances when we were ambushed at high speed while we were driving, whereupon we continued to drive. Once we were stationary, we resolved not to respond when charged. In other words, we aimed not to drive off, start the engine, or cause any kind of disturbance in the vehicle, until the elephants departed. Exceptions occurred, for example, when an elephant head-butted our vehicles.

Analysis of charging behaviour across families and individuals

Analysis of charging behaviour across families included only records in which individuals could be positively identified. Most of these observations were made by JP and PG. Records collected by others were included if: 1) they were of a well-known individual/family; 2) identity could be verified via satellite collar; 3) we were able to obtain photographic or videographic documentation.

We made a special effort to identify the perpetrators of physical attacks on vehicles as this information was important for GNP management. In each case where photographs or videos were available (six out of nine attacks), we were able to identify the

Table 2. Behavioural response to vehicle and scores assigned. Descriptions of key behaviours can be found in *The Elephant Ethogram*

Context	Key behaviours	Score
Avoidance	Panic-Running	-2
Avoidance	Full-Retreat, Retreat-From, Walk-Away, Look-Back, Rear-Guard	-1
No response	No obvious reaction	0
Vigilance	Freezing, Listening, Periscope-Trunk, Ear-Spreading, Bunching	1
Confrontation	Standing-Tall, Head-Shaking, Ear-Folding, Throw-Debris, Kick-Dust, Stand-Guard, Head-Swinging, Chin-Up	
Advance	Perpendicular-Walk, Advance-Toward, Group-Advance	2
Charge	Charge, Group-Charge, Trunk-Bounce, Trumpet-Blast	3
Sustained Charge	Sustained Charge, sustained Group-Charge (>25m)	4
Physical Attack	Push, Tusk, Ram, Head-Butt vehicle	5

aggressor. The extra effort we made to identify elephants who attacked vehicles means that the proportion of charges that ended in attacks in our data represents an overestimate of their relative frequency of occurrence.

In some places in Africa, there is a widely held belief that tuskless females are more aggressive than tusked females. The prevalence of tuskless females in GNP gave us an opportunity to examine whether there is any credence to it. To do so we compared the frequency of charges led by tuskless, one-tusked and two-tusked females born prior to the war to the frequency of occurrence of each tusk configuration type in the same age-sex cohort.

Acquisition of behaviour

We compared Gorongosa NP videographic records held in *The Elephant Ethogram* (https://www.elephantvoices.org/elephant-ethogram; Poole and Granli 2021) of aggressive and vigilant behaviour towards vehicles, to examine acquisition of these behavioural traits by young elephants. We noted which adult female initiated and led each Advance-Toward or Charge and whether she did so alone or was joined in a Group-Advance or Group-Charge by other members of her family (including infants and calves).

We know from our behavioural studies that new-borns instinctively follow the movement of other elephants. Therefore, to better understand the age at which infants (0-<1 year) and older calves (1<5 years) become aware of older elephants' responses to perceived threats and begin to participate in learned behaviour with them, we examined videos illustrating stationary vigilant behaviour only. We examined 22 videos from Gorongosa NP which included examples of Head-Swinging, Chin-Up, Standing-Tall and Periscope-Trunk in response to vehicles. For each video we scored how many adult females, juveniles/adolescents (5<15 years), calves and infants we could see and, of those, how many exhibited vigilant behaviours. Such behaviour was taken to indicate that they had learned or were cognizant that vehicles were perceived as a threat, or that other members of their family had perceived a threat. We then summed up each behaviour over the 22 videos to arrive at a percentage response by each age/sex group.

Response to vehicles over time

We used the sightings in our database as a proxy for the relative exposure of different families to vehicles. Since we made an effort to use the entire road network, including remote tracks, and also made some off-road excursions to look for families photographed by our cameras positioned along the Pungue River (Fig. 1), it is likely that we overestimated the frequency with which some families were exposed to vehicles. Many families were only sighted a few times. To determine whether aggression declined with time, we focused on families whose range fell in the core tourist area and for whom we had >40 sightings during which data on behaviour was collected (families C, I and M). We gave consecutive sightings of each family a matching consecutive number (i.e. first sighting = 1; second = 2, third = 3, etc) and looked at the relationship between the degree of aggression and its occurrence over time.

Since not all members of a family were present on each sighting of the family, we also analysed the behaviour over time of key individuals who, based on our observations, had been among the most consistently aggressive members of the family. Focusing on the sightings of the family in which the selected individual was noted as present, we used the same method.

Comparison with other poached populations

In 1989 author JP carried out rapid assessment surveys of four heavily poached populations: Tsavo East and Tsavo West NPs in Kenya, Mikumi NP in Tanzania, and Queen Elizabeth NP in Uganda, during which JP recorded age, sex and family structure, tusk configuration (Poole 1989b) and response to vehicles. Each of these populations was experiencing, or had recently experienced, heavy poaching, as described above. The response to vehicles data, which were never published, provide a useful basis for comparison with the Gorongosa population. In the previous study, the author noted the distance to which elephants were approached and classified their responses as Retreat, Neutral or Attack.

Contribution towards management

We worked with Gorongosa NP management, guides, rangers, and scientists to promote respectful interactions with elephants to build trust. The management interventions we used have been written up separately (Poole et al. 2023). We also advised Park management that if we found particular elephants to be responsible

for serious aggression we would recommend *against* their removal, in the belief that any such violence would cause a further escalation of elephant aggression.

Results

Visitors to, and vehicular presence in Gorongosa National Park

After a public–private partnership to restore Gorongosa NP was signed in 2004 between the Government of Mozambique and the Greg Carr Foundation, the number of visitors to Gorongosa NP climbed steadily from <1,000 in 2006 to 7,000 by 2011 (Fig. 2). Subsequently, the number of international travellers declined due to a resurgence of civil conflict in central Mozambique, with only 1,312 visitors to Gorongosa NP in 2013. After 2016 visitor numbers began to recover again although in 2019 these were adversely affected by Cyclone Idai (Vasco Galante, pers. comm., September 2022).

The number of tourist vehicles on game drives varies over the course of each year. In 2018 and 2019, for example (Fig. 3), there was little if any vehicular traffic in the Park in December to February, due to seasonal flooding. For more than half the year, November to June, there were only a few vehicles on the road network each day.

Response of family and male groups to vehicles

Of the 849 group sightings in our database of known type (357 all-male groups and 492 family groups, including those with associating males), reactions to vehicles were noted from 505 groups (201 all-male groups and 304 family groups). The responses of these two types of groups were significantly different, with females showing more aggression towards vehicles than males (χ^2 = 124.95, df = 8, n = 505, $p < 0.00001$; Fig. 4). Most all-male groups showed little or no visible reaction to our approach (56% of sightings) or retreated (19%). While 22% of family groups showed no obvious reaction to the approach of vehicles, they were much more likely to engage in vigilance (18%) and to charge (Charge or Group Charge: 20%; Sustained Charge: 8%) or physically attack (Tusk, Push or Head-Butt: 3%) the vehicle. We did not experience any serious Charges by individual males. The few cases in which males Charged (1%) can better be described as Short Rushes, behaviour typical of insecure young males. All of these cases involved males less than 25 years old. A small proportion of groups exhibited Panic-Running and fled from the vehicle (all-male: 4%; family: 4%). It is likely that there were unrecorded groups of both types that retreated when they heard our vehicle approaching in the distance.

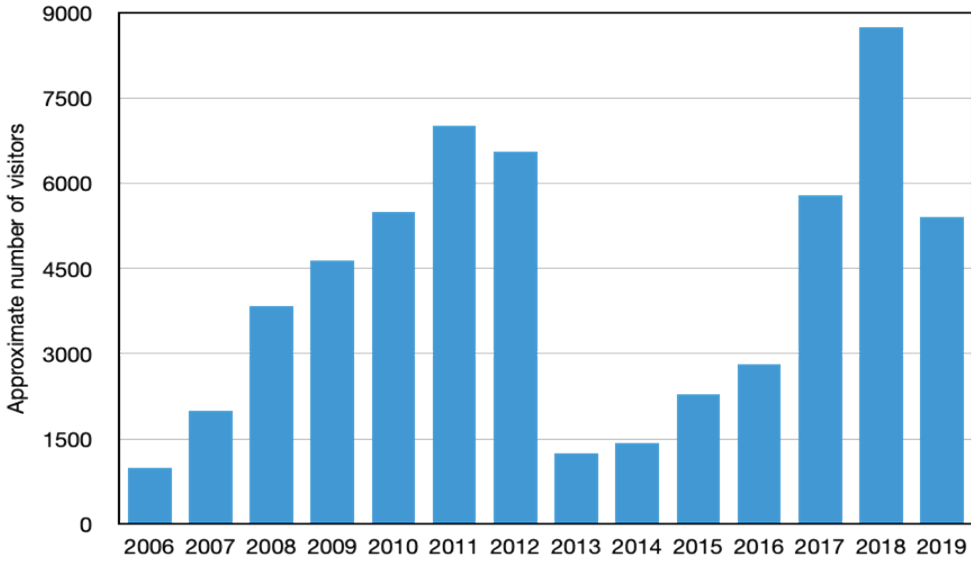

Figure 2. Number of tourists entering Gorongosa NP from 2006 to the end of 2019.

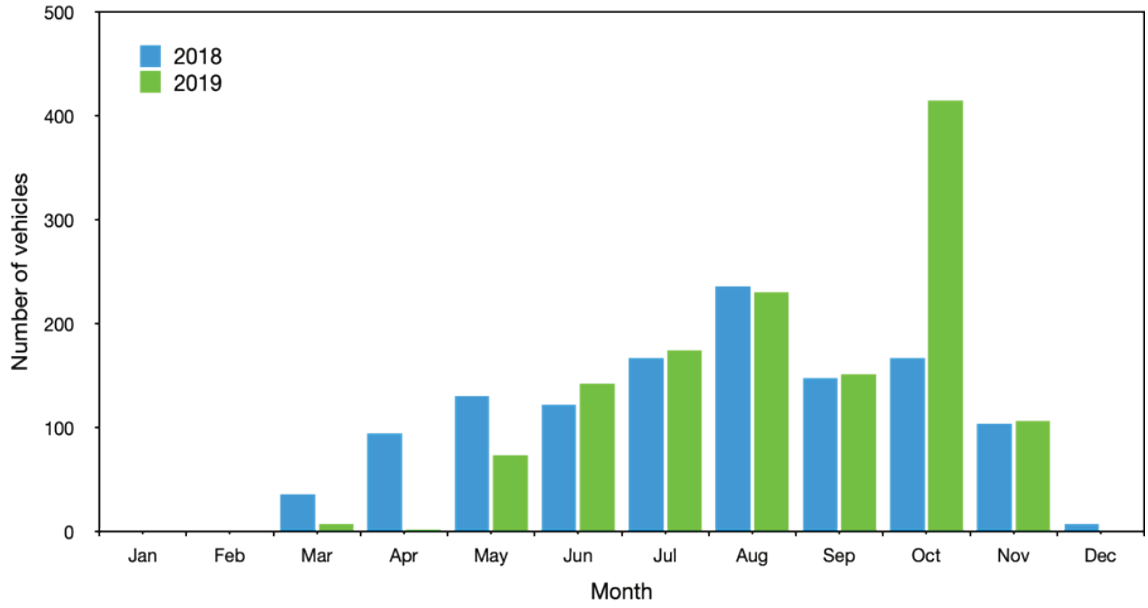

Figure 3. Number of tourist vehicles entering Gorongosa NP for game drives during 2018 and 2019.

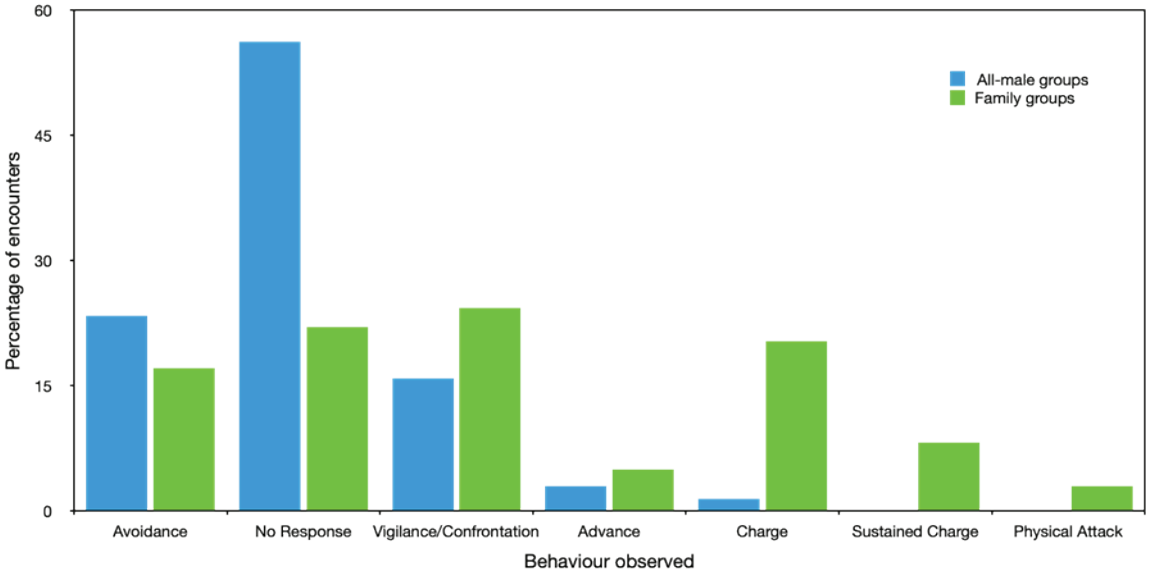

Figure 4. Behavioural responses of family groups and all-male groups to vehicles.

Behavioural response in relation to vehicle distance

Examining only those records of family groups that were characterized by avoidance (Retreat-From or Panic-Running) or aggression (Advancing-Toward or Charging), we found a significant difference in the distance at which elephants retreated from (median: 100 m; interquartile [IQ] range: 60–200 m; range: 10–400 m, n = 33) or advanced upon vehicles (median: 62.5; IQ range: 40–80; range: 20–300, n = 76) (one-tailed Mann–Whitney $U = 692.5$; $n_1 = 33$, $n_2 = 76$, $z = -3.699$, $p < 0.0001$; Fig. 5). The closer the vehicle was to the elephants, the more likely they were to respond with aggression.

Vehicles on and off the road

We found no significant difference in the distance at which family groups took evasive action based on whether the vehicle was on the road (median: 100 m, IQ range: 48–162 m, range: 10–350 m; n = 13) or off-road (median: 110 m, IQ range: 69–200 m, range: 25–400 m; n = 21) (Mann–Whitney $U = 105$; $z = 0.564$, $p = 0.287$). Nor was there a significant difference in the distance at which they advanced upon, charged or attacked based on whether the vehicle was on the road (median: 62 m, IQ range: 48–85 m, range: 20–300 m; n = 49) or off-road (median: 72.5 m; IQ range: 42–80 m; range: 25–120 m; n = 24) (Mann–Whitney $U = 704$; $z = -0.159$, $p = 0.436$; Fig. 6). However, family groups were significantly more likely to retreat if the vehicle was off-road and more likely to advance if the vehicle was on the road ($\chi^2 = 5.3$, df = 1, n = 110, $p = 0.02$; Fig. 7).

Patterns of aggression across family groups

Almost a third of all encounters with families in which behavioural responses to the vehicles were noted (n = 303) involved Charges (n = 94) at the vehicle. Aggressive behaviour was a widespread response to vehicles across most families, although some families (Fig. 8), and some individuals within families, were notorious. Of 279 encounters in our database in which families were identified, aggressive behaviour was documented in 202 cases. Of these, 74 involved Charges, of which 22 were sustained Charges and six culminated in a female Head-Butting and damaging a vehicle. Some families were well known for engaging in highly coordinated Group-Advances and Group-Charges, while in other families the matriarch or another adult female specialized in sustained lone Charges or in demonstrative Perpendicular-Walks or specific idiosyncratic defensive behaviour.

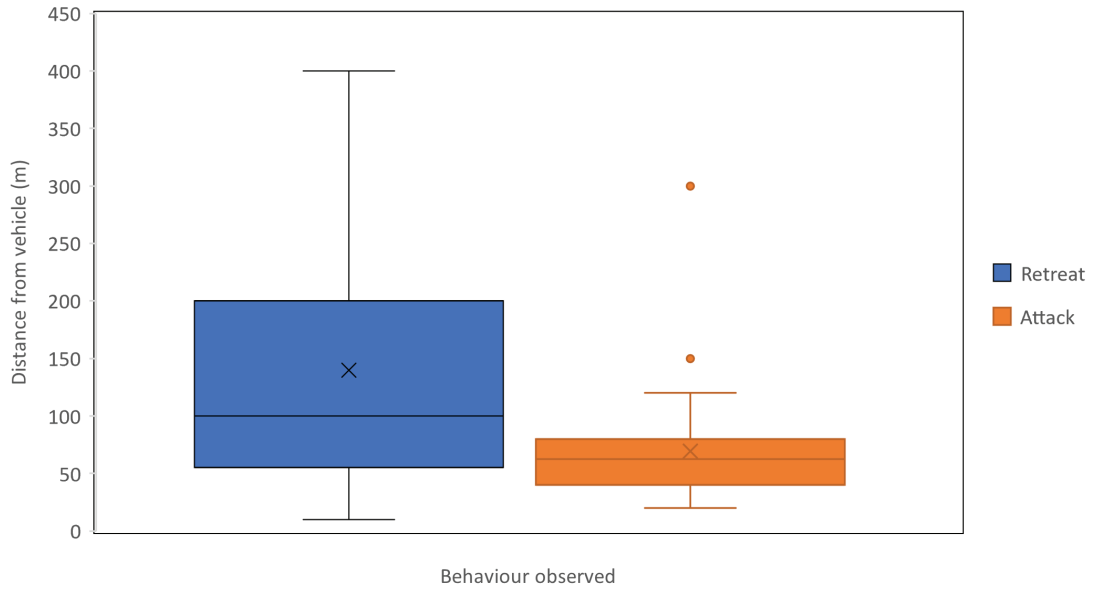

Figure 5. The median distance from the vehicle at which family groups retreated or attacked. In the box-and-whisker plot, the horizontal lines in the boxes are medians, the upper and lower edges of the boxes show the interquartile range, the whiskers indicate the range and the x mark the means.

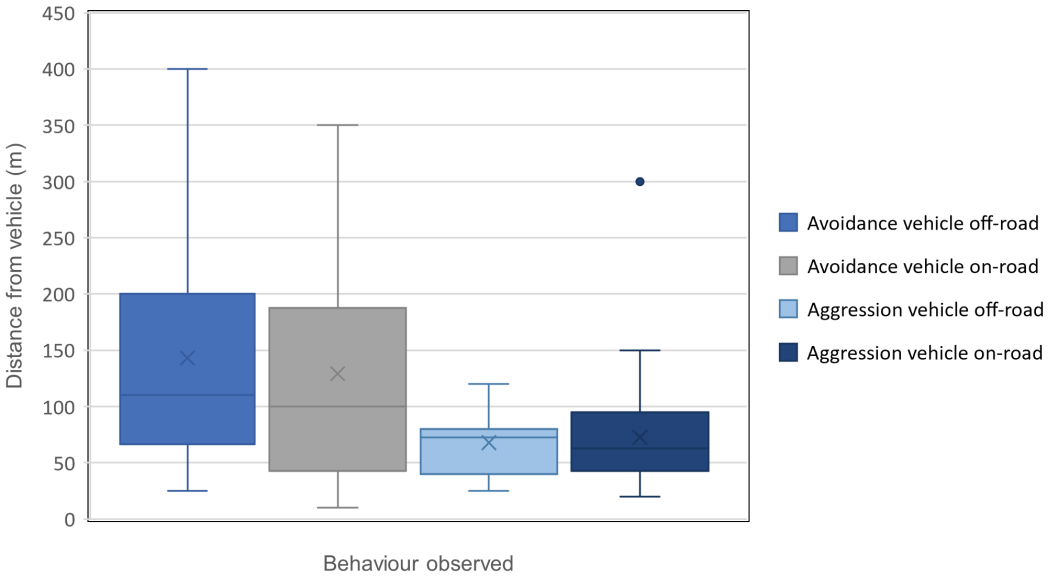

Figure 6. The median distance at which elephant family groups took evasive or aggressive action in response to the presence of vehicles overall, and whether our vehicle was on or off the road. The components of the box-and-whisker plots are the same as in Fig. 5.

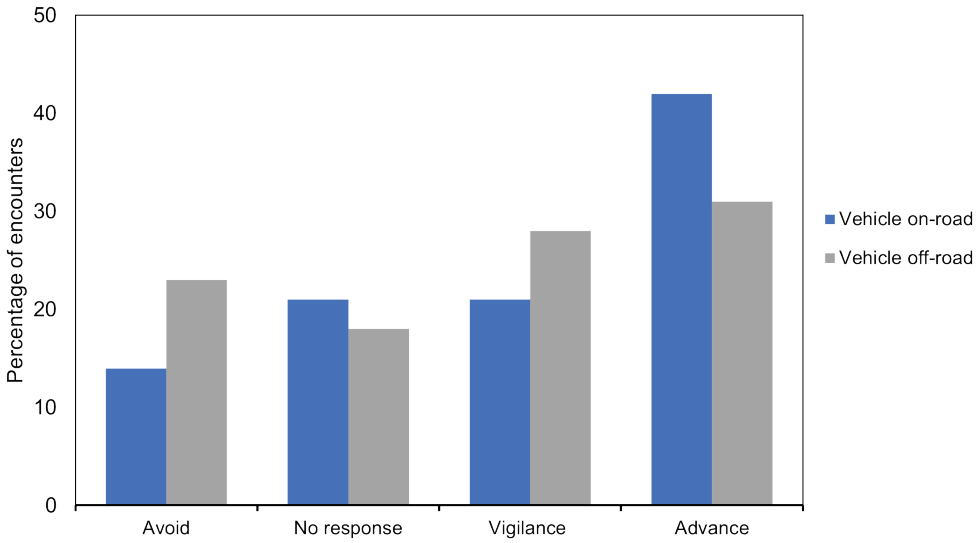

Figure 7. Responses of family groups in on-road and off-road encounters.

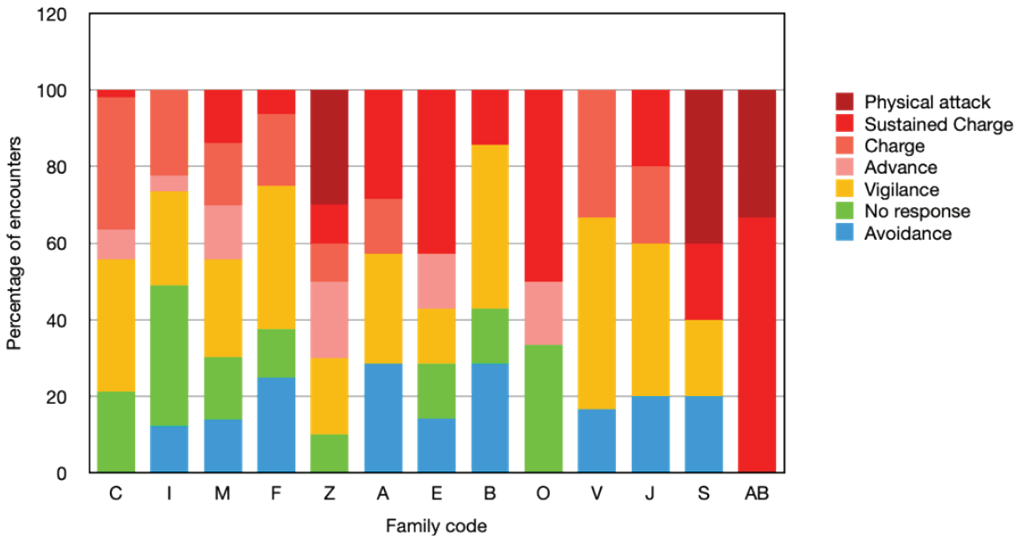

Figure 8. Frequency of different defensive behaviours in encounters with family groups. The number of times each family was observed and behaviour documented is given above each column.

Physical attacks on vehicles

Between 2010 and 2017 there were nine incidents in which an adult female physically attacked a vehicle. The individuals involved and the behaviour observed are summarized in Table 3. Only one of these attacks was carried out by a tusked female. In six of the nine incidents, we were able to identify the attacking elephant from videos and/or photographs that were taken. Three matriarchs carried out the six attacks, each of whom was observed very infrequently during the study: Zira (4 encounters), Stephanie (5) and Akashinga (3). From a tourism and safety perspective, the most problematic individuals were those from families that were encountered rarely because their core area was not in the primary tourist circuit. There have been no reported attacks on vehicles since 2017 (Test Malunga, pers. comm., February 2022).

Age, tusklessness and individual personality

Not all adult females initiated or led Charges; indeed, most did not. Those elephants who did tended to be matriarchs or older females (Fig. 9), the vast majority of whom would have been alive during the war.

Contrary to widely held beliefs by local people, there was no indication that tuskless females were more likely to Charge than two or one tusked females. Among the cohort of females who were born before the war, 24 were tuskless, four were one-tusked and 12 were two-tusked, while of the 21 individuals of this group who were recorded leading Charges 11 were tuskless, four were one-tusked and six were two-tusked ($\chi^2 = 1.01$, df = 2, n = 61, p = 0.60).

We were threatened and Charged regularly and, in many cases, multiple times by the same individual. With time we noticed that some individual elephants adopted idiosyncratic patterns of behaviour, such as exaggerated postures or particular Charging styles; likewise, some families appeared to specialize in particular strategic group manoeuvres and these we viewed as family traditions. In Table 4 we summarize some of these patterns.

Acquisition of behaviour

Older females, in particular those who survived the war, disproportionately took the lead role in defensive behaviour and in initiating and leading charges (Fig. 9). Yet reactions to vehicles involved most family members at some level, at the very least as agitated and sometimes vocal spectators, or more often, as fully engaged participants. Of the charges (n = 16) and advances (n = 9) by Gorongosa females that are publicly documented in *The Elephant Ethogram* at the time of writing, (Poole and Granli 2021) all involved responses by other members of the family. While the most actively engaged were other adult females; juveniles, calves and even infants also participated. Of these 25 charges and advances, 17 involved the entire

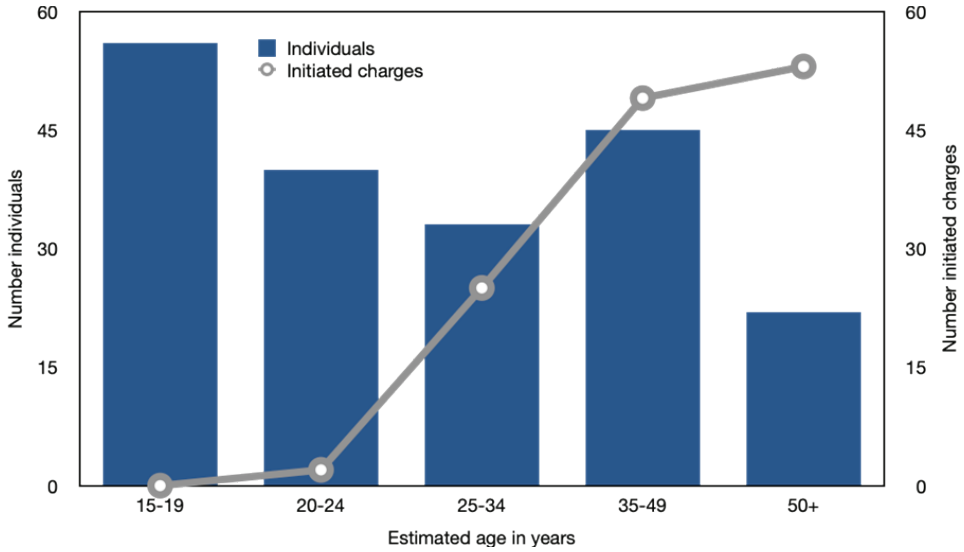

Figure 9. The number of registered females by age class and the number of times individuals of each age class took the lead role in charging.

family (including small calves) following the initiator in the charge or advance. In the instances they did not follow the leader they remained bunched and vigilant awaiting her return. During Group-Advances and Group-Charges calves rushed at the vehicle alongside their mothers (e.g. Fig. 10d), whereas when a single female charged, her calves remained Bunched with the rest of the family.

Vigilant behaviour was typically initiated by an adult female and quickly adopted by other members of the family, who were either also aware of the perceived threat or were alerted by the behaviour of the initiator or by other family members. We found that once one elephant exhibited vigilant behaviour all other adult females present followed suit, while the likelihood of immature elephants responding depended on their age (Fig. 11). Older juveniles were significantly more likely to exhibit vigilant behaviour in response to adult behaviour than were younger juveniles ($\chi^2 = 25.24$, df = 2, n = 101, $p < 0.001$). Ninety percent of adolescents/juveniles responded appropriately (n = 40), 68% of calves (n = 37), while only 29% of infants (n = 24) responded with appropriate vigilant behaviour, suggesting that individuals gradually acquired knowledge about danger in a social context.

Response to vehicles over time

To see whether the degree of aggressive behaviour declined with exposure to vehicles, we examined the behaviour of three families whose range fell in the core tourist area and had been observed most frequently (C, I and M). While all three families showed a negative correlation (C family: Spearman Rank Correlation $r_s = –0.216$, $p = 0.123$, n = 52; M family: $r_s = –0.198$, $p = 0.240$, n = 37), only the I family showed a significant decline in aggressive behaviour over time ($r_s = –0.438$, $p = 0.003$, n = 43). These results, however, reflect the behaviour of the family as a whole, while aggression was typically instigated and carried out by specific individuals who might or might not have been present when other family members were sighted. Each of these families contained an individual, or individuals, who stood out from the rest as being most likely to instigate and carry out aggressive behaviour. These were: *Corajosa*, *iJunia* (matriarch), and *Mwana Nzo*. When we included only the observations and behaviour of the families when these individuals were known to be present we found that both *Corajosa* and *iJunia* exhibited a significant decline in the degree of aggressive behaviour over time (*Corajosa*: $r_s = –0.407$, $p = 0.039$, n = 26; *iJunia*: $r_s = –0.577$, $p = 0.015$, n = 17), while *Mwana Nzo* did not ($r_s = –0.251$, $p = 0.236$, n = 24).

Table 3. Recorded physical attacks by elephants on vehicles, including those of the authors (pax = passengers)

Date	Occupants	On/off-road	Age, sex, tusks	Elephant	Notes
2010	Guide, ~5 pax	On	Adult female, tuskless	Zira	Charged and Head-Butted side and bonnet of Land Cruiser and knocked it onto its side into a ditch.
2012	Film crew, 6 pax	On, but drove off around fallen tree	Adult female, tuskless	Unknown, no photos	Dusk, did not see elephants in forest. As filmmaker drove around fallen tree female Charged and Head-Butted front fender and blew tyre off rim; she paused as warning shot was fired by ranger; Charged again and Head-Butted bonnet and roll cage, pushed Land Rover back into tree. Stood-Guard over vehicle and Charged again while tyre being changed.
2013	Building contractors, 2 pax	On	Adult female, 2 tusks	Unknown, no photos	Charged pickup and pushed tusk through passenger window and seat, and back through pickup cab window.
2013	Park manager, Film crew, 4 pax	On	Adult female, tuskless	Zira	Waiting on road as manager drove Hilux around bend. Charged from 15–20 m and Head-Butted bonnet and smashed front windscreen. Stepped back and Head-Butted vehicle again. For the third time Head-Butted driver's side and tried to push Hilux off road. Backed up 15–20 m, then turned and departed.
2016	Guide, 5–6 pax	On	Adult female, tuskless	Zira	20+ elephants Group-Charge, rumble and trumpet which alerted matriarch, Zira, who ran to them from 120 m away. Paused in trees behind family and then initiated attack with a Perpendicular-Walk and a 50 m Charge followed half-way by family. Head-Butted back of open Land Cruiser several times. A tourist jumped out of vehicle and hid in bushes.
2016	Scientists, (DG, JD), 3 pax	Off	Adult female tuskless	Stephanie	Charged from 80 m, paused at 20 m, Charged again. Head-Butted bonnet and left fender and smashed window, tried to flip Land Cruiser.
2016	Scientists, 3 pax	On	Adult female, tuskless	Unknown, no photos	Charged from 100 m, paused 1 m from car, walked around it, went back into forest. Returned Charging then shuffled toward vehicle, got down onto knees and Head-Butted the bonnet of the vehicle three times lasting about five seconds. Stood-Guard for 30 minutes and then Charged again chasing car down road for 15 seconds.
2017	Scientists, 2 pax (JP, PG)	On	Adult female tuskless	Akashinga	Solitary Charge from 200 m, paused on road in front of the open Land Cruiser before crossing track to the other side. Hid behind tree peering out with one eye and then the other. Charged again, from 25 m then shuffled toward the Land Cruiser, lowered body and head and Head-Butted bonnet and right fender for ten seconds. Put trunk under vehicle as if to flip. Sustained Charge of 300 m as we drove away.
2017	Guide, ~5 pax	Off	Adult female tuskless	Stephanie	Driving off road. Family group seen running then Stephanie charged from 70 m with family following. Paused at 20 m. Led family away, engaged in Rear-Guard, retreated to 70 m. Charged with family following and Head-Butted side of open Land Cruiser for 20 seconds; got head inside vehicle with tourists, damaged middle back seat of vehicle and was in contact with several people who sustained bruises from her or from falling out of vehicle on other side.

Table 4. (a) Typical and idiosyncratic defensive behaviours of some adult females (and see Fig. 10). (b) Defensive family traditions. An explanation of capitalized behavioural terms can be found on *The Elephant Ethogram*

Family (no. of individuals)	Name (age class)	Leadership status (when applicable)	Tusks	No. of sightings (no. of times as leader of aggression)	Typical defensive behaviour (% aggressive incidents in which behaviour observed)
	a. Examples of individual or idiosyncratic defensive behaviour				
I (30–35)	*Iphigenia* (4)	Led sub-group	2	13 (6)	Highly dramatized Perpendicular-Walk with Chin-Up (100%; Fig. 10b), Stood-Guard, Charged in short bursts.
	Iria (4)	Led sub-group	0	38 (1)	Peaceful, relaxed female. Very little reaction from her and her sub-group when approached beyond some vigilance (97% of sightings).
C (35–40)	*Camilla* (4)		0	22 (3)	Placed herself between family and vehicle and Stood-Guard over vehicle for long periods. Threatened us if we made a move (66%); engaged in short Charges (100%).
	Corajosa (3)		0	33 (15)	Uppity agitator. Charged frequently and incited others present (100%).
M (34–40)	*Provocadora* (5)	Matriarch (previously)	2	13 (5)	Instigator, until her death in 2014. Initiated aggression with purposeful Perpendicular-Walk signalling to *Valente*, *Mwana Nzo* and *Marcela* (see below) to take over with a coordinated Group-Advance or Group-Charge (80%).
O (10)	*One Tusk* (5)	Matriarch	1	10 (5)	Engaged in sustained solitary Charges (80%) up to several hundred meters; returned at run to vocalize and 'High-Five' (see Fig. 10 legend) with waiting family.
A (20–25)	*Ambuscadora* (4)		2	4 (3)	Ambusher. Burst out of the forest at high speed, sustained Charges of up to several hundred meters (100%), gave Trumpet-Blasts and punched ground with audible Trunk-Bounces (75%).
S (15)	*Stephanie* (5)	Matriarch	0	5 (3)	Very aggressive; engaged in sustained Charges (100%). Once led wall of 25 elephants in sustained 100 m Charge (Fig. 10d). Damaged two vehicles following sustained Charges (See Table 3).
ab (20–25)	*Akashinga* (4)	Matriarch	0	3 (3)	Very aggressive (100%). Charged from long distance (>150 m; 66%) and chased vehicles for up to 300 m (66%). Charged and then lowered head, pounded ground with Trunk-Bounces (66%); once came within <1 m of hitting vehicle, and on another occasion Head-Butted a vehicle (see Table 3).
Z (25–30)	*Zira* (5)	Matriarch	0	4 (4)	Very aggressive. (100%) Attacked three vehicles (see Table 3) and almost hit the vehicle on a fourth occasion.
	b. Examples of defensive family traditions				
M (34–40)	*Valente* (5)	Matriarch (current)	2	37 (10)	In response to *Provocadora*'s instigation (see above) and, after her death, of their own volition, these three engaged in highly coordinated and sustained Group-Advances and Charges (91% of 11 sightings when aggression occurred and all three were noted as present); one lasted eight minutes during which they alternatively shared the lead, as if in relay race. Typically, the entire family of 34 individuals participated. Often Coalitions began with, and successful.
	Mwana Nzo (4)		0	35 (14)	
	Marcela (4)		2	20 (8)	Group-Advances/Charges were celebrated with, loud vocalizations and 'High-Fiving' between the lead females (n = 9; Fig. 10c). *Mwana Nzo* was notorious. She was most vigilant, typically took lead alerting *Valente* of trouble. She was backed up by *Valente* and *Marcela*.
I (30–35)	*iJunia* (5)	Matriarch	0	27 (6)	Presumed mother and daughter look-alikes who postured, gestured with heads and trunks, and moved in such remarkable synchrony as if choreographed (100% of four sightings when aggression occurred, and both were present; Fig. 10b). Toward the end of the study a third, younger female participated.
	Isabella (4)		0	21 (4)	

Figure 10. Some females adopted idiosyncratic defensive behaviours and some families appeared to have defensive traditions. (a) *Iphigenia* adopts an exaggerated Perpendicular-Walk; (b) *iJunia* and daughter, *Isabella*, move in synchrony; (c) *Valente* and *Mwana Nzo* engage in a 'High-Five' (heads raised, open mouths, trunks entwined in victory) after a Group-Charge and as they prepare again to see us off; (d) *Stephanie* and *Berta* lead a sustained Group-Charge as calves and infants join in (© *Joyce Poole*)

Comparison with other poached populations

The four heavily poached populations surveyed in 1989 (in Kenya, Tanzania and Uganda) differed from each other and from the Gorongosa population in their response to our vehicle (Fig. 12). In the open habitat of Uganda's Queen Elizabeth NP, the majority of the population moved in one semi-permanent aggregation of 170 elephants (observed for four days) and permitted close approach (~30–40 m). In Tanzania's Mikumi NP, where the habitat was generally denser, many of the remaining elephants sought safety near the lodge and Park headquarters in small fragmented and orphan groups. They permitted approach to a median distance of 150 m (IQ range 97–200). In the mixed open savannah bushland of Tsavo East NP and Tsavo West NP in Kenya, elephants were more likely to Retreat-from or Panic-Run from vehicles sometimes from up to a kilometre away. In both populations the median distance we observed elephants was 200 m (IQ range: Tsavo East NP 150–350; Tsavo West NP 100–500). While the response pattern of Tsavo East NP and Tsavo West NP was similar, the groups in Tsavo West NP were twice as likely to Panic-Run than those in Tsavo East NP. At the time of the 1989 survey, heavy poaching was ongoing in Mikumi NP and in Tsavo NPs and had only recently declined in Queen Elizabeth NP. The Gorongosa elephants lived in the densest habitat and were the most likely to respond aggressively to vehicles, despite poaching having ended decades previously.

Discussion

In 1972, prior to the Mozambican civil war, 22,000 tourists visited GNP. Those who lived there or visited Gorongosa NP at that time agreed that the

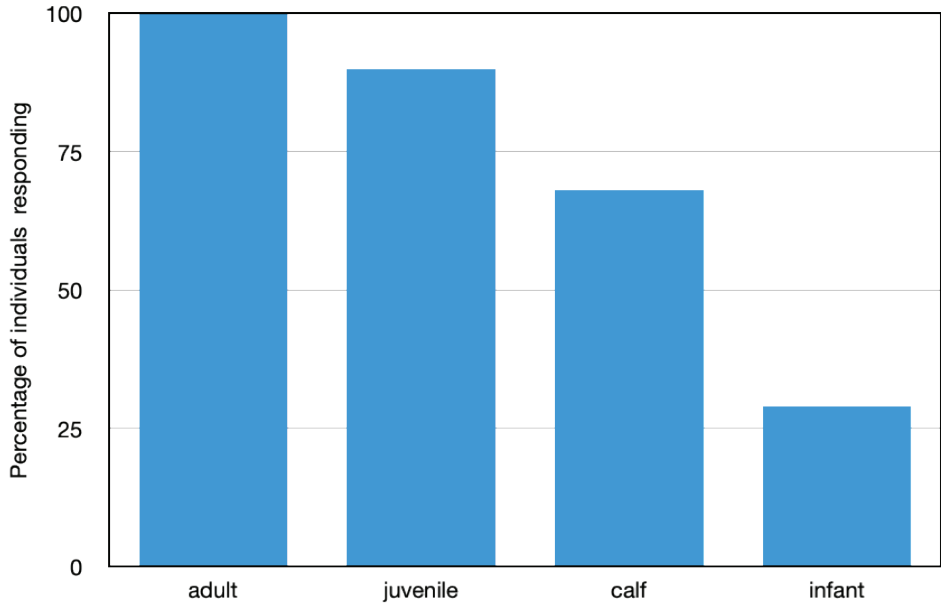

Figure 11. Frequency of vigilant behaviour by differently aged family members in response to adult female behaviour; scored from 22 videos illustrating the following stationary vigilant behaviours: Head-Swinging, Chin-Up, Periscope-Trunk, Standing-Tall. The number of individuals observed in the videos are listed above each column.

elephants were calm and unaggressive. In 1977 Mozambique entered a 15-year civil war during which hostilities raged in and around Gorongosa NP and >90% of the elephant population were killed by soldiers hunting for meat and ivory with automatic weapons. After the war until about 2016 there was subsistence bushmeat snaring in Gorongosa NP. Despite human activity, however, records indicate that human-induced elephant mortality was relatively low (Poole and Granli 2022).

Nineteen years after the war ended, when we began our study, the elephants were highly aggressive. The war had imposed a 'landscape of fear' for elephants causing them to abandon huge areas of the Park (Stalmans and Peel 2020) and to adjust their behaviour, avoiding roads where they might expect to encounter humans (Gaynor et al 2018). Elephants often appeared vigilant in photographs captured by our trail cameras placed along the Pungue River (Fig. 1), where they might expect to meet people.

We found aggressive behaviour towards vehicles to be common, although almost exclusively among females and family groups. Several factors affected whether a family in Gorongosa NP charged, including the distance between the vehicle and the elephants, whether the vehicle was on or off the road, and the age and personality of the matriarch or other lead females. The closer the vehicle, the more likely family groups were to act with aggression. Furthermore, they were more likely to respond aggressively if a vehicle was on the road, and to retreat if it was off the road. The vehicle's speed, the noise it or its occupants created, and the respectfulness of their approach, may also have been factors. Furthermore, the response of some drivers to depart in haste when threatened may also have stimulated elephants to charge and chase vehicles.

The dense vegetation in Gorongosa NP meant that the presence of elephants was often not detected until a vehicle was upon them. Since elephants were more likely to respond with aggression when vehicles were on roads and in close proximity, the lack of visibility meant that one could come upon elephants unexpectedly, some of whom became confrontational. We know from our camera trap study (Gaynor et al. 2018) that, generally, elephants actively avoided roads during game drive hours when they expected vehicles to be present. We also know from our audio recordings from Amboseli (JP), and from our observations of elephants in Tsavo West NP, that elephants can detect

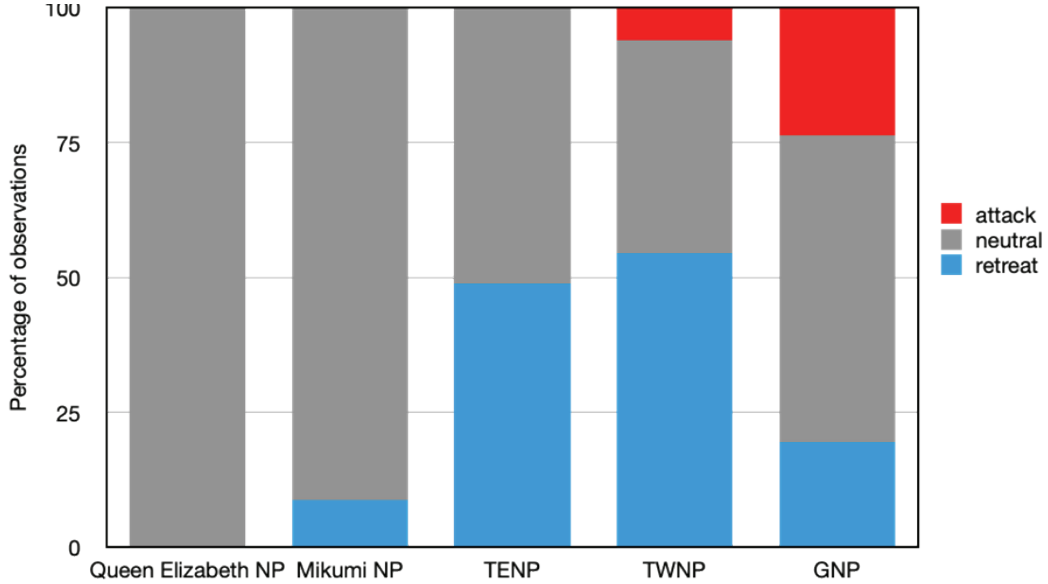

Figure 12. Responses of elephant groups to vehicles in several heavily poached populations illustrating the distinctive patterns of response. The numbers at the top of each column refer to the number of groups observed (parentheses = total number of elephants observed).

the sound of vehicles from up to 1.5 km away. This begs the question: If elephants could hear or feel us coming, why didn't they move further away so as to avoid confrontation? While we were likely unaware of the departure of some elephants due to the dense habitat, aggressive behaviour was remarkably prevalent given the elephants' ability to avoid us if they wanted to. It is quite possible, even probable, that some individuals were seeking confrontation. Indeed, our data showing that elephants were more likely to attack when vehicles were on the road suggest that some individuals may have been waiting for us.

It is also possible that elephants just did not want to move. Examining the situation from an elephant's perspective, since they knew when vehicles were approaching, they may have assumed that *we also knew that they were present*. If so, they may have wondered why we were being so provocative. While this is pure conjecture, when dealing with an intelligent social animal capable of empathy (Bates et al. 2008), reasoning and coordinated planning (Poole 2011), it is unwise to discount such possibilities when searching for solutions to conservation problems.

Although eight of the nine attacks on vehicles were by tuskless females, the widely held belief that tuskless females are more aggressive than tusked females was not born out by the overall data on aggression. Among the older cohort of females who were born before the war there was no indication that tuskless females were more likely to Charge than two-tusked or one-tusked females.

Personality, idiosyncratic behaviour, and family traditions (Fragaszy and Perry 2003; Whiten 2017), where two or more individuals from the same family engaged in distinctive defensive behaviour that persisted through time, all played a role in the overall culture of aggression that characterized the Gorongosa population post-civil war. Some individual females were more aggressive than others. Others adopted specific idiosyncratic defensive behaviours, or routines, that were repeated and could be expected of them. For example, extreme postures or actions (e.g. exaggerated Perpendicular-Walk, exaggerated Standing-Tall), manner of Charging (e.g. ambush, sustained lone Charge, Charge in short bursts), Standing-Guard over the vehicle, attempting to cut it off by taking short cuts, or by using a Perpendicular-Walk to instigate other members of the family to mob the vehicle (Poole and Granli 2021 and *The Elephant Ethogram*). Family traditions included, for example, highly synchronized "mirroring" of movement among closely bonded members of a family; engaging in

'High-Fiving' during initiation and conclusion of highly coordinated and strategic mobbing; and the tendency of others to hold back while their leader engaged in a sustained lone Charge. The existence of family traditions, that persisted over time and involved the addition of new practitioners, suggests that elephants are learning distinctive defensive behaviour from one another (i.e. via social learning). Such behaviours are likely to be established through the example of older females.

Young Gorongosa elephants learned defensive behaviour in the context of their families. While older females disproportionately took the principal role in initiating and leading Advances and Charges, 68% of these events involved the entire family following the initiator. During Group-Advances and Group-Charges, calves rushed at the vehicle alongside older females. While very young elephants likely learned to view vehicles as a threat in this social context, it is also true that they might have simply been running to stay close to their mothers without being cognizant that they were engaging in mobbing. However, the fact that calves remained with other members of the family when their mother engaged in a lone Charge, suggests learned behaviour, as did the acquisition of vigilant behaviour directed at vehicles.

Vigilant behaviour was typically initiated by an adult female and quickly adopted by other members of her family, who were either also aware of the perceived threat or were alerted to it by her or others' behaviour. We found that once one elephant exhibited vigilant behaviour, all other adult females (100%) present followed suit, while the likelihood that immature elephants did so depended on their age, with infants and calves sometimes apparently unaware of the concerns of their elders, attempting to suckle as their mothers threatened the vehicle. Ninety percent of juveniles and adolescents, 68% of calves and only 29% of infants engaged in vigilant behaviours when adults were vigilant.

The increase in the expression of vigilant behaviour with age supports the argument that young elephants learn from their elders to be aggressive toward vehicles. The pattern of aggression we observed among Gorongosa elephant families led by survivors of civil war is a long-term consequence of the trauma these individuals experienced as calves. With these individuals now acting as role models (Bates et al. 2010), the participation of their daughters and granddaughters is evidence of the transfer of behaviour across generations and families creating an elephant culture of aggression. Thirty years after the end of the war, during which the levels of recorded human induced mortality have been very low (Poole and Granli 2022), infant elephants are still learning to respond to vehicles with aggression.

Our data suggest that while the level of aggression exhibited towards vehicles by well-known families and particular individuals is decreasing, change is extremely slow. The process of habituation is hampered by several factors including: relatively few visitors to the Park, only a small part of the Park being accessible by road, and the core tourist section being subject to annual flooding and closed to traffic for a third of the year. Thus, the opportunity for individual elephants to learn that vehicles no longer present a threat is low, even for the minority of families whose core range lies in the vicinity of the primary road network (Poole and Granli 2022).

As we document in this paper, elephant behaviour toward humans varies among populations, presumably due to environmental differences and unique historical experiences, and because individuals learn from one another in a social context. In other words, we argue, elephant populations develop different culturally learned behavioural variants. Of relevance to conservation are questions such as: How long does it take for such behavioural variants to become established, or be modified, and through what transformative processes? Furthermore, are there management interventions we can adopt to facilitate change in a desired direction?

In Pilanesberg NP, South Africa, for example, the unwanted behavioural variant involving the killing of rhinos by young males in musth was halted by the introduction of higher-ranking male role models (Slotow et al. 2000).

In Amboseli NP, despite increasing human, livestock and elephant numbers, there is now more tolerance between people and elephants encouraged by an intervention implemented through the Amboseli Trust for Elephants that involves consolation payments for livestock killed in exchange for a pledge not to retaliate by spearing (Sayialel and Moss 2011).

In Gorongosa NP, we recognized that the culture of aggression was caused by the elephants' traumatic history. As a Park management intervention, we

collectively promoted consistent respectful interactions with elephants to allay their fears and to build trust (Poole et al 2023). Although we have documented a decline in the frequency of severe aggression, with no physical attacks on vehicles since 2017, and a decline in the frequency of charging behaviour among specific individuals, we cannot prove that this is a direct result of our management intervention. As long as hostilities do not resume, however, we believe that the elephants' culture of aggression will gradually abate as the number of responsible visitors increases and the road network is expanded, and as elephants learn from one another that vehicles are not a threat.

Elephants have been killed by humans at least since the Palaeolithic era (Agam and Barkai 2018). We would argue that the elaborate, flexible, and strategic behaviours and gestural and vocal communication exhibited by elephants in their complex anti-predator reactions (Poole and Granli 2021) are likely an adaptive response shaped, in part, by confronting these cunning human predators over millennia.

In recent centuries, however, the use of modern weapons and sophisticated technology in the targeted mass killings of elephants has resulted in populations that exhibit hyper-aggression, extreme fear, abnormal behaviour and impaired decision making (Bradshaw et al. 2005; Slotow et al. 2000, 2008; Shannon et al. 2013). Furthermore, because elephants learn in a social context, particular behavioural responses to traumatic events or historical experiences can be transmitted through groups to give rise to culturally learned behaviours that persist over time and generations. Our assessment is that witnessing the slaughter of other elephants during the Mozambican civil war caused the aggressive and fearful patterns of behaviour, giving rise to the different family traditions and the population level cultural variant that we observed among the Gorongosa elephants.

Our findings indicate that the flexibility of elephant behaviour (Poole and Granli 2021) combined with their ability to learn in a social context (Bates et al. 2010; Chiyo et al. 2012), can result in distinct culturally learned behavioural variants in response to a range of anthropogenic threats and differing environmental circumstances. Such variants are exemplified by the behavioural patterns we observed in Gorongosa NP, Queen Elizabeth NP, Mikumi NP, Tsavo East NP, Tsavo West NP and Maasai Mara NR and further supported by studies in Amboseli NP (Bates et al. 2007; McComb et al. 2014), Pilanesberg NP (Slotow et al. 2000) and elsewhere.

Behavioural variants can have implications for elephant conservation and management, with potentially negative ramifications for human–elephant co-existence as well as for revenue streams from tourism. Furthermore, elephants who put considerable time into avoiding or attacking humans are using energy that could otherwise be spent on survival and reproduction (Brakes et al. 2021). Since cultural variants may affect the viability of populations, our ability to recognize and adapt management interventions to them (Sayialel and Moss 2011; Slotow et al 2000; Poole et al 2023) will impact the results of conservation efforts focused on this endangered species (Brakes et al. 2021).

While the elephants of Gorongosa NP are, at least numerically, on the road to recovery (Poole and Granli 2022), many populations of traumatized elephants are less fortunate. Given rapid environmental change, increasing contact between elephants and people, and the extreme losses caused by poaching and armed conflict, a better understanding of the role culture plays in the response of elephants to people is urgently needed. Conservation and management strategies may have to be adapted to meet the changing cultures of specific elephant populations.

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MANAGEMENT

All aboard the 'Elephant Express', a practical solution for human-elephant coexistence

Anna Songhurst[1], Makata Baitseng[1], Jennifer S Lalley[2], Sarah Lupton[1], Maipelo Molatlhegi[1], Ohitiseng Mosupi[1], Ipelefatso Nkalolang[1], Botshelo Sensinyi[3], Amanda Stronza[1,4], Tracey L Taylor[1], Kurt Holle[1,5], Graham McCulloch[1]*

[1]Ecoexist Trust, Gusu Camp, Kachirachira, Botswana
[2]Natural Selection Conservation Trust, Maun, Botswana
[3]Okavango Community Trust, Seronga, Botswana
[4]Texas A and M University, Texas, USA
[5]WWF, Lima, Peru

*corresponding author: fielddirector@ecoexistproject.org

Abstract

One of the most significant challenges for elephant conservation is managing negative interactions that occur where people and elephants use the same space and compete for resources. Human–elephant conflict (HEC) incidents often manifest as direct impacts to humans or elephants. However, some HEC situations result in long-term risk and chronic stress among communities living with elephants. Indirect impacts or opportunity costs, such as people being disadvantaged by the presence of elephants are harder to quantify and are not often addressed. In the eastern Okavango Panhandle, in northern Botswana, about 17,500 people share space and resources with 18,000 elephants in an area of 8,700 km^2. Elephants here use distinct, historical corridors on a daily basis, moving from dryland resources to the wetlands of the Okavango Delta. Confrontations with elephants occur most frequently where these elephant corridors cross the main service road in the area, increasing fear among people walking to work, children going to school, parents sending children to school, and the elderly or expectant mothers accessing medical care. This constant fear contributes to chronic stress and can drive negative perceptions towards elephants. A novel intervention has been introduced to help reduce the costs of HEC and foster coexistence, in the Okavango Panhandle area—the 'Elephant Express'. The bus service was established through a multi-stakeholder collaboration to provide primary school children and medical personnel safe transport across elephant corridors to schools and health clinics. The complementary bus service has reduced stress from living with elephants, increased attendance and performance in schools, and facilitated improved access to medical care.

Résumé

La gestion des interactions négatives ayant lieu lorsque les habitants et les éléphants utilisent les mêmes ressources et un espace commun représente l'un des défis les plus importants pour la conservation de l'espèce. Les incidents liés aux conflits humains-éléphants (CHE) se manifestent souvent par des conséquences directes sur le quotidien de chacune des deux populations. Cependant, certaines de ces

situations entraînent des risques sur le long terme, ainsi qu'un stress chronique parmi les communautés qui vivent avec les éléphants. Les impacts indirects ou coûts d'opportunité, tels que les désavantages induits par la présence de ces animaux, sont difficiles à quantifier et ne sont que peu pris en compte. Dans la partie orientale de l'Okavango Panhandle au nord du Botswana, quelque 17 500 personnes partagent l'espace et les ressources avec 18 000 éléphants. Ces derniers utilisent quotidiennement des corridors précis et historiques, se déplaçant sur plus de 8 700 km^2 depuis les régions arides vers les zones humides du delta de l'Okavango. Les confrontations avec les habitants se produisent le plus souvent à l'intersection entre ces couloirs et la route principale, un axe emprunté par les travailleurs, les enfants se rendant à l'école et leurs parents qui les accompagnent, les personnes âgées et les femmes enceintes se dirigeant vers les centres de santé. Cette peur constante contribue au stress chronique ressenti et peut susciter des perceptions négatives à l'égard des éléphants. Une initiative novatrice nommée « Elephant Express » a été mise en place afin d'atténuer les coûts des CHE et d'encourager la coexistence dans l'Okavango Panhandle. Issu de la collaboration de plusieurs parties prenantes, ce service de bus a été organisé dans l'objectif de fournir un moyen de transport sécurisé aux élèves d'école primaire et au personnel médical, pour traverser les corridors d'éléphants. Ce dispositif gratuit a réduit le stress lié à la vie quotidienne auprès des éléphants, a augmenté la présence et les performances scolaires et a facilité l'accès aux soins médicaux.

Introduction

One of the most significant challenges for elephant conservation is managing situations where people and elephants use the same space and compete for similar resources (Balmford 2001; Sitati et al. 2005; Woodroffe et al. 2005; Dickman 2010; Songhurst 2017). Such competition can lead to increased encounters between people and elephants, which, when negative, can result in human-elephant conflict (HEC). Wherever HEC occurs there are costs involved, which have direct or indirect effects on people and elephants. Direct effects can include loss of crops, damage to property, loss of life, injuries, or loss of livestock; and indirect effects can include competition for natural resources, restricted movement, fear, sleepless nights, or disruption to daily routine, (Conover 1997; Barua et al. 2013). The effects of HEC can consequently lead to decreased food security, interruptions of work activities, decreased physical and psychological well-being, economic hardship, and at times an increase in illegal or dangerous activities (Ogra 2008; Jadhav et al. 2012).

Perceptions of the level of negative interactions people are experiencing living with wildlife are as important as the actual losses from wildlife damage (Naughton-Treves et al. 2005), as they affect the level of antagonism people feel towards a wildlife species and consequently influence what actions people are likely to take in such situations (Dickman 2010). Ogra (2008), argued that it is essential to acknowledge both the visible and hidden costs associated with human-wildlife conflicts (HWC) and, understanding the social determinants of negative interactions between people and wildlife is critical in order to develop and implement successful, long-term mitigation strategies (Songhurst 2023).

Negative feelings towards some wild animals can be exacerbated by past experiences (O'Connell-Rodwell et al. 2000; Hill 2004; Madden 2004; Dickman 2010) and attitudes towards dangerous animals such as elephants may be influenced by the perceived risks of living near such wildlife species (Knight 2000; Naughton-Treves; Grossberg et al. 2003; Kaltenborn et al. 2006; Songhurst 2023). If people are scared and believe they have little control over a conflict situation or have limited coping strategies, then they are also likely to further inflate perceptions of risk (Hill 2004). Fear of elephants generates safety concerns and restricted mobility for people (Naughton-Treves et al. 2005; Mayberry et al. 2017) and can influence both the temporal (Mayberry et al. 2017; Buchholtz et al. 2019) and spatial behaviour patterns of people (Redmore et al. 2023). Similarly, elephants have been found to adapt their behaviour to avoid risking encounters with people (Douglas-Hamilton et al. 2005; Graham et al. 2009; Songhurst et al. 2015; Buchholtz et al. 2019). It is essential that people feel safe where they are living, both to reduce levels of HEC (SLWCS. 2016, Henley et al. 2023) and to ensure psychological well-being (Maslov 1943; Henley et al. 2023).

The extent to which people accept the presence of wildlife and tolerate interactions with wild animals

is influenced by people's experiences, attitudes and cultural values. A greater understanding of the drivers of these is needed to develop socially acceptable wildlife management strategies (Jonker et al. 2006). In the Okavango Panhandle, Botswana, where people share space with a large population of elephants (Thouless et al. 2016), fear and stress due to encountering elephants contribute significantly to negative perceptions towards them, tolerance levels, and overall perceived levels of conflict (Songhurst 2012). If loss (actual and perceived) is matched by benefit (actual and perceived), then overall conflict can be reduced. However, improving perceived conflict levels is difficult because they are so complex. Songhurst (2023), found that perceived HEC in the Okavango area is affected by a variety of factors including socio-demographic characteristics, cultural beliefs, socio-economic circumstances, past conflict experience, and indirect and direct experiences with elephants. Management strategies that address the complexities of perceived and actual conflicts are therefore needed to reduce HEC.

In the Okavango Panhandle, elephants use distinct corridors to travel from dryland resources to the Delta, moving near fields and settlements and crossing the main road daily to do so (Songhurst et al. 2015). Children in the same area walk across these elephant corridors to attend school, and people also walk through the corridors to reach services such as shops and health clinics. The elephant corridors are essential habitat for elephants to access the resources they need and elephants are increasingly affected by people accessing former historical wilderness areas (Blake et al. 2008). Crossing points form hotspots for direct encounters between people and elephants, which ultimately increase fear in people and opportunity costs for children travelling to school, or people going about their daily lives (Lupton et al. 2015; Songhurst 2023). Fear for children walking to school was expressed most fervently by parents, and reports of children missing school due to elephant encounters was commonly reported by school teachers (Mr Radiposo, Head Teacher, Eretsha Primary School, pers. comm., February 2019). The community highlighted the need to increase the availability of transport, especially for vulnerable members of the community (school children, elderly, and disabled) (Stakeholder Consultations, pers. comm., February 2019).

This paper describes an innovative practical intervention: the 'Elephant Express' (EEB) that has been implemented as a result of research and consultations led by the NGO Ecoexist Trust, to improve safety for people and reduce fear towards elephants, providing safe passage for school children, medical staff and their patients across elephant corridors to schools and health clinics and, ultimately, helping to foster coexistence between people and elephants in the Okavango Panhandle.

Study Area

The study was conducted between January 2021 and July 2023 on the eastern side of the Okavango Panhandle, where the Okavango River flows into the Okavango Delta (Fig. 1). The Okavango Delta, a Ramsar Wetland and World Heritage site harbours one of the largest populations of elephants in Africa. One-hundred and thirty thousand elephants, a third of Africa's remaining elephants are found in northern Botswana (Thouless et al. 2016), therefore it is of conservation significance (Adams et al. 2021). The eastern Panhandle covers 8,732km^2 and its northern and southern boundaries are delineated by the Namibian border and a veterinary fence, the 'northern buffalo fence', respectively.

The census of 2022 recorded approximately 17,545 people living in the eastern Panhandle (CSO 2022), with 14 villages (population >500), and additional settlements scattered between villages. An estimated 61% of residents in the wider district live in poverty, and 15.8% in severe poverty, relying heavily on subsistence agriculture—a livelihood that directly competes with elephants for resources (OOP 2021). Families in the eastern Panhandle move between villages and crops during planting and harvesting periods to guard their fields.

The elephant population in the eastern Panhandle is estimated to be around 18,000 (Songhurst 2017). Elephants have been observed in the study area to use distinctive pathways to move between the Okavango Delta and foraging areas in dry woodland habitat (Songhurst et al. 2015).These pathways are bisected by the main road (gravel-surfaced) that serves all villages in the eastern Panhandle, which are distributed in a ribbon-type development pattern along the edge of the wetland. Elephants damage crops, break fences,

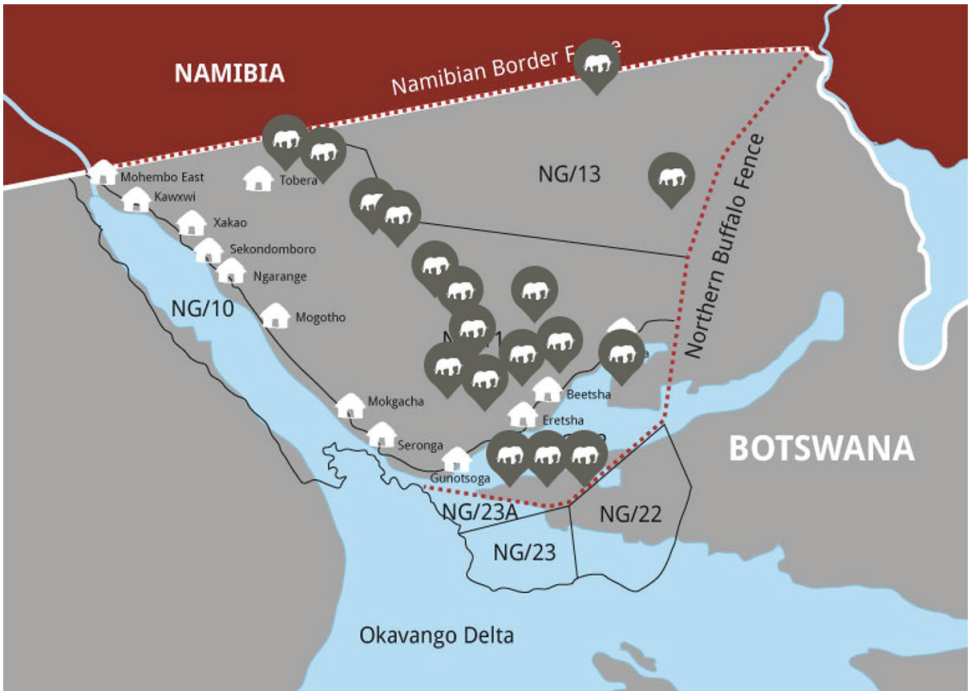

Figure 1. Map of the eastern Okavango Panhandle, Botswana. (*Map drawn by Ecoexist Trust 2023*)

damage property and chase, injure and sometimes kill livestock and people. Meanwhile, people are modifying ancestral elephant habitat by cultivating land and developing new settlements, and they also chase, injure and occasionally kill elephants. Before the implementation of this conflict mitigation programme, there was an average of one person killed per year by elephants in the area and approximately 25 elephants were killed annually through problem animal control (Songhurst 2017).

The EEB initiative is a collaborative effort between the community (Okavango Community Trust who has a jurisdiction covering six villages (Mokatcha, Seronga, Gunotsoga, Eretsha, Beetsha and Gudigwa), an NGO (Ecoexist Trust focused on reducing HEC), the Government of Botswana (Clinics, Schools and the Department of Wildlife and National Parks: DWNP) and the private sector (Natural Selection Safaris, Uncharted Africa, Halfway Toyota, and SATIB insurance company) stakeholders. The aim of EEB is to help reduce negative HEC interactions by providing safe passage for the most vulnerable people who make daily journeys on foot.

Materials and methods

Transport demand assessment

In 2015, a transport demand assessment study was conducted to understand the transportation needs of people living in the eastern Okavango Panhandle in relation to elephant corridors (Lupton et al. 2015). The assessment consisted of focus group discussions and semi-structured interviews with key stakeholders in the Panhandle. Seven focus group discussions, 13 interviews with school heads, nine interviews with clinic nurses, and five private sector interviews were held. Data were collected on: i) village population size; ii) average household size; iii) number of patients serviced at each clinic; iv) number of chronic patients serviced at each clinic; v) number of referral patients at each clinic; vi) number of students per school; vii) number of students walking more than 5 km each way per school; viii) number of students boarding at each school; ix) frequency of shoppers at each village; x) number of farmers selling their produce; and xi) type of produce sold.

The demand for transport per segment was calculated using the formula below to determine the demand for transport from various user segments.

Demand = Users * Frequency of Use

Stakeholder consultations

Semi-structured interviews and focus group discussions were conducted with key community and government stakeholders by the Ecoexist team between November 2018 and March 2019 to determine who the buses should service, the most expedient routes, and to ensure that the EEB service would assist in reducing HEC. Five focus group discussions took place with 47 key stakeholders from five villages in November 2018.

In 2019 two safari companies (Natural Selection Safaris and Uncharted Africa) pledged the provision of two buses and operational funds. A multi-stakeholder workshop took place in February 2019 with 56 participants from five villages. The stakeholders consulted included village chiefs, village development committees, clinic heads, school heads, the DWNP, the district commissioner and the Northwest District Council.

Mapping the elephant corridors and bus routes

The distances of the six villages (including Mokatcha, Seronga, Gunotsoga, Eretsha, Beetsha and Gudigwa) where the buses would operate were measured and mapped. The elephant corridor maps were prepared using data from ground surveys, local information and data from elephant collars based on their movements in the area. These maps were used to identify where the EEB service would be most useful to address HEC and reducing the risk of vulnerable people walking across corridors. A bus route for each EEB was proposed, with two buses in operation.

Management of the buses

A series of meetings between collaborators was held to determine the role and responsibility of each partner. Discussions included topics such as which actors would manage the bus, who the EEB would service, how beneficiaries would be selected, and how the buses would be monitored. This led to the production of two guiding documents (a Memorandum of Understanding (MOU) and Operations Plan (OP)) to outline how the buses would be managed and to define the standard operational procedures.

Two-year assessment: stakeholder feedback

Semi-structured interviews with key stakeholders and beneficiaries were conducted by the Ecoexist team over three days in October 2022 in five villages and six settlements where the buses operated, to gain qualitative feedback on the two years of bus operations and impact on reducing HEC.

Results

Transport demand assessment

In 2015, when the assessment was carried out, there was a human population of approximately 16,400 (CSO 2011) with 13 main villages. Four types of transport users or market segments were identified in the eastern Panhandle. These included: i) chronic patients, those needing access to medical care on a bi-weekly or monthly basis; ii) school children: most children walk <5 km to reach school, however 10% walk >5 km to attend school. Also, some children are weekly boarders; iii) shoppers, people needing to travel from villages to the main district town (Shakawe) to shop; and iv) vendors, who need transport to take produce to market.

Shoppers made up the majority of transport needs in the Panhandle (51% of demand), followed by children commuting to school daily (43% of demand), weekly-boarding school children (3% of demand) and chronic patients (1% of demand); (Tables 1 and 2 below).

Stakeholder consultations

All stakeholders present (100%) agreed that bus transport was needed and would help to reduce some of the HEC. Children getting to school and medical staff and patients were identified as the main people in need of transportation. The number of children and patients

Table 1. Total monthly demand

User type	Monthly demand
Shoppers	35,875
Sellers	3.5
Chronic Patients	542
Referral Patients	94
Daily School Children	31,394
Weekly School Children	2,376
Term School Children	267

*(Demand = Users x Frequency of Use)

Table 2. Market size for transport

Village	Market size						
	Shopping	Selling (est # loads)	Chronic patients >5km	Referral patients	Daily School >5km	Weekly School	School Term
Mohembo East	154	4	38.5	0	188	0	0
Kauxwi	332	3	0	4.5	0	0	0
Xakao	546	3			446.75	0	103
Tobere	143	4	21	0	0	0	177
Sekondomboro	280	4	0	8	100	0	0
Ngarange	349	3	7.5	7.5	276	20	0
Mogotho	400	3	40	10	146	146	0
Mokatcha	231	3	36.68	0	2	8	0
Seronga	2,125	3		40	0	180	500
Gunotsoga	396	3	23	6	65	10	0
Eretsha	201	3	120	0	20	0	0
Beetsha	572	3	120	10	0	200	0
Gudigwa	262	3	86	8	12	30	20

in need of transport was recorded (Table 3) and it was agreed that a multi-stakeholder workshop was needed to determine the best operations and management plan for the buses.

The multi-stakeholder meeting resolved that the two buses should be managed by both the Okavango Community Trust (OCT) and Ecoexist Trust, because the OCT has a responsibility to provide services to the community and Ecoexist Trust can ensure the buses are used for the intended purpose—to reduce HEC. It was also agreed that the first two EEBs needed to focus on the children commuting to and from school on a daily and weekly-boarding basis and between school runs, and to assist clinics with out-patient care for inter-clinic staff transport.

These discussions also emphasized the need to ensure that all stakeholders understood the purpose of the EEB service and that this was communicated through three strategies: a) the buses should be clearly branded as EEB; b) the buses should be launched at a series of village meetings (Kgotla meetings), where the purpose of the buses to reduce HEC would be clearly communicated to the community; c) a stakeholder WhatsApp group should be established to facilitate communications and awareness on operations; d) safety around elephant messages should be created and displayed inside the bus; and e) bus shelters should be erected for children and used to display further educational materials on the environment, elephants and elephant corridors (Fig. 2).

Elephant corridors and bus routes

Songhurst et al. (2015) identified 13 main elephant corridors in the eastern Okavango Panhandle, where most of the elephant-movement occurred. Figure 3 shows these corridors and where priority for transportation needs and assistance were identified to improve human safety. Through stakeholder consultations, it was agreed that the villages between Mokatcha and Gudigwa would be the priority focus for the first two EEBs and the distance between these settlements was recorded and mapped to assist with developing a bus route schedule. (Fig. 4)

Table 3. Summary of beneficiary numbers within and around the five main village service centres during the first community consultations

Village	Seronga	Gunotsoga	Eretsha	Beetsha	Gudigwa
Group					
Primary school	50 daily	24 daily	30 daily	149 daily	37 daily
Secondary school	9 daily	Boarding	Boarding	Boarding	Boarding
Clinic	100 monthly	50 monthly	50 monthly	231 monthly	85 monthly
Elderly	No	Yes	22	No	No

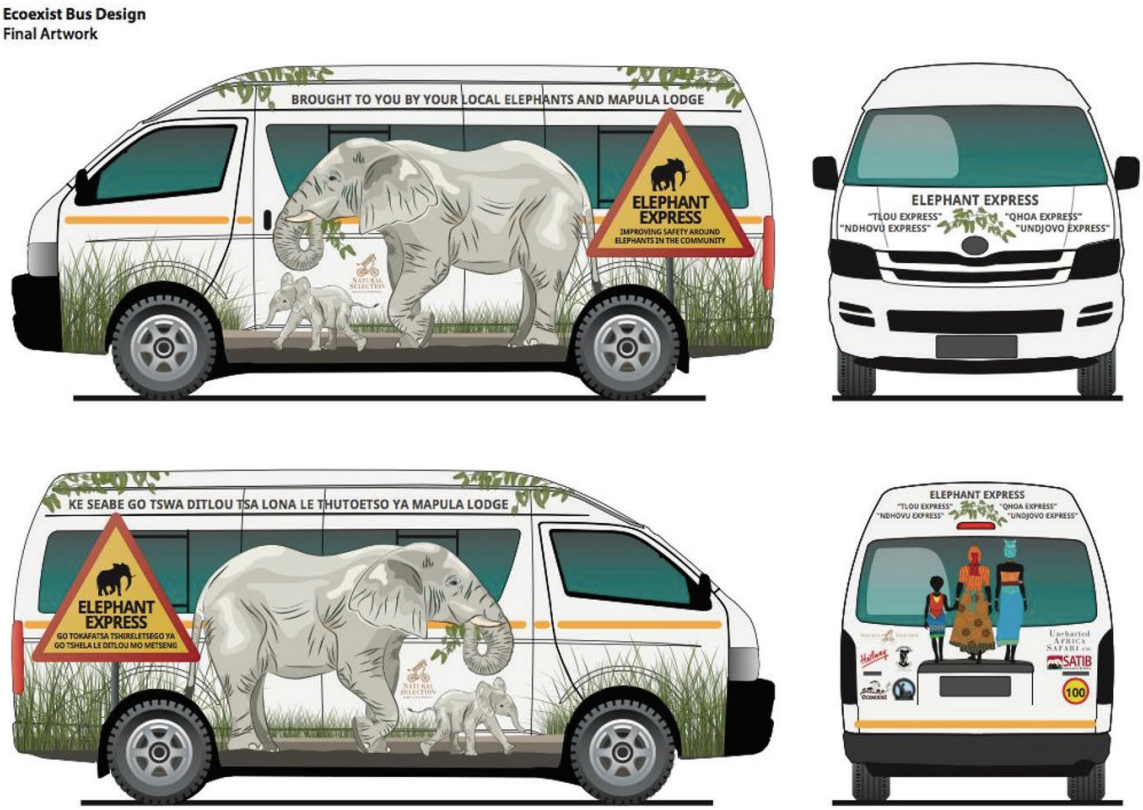

Figure 2a. The 'Elephant Express' bus exterior branding designs. (*Illustrations © Natural Selection Safaris*)

Figure 2b. The 'Elephant Express' bus interior sticker designs. (*Infographics © Ecoexist Trust*)

It was agreed that EEB 1 would serve the needs of children between Matswii and Eretsha to Beetsha School and the EEB 2 would serve the needs of children between Ndorotsha and Xao to Gunotsoga School and Mbiroba to Seronga Primary School.

Management of the buses

The collaborating partners for the EEBs agreed to some key points under the MOU to assist in managing the buses, define the roles and responsibilities of each partner and outline the commitment pledged for the initiative. These points included service provision; funding; accountability; maintenance and care of the buses; an agreement on who should use the bus; liability; and reporting. The eligibility of bus users was a key discussion point in all meetings, and it was essential to establish clear guidelines on how passengers should be selected and recorded.

An EEB OP was also developed which outlined more specific details on how the buses would operate, including passenger selection, hygiene, health and safety procedures, daily schedules, bus maintenance schedules, and record keeping. The monitoring of the buses was made the responsibility of all stakeholders to ensure that they would be used for their intended purpose. A co-management arrangement was established between the Okavango Community Trust and Ecoexist Trust to ensure transparency and accountability for daily bus operations. Additionally, each bus was equipped with a GPS spot tracker to monitor location and timings.

Two EEBs have been operating since January 2020 under the co-management arrangement between OCT and Ecoexist Trust (Fig. 5). Eligible children were registered with the school by their parents at the beginning of term and the clinics indicated transport needs for their staff through a monthly schedule (Fig. 6). The buses pick up and drop off children at designated bus stops which are equipped with shelters (Fig. 7). An important role of the EEBs is to provide education and awareness to the beneficiaries of the complimentary service, as well as the wider community. In addition to the buses being branded with information stickers, the bus shelters provided

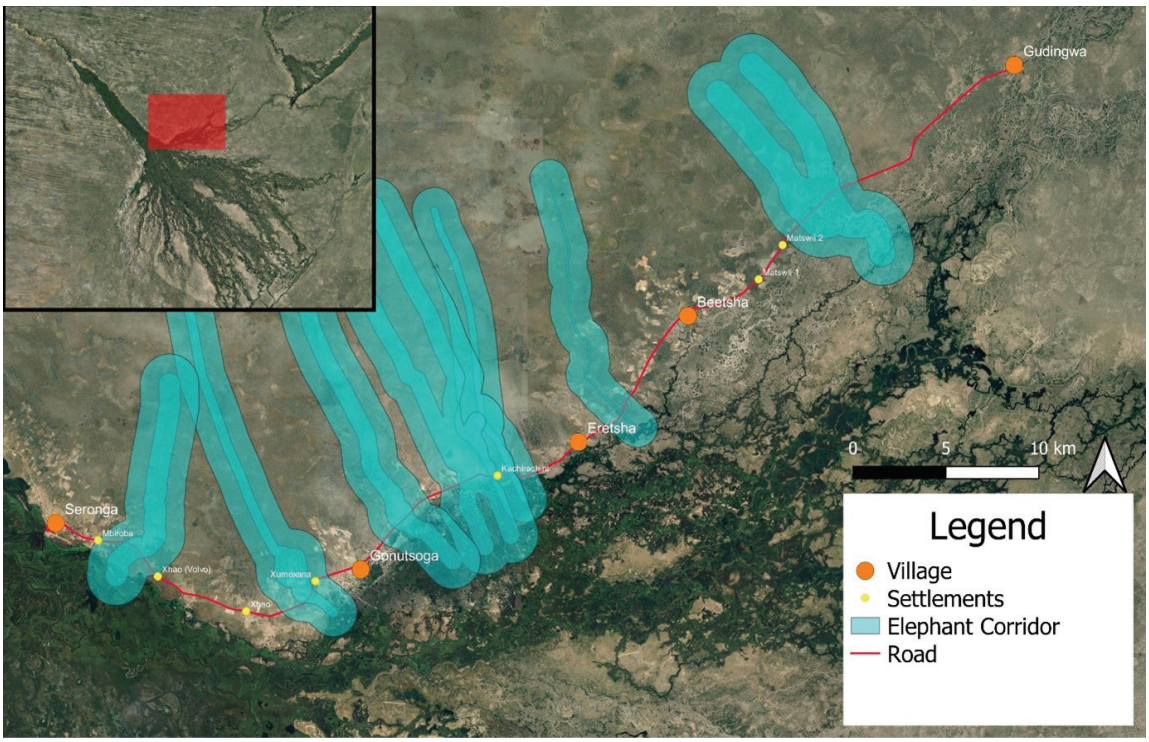

Figure 3. Map indicating villages and settlements (orange and yellow circles) serviced by the 'Elephant Express' bus, with elephant corridors coloured turquoise. (*Map drawn by Ecoexist Trust 2023*)

Figure 4. Map showing the distance between villages. (*Map drawn by Ecoexist Trust*)

information on elephant corridors, safety around elephants, wildlife crime, and a "how-to" on local environment protection (Fig. 7).

Two-year review: stakeholder feedback

A total of 29 interviews were conducted with five stakeholders and beneficiary groups (Table 4), including village chiefs (4), medical personnel (2), school personnel (8), parents (14), and OCT staff (1).

Situation before the introduction of the 'Elephant Express' buses

The responses of the interviews with parents indicated that before the introduction of EEBs parents feared for the lives of their children. Children missed school or arrived at school late after encounters with elephants. School performance was poor, and some children walked long distances, which made it difficult for younger children to attend.

Interviews with teachers also indicated that before receiving help from the EEB service, students were experiencing challenging encounters with elephants that often contributed to tardiness, poor attendance, poor performance, and lack of concentration in class, due to fear of elephant encounters. It also resulted in truancy as some students took advantage of the situation. Prior to the arrival of the EEB service in 2020, Standards 2 to 5 in some primary schools had a 0% pass rate.

The interview with the clinic midwife in Seronga revealed that women often missed their antenatal check-ups and there were many home births without the presence of a medical professional, due to lack of transport. With the help of the buses, an antenatal outreach programme now sends nurses and midwives to satellite clinics on a more regular basis.

Summary of the situation after the introduction of Elephant Express buses

The monthly records of the bus drivers showed that the transport needs of 228 individual children (on average) and six clinic staff have been helped by the EEB service since September 2020 (Table 5).

Interviews with all stakeholders indicated that the EEB service was making a positive impact for people living in the eastern Okavango Panhandle. Teachers have acknowledged the importance of the buses observing an improvement in student performance, punctuality, and attendance at school. Since the inception of buses, teachers in one school indicated that results have improved from a 0% pass rate to a 20% pass rate, which they attributed to increased attendance

Figure 5. The 'Elephant Express' bus operating across the elephant corridors. (© *Ecoexist Trust*)

Figure 6. Morning pick up at Matswii bus stop. (© *Ecoexist Trust*)

Figure 7. Elephant Express Bus shelters. (© *Ecoexist Trust*)

due to meeting transport needs. A second primary school reported a similar improvement in the pass rate since the introduction of the buses.

Interviews with midwives indicated that there has been an improvement in the delivery of antenatal care services. One interviewee from Seronga clinic estimated that unassisted home births have reduced by 50% since the introduction of the buses due to midwives from Seronga being assisted by the EEB to visit remoter villages. It was revealed that the buses play an active role in enabling midwives to provide emergency care for newborns and mothers.

The interviews did identify some challenges with the current bus operations, including the need for more buses due to the number of children and clinic staff needing assistance; the pick-up/drop-off schedule needing adjustments to ensure that children arrived at school and returned home on time/safely; communications with all stakeholders on schedule changes, bus breakdowns, and driver unavailability also needs to be improved.

Discussion

The EEB initiative has played an important role in improving the lives of people in the eastern Okavango Panhandle and reducing the fear of living with elephants and the consequent indirect effects of HEC. Stakeholder feedback indicated that since the introduction of the EEB service, school student performance, attendance, and punctuality have improved, as well as antenatal care for expectant

Table 4. Summary of survey participants

Institution/Organization	Informant	Place	Date
Village	Headman	Gudigwa	11/10/2022
	Chief	Eretsha	12/10/2022
	Chief	Gunotsoga	12/10/2022
	Chief	Seronga	13/10/2022
Okavango Community Trust Schools	Accountant	Seronga	13/10/2022
	Head teacher	Beetsha Primary	11/10/2022
	Teacher		
	Acting Head teacher	Eretsha Primary	11/10/2022
	Headteacher	Gunotsoga Primary	12/10/2022
	Teacher (Guidance & Counselling)		
	Head teacher	Seronga Primary	13/10/2022
	Teacher (Guidance & Counselling)		
	Teacher		
Clinic	Midwife	Seronga Clinic	13/10/2022
	Doctor		
Beneficiary of 'Elephant Express' Buses	Parent (2)	Matswii 1	11/10/2022
	Parent (2)	Matswii 2	11/10/2022
	Parent (2)	Moyagogo	11/10/2022
	Parent (1)	Gombo	11/10/2022
	Parent (2)	Kachirachira	12/10/2022
	Parent (3)	Mbiroba	12/10/2022
	Parent (2)	Xumoxana	12/10/2022

Table 5. Number of beneficiaries using the Elephant Express buses

Year	Children	Clinic Staff
2020	335	6
2021	260	6
2022	260	6
2023	208	6

mothers and babies. Responses of interviewees suggest that the fear of elephants and the attitudes towards living with elephants have changed since the implementation of the EEB service. Responses also suggest that there is a greater sense of control and comfort in living alongside elephants, which is fundamental to finding ways to reduce HEC (Henley et al. 2023). In the past, Songhurst (2023) found that negative feelings towards elephants were prevalent in the eastern Okavango Panhandle and many (16%) interviewees identified the issue of elephants killing and injuring people as the biggest problem. In this study, we have found that an intervention like the EEB service, has facilitated positive feelings towards this assistance and reduced the fear of living with elephants through providing safer transport. The Sri Lankan Wildlife Conservation Society (SLWCS) established a similar elephant bus programme in Sri Lanka in 2016 after a field exchange visit to the eastern Okavango Panhandle. Service provision was carried out along an elephant corridor outside the Wasgamuwa NP, with the aim of reducing pedestrian traffic and thus protecting elephants using the corridor. SLWCS (2016) reported that both human and elephant disturbance decreased as a result of the bus service.

Conservation education value

One of the primary goals of the EEB service was positioning the implementation of the project as a benefit of living with elephants. Tolerance of wildlife is strongly linked to awareness, and successful conservation education programmes are those that are multifaceted and provide ongoing points of contact that reinforce learning (Jacobson et al. 2015). The EEBs were designed to provide educational material both inside as well as on the outside of the buses to convey a sense that elephants are part of our environment and can be beneficial. The promotional message reads "Brought to you by your local elephants…" and a photograph of an elephant mother and calf—a relatable image—is displayed on the bus exterior. In essence, the buses serve as mobile billboards, continually advertising the benefits of living with elephants, and the bus shelters are sources of information for both children and adults.

Instruments to measure learning outcomes were not implemented in this study, but there is an opportunity to assess these outcomes in the future, particularly with children who use the buses and shelters.

With conservation education value in mind and the multiple benefits of the buses revealed by this study, there is a call to introduce this conflict mitigation tool in other areas of the Okavango Panhandle, and beyond. Several interviewees commented on the need for more buses in their communities and for the initiative to be rolled-out to those villages that currently do not benefit from the buses.

The further development of this or similar programmes comes with its challenges. The lengthy stakeholder engagement process was an important component of this programme and a pillar of its success; however, this delayed process can also be seen as a barrier to implementation and a risk of losing the interest of funding partners. Furthermore, the long-term nature of this programme can detract funders who prefer one-off donations. In the case of the EEBs the existing relationships held by the local NGO and the involvement of the OCT helped to drive lengthy stakeholder engagements and develop a well-supported programme. The long-term funding requirement was made possible with the involvement of local businesses and a tourism sector that has the ability to attract international donors. Hence the multi-sector partnership was important to the success of this programme and can serve as a model for similar long-term conservation. The success of this project also highlights the power of creating long-standing partnerships and what can be achieved through participatory co-design processes and collaboration among multi-sector stakeholders. Through a different lens, the EEB service of the eastern Okavango Panhandle highlights the need for multi-stakeholder engagement in the design and implementation of practical, lasting solutions to HEC.

Conclusion

Practical interventions that reduce fear among people living with elephants have a large impact on perceptions towards elephants. The lessons learned in the current management and operation of the Elephant Express buses will shape and improve future operations of the buses. The consultation process was a big learning curve that built a solid multi-stakeholder partnership and management framework, to scale up the programme in the area, benefiting from existing collective goodwill and trust among the stakeholders involved. Every situation is context-specific, and this includes context differences between and among villages in the same area—a participatory approach in the co-design of the management and operations of any similar programme is key to reconciling these differences and finding local-specific solutions. The sustainability of any such intervention to reduce conflict is a challenge, and this project has shown that partnerships can overcome such long-term funding challenges. The private sector represents a very strong partner in this regard, being able to sustain such social enterprise interventions, through long-term investment and partnership.

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Twisting collars on male elephants in shrub terrain: animal welfare considerations for researchers, managers and manufacturers

Brooke Friswold[1,2], Brett Mitchell[3], George Gale[1], Antoinette van de Water[2,4]*

[1]Conservation Ecology Program, School of Bioresources & Technology, King Mongkut's University of Technology Thonburi, Bangkok 10150, Thailand
[2]Bring the Elephant Home Foundation, Vlaardingen, The Netherlands
[3]Elephant Reintegration Trust, 3 Port Frances Crescent, Port Alfred, 6170, South Africa
[4]School of Life Sciences, University of Kwazulu-Natal, Private Bag X01, Scottsville, 3209, Pietermaritzburg, South Africa

*corresponding author: brooke@bteh.org

Abstract

For the purposes of testing the impacts of habitat expansion on elephant movement, six XL LoRa elephant radio collars were fixed on three adult male elephants and three adult female elephants prior to a fence being removed at Kariega Game Reserve, South Africa. While none of the collars on female elephants twisted, within five months, all the male elephant collars had twisted, with some triple and double twisting. Behavioural monitoring revealed indications of irritation that resulted in the removal and/or replacement of all twisted collars. It was discovered that two of the male elephants had developed wounds underneath their twisted collars, therefore, only one elephant was re-collared, with a collar that was modified to minimize further risk of twisting, however it twisted again. To investigate this rare incidence of elevated collar twisting, our study assessed the following: elephant behaviour to guide decision-making around interventions and well-being; when, where and how these incidents occurred to investigate the mechanism of twisting and the likelihood of human error; collar design and refurbishment to develop recommendations to minimize the likelihood of twisting; and data obtained from organizations using elephant collars for comparison. From this, it was theorized that browsing behaviour in bulls in dense vegetation, and inadequate collar design were the likely causes in twisting occurrence. We urge organizations using LoRa elephant collars to emphasize post-application monitoring, and exercise caution, when attaching on bulls in dense vegetation. We encourage collar manufacturers to thoroughly investigate twisting incidents and adjust collar structures accordingly and inform clients about the possibility of twisting. By addressing these issues, we can better ensure the well-being of elephants, research success, and improved device safety and efficacy.

Additional Keywords: *Loxodonta africana*; wildlife reserve; conservation research; tracking equipment African elephant

Résumé

Afin d'évaluer l'impact de l'expansion des habitats sur leurs déplacements, six éléphants adultes (trois mâles et trois femelles) ont été équipés de colliers radio XL reposant sur le protocole LoRa, avant le retrait d'une clôture dans la Réserve de Kariega Game en Afrique du Sud. Aucune des femelles n'a vu son collier se retourner, tandis qu'en l'espace de trois mois, les dispositifs des mâles avaient tous montré des torsions, doubles voire triples. Lors du suivi comportemental, des signes d'irritations ont été constatés et il a été décidé d'ôter ou de remplacer tous les colliers concernés. Deux des trois mâles avaient développé des

plaies sous leur collier, qui a donc été complètement supprimé. Un nouveau collier, modifié de manière à minimiser les risques, a été posé sur le dernier mâle. Il s'est néanmoins retourné de nouveau. Pour une meilleure compréhension des facteurs à l'origine de ces torsions, rarement observées à un tel niveau de récurrence, notre étude s'est penchée sur les points suivants : évaluation de la prise en compte du comportement des éléphants dans les choix des interventions et du bien-être des animaux ; identification des circonstances (où, quand et comment) durant desquelles ont eu lieu ces incidents afin d'analyser les mécanismes des retournements et la probabilité de l'erreur humaine ; examen de la conception des colliers et de leur réparation dans le but de constituer des recommandations pour éviter ce type de situation ; et étude des données issues d'autres organisations déployant ces dispositifs sur les éléphants pour obtenir une base de comparaison. Il en a été déduit que le comportement des mâles pendant de la recherche de nourriture, notamment dans des espaces de végétation dense, ainsi que la conception du collier, étaient potentiellement les causes des retournements. Nous appelons les utilisateurs de systèmes reposant sur le protocole LoRa à intensifier la surveillance consécutive à la pose de ces dispositifs spécifiques (de faible épaisseur) et à user de précautions lors de leur mise en place sur des éléphants mâles et dans des conditions de végétation dense. Nous encourageons leurs concepteurs et fabricants à enquêter sur ces incidents, à ajuster les structures en fonction des conclusions relevées et à informer les clients de cette problématique de torsions. En prenant ces questions en compte, nous pourrons mieux assurer le bien-être des animaux sauvages ainsi que les progrès de la recherche, et améliorer la sécurité et l'efficacité de ces dispositifs.

Mot-clés supplémentaires: *Loxodonta africana*; réserve naturelle; recherche et conservation; équipement de suivi de l'éléphant d'Afrique

Introduction

Globally, range expansion and increased connectivity are considered priority elephant conservation strategies, as they promote ecological processes and reduce the need for elephant management interventions (CITES 2010; Department of Environmental Affairs 2014; Zungu and Slotow 2022). South Africa's Protected Area (PA) Expansion Strategy aims to increase PAs to enhance biodiversity conservation, ecological sustainability and resilience to climate change (Department of Environmental Affairs 2016), and the strategy especially includes increasing connectivity in small, fenced reserves. In the Eastern Cape, South Africa, the Indalo private game reserves (GR) are actively working to establish a corridor interlinking the three sections of their reserve. This started with the removal of internal fences between the private sanctuary of Kariega GR in South Africa which holds 75 elephants (Fig. 1), and necessitated a study on elephant movement.

Elephant movement is currently best studied through tracking devices that use GPS signals to provide location points (Pastorini et. al. 2015). For elephants, tracking devices can only be anchored on collars which are placed around the neck, which is an effective mechanism for studying movement and behaviour, without any confirmed impact on the overall behavioural patterns of elephants (Horbeck et. al. 2012). Collaring can be used for research, security and anti-poaching purposes, decreasing human-elephant conflict (HEC), ecological monitoring, and to streamline management interventions.

Although GPS collaring of wildlife provides crucial information for conservation, management, and research, transparency in the development and use of these mechanisms is vital to prevent adverse consequences. Therefore, it is important to properly investigate equipment successes and failures to advance the field of wildlife tracking technology (Matthews et al. 2013). To date, no reports on collar twisting or malfunctioning have been published, despite the fact that elephant collaring is highly used in conservation management; and equipment failure is financially costly, time intensive and can greatly impact research outcomes and welfare and thus is of concern among researchers using tracking devices. In a study in Sri Lanka (Pastorini et al. 2015) researchers tested the effectiveness and safety of six different types of GPS models.

Long-range radio collars (LoRa) have been developed by African Wildlife Tracking in conjunction with EarthRanger software (who were not involved in collar development) and were used in Kariega GR

to more effectively monitor the movements of elephants. A LoRa tracking device that uses long-range and ultra-high frequency provides near real-time GPS tracking with the aid of a small low-power ultra-high frequency transceiver (African Wildlife Tracking 2023). LoRa collars are a relatively new development in wildlife tracking equipment, as an alternative to standard GPS collar systems, and are gaining popularity for wildlife tracking and monitoring due to their advanced tracking ability and reduced cost (however, initial capital is required for tower development).

When trialling new wildlife tracking equipment, it is vital to closely observe the suitability of new devices, which can be difficult to assess and test prior to field deployment. While elephant collaring is widely considered a safe tracking method, it is essential to consider potential problems such as equipment failure, intervention stress and injury, and changes in behavioural and social dynamics before initiating a collaring study. Given the key role of wildlife tracking for conservationists across diverse African (and increasingly Asian ecosystems), the necessity of continuous monitoring and refinement of tracking devices is essential; as is sharing the experiences and unintended consequences of using tracking devices, or any wildlife research equipment, especially when new technologies are developed. This approach will ensure best practices in wildlife research and monitoring.

To study the spatial behaviour of the resident elephant population in response to range expansion, researchers from *Bring the Elephant Home* and King Mongkut's University of Technology Thonburi (Bangkok, Thailand) in partnership with Kariega GR, used AWT LoRa collars to track six elephants. Upon completion of the collaring interventions, we encountered a rare and challenging equipment failure: twisting collars, often with multiple twists, on all three male elephants collared, comprising half of the subjects of our study. This situation presented both an opportunity and a necessity to investigate the causes and nature of these twisting events and to assess the welfare implications.

After the twisting of the collars was observed, we assessed: 1) the elephant's behaviour using determined well-being parameters to guide intervention decision-making; 2) data from accelerometers embedded in the collars to analyse underlying factors that caused the twisting of these collars, including when and in what specific types of vegetation these incidents occurred, as well as the possibility of human error; 3) collar design to identify equipment failure and specifications for collar refurbishment to prevent future collar twisting and mitigate welfare concerns; and 4) data collected through a short questionnaire administered to other organizations using elephant collars to determine the frequency, nature and severity of twisting and subsequent injury (if any), and the specifications of collars that have twisted.

Materials and methods

Study site

The Kariega GR is a fully fenced area of 8,192 ha and classified as a subtropical thicket biome, consisting of eastern thorn bushveld, secondary acacia thicket, coastal forest, valley thickets, and characterized by sparse to dense, spiny, evergreen shrub vegetation (Parker and Bernard 2005; Kerley and Landman 2006; Figs. 1 and 2). The vegetation in Kariega GR has been classified as one of the most diverse vegetation types in this region of Africa (Lubke et al. 1986), and among 41 South African reserves, Kariega GR received one of the highest environmental heterogeneity scores (Purdon et al. 2022). Diversity in vegetation composition and structure enhances the availability of ecological niches, allowing multiple species to co-exist successfully in smaller reserves (Beier and de Albuquerque 2015).

Collaring

Six XL LoRa radio collars purchased from African Wildlife Tracking (AWT) were used to facilitate GPS monitoring and research of three adult male and three adult female elephants before and after the removal of an internal fence at Kariega GR in South Africa to study the impacts of range expansion on elephants.

The collaring procedures were conducted in August and September 2022 with a veterinary team under the supervision of Dr William Fowlds and Vets Go Wild, a measurement and research team from *Bring the Elephant Home* (BTEH) and *Elephant Reintegration Trust*, and a ground safety team from Kariega GR. The elephants were darted from a helicopter and collared while lying on their side. The tightness of the collar was decided by the veterinarian according to the manufacturer's

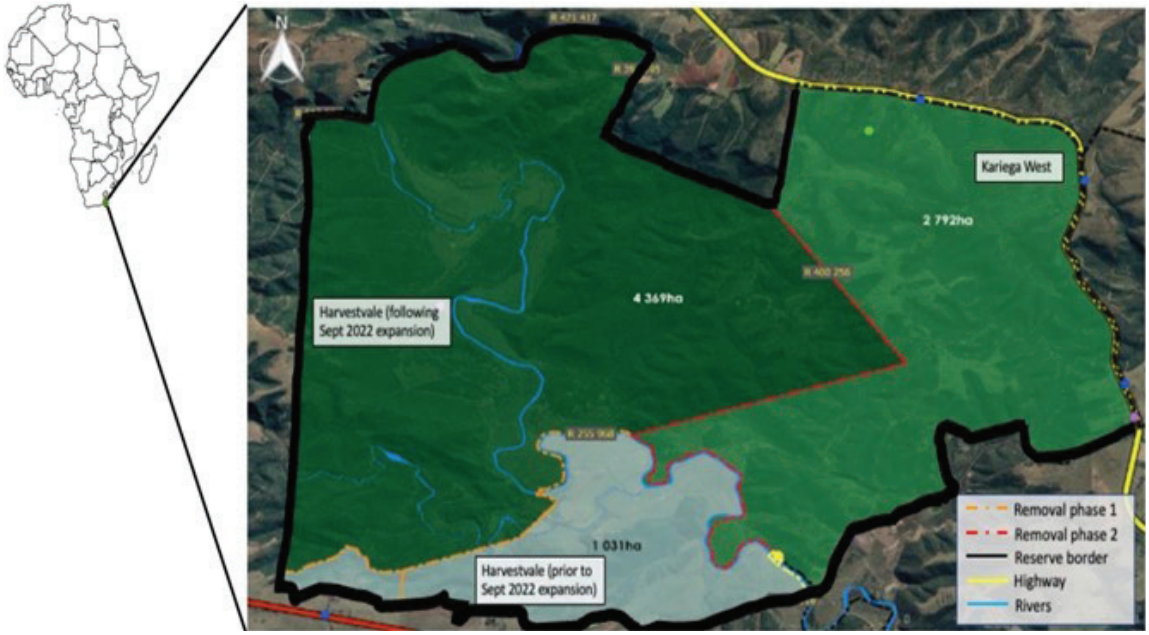

Figure 1. Map of the Eastern Cape, South Africa showing the distribution and sizes of the sections of Kariega GR where collaring occurred. The fenced Reserve (8,192 ha) is separated into three sections that are divided by internal fencing, of which two sections (coloured light green and dark green) hold a total number of approximately 75 elephants. The grey section in the south was added in September 2022, and the internal fence that is scheduled to be removed in November 2023 is indicated by the red dotted line. In August–September 2022, two male and two female elephants were collared on Kariega West (light green), and one male and one female in the Harvestvale section (dark green).

Figure 2. Images of elephants in Kariega GR surrounded by subtropical thicket biome vegetation, which frequently reaches or nearly reaches the height of an elephant's head. (© *Brooke Friswold*)

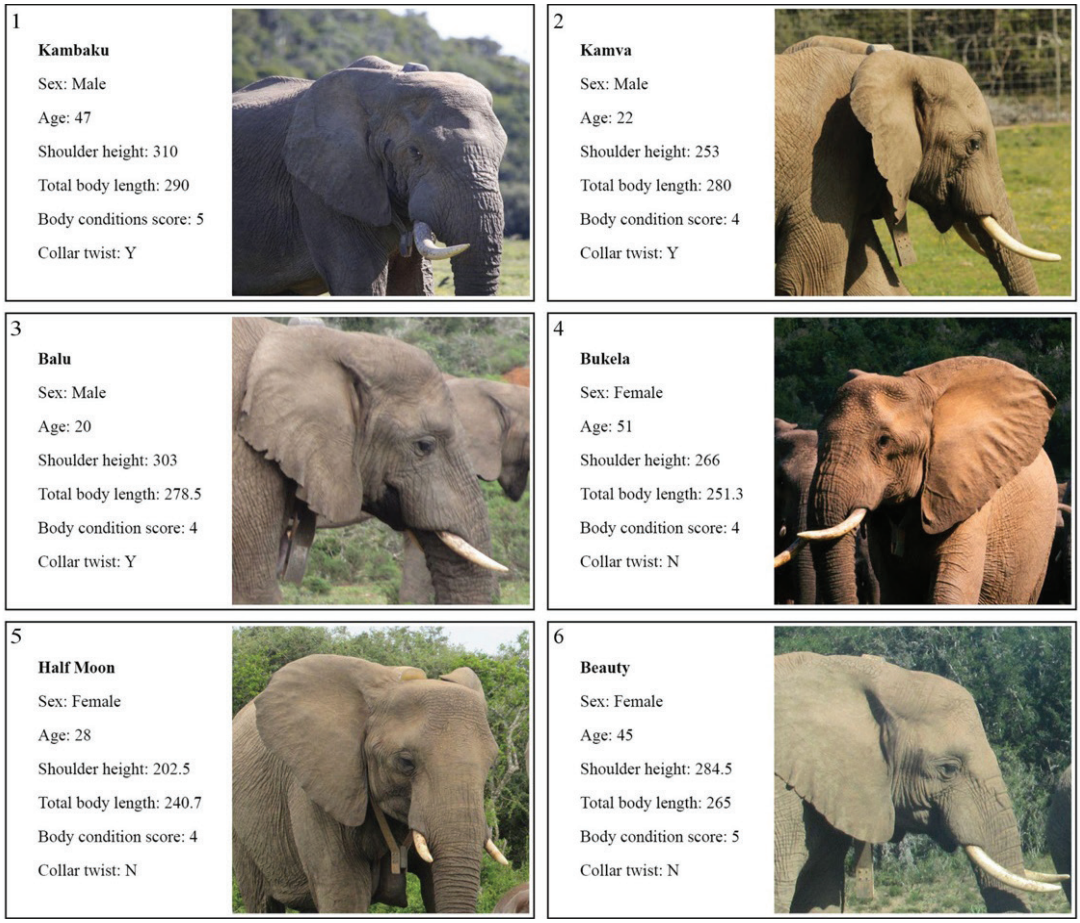

Figure 3. Profiles of the six collared elephants; height and length in cm. Body condition score from 1 to 5 (Morfeld et al. 2016). Twisting of collars occurred on all male elephants (1–3), while none of the female elephants (4–6) experienced twisting. (© *Brooke Friswold, Jaco Mitchell, Ram Marsi and Emma Hankinson*)

parameters and affixed based on considerations of body and neck size, expected growth over 2.5 years (the length of the study), and neck swelling while in musth (for males). All collars were fitted with a 4-kg counterweight and applied as directed by the veterinarian team (Fig. 3).

Results

Monitoring elephant behaviour to guide intervention decisions

Within five months of application, all the collared male elephants experienced various degrees of collar twisting, while none of the female elephant collars showed any signs of twisting or irregularities. All elephants with twisted collars required regular monitoring to assess any behavioural signs of irritation to the elephants from the twisted collars (e.g. sand dusting, mud packing, frequently touching, head shaking, shoulder shrugging, and other stress responses). Wounds caused by collar twisting, collar rubbing, or mud compaction can develop underneath the collar unit or along the collar strapping where it makes contact with the skin, which are often not visible without removing the collar. In some cases, collars untwisted without intervention (Mitchell, pers. obs., 2022). Therefore, it was decided to monitor closely the elephants' behaviour for visible signs of distress to guide the timing of any intervention, allowing for the possibility that the collars could naturally untwist over time. Unfortunately, for all three elephants, untwisting did not occur after 2 to 5 months, and it was decided to remove and/or replace all the twisted collars.

Collared elephants under study:

Kambaku (Fig. 4a and b). At six months (January to March 2023), *Kambaku* had developed a triple twist and started showing signs of irritation through mud-packing on the collar and continuously twitching his ears. Due to the location of the twist high along the neckline and the signs of irritation, it was decided to remove the collar on 9 March 2023. During removal, it was discovered that a skin-breaking laceration had formed on the left side of the neck, specifically in the area where the collar had twisted and cut into the skin behind the upper portion of the ear (Fig. 5a, b and c). Due to the position of the elephant after darting, it was not possible to assess for potential wounds on his right side. Following the removal of the collar and wound treatment, it was found that mud had compacted underneath the collar, potentially causing additional discomfort. In other studies, 2% of the fitted collars were observed to cause skin ulcerations, resulting from mud compacting beneath the collar (Delsink, pers. obs., 2008). After removal, we found that the collar material was extremely pliable and held its twisted shape (Fig. 5e)— making reapplication, if desired, not possible due to the high likelihood of it reforming into that shape and twisting again. As a consequence, the collar was ultimately removed and not replaced, leading to the exclusion of *Kambaku* from the study despite his importance as a key study subject.

Kamva (Fig. 4c and d) In April 2023, three months after developing a double twist in February 2023, *Kamva* was sighted with a wound developing underneath the collar on the left side behind his ear (Fig. 5d). Based on this observation and the extent of the wounds discovered under *Kambaku's* collar, an emergency intervention was organized to remove *Kamva's* collar on 21 April 2023. The wound was less deep than *Kambaku's*, likely because *Kamva's* collar had only twisted twice and not three times, as was the case with *Kambaku's* collar.

Balu (Fig. 4e and f) Prior to the intervention, *Balu*, who had developed a triple twist in October to December 2022, had not exhibited any signs of discomfort as *Kambaku* had, nor any visible wounds, as *Kamva* had. However, it was decided to intervene as wound development was likely based on the other twisted collars, and the fact that if the collar twisted again, it could also tighten around the neck. Meetings were held with collar manufacturer personnel to discuss the refurbishment options of *Kambaku's* collar with reconstruction in a way that would reduce the likelihood of twisting (thicker belting, changes in upper unit dimensions) to replace *Balu's* twisted collar. A refurbished collar developed from *Kambaku's* collar replaced *Balu's* twisted collar on 10 May 2023, so that one bull could remain in the study. Upon removal of the collar, no wounds or abrasions had developed. The refurbished collar was applied slightly tighter than previously and contained thicker belting and an elongated width of the upper unit (Table 1; Fig 8). However, the researchers suggested refurbishment changes to the manufacturers that included upper unit dimension alterations by either increasing height to reduce the ability for rotation, or decreasing the height to reduce the likelihood of catching on an object but these modifications were not amended as requested. On 1 October 2023, less than five months after collar replacement the refurbished collar again twisted, and the situation is currently being monitored for next steps.

Assessment of twisting mechanisms and locations

Accelerometer data (Fig. 6) from the collars were used to determine whether the twisting of the collars originated from the bottom, which would suggest that the twisting was potentially caused by elephants manipulating them with their trunks. Should elephants twist their collar by interacting with the bottom weight, the upper unit will likely remain upright, with the twists originating from below and hanging lower on the elephant's neck, as has been observed by other elephant researchers (Henley, pers. obs., 2008). A twist originating at the top unit of the collar would likely indicate that the collar rotated as the elephant moved through dense vegetation, catching branches with the upper unit and pushing the unit resulting in a twist. Such twists could pose a greater risk to the elephant, as they occur higher up on the neck, with the edges of the collar more likely to press against the skin. If the collar had inverted at the upper unit, accelerometer data would shift to a negative frequency to indicate that the upper unit had rotated downward and a return to a positive frequency would confirm that the unit had resumed its upright position after completing the twist. It was confirmed via accelerometer data that all twisted units, and for

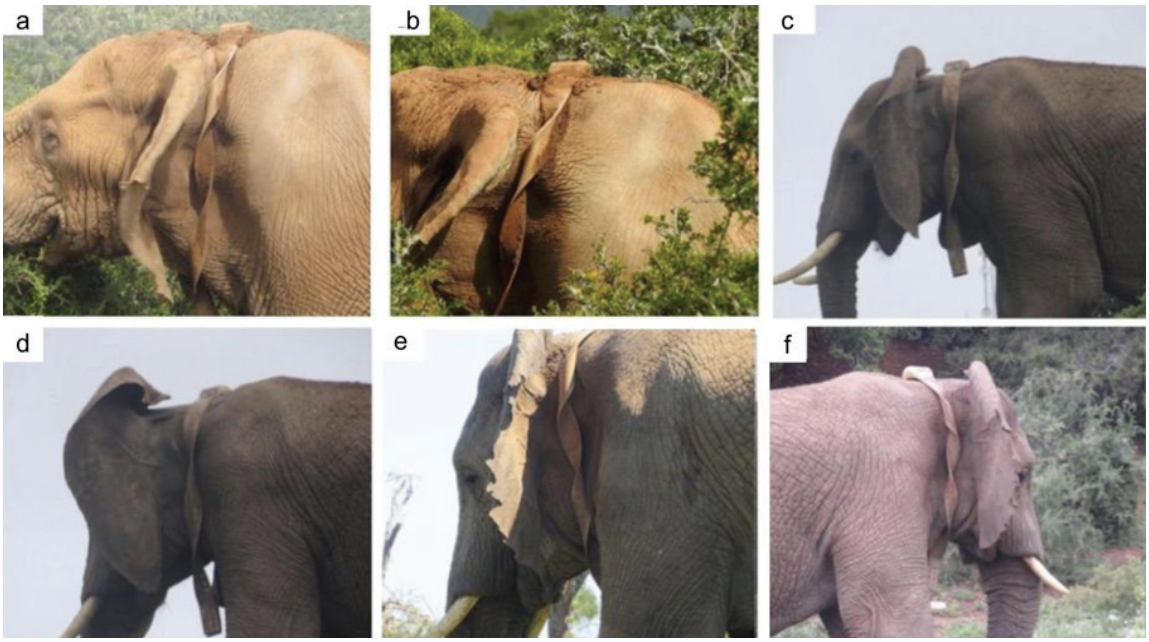

Figure 4a and b. *Kambaku's* collar with triple twists. Figure 4c and d. *Kamva's* collar with double twists. Figure 4e and f. *Balu's* collar with triple twists. (© *Brooke Friswold and Jaco Mitchell*)

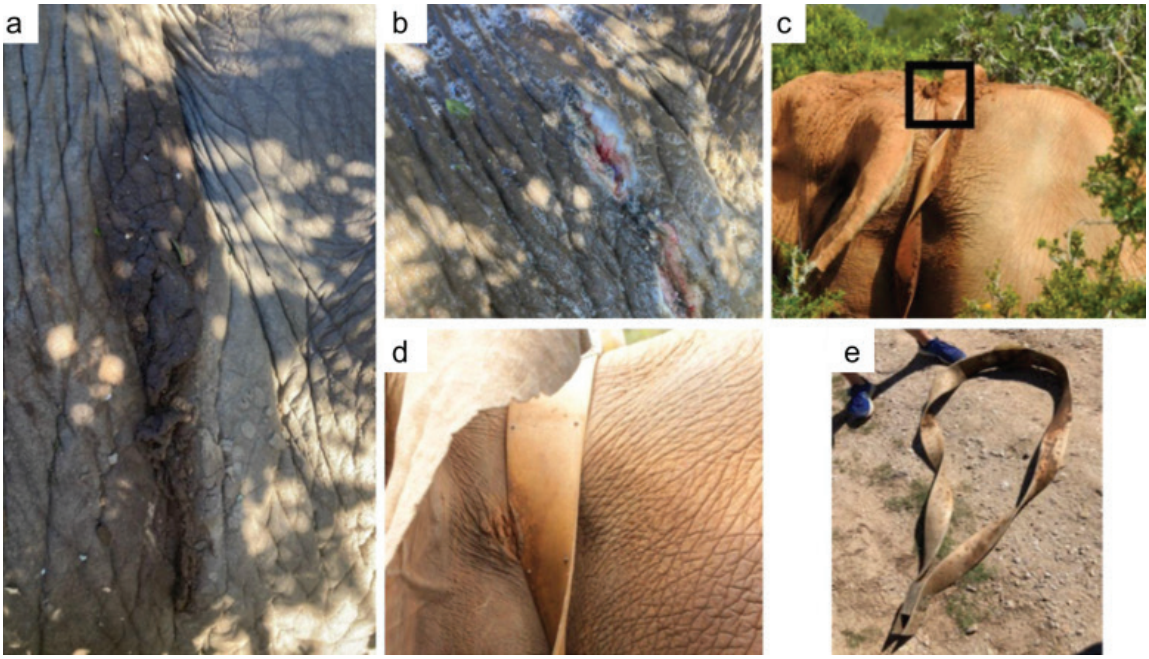

Figure 5a. The wound underneath *Kambaku's* collar before flushing. Figure 5b. The wound underneath *Kambaku's* collar after flushing. Figure 5c. The location of *Kambaku's* wound underneath the collar. Figure 5d. The wound underneath *Kamva's* collar is visible with the naked eye. Figure 5e: *Kambaku's* collar after removal holding a twisted shape. (© *Brooke Friswold and Jaco Mitchell*)

Figure 6. Using accelerometer data from the collars, we were able to determine the exact time and location of the twists and whether they were caused by the position of the upper unit. A shift to a negative frequency would indicate that the upper unit had rotated downward, and a return to a positive frequency would confirm that the unit had resumed its upright position. (*Images obtained using EarthRanger software (2023), Brooke Friswold*)

each twist (including on the refurbished collar) had originated at the upper unit indicating that the twists were not done through manipulation by the elephant but likely through movement through vegetation.

The time stamps of the upper unit inversions were then paired with their GPS locations to determine when twisting occurred (Fig. 7). From this, the time stamps could then be paired with their GPS points to determine where twisting occurred using ArcGIS Online (ESRI 2023). GPS points from the collars were taken every 30 minutes, which offered a relatively small degree of variability to pinpoint the timing and location of the collar twisting. Data points were selected as those closest to the moment the unit flipped and then cross-referenced with locations recorded minutes before and after unit rotation to assess whether the elephants were in areas of dense thicket and/or other vegetation types during the period the twisting occurred. All twists except for *Kamva's* were clearly confirmed to have occurred in dense thicket or thicket edges. However, *Kamva's* twist occurred within the 30-minute window, when he was in open terrain but near thickets and it was not possible to determine the exact location at the moment of twisting, although thicket clumps nearby suggested the possibility of twisting by movement through vegetation.

Collar design and refurbishment

The collar manufacturer reported that they have developed and sold approximately 100 LoRa collars without receiving any previous reports of twisting events (other than the four incidents in our study). Batteries are a determining factor in the final dimension size of the unit, as well as the bottom weight. Therefore, GPS and LoRa collar dimensions are not entirely standardized and can vary according to client requirements and manufacturer advice. Given the 57% rate of collar twisting observed in our study, we suggested revisiting the initial dimensions of the collars with which we were provided. Specifically, the issues could have been: 1) insufficient weight requirements; 2) the length and depth of the strap being too thin and malleable; 3) design issues in the height and length of the upper unit, which increases the risk of it catching on branches and/or allowing for rotation.

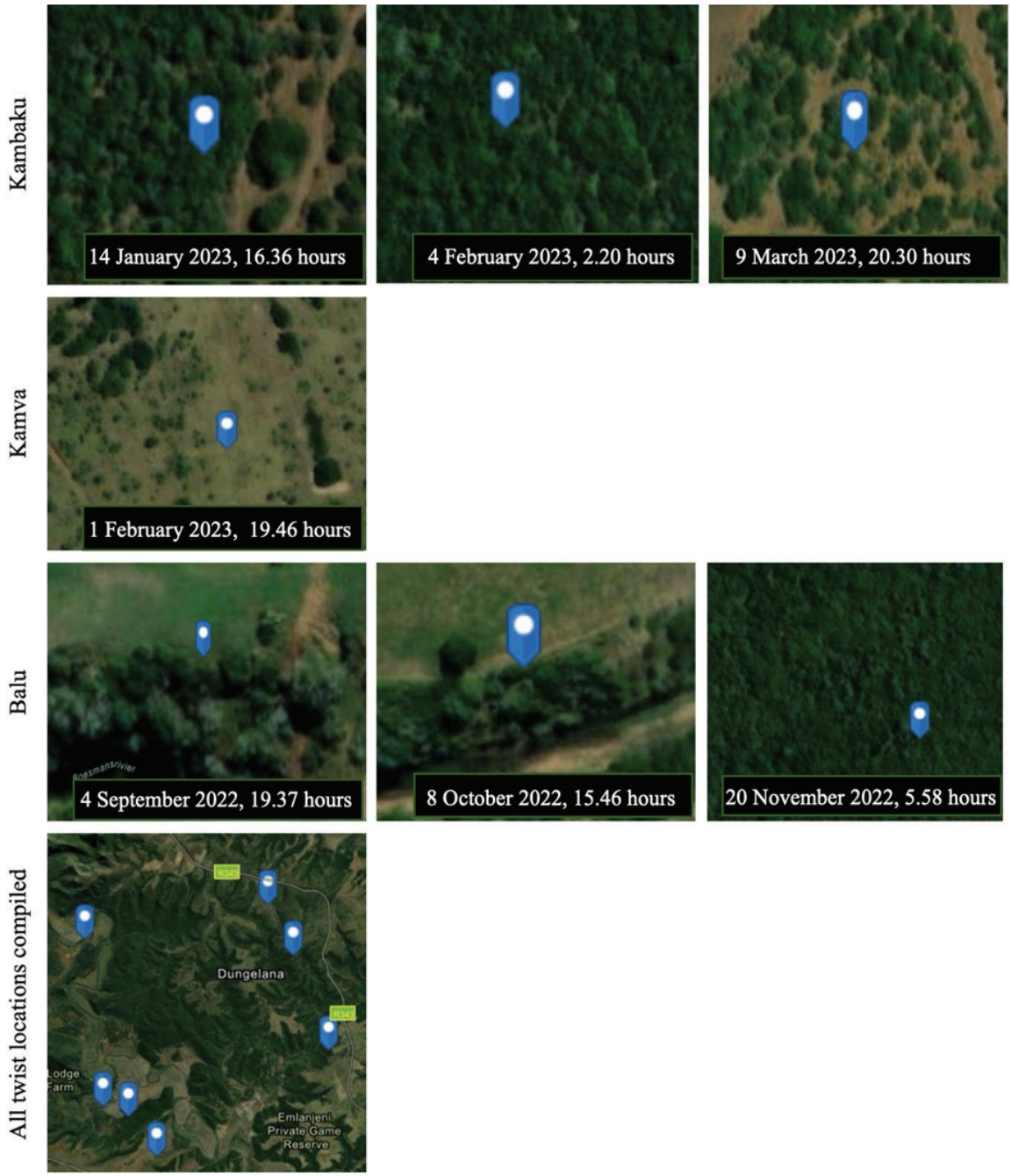

Figure 7. By comparing the timestamps of the collar inversions from the accelerometer data with GPS location data, we were able to identify the locations where collar twisting occurred. The analysis suggests that the twisting was primarily caused by male elephants moving through dense vegetation. Images obtained via ArcGIS Online (ESRI, 2023) (© *Brooke Friswold*)

The refurbished collar that was provided by the collar manufacturer and developed in conjunction with BTEH had a wider and thicker belt (Fig. 8) and slightly elongated upper unit dimensions in an attempt to prevent twisting (Table 1). Unfortunately, not all the specifications requested by the researchers for the refurbished collar upper unit dimensions—whether to be increased or decreased in height—were incorporated by the collar manufacturer, neither were we made aware of this until after collaring had taken place, likely increasing the risk of re-twisting. In discussions with the collar manufacturer, reviewing photos, and consulting with the veterinarian and support team on the ground during collaring, it was recognized that the collars were placed at the correct tightness considering elephant safety (musth neck swelling, growth over time, etc.) therefore displaying that human error was not the primary cause in twisting, suggesting instead collar structure and design. The collar manufacturer's recommendation was that the weight of the collar is in line with the bottom of the ear when viewed from the side, which was confirmed by photos (Fig. 3), and that *Balu* could potentially have benefitted from a slightly tighter fitting collar. Furthermore, the fact that double and triple twists occurred showed how tightness would not alleviate the twisting issue—as the tightness of the collar increased with each twist.

Because the collar application was determined not to be the likely cause of twisting and as the elephants are not twisting it themselves, we believe that redesign and restructuring of the LoRa collar are needed to fully alleviate the issue of twisting. We recommend the modification of collars to prevent twisting before future use by researchers and participating organizations; these modification recommendations are: 1) a thickened width or denser strap material that does not twist easily and which stays in position to avoid changing shape, such as the belting used for GPS collars; 2) a mechanism that prevents the flipping of the upper unit by increasing it in height (similar to the height of the GPS collars) or attaching a piece of belting or other material at the top sides of the unit to prevent flipping. On the contrary, the upper unit could be flattened to reduce the risk of catching on branches and being flipped over; 3) a mechanism that allows for twisting at the bottom if the strap twists at the top so that the twist does not retain permanently and/or cause harm, although this would be difficult considering an elephant's strength; and 4) a heavier counterweight to reduce collar mobility.

Considering that LoRa collars are fairly recent in their development, it seems likely that the specifications used for GPS collars, which have been adapted and corrected over the last three decades, are potentially less likely to twist due to these differences in structure (Table 1).

Collar twisting history and demographics obtained from other organizations

Input from a variety of organizations that have conducted elephant collaring has been acquired to provide insight into the prevalence and conditions of collar twisting. It should be noted that this list is not exhaustive, and there are likely other collar twisting and malfunction events that we were not able to record as we were unable to retrieve collaring data fully from all organizations, warranting the need for further research in this area. The Elephant Reintegration Trust collared 15 elephants using AWT GPS collars and reported only one twisting event on a mature male elephant.

This twist was observed at the time of occurrence and was caused by the collar's upper unit catching on the top of a translocation truck when the elephant was being loaded (Mitchell, pers. obs. 2022). Researchers were able to closely monitor the elephant to determine if the twist was causing a problem and the collar untwisted by itself after one month.

Elephants Alive, under the supervision of Dr Michelle Henley, has fitted more than 200 collars to elephants, primarily AWT GPS collars, and experienced two twisting events. On one occasion, the collar was fitted relatively loosely on an adult male elephant that was still growing and needed extra space to accommodate the swelling of the neck during musth. The male elephant would lift the collar with his trunk and push it through the rest of the collar's loop which gradually twisted the collar (Henley, pers. obs., 2022). The elephant was darted to allow a vet to untwist the collar, but due to the animal's behaviour, the collar twisted again, after which the elephant was darted a second time, and the collar was ultimately removed. All organizations contacted have confirmed that the high prevalence of twisting experienced in this study is alarming and should be addressed as a matter of urgency due to serious impacts on elephant fitness, survival, and reproduction.

Table 1. The dimensions of the original LoRa collars that were deployed and then twisted compared against the GPS collar dimensions (provided by Elephant Reintegration Trust not used in this study), and the refurbished LoRa collar dimensions that were reapplied following removal. These measurements were obtained by those involved in this study and were not provided by the collar manufacturer

	LoRa collar	GPS collar	Refurbished LoRa collar
Belt width	115 mm	115 mm	120 mm
Belt depth	8 mm	8 mm	14 mm near unit tapering to 8 mm
Unit length	150 mm	160–170 mm	190 mm
Unit width	150 mm	150 mm	120 mm
Unit height	65 mm	80 mm	65 mm
Bottom weight	4 kg	6 kg	4 kg

Figure 8. The original XL LoRa collar after it was removed from *Kamva* (left) and the refurbished LoRa collar that was fitted on *Balu* (right). (© *Chris Reynecke*)

Table 2. Information on elephant collar deployment and subsequent twisting provided by various organizations engaging in elephant collaring in other regions of Africa. Collar information includes all manufacturers and models of elephant collars. Note that this list is not exhaustive of all organizations involved in elephant collaring in Africa

Organization	No. collars deployed	Manufacturer and model of collars deployed	No. collars twisted	Manufacturer and model of twisted collar(s)
Elephant Reintegration Trust	14	AWT GPS, Iridium Satellite	1	AWT GPS
Elephants Alive	200+	AWT, African Savannah Tracking, VHF, GSM, Iridium and Inmarsat	2	AWT GPS
Humane Society International-Africa	55	AWT and Vectronics GPS, VHF, UHF, Iridium Satellite	0	N/A
Selati Game Reserve	7	AWT LoRa	0	N/A
Save the Elephants and The Elephant Crisis Fund	600–800	Various brands and models	1	GPS
Mara Elephant Project	82	GPS collars (AWT, Vectronics, Savannah Tracking and Followit)	1	GPS
Smart Parks		ElephantEdge	0	N/A
African Wildlife Tracking	1000+	AWT GPS, UHF, VHF	1%	AWT GPS, UHF, VHF
African Wildlife Tracking	*~100*	AWT GPS, UHF, VHF	*4 (this study)*	*LoRa*

Discussion

Considering that all the male elephants in the study had twisted collars, while none of the females experienced equipment failure of this kind, may be due to sexually dimorphic physical and behavioural differences. Male elephants pushing through dense vegetation may be more likely to hook the upper collar unit on a branch and fully rotate it due to foraging behaviour and body strength/mass. Furthermore, the direction of the twist is indicative of a forward movement due to the twist showing a 360-degree distal rotation toward the rear of the elephant, further supporting collective agreement that vegetation was playing a role in twisting. Kariega GR possesses a diverse range of vegetation characterized by many strong and low-hanging branches, making it particularly likely for collars to become hooked on branches. If the collar structure and belting are not robust enough or designed in such a way to mitigate this, the risk of twisting increases. When designing wildlife equipment for the greatest safety and efficacy these behavioural and ecological conditions should be considered so that they will not impact the effectiveness of equipment or increase twisting risk.

Male elephants may be more likely to push forcefully through dense vegetation during locomotion and browsing (Friswold, pers. obs., 2022), whereas a female in a herd may walk around dense vegetation and be less forceful due to the presence of calves. Furthermore, as other studies confirm, male elephants consume a higher diversity of plants and break larger stem diameters when foraging (Stokke and du Toit 2000), suggesting a preference of foraging in denser vegetation areas. Male elephants may also be more likely to twist their collars in dense vegetation due to their larger mass size as foraging behaviour has been shown to be dimorphic in elephants and that elephant herd foraging strategies were driven by body size, age-specific nutritional requirements, and intraspecific competition (Woolley et al. 2011). Research has also shown that larger-bodied bulls can tolerate a wider range of forage quality and can thus use a wider range of habitats (du Toit and Owen-Smith 1989).

Avoidance behaviour in musth bulls has shown that bulls use widely scattered feeding ‘hotspots’ while family units congregate near permanent water, which may further highlight browsing behaviour as a factor in collar twisting in bulls (Stokke and du Toit 2000). Additionally, movement behaviour in male elephants is faster and more directed during musth periods, which could increase the possibility of pushing through vegetation (Poole 1989). *Kambaku* showed clear signs of musth during the period he was collared, whereas the other elephants did not. Due to these differences and the observed phenomenon in this study of collar twisting occurring only on males, additional care should be taken when considering collaring bulls, especially in areas of dense vegetation, and post-collaring monitoring should form an integral part of elephant collaring studies to ensure that twisting has not occurred.

Post-collaring monitoring and awareness

Researchers and organizations that conduct collaring procedures for male elephants, especially those in dense shrub, should be aware that LoRa collars in their current state have the possibility of twisting, which can cause wounds and other welfare concerns. Elephants with LoRa collars should be monitored at close range regularly, as well as checking accelerometer data, to ensure that no twisting occurs, and that the welfare of elephants is considered. In our case, our ability to monitor these elephants closely and regularly allowed us to detect instances where the collars had twisted and were causing negative impacts on the elephants under study. However, we faced challenges as the twists were not easily observable from a distance, specific angles, or from a helicopter, often remaining concealed behind the ear/underneath the collar. The visibility of these twists was only evident at close range when the elephant flapped its ears open. However, often the ability to regularly monitor elephants at close range is not possible in many collaring studies, which limits researchers’ awareness of potential problems and hinders their ability to address effectively and mitigate concerns related to collar malfunction and elephant welfare and safety.

Impact

Due to significant concerns about the twisting of LoRa collars and its impact on elephant well-being, we were compelled to remove the collars from two male elephants with no intention of replacing them. Collar removal took place before the fences were dismantled, the key event in our comparative study. As male

elephants are trailblazers and the first to explore new territory (Bedetti et al. 2020), the bulls were vital individuals in our study design (Allen et al. 2020). However, it was decided not to recollar *Kambaku* due to his wounds and *Kamva* due to not having a replacement collar in time for the intervention. The removal of two key elephants resulted in a loss of 33% of the study data and will potentially increase the level of uncertainty for interpreting the impacts of the study.

Another factor that influenced our decision not to recollar two of the elephants was the ethical consideration of subjecting elephants to additional interventions within a three to six-month period instead of the anticipated three years, which would cause undue stress on the elephants, surrounding herds, and other wildlife within the reserve. Additionally. The risks associated with each elephant management intervention to elephant and human life and well-being are considerable, often indirect, and unintended, which need to be carefully weighed against the value of the research gained and the positive implications the findings can have on future elephant conservation strategies (Van de Water et al. in prep; Zungu and Slotow 2022). Furthermore, the financial costs for elephant interventions are immense, with significant cost and time incurred for helicopters, the refurbished and unusable collars, vet teams, ground safety teams, and transport for researchers. This all requires substantial funding and is especially challenging for NGOs that rely almost entirely on grant funding for research.

Conclusion

Elephant management interventions that potentially impact elephant well-being, such as twisting of collars, should be adequately investigated and mitigated by collar manufacturers to avoid future animal well-being issues, loss of research efforts, and damaging financial repercussions. We strongly urge researchers and organizations embarking on collaring procedures to exercise caution in their application, especially with male elephants ın dense vegetation, and always to employ regular post-collaring monitoring. Because LoRa collars are a relatively new product in wildlife tracking equipment, we consider our experience potentially indicative of key issues in quality management, unit design, and equipment breakdown that were not able to be tested prior to distribution and thus requires attention from manufacturers and consumers alike. We encourage collar manufacturers to investigate these events further, and to inform conservation partners of this occurrence and the possibility of twisting. Although elephant collaring serves as an invaluable tool for research and conservation, it is crucial to investigate, share outcomes and challenges, and address any instances where the equipment compromises the well-being of study subjects. It is our hope that these findings will contribute to the efforts of wildlife conservation and management practitioners to continually develop more ethical and effective wildlife monitoring tools.

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Behaviour and habitat preferences of translocated rhinos (*Rhinoceros unicornis*) at Manas National Park, Assam, India

Deba Kumar Dutta

WWF–India, Programme Office, Milan Nagar Opposite Oma Asharam, Barpeta Road, Assam, 781315 India
email: debakumerdutta@gmail.com

Abstract

Manas National Park (MNP) is located in the foothills of the Himalayas along the border between India and Bhutan. The original greater one-horned rhino population (*Rhinoceros unicornis*) of the Park was annihilated in the year 2000 by poaching. Less than a decade later, a new rhino population was reintroduced with the support of Indian Rhino Vision 2020, as part of a wider programme that included infrastructure improvements, anti-poaching schemes, and other management interventions. Between 2008 and 2021, 22 rhinos were translocated to MNP from Kaziranga National Park (KNP) and Pobitora Wildlife Sanctuary (PWS). Post-release monitoring was carried out over a six-year period, from 2008–2013, during which 10 animals (three adult males, four adult females, and three calves) were monitored continuously, using radio telemetry to track collared animals, and direct observation to monitor their behaviour. The study period yielded 4,941 radio-tracked locations and 3,711 observations, which provided sex/age specific seasonal data on activity patterns, home ranges, association patterns, habitat preferences, and 'stray incidents' when animals wandered outside the Park boundaries. Some differences from behaviour patterns observed in high flood-risk areas such as KNP and PWS were attributable to MNP's slightly higher elevation that protects rhinos from annual river floods. Overall, however, the translocated rhinos did not exhibit significant differences in their behaviour and ranging patterns compared to wild rhino populations documented in previous studies. This suggests that the translocated rhinos were able to adapt effectively to their new environment. The first calf was born to a translocated adult female in 2011 and, by 2022, the population of rhinos in MNP was estimated at 50 individuals, including 38 calves born following the reintroduction. This study demonstrates the potential of well-managed translocation schemes to contribute to the recovery of endangered rhinos.

Résumé

Le parc national de Manas (MNP) est situé sur les contreforts de l'Himalaya, le long de la frontière entre l'Inde et le Bhoutan. La population originale de rhinocéros indiens (*Rhinoceros unicornis*) y a été totalement exterminée par le braconnage en 2000. Moins d'une décennie plus tard, un nouveau groupe y a été établi avec le soutien du plan Indian Rhino Vision 2020, dans le cadre d'un programme plus vaste qui associait améliorations des infrastructures, projets de lutte contre le braconnage et autres interventions de gestion. Entre 2008 et 2021, 22 rhinocéros ont été transférés à Manas depuis le parc national de Kaziranga (KNP) et la réserve de Pobitora Wildlife Sanctuary (PWS). Après leur introduction, une surveillance a été menée jusqu'en 2013, six années durant lesquelles dix sujets (trois petits et sept adultes, dont trois mâles et quatre femelles) ont porté un collier de suivi. Leurs déplacements ont été inspectés en continu grâce à un système de radiopistage et leur comportement a été rapporté par observation directe. L'étude a produit 4 879 lieux radiopistés et 3711 observations, qui ont permis de fournir, par saison, des données spécifiques au sexe et à l'âge des individus sur les patterns d'activité, les zones et préférences d'habitat, les modes d'association et les « incidents isolés » (rhinocéros s'aventurant au-delà des frontières du parc). Quelques variations quant aux schémas comportementaux relevés dans des zones à haut risque d'inondation telles que KNP et PWS sont attribuables à l'altitude légèrement supérieure de MNP, qui, de fait, protège les animaux des crues annuelles

de la rivière. De manière générale, pour autant, les rhinocéros transférés n'ont pas montré de différences significatives dans leur attitude ou leurs aires d'habitat par rapport aux populations de rhinocéros sauvages répertoriées dans de précédentes études. Ces constatations indiquent que ces rhinocéros transférés se sont acclimatés efficacement à leur nouvel environnement. Une femelle adulte transférée a donné naissance au premier bébé du parc de Manas en 2011 et en 2022, la population était estimée à 50 individus, dont 38 petits nés après la réintroduction. Cette étude démontre le potentiel d'une translocation conduite selon des modèles de gestion adaptés, pour contribuer au rétablissement de ces animaux en danger d'extinction.

Introduction

The greater one-horned rhino (GOH; *Rhinoceros unicornis* Linnaeus, 1758) is a threatened mega-herbivore in the family Rhinocerotidae belonging to the order Perissodactyla (odd-toed ungulates). The global wild population of GOH was 4,023 in June 2022, of which 3,271 (81.3%) resided in India's national parks and wildlife sanctuaries (Sharma 2022). During the 16th–19th centuries, rhinoceroses were a favourite target of hunters, who regarded the animals' imposing size and appearance as a testimony to their abilities. This intensive hunting played a significant role in the decline of rhino populations in the region (Dutta 1991). In addition, the species' range and population have gradually diminished over the time due to habitat fragmentation, driven by rapid socio-economic change, and poaching. Being a K-selected species (long gestation, long calving intervals, slow maturity, and single offspring) has made rhinos vulnerable to these pressures (Dutta 2018). By the end of the 19th century, the GOH rhino population in India was limited to Assam's Brahmaputra valley, Northern Bengal, Northern Uttar Pradesh, Bihar, and a small population in southern Nepal. GOH populations are now confined to small, isolated protected areas, resulting in genetic drift, making surviving populations vulnerable to stochastic environmental events (Dutta 2018). Additionally, the concentration of remaining animals in small home ranges increases competition for space and resources, leading to clashes and injuries. This highlights the need for range expansion through translocation to ensure longer-term species conservation.

Translocation involves releasing an animal into the wild to re-establish or increase its population, and also to avoid diverged and isolated genetic lineages. It is a valuable tool for the recovery of species in response to multiple conservation challenges (Griffith et al. 1989). Post-translocation monitoring plays a pivotal role in the success of rhino conservation initiatives, to ensure that the translocated animals thrive in their new environment (Emslie et al. 2009). It enables tracking of behavioural adaptations and reproductive success and allows managers to detect and respond promptly to potential poaching threats (Dutta 2018). Furthermore, conducting a comprehensive assessment of survival and health is vital for early identification of any health-related risks (Jnawali 1995; Emslie et al. 2009). To evaluate the suitability of rhino habitats and the availability of essential resources, rigorous monitoring and continuous observation are essential.

Manas National Park (MNP) is located in Assam, India along the international border with Bhutan. MNP has suitable rhino habitat and prior to 1989 there was a population of over 100 rhinos. By the year 2000, the entire rhino population of the MNP had been exterminated by poaching. In 2005, the government of Assam, with support from the International Rhino Foundation (IRF), World Wide Fund for Nature (WWF) and the United States Fish and Wildlife Service (USFWS), launched the Indian Rhino Vision 2020 (IRV-2020) programme. The objective was to protect the current rhino populations in Assam and relocate rhinos to protected areas (PAs) where they previously inhabited. The programme aimed to achieve a population of 3,000 rhinos in seven PAs in Assam by 2020. Under IRV-2020, 22 rhinos were translocated from Kaziranga National Park (KNP) and Pobitora Wildlife Sanctuary (PWS) to MNP between 2008 and 2021.

This study had the following objectives: to ascertain (i) the behaviour of translocated rhinos in MNP; and (ii) their utilization of habitats in the Park. In this way, the study aimed to improve the understanding of the adaptation and habitat preferences of translocated rhinos in MNP.

Study area

MNP was listed as a UNESCO World Heritage Site in 1985 and is the core area of the Manas Tiger Reserve (MTR). MNP is located in the foothills of the Himalayas in the northern Brahmaputra valley and is situated between latitude 26°30' and 27°00' N and longitude 91°51' and 92°00' E (Fig. 1). The climate is tropical; the monsoon (June–September) is the hottest season with high humidity and the wettest period of the year, while winter (December–February) is characterized by cool, dry weather and fog. The pre-monsoon season (March–May) and the retreating monsoon (October–November) are transitional periods (Barthakur 1986). Average monthly temperature and rainfall range between 27 ± 6°C and 2,860 mm respectively during the monsoon and 20 ± 5°C and 114 mm respectively during winter months.

The MNP comprises alluvial grasslands, a semi-evergreen forest, and moist and dry deciduous forests, located at between approximately 50 and 250 m AMSL. The Manas–Beki river system provides a constant source of water for the diverse wildlife and vegetation of the Park. MNP is famous for its rich floral and faunal biodiversity, with notable fauna including threatened species such as tiger (*Panthera tigris tigris*), pygmy hog (*Sus salvanius*), golden langur (*Trachypithecus geei*), hispid hare (*Caprolagus hispidus*), Bengal florican (*Houbaropsis bengalensis*), and white-winged wood duck (*Cairina scutulata*).

The MNP was declared a sanctuary in 1928 with an area of 360 km^2. Prior to the declaration of the sanctuary, it was a reserved forest known as the Manas Reserve Forest (RF) and the North Kamrup Reserve Forest, established in 1905 (area: 500 km^2), and declared a national Park in 1990. (Wikipedia 2023). In 2016, 350 km^2 of the Manas Reserve Forest was added to MNP, marking the first stage of planned rhino range expansion. The MNP is bounded to the north by Royal Manas National Park of Bhutan and to the east and west by buffer zones of the MTR. The southern boundary of the MNP is contiguous with densely populated human settlements and agricultural areas. There are three forest ranges within MNP, namely, Panbari (Western Range), Bansbari (Central Range) and Bhuyanpara (Eastern Range).

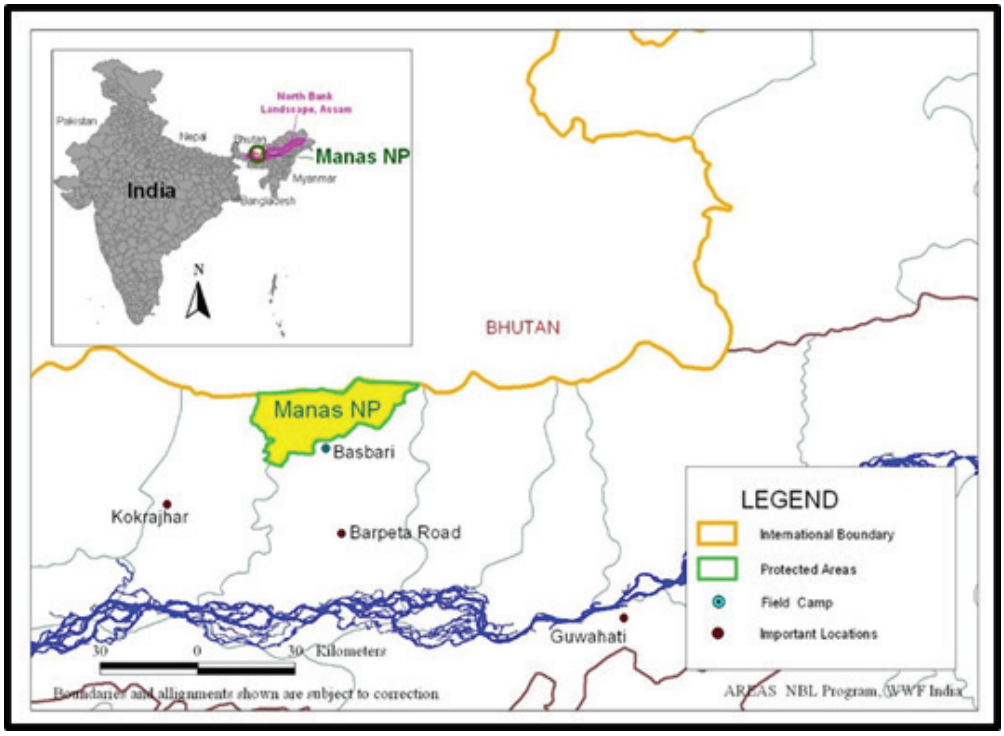

Figure 1. Location of Manas National Park. (© *WWF-India*)

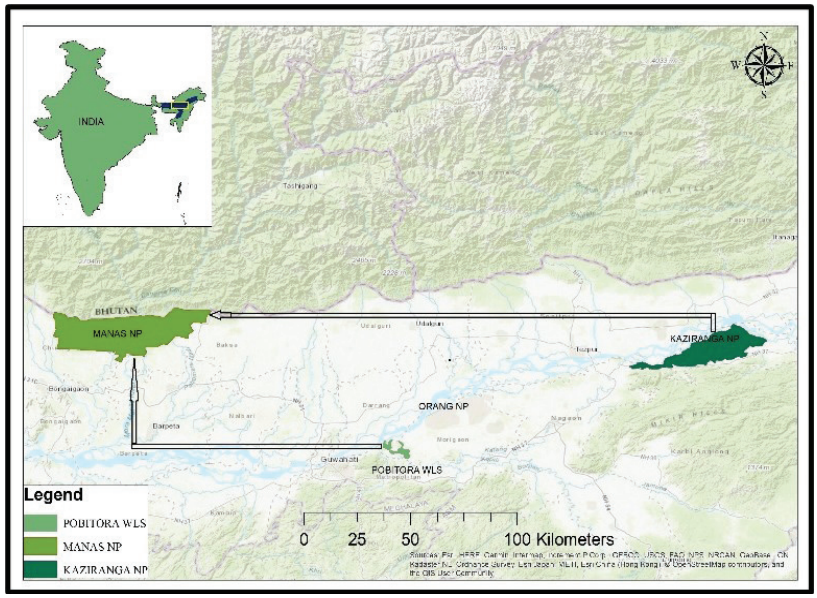

Figure 2. Translocated rhinos source sites KNP and PWS with MNP.

Material and methods

Ten translocated rhinos in MNP were studied to document their behaviour over a five-year period from 2008 to 2013. The number of rhinos monitored increased over the study period, starting with rhinos R1 and R2, the first to be reintroduced. In total 18 rhinos were released: 10 rhinos from PWS and eight rhinos from KNP (Fig. 2), (Table 1). However, due to the difficulty of accessing some of the terrain, such as swamps and rivers, only 10 rhinos were located consistently and could be monitored: three adult males (R1, R2 and R5), three adult females with calves (R3, R6 with calf R7, and R13 with calf R14; Fig. 3) and one solitary female (R8). R3 and her calf R4 separated after translocation, and the calf was not part of the monitoring study.

Rhinos were radio collared using high-frequency (VHF) radio collars at the capture sites (KNP and PWS). The tracking of the rhinos was carried out using directional antennae (Telonics RA-14K antennae, 148–152 MHz) and VHF radio receivers to record the data (Communication Specialists, R-1000 receiver, 148–152 MHz). A directional compass was used to triangulate rhino locations in dense and tall vegetation, and Windows software Locate II and Locate III were used to obtain spatial information. Camera traps were used to monitor rhinos in more inaccessible areas. The rhinos were ear-notched following the IUCN-AsRSG methods (Fig. 4) at the capture sites to ensure permanent identification, complementing the use of radio collars for real-time tracking and monitoring. As a result, rhinos could be recognized even if their radio collars stopped working (Dutta 2018). Immediately on release, the rhinos were monitored three times a day, in the morning (06:00–0.00), midday (10:00–14:00) and late afternoon (14:00–18:00). Sometimes, they were also located at night (18.00–06:00), depending on accessibility. During the monitoring process, patrolling elephants were used, as well as four-wheel jeeps, motor bikes and bicycles (Fig. 5); sometimes rhinos were tracked on foot to acquire GPS coordinates.

Behaviour sampling (Altman 1974) was conducted whenever a direct observation was made. Following this method, which focuses on a particular behaviour rather than a particular rhino, all occurrences of specified actions were recorded during a predetermined sample period of one hour. Behavioural categories were broadly defined as: grazing, wallowing, walking, browsing, and resting (Table 2). Temporal activity refers to actions or events that occur over a specific period of time or are related to time. Behavioural states were recorded if they lasted more than one minute (Kandel and Jhala 2008). All data were recorded and analysed with the support of MS Excel.

Table 1. Translocated rhinos details from the year 2008–2013

Batch No.	Details of Translocated rhinos			Place of origin	Date of release at MNP
	No. of Rhinos	Description	Code Nos.		
1	2	Two adult males	R1, R2	PWS	12 Apr 2008
2	2	Adult female with female calf	R3, R4	PWS	28 Dec 2010
3	4	Adult female with male calf	R6, R7	PWS	18 Jan 2011
		One adult male	R5	PWS	
		One adult female	R8	PWS	
4	2	Two adult females	R9, R10	PWS	9 Jan 2012
5	4	Adult female with female calf	R12, R11	KNP	20 Jan 2012
		Adult female with male calf	R13, R14	KNP	
6	4	Adult females with male calf	R15, R16	KNP	12 March 2012
		Adult female with male calf	R17, R18	KNP	

Figure 3. Release of Rhinos 13 and 14 at Buraburijhar, MNP.

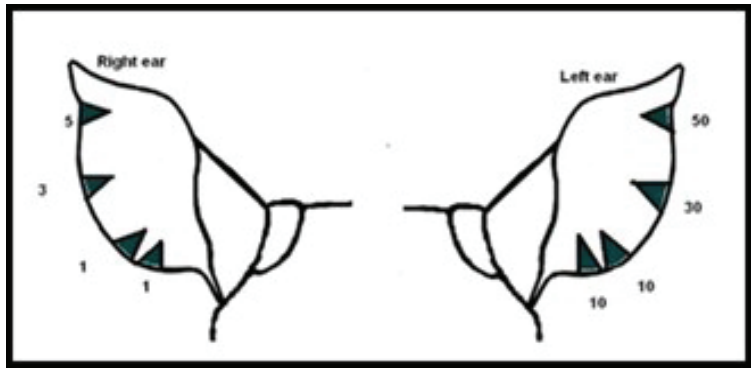

Figure 4. GOH ear notching method (Courtesy of AsRSG).

Spatial data were plotted and analysed using ArcGIS 9.2 and ArcView 3.2a (ESRI 2006). Two non-parametric techniques were used to estimate home range size: minimum convex polygon (MCP) (Mohr 1947) and fixed kernel density (FKD) (Worton 1989). The animal's core area encompassed 50% of its utilization distribution, while its home range extended to 95% of the distribution (Powell 2000). The core area home range was estimated using CALHOME (Kie et al. 1996); ArcGIS 9.2 (ESRI 2006), Hawth's Tool, and Home Range Tool (Rodgers et al. 2007). Bonferroni confidence interval was used to determine habitat preference (Neu et al. 1974; Byers et al. 1984). Habitat information was derived from a satellite image of habitat data from IRS P6 LISS III of November 2013.

Results

The study period yielded 4,941 radio-tracked locations, 4,879 locations were used for home range analysis (1,822 locations for three adult male rhinos; 1,842 for four adult females; 1,015 for two male calves; and 200 locations for one female calf) and repeated locations were discarded for some of the analyses. In terms of seasonal behavioural analysis, 1326 locations were recorded in the pre-monsoon period, 1840 during the monsoon, and 642 and 1133 locations in the receding monsoon and winter season, respectively. Tracked rhinos could not always be observed directly due to difficult terrain and dense vegetation. The study yielded a total of 3711 observations: 1089 in the pre-monsoon period, 1323 during the monsoon, and 491 and 808 observations in the receding monsoon and winter season, respectively.

Table 2. Ethogram of rhinoceros' behaviour

Type of behaviour	Description
Grazing	Approached grasses and observed with fodder in mouth
Browsing	Approached bushes, tree twigs, observed with fodder in mouth while standing or walking
Resting	Rhino in resting position (lying or sitting), inactive and relaxed
Walking	Rhino moving attentively
Wallowing	Almost all parts of body immersed in mud and water

Figure 5. Rhino tracking from the top of a range patrol vehicle at Kuribeel area, MNP.

Behaviour in first 90 days after release

Observations of rhinos during the 90-day monitoring period after release were incorporated into seasonal data (see below), but also analysed separately to assess behaviour during the settling-in phase. In total, the 10 rhinos were located 891 times during their respective initial monitoring periods. The three adult males accounted for 33% (n = 294), the four adult females for 41% (n = 362) and the three calves for 26% (n = 235) of observations. In this period, non-uniform and unusual patterns of behaviour was observed among adult males, adult females and calves (Table 3).

Seasonal activity patterns of rhinos

Pre-monsoon period

During this season (March–May), rhinos were tracked 1,326 times and observed 1,089 times (82%). There were 237 (18%) instances in which rhinos couldn't be found due to difficult terrain and dense vegetation. Adult males, adult females and calves were observed on 425 (39%), 398 (37%), and 266 (24%) occasions respectively. No marked behavioural variations were observed among the three age/sex groups, based on the average time engaged in different activities as a proportion of the total observation time (Table 4).

Monsoon period

During the monsoon (May–September), rhinos were tracked 1,840 times and observed 1,323 times (72%). It was not possible to locate rhinos on 517 occasions (28%) during the study period. Adult males, adult females, and calves were observed on 654 (49%), 367 (28%) and 302 (23%) occasions respectively (Table 3). During the monsoon, a non-uniform pattern of behaviour was observed among all age groups.

Retreating monsoon

This is a short season (October–November). During this period, rhinos were tracked 642 times and observed 491 times (76%). There were 152 (24%) instances in which rhinos were not located during searches. Adult males, adult females, and calves were observed on 186 (38%), 171 (35%) and 134 (27%) occasions, respectively (Table 5). During this season, no specific behavioural variations were observed among the three groups of rhinos.

Winter season

During the dry winter season (December–February), rhinos were tracked 1,133 times and observed 808 (71%) times. The rhinos were not found 325 times (29%) during the search. Adult males, adult females, and calves were observed on 464 (57%), 161 (20%) and 183 (23%) occasions, respectively (Table 4). During the winter season, distinct variations in behaviour were observed among the three age groups of rhinos.

Temporal activity pattern of rhinos

During the pre-monsoon season, in response to an increase in rainfall and temperature compared to the preceding winter months, rhinos of all age groups became more active in the morning and in the evening. In the monsoon season, adult males were more active during the morning and night, while adult females and calves were active during the morning and afternoon (Table 6).

Rhinos of all age groups were more active in the morning and afternoon during the retreating monsoon. During winter, rhinos of all ages were found to be active in the morning and afternoon, with very few activities at night (Table 7).

Home ranges, ranging areas and association patterns of translocated rhinos

An asymptote curve was generated to understand the relationship between the number of data points (locations) collected at 10-day intervals and the corresponding home range size, calculated as 100% MCP, for adult male and female rhinos. The analysis indicates that adult male rhinos tend to establish their home range at approximately 210 distinct locations, and at this point, they occupy an estimated average area of 130.30 km^2. In contrast, adult female rhinos reach a similar stabilization point at approximately 270 locations, where their habitat utilization levels off. At this stage, they occupy an average area of 67.71 km^2. Based on analysis of tracked locations, adult males' home ranges, calculated as 100% MCP, ranged from 93.35 km^2 to 207.50 km^2, those of adult females from 35.31 km^2 to 134.14 km^2, and those of rhino calves from 53.75 km^2 to 111.36 km^2 (Table 8).

During the pre-monsoon period, adult males and females were observed to be associated in an area of approximately 64.8 km^2 in the central Bansbari range (Fig. 6). In the monsoon period, their association was observed in a reduced area of approximately 56.0 km^2

Table 3. Percentage of total observation time (mean ± SD) that GOH engaged in different activities, during the first 90 days after translocation

	Settling-in phase		
Activity	**Adult males**	**Adult females**	**Calves**
Grazing	45 ± 3	47 ± 1	45 ± 1
Browsing	8 ± 1.1	7 ± 1	10 ± 2
Resting	15 ± 3.1	12 ± 2	12 ± 4
Walking	13 ± 1.6	17 ± 5	17 ± 5
Wallowing	19 ± 1	17 ± 2	16 ± 4

Table 4. Percentage of total observation time (mean ± SD) that GOH translocated to MNP engaged in different activities, during pre-monsoon and monsoon seasons

	Pre-monsoon			Monsoon		
Activity	**Adult males**	**Adult females**	**Calves**	**Adult males**	**Adult females**	**Calves**
Grazing	44 ± 6	61 ± 2.6	61 ± 3	54 ± 4.2	69 ± 4	59 ± 1.4
Browsing	12 ± 2.07	6 ± 1.8	6 ± 0	0	0	5 ± 3.2
Resting	6 ± 3	6 ± 1.5	6 ± 3	1 ± 0.5	4 ± 2	6 ± 1.4
Walking	13 ± 1.6	17 ± 5	17 ± 5	20 ± 4	17 ± 4	24 ± 13.1
Wallowing	25 ± 6.3	10 ± 0.4	10 ± 3	25 ± 1.3	10 ± 1	6 ± 2

Table 5. Percentage of total observation time (mean ± SD) that GOH translocated to MNP engaged in different activities, during retreating monsoon and winter seasons

	Retreating monsoon			Winter		
Activity	**Adult males**	**Adult females**	**Calves**	**Adult males**	**Adult females**	**Calves**
Grazing	65 ± 4	67 ± 9	83 ± 1.6	37 ± 3.25	51 ± 3.3	53 ± 2.7
Browsing	13 ± 7	0	1 ± 0.8	23 ± 2.1	12 ± 7.05	10 ± 3.2
Resting	2 ± 1	1 ± 1	3 ± 1	11 ± 2.1	5 ± 1.9	8 ± 1.04
Walking	12 ± 4	20 ± 10	9 ± 3	15 ± 3	23 ± 4.06	20 ± 3
Wallowing	8 ± 5	12 ± 4	4 ± 2.4	14 ± 0.7	9 ± 1.9	9 ± 2.1

Table 6. Time (mean ± SD) engaged in temporal activities by translocated GOH in the MNP, during pre-monsoon and monsoon seasons

	Pre-monsoon			Monsoon		
Time slot*	**Adult males**	**Adult females**	**Calves**	**Adult males**	**Adult females**	**Calves**
Morning	8 ± 0.1	7 ± 0.1	6 ± 0.4	5 ± 0	5 ± 0.1	5 ± 4
Mid-day	3 ± 0.2	2 ± 0.2	4 ± 0.4	3 ± 0.2	2 ± 0	2 ± 0.1
Afternoon	7 ± 0.1	8 ± 0.1	8 ± 0.2	4 ± 0.2	8 ± 0.1	8 ± 0.1
Night	3 ± 0.2	2 ± 0.1	2 ± 0.4	8 ± 0.1	5 ± 0.2	5 ± 0.4

*Time slots: Morning 06:00–10:00; mid-day 10:00 am–14:00; afternoon 14:00–18:00; night 18:00–06:00.

(Fig. 7), in the same area. During the retreating monsoon, the corresponding area was approximately 53.8 km^2, covering the central areas of Bansbari and some parts of the eastern Bhuyanpara range. In the winter season, while rhinos ranged widely over the Bansbari and Bhuyanpara ranges, with a total association area of about 80.7 km^2, they were mainly found to concentrated in Bansbari and limited areas of Bhuyanpara.

The total area covered by all individual rhinos within the MNP was 280 km^2 with the central area of Bansbari range serving as the core zone. However, males spent much of the time in the eastern the Bhuyanpara range, where females were absent (e.g. the 80% range area of adult male R5 was located in the Bhuyanpara range), while calves also occupied the western Kahitama area of the Bansbari range (e.g the 70% range area of female calf R11 was in this area) (Fig. 8).

A rhino is considered 'stray' when it ventures outside the boundary of a protected area. There were 195 'stray' incidents recorded among the rhinos during the period of 2008–2013. Stray incidents were more frequent among adult males (n = 121) than adult females (n = 74). Out of 195 incidents, 95% (n = 186) took place in nearby areas (within 1–2 km distances) of MNP boundary, mainly in monsoon season (Fig. 9).

Habitat preferences

The translocated rhinos spent most of their time in grasslands and swampy habitats. They sought out relatively scarce swampy habitats and spent relatively little time in woodland habitats, even though these cover a large part of the MNP. Adult males showed a particular affinity for swampy habitats; more so than females and calves (Tables 9, 10, 11).

Discussion

This study utilized a comprehensive data set obtained from continuous monitoring activities conducted day and night over a period of six years (2008–2013), which gave a solid foundation for analysing the home ranges of translocated rhinos and yielded valuable insights into their behaviour and habitat use throughout different seasons.

To ensure the safety and well-being of the translocated rhinos in their unfamiliar surroundings, strict monitoring measures were implemented immediately after their release in MNP. Subsequently, the rhinos embarked on a journey of exploration, seeking optimal habitat within and around the release site, as would be anticipated. It is understood that this period of acclimatization facilitates gradual adaptation to the new environment. R1 and R2, the first rhinos reintroduced to MNP, exerted a profound influence on the establishment of home ranges and the subsequent behaviour of the other 16 translocated rhinos, including the other eight rhinos observed in this study. There were no distinct behavioural variations during the 90-day settling-in phase compared with those observed in wild rhino behaviour studies such as Laurie (1982); Hazarika (2007); Dutta et al. (2017); Dutta (2018).

A distinct seasonal variation in activities (Tables 4 and 5) was observed among rhinos. Maximum grazing activity was observed in the monsoon and in the retreating-monsoon season, and minimum grazing during the winter season. The adult rhinos were not observed to browse during the monsoon season. These patterns differ from those observed in areas with high flood risks such as KNP, PWS, and Orang NP. MNP's slightly higher elevation protects rhinos from annual river floods. Furthermore, the grasslands in MNP provide rhinos with an abundant and succulent source of food, so browsing is unnecessary during the monsoon season. Hazarika (2007) and Laurie (1982) both mention that

Table 7. Time (mean ± SD) engaged in temporal activities by translocated GOH in the MNP, during retreating monsoon and winter seasons

	Retreating monsoon			Winter		
Time slot	**Adult males**	**Adult females**	**Calves**	**Adult males**	**Adult females**	**Calves**
Morning	6.9 ± 0.2	6.3 ± 0.1	7 ± 0.1	6 ± 0.1	7 ± 0.4	7 ± 0.4
Mid-day	3.6 ± 0.1	1.6 ± 0.4	2 ± 1	4 ± 0.1	3 ± 0.2	4 ± 0.1
Afternoon	6.1 ± 0.1	9 ± 0.1	9 ± 0.2	9 ± 0.2	8 ± 0.3	3 ± 0.2
Night	4.5 ± 0.2	2 ± 0.2	3 ± 0.1	1 ± 0.1	2 ± 1	2 ± 0.1

grazing and browsing activities vary with available grass and its palatability. In MNP, there is a scarcity of naturally palatable grasses during the dry season, which explains the lower grazing activity observed in winter, compared to other seasons. During this season, the population becomes more dependent on browsing tree saplings, creepers, shrubs, and other vegetation for food.

Resting activity was at a maximum during the dry winter season and the pre-monsoon season. The rhino calves were often observed to rest after exploring a new territory with their mother. However, adult females with calves remained vigilant, showing minimal resting behaviour and their care for their offspring was constant (Dutta et al. 2017; Dutta 2018).

Table 8. Home ranges of translocated rhinos

Rhino ID	Gender/age	100% MCP home range
R1	Adult male	93.35
R2	Adult male	168.95
R3	Adult female	95.40
R5	Adult male	207.50
R6	Adult female	35.31
R7	Male calf	53.75
R8	Adult female	96.13
R11	Female calf	90.66
R13	Adult female	134.14
R14	Male calf	111.36

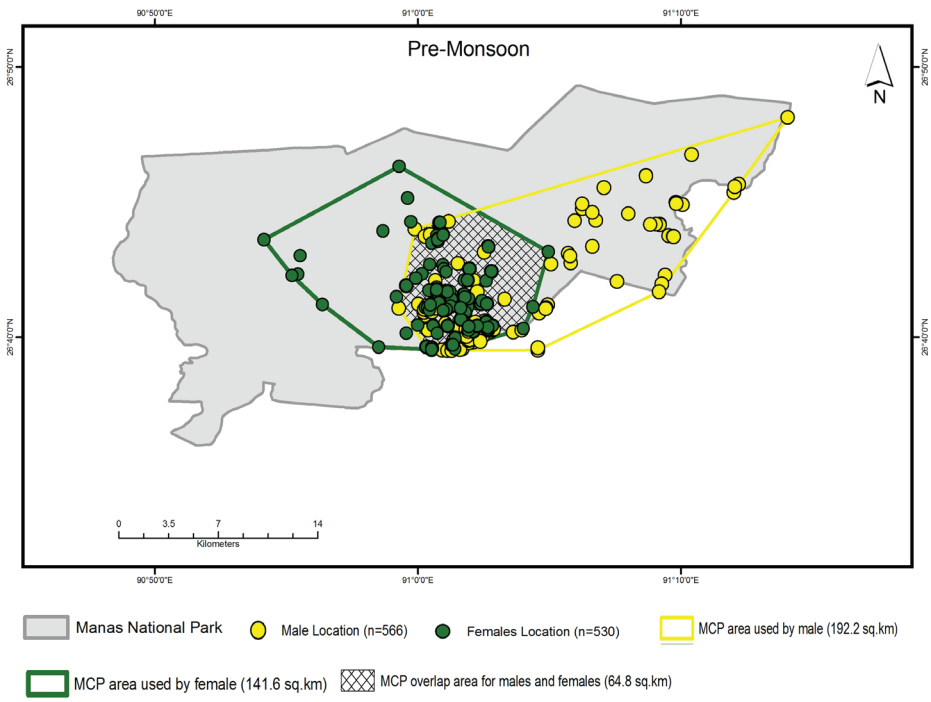

Figure 6. Areas of association of adult male and female rhinos before the pre-monsoon.

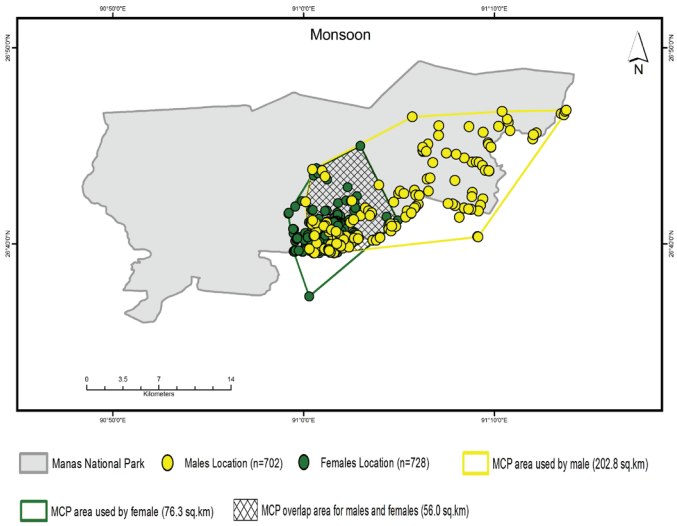

Figure 7. Areas of association of adult male and female rhinos during the monsoon.

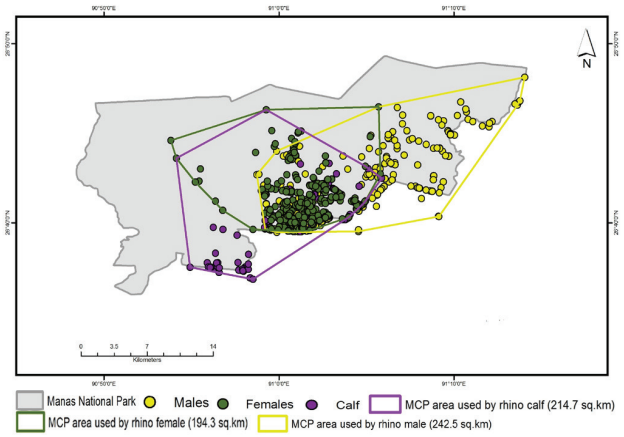

Figure 8. Total ranging areas of rhinos in MNP.

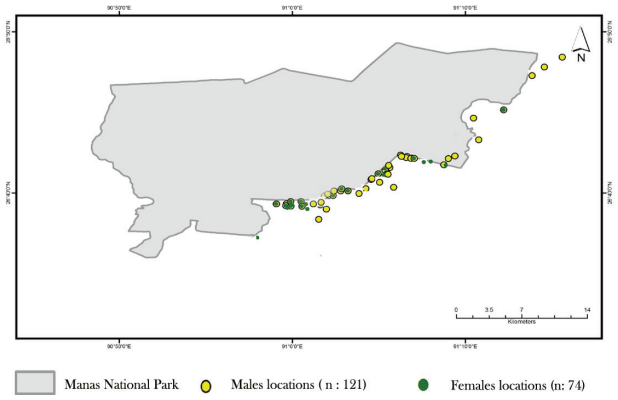

Figure 9. Stray zones of rhinos.

Table 9. Utilization availability data for habitat types in the MNP (adult males)

Habitat types	Total area (km^2)	Proportion of total area	Expected no. occurrences*	Observed no. of instances	Observed proportion
Grassland	206.30	0.43	811	965	0.51
Swamp	17.50	0.04	68	655	0.35
Water bodies	22.55	0.05	88	95	0.09
Woodland	233.20	0.49	917	172	0.05
Total	479.55	1.00	1,884	1,887	1.00

*I.e. if the animals showed no preference for one habitat over another.

Table 10. Utilization availability data for habitat types in the MNP (adult females)

Habitat types	Total area (km^2)	Proportion of total area	Expected no. occurrences	Observed no. of instances	Observed proportion
Grassland	206.30	0.43	787	1384	0.76
Swamp	17.50	0.04	66	271	0.15
Water bodies	22.55	0.05	86	83	0.04
Woodland	233.20	0.49	889	92	0.05
Total	479.55	1.00	1,828	1,830	1.00

Table 11. Utilization availability data for habitat types in the MNP (rhino calves)

Habitat types	Total area (km^2)	Proportion of total area	Expected no. occurrences	Observed no. of instances	Observed proportion
Grassland	206.30	0.43	522	881	0.72
Swamp	17.50	0.04	44	216	0.18
Water bodies	22.55	0.05	57	70	0.06
Woodland	233.20	0.49	590	47	0.04
Total	479.55	1.00	1,213	1,214	1.00

In their new habitat, adult males were observed to move from one place to another, seeking food or interacting with adult females (Dinerstein 2003). A noticeable increase in walking activity was observed among adult males during the monsoon season, indicating active movement within the habitat ranges. This trend also led to an increase in the incidents of straying during this time-frame. However, as time progressed, the number of rhinos straying decreased, suggesting gradual adaptation and settlement in their new habitat within MNP.

Overall, no marked differences were observed in the behaviour patterns (grazing, browsing, wallowing, walking, resting) of translocated rhinos in MNP, compared to the behaviour of other wild rhinos as reported by Laurie (1982), Jnawali (1995) and Dinerstein (2003) in Nepal; and Dutta (1991), Patar (2004), Bhatta (2011) and Hazarika (2007) in Assam. The behavioural similarity between translocated rhinos and wild rhinos indicated that rhinos had adapted well to the new environment in MNP.

The core home ranges of translocated rhinos in MNP varied among seasons and age groups (Figs. 6–7). Adult males typically have the most extensive and variable core home ranges, while adult females tend to occupy smaller, yet still variable core home ranges, with calves maintaining relatively small and consistent core home ranges. These core home range patterns illustrate the rhinos' habitat preferences and are critical for understanding their use of habitat and resources and for effective conservation management of the Park's rhino population (Dutta 2018).

Translocated rhinos showed a strong preference for grassland and swamp habitats for rhinoceros and were seldom observed in woodland habitats. In the grassland and swamps, a large number of natural water bodies are present which were extensively used by rhinoceros mainly for wallowing and rest. However, large water bodies like the river Beki were generally avoided by the rhinos, except for occasional drinking. This seasonal habitat shift observed in MNP is similar to those recorded by Subedi (2012) and Adhikari (2015) in Chitwan NP and by Bhatt (2011) in PWS.

Rhinos tended to associate in central areas of the Bansbari range, which could be due to the highly nutritious food quality, and quantity of food, as well as more secure protection measures. Females accompanied by male calves formed prolonged associations, while other associations between individuals were relatively shorter. Adult males R1 and R2 formed a social bond at the start of the study period when other rhinos were absent. The frequency of association between adult males and adult females varied. In Bansbari, adult male R2 and adult female R6 formed a common association that lasted for about 14–20 days. This occurred just 90 days after the release of R6 and culminated with her mating with R2 and the birth of a male calf in 25 months 5 days. During much of study period R2 shared a home range with R6 (and her male calf R7) and no conflict between them was observed.

During and after the study period, courtship and mating became frequent among translocated rhinos. All courtship observations were recorded in the late evening or at night. The maximum pre-mating courtship pairing was observed from pre-monsoon to monsoon season (March-September) and most births occurred in the retreating monsoon seasons. Translocated female rhinos gave birth in thick grassland and dense woodland within secluded areas of the Park. Their offspring may have been protected due to this coveting behaviour. Owen-Smith (1988) mentions similar site selection seclusion of adult female white rhinos in South Africa in their natural habitat. Thirty-eight calves were born after the rhino reintroduction at MNP between 2011 and 2021.

Conclusion

According to the official record for 2022, there are now 50 rhinos in total in MNP, including 38 calves born after reintroduction. Going forwards, the newly established rhino population should continue to thrive in MNP with effective anti-poaching measures, effective habitat management, community engagement, disease surveillance, India-Bhutan cooperation, and collaborative efforts.

Compared with the behaviour of rhino populations in the wild documented in previous studies, the translocated rhinos did not exhibit significant differences in their behaviour and ranging patterns. This suggests that the translocated rhinos were able

to adapt effectively to their new environment after relocation. The success of the rhino reintroduction programme has enhanced GOH conservation in India and provided valuable procedural and technical guidelines for future rhino translocation programs.

The establishment of the GOH population at MNP through the wild-to-wild translocation programme under IRV-2020 opened a new dimension in the conservation efforts for the largest of the Asian rhinos three species. Translocation has resulted in the revival of the entire Park infrastructure, anti-poaching schemes, management interventions, and recovery of other wildlife populations. Tourism has also been revived in MNP, and local communities have started benefiting from this. However, anthropogenic pressures and inadequate habitat management practices have continued to affect rhinos' ranging and habitat preferences, as well as their preferred food plants. This study strongly emphasizes the need for continued protection of rhinos.

Specifically, to ensure the future survival and well-being of the newly established rhino population at MNP, several crucial measures are recommended. These include the implementation of genetic management plans to maintain genetic diversity and prevent inbreeding; sustainable habitat management practices to restore preferred rhino habitats; and the establishment of a robust disease surveillance system to safeguard against potential health threats. Furthermore, community engagement initiatives should empower local communities with a sense of pride and responsibility for rhino conservation, and anti-poaching efforts must be fortified to protect the population from poaching threats. Sustainable tourism management should be prioritized to minimize disturbances to rhinos while generating revenue for conservation. Transboundary cooperation between India and Bhutan can greatly benefit interconnected wildlife and ecosystems, and collaboration among governments, conservation organizations, and local communities is essential for effective conservation of this iconic species.

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FIELD NOTES

Bridging the Rift: demonstrating large mammal landscape connectivity from Amboseli National Park to the greater Maasai Mara

Vicki Fishlock[1,2], Lydia Tiller[1], Norah Njiraini[1], Catherine Sayialel[1], Phyllis Lee[1], Cynthia Moss[1], Joseph Mukeka[3], Shadrack Ngene[3], Patrick Omondi[3]*

[1]Amboseli Trust for Elephants, PO Box 15135, Nairobi 00509, Kenya
[2]Centre for Ecology and Conservation, University of Exeter, Exeter EX4 4PY, UK
[3]Wildlife Research and Training Institute, PO Box 20117, Naivasha 20117, Kenya

*corresponding author: vfishlock@elephanttrust.org

Introduction

Elephant movements are non-random, driven by the need for resources such as food and water (Western and Lindsay 1984) and social and reproductive opportunities (Croze and Moss 2011). Savannah elephants are sexually segregated, meaning that males and females use landscapes very differently (Stokke and Du Toit 2002; Shannon et al. 2006). However, for both sexes, movement patterns vary by season and habitat (Duffy et al. 2011) and are affected by both anthropogenic influences (Graham et al. 2009; Loarie et al. 2009) and individual life history stage. Individual movement patterns are also highly variable, with a five-fold difference in home range sizes commonly reported within the same study (Ngene et al. 2017). With such high variability and sensitivity to environmental and anthropogenic change (Goldenberg et al. 2018; Ihwagi et al. 2018), most of the research to date focuses on individuals already in adulthood, where strategies for males centre on growth, competition, and reproductive opportunities (Taylor et al. 2020), or on pressures at the human-elephant interface such as crop foraging or fence breaking (Wilkie and Douglas-Hamilton 2018; Troup et al. 2020).

Despite the persistent myth that males are solitary, a growing body of evidence shows that, like females, male elephants socialize have long-standing bonds and friendships (Lee et al. 2011), depend on knowledgeable others (Allen et al. 2020), and require social stability for individuals to develop successfully (Slotow and Dyk 2001). How then do males manage this transition from a matriarchal multigenerational family structure, to mature individuals balancing friendships and the intensity of male-male competition (Evans and Harris 2008; Poole et al. 2011; Murphy et al. 2019)? If males are indeed risk-takers (Chiyo et al. 2011), then how do they buffer and manage risks as they develop their own strategies, and what are the long-term consequences of early experience and strategy adoption for survival and reproductive success? To answer this first question regarding the transition to independent ranging, in 2019 the Amboseli Trust for Elephants (ATE) fitted eight collars to dispersal-age males. In this paper, we focus on the movements of one male, *Esposito*, as a case study in ecosystem connectivity.

Figure 1. *Esposito*, in May 2021 during a routine check to ensure that his collar fitted well. © *Amboseli Trust for Elephants*

Methodology

The life histories of Amboseli elephants have been continuously monitored since 1972, following methodologies described by Moss et al. (2011). The targets for the collaring study were selected based on known dispersal dates and family history. Savannah Tracking Ltd GSM-satellite collars were fitted in July 2019, set to hourly fixes and a minimum 12-hourly reporting schedule. Permissions were obtained from the Kenya Wildlife Service (KWS), and deployment was carried out with the support of a KWS vet and fitting team from Save the Elephants (STE). The collars were monitored for fit whenever the animals were resighted. *Esposito*, born in May 2003 to the EA family (first identified in September 1972) was 16.16 years old at the time of collaring (Fig. 1). As the oldest son of his mother, he had started spending time away from his family at the age of 11.0 years and was fully independent by age 12.75 (within the normal range of 7.42–19.9 years, median age 14.5 years (Lee et al. 2022). After independence, *Esposito* was sighted four times during ATE's long term monitoring.

Results

After collar deployment in 2019, *Esposito* showed a sedentary pattern, focused in bushland-dominated habitat to the north of Amboseli National Park (NP). From September 2022 he began an incredible journey, covering 1,780 km over 28 weeks (Fig. 2). In the first phase of his journey south of Bisil, he was seen in the company of other elephants, mostly young males, but was not sighted after that. *Esposito's* exploration covered three phases: first movements in a southerly direction to South Rift, second a cross-border movement to Lake Natron, and third walking back to the base of the Ngurumen Escarpment, a known elephant hotspot and connection between the South Rift and the extreme east of the greater Maasai Mara ecosystem. On 23 January 2023 the collar stopped reporting, and supposing unit failure we began searching together with the Mara Elephant Project (MEP) to attempt to recollar *Esposito* but were unable to locate him. On 27 April 2023, MEP rangers recovered *Esposito's* collar in thick forest in the Loita Hills; a straight-line distance of approximately 185 km from the home range of his natal family in Amboseli NP. The collar began reporting again once back in mobile signal and we found it had 'dropped' in early March 2023.

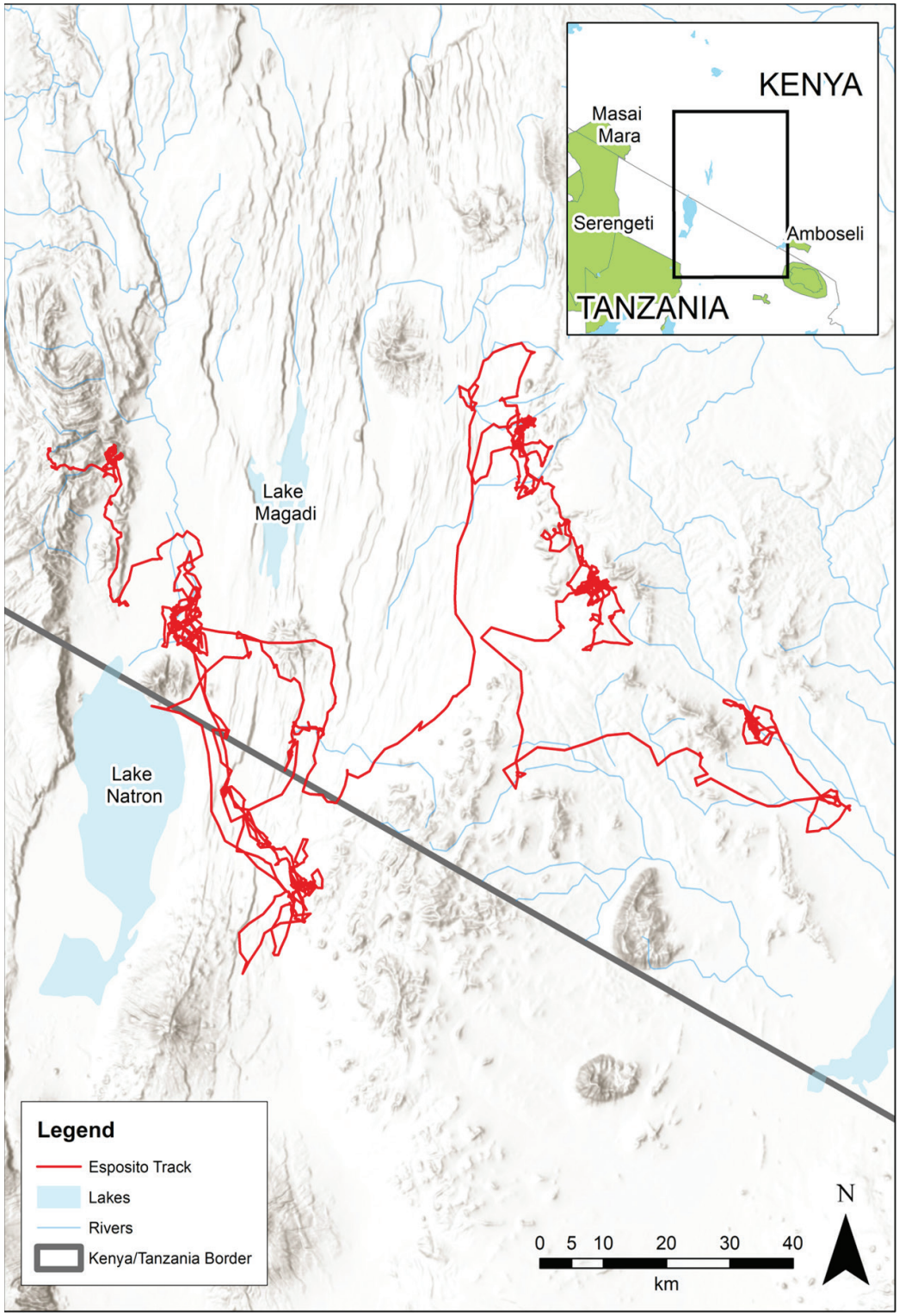

Figure 2. Track movement for male *Esposito*, collared in Amboseli NP and travelling to the greater Maasai Mara ecosystem via Lake Natron.

Discussion

Although the Amboseli elephant population has long been known to be contiguous with those in the Tsavo NPs, Lake Magadi area and Lake Natron West (Kenana et al. 2013; Ngene et al. 2017), this is the first demonstration of elephant population connectivity between Amboseli NP and the greater Maasai Mara ecosystem. This case may be a rare or unique movement in modern times, but at this time of changing land use and land ownership structures (Tyrrell et al. 2022a,b), it is both encouraging to see large mammal connectivity on this scale, and an urgent reminder of what is at stake if conservation policies are allowed to fail (Western et al. 2020). Collaring operations of this type are not without risk—deploying collars ethically should always require a sound exit strategy to avoid compromising welfare, especially because the growth rate of males at this life history stage means collars can easily be outgrown. Nonetheless, we feel further tracking data on this population cohort will help (in combination with other methods, such as genetics) to understand how frequently long-range dispersals occur, and if these are permanent movements or provide bridges where animals move back and forth. *Esposito* returned to Amboseli NP on 27 June 2023, and we were able to recollar him on 1 July, again with support from KWS and STE. With this new collar we expect to be able to confirm any repeat journeys to the Mara.

Acknowledgements

We are grateful to the Kenya Wildlife Service and Save the Elephants for support in deploying collars, and to the Mara Elephant Project for their collaboration in searching for Esposito when the signal failed and ultimately recovering the collar. We thank our donors for supporting our work; the partner network and the communities of Amboseli and SORALO for their cooperation; and the Government of Kenya for permission to work in the Amboseli ecosystem.

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A possible case of congenital tusklessness in a male African elephant (*Loxodonta africana*)

Giacomo D'Ammando[1], David Daballen[1†], David Lolchuragi[1], David Letityia[1], George Wittemyer[1,2], Vincent Obanda[3], Iain Douglas-Hamilton[1], Chris Thouless[1]*

[1]Save the Elephants, PO Box 54667, Nairobi, 00200, Kenya
[2]Colorado State University, Fort Collins, Colorado, USA
[3]Wildlife Research and Training Institute, Naivasha, Kenya

*corresponding author: giacomo@savetheelephants.org

[†]Credit for the discovery of this individual goes to David Daballen

Introduction

The tusks of African elephants (*Loxodonta africana*) have evolved as intra-sexual combat weapons, as well as tools for feeding and digging (Kingdon 2015; LaDue et al. 2021). They are also the target of ivory poaching, which may drive phenotypic and/or genetic selection for tusklessness (Jachmann et al. 1995; Tiedemann and Kurt 1995; Chiyo et al. 2015). Some studies have indeed shown how selective pressures from sustained ivory poaching against tusk-bearing phenotypes could lead to an increase in fitness for tuskless individuals, and thus to the rapid spreading of tuskless phenotypes (Kurt et al. 1995; Steenkamp et al. 2007; Raubenheimer and Miniggio 2016; Campbell-Staton et al. 2021). These studies have, however, focused solely on female African savannah elephants, since congenitally, bilaterally tuskless males (i.e. males that genuinely lack both tusks since birth) seem to be rare to non-existent in this species (see below). However, it should be noted that this condition is common in Asian elephant bulls (*Elephas maximus*), especially from populations with a long history of being hunted for ivory (Kurt et al. 1995; Chelliah and Sukumar 2013).

Here we describe what is, to our knowledge, the first documented occurrence of a potentially congenital tuskless male African elephant↓with tusklessness present from birth, probably due to genetic causes. We substantiate our claims with photographic evidence and long-term observations, while discussing possible hypotheses to explain such a unique phenomenon.

A genetic study on the elephant population of Gorongosa National Park (NP), Mozambique provides a robust explanation for the apparent lack of congenitally tuskless male African elephants. Campbell-Staton et al. (2021) found that tusklessness in female elephants is an inherited condition, deriving from an X-chromosome-linked dominant gene. They propose that this dominant tuskless allele is connected to male lethality↓i.e. the dominant tuskless allele in sex chromosome heterozygosity results in the death of male offspring. This was based on the observation that there were no bilaterally tuskless males in the study population, with a bias towards females in the sex ratio of the offspring of tuskless females↓as all the tuskless male offspring would not survive (Campbell-Staton et al. 2021) unlike in Asia (Kurt et al. 1995). Although comparative demographic data is needed from other sites and the lethality mechanism needs to be further clarified, this seems a plausible explanation for the apparent absence of tuskless males among African elephants.

The hypothesis of Campbell-Staton et al. (2021) is supported by other field observations. Although unilaterally tuskless males have been documented in various African populations (due to yet unknown causes; Jachmann et al. 1995; Whitehouse 2002; Campbell-Staton et al. 2021), bilateral congenital tusklessness in males has not been previously confirmed. In South Africa (Kruger NP and Addo Elephant NP) and in East Africa (Murchison Falls NP, Amboseli NP, and Tsavo NP), long-term research did not produce any evidence for the presence of bilaterally tuskless males (Whitehouse 2002; Whyte and Hall-Martin 2018;

Figure 1. The tuskless male S50.10, photographed at different stages of his life: (a) 2016 (6 years old), (b) 2021 (11 years old), (c) 2022 (12 years old), and (d) 2023 (13 years old).
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Parker 2023). Similarly, a comprehensive review of data from 15 elephant populations across eastern and southern Africa did not find any evidence for bilaterally tuskless males (Steenkamp et al. 2021), and bilateral male tusklessness seems to be absent also from forest elephants (*Loxodonta cyclotis*) in Central Africa (A. Turkalo, pers. comm., 2023). The only documented case of a bilaterally tuskless male in Addo Elephant NP was the result of the loss of both tusks in fights (Hall-Martin 1987). According to Steenkamp et al. (2007), male bilateral tusklessness is very rare (one case out of 10,000 examined elephant pictures), and suggests that most, if not all, of the very few cases of bilateral tusklessness might derive from tusk loss due to trauma. The only other substantiated observations of tuskless males comes from South Luangwa NP (Zambia, n=2; Jachmann et al. 1995) and Queen Elizabeth NP (Uganda, 9.5% of all bulls examined; Abe 1996). A tuskless male was also observed in 2021 in Murchison Falls NP (D. Daballen, pers. comm., 2022); (Fig. 6). Since it was not reported whether tusklessness was congenital or acquired, these cases may also reflect secondary tusk loss during contests (especially since all tuskless bulls in Queen Elizabeth NP appeared to be 'very old'; Abe 1996). However, contrary to this evidence, we observed a young male African elephant in the Samburu-Laikipia ecosystem of northern Kenya, which appeared to be congenitally tuskless.

The tuskless male elephant is a 13-year-old individual identified as S50.10, and part of a family named the 'Hawaiian Islands'. The family consists of five adult females and their offspring, and has been the subject of monitoring and research since the onset of the Save the Elephants project in Samburu National Reserve (NR) in the late 1990s↓although only visiting the core study area during periods of very high rainfall (Wittemyer 2001; Save the Elephants, unpublished data). The tuskless male was first identified on 6 September 2011, when he was approximately one year and four months old↓and therefore too young to bear tusks (the usual age of tusk eruption is generally ~2 years old). We are confident of the estimated age,

since ageing an elephant calf tends to be very accurate via comparisons of relative body size with its mother and siblings and with other known age individuals in the same population. The individual was observed on 19 occasions over 13 years↓with at least one observation per year since identification, except for 2012. This means that, although there are temporal gaps between records, S50.10 could be followed throughout his growth. No tusks or signs of tusk eruption or tusk breakages were observed between 2011 and the present day (Fig. 1).

The first possible explanation for bilateral tusklessness is that the individual is not actually congenitally tuskless, but rather that he broke both off his tusks (or one of them in case he was originally unilaterally tuskless) at an early age. We believe that this is highly implausible for several reasons. First, our long-term records strongly support the conclusion that the individual did not grow tusks at any stage in his development, given that bilateral tusk growth and subsequent breakage at such a young age and between observations was unlikely to go unnoticed. Second, the morphological features of the male face closely mirror those of congenitally tuskless females, based on the examination of close-up pictures. S50.10 presents the characteristic 'pinched' appearance of tuskless females in frontal view, indicating the absence of tusk roots (Fig. 2). His symmetrical appearance makes it improbable that he was unilaterally congenitally tuskless and lost the other tusk to trauma. The morphology of the tuskless male is different from that of an adult male in the Samburu study population who lost his tusks due to trauma during his lifetime: in the latter, tusk sockets are visibly swollen, denoting the presence of tusk roots, with the base of the tusks still slightly protruding from the upper lip (Fig. 3). Finally, potential bilateral tusklessness due to trauma is most likely due to intense fighting, for which the study individual was too young (the age at first full musth is usually around 30 years; Hall-Martin 1987; Poole 1989; Goldenberg et al. 2014).

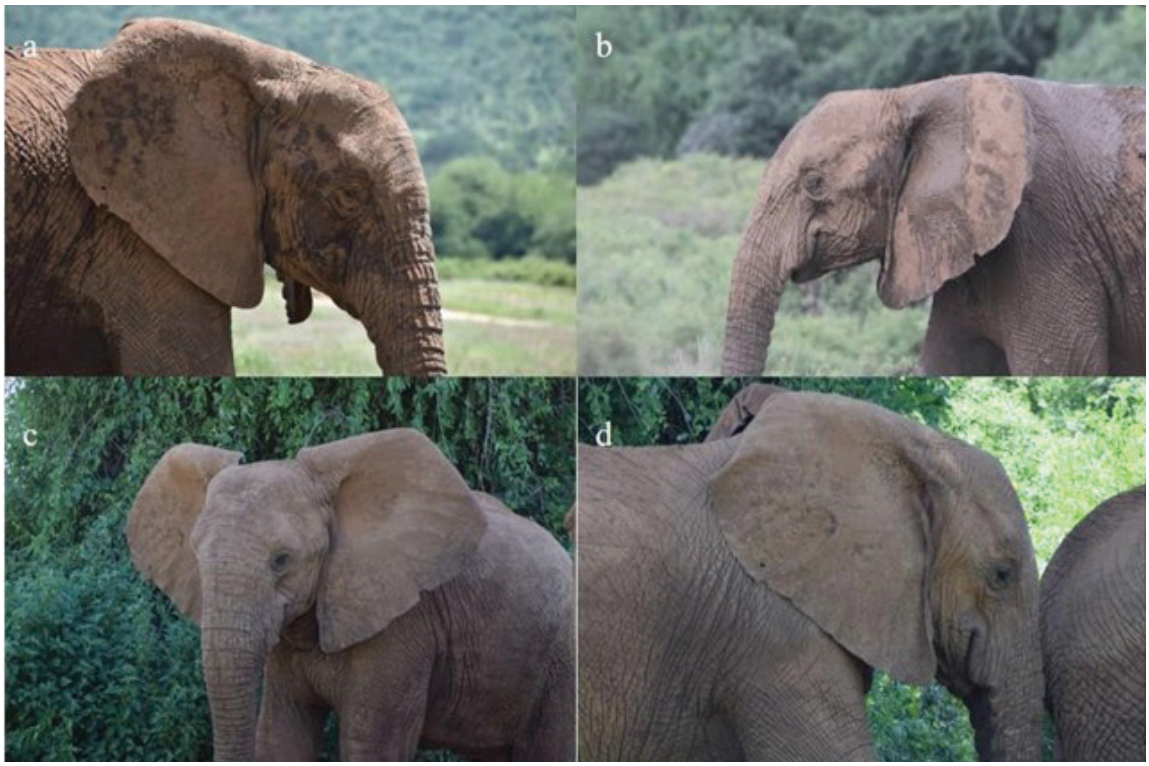

Figure 2. Morphological characteristics of the tuskless male S50.10 denoting the complete absence of tusks. The 'pinched face' appearance, characteristic of tuskless females, is very visible. Close-ups in lateral view (a, b), three-quarter front view (c, d), and three-quarter rear view (e, f), from pictures taken in 2013, when the individual was 13 years old. *© Olympia Brule (a, c), Giacomo D'Ammando (b, f) and Alice Clark (d, e)*

Figure 3. Close-up of the tuskless male S50.10 (a,c) evidencing the similarities and differences in tusk socket morphology with a tuskless female (b), and the differences with an adult male who had lost his tusks due to trauma (d). *© Giacomo D'Ammando (a), Jemima Scrase (b), Olympia Brule (c) and Save the Elephants (d)*

An alternative explanation is that the observed male is truly congenitally tuskless and that this is an inherited trait. This is supported by the fact that his mother (coded as S50 or *Kauai*) is also tuskless (Fig. 4). However, this contradicts the findings of Campbell-Staton et al. (2021) on the lethality of the dominant X-linked tuskless allele for male offspring↓especially since three of the four known calves of S50 are males (and all tusked except S50.10), contrary to the expectations of female-biased sex ratios in the offspring of tuskless females. There are two potential paths to resolve such contradictions: (i) there could be other genetic mechanisms underlying male tusklessness, possibly varying among different African elephant populations and/or involving interactions between multiple genes driving phenotypic expression, as already proposed by Campbell-Staton et al. (2021); or (ii) the lethality of the dominant tuskless allele is not always complete and might sometimes allow for the survival of a tuskless male into adolescence and possibly adulthood. For example, it is possible that the male-lethal loci on the X chromosome could also carry rare variants that suppress the lethality of the dominant tuskless allele. These hypotheses are for now highly speculative and will need quantitative testing.

It is interesting to note that in at least two elephant populations with very large proportions of tuskless females, namely Gorongosa NP and South Africa's Addo NP (up to 98% of the female population in the latter), congenitally tuskless males have never been observed (Whitehouse 2002; Campbell-Staton et al. 2021; A. Stoeger, pers. comm., 2023). Thus, it is not implausible that the cause of congenital tusklessness in the observed individual is indeed genetic but connected with rare and unusual mechanisms of inheritance. One possibility involves inactivation of the X-chromosome in the somatic cells of the tusk sockets, in case the male had inherited two

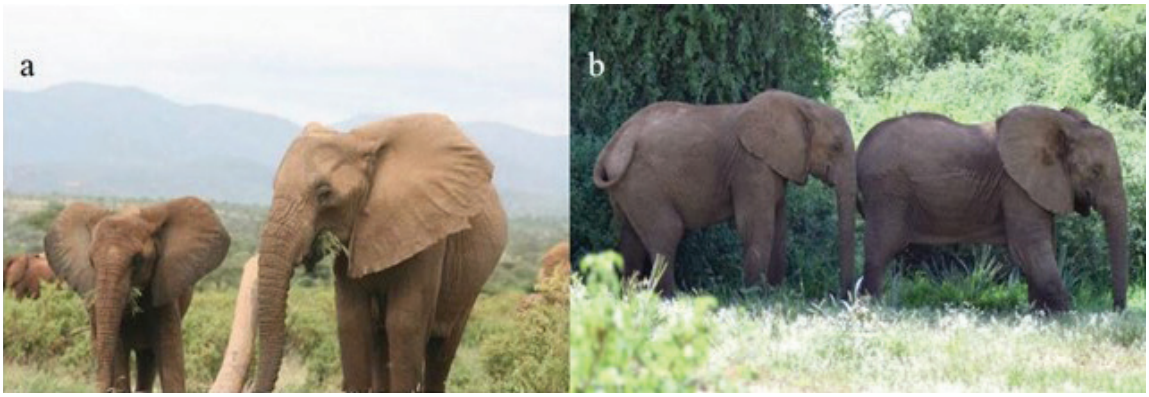

Figure 4. S50, the mother of the tuskless male S50.10, shown here with her calf when the latter was 6 years old (a), and 13 years old (b). The similarities between mother and calf in tusk socket morphology is evident.
© Save the Elephants (a) and Alice Clark (b)

X chromosomes from its mother (Pedersen et al. 2014)—an eventuality that could be easily tested via karyotyping.

Another possible explanation is that congenital tusklessness in S50.10 was caused by environmental factors that occurred during foetal or calf development. However, this seems most unlikely since he shows no other signs of mineral deficiency (i.e. similar size to other males of the same age) and soils around Samburu are not mineral deficient (Ihwagi et al. 2011). A last possibility is that the individual is a genetic female that has developed external masculine sexual characters. This has been observed in other mammals, such as lions (*Panthera leo*) (Gilfillan et al. 2017), but it is also highly unlikely due to the fact that the individual seems to possess fully developed male sexual organs (unlike masculine females in other species; G. D'Ammando, pers. obs., 17 December 2022).

There is no evidence that tusklessness has affected the behaviour of S50.10, although we have limited information because S50.10 is rarely observed in the core Samburu study area. The tuskless male was observed in December 2022 in a group of young males of similar age and size, while engaging in a sparring 'play' contest. Although he struggled to grapple the tusks and trunks of other individuals, he did not back off from the contest (G. D'Ammando, pers. obs., 17 December 2022); Fig. 5. He seemed to be able to push back against other males using his forehead and trunk.

Conclusion

In summary, it appears highly probable that the tuskless African male elephant reported here is the first publicly documented case of congenital male tusklessness in this species and that, due to his tuskless mother, this has a genetic origin. More data is now needed to answer the questions emerging from our observations. We therefore ask the elephant research community to provide any visual evidence of other possible cases of congenital tusklessness in savannah elephant bulls↓with the aim of collecting as much information on such occurrences as possible. Pictures and videos can be sent toW the corresponding author.

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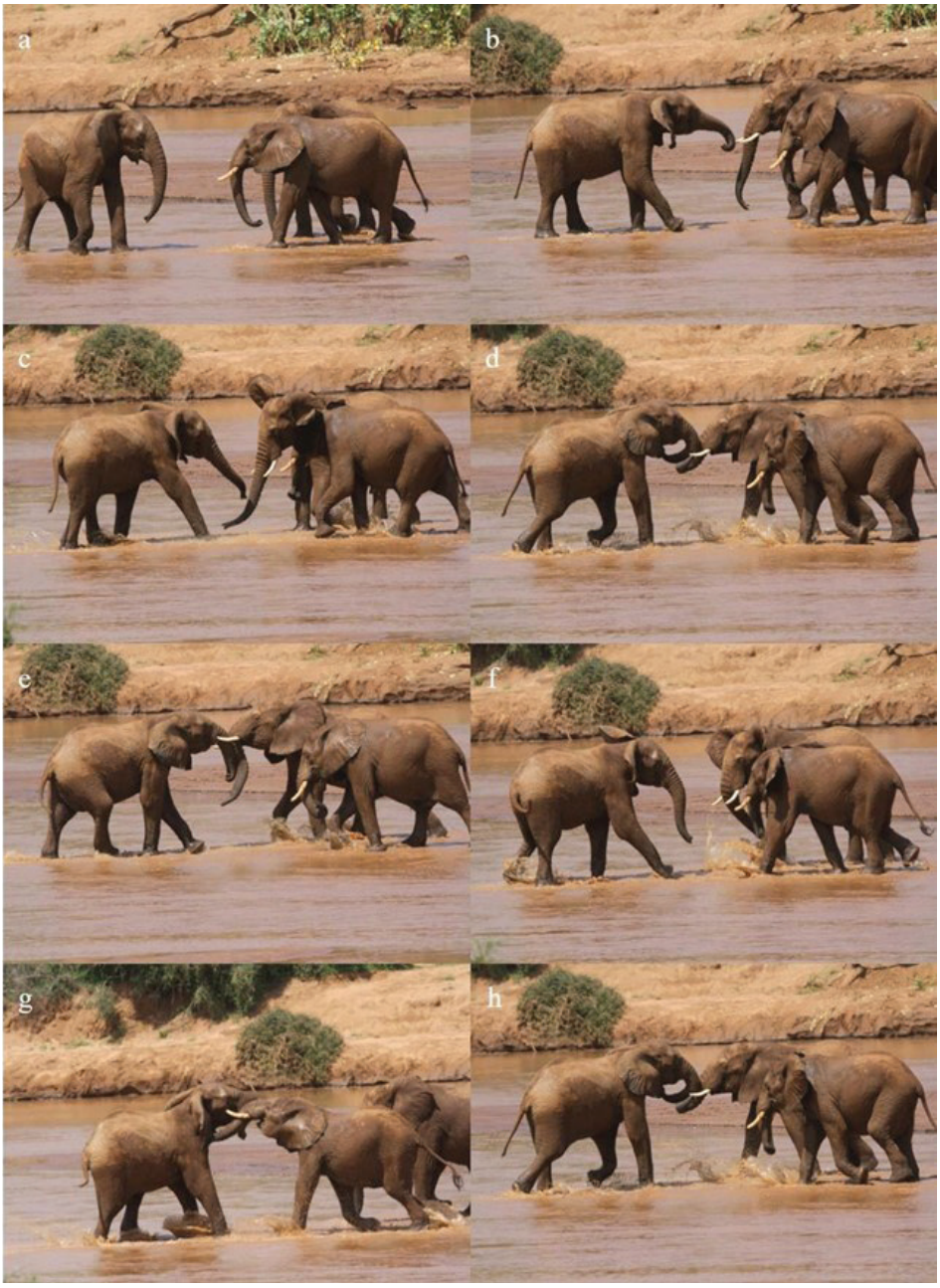

Figure 5(a-h). The tuskless male S50.10 in the company of other young bulls and engaging in 'play-fight' or sparring behaviour. From top left, clockwise: the young male was first approached by two other young bulls (a-b); he then engaged in sparring, by approaching a slightly older individual and pushing against him with the base of his trunk in typical face-to-face sparring posture (c-d); after breaking off the trunk engagement and initially retreating from the older individual (e-f), he continued sparring with the other tusked bull (of roughly equal age and size), and managed to hold his ground before the play-fight was interrupted by both parties (g-h). It appears that, during sparring, the tuskless individual was pushed on the side of the head (rather than front), likely due to the absence of tusks↓and that might have caused the opponents to slip off each other (g-h). This sequence of behaviour strongly suggests that S50.10 has male-like traits except for the absence of tusks. The sequence of events unfolds from left to right in each row. © *Giacomo D'Ammando*

Figure 6. A tuskless adult male elephant, immobilized during collaring operations by Save the Elephants and the Uganda Wildlife Authority team in Murchison Falls National Park (Uganda). The tusk sockets proved to be empty upon manual inspection by David Daballen (co-author of this study), suggesting congenital tusklessness in this individual. © *David Daballen*

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Integrating local and scientific ecological knowledge to assess African forest elephant (*Loxodonta cyclotis*) populations in a data-deficient region, eastern DR Congo

Leonard K Mubalama[1], Gedeon T Banswe[2]*

[1]Centre for Research in Biodiversity Management and Climate Change, Higher Institute of Rural Development-Bukavu, Q/ Bugabo; Ville de Bukavu, Sud-Kivu, Boîte Postale 2849 03, Avenue RP Georges Defour, Commune de Kadutu, RD Congo
[2]World Health Organization - iMMAP deployment, Goma/DR Congo

*corresponding author: lmubalamak@gmail.com

Introduction

Effective wildlife management requires monitoring changes in the spatial distribution of species, their population size and population trends (Sinclair et al. 2006). However, obtaining this data, particularly for rare and elusive species such as forest elephants (*Loxodonta cyclotis*), is not a trivial task. Surveys designed to collect the relevant data are often challenged by environmental factors (weather, land cover) and animal behaviours that can cause imperfect detection of all individuals, leading to estimates that are biased and/or imprecise (Williams et al. 2002). Moreover, methods currently used for assessing wildlife density in rainforests are time-consuming and expensive, or not suitable to cover large areas, at least on a regular basis (Hoeven et al. 2004; Zhou and Griffiths 2007). Significant research effort continues to be directed at developing reliable, cost-effective monitoring methods for rare and elusive species (Thompson 2004; Conroy et al. 2008; Royle et al. 2013). However, field data with which to assess the forest elephant's status and population trends across its geographical range remain limited, and recent field surveys using standard ecological field techniques have typically failed to detect wild individuals (Camino et al. 2020).

Conventional methods predominantly used to study wildlife populations include transect and point count surveys using distance sampling techniques, and camera trap surveys (Paddock et al. 2020). These methods require researchers to follow standard protocols and assumptions, which if incorrect leads to misleading measurements and erroneous inferences about the population under study (Mathai et al. 2013). However, the difficult terrain of the sampling unit often hinders the ability of observers to carry out detections efficiently over long distances, undermining the reliability of results obtained (Mathai et al. 2013). Moreover, estimating wildlife densities often requires collecting data over long time periods, which, when using these traditional methods, requires significant resources in terms of equipment, finance, and personnel.

In order to overcome such difficulties inherent in using conventional contemporary wildlife survey methods, conservationists and wildlife managers have used social surveys as a complimentary tool to study wildlife populations (White et al. 2005). In addition, researchers have called for incorporating local knowledge from communities living close to wildlife to help tropical biodiversity conservation (Gilchrist et al. 2005; Bawa et al. 2006; Danielsen et al. 2014). Though once considered anecdotal, local ecological knowledge (LEK) is now used routinely to guide the management of conservation programmes (Gilchrist et al. 2005; White et al. 2005, Sandbrook et al. 2013; Peñaherrera-Palma et al. 2018).

LEK extends back in time over generations. Therefore, in addition to constituting a valuable source of information on the current situation, LEK has been successfully used to track historical changes in species distribution (Huntington et al. 2011). Collecting LEK involves collaboration with local communities, which creates the scope to engage such communities and grassroots conservation NGOs in the conservation process and promote their commitment to continued action (Sheil and Lawrence 2004; Schewe et al. 2020).

There is a need to carefully compare results obtained from LEK with those obtained from field surveys, because they reflect independent sources of information which could either corroborate or refute each of the findings. Such a comparison could also increase confidence and depth of knowledge in both approaches (Huntington et al. 2000). While the agreement between results obtained by the two methods has not been extensively analysed, studies indicate that data collected from local knowledge are comparable with those collected using conventional methods (Jones 2011; Parry and Peres 2015). Our study aims to confirm the validity of these conclusions for the case of the African forest elephant. Thus, the research question is: Does the combination of local and scientific knowledge provide a potential tool to improve our knowledge of African forest elephant and foster the development of effective wildlife management strategies to meet biodiversity conservation goals?

Methodology

Study site

The study area is located in Itombwe Massif Forest in the Albertine Rift region in eastern Democratic Republic of Congo (DRC), to the west of the northern tip of Lake Tanganyika (Fig. 1). It extends between 2° 51.286' and 4° 00.690' south, and between 28° 09.889' and 28° 58.511' east. The area holds the largest and most remote block of intact montane forest (>1,500 m elevation) in Africa and is one of the most biologically diverse sites in Sub-Saharan Africa. The massif lies at the intersection of three phytogeographical regions: the Guineo-Congolian, Afro-Montane and Zambezian regional centres of endemism. This location, at the crossroads of three regions, partly explains the vegetational diversity (Omari et al. 1999). The Massif is recognized as a sanctuary for endangered forest elephants, gorillas (*Gorilla gorilla graueri*), and many other rare and endangered mammal, reptile, amphibian, bird and fish species, as well as invertebrates and plants. (Omari et al. 1999).

The forests of the Itombwe Mountains are subject to intense human pressure. Causes of deforestation and forest degradation include cattle ranching (particularly at higher altitudes) gold mining, shifting slash-and-burn agriculture, small-scale commercial forestry plantations (such as oil palm), felling of trees for firewood and construction, and hunting.

The study area comprises the wildlife corridor linking two protected areas (PAs) within the Itombwe Massif, the Itombwe Natural Reserve (NR) and the Luama Hunting Domain (Figs. 1 and 2). This wildlife corridor comprises 1,712 km^2 of mainly forested landscapes, representing a gradient of disturbance from undisturbed primary forest to unlogged but hunted natural forest, 30-year-old secondary forest and forest gardens. The study area is subject to the same pressures as other parts of the massif. Evidence of earlier agricultural clearing was recorded in most survey areas, and settlement relocation continues at the present time. Gardens in the west of the survey zone were small (< 0.5–2.0 ha), with manioc being the principal crop. Most active gardens were opened in previously cleared areas with few located in primary forest.

The paper compares results of two studies carried out to estimate elephant populations in the study area: a field inventory of dung counts using line transects in 2018, and interviews with local subsistence hunters (who use arrows, traps and dogs) carried out in 2019. Both studies focused on sample areas in the vicinity of nine villages where the hunters we interviewed lived. For analysis, the survey area was divided into a northern Compartment 1 comprising villages 1, 2 and 3, central Compartment 2 comprising villages 4, 5 and 6, and southern Compartment 3 comprising villages 7, 8 and 9 (Fig 2). For comparative analysis of the two survey methods, data from each line transect were assigned to the nearest village.

Field inventory

Often, elephants cannot be counted directly in forests because they are difficult to see in the thick undergrowth. Therefore, the census was based on dung counts, which have been used successfully elsewhere in Africa where visibility is limited (Buckland et al. 2001). The census was carried out during July–August 2018 by Leonard Mubalama (MK-L) and three local assistants. Surveys were conducted using line transects (Buckland et al. 2001) coupled with

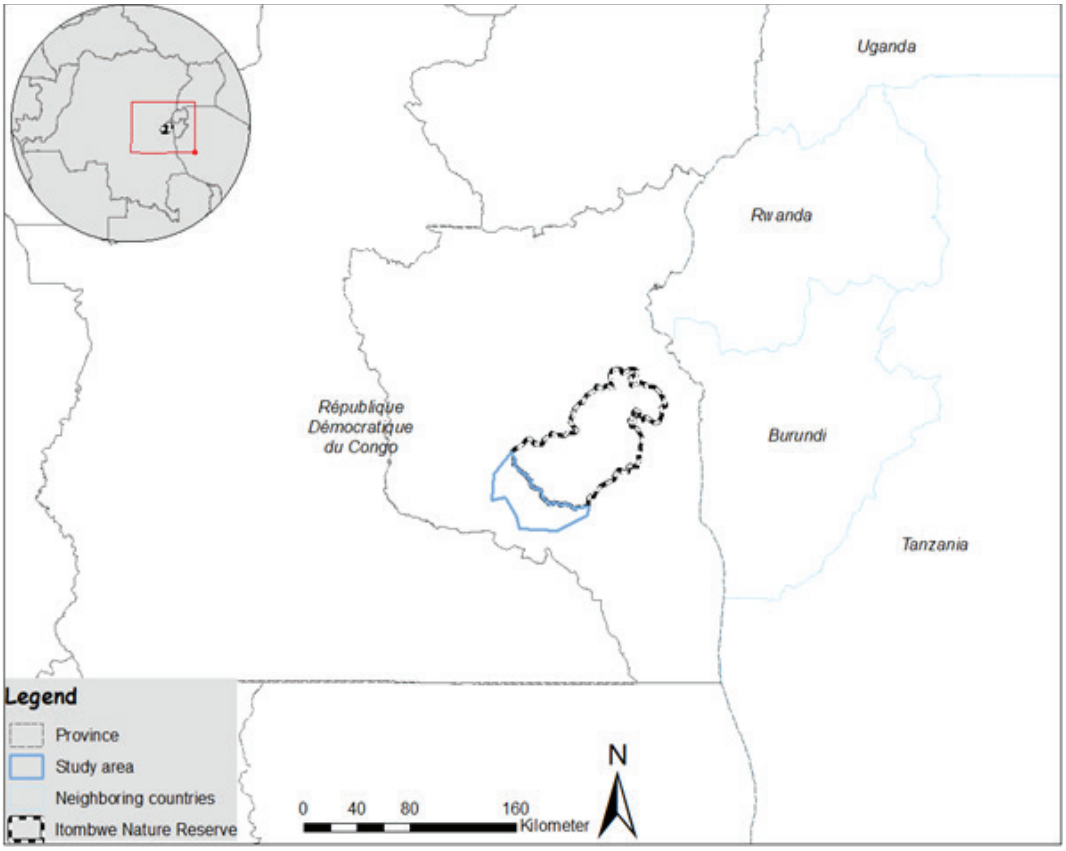

Figure 1. Location of the study area in Itombwe Massif Forest in eastern DR Congo.

reconnaissance transects (recce.) following the path of least resistance, a tried and tested method for surveying animal populations in dense forest habitats (Walsh and White 1999). A total of 38 transects of 1000 m were established, at least 500 m apart, with 12, 16 and 10 transects in the northern, central and southern compartments, respectively. Each transect was walked in the morning (07.30–12.30) and afternoon (13.00–17.00). For each direct encounter of an elephant sign (dung), we measured the perpendicular distance from the sign to the transect. At each encounter location, we noted the habitat type (as either primary forest, natural forest, secondary forest or forest garden) and recorded other vegetation parameters. As measures of forest disturbance, we counted human trails and hunting traps encountered along each transect and measured the distance from the starting point of each transect to the nearest village.

Interviews

In July–August 2019, we conducted participatory rural appraisals covering a wide range of issues with the participation of a total of 496 people from the nine villages, and in-depth interviews with a stratified random sample of 50 local hunters ranging in age from 25 to 78 drawn from the three forest compartments (Table 1). Hunters interviewed included both bushmeat hunters, using arrows, traps and bows, and commercial hunters using snares and, in some cases, shotguns.

Interviewees spoke a variety of local languages (Fang, Lega, and Bembe, as well as Kiswahili). Interpreters were used to help with interviews, in order to use the local vernacular whenever possible in those communities where traditional languages are still spoken. Using local dialects is advantageous because much of the detailed traditional ecological knowledge is best conceptualized and more thoroughly expressed in the local vernacular (Maffi 2001), while community and individual rights are respected (Mubalama 2001).

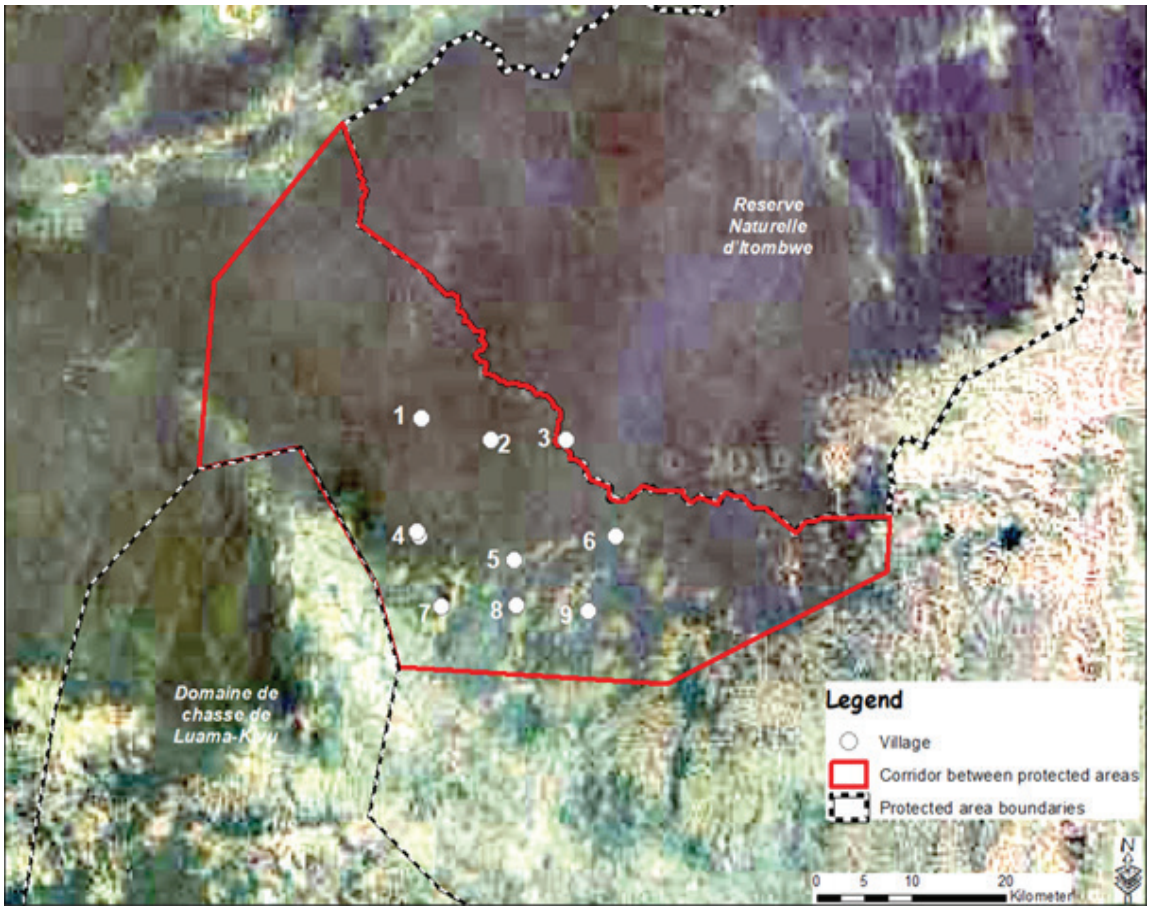

Figure 2. Location of the nine villages in the study area in the corridor between Itombwe Nature Reserve and south Kivu Luama Hunting Domain.

Table 1. The three forest compartments in the Itombwe-Luama Forest landscape, with number of villages, number of households in 2019, total number of interviewees, and the number of hunters whose in-depth interviews provided data on elephant populations and trends

Area	Number of villages	Number of households	Number of interviewees	Number of hunters
Compartment 1	3	23	192	15
Compartment 2	3	32	183	20
Compartment 3	3	16	121	15
Total	9	71	496	50

All interviews were structured with open-ended questions within an informal and flexible framework. A concerted effort was made to avoid potentially leading questions or to pre-empt the conversation. Maps, calendars, animal picture cards and multiple-choice options were used to aid understanding of the questions by hunters and to maintain interest and enthusiasm during the interview.

Hunters were asked for personal details such as age, education, and marital status; whether they had been born in the study area or elsewhere; previous and current alternative livelihoods; and previous and current hunting activity. To elicit information about current hunting activity, interviewees were asked about reasons for hunting, species targeted, traps and hunting gear used, and hunting locations. Based on this experience, they were asked to estimate the numbers of elephants and other key species in the areas where they hunted. Hunt locations were assigned to numbered zones on the map of the villages.

Conversations regarding elephants encompassed local language names; aspects of the species' ecology (i.e. habitat, shelter, diet, breeding biology, behaviour); whether the elephant is traditionally (and is still) used as a food or for other purposes; and the locations the species is or was found in three general time periods: in the past when the participant was a young man (nominally more than 20 years ago), in the recent past (up to 20 years ago) and the current status. For each period, participants were asked to indicate whether the species was common (many individuals seen often), present in low numbers (some individuals seen occasionally) or absent. By analysing and comparing information provided by the interviewees we estimated, for hunting areas around each village, general trends over time; and, for the current period, numbers of sites where elephants were found and the minimum number of elephants in each area (see Table 2 below).

As is evident from the above description, the interviews yielded a wide range of rich LEK about elephants, as well as other animal species. In this field note we focus on information provided about elephant populations, including distribution and trends, for the purpose of comparison with results of the field survey.

Data analysis

Data from the field inventory were analysed using single individual signs as the sampling unit. We used geometric mean regression to test the relationship between the transect dung pile encounter rate and the dung pile encounter rate of recce samples. Results showed that the transect dung pile encounter rate was not significantly different from the recce encounter rate ($p < 0.0001$). We used DISTANCE v. 6.2 (Buckland et al. 2001) to model a global detection probability, and the detection probability in hunting areas around each village, (average size: Between 25 and 31.25 km^2) and used these probabilities to estimate the number of elephants in each area. We used habitat as a covariate to estimate elephant density for each habitat. The Kruskal–Wallis test (one-way ANOVA; SPSS 2007), with p-values adjusted using the Bonferroni correction, was used to assess differences between the results of the field inventory and the surveys, and the differences in the abundance of elephants among areas, as well as differences in vegetation parameters across habitats. We also assessed bivariate relationships between elephant abundance and vegetation variables, using Spearman rank correlations.

Results

Evidence of the presence of elephants was found or reported in every sample area during each survey period. The field inventory in 2018 identified 249 locations with dung samples in transects around the nine villages (average 27.66 per village). Interviews with hunters in 2019 identified 210 locations where elephants were known to be present (23.33 per village). The minimum number of elephants in the nine hunting areas was estimated at 155 by the field study in 2018 and at 161 in 2019, based on information provided by the hunters we interviewed (Table 2).

The differences between the numbers of locations where elephants were present based on LEK compared to results of the field inventory were not statistically significant (ANOVA: $F = 1.51$, df = 1, $p = 0.24$).

The two survey methods also produced strikingly similar estimates of elephant presence and elephant populations across the study area (Table 2). Comparative analysis of differences among villages and forest compartments found by the field survey showed that elephants were most abundant in the central region of the study area. There were statistically significant

differences between the study areas in central sector and those in southern and northern study areas, in terms of both the number of locations where elephants were present (one-way ANOVA: $F = 9.03$, df = 1, p = 0.0005 between central and northern study areas; $F = 4.14$, df = 1, p = 0.05 between central and southern study areas) and the minimum numbers of elephants (central vs. northern: $F = 8.83$, df = 1, p = 0.006; central vs. southern: $F = 5.24$, df = 1, p = 0.03). There were no significant differences in the abundance of elephants between the south and the north (locations: $F = 0.91$, df. = 1, p = 0.35; numbers of elephants: $F = 0.22$, df = 1, p = 0.64). Clear differences were also evident between hunting areas (villages) within the forest compartments, with elephants being most abundant in hunting areas around villages 4 and 6 (Table 2).

With regard to population trends, 97% of hunters we interviewed reported that populations of elephant have declined during the last 20 years. The majority of respondents believed that this is predominantly a consequence of hunting pressure (62%), resulting in elephant migrating away from visited areas (66%), as well the incidental entangling of animals in pitfalls used for hunting forest species (54%) (Fig. 3). Conservation problems identified by hunters as contributing to this decline included growing human population; illegal elephant hunting (poaching and for bushmeat); deforestation, and mining. (Hunting is not illegal outside protected areas, except when involving totally protected species such as elephant). Perceptions of conservation problems were broadly similar across the study area, except that mining was mentioned less often by respondents in the central forest compartment (Compartment 2).

Data from a single field survey cannot provide information about population trends. However, analysis of differences in elephant abundance between habitats supported hunters' assertions that human disturbance was the principal driver of elephant population decline. Forest elephant abundance, measured as the number of encounters per transect differed significantly between habitats ($H = 21.49$, df = 3, n = 58, $p < 0.01$). However, this difference was mainly accounted for by the difference between encounter rates in primary forest and all other habitats (natural forest, secondary forest and forest gardens), where mean encounter rates were similar. To further elucidate these findings, we analysed habitat characteristics in terms of vegetation parameters and the presences of human activities (Table 3). Abundance was positively correlated with vegetation parameters associated with primary forest, i.e. canopy cover ($r_4 = 0.76$, $p < 0.05$), and tree height and diameter ($r_4 = 0.52$, $p < 0.05$ and $r_4 = 0.57$, $p < 0.05$, respectively). In contrast, elephant abundance was negatively correlated with variables indicating human presence, i.e. wildlife traps ($r_4 = -0.67$, $p < 0.05$), human trails ($r_4 = -0.78$, $p < 0.05$), and positively correlated with mean distance to the nearest village ($r_4 = 0.62$, $p < 0.05$). Elephant abundance was also negatively correlated with indicators of disturbed habitats, i.e. understorey vegetation cover ($r_4 = -0.60$, $p < 0.05$) and ground vegetation cover ($r_4 = -0.67$, $p < 0.05$).

While undertaking the field survey we also encountered direct evidence of the effects of one of the factors mentioned by commercial hunters, namely, poaching. We found three poached elephant carcasses during our survey, all of which were adjacent to roads in each of the 3 blocks, indicating that poachers are profiting from the road networks to penetrate deeper into the forest away from human settlements to hunt wildlife. (No tusks were recovered by us, however the management of the Itombwe NR was informed).

Discussion and conclusion

Realistic estimates of wildlife population abundance is an important component of population monitoring, and ultimately essential for the development of conservation actions. Diurnal line-transect surveys are one of the most applied methods for abundance estimations. Local ecological knowledge (LEK) is empirically acquired through the observation of ecological processes by local people. Supporting the findings of previous studies (Jones 2011; Parry and Peres 2015), our study suggests that LEK-based methods can be efficient and accurate for detecting large terrestrial mammals in large, remote areas and have been reliable if not vital for tracking megafauna for many decades (Maxwell 1924). Furthermore, our study confirms, as noted by Huntington et al. (2011), that LEK can provide complementary information on historical trends and drivers of change that is difficult to obtain from conventional field survey methods. This

Table 2. Number of locations in hunting areas around each village where elephants were present, based on findings of the field inventory and hunters' reports (interviews), and estimated minimum numbers of elephants using each survey technique

Village number	Locations where elephants were present		Estimated minimum number of elephants	
	2018 (Field inventory)	2019 (Interviews)	2018 (Field inventory)	2019 (Interviews)
1	12	11	3	3
2	14	12	4	4
3	23	27	10	12
4	57	36	53	54
5	13	16	8	8
6	85	58	66	68
7	15	19	4	4
8	15	16	3	4
9	15	15	4	4
Totals	**249**	**210**	**155**	**161**
Mean	**27.67**	**23.33**		

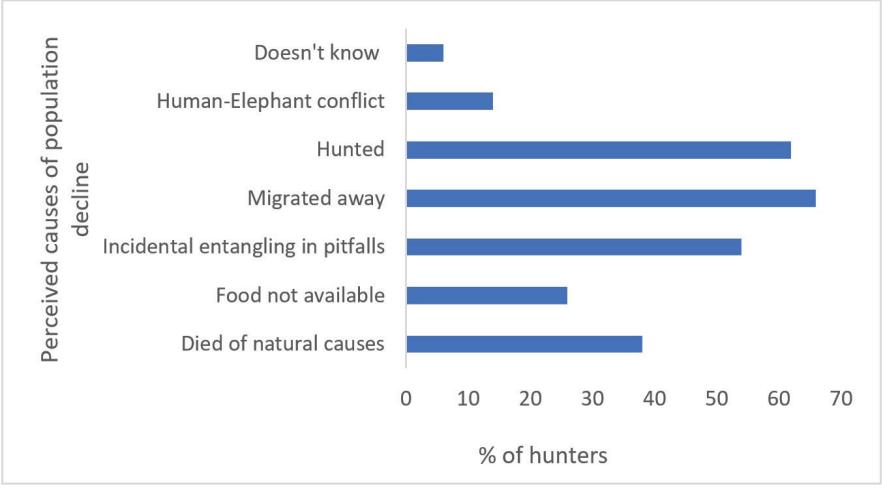

Figure 3. Perceptions about why the forest elephant is becoming rare, as determined from interviews with 50 local hunters.

also supports the results of previous studies that information provided by local resource users on species-specific depletion can be consistent with current scientific knowledge (Turvey et al. 2015).

With regard to efficiency, in our study, we estimated that around USD 161,368 would be spent to conduct a single full linear transect survey of the study area, considering travel expenses to transect sites from the field stations, food supplies, and the cost of a technician (USD 50 per day) and a local assistant (USD 20 per day). In comparison, considering two technician interviewers (USD 50 per day) for each of the nine villages sampled, we estimate that the LEK-based method would cost USD 1,700 to obtain comparatively reliable abundance indices. This supports the findings of previous studies (Gardner et al. 2008) that participatory approaches provide cost-effective monitoring of the distribution and abundance over large spatiotemporal scales even for rare and cryptic species (Stephenson 2019).

With regard to accuracy, a possible limitation of LEK-based research methods is that respondent biases, for example driven by social norms, can cause deception or unconscious distortion of responses (Moller et al. 2004). In our study, these could arise from the fact that commercial hunting is a major income-generating activity in the villages, while agriculture and fishing are not. There is a clear gender split: men are the main income-earners in the villages and commercial hunting is an exclusively male activity. Agriculture is predominantly for subsistence and mostly carried out by women. In these circumstances, hunters may be reluctant to provide information that indicates they are breaking hunting laws, or that may be used to formulate policies that further restrict their freedom to hunt.

A case in point relates to hunting in PAs. The wildlife corridor which corresponds to the study area is a legal hunting zone, while hunting is prohibited in the adjacent PAs. Since the hunters knew that we worked in close collaboration with the wildlife authorities managing both the Itombwe NR and the Luama Hunting Domain, they refrained from revealing that they also operate in these PAs for fear of being prosecuted in the future by Ecoguards. However, intelligence work carried out separately by our field assistants (who are native to the study region) subsequently identified 15 respondents who hunt in zones located within the two reserves.

Similarly, several hunters were extremely reticent about providing information on elephants, as they were aware of the Provincial Decree of 10 April 2015 banning the trade in ivory and similar products in the Province of South Kivu where the study zone is located. We were largely able to overcome this reluctance through the use of local languages and assistants familiar with the area who were trusted by respondents. However, we cannot know whether the hunters we interviewed were themselves involved in killing elephants. Shotguns, which are sometimes used to kill elephants, were recorded in all survey

Table 3. Mean values of canopy cover, understorey cover, ground cover, tree height, diameter at breast height (DBH), numbers of water courses, human trails and hunting traps for each of the four habitat types studied. p-values indicate significant different in vegetation parameters across habitat types

	Primary forest	Natural forest	Secondary forest	Forest garden	Kruskal–Wallis p
Canopy cover (%)	76.44 ± 6.65	73.3 ± 7.95	65.41 ± 4.92	26.4 ± 7.01	<0.01
Understorey (%)	41.0 ± 5.94	45.85 ± 5.88	51.0 ± 8.70	54.7 ± 5.72	0.01
Tree height (m)	21.69 ± 1.65	17.53 ± 2.12	15.92 ± 2.72	10 ± 1.63	<0.01
DBH (cm)	31.3 ± 3.82	27.65 ± 4.55	25.66 ± 4.88	14.83 ± 3.55	<0.01
Water course	4.34 ± 2.02	3.43 ± 1.86	2.88 ± 1.29	0.5 ± 0.87	<0.01
Human trails	0.18 ± 0.37	0.72 ± 0.71	1.26 ± 0.85	1.92 ± 0.59	<0.01
Hunting traps	0	0.5 ± 0.53	0.65 ± 0.82	0.81 ± 0.75	0.05

sectors, although these were used less frequently than snares. Poachers with access to military arms are reported to have killed elephants in the area over the last 15 years, although this appears to occur infrequently at present because elephant population numbers are now extremely low. However, we found direct evidence (see Results) that elephant poaching for the illegal ivory trade, continues in the area.

Bearing in mind these possible limitations, our findings confirm that LEK is an invaluable source of information for monitoring hunted species in data-poor environments. Using a combination of LEK and field surveys to monitor populations can greatly assist co-management for sustainable customary wildlife harvests by indigenous people (Moller et al. 2004). However, improved management is more likely when local stakeholders are empowered to monitor and co-manage their own resources (Raymond et al. 2010), highlighting a weakness of rapid surveys. Therefore, we suggest that future studies should engage with local people, not only as sources of information, but as potential partners and possibly engaging the hunters as rangers for the conservation of endangered forest elephants against commercial poaching.

In conclusion, although LEK-based methods have been long neglected by ecologists, our comparative study demonstrated their effectiveness for estimating elephant abundance in forest environments. This can be used simultaneously with line-transect surveys to calibrate abundance estimates and trends, and record elephants and other species that are rarely sighted during surveys on foot, but are often observed by local people during their daily extractive activities. The methodology is simple and it can be incorporated into many tropical biodiversity and conservation projects. It can also be used for long-term monitoring of wildlife status in a given area. In contrast with classical methods, the combination of LEK and scientific field data is low in cost and ensures local ownership of the results (Hoeven et al. 2004). Thus, the combination of local and scientific knowledge is a potential tool to improve our knowledge of tropical forest species and foster the development of effective strategies to achieve biodiversity conservation goals. This study was carried out as part of a project whose wider goal is to involve local people in wildlife conservation.

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Speculating on transverse grooves in African elephant tusks

Ian SC Parker[1], Erwan Theleste[2], Gerhard Steenkamp[3,4]*

[1]PO Box 1115, Tolga, Queensland 4882, Australia
[2]Boîte Postale 583 Franceville; Batéké Plateaux National Park, Gabon
[3]Department of Companion Animal Clinical Studies, Faculty of Veterinary Science, University of Pretoria, Private Bag X04, Ondersteport 0110, South Africa.
[4]Centre for Veterinary Wildlife Studies, Faculty of Veterinary Science, University of Pretoria, Private Bag X04, Ondersteport 0110, South Africa.

*corresponding author: ipap@activ8.net.au

Introduction

This Field Note arose from a request from the Editor of *Pachyderm* for opinions on what might have caused the distinctive black bands on the right tusk of an elephant (Fig.1) photographed by Erwan Theleste (ET), Director, Loango and Ozouga Chimpanzee Projects. The elephant was one of four male forest elephants (*Loxodonta cyclotis*) that were photographed in the Batéké Plateaux National Park in south-eastern Gabon crossing the Mpassa River, on 29 December 2022 (Fig. 2). ET expanded the scope of the Editor's request by augmenting the initial photograph with 12 more of all four members including aspects of both their right and left tusks.

Centuries before taxonomists separated African elephants into two species—forest *Loxodonta cyclotis* and savannah *L. africana*—ivory traders knew there was a difference. Tusks of the former in equatorial and western lowland rain forests were classified as 'hard' or 'yellow' ivory, and the latter from the rest of Africa as 'soft' or 'white'. A cline of hybrids between the two forms existed wherever the two species met: a fact established from their different market values that forced traders to assess which was the greater influence when offering prices. Forest elephant ivory is pale yellow, light yellow-brown on the tusk surface, but commonly stained black under the lip where emerging

Figure 1. The photograph of dark bands that gave rise to this Field Note. © *Erwan Theleste*

Figure 2. The four male forest elephants, subjects of this paper. © *Erwan Theleste*

from the gum and often far down the exposed tusk. Occasionally, almost the whole tusk was black. Such dark colouring occurs on savannah tusks but tends to be confined to the upper end of the tusk, close to and under the lip area. Assumed to be staining from vegetable saps etc., this is speculation for the black stains have not, to our knowledge, been objectively analysed. Yellow ivory, the extent of blackness and forest elephant tusks being more or less straight with relatively less twist, make them readily distinguishable from savannah tusks. From the location, the tusks of the elephant photographed by ET, together with the absence of an upper-ear fold-over we are certain that they are the forest species.

Observations

The four heavily stained transverse dark bands on the right tusk of Elephant 1 are regularly spaced (guessed approximately at ~10 cm apart) where the tusk emerges from the lip. There is a possible indistinct fifth in the shadow of the lip fold. The first question we address is whether these bands are ridges, rising above the tusk surface or grooves into that surface? Projecting the tusk surface by a line across the bands in Figure 3 they are clearly round-bottomed grooves. The dark colour is assumed to be accumulated staining in these sumps because they afford protection from wear. Figure 4 is of Elephant 1's left tusk which, in shadow and against a dark background, grooves are not clear (while the right tusk's grooves are clearer against a pale background). When magnified x 10, grooves are present in both Elephant 1's left tusk and detectable in both Figs. 3 and 4 but are too indistinct for us to be certain they match one another. However, they confirm that in this elephant the condition is bilateral.

Figure 3. Photograph illustrating dark bands associated with grooves in the tusk surface of Elephant 1. © *Erwan Theleste*

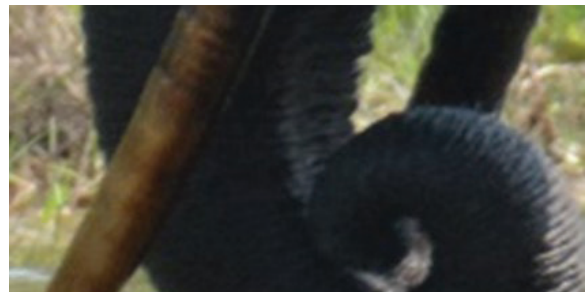

Figure 4. Elephant 1's left tusk. This is in the background to the right tusk in Figure 3. and combined we believe that both tusks are grooved, but the pictures are not of high enough quality to be sure that the grooves match one another. © *Erwan Theleste*

The rounded depressions on the right tusk of Elephant 1 indicate periods where growth in tusk circumference but not length, had been reduced during tusk formation. We considered whether these depressions might be variants of tip-notching: a process occurring around tusk points. These arise when vegetation dragged across a tusk while feeding catches in cuts or nicks in its surface, gradually creating a progressively deeper notch or groove that eventually results in the tip breaking off (Fig. 5). This purely mechanical process is common in East African savannah elephants (Parker in prep). An obvious difference is the grooves in Elephant 1's right tusk are circumferential whereas the tip-notches are not. However, while not tip-notching, *in sensu stricto*, the grooves illustrated in figure.1 would deflect vegetation dragged across the upper tusk into them and develop a secondary groove along the path of contact. We suggest this may have produced the thin darker lines obvious in Figure 3.

The evidence in the right tusk of Elephant 1 is similar to four cases recorded from 3,169 savannah elephants (*Loxodonta africana*) culled from six populations in East Africa (Parker and McCullagh 2021). These were: i) Murchison Falls NP, South female GMU 285, age 10, right tusk; ii) Murchison Falls NP, South female GMU 327, age 24, left tusk; iii) Murchison Falls NP, South male GMU 336, age 8, both tusks; and iv) Tsavo East NP 12, male age 8.5, both tusks.

Figure 5. Illustrating tip-notching in four East African female tusks. © *Ian Parker*

The grooves were of the same approximate dimension as in Figure 1, were apparent in the upper section of the extruded tusk within ~30 cm of the lip, but without dark colouration. The condition was not only apparent in the tusk out of the head, but internally, confirming the grooving developed within the alveolus.

Ian Parker (IP) has also seen similar grooves while examining many thousands of tusks from all over Africa while researching the international ivory trade (Parker 1979). However, no measurements or notes on the condition were recorded; it was simply referred to as ridging. From this subjective recall the condition occurs widely, albeit occasionally.

From Elephant 1 and our small sample the following points emerge:

- The condition occurs in both sexes.
- It may arise both unilaterally or bilaterally in tusk pairs
- The four culled GMU cases were from different family units, in which no other members exhibited the condition.
- The condition occurs both in savannah and forest elephant species, with Elephant 1 presenting a bilateral case in the latter.

The second point challenges the idea that the grooves reflect straightforward seasonal fluctuations in nutrition quality (McCullagh 1969) since, if this were so, they would likely appear synchronously in both tusks of a pair and not unilaterally as in cases i); and ii) above. In the same vein, this condition might be expected to be present in other members of the same herd, which was not the case in the four savannah elephant cases quoted above.

Laws (1952) working on the elephant seal (*Mirounga leonina*) developed an accurate aging system from growth rings from variation in tooth calcification. Such rings are apparent in all elephant tusks, which allowed him to calculate the average annual tusk length growth for savannah elephant (Laws 1970). Figure 6 illustrates such growth rings. Visually, in 39 photographs taken at the same time as Figure 6, there is no evidence that these growth rings are associated with changes in tusk circumference. While magnification of these photographs may change this perception, pro tem, the development of grooves within the alveolus does not seem to be an aberration of the normal tusk ring formation, but a different phenomenon.

At this point we considered such evidence as was apparent in the three other bulls that were with Elephant 1. While the photographs of elephants 1, 2, 3 and 4 are

Figure 6. Illustrating the growth rings that are present in all elephant tusks, most obvious in the base sections within the alveoli. This is the right tusk of male elephant GMU 1,443 aged 38 years. © *Ian Parker*

clear enough to exhibit transverse dark tusk bands in all, they were taken at too great a distance and/or because they are in deep shadow, resolution is inadequate to see grooves with certainty. While the dark bands are most obvious close to the elephants' heads, those on Elephant 4's right tusk extend faintly along its entire length out of the water (Fig. 7). Further, the regularity and dimensions of the bands seem unique to each elephant. If reactions to seasonal variation in food quality, we would expect a greater degree of symmetry. In overview, while familiar with the dark staining as a feature of forest elephant tusks, IP had no recall of seeing transverse bands as on the elephants photographed by ET.

Figure 7. Illustrating transverse banding along the entire length of the visible right tusk of Elephant 4.

New to science is the phenomenon that grooves in the upper portions of tusks, in contradistinction to tip-notching, occurs in both species of the African elephant. Its aetiology remains obscure and until good supporting data become available, we cannot proceed further than the foregoing speculations.

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One year after the rollout of the *Coexistence Toolbox* for reducing human-elephant conflict

Tanya Onserio[1] and Lucy King[1,2]*

[1]Save the Elephants, PO Box 54667, Nairobi 00200, Kenya
[2]Department of Biology, University of Oxford, Oxford, OX1 3PS, UK

*corresponding author: media@savetheelephants.org

Introduction

Three of the most significant issues for elephants across Africa today are habitat loss, climate change, and an expanding human population (Abrahms 2021). It is predicted that by 2050, Africa's human population will have doubled in elephant range States, creating enormous pressures for elephants (Powers and Jetz 2019; Shaffer et al. 2019). As farmland spreads and infrastructure developments fragment habitat, elephants are forced into increasing conflict with people (De Minin et al. 2021; Frank et al. 2019; King et al. 2017).

In Kenya, the problem is exacerbated by elephant corridors being blocked by human settlements and infrastructure (Okita et al. 2016) and erratic weather patterns. A prolonged drought from 2021 to 2023 affected much of Kenya, as communities are experiencing more extreme weather conditions due to the changing climate (Kogo et al. 2021). Both humans and elephants have lost their lives following conflict altercations in the East African country (Hamm 2023).

In Samburu–Laikipia, where Save the Elephants (STE) north Kenya research centre is located, at least 97 elephants were killed in 2022 as a result of human-elephant conflict (HEC) (Wildlife Research and Training Institute (WRTI), Kenya Wildlife Service, Save the Elephants, unpublished data). HEC will become one of the most significant threats to elephants, and for conservation practitioners to combat over the next 50 years. Communities will need practical, sustainable, and affordable ways to coexist peacefully with these mega herbivores.

Figure 1. An elephant under a standard gauge railway (SGR) underpass in Tsavo, Kenya, in 2022. The railway divides the Tsavo East and West NP ecosystem into two. (© *Josh Clay/Save the Elephants*)

Figure 2. A beehive fence on a farm in Kajire, Tsavo, in 2023.
(© *Meha Kumar/Save the Elephants*)

In 2022, STE launched a unique 'how-to' manual, the *Human-Elephant Coexistence Toolbox* (the Toolbox)—which carefully details deterrents which have been tested in the field—to enable rural communities to protect their lives and livelihoods from elephants (King et al. 2022). Built on the success of the Elephants and Bees Project in Tsavo, the Toolbox comprises over 80 elephant-friendly tools, including the successful beehive fence method which has been deployed worldwide across 90 elephant conflict sites in 23 countries. The Toolbox manual is currently available in English, French, and Swahili with plans to translate it into more African languages for broader access. The second edition with more tools and updates from our field partners has just been launched[1].

Since its launch, the Toolbox has introduced several methods to partner organizations and farming communities through our Elephant Crisis Fund (ECF) and the IUCN AfESG. Training workshops on how to use the methods of the Toolbox effectively, are also in place.

In Tanzania, on the edge of the Serengeti National Park (NP), the Frankfurt Zoological Society (FZS) has implemented several mitigation tools as prescribed in the Toolbox, including elephant-safe grain stores and watch towers for communities suffering from food losses. Losing a grain harvest which could feed a family for months presents a huge cost to small-scale farmers, and elephants can easily destroy traditional storage structures made from 'mud and wattle' which are

Figure 3. A woman stands in front of an elephant-proof grain store installed by FZS in Tanzania; cement/brick stores like this are used to protect grains from elephants.
(© *Lucy King/Save the Elephants*)

[1]Contact the authors to receive updated methods of the *Human-Elephant Coexistence Toolbox* manual which will be made available on the web platform in the future. King et al. 2023 HEC Toolbox vr2 (English)

what these communities previously used. To help prevent the raiding of grain stores in buffer zones around Tanzania's unfenced Serengeti NP, and communities becoming intolerant of elephants, sturdy storage is essential.

In southern Zambia, Conservation South Luangwa is supporting farmers to harvest chillies that are used to make a pungent elephant repellent, a recipe designed by WildAid that is featured in the Toolbox (Oniba et al. 2020; Tiller et al. 2022). The repellent, brewed from ingredients including chilli, garlic, ginger, dung, and rotten eggs, has proven to be successful in keeping elephants at bay. In 2023, farmers harvested more than 3.3 tonnes of chillies, generating more than USD 3,800 in sales. Methods such as these are not only proof that there are other peaceful ways for farmers to protect their livelihoods but also, in some cases, even secure an income.

Another HEC Toolbox intervention, an audio gadget called a BuzzBox™, has proved successful in Liberia. Rare camera trap footage captured a forest elephant (*Loxodonta cyclotis*), fleeing from the technologically produced bee sounds in Liberia. Created by Wild Survivors, who are based in Tanzania, the BuzzBox™ wildlife technology was specifically designed for savannah elephants to create an acoustic deterrent that would prevent the pachyderms from crop raiding and help reduce conflict. This was the first time that BuzzBox™ had been trialled on forest elephants, which are now 'Critically Endangered'.

The trial, in collaboration with Elephant Research and Conservation (ELRECO) in Liberia, showed that this noise deterrent is an effective tool for preventing both forest and savannah elephants from entering farms and could be a valuable mitigation tool in HEC hotspots in elephant range States. Forest elephants have endured rapid population decline, losing more than 86% of their numbers in just over three decades.

In our Tsavo research station in Kenya, several Toolbox methods such as beehive fences (King et al. 2017) and metal strip fences (Von Hagen et al. 2020), noise deterrents, early-warning alarms, water tank protection, non-palatable crops, and watchtowers have already proven to be effective. The metal strip fences create clanging noises as they blow in the wind and reflect light from the sun (or torches) towards approaching elephants, doubling up as both an audio and visual deterrent (Von Hagen et al. 2020).

Figure 4. The settings of a BuzzBox™ are adjusted shortly before its deployment in Liberia in 2023. (© *ELRECO*)

Another farmer in Mwakoma village, Samuel Salim, has used the Toolbox to build his own modified version of the watchtower using mud and sticks, both of which are affordable and readily available resources. Nighttime monitoring from watchtowers is an effective way to deter elephants from raiding crops, as farmers can spot approaching elephants from a distance, warn their neighbours, and use torches or noise to scare them off before elephants reach their farms.

To avoid elephants decimating an entire farm in just one night, farmers are also growing non- palatable crops such as sunflowers, neem and red chillies instead of the traditional maize and tomatoes. Alternative crop choices mean that farmers can protect their farms and livelihoods, as well as learn to live in closer harmony with elephants.

Agriculture is not a sustainable income-generating activity for the Kajire and Mwakoma communities due mainly to dry conditions, but also increased crop-raiding by Tsavo's elephants. This semi-arid area receives minimal rainfall, which reduces harvest yields and income from farm produce, making agriculture an undependable economic option that forces farmers to diversify their income. The Toolbox provides plenty of ideas for alternative income generating ideas for subsistence farmers in these conditions also living with elephants.

Figure 5. A watchtower in a farm in Kajire village, Tsavo, Kenya. (© *Sarah Kunkel*/*Save the Elephants*)

Figure 6. Living near Tsavo East NP in Kenya, Jones Mwakina, a farmer displays his homemade noise cannon device designed to scare elephants away from his farm.
(© *Jane Wynyard*/*Save the Elephants*)

Figure 7. An STE team monitors a beehive fence on a sunflower farm in Sagalla, Kenya. Sunflowers are an unpalatable crop to elephants. (© *Jasper Scofield*/*Save the Elephants*)

Figure 8. Fishermen in Lake Jipe share the lake with wild Tsavo elephants, and example of coexistence. (© *Anthony Ochieng*/*Save the Elephants*)

Figure 9. Participants and trainers of the second Trainer of Trainers Workshop display copies of the *STE Human-Elephant Coexistence Toolbox* during the training which took place at our research centre in Tsavo, Kenya, from 18 to 20 July 2023. (© *Meha Kumar*/*Save the Elephants*)

Conclusion

In Kenya, our team now hosts training workshops to teach partners, farmers, and communities how to use the *Human-Elephant Coexistence Toolbox* and to learn new ways to coexist peacefully with elephants. These three-day training events combine theory sessions with visits to farms in the vicinity of Tsavo West and East NPs, to see many of the farm-based mitigation tools available in the Toolbox such as metal strip fences, watchtowers, and beehive fences.

The trainees are now equipped to help others in their respective hotspots and to establish elephant-friendly deterrents in communities throughout Kenya, spreading awareness on how they can harvest and store crops safely, and live peacefully alongside their elephant neighbours.

To date, the Human-Elephant Coexistence Toolbox manual has been shared free with more than 350 individuals and partners in 54 countries. Many of these are NGOs or conservation bodies that have funding available for community conservation work but struggle to know which interventions can be used with positive livelihood results in order to help people in African range States learn to coexist with elephants. In the second year of implementation of the Toolbox manual, it is encouraging to see that the methods are showing evidence of the effectiveness of each of the interventions in the Toolbox manual. We invite feedback from the conservation network and encourage practitioners to download the second edition from our website: https://ste-coexistence-toolbox.info/en/

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Promoting positive interactions with the traumatized elephants in Gorongosa National Park

Joyce Poole[1], Jason Denlinger[2], Dominique Gonçalves[3,4], Test Malunga[5], Petter Granli[1]*

[1]ElephantVoices, Buskhellinga 3, 3236 Sandefjord, Norway
[2]Dubuque County Conservation, 13606 Swiss Valley Rd, Peosta, Iowa, USA
[3]Durrell Institute of Conservation and Ecology, School of Anthropology and Conservation, Marlowe Building, University of Kent, Canterbury, Kent, CT2 7NR, UK
[4]Scientific Services, Gorongosa National Park, Avenida Mártires da Revolução Nº 1452, Edifício CPMZ – 1º Andar, Bairro do Macuti, PO Box 1983, Beira, Moçambique
[5]Tourism Department, Gorongosa National Park, Avenida Mártires da Revolução Nº 1452, Edifício CPMZ – 1º Andar, Bairro do Macuti, PO Box 1983, Beira, Moçambique

*corresponding author: jpoole@elephantvoices.org

The elephants of Gorongosa National Park (NP), Mozambique, suffered extreme disruption during the country's 15-year civil war between 1977 and 1992. Elephants were shot and killed for meat and ivory by the forces of FRELIMO[1] and RENAMO2[2] and large quantities of ivory were exported from the area. During this period, an estimated 90% of the elephant population was killed (Campbell-Staton et al. 2021; Poole and Granli 2022). More than a quarter of a century after the end of the war an enduring legacy among elephant families has been a culture of aggression towards vehicles (Poole et al. 2023 this issue).

The experience of the Gorongosa elephants is not unique. Wars, civil conflict, intense levels of ivory poaching, and heavy-handed management interventions (e.g. culling) have disrupted many populations of African savannah (*Loxodonta africana*) and forest (*L. cyclotis*) elephants (e.g. Beyers et al. 2011, Bouché et al. 2011; Thouless et al. 2016; Daskin and Pringle 2018). In some cases this has caused unusual levels of fearful and aggressive behaviour (Poole et al. 2023).

In 2011 we (Joyce Poole (JP) and Petter Granli (PG)) were invited to Gorongosa NP to study the elephant population to better understand the lasting physical and behavioural scars inflicted by the war, and to provide scientific data to ensure its strategic protection, management and recovery (Poole and Granli 2022; Poole et al. 2023). In the year prior to the onset of our study, a tourist vehicle, driven by a guide, was overturned by an adult female. In the following two years, another three vehicles were tusked or head-butted by adult females (Poole et al. 2023). In 2013, in an attempt to reduce the frequency of attacks and habituate elephants to vehicles, Goronogosa NP management asked us to write a set of general guidelines for appropriate behaviour around this population of elephants. As the document was primarily intended for use by lay visitors to the Park, we wrote a list of simple instructions that did not require knowledge of elephant behaviour (Table 1).

Based on our long experience with elephants and knowledge of their behaviour, our own approach was different. Instead of remaining 100 meters away, we responded to the signals the elephants gave us. We observed the behaviour of the elephants as we approached them, stopped the vehicle, and turned off the engine at the first indication that they were concerned by our presence. Our intention by stopping the vehicle—even when we were charged—was to show the elephants that we understood and respected their signals and that we were not a threat. Once stationary, we resolved to remain calm and quiet, even when we were threatened or charged, in the knowledge that any noise might increase the elephants' agitation and that, if we drove off, we would encourage them

[1]FRELIMO: Frente de Libertação de Moçambique/Liberation Front of Mozambique
[2]RENAMO: Resistência Nacional Moçambicana/Mozambican National Resistance

Table 1. 2013 guidelines prepared with Gorongosa NP management for self-drive visitors entering the Park

Gorongosa NP Elephant Guidelines for Game Drives

The elephants of Gorongosa are wild animals. They are not habituated to people nor to the approach of vehicles. Due to their particular history of persecution, they may respond to your presence with aggression. For your own safety and the well-being of the elephants, please be respectful of them. Each situation and possible interaction is different, but we ask you to take note of the following:

- Meeting elephants is not without risk; they are extremely powerful, intelligent animals and can easily crush your car.
- By entering the Park you accept responsibility for the risks involved, and their consequences.
- Elephants have the right of way; you are a guest in their habitat and home.
- The maximum speed in the park is 40 kph. You will be safer and see more if you drive more slowly.
- In open areas with good visibility do not approach elephants closer than 100 meters.
- In areas with tall grass and dense vegetation always reduce your speed and expect that you may meet elephants around the next curve.
- At times we may choose to close certain roads to reduce the risk of dangerous encounters.
- Use your observational skills. If elephants are agitated leave them alone or stay further away.
- Noise can frighten and provoke elephants; remain quiet in their presence.
- Note that an elephant can hear you coming from over a kilometre away, and that they may feel threatened if you are disrespectful of their boundaries by continuing to approach.
- If at all possible, avoid confrontations with elephants by keeping a safe distance.
- If you experience an aggressive encounter with elephants, we would like to hear about it. Please inform the reception or the Park administration.

We want you to experience Gorongosa's beautiful elephants in a safe and positive way.
Help us to habituate them by being a responsible, respectful visitor.

to chase us. Thus, we did not start the engine or make any kind of disturbance in the vehicle until the elephants departed.

Exceptions to our approach were: 1) instances when we were ambushed at high speed while we were driving, whereupon we continued to drive and, 2) when an elephant head-butted our vehicles (JP/PG and Jason Denlinger (JD), Dominique Gonçalves (DG)) we created commotion and drove away when it was possible. This method allowed us to gather data on how different types of groups (all-male versus family), different families, and individual elephants responded to vehicles (Poole et al. 2023).

In an effort to minimise variation in human behaviour around elephants, and due to concerns for visitor safety, the Park management took the decision to close the Park to self-drive vehicles soon after we wrote the guidelines. Thus, the guidelines were never formally used by visitors to the Park as game-drives were, thereafter, led by a small number of experienced, long-term guides. Throughout our study, we collaborated closely with the guides, joining them on game drives, taking them with us to observe elephants, teaching them how we approached elephants and discussing elephant behaviour with them. Many of the guides collected data for us, recounted incidents and shared photographs or videos of elephants with us that were invaluable to our collective understanding of the Gorongosa population and individuals within it. Many of the scientists and the Park management team who regularly encountered elephants had evening meals together at the lodge dining room, where we shared and reflected on daily experiences. This social

context was ideal for building a communal understanding of the Gorongosa elephants.

Over the years, we collectively established a relatively uniform way of interacting with the elephants, which relied on the majority of us being able to read their signals and respond to them in a similar manner. Our culture, in a sense, was aimed at building a relationship with elephants within which they could depend on us to behave in a predictable and respectful way. We stopped the vehicle when elephants indicated that they were concerned, we remained quiet and calm in their presence, and we tried not to drive away when charged. Over time we learned that in Gorongosa NP, males could be approached relatively closely without causing them agitation while the response of families varied substantially depending on family tradition, the personality of individual adult females, and the location of their core area (Poole et al. 2023). Families who resided in areas that were inaccessible to vehicles displayed increased likelihood of responding with fear or aggression compared with those who frequently encountered vehicles. A few families could be approached to within 30 meters without any negative reaction, while others fled or charged at much greater distances.

Is there any indication that our interventions promoted more positive interactions between vehicles and Gorongosa's elephant families? After the closure of Gorongosa NP to self-drive vehicles in 2013, two years of renewed civil unrest in the surrounding area meant that elephants encountered relatively few visitors (Poole et al. 2023). As visitor numbers increased thereafter, tuskless adult females who had only rarely been observed, head-butted another three vehicles in 2016 and two in 2017 (Poole et al. 2023). In the six years since, there have been no further incidents. Through continued positive interventions by trained Park staff, physical attacks on vehicles since 2017 have ceased as far as the authors are aware. As we describe in Poole et al. (2023) there are other indications that the aggressive culture of the Gorongosa elephant families is slowly changing as they begin to learn from experience and from one another that vehicles are no longer a threat, though longer-term study is needed.

Aggressive elephants can pose challenges for conservation and management, potentially causing negative ramifications for human-elephant co-existence as well as for revenue streams from tourism. Furthermore, elephants who put considerable time into avoiding or attacking humans are using energy that could otherwise be spent on survival and reproduction (Brakes et al. 2021). Recognizing that the Gorongosa elephants' culture of aggression was caused by their traumatic history, and adapting management interventions to allay their fears, we believe we have helped this population towards recovery. While the process of building mutual trust is slow, continued consistent respectful interactions will positively impact Gorongosa's human-elephant relationship. The overall collective approach used in Gorongosa could provide a model for other traumatized elephant populations.

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White rhino ecology, a comparison of two rhino populations (*Ceratotherium simum simum*) in South Africa and Uganda

Felix J Patton[1], Petra E Campbell[1], Angie Genade[1]*

[1]Rhinoswildlife, Hannover, Germany

*corresponding author: rhinoswildlife@gmail.com

Introduction

In the early 1970s, the now Professor Norman Owen-Smith of the University of Witwatersrand, South Africa, conducted research on the behavioural ecology of white rhinos over a three-and-a-half-year period, in the Hluhluwe-iMfolozi area, South Africa, for his PhD thesis presented in 1973.

Rhino Fund Uganda (RFU) collected white rhino behaviour data at the Ziwa Rhino Sanctuary (RS), Uganda, for some 10 years which have been published in a series of papers and reports updated in 2021 (Patton and Genade 2021).

This paper examines similarities and differences in the results and conclusions made on aspects of white rhino (*Ceratotherium simum simum*) behaviour between the studies. It is of importance to managers, since the earlier work was carried out in an extensive area with a long-established population, while the latter was in a smaller enclosed area with an introduced, low-density population, more akin to many white rhino conservation areas today. The smaller size landscape available to rhinos is increasingly becoming the norm in conservation settings today, as rhino populations are secured in intensive protection zones (IPZs).

Hluhluwe-iMfolozi has a sub-tropical climate with temperatures ranging from 11°C in May to 24°C in August. From December to February, mean temperatures increase to 29°C, but can be higher. The rainfall patterns in the study years in Hluhluwe-iMfolozi were characterized by summer droughts and late rains. The driest conditions prevailed in January 1970. The total annual rainfall of 1,545 mm, in 2022 represented an average year.

In Ziwa RS, Nakasongola district in central Uganda during the study period 2017–2019, 31°C was the average maximum temperature. The wet season occurs from March to November, with a dry period in June and July. There is little rain during the dry season (December to February).

The variation in climate may have a bearing on the differences observed in this comparative study.

Use of Space

Owen-Smith reported that territorial male rhinos occupied mutually exclusive home ranges of 0.7 to 2.6 km^2 that were co-habitated by 0 to 3 subordinate adult males. He concluded that the ranges were defended by males and therefore should be considered territories.

The male territories of the RFU studies at the ZRS developed from three mutually exclusive areas to three areas with one male sharing part of its territory with another male and limited overlap of all three territories. The core areas within the territories showed almost complete exclusivity of one male, with the other two sharing much of the cores. The three male territories of ZRS were 5.7 km^2, 11.1 km^2 and 23.3 km^2 respectively, with core areas of 1.7 km^2, 2.01 km^2 and 4.2 km^2.

The male with the noticeably large territory was very aggressive towards the other two males, who avoided contact with him as much as possible. These two males shared part of their territory, but both were responsible for breeding. They were accepting of each other, sometimes seen as close as 30 metres. Both fought the solitary male when they came into contact, so neither was a subordinate.

Owen-Smith reported that ranges covered between 10 km^2 and 15 km^2 which included corridors but with movements restricted to the core areas of 6 km^2 to 8 km^2 during optimal grazing conditions. The actual data given were:

The mean home range was 11.6 km² (range 8.9–14.7); core area was 6.7 km² (range 5.3–9.6)

The mean home range of ZRS was 16.2 km² (range 5.6–41.6); core area was 2.4 km² (range 1.1–5.4)

A female (in the RFU study) moved long distances (considered to be due to male avoidance), while another changed its range during the year. If the data for these two are removed, the mean home range reduces to 9.8 km² and core area to 1.5 km². The water points were abundant in ZRS and replenished in dry periods.

Owen-Smith stated that individual females each had a preferred area of occupancy which was different differs from that of other individuals, though there was extensive, multiple overlapping between the two various ranges.

The ZRS core area map for RFU females (Fig. 1) shows overlaps of 2, 3, 4 and 7 individuals sharing the same cores, suggesting that there was more sharing of preferred areas than found by Owen-Smith.

Activity[1]

The basic daily activity schedule reported by Owen-Smith was confirmed by the RFU data.

Both found no striking differences between the activity patterns exhibited by adult males, adult females, and subadults.

Owen-Smith found that over a 24-hour period, rhinos of all age/sex classes devoted 12 hours to feeding, 8.5 hours to resting and the remaining 3.5 hours to mixed activities (walking, standing alert, wallowing, and social interactions).

The RFU data, as shown by the 24-hour clock, contain a significant amount of detailed night time. Data are similar to that of Owen-Smith, which show rhinos spending some 50% of their time feeding (12 hours), 33% resting (8 hours), and 17% moving/mixed activities (4 hours).

However, much of the moving involved feeding at the same time. This meant that rhinos could be taken to the ground spend up to 16 hours a day feeding, 6 hours resting, and 2 hours moving/mixed activities.

Grazing

Owen-Smith reported that white rhinos were entirely grazers that preferred short grass but used tall grass during late dry periods. At least 30 different grass species were recorded on the terrain. However, 12 species comprised about 95% of the food intake.

Forbs made up only about 1% of the food intake and in most cases seemed to be eaten accidentally when mixed with grasses.

The RFU study found that of the 23 recorded species, rhinos grazed 14 species while 9 of them were not grazed. Forbs also made up only a small proportion of the diet, but two were preferentially grazed rather than accidentally grazed.

Both Owen-Smith and the RFU monitors noted a particular preference for grazing the grass found on termite mounds.

Drinking

Owen-Smith reported that, when pools were plentifully scattered, rhinos paused to drink sometimes twice a day and or at any time. During the late dry periods, drinking took place every 2–3 days as water supplies became restricted and the rhinos were forced to undertake a special journey to one of the remaining water holes. Visits to the water holes usually began in the late afternoon.

Sixty per cent of the rhinos drank water between 1700 and 2100 hours, another 26% thereafter, and only 14% drank during daylight hours. After a hot day, peak numbers of rhinos were not recorded until 2000 to 2100 hours.

The RFU monitors found that the main drinking period was between 1500 and 1800 hours (44%) in all weather conditions. Depending on the weather, especially during dry periods, there was also some extension to the main period where there was limited drinking from 1400 to 1500 (6%), 1800 to 2100 (19%) and 0900 to 1100 (8%) hours.

[1]Major categories of behaviours (activities) as described by Kendal (2018):

i. Grazing: foraging on the food plant or parts of available food.
ii. Moving: traveling to different feeding ground while performing other social behaviours.
iii. Resting: this is the activity without movement that includes standing, sitting, lying, sleeping.
iv. Wallowing: animals remain submerged in water for thermo-regulatory activity.
v. Other Activities: playing, aggression, sexuality, sympatric behaviour, territorial encounters, etc.

The number of times a rhino would drink per day was 0 to 3 times. About 30% of ZRS was marshland, and rhinos were often found feeding on short, soft grass that was fully or partially exposed as the swamp retreated in drier periods. It was clear that while grazing the rhinos could take in water directly or from the high moisture content of waterlogged grass.

Reproduction

Owen-Smith reported that persistent companionship of a female by a male rhino over a period of up to 20 days was a reliable indication that the female was entering or in oestrus. Territorial bulls confined pre-oestrus females for between 4 and 20 days prior to mating. These consort relationships ended between 2 and 6 days after copulation.

Owen-Smith observed seven copulations that lasted between 15 and 28 minutes. All were seen at various times during the day, but Owen-Smith concluded that there was no reason why mating should not occur at night. As only in one case a repeat mating was observed (after 3 hours), it seemed that a single copulation was the norm, leading to the conclusion that oestrous is apparently terminated by a successful copulation and consequently lasts about one day.

Oestrus data are confirmed by those of RFU research, which showed a pre-oestrus period of between 1 and 24 days and a post-copulation period of 1 to 8 days for 24 encounters.

Owen-Smith found that the first oestrus occurred at about 5 years of age, while the RFU calving data show that it occurred much earlier. The mean age at first calving for six females was 5 years 2 months and 18 days, which, based on a 16-month gestation period (see below), gives a conception mean of 3 years 10 months and 12 days. The earliest conception was at 3 years, 1 month and 20 days.

Furthermore, Owen-Smith reported that females came into oestrus when the calf was 6–12 months old. However, three of the ZRS females mated when their calves were 2, 4 and 5 months old, respectively. The average interval between their first and second calves for the first six calving females mentioned above, was estimated to be 34 months.

The early age at first calving recorded (5 years 2 months and 18 days) followed by the extended inter calving interval (34 months) suggests that it is not the onset of returning oestrus that dictates when the females will mate, but whether they have reached a level of fitness naturally required to support a new calf.

Owen-Smith found that two peaks in oestrus levels occurred in November and February resulting in peak calving months in March and July, the main calving months being March to May, but, with variability in rainfall patterns, calves were born year-round, and in any month.

Of the three calvings at the ZRS, 17 occurred in three months (June (7), August (5), January (5)) and there were no births in May or November.

RFU monitors recorded a much greater number of copulations, which showed that while most occurred only once per day, they could be repeated two, three, or four times in one day. The copulations lasted on average 17 minutes (range 5-50, n=83).

A total of 71% of the copulations occurred during the day and 29% during the night. On 14 occasions, where copulations occurred more than once on the same day, there was an average of 4 hours between each (range 1–9 hours).

Owen-Smith found that the male usually remained with the female for 2 to 6 days after copulation, which was confirmed by the RFU data of 0 to 8 days.

Gestation period data were also similar with nine records from Owen-Smith's studies suggesting probably 16 months (around 487 days), while RFU data estimated a mean of 26 gestation periods of 493 days (range 484–502)

Owen-Smith considered the age at first calving to be 6.5 to 7 years, and this is widely used in the literature. However, the RFU data showed that the first six recorded calvings averaged 5 years 2 months and 18 days. The ease of opportunity and the aggressive nature of the male probably led to particularly early mating, but it is clear that the female is capable of reproducing around a year earlier than is usually referenced.

Parturition was not observed by Owen-Smith while RFU monitors observed and recorded rhino births, one of which was analysed for a research paper (Patton and Genade 2015).

Owen-Smith observed that the previous calf or other companions were driven away or avoided only a day or less before the birth and normally did not rejoin the mother again, but had few observations to indicate

how the longstanding and close bond was broken.

However, RFU monitors recorded nine occasions of the time from when the former calf was chased and the birth of the new calf with an average of 6 hours 8 minutes (range 2 hours 17 minutes to 16 hours 59 minutes). On 14 occasions, the former calf stayed up to 50 metres from the new calf for between 3 and 57 hours. On three occasions, the former calf stayed with the new calf and formed an association.

The action of chasing started only a few hours before the birth and varied from highly aggressive to passive, but in all cases the current calf quickly worked their way back or remained within 50 metres while occasionally the female did not even bother to chase the calf off at all.

Owen-Smith observed that calves under two months of age nursed frequently and those between two and 12 months nursed about half as much. Nursing continued until calves were well over a year in most cases, but the frequency declined after 15–18 months. There were three records of nursing by calves over 18 months of age, in one instance by a 24-month-old calf.

RFU recorded some aspects of suckling from January 2017 to the end of May 2019 for eight females with new calves. During the period, some 4,178 suckling observations were made.

The average number of sucklings per day for each of the eight females was 3 (range 2 to 4) and the range in number of sucklings per day across all records was 1 to 12.

The 4,178 suckling records could be apportioned by the age of the calf, in months:

0–6m 35%; 7–12m 22%; 13–18m 23%; 19–24m 14%; and 25+m 5%

The reduction in the amount of suckling as the calf gets older would be expected as it gradually weans off milk to feeding on grass (grazing) and drinking water.

The average ICI estimated by Owen-Smith was 30 months with a range of 22 to 36 months.

In RFU research, the average inter calving interval for 25 records was 25 months with a range of 18 to 36 months. It appears that, with better grazing conditions, females recover their body condition faster and will reproduce again sooner.

Social

According to Owen-Smith, young males were considered adult at 10–12 years of age, some becoming solitary at 8 years of age. Two young males at ZRS split up after a fight when one was 7 years and 10 months old and the other 7 years and 5 months old. The younger, large for his age and very aggressive, became a breeding male at 8 years and 7 months, while the older remained solitary.

Adult females were usually accompanied by a single offspring, or a "surrogate" bond was formed with a single adolescent, which may have been a former calf but unlikely, or up to six adolescents.

Following 22 calvings, the RFU monitors recorded only three adolescents who remained with their mother and new calf, four joined one particular female and her calf, with fifteen joining sub-adult groups of between two and five individuals.

Owen-Smith reported that, although groups may be isolated from other groups, sometimes several groups may be found feeding in the same vicinity. The two main RFU subadult groups joined to form a settled group of nine.

Discussion

In general, the RFU data collected over 10 years support the observations and some speculations made by Owen-Smith. An important difference between the research is that in the smaller and wetter areas of ZRS the onset of oestrus is three years; in Hluhuwe-iMfolozi it was five years leading to earlier first calvings. In addition, the average inter calving interval is typically 24 months, not 30 months.

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Observations on the first inter calving interval for six, particularly early breeding white rhinos at Ziwa Rhino Sanctuary, Uganda

Felix J Patton[1], Petra E Campbell[1], Angie Genade[1]*

[1]Rhinoswildlife, Hannover, Germany

*corresponding author: rhinoswildlife@gmail.com

Introduction

The Ziwa Rhino Sanctuary (RS) covers an area of 64.2 km^2 in the Nakasongola district of central Uganda. Before becoming a wildlife refuge in 2004, the area was part of a cattle ranching operation. Ziwa RS was established in 2005 and was operated under private management. In May 2021, the Uganda Wildlife Authority assumed responsibility for the management of Ziwa RS, and monitoring studies have been limited since then. Ziwa RS holds the only semi-wild (introduced from South Africa to East Africa in the 1960s) southern white rhinos (*Ceratotherium simum simum*) in Uganda. Three sub-adult males and three sub-adult females formed the founder population in 2005/2006. At the end June 2023 the white rhino population was 38.

The three founder sub-adult females started breeding in 2009/2010 when, at the age of 8.5 years old, one of the founder sub-adult males, *Taleo*, had reached maturity and became the dominant, assertive male. *Taleo* was the father, confirmed by genetic analysis, of the first six females born in the Sanctuary, as shown below.

Following the death of one of the founder breeding females *Nandi* in January 2021, as of the end of 2022 there were eight breeding females as follows:

Multi-calving, founder females: *Kori, Bella*
First born calving females: *Malaika, Laloyo, Donna*
Second born calving females: *Uhuru, Luna, Waribe*

White rhinos are generally reported to reach sexual maturity between 4 and 5 years of age but do not reproduce until 6 to 7 years of age.

The average age at first calving is a useful indicator of breeding performance which can be applied where the rhinos are individually known and frequently sighted. Females in rapidly growing populations may have their first parturition as young as 6.5 years but in populations with poor performance the age at first calving may lengthen to over 7.5 years (Owen-Smith 1975; du Toit 2006)

However, with only three adult females, *Taleo* used his strength to mate with the six sub-adult females, earlier than the 6.5 years normally expected.

The calving interval (CI) is the period between one calving and the next calving. One of the best indicators of population performance is the average inter calving interval (ICI) as it is largely independent of sex ratio. The measure is determined by observing the calving frequency of known females and averaging these values. In white rhinos, the ICI should be between 2.5 and 3 years (Kenya Wildlife Service 2021; Ververs et al. 2017).

ICI is used by the South African Development Corporation (SADC) on a scale to describe the level of fecundity in a white rhino population:

>3.5 years (42m) for ICI indicates poor to very poor fecundity; 3.1–3.5 years (37–42m) for ICI indicates moderately poor to poor fecundity; 2.5–3.0 years (30–36m) for ICI indicates good to moderate fecundity; <2.5 years (30m) for ICI indicates good to excellent fecundity. (du Toit 2006)

This paper presents observations on the ICI between the birth of the first and second calves of the six Ziwa females that produced their first calf at a particularly young age.

Results

Table 1 shows the age of the Ziwa RS founder females when they had their first and second calves and the resulting CI with an average of 25 months (range 23–27).

Table 2 shows the age of the Ziwa RS-born females at the time of first and second births, with the resulting CI being on average 34 months (range 27–44).

Table 3 shows a summary of the first and subsequent calving intervals recorded for the nine Ziwa RS breeding females with an average of 25 months (range 18–45).

Table 4 shows an analysis of ICIs for the Ziwa RS breeding females, illustrating a much longer average for the Ziwa RS-born females (34m) compared to the average from the founder females (24m).

Table 1. Breeding data and first calving interval for Ziwa founder females between 2010 and 2022

Rhino	First birth age	Second birth age	First CI
Nandi	9y 11m	11y 11m	23m
Bella	9y 9m	12y 0m	27m
Kori	10y 0m	12y 0m	24m
Average	9y 9m	12y 0m	**25m**

Table 2. Breeding data and first calving interval for ZRS-born breeding females between 2010 and 2022

Rhino	First birth age	Second birth age	First CI
Donna	4y 6m	7y 5m	35m
Luna	4y 9m	8y 5m	44m
Uhuru	5y 1m	7y 6m	29m
Malaika	5y 7m	7y 10m	27m
Laloyo	5y 7m	8y 7m	36m
Waribe	5y 8m	8y 7m	35m
Average	**5y 3m**	**8y 1m**	**34m**

Table 3. Calving Intervals for the Ziwa breeding females between 2010 and 2022

Calving intervals	1st	2nd	3rd	4th	5th	6th
Nandi	23	24	26	23	20	21
Bella	27	27	26	26	24	
Kori	24	24	26	23	18	23
Malaika	28	22				
Donna	36	37				
Laloyo	35					
Uhuru	30					
Luna	45					
Waribe	34					

Table 4. Analysis of the summaries of the Inter-Calving Intervals for the ZRS breeding females between 2010 and 2022

First ICI founder females	**25m**	n=3
First ICI ZRS born females	**34m**	n=6
All ICI all females	**25m**	n=25
All ICI all less ZRS born females	**24m**	n=19

Discussion

The average age of first calving of the three Ziwa RS founder females, at 9.75 years, was well above that of the 6.5 years indicated by du Toit (2006). This was likely due to the absence of a male of breeding age as the founder males were of the same age as the founder females at the time of introduction and were not in optimum condition to mate.

The average age of first calving of the six Ziwa RS-born females, at 5.25 years, was much earlier than that of the 6.5 years reported in the SADC guidelines (du Toit 2006). This was likely due to the lack of opportunity for the breeding male to find mating opportunities once the three founder females had conceived. As soon as each Ziwa RS-born female had reached a condition to conceive, the breeding male exerted his greater physical presence.

The ICI of the founder females at 24 months is well within the SADC performance indicator of <30 months to indicate good to excellent fecundity (du Toit 2006). All 25 calving intervals were below the 30-month threshold.

The ICI of the Ziwa RS-born females at 35 months is just within the SADC performance indicator of good to moderate fecundity. One of the CI, at 45 months, would even be rated as poor to very poor fecundity. The available mating data show that it was possible that the female could have had an absorbed miscarriage and conceived immediately after she lost the calf-in-utero, but this would have reduced the CI to just 40 months.

There is only one second CI available from the Ziwa RS born females, that for *Donna* at 37 months (Table 3). Therefore, it is not possible to postulate as to whether future CIs will be reduced to a level more similar to that of the founder females or not.

A literature search was unable to find any data for first CI of early-aged calving females for comparison.

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How to raise a rhino: a biography of Anna Merz, founder of Lewa Downs black rhino sanctuary

Deb Aronson

Reviewed by Michael Dyer

Borana Conservancy, PO Box 137, Laikipia 10400, Kenya.
email: Michael@borana.co.ke

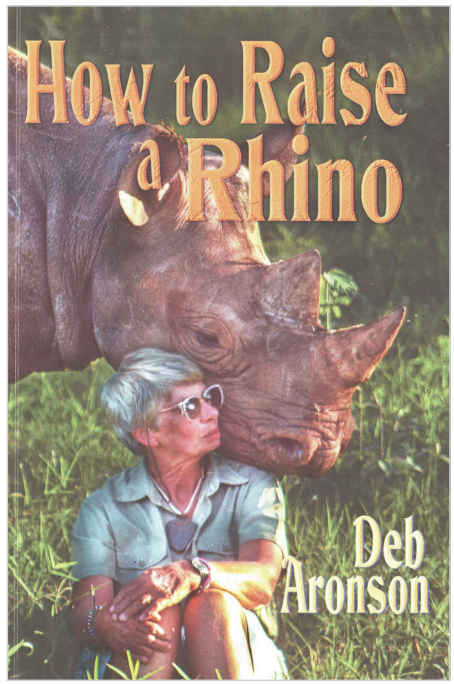

Photo © Boyd Norton

How to raise a rhino by Deb Aronson takes the reader on Anna Merz's journey as she commits the fourth quarter of her life to saving a species that has been on this planet for 40 to 50 million years. By the end of the 1970s and early 1980s the population of wild black rhino in Kenya had crashed from 20,000 to less than 400 and was critically endangered. Through her friendship with Mama and Mzee Craig, she found her calling and embarked on an adventure that brought a group of people together— farmers, vets, trackers and hunters turned conservationists committed to finding the last isolated rhinos in northern Kenya and bringing them together into a safe and secure sanctuary known as the Ngare Sergoi on land made available by the Craig family. This founding population of 11 rhinos were the beginning of the reversal of fortune for the rhino population in Kenya and started a conservation movement that has ensured the survival of this species.

This book brings to life the passion, dedication, and emotion that are needed to succeed and created a generation of change makers. Her principal partners were Ian and Will Craig, Kinyanjui Lesanderia, Fuzz Dyer, Ted Goss, and Dr Dieter Rotcher. Today's East African rhino population is now secure, and the challenge faced by the Kenya Wildlife Service and conservationists is no longer about a species becoming extinct, but about finding more space and suitable habitat for a growing population. The book confirms that Anna had no ego and was therefore not constrained in committing her life to her cause, and although she ultimately stepped away, her legacy went from strength to strength. The current population of rhino sin private sanctuaries exceeds by a wide margin the total number of rhinos at the most critical point of the crisis. Her Samia Trust continues to this day to provide support to rangers dedicated to protecting rhinos across the African continent.

40 chapters. Available from: Dragonfeather Books (Bedazzled Ink Publishing Company)
Fairfield, California http://www.bedazzledink.com

OBITUARIES

Mark and Peter Jenkins

Following in a father's footsteps, two lives cut short while on active duty

Mark Jenkins
Born: 6 May 1965
Died: 8 December 2022

Peter Jenkins
Born: 7 May 2001
Died: 8 December 2022

Tribute by Bongo Woodley

email: bongowoodley@gmail.com

On 8 December 2022, Mark Jenkins, together with his younger son Peter, lost their lives in a plane crash while directing ground operations against illegal livestock in the eastern area of Tsavo East National Park. At the time, Mark was working for the Sheldrick Wildlife Trust.

Mark was the son of Peter Jenkins, who took over as Warden of Meru National Park (NP) in 1968 (with additional responsibility for Marsabit and Sibiloi NPs) and is well remembered for transforming Meru NP into a model park. Mark's father, Peter Jenkins was an exacting man with great attention to detail and high standards expected of park personnel; Mark shared many of these attributes.

Mark was educated at Pembroke House in Gilgil, Kenya, and at Allhallows in Devon, UK. He attained a Diploma in Land Management at Cirencester, UK. After completing his education, Mark went to

Zimbabwe to learn to fly on a J3-Cub, following this to South Africa for his rotary licence and to gain work experience with a Game Capture unit.

In February 1976, the independent Kenya National Parks (KNPs) amalgamated with the Game Department to eventually become the Wildlife Conservation and Management Department (WCMD). With national parks now being run as a government department, this heralded an inexorable deterioration of infrastructure and operational capability with budgets curtailed, an inability to recruit park rangers directly, and random transfer of key personnel without consultation.

Against this background, Mark was raised and engendered by his father's achievements under KNPs. Being raised in a national park was not without risk and Mark as a toddler was severely mauled by one of George Adamson's lions. Peter Jenkins worked tirelessly against the odds during the subsequent decline and mismanagement of parks if not wilful destruction; and widespread poaching that occurred under the new entity. Such were the ups and downs of wildlife conservation in Kenya in the 1980s, which culminated in the appointment of Richard Leakey as director of WCMD in 1989, and in January 1990, the creation of the Kenya Wildlife Service (KWS). KWS was enacted as a state corporation with, in the early years at least, financial independence and a high degree of autonomy from direct ministerial control. This attracted considerable funding to KWS, some of which was destined for Meru NP.

This was the once-in-a-lifetime opportunity for Mark to follow in his father's footsteps, and he joined the new parastatal. Mark was instrumental in establishing and leading the KWS Special Operations Unit, frequently at the sharp end of anti-poaching operations. Rangers were better armed, equipped, and mobilized, and hundreds of new ranger recruits were trained by the General Service Unit.

Units were urgently deployed to counter the relentless attacks from well-armed *shifta* bandits and poachers, the killing of rangers striving to carry out their duties, the robbery and murder of tourists in several conservation areas including Meru NP and Tsavo East and West NPs, the murder of George Adamson in Kora National Reserve, the burning of Meru Mulika Lodge, and severe associated insecurity within the adjacent community areas. An estimated five elephants were poached daily nationwide, and five white rhinos ostensibly under guard were slaughtered in Meru NP. These alarming 1988/89 events were countered by the appointment of Leakey and the first ivory burn in July 1989.

Mark's career in wildlife conservation varied widely. In 1992 he left KWS and went to South Africa to obtain his pilot's licence on fixed-wing and helicopter. German Technical Cooperation (GTZ) was supporting the Uganda Wildlife Authority with the rehabilitation of Murchison Falls NP and Mark flew a Super Cub from South Africa to Uganda, where he joined the programme. At Murchison Falls NP he experienced 'exciting times' in close proximity to the Lord's Resistance Army and actions of the Ugandan Army, and he would recount with great hilarity many an outlandish and downright life-threatening experience. It was in Uganda that Mark met Clare, his wife-to-be.

Together, they went to Niassa Game Reserve (GR) in northern Mozambique where Mark used his growing experience in wildlife management by conducting a baseline survey of the depleted wildlife populations, rebuilding infrastructure and operational capability.

Following the reappointment of Richard Leakey as Director of KWS In 1998, Mark re-joined KWS in 1999, this time as Senior Warden Meru NP. He was instrumental in raising funding for the Meru/Kora ecosystem through the French Development Agency (AFD) and then formulating and implementing the project that included the translocation of black rhinos to Meru. Mark also advocated for the use of elephant collars to track the movement of elephants between and out of protected areas. This was an invaluable management tool for elephant security and was used by the NGO Save the Elephants to leverage funding for what has since become a widely used strategy. In July 1999, Leakey resigned to take up a position as head of the civil service. Eventually, perennial institutional politics with a lack of support from the top and direct security threats to him and his family saw Mark depart KWS in 2008.

Mark then worked in the Ngurumans, south Kenya and afterwards at Segera Ranch in Laikipia, Kenya where he transformed the predominantly livestock-focused ranch to a landscape prioritising wildlife conservation. From 2014 to 2016, Mark was a project

leader for the Frankfurt Zoological Society, initially in Selous GR then in Serengeti NP in Tanzania.

Mark's third tenure with KWS from 2017 was as an advisor to the Director and the Board of Trustees headed by Leakey. As always, politics in the form of ministerial overreach in September 2018 resulted in a blame game over the deaths of an entire contingent of 11 rhino being translocated into Tsavo East NP. This culminated in the eventual appointment of a new KWS Board and the departure of Mark.

He continued his career in wildlife in 2019 and 2020 with consultancies in countries such as DRC (Virunga), South Sudan, Zambia and closer to home in Kenya.

Mark started working for the Sheldrick Wildlife Trust in January 2021 and focused his efforts on wildlife conservation and protection of Galana and Kulalu Ranches. These two extensive land areas fall under the Agricultural Development Corporation (ADC) and form a buffer along much of the eastern boundary of Tsavo East NP.

Following a formal agreement between SWT and ADC, Mark established a base in Lali Hills on Galana Ranch in May 2021. After that, desnaring/anti-poaching efforts resulted in numerous arrests and convictions, a reduction of the vast herds of illegal livestock in the adjacent Tsavo East NP and an increase in wildlife presence in the two ranches. Mark and the ranger teams were ably assisted in this campaign by his sons, Peter, and his older brother Myles.

Peter was following in the footsteps of his father and grandfather and had completed a BSc in environmental management at Reading University and had recently obtained his Private Pilot Licence. He was also a Reserve Officer in 4th Battalion Parachute Regiment and was destined for the Sandhurst Commissioning Course in May 2023, all of which would have stood him in good stead for his intended career, tragically cut short. Peter was greatly influenced by his father Mark, who was always very proud of the fact that he was able to stabilise management in several ravaged PAs and give wildlife the opportunity to again flourish and he was relentless in his views on this. Mark was relentless in his views on effective PA management and Peter was establishing his own conviction for the same cause.

Mark leaves behind his wife, Clare; his older son, Myles; and his sister, Siana. In April 2023, Myles was awarded the Sword of Honour by King Charles III upon passing out of Sandhurst Military Academy as the best officer cadet on the course, an achievement his father and his brother, Peter, would have been immensely proud of.

Rudi Van Aarde—beyond the loss, celebrating the Professor's indelible footprints

Born: 21 September 1951
Died: 21 July 2023

Tribute by Jason Bell

Email: jbell@ifaw.org

It is with great sadness that I share the tragic news that Professor Rudi van Aarde passed away suddenly on Friday 21 July 2023.

Rudi grew up in Pretoria and went to Mayville Laerskool en Hoerskool Wonderboom. Following high school, he studied at Pretoria University, and continued on to do his graduate studies at the Mammal Research Institute.

The short answer to who Rudi was is that he was the Director of the Conservation Ecology Research Unit (CERU) at the University of Pretoria, with whom IFAW had partnered for over 20 years.

But Rudi is a lot more than a job title and he and I go back a long way.

Rudi taught me while I was at the Mammal Research Institute at Pretoria, (Department of Zoology and Entomology) and our paths crossed over common goals for elephant protection in my early days at IFAW. The fact that IFAW is pioneering one of the most ambitious global conservation initiatives of our time, Room to Roam, is due to Rudi and CERU's work over the past 20 years.

He has led one of the most comprehensive elephant population-level research programmes ever conducted, the conversations in turn led to implementing the NGO's Room to Roam in recent years. As with IFAW's past contributions to whale and seal science, Rudi's work was geared towards the use of science to inform conservation decision-making.

This is how it all started 20 years ago. His mantra was to put science on the table first and foremost, and then decide whether science or politics would lead the way in policy and conservation management decisions.

For IFAW, our paths first crossed in the controversy around renewed calls for elephant culling in the Kruger National Park (NP) in the late 1990s. We quickly rallied around Rudi to present the data, i.e. to understand the drivers of the dynamics of Kruger NPs elephants before making archaic, ill-informed decisions with serious animal welfare consequences.

Fortunately, South African National Parks (SAN Parks) adopted Rudi and IFAW's recommendations and developed a new management plan for Kruger NP's elephants based on spatial management of water in the Park and the removal of the fence between South Africa and the Mozambique border. The elephant population stabilized in a few years, and culling was no longer a consideration.

Rudi knew that politics would drive poor management decisions in southern Africa, with calls for culling coming from Botswana, Namibia and Zimbabwe. At the helm of CERU and IFAW, the focus shifted to a regional one, and thus started the work of Room to Roam.

The goal in 2007 was simple–to understand the drivers of elephant population dynamics across southern Africa, where 80% of Africa's elephants lived. His vision was about what Africa should look like for elephants and people 10, 30, 50, and 100 years

from now, something I often repeat regarding how we comprehend the importance of Room to Roam.

While this is saddening news, the legacy that Rudi has left behind is immeasurable.

I will say that if it were not for Rudi and his passion for elephants, science and nature, we would still be deep in the throes of the politics around elephant management in southern Africa.

He was a seeker of the truth, and if you have ever seen any of his amazing photographs, you could attest to his deep spiritual connection to elephants and nature. I always told him this, and he would always groan about it.

I have spent a lot of time with Rudi over the years, mainly in the bush, memories that I will forever cherish. I have learned an incredible amount from a friend and mentor, a larger-than-life character. IFAW will continue to honor Rudi's legacy through our ongoing commitment to the science behind Room to Roam, an initiative that will live on as a celebration of his life.

Rudi married Camilla Norgaard in 2012, and sadly leaves Camilla and his wonderful dogs behind.

GUIDELINES FOR CONTRIBUTORS

Aim and scope

Pachyderm publishes papers and notes concerning all aspects of African elephants, African rhinos and Asian rhinos with a focus on the conservation and management of these species in the wild. At the same time, the journal is a platform for disseminating information concerning the activities of the African Elephant, the African Rhino, and the Asian Rhino Specialist Groups of the IUCN Species Survival Commission. Currently, *Pachyderm* is published online once a year and is 'Platinum Open access' (for all readers free access to published scientific works; with no publication fees for the authors to publish). All research, management, and history papers are peer-reviewed.

Submission of manuscripts

All manuscripts should be submitted online at: http://Pachydermjournal.org & https://pachydermjournal.org/index.php/pachyderm/about/submissions.

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Manuscripts are accepted in both English and French. Where possible, the abstract should be provided in both languages, whether submitted in English or French.

Pachyderm's Editorial Board categorizes material received into the following sections:

Research and management papers

Papers may be reports of original biology research or they may focus more on the socio-economic aspects of conservation, including market surveys. Each Research and Management paper is subject to peer review, the reviewers who are assigned have expertise in the specialist subject/s related to your paper. This process is "blind" with both author(s) and reviewer(s) anonymous to each other unless otherwise agreed.

Papers should not exceed 6,000 words (the word count is inclusive of all parts of the manuscript, including the title page, abstract, references, table and figure legends). Papers should be structured as follows: 1a) Title, 1b) Names, addresses and emails of authors, 2) The Abstract must not exceed 250 words (informative type, outlining information from the Introduction, Materials and methods, Results, Discussion, but not detailed results); 3) additional key words (if any); not appearing in the title, maximum six; 4) Introduction; 5) Materials and methods; 6) Results; 7) Discussion; 8) Conclusions; if appropriate; 9) Acknowledgements (optional, brief); 10) References should be included only when essential and quoted in the text (maximum of 25); 11) Tables; 12) Figure and photo captions; 13) Figures and photos. (Tables, figures and images should be inserted in the text in the relevant section). Should your paper exceed 7,500 words, an article processing contribution (APC) fee maybe requested by the Editorial Board.

Field notes

The journal welcomes notes from the field. They may contain figures and tables but should be a maximum of 3,000 words, including references.

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Review papers, which are unbiased reviews of all the existing knowledge on a specific topic, are welcomed. Length should be a maximum of 5,000 words, including references.

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Pachyderm invites reviews of newly published books, which can be up to 1,500 words. Kindly liaise with the editor prior to submission.

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Letters should be addressed to the relevant Specialist Group Chair/ or Editor and should be a maximum of 1,500 words. Letters are welcome that comment on articles published in *Pachyderm* or on any other issue relating to elephant and rhino conservation in the wild.

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Submissions may be prepared using any word processing software but must be submitted in .doc or .docx format. Submissions should be set in 12pt Times New Roman font, left-aligned, and with double-spacing. Submissions in PDF format are not acceptable.

Tables, figures, images and maps

Preferably provide figures and maps in their original form, and data in Table format; (Excel files are not accepted), maps as EPS and images should be submitted in the highest quality possible, such as TIF (minimum 300 dpi), or JPEG (minimum 300 dpi). Indicate clearly the author or source of figures, maps and photographs. Colour is acceptable. We shorten figure to 'fig. x' within the text, and 'Figure x.' in full in the caption.

Title and authors

The title should contain as many of the key words as possible but should not be more than 25 words long. Follow with the name(s) of the author(s) with institutional affiliation, postal and email address of the corresponding author, to whom proofs and editorial comments will be sent.

Journal conventions

Nomenclature

Use common names of animals and plants, giving scientific names in italics on first mention. Generally, refer to animals in the plural form (i.e. rhinos, elephants). We do not capitalise elephant, black rhino, white rhino and greater one-horned rhino. We do capitalise Javan and Sumatran rhino.

Spelling

Use British spelling, following the latest edition of the Oxford Advanced Learners Dictionary using 'z' instead of 's' in words like 'recognize', 'organization', 'immobilized'; but 'analyse', 'paralyse', a full list can be obtained from the Managing Editor: https://elt.oup.com/catalogue/items/global/dictionaries/oxford-advanced-learners-dictionary/?cc=global&selLanguage=en

Numbers

Use the International System of Units for measurement (m, km, kg, ha, h) with a space between the numeral and the unit of measurement. Give measurements in figures, for example 12 mm, 1 km, 3 ha, except at the beginning of a sentence; in which case write out the full number, e.g Forty-two black rhinos were born in 2023.

Spell out numbers under 10 if not a unit of measurement unless the number is part of a series containing numbers 10 or over, for example: 14 adult males, 23 adult females and 3 juveniles or there were nine people watching the group of 65 elephants.

In the text, use a comma as the separator for figures four digits or more: 1,750 and 11,750. The separator will be a full stop in French papers.

Hyphens, en dashes and em dashes

Hyphens (narrow):

Used to separate compound words, such as long-term; seventy-two.

The en dash (wider) expresses a period of time, examples:

The 'en' dash, so called because it is the width of a printed 'N' character, is longer than a hyphen but

shorter than an 'em' dash. It should be used without spaces on either side, e.g.

A rhino census was carried out in four rhino bearing areas during March–April, 2022. (NB: Rhinos occurred in the area from at least 1898 until 1979;

Elephants born between 2009 and 2019 were counted by our field staff).

The en dash is used to indicate a range of numbers, examples:

South Africa's Kruger National Park is home to 7,000–8,300 rhino as of 2016.

Overall, all of the elephants had smaller annual home ranges (~450–1,750 km^2).

The en dash is used to indicate distance, example:

The headwaters of the Chobe River–Victoria Falls is a distance of 136.3 km.

The em dash (even wider) is used for emphasis in place of a colon:

The 'en' dash, so called because it is the width of a printed 'M' character, and is used to enclose a sentence of phrase within a sentence and it provides greater emphasis than parenthesis, e.g.

Our core values—integrity, collaboration, adaptability, sound decision-making and commitment—are at the heart of everything we do.

The presence of the new species—that scientists suspected existed—was confirmed last week.

DOI

A DOI should be provided where available and especially for digital sources, in the format "doi:prefix/suffix" and hyperlinked to "https://doi.org/prefix/suffix". Whenever both a URL and DOI are available for a source, the DOI is preferred, and the URL may be omitted. The preferred format is: doi:10.1000/182

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We use the name-year method of citing and listing references. The punctuation and typographic style is as follows:

In the text, cite a single author: '(X 2005)' or 'X (2005)'; cite two authors: '(X and Y 2005)' or 'X and Y (2005)'; cite more than two authors '(X et al. 2007)' or 'X et al. (2007)'. Note that there is no comma between the author(s) and the year. If multiple works are being cited, separate them by a semicolon, listing them in chronological order: (X et al. 1998; B 2002; Z 2010). Multiple works by the same author(s) published in the same year are denoted by suffix -a or -b.

Note that in the reference list, punctuation is minimized, remove full stops at the end of online cited references.

Journal names in full without leading article. Book titles are italicised. Journal titles are italicised.

Article in a journal or periodical

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Common Acronyms (the following can be abbreviated in your manuscript)

SSC	Species Survival Commission
AZA	Association of Zoos and Aquariums
AfESG	African Elephant Specialist Group
AfRSG	African Rhino Specialist Group
AsRSG	Asian Rhino Specialist Group
CITES	Convention on International Trade in Endangered Species (of Wild Fauna and Flora)
CMS	Convention on Migratory Species
DEFRA	Department for Environment, Food and Rural Affairs
EAZA	European Association of Zoos and Aquaria
ETIS	Elephant Trade Information System
IUCN	International Union for the Conservation of Nature
IRF	International Rhino Foundation
KAZA- TFCA	Kavango–Zambezi Transfrontier Conservation Area
MIKE	Monitoring the Illegal Killing of Elephants
RRC	Rhino Resource Center
SRI	Save the Rhino International
USF&WS	US Fish and Wildlife Service
WAZA	World Association of Zoos and Aquariums
WCS	World Conservation Society
ZSL	Zoological Society of London

Jargon to avoid

Catalyse
Framework
Process
Leverage
Synergy
Linkages
Utilize (instead just 'use')
Thus