Pachyderm

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Cover caption: African forest elephant, *Loxodonta cyclotis* in a Bai, Gabon. In March 2021 the IUCN declared that *L. Cyclotis* were a separate species from African savannah elephants (*Loxodonta africana*), and also listed African forest elephants as critically endangered.
The small nation of Gabon is the last stronghold of the forest elephant.

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To support the continued publication of *Pachyderm* and its contribution to the conservation and management of African elephants, African rhinos and Asian rhinos, please contact the Managing Editor.

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CHAIR REPORTS

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

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Introduction

As we moved into the new quadrennium, 2021–2024, we were hoping to build on the foundations developed during our tenure to date. Unfortunately, the Covid-19 epidemic significantly changed the landscape, effectively delaying the start of the new quadrennium and/or direct physical engagements and field visits due to travel and meeting restrictions. Regardless, we are very pleased to be able to continue to facilitate, coordinate and enable the work of the African Elephant Specialist Group (AfESG). As we entered the new quadrennium, we are fortunate to have the continued involvement of the existing membership, but also pleased that a number of new members have joined the Group. We have strengthened our membership through increased numbers, additional skillsets and by building collegiality with governments and multi-lateral agencies. Our nine working groups and task forces are poised to tackle some thirty odd targets, which we developed around our goals and aligned to the five key components of Assess, Plan, Act, Communicate and Network in the IUCN's Species Strategic Plan.

In this report we highlight progress made in implementing our Group's 2021–2024 quadrennium targets. Key among them are the achievements and plans of the working groups and task forces. We have developed a process that would allow members of the sustainable use task

Introduction

En ce début de nouveau quadriennat 2021-2024, nous avions l'espoir de poursuivre nos actions sur les bases établies durant notre mandat précédent. Malheureusement, l'épidémie de Covid 19 a drastiquement bouleversé le programme, en retardant l'amorce du quadriennat, les rendez-vous et les visites de terrain en raison des restrictions de voyages et de réunion. Néanmoins, nous sommes ravis d'être de nouveau présents pour faciliter et coordonner le travail du Groupe de Spécialistes de l'éléphant d'Afrique (GSEAf). Dans cette nouvelle période de quatre ans, nous avons la chance de pouvoir compter sur l'implication de membres historiques, et nous nous réjouissons d'accueillir de nouvelles recrues dans notre groupe. Notre équipe s'est étoffée en nombre et en compétences et nous avons développé des liens de collaboration avec des gouvernements et des organisations multilatérales. Nos neuf groupes de travail et unités opérationnelles sont en passe de faire émerger une trentaine d'objectifs, déployés autour de nos missions et alignés sur les cinq composantes clés du plan stratégique de l'UICN pour la biodiversité : évaluation, planification, action, communication et réseau.

Ce rapport souligne les progrès accomplis dans la mise en place des enjeux quadriennaux pour 2021-2024. Parmi eux, les résultats et projets des groupes de travail et unités opérationnelles sont capitaux. Nous avons développé une procédure permettant aux membres de la cellule dédiée à l'utilisation durable de s'investir massivement dans la recherche

force to engage deeply with the evidence around these issues, such that the AfESG can present the evidence in an objective manner. The Data Review working group (DRWG) has finalized the production of the forest elephant status report and is embarking on the savannah elephant status report, whereas the CITES Animals Committee 31 came up with decisions and implications of the two African elephant species recognition for consideration at CITES CoP 19 for Panama in November 2021. Substantive progress is being made in fundraising and in establishing a sustainable financing mechanism for the AfESG through a formation of a circle of funders for the AfESG's mandate. In collaboration with the University of KwaZulu Natal, we present a systematic review of success, and unintended consequences, of management interventions on African elephants in this volume of *Pachyderm*.

African forest and savannah elephants treated as separate species

The AfESG now recognizes Africa's two elephants as distinct species: the African forest elephant (*Loxodonta cyclotis*) and the African savannah elephant (*Loxodonta africana*). Accordingly, the IUCN Red List assessments for each species were recently published and the AfESG will be publishing the next iteration of the African elephant status report in two volumes. One in 2022 for the Critically Endangered[1] *L. cyclotis* and another in 2023 for the Endangered[2] *L. africana*.

The AfESG made an official statement of recognition of the two species in 2021[3]. Prior to

d'indicateurs, qui pourront être présentés de façon objective par le GSEAf. Le Groupe de Travail sur l'Examen des Données (GTED) est en phase de finalisation du rapport de situation de «l'éléphant de forêt» et débute celui concernant «l'éléphant de savane». D'autre part, lors de la trente-et-unième session du Comité pour les animaux de la CITES, des décisions ont été prises et les implications de la reconnaissance de deux espèces distinctes d'éléphants d'Afrique ont été soulignées. Elles sont examinées lors de la CdP 19 de la CITES, qui se tient en novembre 2021 au Panama. De réels progrès sont visibles dans le secteur de la collecte de fonds, avec notamment la mise en place d'un mécanisme financier durable pour le GSEAf, grâce à la création d'un cercle de donateurs pour la durée du mandat. En collaboration avec l'université du KwaZulu-Natal, nous présentons dans cette édition de *Pachyderm* un bilan des réussites et des conséquences inattendues des interventions de gestion sur les éléphants d'Afrique.

Les éléphants de forêt et de savane désormais considérés comme des espèces différentes

Le GSEAf divise les éléphants d'Afrique en deux espèces : l'éléphant de forêt (*Loxodonta cyclotis*) et l'éléphant de savane (*Loxodonta africana*). En conséquence, l'évaluation pour la Liste rouge de l'UICN a été récemment publiée pour chaque espèce et le GSEAf diffusera la prochaine édition du rapport de situation de l'éléphant d'Afrique en deux volumes : l'un en 2022 pour *L. cyclotis* en danger critique[1] d'extinction et l'autre en 2023 pour *L. africana*, espèce menacée[2].

Le GSEAf a fait une déclaration officielle de reconnaissance des deux espèces en 2021[3]. Avant cela, il demeurait difficile d'analyser les conséquences concrètes pour leur conservation. 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, avec ses caractéristiques uniques, et de renouveler l'attention sur la situation préoccupante de chaque groupe et leur conservation. Cela peut en outre générer un intérêt accru pour des populations spécifiques et susciter des actions lorsqu'il est notoire qu'elles sont, par exemple, les dernières de leur espèce dans un pays en particulier.

[1]Gobush KS, Edwards CTT, Maisels F, Wittemyer G, Balfour D, Taylor RD. 2021. *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 on 25 September 2022.

[2]Gobush KS, Edwards CTT, Balfour D, Wittemyer G, Maisels F, Taylor RD. 2021. *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 on 25 September 2022.

the two-species recognition, it was challenging to assess the practical implications for their conservation. Producing two separate Red List assessments and status reports provides opportunities at national, regional and global levels to prioritize actions specific to each species and their unique circumstances, and to re-focus and renew attention on the plight and conservation of both species. Furthermore, more attention and action may be garnered for particular populations with the knowledge that they are the last of their species in a particular country, for example.

Two species and implications, legislations, conservation and management

At present, CITES has deferred decisions incorporating changes in their standard nomenclature for African elephants, until the 20th Meeting of the Conference of the Parties. During the interim, and at CoP 19 leading up to CoP 20, CITES will seek the perspectives of the Parties and other stakeholders on the potential effects on CITES decisions of recognizing *L. cyclotis* and *L. africana* as separate species. This will include a review of the taxonomic-nomenclatural history of African elephants in CITES and accepted use in biological literature.

Draft decisions in the context of progressive scientific acceptance of listing the two African elephant species in CITES were produced by the Nomenclature Committee at AC31 held in 2021[4]. The draft decisions 19.AN4, 19.AN5 and 19.AN6 are contained in CITES CoP 19 Doc 84.1[5] for consideration at CoP 19. To support this task, and further the management of the two species, range States are urged to evaluate the taxonomic status of their elephants and incorporate the findings into their legislation.

Deux espèces distinctes : les implications en termes de législation, de conservation et de gestion

Pour l'instant, la CITES a différé la décision d'intégrer ces changements au sein de sa nomenclature type jusqu'à la vingtième session de la Conférence des Parties. Dans l'intervalle, lors de la 19e CdP et jusqu'à la vingtième session, la CITES recueillera les points de vue des Parties et autres intervenants sur les effets potentiels de la décision de reconnaître *L. cyclotis* et *L. africana* comme espèces différentes. Cela impliquera une revue de l'histoire de la nomenclature taxonomique des éléphants d'Afrique au sein de la CITES et de son usage accepté dans la littérature biologique.

Les projets de décisions, dans un contexte où l'acceptation scientifique de lister les deux espèces d'éléphants d'Afrique progresse au sein de la CITES, ont été rédigés par le comité de nomenclature lors de la trente-et-unième réunion du Comité pour les animaux (AC31) qui s'est tenue en 2021[4]. Les projets de décisions 19.AN4, 19.AN5 et 19.AN6 se trouvent dans le document de la CITES CdP 19 Doc 84.1[5] pour examen durant la CdP 19. Afin de soutenir cette action et la gestion de deux espèces, les États de l'aire de répartition sont vivement encouragés à évaluer le statut taxonomique de leurs éléphants et d'en intégrer les résultats dans leur législation. Cela s'avérera particulièrement important dans les États de l'aire de répartition abritant des populations des deux espèces *L. cyclotis* et *L. africana*, et dans le cas où les politiques de gestion et de conservation reflètent des enjeux espèce-dépendants (déplacements transfrontaliers ou longues distances de populations, activités économiques telles que l'exploitation forestière dans les zones d'habitat des éléphants).

Nous encourageons tous les États de l'aire de répartition à favoriser la recherche, y compris les études génétiques qui permettront une meilleure caractérisation du statut taxonomique de leurs populations. Les désignations taxonomiques des éléphants présents dans ces États faciliteront et clarifieront le traitement de la question des éléphants par les Parties à la CITES. Les États abritant les deux espèces devront probablement adopter une approche harmonisée sur plusieurs aspects de la conservation et de la gestion des éléphants, ainsi que sur les menaces, uniques ou communes, qui pèsent sur les deux groupes. L'un des défis sera de reconnaître les besoins spécifiques de *L. cyclotis* en matière de conservation,

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

[4]CITES 2021 Thirty-first meeting of the Animals Committee Online, 31 May, 1, 4, 21 and 22 June 2021 (https://cites.org/sites/default/files/eng/com/ac/31/com/E-AC31-Com-04.pdf)

[5]https://cites.org/sites/default/files/documents/COP/19/agenda/E-CoP19-84-01_0.pdf

This will be especially important for range States harbouring populations of both *L. cyclotis* and *L. africana*, and in cases where management and conservation policy reflects species-specific concerns, such as large-scale or cross-boundary movements, or economic activities, such as logging that occur in occupied range.

All range States, should encourage research, including genetic studies that will permit a better characterization of the taxonomic status of their populations. Taxonomic designations by range States of their elephants will facilitate and clarify the treatment of elephant issues by the Parties to CITES. Range States with both species will probably need to take a harmonized approach to many aspects of elephant conservation and management, and to the threats that are unique or are shared between the two species. A challenge will be to ensure recognition of the special conservation needs of *L. cyclotis*, given its Critically Endangered status.

AfESG was invited by the Convention on Migratory Species (CMS) to attend the third meeting of the signatories to the Memorandum of Understanding (MoU) concerning conservation for the West African Population of African Elephant, which was held from 30 November to 1 December 2021 online (https://www.cms.int/west-african-elephants/en/meeting/third-meeting-signatories-memorandum-understanding-concerning-conservation-measures-west).

The AfESG presented an overview of the conservation status of West African elephant populations, including implications of the recent recognition of *Loxodonta africana* and *Loxodonta cyclotis* as two distinct species and its revised assessment of the conservation status of these species. The signatories agreed to amend the MoU to align its contents with the African Elephant Action Plan, and maintain the original purpose of the MoU, which is to conserve and protect transboundary elephant populations and their habitats in West Africa.

2021–2024 quadrennium targets and achievements

As reported in the last issue of *Pachyderm* (62) for the 2021–2024 IUCN quadrennium the

du fait de son statut d'espèce en danger critique d'extinction.

Le GSEAf était invité par la Convention sur la conservation d'espèces migratrices (CMS) à la troisième réunion des signataires du Mémorandum d'Entente (MoU) sur la conservation des populations d'éléphant d'Afrique de l'Ouest, du 30 novembre au 1er décembre 2021 en visioconférence.

Le GSEAf a présenté une vue d'ensemble du statut de conservation des populations d'éléphants ouest-africains — y compris les implications de la récente reconnaissance de *Loxodonta africana* et *Loxodonta cyclotis* en tant qu'espèces distinctes — et son évaluation révisée selon ces critères. Les signataires ont accepté de modifier le MoU afin d'uniformiser son contenu avec le Plan d'action pour l'éléphant d'Afrique et de maintenir l'objectif initial du MoU de conserver et protéger les populations transfrontalières d'éléphant et leurs habitats en Afrique de l'Ouest.

Résultats et objectifs du quadriennat 2021–2024

Comme rapporté dans le précédent volume de *Pachyderm* (no 62), les objectifs du GSEAf pour le quadriennat 2021–2024 ont été alignés sur les cinq composantes clé du Plan Stratégique pour les espèces 2021–2024 (https://www.iucn.org/our-union/commissions/species-survival-commission/our-work/iucn-species-strategic-plan). Onze objectifs ont été listés dans la composante «Évaluer», huit pour la section «Planifier», deux pour «Agir», cinq dans «Communiquer» et quatre dans «Travailler en réseau». Nous résumons ici quelques-uns des objectifs atteints par les unités opérationnelles/groupes de travail du GSEAf pour chaque composante clé.

i) Groupe de travail sur l'examen des données — production du rapport de situation pour l'éléphant de forêt d'Afrique

Le GSEAf produira deux rapports : le Rapport de situation de l'éléphant de forêt d'Afrique (AFESR) et le Rapport de situation de l'éléphant de savane d'Afrique (ASESR). Le document «AFESR 2022» représentera le sixième rapport de situation publié par le GSEAf. Comme les précédents, son 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. Pour ce rapport, les dernières données

AfESG's targets were aligned to the five key components of the IUCN Species Strategic Plan 2021–2024 (https://www.iucn.org/our-union/commissions/species-survival-commission/our-work/iucn-species-strategic-plan). Eleven targets were listed under the Assess component, eight targets under Plan, two targets under Act, five targets under Communicate and four targets under Network components. Here we summarize some of the achievements of the targets under each key component that were undertaken by the AfESG's task forces/working groups.

i) Data Review working group—production of African Forest Elephant Status Report

AfESG will produce two component reports, the African Forest Elephant Status Report (AFESR) and African Savannah Elephant Status Report (ASESR). The AFESR 2022 will be the sixth printed African Elephant Status Report produced by the AfESG. Like its predecessors, it aims to provide the most authoritative, comprehensive and up-to-date information on the numbers and distribution of African forest elephants at national, regional and continental levels. The last year of admissible data collected for this report was in 2022.

A sub-group of DRWG working on the forest elephant report led by Fiona Maisels and Chris Thouless and Taxonomic task force led by John Hart have been working on the report since June 2021. All survey reports of *L. cyclotis* populations since 2015 have been collated, and the population metrics entered into the African Elephant Database (AED). The last AESR was published in 2016 and treated all African elephants as one species; previous AESRs were published in 1995, 1998, 2002, 2007 and 2013. The Group has embarked on the next production of the ASESR that will be published in 2023. The ASESR has been delayed to enable the ongoing Kavango-Zambezi Transfontier Conservation Area survey data to be included, given that this is the single largest population of savannah elephants. When the ASESR is published, we also intend to publish a combined report, that collates data for both species per range State/Region/Continent, which will enable comparison with previous status reports. admissibles seront celles collectées en 2022.

Une sous-section du GTED, dirigée par Fiona Maisels and Chris Thouless, ainsi qu'une cellule opérationnelle taxonomique menée par John Hart, travaillent sur le rapport depuis juin 2021. Tous les rapports d'études sur les populations de *L. cyclotis* depuis 2015 ont été rassemblés et les indicateurs de population ont été entrés dans la base de données sur l'éléphant d'Afrique (BDEA), ce qui a permis de rédiger un projet AFESR pour une publication en 2022. Le dernier AESR datait de 2016 et considérait les éléphants d'Afrique comme appartenant à une seule et même espèce. Les AESR précédents avaient respectivement été publiés en 1995, 1998, 2002, 2007 et 2013. Cette tâche terminée, le groupe se lancera directement dans la production du prochain rapport qui sortira en 2023. Le rapport ASESR a été retardé afin d'inclure les données de l'actuelle étude dans l'aire de conservation transfrontalière Kavango-Zambezi, du fait que les individus de cette région représentent la plus grande population d'éléphants de savane. Lorsque l'ASESR sera publié, nous souhaitons présenter un rapport conjoint dans lequel les données seront collectées pour les deux espèces par aire de répartition/région/continent, ce qui permettra une comparaison avec les rapports de situation précédents.

ii) Unité opérationnelle pour la coexistence humain-éléphant

Les conflits homme-éléphant (CHE) représentent déjà une préoccupation majeure et pourraient s'aggraver à l'avenir, dans un contexte de dégradations, perte d'habitats et changement climatique. Les données du programme MIKE (surveillance de l'abattage illégal d'éléphants) indiquent que les abattages illégaux, résultant de ce type de conflits, sont en augmentation et qu'ils pourraient affecter la croissance de certaines populations. En outre, ils signalent un risque accru pour le bien-être des humains, ce qui est également inacceptable. Un aménagement du territoire rigoureux couplé à une approche paysagère est nécessaire, y compris la prise en compte de la coexistence avec les éléphants dans des zones dominées par l'humain. Cela demandera l'engagement des communautés et un volontarisme politique — tous deux essentiels pour une coexistence humain-éléphant (HECx) harmonieuse — tel que le développement d'une agro-industrie et des infrastructures qui modèrent l'impact sur les habitudes de déplacement des éléphants afin d'éviter

ii) Human–Elephant Co-existence task force

Human-elephant conflict (HEC) is already a major concern and has the potential to escalate in future scenarios of habitat degradation and loss and changing climate. There are indications from Monitoring the Illegal Killing of Elephants (MIKE) data that illegal killings as a result of such conflict are on the increase with the potential to significantly impact on the growth of some populations. Importantly, the killing because of conflict indicates increased risk to human lives and well-being, which is also unacceptable. Careful land-use planning is vital at the landscape level, including considering the co-existence of elephants in human-dominated landscapes is necessary. This will require community engagement and political action—both of which are essential for harmonious human–elephant co-existence HECx—such as developing agroindustry and infrastructure in ways that minimize impacts on elephant ranging patterns in order to avoid human-elephant conflict. Wildlife corridors are urgently required to allow elephants to move between habitats to access the resources they need without costs to the local people. There are still possibilities for elephant range States to plan their lands better, to designate lands for wildlife, including in areas with human use, and to ensure connectedness of those areas in such a manner to reduces risk and enhances benefits to people.

The HECx task force will focus on three items in 2022 through to 2023. The activities will include: 1) data collation and sharing: harmonizing the use of technology using apps across a selection of conflict hotspots; 2) understanding short- and long-term mitigation interventions and the need for holistic conflict and co-existence management approaches; and 3) land use planning and corridor conservation Standard Operating Procedures (SOPs) to mitigate risks and improve benefits. In much the same way as dealing with climate change, we need to consider approaches to both mitigation and adaptation for solutions, and integrate these holistically.

iii) African Elephant Taxonomy task force

The AfESG and the Centre for Environmental Forensic Science (CEFS) has organized a side

les hostilités. Il est urgent de créer des corridors biologiques pour la liberté de déplacements des éléphants entre leurs différents habitats et leur accès aux ressources sans que les populations locales en pâtissent. Les États de l'aire de répartition ont encore la possibilité de mieux aménager leur territoire, de déterminer des terres réservées à la faune — y compris dans des espaces d'activité humaine — et d'assurer les connexions entre elles de façon à réduire les risques et faire bénéficier des avantages aux habitants.

Les unités opérationnelles HECx se concentreront sur trois enjeux en 2022–2023 : 1) la collecte et le partage de données : harmonisation de l'utilisation des technologies grâce à des applications autour de certaines zones sensibles de conflit ; 2) la compréhension des interventions d'atténuation à court et long terme et la nécessité d'approches globales en ce qui concerne la gestion de la coexistence et des conflits ; 3) l'aménagement du territoire et les procédures opérationnelles normalisées (PON) pour la conservation des corridors biologiques, afin de limiter les risques et d'accentuer les bénéfices. Comme nous le faisons à propos du dérèglement climatique, nous devons explorer des stratégies d'atténuation et d'adaptation afin de trouver des solutions, et les intégrer de façon globale.

iii) Unités opérationnelles taxonomiques pour l'éléphant d'Afrique

Lors de la CdP19 de la CITES, le GSEAf et le Centre des études médicolégales environnementales (CEFS) organiseront un événement sur la poursuite des assignations génétiques taxonomiques des éléphants d'Afrique de l'Ouest sur site, afin de répondre aux besoins fondamentaux des États de l'aire de répartition, de la CMS et de la CITES. Les informations qui en découleront seront décisives pour la mise en place du Plan d'action pour l'Éléphant d'Afrique (PAEA) et d'autres programmes nationaux, et seront utilisées pour mettre à jour les cartes des aires de répartition et les rapports de situation des deux espèces. Les délégations des treize États signataires du Mémorandum d'entente sur la conservation des éléphants d'Afrique de l'Ouest (Bénin, Burkina Faso, Côte d'Ivoire, Ghana, Guinée, Guinée-Bissau, Libéria, Mali, Niger, Nigéria, Sénégal, Sierra Leone et Togo) ainsi que des représentants d'ONG compétentes en la matière seront invités. Un rapport d'avancement à jour sur la procédure suivie durant le travail taxonomique sera présenté et une carte collaborative sera développée

event at CITES CoP 19 on the continuation of the taxonomic genetic assignment of West African elephants at the site level, to address primary needs of range States, the CMS and CITES. Information provided by this project will inform decisions and actions taken under the AEAP and national action plans and will be used to update the IUCN AfESG's range maps and status reports of the two species. The delegations of the 13 range State signatories of the West Africa Elephants Conservation MoU (Benin, Burkina Faso, Cote d'Ivoire, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo) and individuals of relevant non-governmental agencies will be invited. A progress report on conducting taxonomic work will be presented, and a collaborative road map for comprehensively accomplishing the species assignments in West Africa in 2023, developed.

iv) Sustainable Use task force

We are all aware of the polarized and contentious nature of the sustainable use of elephants, especially of consumptive use. As such, we have been working on developing a process that would allow members to engage deeply with the evidence around these issues, such that the AfESG can present the evidence in an objective manner. We have taken time to identify a convener for the task force who understands the context of the sustainable use of elephants, but also has experience in conflict resolution. We are very pleased that Professor Duan Biggs, who is based at Northern Arizona University in the US, has agreed to become a member of the AfESG, and to convene the Sustainable Use task force. Duan is also an adjunct appointment at Stellenbosch University Centre for Sustainability Transition in South Africa.

We have been working with Duan over the last few months to draft a process that we believe can take this matter forward in a positive and successful way. Key elements that will be addressed will include synthesis of the evidence base, including gaps, risks, and areas of disagreement. Following from this, Duan will initiate a process for building consensus using an externally facilitated process, and Professor Hugh Possingham, from Australia has agreed to be a neutral Senior Chair for this process. From

afin d'atteindre l'objectif d'assignation des espèces en Afrique de l'Ouest d'ici à 2023.

iv) Unités opérationnelles pour l'utilisation durable

Nous sommes tous conscients de la nature controversée de ce sujet et des divisions qu'il engendre, particulièrement la dimension d'une utilisation consommatrice des éléphants. Nous avons développé une procédure permettant aux membres de s'investir massivement dans la recherche d'indicateurs, qui pourront être présentés de façon objective par le GSEAf. Nous avons pris le temps, au sein de la cellule, d'identifier un coordinateur sachant appréhender le contexte de l'utilisation durable des éléphants et ayant également de l'expérience dans la résolution des conflits. Professeur Duan Biggs de l'université de l'Arizona du Nord aux États-Unis nous fait l'honneur de devenir membre du GSEAf et d'accepter ce poste. Duan est, de plus, enseignant au centre universitaire de Stellenbosch (Afrique du Sud) pour la transition écologique.

Nous travaillons depuis plusieurs mois avec lui sur une procédure qui, nous en sommes convaincus, permettra d'approfondir sur ce sujet dans une démarche positive et productive. Les éléments clés discutés incluront une synthèse de la base de preuves, intégrant les lacunes, risques et points de divergence. Puis, Duan débutera une recherche de consensus grâce à un processus simplifié externalisé, sous la présidence impartiale du professeur australien Hugh Possingham. De ces différentes étapes découlera un avis collectif du GSEAf sur l'utilisation durable, qui pourra être soumis aux membres pour discussion. Nous envisageons que ce processus soit participatif et inclusif, et qu'il soit également itératif.

v) Unités opérationnelles pour le déplacement des éléphants de in situ à ex-situ

Jon-Paul Rodrigues, Président de la Commission de la Survie des Espèces de l'UICN (CSE UICN), a demandé aux co-présidents d'instaurer une collaboration plus étroite avec les représentants des zoos. Comme annoncé précédemment, nous avons créé un petit groupe issu des unités opérationnelles pour le déplacement des éléphants de in situ à ex-situ pour soutenir ce processus. L'équipe a rapporté les progrès accomplis à la cellule opérationnelle en place et a détaillé plusieurs éléments à aborder, qui ont été communiqués au Président de la CSE. La

that a process will unfold to develop a collective draft AfESG position on sustainable use that can be brought to the membership for discussion. It is envisaged that this will be a participatory and inclusive process and one which will also be iterative.

v) In-situ and ex-situ Elephant Movement task force

The IUCN SSC Chair, Jon-Paul Rodrigues had requested the co-Chairs to engage with the zoo community about working together more closely. As previously communicated, we established a small group drawn from the in-situ/ex-situ task force to assist with this process. This group reported back to the in-situ/ex-situ task- force on progress and tabled a number of concerns for discussion. These concerns have been shared with the SSC Chair. The task force was not consulted by the CITES Secretariat or range States' Scientific Authorities on the movement of elephants from Namibia to the United Arab Emirates, in terms of Resolution Conf. 11.20 (Rev. CoP18) on the Definition of the term 'appropriate and acceptable destinations'. The AfESG remains ready to provide evidence-based evaluation in terms of that resolution should we be requested to do so.

vi) African Elephant Action Plan (AEAP) task force

The AEAP task force reviewed and gave comments on the Nigerian Elephant Action Plan. We have engaged with the African Elephant Fund Chair and Secretariat on revision of the AEAP, and communicated our willingness to assist as needed through the AEAP task force. The task force is also ready to provide inputs to additional range States on their National Elephant Action Plans.

vii) Communication task force

One of the tasks of the Communication task force is to communicate to the outside world in an interactive way. A decision was made that the IUCN website limited the content and limited our involvement in being able to regularly update the site. Dr Loki Osborn and Lucy Osborn's generous contribution of USD 2,000 to kickstart the website development is highly appreciated.

cellule n'a pas été consultée par le secrétariat de la CITES, ni par les autorités scientifiques des États de l'aire de répartition, en ce qui concerne le transfert d'éléphants de Namibie vers les Émirats arabes unis, conformément à la résolution Conf. 11.20 (Rev. CoP18) sur la définition de l'expression « destinataires appropriés et acceptables ». Le GSEAf reste disponible pour fournir des évaluations sur la base de cette résolution et d'éléments tangibles si la demande nous en est faite.

vi) Unités opérationnelles du Plan d'Action pour l'Éléphant d'Afrique (PAEA)

La cellule a examiné le plan d'action pour l'éléphant nigérian et a livré ses commentaires. Nous avons entrepris, avec le Président et le secrétariat du Fonds pour l'éléphant d'Afrique, la révision du PAEA, et nous avons communiqué notre volonté d'apporter au besoin notre aide via la force opérationnelle PAEA. Cette dernière est également disposée à fournir des données à d'autres États de l'aire de répartition au sujet de leur Plan d'action national pour l'éléphant.

vii) Unités opérationnelles sur la communication

L'une des tâches de cette cellule est l'instauration d'une communication interactive avec le monde extérieur. Une décision a été prise de limiter le contenu sur le site Internet de l'UICN et de réduire notre implication dans la mise à jour des informations. Nous avons grandement apprécié la généreuse donation de 2 000 $ de la part du Dr Loki Osborn et de Lucy Osborn, qui permettra de relancer le développement du site. Le GSEAf contribue également à cet effort à hauteur de 3 000 $, grâce à WWF International. L'équipe a l'intention d'en faire un site Internet multilingue pour les utilisateurs de langue française, swahilie, espagnole, portugaise et chinoise. La traduction du site se fera par étapes. La cellule a organisé des webinaires sur les sujets de la Liste rouge de l'UICN et de la reconnaissance de deux espèces, et a planifié la neuvième réunion (virtuelle) du GSEAf en septembre et octobre 2022.

viii) Unités opérationnelles d'évaluation de la Liste rouge de l'UICN

Les membres de cette équipe ont répondu à une requête officielle soumise à l'UICN qui contestait la catégorie « menacée » pour *L. africana*. Les évaluateurs ont présenté début juillet 2022 leur avis final au Comité

The AfESG is contributing an additional USD 3,000 from WWF International for this website. The intention of the task force is also to have the website cater for other users who speak French, Swahili, Spanish, Portuguese and Chinese. The extension of the website into other languages will be done in phases. The task force has arranged and facilitated webinars on the IUCN Red List and two species recognition, as well as organizing the 9th (virtual) meeting of the AfESG in September and October 2022.

viii) IUCN Red List Assessment task force

The Red List Assessment team has been responding to a formal petition which was submitted to the IUCN contesting the category of 'Endangered' for the *L. africana*. The team of assessors submitted their final response to IUCN's Standards and Petitions Committee (SPC) in early July 2022. The SPC will make a ruling on the petition in October 2022.

Participation in MIKE–ETIS Technical Advisory Group (TAG)

The AfESG co-Chair Ben Okita participated in the 17th meeting of the Technical Advisory Group (TAG), held virtually on 28–29 June 2021, convened by CITES MIKE at the UNEP offices in Nairobi. Participants were drawn from TAG sub-regional representatives, TAG Global members and co-Opted members of IUCN AfESG and IUCN's Asian Elephant Specialist Group (AsESG), TRAFFIC–ETIS, CITES Secretariat–Science Unit, MIKE Central Coordination Unit (CCU), and Sub-regional support Unit representatives–Asia. The AfESG Co-Chair provided an update on the activities implemented by the AfESG. This included activities related to estimating African elephant population size and the integration of the AED and MIKE trend analysis, by providing names of experts who could compile current methodologies used by range States to estimate population sizes in forested areas and to determine whether the current MIKE dung survey standards (https://cites.org/sites/default/files/common/prog/mike/survey/dung_standards.pdf) required an update, and to help document alternative elephant survey techniques in gallery forests/canopy forests. We also provided the names of experts who could advise on the integration of the AED and MIKE

des normes et des pétitions, dont la décision est attendue pour octobre 2022.

Participation au Groupe consultatif technique (TAG) MIKE–ETIS

Le co-président du GSEAf Ben Okita était présent à la dix-septième réunion du Groupe consultatif technique MIKE–ETIS, organisée par le MIKE CITES dans les bureaux du PNUE à Nairobi et qui s'est tenue en visioconférence les 28 et 29 juin 2021. Les participants étaient composés de représentants sous-régionaux et de membres internationaux du TAG, de membres cooptés du GSEAf et du GSEAs (Groupe de spécialistes de l'éléphant d'Asie de l'UICN), de TRAFFIC-ETIS, de l'unité scientifique du Secrétariat de la CITES, de l'unité centrale de coordination MIKE (CCU) et de représentants de l'unité sous-régionale de soutien Asie. Ben Okita a fourni les dernières informations sur les activités mises en place par le GSEAf du CSE de l'UICN. Ces actions consistaient en l'estimation de la taille de la population d'éléphants d'Afrique et en l'intégration des analyses tendancielles MIKE et BDEA, en transmettant le nom d'experts en mesure de compiler les méthodologies actuelles utilisées par les États de l'aire de répartition pour évaluer le nombre d'individus dans les zones forestières. Il s'agissait également de déterminer si une mise à jour des protocoles d'étude MIKE sur les excréments était nécessaire (https://cites.org/sites/default/files/common/prog/mike/survey/dung_standards.pdf) et d'aider à la documentation de techniques alternatives pour la recherche d'éléphants dans les forêts-galeries ou les canopées. Puis, nous avons communiqué le nom d'experts à même de conseiller sur l'intégration de la BDEA et de MIKE (analyse tendancielle PIKE : proportion d'éléphants tués illégalement), y compris les estimations à utiliser, les moyens de gérer les incertitudes quant à ces chiffres et les interpolations entre les données. Fait important, le GSEAf a apporté des informations sur le statut de la population d'éléphants africains au comité permanent 74 de la CITES, comme l'exige le groupe de spécialistes conformément à la Res. Conf. 10.10 (Rev. CoP18) dans le paragraphe 12 (b). Le rapport peut être consulté via le lien ci-dessous, dans les paragraphes 66 à 87 : https://cites.org/sites/default/files/eng/com/sc/74/E-SC74-68.pdf. Rob Slotow remplacera Ben Okita pour représenter le GSEAf dans les réunions des trois prochaines années, tel que prévu dans le modus operandi du TAG (rotation des

(Proportion of Illegally Killed Elephants (PIKE) trend analysis), including estimates to be used, means to address uncertainties in estimates and interpolation between estimates. Importantly, the AfESG contributed information on the population status of the African elephants to CITES Standing Committee 74 as required of the Specialist Group as per CITES Res. Conf. 10.10 (Rev. CoP18) in operative paragraph 12(b). The report can be found in paragraphs 66 to 87 in the following link: https://cites.org/sites/default/files/eng/com/sc/74/E-SC74-68.pdf. Rob Slotow will replace Ben Okita in representing the AfESG in subsequent meetings for three years as provided for in TAG's modus operandi where co-Chairs rotate every three years as co-opted TAG members.

The Ninth AfESG Members Meeting in September (13 and 14) and October (18 and 19) 2022

The theme for the 9th meeting of AfESG was "Forest and savannah elephant conservation and emerging challenges" with the overall objective of bringing together the latest evidence and lessons learned for managing forest and savannah elephants, and their habitats, to support better decision-making across the continent. The four-day technical meeting aimed to: 1) share knowledge on the status and threats to the two African elephant species with an emphasis on the critically endangered forest elephants (*L. cyclotis*); 2) discuss and initiate practical solutions to address emerging conservation challenges particularly on human- elephant co-existence; 3) review current methods/practices and consider new ones to monitor, manage and conserve elephants; and 4) seek stakeholders' views and input into AfESG work for future consideration.

A summary of the meeting will be provided in the co-Chairs report of the next volume of *Pachyderm* (64).

African Elephant Database sustainability plans

The AED is the repository of African elephant survey data and is the most authoritative and up-to-date source of knowledge on African elephant populations and distribution. The

co-présidents tous les trois ans en tant que membres cooptés du TAG).

Neuvième réunion des membres du GSEAf les 13–14 septembre et 18–19 octobre 2022

Cette réunion avait pour thème : « Forest and savanna elephant conservation and emerging challenges » (« La conservation des éléphants de savane et de forêt et les défis émergents »), avec l'objectif principal de rassembler les dernières constatations et les leçons apprises de la gestion des deux espèces et de leur habitat pour appuyer de meilleures prises de décisions à ce sujet sur le continent. Les quatre jours de cette réunion devaient amener à : 1) partager les données sur le statut des éléphants d'Afrique et les menaces qui pèsent sur eux, avec une attention particulière portée aux éléphants de forêt (*L. Cyclotis*) en danger critique d'extinction ; 2) discuter de solutions pratiques pour gérer les défis de conservation, notamment la coexistence humain-éléphant ; 3) revoir les méthodes et pratiques actuelles de surveillance, gestion et conservation des éléphants ; 4) interroger les parties prenantes sur leur vision du travail du GSEAf dans le futur et leur contribution à cet effort.

Un résumé de cette réunion sera présenté dans le rapport du prochain volume de *Pachyderm* (no 64).

Plans de durabilité de la Base de Données de l'Éléphant d'Afrique

La BDEA est le référentiel des données d'étude sur l'éléphant d'Afrique et constitue la base de connaissances la plus fiable et actualisée sur la répartition et les populations. Le GSEAf utilise les données de la BDEA pour s'acquitter de son mandat relatif aux espèces à l'UICN, tel que la Liste rouge. La BDEA est également la principale source de données pour les comptes-rendus du GSEAf à la CITES sur le statut de conservation de l'éléphant d'Afrique. L'AESR, largement issu de la BDEA, fournit les informations nécessaires aux analyses des programmes MIKE et ETIS (Système d'information sur le commerce des éléphants) de la CITES. La BDEA est en outre utilisée par les États de l'aire de répartition dans leurs plans d'action à l'échelle continentale et régionale, dans le développement des plans d'action nationaux et des activités de conservation et de gestion.

La version en ligne lancée en 2012 a été profondément remaniée. Plus qu'une simple plateforme d'affichage

AfESG uses data from the AED to fulfil its IUCN mandate related to the species such as the Red Listing process. The AED is also the main data source for the AfESG's reporting to CITES on the conservation status of African elephants. The AESR, which is largely derived from the AED, provides necessary information for the CITES MIKE programme and Elephant Trade Information System (ETIS) analyses. It is also used by elephant range States in their continental, regional action plans, and in the development of national elephant action plans and conservation and management activities.

The AED's online version launched in 2012 has been substantially redesigned. It not only offers a platform for displaying data in between the published status reports, but also provides new ways to view the data from all the status reports, and access more detailed information on new surveys than are presented in reports or numbers updates. Future AED design will include real-time assessing of savannah and forest elephant populations, and the AED will furthermore build visualization, analysis, query/search and output tools (maps and graphs) on elephant status and trends at National, Regional and Continental levels. Further development will link elephant numbers and distribution to environmental and anthropogenic data, and link in work of the AfESG Human-Elephant Co-existence (HEC), Taxonomy, and African Elephant Action Plan task forces to add value to the database. The management of the AED needs consistent financing and a fulltime technical person to update the database.

The AfESG is currently building an AED consortium of partners that would commit financial, technical and in-kind support for the sustainability and resilience of the AED. The consortium will provide support for the requirements of a revamped AED, such as data collection, data storage and analytical outputs, methodological and analytical improvements, survey designs or strategic advice. Collaborative working in such a consortium, where the member's strengths, capabilities, and resources are harnessed and shared, will facilitate for example the development of innovative technical solutions to challenges facing AED. It would also create a deep understanding and appreciation for

des données entre les publications des rapports, elle fournit aussi de nouvelles possibilités de visualiser les données de tous les rapports de situation et d'accéder à un meilleur niveau de détail sur des études récentes que lorsqu'elles sont présentées dans les rapports ou les mises à jour des chiffres. Les nouvelles fonctionnalités de la BDEA incluront les évaluations en temps réel des populations d'éléphants de forêt et de savane, et comporteront des outils de visualisation, d'analyse, de recherche et d'extraction (cartes et graphiques) sur le statut des éléphants et les tendances à l'échelle nationale, régionale et continentale. De futurs développements permettront de faire le lien entre le nombre d'individus, leur répartition et des données environnementales et anthropogéniques, et entre le travail des différentes cellules opérationnelles du GSEAf (Coexistence humain-éléphant, Taxonomie et Plan d'action pour l'éléphant d'Afrique [PAEA]). La gestion et la mise à jour de la BDEA demandent un financement cohérent et du personnel technique à plein temps.

Le GSEAf s'attache actuellement à mettre en place un consortium de partenaires qui fourniraient un soutien financier, technique et en nature pour la solidité et la résilience de la base de données — appui nécessaire pour les besoins de cette base de données nouvelle génération : collecte, partage et stockage de données, résultats analytiques, améliorations en termes de méthodologie et d'analyse, et conception des études ou conseil stratégique. Un travail collaboratif, dans ce type de groupe où forces, capacités et ressources des membres sont mises à profit et partagées, facilitera, entre autres, le développement de solutions techniques innovantes pour les défis auxquels est confrontée la BDEA. Cela permettrait également de construire une profonde compréhension et reconnaissance de l'outil et d'engager les parties prenantes sur une base régulière plutôt qu'occasionnelle. Enfin, un consortium aidera à combiner les différentes sources de financement de la BDEA et l'AESR.

Participation aux réunions internationales

Les réunions en présentiel reprennent et le GSEAf en profite pour y participer plus régulièrement. Notre démarche se caractérise par un travail auprès des membres de la région concernée, ou de ceux qui assisteront à la réunion, pour y représenter les intérêts du GSEAf. Nous sommes convaincus de l'efficacité de ce procédé et pensons qu'il donne de l'autonomie

the AED and engage stakeholders on an ongoing basis, rather than only occasionally. A consortium will also help to combine different sources of sustainable funding for AED and AESR.

Participation in international meetings

As more face-to-face meetings are being organized, the AfESG has taken this opportunity to be present in these meetings. Our approach is to work with members based in the region, or who will be attending the meeting, to represent the interests of the AfESG at such meetings. We believe that this is an effective manner in which to engage and is also empowering for the members that are attending such meetings. Our members have our confidence that they will present and represent the collective interest of the Group, while they will also be attending and participating in their individual capacities, and doing their work.

The AfESG was represented at the African Elephant Conference that was held in Hwange National Park, Zimbabwe between 24 and 26 May 2022 (https://www.zimparks.org.zw/2022/05/08/7508/) by Malvern Karidozo and Dr Patience Gandiwa. They presented "Perspectives of Elephant Conservation in the range States". Also in attendance at the conference were our members Drs Dan Stiles and Sam Ferreira.

The 19th Meeting of Parties of the Congo Basin Forest Partnership (CBFP) took place from 5 to 8 July 2022 in Libreville, Gabon. Dr Thomas Breuer represented the Group in the meeting and talked about the Forest elephant and implications of recognizing the species for conservation and management. Among the issues discussed in the meeting of the Parties, were international, regional, and national challenges related to the protection of biodiversity and the sustainable management of forests, climate change, and the sustainable development of the Congo Basin (https://pfbc-cbfp.org/meetings-news/RDP19-Programme-fina-len.html). The Parties noted considerable progress regarding the international visibility of the importance of central African forests and their ecosystem services for the entire continent of Africa as well as the world. The CBFP Parties insist on the importance of pursuing, in an

aux membres qui se rendent dans ces réunions. Nous sommes tout à fait confiants en ce qui concerne leur implication à présenter et représenter l'intérêt collectif du groupe tout en participant à titre individuel et en accomplissant leur travail.

Le GSEAf était représenté par Malvern Karidozo et la Dr Patience Gandiwaqui à la Conférence pour l'éléphant d'Afrique qui s'est tenue du 24 au 26 mai 2022 au sein du parc national de Hwange au Zimbabwe (https://www.zimparks.org.zw/2022/05/08/7508/). Leur présentation était intitulée «*Perspective of Elephant Conservation in the range states*» («Les perspectives de la conservation des éléphants dans les États de l'aire de répartition»). Les Drs Dan Stiles et Sam Ferreira assistaient également à la conférence.

La 19e réunion des parties du Partenariat pour les Forêts du Bassin du Congo (PFBC) a eu lieu du 5 au 8 juillet 2022 à Libreville au Gabon. Le Dr Thomas Breuer y représentait le GSEAf et y est intervenu pour parler de l'éléphant de forêt et des implications de la reconnaissance de cette espèce pour sa gestion et sa conservation. Ont été abordés les sujets des défis internationaux, régionaux et nationaux rencontrés dans le cadre de la protection de la biodiversité et la gestion durable des forêts, le combat contre le dérèglement climatique et le développement durable du bassin du Congo (https://pfbc-cbfp.org/meetings-news/RDP19-Programme-fina-len.html). Les parties ont noté des progrès considérables en ce qui concerne la visibilité des forêts d'Afrique centrale, leur importance à l'échelle internationale et les services rendus par leurs écosystèmes au continent africain et au monde entier. Les parties du PFBC ont insisté sur la nécessité de poursuivre et accélérer les engagements pris dans la déclaration faite par les États membres de la Commission des Forêts d'Afrique Centrale (COMIFAC), et d'appeler à un financement équitable et à un juste partage des fonds, comme annoncé à Berlin en septembre 2021 par les pays de la CEEAC/COMIFAC, puis confirmé lors de la CoP 26 à Glasgow.

Lors du Congrès de l'UICN sur les aires protégées d'Afrique qui s'est tenu du 18 au 21 juillet 2022 à Kigali (Rwanda), le secrétariat du GSEAf et Thomas Breuer ont créé et commenté des affiches sur les éléphants de forêt et les conséquences pour la conservation et la gestion de l'espèce, ainsi que sur les lacunes dans le travail de recensement des pays de l'aire de répartition.

accelerated manner, the implementation of the commitments of the *Declaration of Commitment by the Commission of the Forests of Central Africa (COMIFAC) member States to the forests of central Africa and call for equitable financing and fair share* announced in Berlin by the ECCAS/COMIFAC countries in September 2021 and confirmed in Glasgow at CoP 26.

The AfESG secretariat and Dr Thomas Breuer organized and presented posters and a presentation on forest elephants and their implication for the conservation and management of the species and also on gaps in census work in the range States at the IUCN Africa Protected Areas Congress (APAC) Kigali, Rwanda, that was held from 18 to 21 July 2022.

Participation for CITES CoP 19 meeting in Panama

The AfESG is preparing for full participation in the forthcoming CITES CoP 19 meeting in Panama in November 2022, as part of the IUCN delegation. The AfESG will host a side event to present the forest elephant status report, discuss the Red List, implications of the recognition of two species of African elephants, and the need for further work in identifying hybridization zones, and refining classification of elephants in those zones into one or other species, or hybrids of some form. Discussions on the two species will include how to assist in data collection for the determination of the genetic identity of taxonomically undefined elephant populations of 13 West African range countries (Benin, Burkina Faso, Cote d'Ivoire, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo). The side event will be used as a platform for further engagement with the West African elephant range States in the conservation and management of African forest elephant in the region.

Fundraising for AfESG Activities

The AfESG recently received financial support from the International Fund for Animal Welfare (IFAW), Save the Elephants (STE), WWF–International, and WWF–US. These organizations in addition to the European Union through CITES-MIKE and the Paul G. Allen

Participation à la 19e CdP de la CITES au Panama

Le GSEAf se prépare à participer à l'intégralité de la 19e CdP de la CITES au Panama en novembre 2022, en tant que membre de la délégation de l'UICN. Le GSEAf accueillera un événement en marge de la conférence, où l'on présentera le rapport de situation, on abordera le sujet de la Liste rouge, les implications de la reconnaissance de deux espèces d'éléphants africains, le besoin d'intensifier notre travail sur l'identification des zones d'hybridation et de préciser la classification des éléphants de ces zones dans l'une ou l'autre espèces ou hybride. Les discussions à propos des deux espèces porteront sur les moyens de favoriser la collecte de données pour la caractérisation de l'identité génétique de populations d'éléphants indéterminées dans treize pays de l'aire de répartition ouest-africaine (Bénin, Burkina Faso, Côte d'Ivoire, Ghana, Guinée, Guinée-Bissau, Libéria, Niger, Nigéria, Sénégal, Sierra Leone et Togo). Cet événement servira de plateforme pour davantage d'engagements avec les pays de l'aire de répartition d'Afrique de l'Ouest en ce qui concerne la conservation et la gestion des éléphants de forêt dans la région.

Collecte de fonds pour les activités du GSEAf

Le GSEAf a récemment reçu le soutien financier du Fonds international pour la protection des animaux (IFAW), de l'organisation Save The Elephants (STE), de WWF International et WWF États-Unis. Ces organismes, accompagnés de l'Union Européenne via CITES-MIKES et la Fondation Paul G. Allen Family qui sont nos donateurs actuels, se sont engagés auprès du GSEAf en vue de la réalisation de ses objectifs stratégiques pour le quadriennat 2021–2024. L'IFAW et le STE ont tous deux garanti une donation annuelle de 50 000 $ pour 2022, 2023 et 2024, tandis que WWF International et WWF États-Unis ont respectivement accordé une donation unique de 10 000 $ et 25 000 $. Nous leur en sommes extrêmement reconnaissants. Notre approche, collective et fructueuse, se traduit par un développement de notre consortium de donateurs pour des projets clés ainsi que pour notre cœur de métier comme le soutien au secrétariat. Nous sommes toujours en discussion avec de nouveaux donateurs potentiels, dont l'organisme d'état américain US-Fish and Wildlife, résultat de la visite du Dr Ben Okita

Family Foundation who are our current funders, have pledged financial support to AfESG towards delivery of its Strategic Targets for 2021–2024 IUCN quadrennium. IFAW and STE have each committed to an annual donation of USD 50,000 for 2022, 2023 and 2024, whereas WWF–International and WWF–US gave a one-off donation of USD 10,000 and USD 25,000 respectively. We are very grateful to them all. Our approach has been to develop a consortium of funders for our core work, such as supporting the secretariat, as well as key projects, and this collective approach is bearing fruit. We are still in discussion with other potential funders including US-Fish and Wildlife as a follow-up of Dr Ben Okita's visit to the USA in September/October 2021. The purpose of getting the additional funders is to sustain the funding streams and bridge the budget gaps for the Group's activities.

A long review article for *Pachyderm*

Dr Manqoba Zungu and Professor Rob Slotow conducted a systematic review of elephant management interventions, assessing their effectiveness, the demographic effects, and unintended consequences in South Africa. Given the large body of literature available, this review was extensive and the resulting article much longer than the current word limitation of *Pachyderm*. The editorial board identified that this would be an excellent article to include in *Pachyderm*, if it was recommended for publication by the independent review process, and, as *Pachyderm* is now published online only, decided to explore the option of accepting longer papers such as this. Now that the paper has been through the review process, and been accepted for publication, the paper appears in this issue of *Pachyderm*: *A systematic review of the success and unintended consequences of management interventions on African elephants* on pp. 99–139. We, and the editorial board, are very interested to gauge the response of the members and the *Pachyderm* readership in general to the publication of a paper such as this. Large reviews, or monographs, which other journals tend not to accept because of their length, may be an important niche area to ensure that such information is published and

aux États-Unis en septembre-octobre 2021. Le but d'obtenir davantage de donateurs est de soutenir les flux de financement et de combler les écarts de budget pour les activités du groupe.

Un article d'une longueur inédite dans *Pachyderm*

Le Dr Manqoba Zungu et le Professeur Rob Slotow ont tenu un compte-rendu systématique des interventions de gestion des éléphants, évaluant leur efficacité, les effets démographiques de ce type d'action et leurs conséquences inattendues. Du fait de l'abondante littérature sur le sujet, ce compte-rendu est volumineux et l'article qui en est issu bien plus long que l'actuelle limite autorisée dans *Pachyderm*. La rédaction a déterminé que cet excellent article gagnerait à être intégré à cette édition si le processus indépendant de révision en décidait autant, et que l'option d'accepter des documents plus longs devait être explorée puisque la publication se fait désormais uniquement en ligne. Après être passé par l'étape de révision, le papier a été approuvé et est donc disponible dans ce numéro sous le titre «*A systematic review of success, and unintended consequences, of management interventions on African elephants*» («Bilan des réussites et conséquences inattendues des interventions de gestion sur les éléphants d'Afrique»), pages 99 à 139. Nous, ainsi que l'équipe de rédaction, sommes très intéressés par l'accueil que les membres et les lecteurs de *Pachyderm* réserveront à ce type d'articles. Cette forme de compte-rendu ou les monographies, qui ne sont généralement pas acceptées par les autres revues du fait de leur longueur, pourraient représenter une niche importante garantissant la publication et la disponibilité de ces informations pour tous ceux qui travaillent dans la recherche, la conservation et la gestion de l'éléphant, ainsi que pour les différentes parties prenantes.

Dans ce numéro

Les éditeurs ont soulevé le fait que les termes «conflit humain-éléphant» et «coexistence homme-éléphant» sont utilisés de façon interchangeable alors même que ces concepts sont très différents et que cela engendre une confusion chez les lecteurs. Le conflit est la réalité sur terrain, tel que des cultures mangées ou des personnes tuées par des éléphants. La coexistence est l'objectif visé mais pas encore réalisable. Nous suggérons l'usage de CHE et HECx pour désigner

available to elephant researchers, conservators, managers, and other stakeholders.

In this issue

Pachyderm editors have noticed that the term Human-Elephant Conflict and Human-Elephant Coexistence are used interchangeably but these are very different concepts, and this is causing confusion with readers. Conflict is the reality on the ground, such as elephants eating crops and harming people. Coexistence is the goal, that we continue to strive for, but is not yet attainable. We suggest HEC when describing one concept, and HECx when describing the other.

There is a wealth of elephant material in this volume (63). Poole and Granli have two manuscripts; the first one provides an important description for further understanding of a recovering elephant population after severe human-caused disruption in Gorongosa NP. Very few such studies at this resolution exist, for example, the inter-calf interval is remarkable when compared to averages in other populations, and accompanying observations (e.g. allosuckling) are fascinating, as is the sex skew in older age classes. (See *The Gorongosa elephants through war and recovery: tusklessness, population size, structure and reproductive parameters,* pp. 38–54). Poole and Granli's companion paper entitled *Who's Who and Whereabouts* focuses on their relational web-based database (DB) system for registering, reidentifying and monitoring elephants, focusing on elephants in two populations: Maasai Mara ecosystem, Kenya, and Gorongosa NP, Mozambique, (see pp. 72–90).

Other elephant papers include: Halliday et al.'s manuscript on the *Process and outcomes of ivory-related trials in Kenya, 2016–2019* (See pp. 55–71) which reviews 247 trials, involving 422 persons accused of possession and dealing in ivory, brought before the Kenyan courts. Data were collected by legal interns who visited courts and studied case records. Ivory related cases were found across Kenya, especially in Tsavo Conservation Area, Nairobi, and southern coastal areas. King et al.'s manuscript details the *new Human-Elephant Coexistence Toolbox for communities living with African savannah elephants (Loxodonta Africana)*, and readers are invited to participate and contribute with chacune des deux notions.

Deux manuscrits par Poole et Granli apparaissent dans cette édition, dont l'un documente l'absence de défenses chez une population d'éléphants du Gorongosa et décrit son rétablissement après une période d'intense perturbation anthropique. Les auteurs ont beaucoup travaillé sur les paramètres de reproduction et les structures familiales. Nous les félicitons pour leur travail et les résultats obtenus malgré les difficultés du terrain et la complexité d'étudier cette population, (pages 38 à 54). Leur second papier, intitulé « *Who's Who and Whereabouts* » (« Qui est qui et où vont-ils ? »), se concentre sur leur système de base de données relationnelle en ligne (DB) créé pour la surveillance, le recensement et la gestion des éléphants. Les auteurs ont privilégié deux populations : celle de l'écosystème de Maasai Mara au Kenya et celle du Gorongosa au Mozambique. L'étude présente une vue d'ensemble détaillée du processus complexe entrepris par les chercheurs : accroître l'implication scientifique des citoyens dans les efforts de surveillance et de conservation des éléphants. L'intégration des analyses de groupes d'utilisateurs ajoutées aux bons résultats de l'algorithme donne une vision globale des réussites des auteurs (pages 72 à 90).

Parmi les articles traitant des éléphants se trouve le papier de Halliday et al. « Process and outcomes of ivory-related trials in Kenya, 2016–2019 » (« Trafiquants d'ivoire au Kenya : déroulement et résultats des procès de 2016 à 2019 ») qui relate le déroulement de 247 procès, impliquant 422 personnes accusées de possession et trafic d'ivoire et traduites devant la justice kényane (voir p.55 à 71). Les données ont été collectées par des stagiaires juridiques, qui se sont rendus dans les tribunaux et ont étudié les dossiers. Ces affaires ont été enregistrées au Kenya, plus particulièrement à Nairobi, dans les zones côtières méridionales et dans le périmètre de Tsavo Conservation Area. Le manuscrit de Kings et al. détaille le contenu de la « new Human-Elephant Coexistence Toolbox for communities living with African savannah elephants (Loxodonta Africana) » (« nouvelle boîte à outils à destination des communautés vivant avec l'éléphant de savane Loxodonta Africana, pour une meilleure coexistence homme-éléphant »). Nous invitons nos lecteurs à participer et à faire part de leurs remarques (p. 153 à 157). Tiller et al. dépeignent les problèmes rencontrés lorsque Save the Elephants a transféré plusieurs individus du Parc national de Meru à celui de Tsavo

feedback (pp. 153–157). Binlinla's paper entitled *Habitat conversion intensifies human–elephant conflict in the Eastern (and Western) Wildlife Corridor (EWWC) in Ghana*, presents data on HEC occurring in the EWWC, corridor, and discusses approaches to mitigate conflicts and ensure the survival of the elephant population in the corridor (pp. 170–175). Translocation is not the silver bullet everyone would hope it to be, Tiller et al. discuss the problems faced when Save the Elephants translocated several elephants from Meru NP to Tsavo East NP the group fragmented and some moved far outside the release site, with two of the five elephants translocated exhibiting homing behaviour. (See *The outcome of an elephant translocation from Isiolo to Tsavo East National Park, Kenya*, pp. 91–98).

Acknowledgements

We are very appreciative of the financial grants from the European Union CITES MIKE+, Vulcan Inc., the Paul G. Allen Family Foundation, Save the Elephants, World Wildlife Fund (International and US offices) and International Fund for Animal Welfare. Your support is going a long way in achieving the 2021–2024 quadrennium targets and in ensuring the survival of African elephants. We urge other donors and agencies to come on board too in support of our 2021–2024 quadrennium targets. We sincerely thank Rose Mayienda, the AED officer and Mohammed Yahya, Senior Programme Officer for their invaluable support to AfESG in the production of African Forest Elephant Status Report and managing the secretariat. We really appreciate the hard work of the members of the various task forces, and especially Boo Maisels and Chris Thouless who lead the work on the forest elephant status report, as well as the other members of the Data Review working group who are contributing. Lucy Vigne and the members of the communications task force have enabled more effective and efficient communication, which is critical to the promotion of conservation of elephants. We also thank Duan Biggs and Loki Osborn for leading and laying strategies and setting the stage for their Sustainable Use and HECx task forces' work for this quadrennium.

Est au Kenya (pages 91 à 98) : deux des cinq éléphants montraient un comportement instinctif de retour vers leur lieu de naissance.

Remerciements

Nous sommes très reconnaissants pour les subventions de l'Union Européenne via CITES MIKES+, de Vulcan Inc., de la Fondation Paul G. Allen Family, de Save The Elephants, du World Wildlife Fund (antenne États-Unis et International) et du Fonds international pour la protection des animaux. Votre soutien est extrêmement utile pour atteindre nos objectifs du quadriennat 2021–2024 et assurer la survie des éléphants d'Afrique. Nous encourageons vivement d'autres donateurs et agences à venir également appuyer nos projets pour ces prochaines années. Nos sincères remerciements à Rose Mayienda, responsable de la BDEA et à Mohammed Yahya, responsable du programme, pour leur aide précieuse au GSEAf dans la création du rapport de situation de l'éléphant de forêt d'Afrique et pour leur gestion du secrétariat. Merci aux membres des différentes unités opérationnelles qui travaillent d'arrache-pied, particulièrement à Boo Maisels et Chris Thouless qui dirigent l'élaboration du rapport de situation des éléphants de forêt, ainsi qu'aux autres participants du groupe de travail sur l'examen des données pour leur contribution. Lucy Vigne et les membres de la cellule communication ont agencé une diffusion plus efficace et plus performante, enjeu essentiel pour la promotion de la conservation des éléphants. Nous tenons également à remercier Duan Biggs et Loki Osborn pour leur implication dans l'élaboration de stratégies et pour avoir préparé le terrain des groupes de travail utilisation durable et coexistence homme-éléphant pour ce quadriennat.

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

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Introduction

The African Rhino Specialist Group (AfRSG) envisages thriving wild African rhinoceroses (rhinos) valued by and contributing to the well-being of people. Africa's large animals, including rhinos, are important biodiversity for future global restoration and rewilding options. They generate ecosystem services and contribute to the sustainable development goals and thus a flourishing future planet. Here we report on guiding and facilitating the conservation of viable African rhino populations across their natural range that add to the well-being of Africans.

Reflection of challenges and best practices facing global rhino conservation

Poaching and trafficking challenges

The Conference of the Parties at the 18th meeting (CoP18) of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) resolved to reflect on challenges and explore best practices to address rhino poaching and horn trafficking. The AfRSG and Asian Rhino Specialist Group (AsRSG) conducted a questionnaire survey focusing on rhino range States and other specialists. Two of three Asian and nine of 12 African range States responded representing 99.9% of white (*Ceratotherium simum*) and 99.9% of black (*Diceros bicornis*)

Introduction

Le Groupe de Spécialistes du Rhinocéros d'Afrique (GSRAf) aspire à un monde dans lequel les rhinocéros sont sauvages, prospères, appréciés et acteurs à part entière du bien-être des populations locales. Les grands animaux d'Afrique, dont les rhinocéros, constituent une importante biodiversité pour une restauration de la nature à l'échelle mondiale et des solutions de réensauvagement. Ils sont pourvoyeurs de services à leur écosystème et contribuent aux objectifs de développement durable pour une planète florissante. Nous rapportons ici les démarches qui guideront et faciliteront la conservation des rhinocéros sauvages d'Afrique sur leurs aires de répartition naturelles, comme valeur ajoutée pour les Africains.

Les bonnes pratiques de la conservation du rhinocéros à l'échelle internationale et les défis à relever

Braconnage et trafics

La réunion de la dix-huitième Conférence des Parties (CdP18) de la Convention sur le commerce international des espèces de faune et de flore sauvages menacées d'extinction (CITES) a engagé une réflexion sur les défis à relever et les bonnes pratiques à mettre en place dans la lutte contre le braconnage et le trafic de cornes de rhinocéros. Le GSRAf et le Groupe de Spécialistes du Rhinocéros d'Asie (GSRAs) ont mené une enquête sous forme de questionnaire auprès des

rhinos in Africa, as well as 82% greater one-horned (*Rhinoceros unicornis*), 100% Javan (*Rhinoceros sondaicus*) and 100% Sumatran (*Dicerorhinus sumatrensis*) rhinos in Asia.

Poaching challenges (n = 77) included general law enforcement, local people and governance, as well as trade and financial sustainability. Anti-poaching examples (n = 66) were disproportionately focused on law enforcement, including animal and habitat security, the use of technological tools (e.g. drones) that enhance enforcement by rangers, and investigation of small crimes with less focus on syndicates and transnational organized crime networks (TOCNs). Respondents deemed that only 53.4% of anti-poaching initiatives were successful.

Trafficking challenges (n = 46) included general law enforcement, ineffective enforcement on TOCNs and insufficient collaborative cooperation between different law enforcement agencies within and between range States and the whole supply chain. Respondents deemed 45.7% of initiatives aimed at curbing trafficking as successful.

The various inputs provided by survey respondents and reflections from previous work allowed the AfRSG and AsRSG to identify 12 strategic poaching and trafficking challenges and 29 key responses (Ferreira et al. 2022).

Reporting to CITES

Overharvesting is a global environmental change driver that, together with other factors (Janssen et al. 2006) such as climate change, habitat alteration, pollution and emergent disease, poses threats to the persistence of all rhino species. Illegal trade in rhino horn is still considered the primary threat to the long-term security of rhinos into the future. The AfRSG, AsRSG and TRAFFIC supported IUCN in reporting to the CITES Secretariat on the conservation of and trade in African and Asian rhinoceroses (CITES 2022).

Covid-19 travel restrictions, stricter laws, and increased law enforcement operations most likely led to fewer rhino horns (1,531–1,729) entering the illegal trade markets in 2020 and 2021 compared to 2,378 in 2017. Although in 2019 an increase in the weight and number of whole horns seized were noted, followed by decreases in 2020, incomplete reporting restricted robust evaluation of the impact of the Covid-19 pandemic. A new product, rhino

États de l'aire de répartition des rhinocéros et d'autres experts. Deux des trois pays asiatiques et neuf des douze états africains ont répondu, représentant 99,9 % des rhinocéros blancs (*Ceratotherium simum*) et des rhinocéros noirs d'Afrique. 82 % des rhinocéros indiens (*Rhinoceros unicornis*) et 100 % des rhinocéros de Java (*Rhinoceros sondaicus*) et de Sumatra (*Dicerorhinus sumatrensis*) font également partie de l'étude.

Le sujet des défis liés au braconnage (n = 77 cas) posait la question de l'application de la loi, des problématiques des habitants et de la gouvernance, ainsi que du commerce et de la durabilité financière. Les exemples de lutte antibraconnage (n = 66) reposaient principalement sur l'application des lois dont la mise en sécurité des animaux et de leur habitat, l'utilisation des technologies telles que des drones de surveillance pour les gardes, et des investigations menées sur de crimes mineurs plutôt que sur les groupes et réseaux du crime organisé transnational (COT). Les personnes interrogées ont estimé que seulement 53,4 % des initiatives anti-braconnage se sont avérées concluantes.

Les défis liés au trafic (n = 46) comprenaient l'application de la loi, les actions inefficaces contre les TOC et la coopération insuffisante entre les différents organismes chargés de faire respecter la loi au sein des États de l'aire de répartition ainsi qu'entre eux et l'ensemble de la chaîne logistique. Les sondés ont estimé que 45,7 % des initiatives destinées à freiner le trafic ont abouti.

Les résultats de cette enquête et les réflexions issues de travaux précédents ont permis au GSRAf et au GSRAs d'identifier 12 enjeux stratégiques dans la lutte contre le braconnage et le commerce, et 29 réponses clefs (Ferreira et al. 2022).

Rapports à destination de la CITES

La surexploitation des ressources est un facteur de changement environnemental mondial (Janssen et al. 2006) qui, ajouté au dérèglement climatique, à l'altération des habitats, à la pollution et à l'émergence de maladies, représente des dangers pour la persistance de toutes les espèces de rhinocéros. Pour autant, le commerce illicite de leurs cornes est encore considéré comme la menace principale pour leur sécurité à long terme. Le GSRAf, le GSRAs et TRAFFIC ont soutenu l'UICN dans son rapport au secrétariat de la CITES sur la conservation et le commerce des rhinocéros d'Afrique et d'Asie (CITES 2022).

Les restrictions de voyages dues à la pandémie de Covid 19, à la mise en place de lois plus strictes et à un

glue, that is more difficult to detect, was present in 27% of online advertisements for rhino specimens promoted as a treatment for multiple ailments.

African range States imported 162 and exported 369 rhinos from 2018 to 2021, 81 out of Africa, and 60 beyond the historical range. South Africa permitted hunting of a sustainable 0.02%–0.08% of its white and 0.13% black rhino populations per year, while Namibia had 0.37%–1.78% of its white and 0.00 to 0.05% of its black rhinos hunted annually between 2018 to 2021.

Not all Parties making seizures regularly report stockpile information to CITES. Seven African range States collectively recorded 87.3 tonnes of rhino horns and pieces by the end of 2020, with a significant proportion in private stocks. Non-range States held an estimated further two tonnes.

Despite several challenges associated with legal procedures, delayed prosecutions and offering bail, some African range States reported participation by local people in developing and implementing protection initiatives. In total, there were 1,588 arrests linked to rhino crimes, 751 prosecutions, and 300 convictions in Africa's range States from 2018 to 2021. Regional cooperation and collaboration in law enforcement and sharing intelligence through trusted relationships are key elements in combatting and dismantling TONCs. Barriers included delayed DNA forensic evidence resulting from low numbers of registered laboratories, inefficient transfer of samples from seizures (a recurring issue), as well as the lack of establishing regional rhino databases. An ongoing important recommendation remains that seizures should be the start of any investigation, not the end.

Rhino conservation accountability is embedded within the mandates of range States. Six range States had active and nationally approved rhino conservation plans, five had plans with no formal government ratification, seven were under review, while two range States were developing new plans. Despite this, range States moved 391 rhinos between and within localities in a country, dehorned 2,217 rhinos, treated 57 injured and wounded rhinos, and recovered 42 rhino orphans from 2018 to 2021. Authorities are increasingly encountering challenges such as suitable sites with cost effective protection to secure additional areas for rhinos. Several existing localities noted reduced growth in numbers due to ecological and

renforcement de leur exécution ont très probablement entraîné la baisse du nombre de cornes de rhinocéros entrées sur le marché en 2020 et 2021 (1 531–1 729) par rapport aux 2 378 en 2017. Bien que l'année 2019 ait vu une augmentation du poids et du nombre de cornes entières saisies, suivie d'une diminution en 2020, un bilan incomplet a empêché l'évaluation solide de l'impact de l'épidémie. Un nouveau produit plus difficile à détecter, la colle de rhinocéros, était présent dans 27 % des publicités en ligne pour des échantillons vendus comme traitement pour de nombreuses affections.

Entre 2018 et 2021, les États de l'aire de répartition africains ont importé 162 rhinocéros et en ont exporté 369, dont 60 au-delà de l'aire de répartition historique et 81 hors d'Afrique. L'Afrique du Sud a autorisé la chasse de 0,02 % à 0, 08 % de ses rhinocéros blancs et 0,13 % de ses rhinocéros noirs par an, tandis que la Namibie a vu 0,37 % à 1,78 % de ses rhinocéros blancs et 0 % à 0,05 % de ses rhinocéros noirs chassés légalement chaque année entre 2018 et 2021.

Tous les acteurs effectuant des saisies ne rapportent pas nécessairement les informations sur les stocks à la CITES. Fin 2020, sept États africains de l'aire de répartition ont collectivement enregistré 87,3 tonnes de cornes et autres parties de rhinocéros, dont une large proportion dans des stocks privés. Les États hors de l'aire de répartition ont ajouté à ce décompte une estimation de deux tonnes.

Malgré plusieurs difficultés associées aux procédures légales, à des poursuites judiciaires retardées et des offres de caution, certains pays africains de l'aire de répartition ont mentionné la participation des populations locales dans le développement et la mise en place d'initiatives de protection. Au total, 1 588 arrestations liées à des crimes envers des rhinocéros, 751 procédures judiciaires et 300 condamnations ont eu lieu dans les États de l'aire de répartition africains entre 2018 et 2021. Une coopération et une collaboration régionales en matière d'application de la loi ainsi que le partage de renseignements grâce à des relations de confiance sont des éléments clefs pour la lutte contre les réseaux COT et leur démantèlement. Le retard dans les analyses ADN de preuves médico-légales du fait du peu de laboratoires agréés, l'inefficacité des transferts de saisies (un problème récurrent) et l'absence d'une base de données régionale réservée au rhinocéros font partie des obstacles cités. L'une des recommandations fondamentales signale que les saisies devraient être le départ, plutôt que l'aboutissement, de toute enquête.

social density-dependence.

Various awareness and demand reduction initiatives focused on China and Vietnam. Where available, evaluations although sparse, highlighted self-reported reduced purchasing, reduced future use, and increased social unacceptability for those consumers that had exposure to demand reduction strategies in Vietnam. There is a need for a critical and objective review of the impact of demand reduction initiatives.

African range States noted that numerous examples of education and awareness, communication, livelihood assistance, infrastructure improvement, and enterprise development contributions towards rhino conservation efforts may carry risks of being perceived as appeasement. Several initiatives seek increasingly meaningful participation of local people in addressing shared challenges and taking part in decision-making and protection of biodiversity, including rhinos.

The status of African rhinos

Africa recorded 2,707 incidences of illegal killings of rhinos from 2018 to 2021, with 90.0% taking place in South Africa. South Africa estimated a 79.4% reduction in poaching of rhinos in Kruger National Park (KNP) during 2020 due to the Covid-19 pandemic. However, some range States (South Africa, Kenya) reported increases in poaching activities in 2021 (Table 1). Encouragingly, continental poaching rates declined from a high of 5.3% in 2015 to 2.3% in 2021. Imperfect carcass detection, as well as indirect effects of poaching such as the deaths of calves that are still dependent on mothers poached, resulted in populations needing to experience less than 3.6% (95% CI: 2.3%–5.7%) poaching rate to enable African rhino numbers to grow.

Despite the poaching pressures resulting in reduced numbers of rhinos, there remained 6,195 black and 15,942 white rhinos at the end of 2021. From 2017, continental numbers of both rhino species combined declined by 1.6% per year. Analysed by species black rhinos increased at 3.0%, while white rhinos declined at 3.1% per annum. Within the white rhino population, the decline was linked to the trends in a few large protected areas in South Africa, while private ownership of white rhinos in that country

La responsabilité de la conservation du rhinocéros relève du mandat des pays de l'aire de répartition. Six d'entre eux ont un plan de conservation du rhinocéros actif et approuvé nationalement, cinq présentent des programmes sans ratification formelle, sept sont en cours de révision et deux développent actuellement de nouveaux objectifs. Malgré cela, entre 2018 et 2021, l'ensemble de ces États a déplacé 391 individus entre des localités d'un même pays ou à l'intérieur de celles-ci, a décorné 2 217 sujets, traité 57 blessés et sauvé 42 rhinocéros orphelins. Les autorités ont de plus en plus de défis à relever, tels que la localisation de sites adéquats équipés de protections rentables pour sécuriser des zones supplémentaires d'habitat. Plusieurs localités ont noté une baisse de la croissance de populations à cause du facteur de densité-dépendance sociale et écologique.

Diverses initiatives de sensibilisation et de réduction de la demande ont ciblé la Chine et le Vietnam. Lorsqu'elles étaient disponibles, les évaluations, bien que sommaires, ont indiqué de la part des consommateurs même, une baisse des achats de produits venant des rhinocéros, l'intention d'en réduire l'utilisation à l'avenir et une acceptabilité sociale moindre s'ils avaient été exposés à des campagnes de réduction de la demande au Vietnam. Il est impératif de procéder à un examen critique et objectif de l'impact des initiatives de réduction de la demande.

Les États de l'aire de répartition africains ont noté que dans de nombreux cas, les démarches d'éducation et de sensibilisation, de communication, d'aide financière, d'amélioration des infrastructures et de contributions au développement des entreprises, en lien avec la conservation des rhinocéros, risquent d'être perçues comme des tentatives d'apaisement par les habitants ayant souffert de nuisances de la part de ces animaux. Plusieurs initiatives visent une participation des populations locales plus significative dans des enjeux communs, des prises de décisions collectives et dans la protection de la biodiversité, dont les rhinocéros.

Le statut du rhinocéros d'Afrique

2 707 cas d'abattage illégal de rhinocéros ont été enregistrés entre 2018 et 2021, dont 90 % ont eu lieu en Afrique du Sud. Le pays a estimé à 79,4 % la baisse du nombre de braconnages dans le parc national Kruger (KNP) en 2020 du fait de la pandémie de Covid 19. Cependant, certains États de l'aire de répartition (Afrique du Sud, Kenya) ont rapporté une hausse des activités de braconnage en 2021 (tableau no 1). Il est encourageant de voir qu'à l'échelle du continent, les taux

Table 1. Detected African rhino poaching mortalities by range States since 2006 (updated from CITES 2022). Zero reflects reports of no recorded poached carcasses by a range State. Na = not available

Tableau 1. mortalité causée par le braconnage chez les rhinocéros d'Afrique par État de l'aire de répartition depuis 2006 (mise à jour CITES 2022). «0» indique l'absence de braconnage. Na = non disponible

Range State	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Botswana	0	0	0	0	0	0	2	2	1	0	1	9	18	31	55	na
Chad	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0
DR Congo	0	0	2	2	-	-	-	-	-	-	-	-	2	0	0	0
Côte d'Ivoire	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0
Eswatini	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0
Kenya	3	1	6	21	22	27	29	59	35	11	10	9	4	4	0	6
Malawi	0	0	0	0	0	0	2	1	1	1	1	1	0	0	0	0
Mozambique	0	9	5	15	16	10	16	15	19	13	5	5	8	6	2	0
Namibia	0	0	0	2	2	1	1	4	30	97	61	44	93	56	40	40
Rwanda	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0
Senegal	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0
South Africa	36	13	83	122	333	448	668	1004	1215	1175	1054	1028	769	594	394	451
Tanzania	0	0	2	0	1	2	2	0	5	5	0	2	0	0	0	0
Uganda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zambia	0	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Zimbabwe	21	38	164	39	52	42	31	38	20	50	35	36	34	82	12	4
Total	**60**	**62**	**262**	**201**	**426**	**532**	**751**	**1123**	**1327**	**1352**	**1167**	**1134**	**930**	**773**	**503**	**501**

increased to 53.2%. Continentally, declines in rhinos from the 1970s to 1990s are linked with that of black rhinos, while recent declines are linked to that of white rhinos (Fig. 1). By 2021, 218 black and 1,077 white rhinos existed in ex-situ collections globally.

Although rhinos experienced stressors linked to poaching, rhino populations did best when government, private, non-government, and local people partnered to manage them. Rhinos living in large areas are often most at risk. This may associate with the ability of site managers to cost-efficiently secure the area. At the same time, there are many rhinos in smaller protected areas where populations are displaying a density-dependent reduction in their growth rates.

Evaluation of CITES listing proposals

The CITES Secretariat received two proposals for southern white rhino (*C. s. simum*) for consideration by the Parties at the 19th Conference of the Parties, 14–25 November 2022 at Panama City. The AfRSG has offered comments on these and they will be reported post CITES CoP19.

de braconnage ont décliné : de 5,3 % de la population en 2015, ils sont passés à 2,3 % en 2021. Une mauvaise détection des carcasses ainsi que les effets indirects du braconnage comme la mort de juvéniles dont la mère a été tuée, font que les populations, afin de croître en nombre, ne doivent plus connaître de taux de braconnage supérieurs à 3,6 % (95 % CI : 2,3 %–5,7 %).

Malgré la pression du braconnage, 6 195 rhinocéros noirs et 15 942 rhinocéros blancs étaient décomptés fin 2021. Depuis 2017, les deux espèces combinées à l'échelle du continent ont décliné de 1,6 % par an. Par espèce, la population de rhinocéros noirs a augmenté de 3 %, tandis que le rhinocéros blanc a connu une baisse de 3,1 % par an. En ce qui concerne le rhinocéros blanc, le déclin est lié aux tendances relevées dans quelques grandes zones protégées en Afrique du Sud, mais le nombre de sujets appartenant à des propriétaires privés augmente de 53,2 %. Au niveau continental dans les années 1970 à 1990, les rhinocéros noirs étaient en diminution alors que les chiffres récents montrent un déclin du nombre de rhinocéros blancs (Fig. 1). Au total en 2021, 218 rhinocéros noirs et 1 077 rhinocéros blancs existaient dans des lieux ex-situ.

Bien que les rhinocéros subissent des stress liés au braconnage, ils se portent mieux lorsque gouvernements,

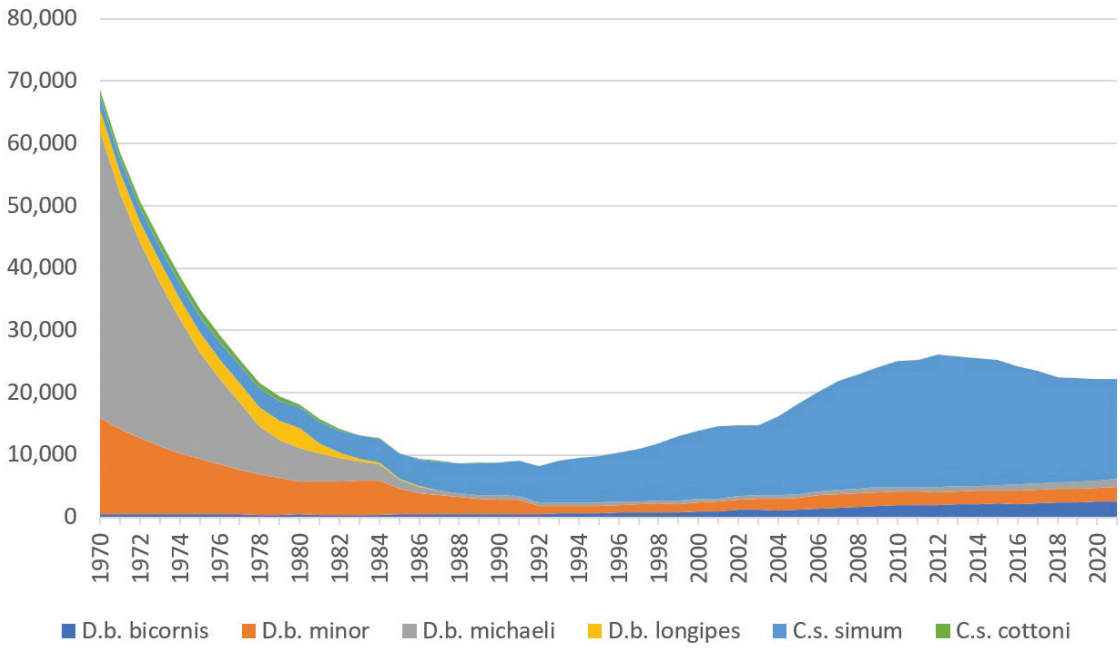

Figure 1. Estimates (CITES 2022) of African rhinos since 1970 by species and sub-species within Africa. Note that by 2021, one white rhino sub-species, northern white rhino (*C.s. cottoni*), is functionally extinct with only two individuals surviving. One black rhino sub-species, the western black rhino (*D.b. longipes*), was extinct by 2011.

Graphique 1. estimations de la population de rhinocéros africains (CITES 2022) depuis 1970 par espèce et sous-espèce. Remarque : en 2021, une sous-espèce du rhinocéros blanc, le rhinocéros blanc du Nord (*C.s. Cottoni*), est quasiment éteinte avec seulement deux individus vivants. Une des sous-espèces du rhinocéros noir, le rhinocéros noir d'Afrique de l'Ouest (*D. b. longipes*), est éteinte depuis 2011.

Reflecting on African rhinos

The 14th AfRSG members meeting

The members met over numerous virtual sessions from March to April 2022. Several of the insights and findings from the meetings fed directly into the report on the status of rhinos to the CITES Secretariat, reflected on above.

The first session involved critically important range State reports with updates on the status, threats, responses, and initiatives in their respective countries. The Scientific Officer (SO) engaged with each range State representative independently to collect the information.

Other sessions involved understanding the processes that the AfRSG plan to use in identifying priority rhino populations and localities as part of guiding donors and allocation of support as well as insights in the global Red Listing evaluation for rhinos. This requires range State summary data and establishing formal data-user agreements between the AfRSG and range

secteur privé, organisations non gouvernementales et habitants s'associent pour leur gestion. Les sujets vivant dans de vastes territoires sont souvent les plus à risque. Cela peut être dû à la capacité des responsables de ces sites à sécuriser les zones de manière rentable. En parallèle, il existe de nombreux espaces protégés plus petits dans lesquels les populations montrent une réduction densité-dépendante de leur taux de croissance.

Évaluation des propositions de la CITES

Le secrétariat de la CITES a reçu deux propositions au sujet du rhinocéros blanc (*C. s. simum*) pour discussion à la 19e Conférence des Parties du 14 au 25 novembre 2022 à Panama City. Le GSRAf a soumis ses commentaires qui seront rapportés après la Cdp19.

Réflexions au sujet du rhinocéros africain

14e Réunion des membres du GSRAf

Les membres ont tenu de nombreuses sessions

States as an important bedrock going forward.

Other sessions included: 1) how rhino conservation initiatives were responding to contracted range, fragmented habitat, and genetic constraints; 2) discussions on concepts of meta-population dynamics, assessing available habitat and the use of introductions and translocations to assist rhino dispersal dynamics to meet regional and national conservation objectives; 3) the exploration of potential site level (scientific/management) support to range States; 4) shared experiences in the tracking of rhinos following introductions and translocations; 5) approaches of evaluating law enforcement effectiveness allowing managers to re-invest in efficient interventions, while disinvesting in inefficient approaches in different contexts; 6) improving the knowledge of drivers threatening rhinos; 7) providing updates on trade routes and state of the market to help inform revisions of continental and national rhino conservation plans; 8) improved understanding of CITES and the regulations relating to rhinos, with a view to clarifying misconceptions that can help guide the AfRSG's mandate in supporting the IUCN's contribution to CITES and; 9) reflections on reducing the rewards for poachers and illegal traders, as well as managing rhino horn stockpiles. This included how to approach the storage or disposal (destruction or sale) based upon the route by which horn is collected (from dehorning, poaching, natural deaths or confiscations) within range States, in transit and/or in consumer states.

The meeting also explored the different values placed on rhinos arising through a continuum of conservation ideologies from animal-rights to human rights focuses. Consequences of these ideologies led to substantive discussions and debates around the impacts of consumptive use of the specimens and products of charismatic African species like rhinos. Members contemplated how such utilization of rhino values, including products derived from rhinos, would benefit rhinos. Recognizing all the values of rhinos may provide multiple opportunities, but these carry different levels of reputational risk. Linked to this, members contemplated several theoretical frameworks embedded within a variety of disciplines that can help guide authorities to achieve successful conservation outcomes for

virtuelles entre mars et avril 2022. Plusieurs idées et conclusions issues de ces réunions ont directement alimenté le rapport livré au secrétariat de la CITES sur la situation des rhinocéros, présenté ci-dessus.

La première séance accueillait les comptes-rendus, d'une importance cruciale, des États de l'aire de répartition, contenant les mises à jour de la condition et des menaces actuelles dans leurs pays respectifs, ainsi que les réponses apportées et les initiatives mises en œuvre. Le responsable scientifique (SO) a collaboré avec chacun des représentants des États individuellement pour recueillir les informations.

Les réunions suivantes étaient dédiées à la compréhension des processus prévus par le GSRAf pour identifier les populations de rhinocéros et les localités prioritaires, afin d'orienter les donateurs, le soutien financier ainsi que les conclusions dans l'évaluation globale de la Liste rouge pour les rhinocéros. Cela nécessite un résumé des données par État et l'établissement d'un accord formel d'utilisation des données entre eux et le GSRAf comme base de travail.

D'autres séances ont abordé : 1) la façon dont les initiatives de conservation répondent à des problématiques d'aires de répartition restreintes, d'habitat fragmenté et de contraintes génétiques ; 2) les concepts de dynamiques de métapopulation, en évaluant les habitats disponibles et le recours aux introductions et aux translocations pour favoriser le processus de dispersion afin d'atteindre les objectifs de conservation régionaux et nationaux ; 3) la question d'un potentiel soutien sur site aux États de l'aire de répartition en ce qui concerne la gestion ou l'aspect scientifique de la conservation ; 4) leurs expériences respectives de suivi des rhinocéros après leur introduction ou translocation ; 5) les approches pour examiner l'efficacité de l'application des lois, permettant aux responsables de réinvestir dans des interventions performantes tout en laissant de côté les activités inopérantes ; 6) l'amélioration des connaissances des facteurs menaçant les rhinocéros ; 7) les mises à jour des informations sur les routes commerciales et l'état du marché pour aider à la révision des plans de conservation nationaux et continentaux ; 8) les enjeux d'une compréhension accrue de la CITES et des règlements relatifs aux rhinocéros, et l'objectif de déconstruire certains préjugés afin de mieux guider le GSRAf dans son rôle de soutien à la contribution de l'UICN à la CITES ; 9) une réflexion à propos de la réduction des récompenses offertes pour lutter contre le braconnage et le commerce illégal, et le sujet de la gestion des stocks de cornes de rhinocéros.

rhinos, which is important as range States revise and develop policies. Discussions also delved into the socio-economic consequences associated with rhinos, particularly in market dynamics and consequences of incentives and socio-economic research within the AfRSG, coordination and sharing of relevant data.

Finally, discussions also probed into whether and how to revise and update the 2016 African Rhino Conservation Plan (ARCP) stressing the need for linked perspectives and expectations, primarily at the political level to meet an identified need. Providing required resources to national or continental level plans and their implementation remains an ongoing activity, this was re-explored with updates of existing initiatives and new ideas/approaches, particularly how to link opportunities to larger landscape levels and funding approaches that more directly engage local communities and stakeholders to be more actively involved in rhino conservation.

As the AfRSG could not undertake normal site visits as part of the meeting, members had three virtual tours of North Luangwa NP (Zambia), Ol Jogi Conservancy (Kenya) and the WWF Khetha Programme (South Africa) to see progress in field work.

The AfRSG members meeting discussed governance, financial, and performance reports as well as feedback from all working groups and task forces. Reports focused on recommendations/decisions and actions, as well as outstanding or new issues to be resolved after the meeting. Attendees discussed membership processes, diversity, equity, and succession, and the governance procedures of the AfRSG. The AfRSG has 53 members, which includes 13 official range State representatives.

Task forces and working groups

The AfRSG has had a number of task forces and working groups addressing issues such as: 1) rewilding rhinos; 2) securing data access through user-agreements; 3) how to improve community participation; 4) improving communications; 5) securing African rhino data management; improving the governance of the group through skills audit and declaration of interests; and 6) ways to incentivize and secure support for rhino conservation by improving livelihoods and empowering local people through the promotion

Ce dernier point incluait la question du stockage ou du traitement (destruction ou vente) du produit selon la situation lors de laquelle il a été collecté (décornage, braconnage, mort naturelle ou saisie) au sein des États, en transit ou dans les pays consommateurs.

La réunion a également exploré l'ensemble du spectre de valeurs placées dans les rhinocéros, créées par un continuum d'idéologies de conservation allant des droits des animaux aux droits de l'homme. Les conséquences de ces idéologies ont donné lieu à des discussions et des débats de fond autour des impacts de l'usage à des fins de consommation d'échantillons et de produits venus d'espèces africaines charismatiques telles que le rhinocéros. Les membres ont réfléchi à la possibilité que ce type d'utilisation, y compris des produits dérivés, bénéficie aux rhinocéros. Reconnaître ces différentes valeurs peut offrir de multiples opportunités, qui envoient cependant des messages divers pouvant nuire à la réputation de l'organisation. Sur le même terrain, les membres ont envisagé plusieurs cadres théoriques, dans une grande variété de disciplines, pouvant aider les autorités à atteindre des résultats positifs dans la conservation des rhinocéros. Ces dispositifs sont importants au moment où les États de l'aire de répartition sont en train de revoir ou de développer leurs politiques. Les discussions ont également approfondi les conséquences socio-économiques associées aux rhinocéros, particulièrement les dynamiques de marché et les effets des recherches incitatives et socio-économiques au sein du GSRAf, la coordination et le partage de données pertinentes.

Enfin, les membres se sont interrogés sur l'opportunité d'une mise à jour du plan de conservation du rhinocéros africain (ARCP) de 2016 et sur la façon d'y parvenir, soulignant, en premier lieu, l'exigence de perspectives et d'attentes communes au niveau politique pour répondre à un besoin identifié. Fournir les ressources nécessaires aux plans nationaux et continentaux et à leur mise en œuvre est une activité de long court. Ce point a de nouveau été examiné au regard de l'actualisation des initiatives existantes et de nouvelles idées et approches, notamment la manière de faire bénéficier de ces opportunités à des territoires plus vastes et de financer des démarches plus engageantes envers les communautés locales et les parties prenantes, pour une meilleure implication de leur part dans la conservation du rhinocéros.

Le GSRAf ne pouvant effectuer de visites sur site, les membres ont profité de trois visites guidées virtuelles pour voir l'avancement des projets sur place : le parc

of benefits derived from wildlife resources. Some of these groups were more effective than others, depending upon the urgency of the issue and member interest and availability.

Noteworthy meetings and contributions

African Protected Areas Congress (APAC), Kigali, Rwanda, 18–23 July 2022

'Thriving rhinos, thriving people', was the theme of the Conservation Clinic hosted by the AfRSG. It highlighted that rhino conservation and benefits for people need to move beyond sustainability to growth. Rhinos generally performed better under private management than by the State. It seems that devolving responsibility to local people may be a key requirement. Theory suggests a resilient socio-economic-ecological system conserved by an empowered civil society as a key outcome. Several case studies in Africa were discussed via selected panel members from Namibia, Kenya, and South Africa. A common view from panellists was the requirement of Local People and Indigenous Communities (LPIC) to participate in decision-making and to receive tangible benefits looking after rhinos. This requires co-developing policies and implementation plans that also carries shared security costs, accountability and responsibility.

Reflections suggest that historic losses of rhinos are typically associated with players from outside local communities. Different levels of societal equality, however, influence the present perceptions that local people have about rhinos. In Namibia and Kenya for instance, local people have a desire to have rhinos back in the landscapes that they formerly inhabited before the onslaught of heavy poaching in the 1970s and 1980s. People recognize values and benefits that accrue with the presence of rhinos (e.g. securing land) but are also cognisant of the risks and responsibilities therein. In contrast, the view of the panel was that LPICs in South Africa associated rhinos with violence.

Developing an African Rhino Conservation Framework, August 2022

Reflections from the 14th AfRSG meeting and APAC informed the process of revising continental African rhino conservation approaches. With national de North Luangwa en Zambie, le conservatoire Ol Jogi au Kenya et le programme Khetha de WWF en Afrique du Sud.

Les discussions ont abordé les enjeux de gouvernance, de financement et de rapports de performance ainsi que les retours de tous les groupes de travail et cellules opérationnelles. Les comptes-rendus se sont concentrés sur les recommandations/décisions, sur les actions et les questions, en suspens ou inédites, à résoudre après la réunion. Les participants ont échangé sur les processus d'adhésion, la diversité, l'équité, la succession et les procédures de gouvernance au sein du GSRAf, qui compte 53 membres, dont 13 représentants officiels des États de l'aire de répartition.

Cellules opérationnelles et groupes de travail

Le GSRAf a mis en place un certain nombre de cellules opérationnelles et groupes de travail pour traiter de questions telles que : 1) le réensauvagement des rhinocéros ; 2) la sécurisation de l'accès aux données via des accords utilisateurs ; 3) les façons de perfectionner la participation des communautés ; 4) l'optimisation des communications ; 5) la sécurisation de la gestion des données relatives aux rhinocéros ; une meilleure gouvernance du groupe à travers des audits de compétence et des déclarations d'intérêt ; 6) les moyens de favoriser et garantir le soutien à la conservation des rhinocéros en améliorant le niveau de vie des habitants et en leur donnant de l'autonomie grâce à la promotion des avantages dérivés des ressources liées aux animaux sauvages. Certains groupes ont montré plus d'efficacité que d'autres selon le degré d'urgence du sujet et la disponibilité et l'intérêt des membres.

Contributions et réunions notables

Congrès des aires protégées d'Afrique (APAC) à Kigali (Rwanda) du 18 au 23 juillet 2022

Le thème de la « Conservation Clinic » organisée par le GSRAf était : « Thriving rhinos, thriving people » (« Des rhinocéros heureux, des populations prospères »). La rencontre a montré que la conservation et les bénéfices tirés par les populations devaient aller au-delà de la durabilité pour perdurer. Les rhinocéros semblent mieux se porter sous gestion privée que sous l'égide de l'État. Un des prérequis serait de déléguer les responsabilités aux habitants locaux. Une des théories suggère qu'un système socio-économique-écologique robuste, entretenu par une société civile

support from WWF, an AfRSG task force convened in North Luangwa NP, Zambia, to define the elements and aspects that are pertinent to rhino conservation through review of various meetings and to construct a vision, mission, and goals for an African Rhino Conservation Framework. The group emphasized that to secure Africa's rhinos for their intrinsic values and contributions to the provision of ecosystem services, will require engaging in global challenges, as well as addressing some of Africa's most disenabling historical legacies. Key elements include highly fragmented and small sizes of rhino habitats and inequality in beneficiation, ownership, and decision-making. The framing has called for a critical review of established mindsets and approaches to rhino conservation.

Other activities

On request from donors, an audit of the rhino population and the monitoring protocols of Save Valley Conservancy (SVC), Zimbabwe, was undertaken by a small team comprising local AfRSG members and other experts. In many ways this audit provided good insights on how to replicate such activities elsewhere.

In addition, the final ecological assessment of the Rifa section of the Middle Zambezi Valley, Zimbabwe, for the potential reintroduction of the black rhino was completed by a contracted ecological expert. Although the area historically supported a sizeable rhino population and has suitable habitat, it was recommended that the proposed introduction protocol using two sanctuaries set at the base of the escarpment was unlikely to provide an adequate food supply throughout the year for a viable population of rhino. The proponents have accepted the recommendations.

The SO has provided advice to the African Parks Network on developing a rhino metapopulation strategy for the organization in preparation for potential rhino introductions to Pendjari (Benin) and Chinko (Central African Republic).

Latest research outputs from members

AfRSG members produced several scientific outputs under the auspices of their various

détenant de réelles capacités, en soit l'aboutissement principal. Plusieurs études de cas menées en Afrique ont été discutées par un panel de membres sélectionnés venant de Namibie, du Kenya et d'Afrique du Sud. Une de leurs positions communes identifiait la nécessité de la participation des LPIC (populations locales et communautés autochtones) à la prise de décisions pour bénéficier de façon tangible de la gestion des rhinocéros. Cela requiert des politiques développées et des plans mis en œuvre ensemble et donc, le partage des responsabilités et des coûts liés à la sécurité.

Les analyses évoquent le fait que les pertes historiques de rhinocéros sont généralement associées à des acteurs extérieurs à la communauté. Cependant, différents niveaux d'égalité sociale influencent les perceptions actuelles des rhinocéros par les locaux. En Namibie et au Kenya, par exemple, les habitants ont le souhait de voir revenir les rhinocéros dans les territoires où ils vivaient avant le grand épisode de braconnage intensif des années 1970 et 1980. Ils reconnaissent la valeur et les avantages qui découlent de la présence des rhinocéros (comme la sécurisation des terres), mais sont également conscients des risques et responsabilités inhérents. Par contraste, le sentiment du panel était que les LPIC en Afrique du Sud associaient les rhinocéros à la violence.

Développement d'un cadre de conservation du rhinocéros africain, août 2022

Les réflexions issues de la 14e réunion du GSRAf et de l'APAC ont renseigné les processus de révision des approches de la conservation du rhinocéros à l'échelle du continent africain. Avec le soutien du WWF, une cellule opérationnelle du GSRAf s'est réunie au parc national de Luangwa (Zambie) afin de définir les critères et les aspects pertinents de la conservation du rhinocéros, après une revue des différentes rencontres et pour bâtir une vision, une mission et des objectifs pour le cadre de conservation. Le groupe a souligné que la sécurisation des rhinocéros d'Afrique pour leur valeur intrinsèque et leur contribution aux écosystèmes demandera de s'engager dans les défis mondiaux et de questionner certains héritages historiques parmi les plus préjudiciables en Afrique. Les éléments clefs comprennent : des habitats extrêmement fragmentés et de petite surface et l'inégalité devant la propriété, la prise de décisions et la possibilité de profiter des retours de bénéfices. La mise en place du cadre a exigé une revue critique des mentalités et des approches établies en matière de conservation du rhinocéros.

institutions. These provide important insights and reflections.

- Translocation is an important tool and relies on safe chemical immobilization. An update on individual species requirements (Burroughs et al. 2022) guides the approach and planning of chemical immobilization and translocation—a key tool for rhino conservation.
- Another study (Lieberich et al. 2022) focused on mitigating risks during transportation, noting that rhinos not fed during translocation events which were longer than 30 hours experienced increased fatigue.
- Under stressful conditions rhinos can succumb to diseases for which they are sub-clinical carriers. Treating babesiosis in a five-year old black rhino female (Zimmermann et al. 2022) proved effective with imidocarb dipropionate administered intramuscularly by pole syringe.
- Free-ranging rhinos had no photoperiodic or seasonal element, but rather suppression of conception at times of resource scarcity. In contrast, zoo populations had a slight accumulation of autumn and reduction of spring births linked to reduced conceptions in November–December—most likely management-related, as most facilities do not allow mating when weather restrictions reduce outdoor husbandry (Radeke-Auer et al. 2022).
- A study focused on applying an ethical matrix to a case of assisted reproduction technologies involving ovum pick-up procedures performed in the current conservation efforts for the northern white rhino (Biasetti et al. 2022). The framework allows the evaluation of complex moral scenarios where different needs, interests, and ethical concerns may conflict. The application to the case study uses value judgements on acceptability influenced by the conservation mission, the welfare of the animals, the people involved, and public opinion when discriminating between those projects that are conducted responsibly and those that are not.
- The effect of poaching is larger than the

Autres activités

Sur demande des donateurs, un audit de la population de rhinocéros et des protocoles de surveillance dans le conservatoire de Save Valley (SVC) au Zimbabwe a été entrepris par une petite équipe composée de membres locaux du GSRAf et d'autres experts. À bien des égards, cet audit a fourni une excellente idée de la façon de reproduire ces activités ailleurs.

De plus, l'examen écologique définitif effectué dans la section Rifa de Middle Zambezi Valley au Zimbabwe en vue de la réintroduction potentielle du rhinocéros noir a été finalisé par un consultant en écologie. Bien que la zone ait historiquement contenu une importante population de rhinocéros et qu'elle présente un habitat adéquat, il a été mis en évidence que le protocole d'introduction proposé, composé de deux sanctuaires basés au pied d'un escarpement, ne fournirait probablement pas assez de nourriture tout au long de l'année pour une population viable. Les partisans du projet ont accepté ces remarques.

Le responsable scientifique (SO) a conseillé le Réseau des parcs africains (African Parks) dans le développement d'une stratégie de métapopulation de rhinocéros en préparation de l'introduction potentielle de sujets au Pendjari (Bénin) et au Chinko (Centrafrique).

Derniers résultats de recherche

Les membres du GSRAf ont produit, sous les auspices de leurs institutions respectives, plusieurs résultats scientifiques qui offrent de précieuses idées et réflexions.

- La translocation est un outil important qui s'appuie sur une immobilisation chimique sûre. Une mise à jour des exigences de chaque espèce (Burroughs et al. 2022) guide l'approche et la planification de l'immobilisation chimique et de la translocation, outil clef de la conservation des rhinocéros.
- Dans une autre étude (Lieberich et al. 2022) portant sur la réduction des risques pendant le transport, il est indiqué que les rhinocéros non nourris pendant un trajet de translocation de plus de 30 heures souffraient d'une fatigue plus élevée.
- Dans des conditions de stress intense, les individus peuvent succomber aux maladies dont ils sont porteurs asymptomatiques. Le traitement de la babésiose sur un rhinocéros femelle noir de cinq ans (Zimmermann et al. 2022) avec du dipropionate d'imidocarbe, administré par

absolute losses of killed rhinos. At Ol Jogi, Kenya, a large proportion of females are not breeding or do so at very low rates. Including this factor into population predictions increases the chance of extinction by 70% under 5% poaching pressure (Harvey et al. 2022). Apart from curbing poaching, potential responses can include habitat and biological management.

- The effect of poaching exacerbates when poachers kill females. A study in Kruger NP, South Africa, found that population declines of white rhino were exacerbated by a combination of poaching, climate change and the loss of calves from poached females. More alarming, poaching levels reduced the lifetime reproductive output per female from 6 to 0.7 calves: a compound effect of the loss of 5.3 future offspring (Nhleko et al. 2022a). Maintaining and improving the lifetime reproductive output of rhino females should be the highest management priority as it provides one of the most effective mechanisms to buffer poaching loss (McCleery et al. 2022).
- The fear of humans can be used to alter the movements and behaviour of female white rhinos, critical for population recovery. Females decreased their visitations by 70% in response to human vocalizations, while visitations by males remained unchanged. Both sexes exhibited more vigilance (males 69.5%, females 96%) compared to controls (Nhleko et al. 2022b).
- A case study in Mozambique highlights how trafficking routes shifted away from areas where conflict is most intense, with involvement of the illicit economy only funding a small proportion of the conflict (Stanyard et al. 2022). These findings challenge assumptions that local conflict is often funded through trafficking of high value products like rhino horns.
- Rhinos integrate with the African wildlife economy (‘t Sas-Rolfes 2022a), but poor documentation of past lessons constrain anticipating future trends and plausible scenarios. Limited evaluation of how varying institutional arrangements and policies affect performance creates knowledge gaps, partly

voie intramusculaire à l’aide d’une seringue télescopique, s’est avéré efficace.

- Les sujets en liberté ne montrent pas de sensibilité photopériodique ou saisonnière, mais plutôt une suppression de la reproduction en périodes de pénurie de ressources. Par contraste, les populations de zoos se caractérisent par une accumulation de naissances en automne et une réduction au printemps, probablement liées à une diminution des conceptions en novembre-décembre, du fait que les institutions n’autorisent pas les accouplements lorsque les restrictions météorologiques ne permettent pas aux animaux de demeurer à l’extérieur (Radeke-Auer et al. 2022).
- Une étude s’est attachée à appliquer une matrice éthique à un cas de technologie de reproduction assistée impliquant des procédures de prélèvement d’ovules et effectuées dans le cadre des efforts de conservation pour le rhinocéros blanc du Nord (Biasetti et al. 2022). On y voit l’évaluation de scénarios moraux complexes, dans lesquels les différents besoins, intérêts et préoccupations éthiques peuvent entrer en conflit. L’étude de cas utilise des jugements de valeur sur l’acceptabilité du processus, influencés par le type de mission de conservation, le bien-être des animaux, les acteurs du projet et l’opinion publique, pour distinguer les initiatives menées de façon responsable de celles qui ne le sont pas.
- Les conséquences du braconnage sont bien plus vastes que la simple perte des rhinocéros tués. À Ol Jogi au Kenya, une large proportion des femelles ne se reproduit pas ou à des taux très faibles. Inclure ce facteur dans les prévisions démographiques augmente les risques d’extinction de 70 % sous une pression de 5 % de braconnage (Harvey et al. 2022). Outre l’endiguement du braconnage, les solutions peuvent se trouver dans la gestion biologique et des habitats.
- Les effets du braconnage sont exacerbés lorsque des femelles sont tuées. Une étude effectuée dans le parc national Kruger en Afrique du Sud a révélé que le déclin des populations de rhinocéros blancs est aggravé par une combinaison de facteurs : braconnage, changement climatique et mort des petits de femelles tuées. Il est plus alarmant encore de constater que les niveaux de braconnage réduisent le nombre de petits de 6 à 0,7 sur toute la période reproductive des femelles — un effet combiné de la perte de 5,3 descendants

responsible for current policy conflicts on various topics. Better knowledge alone, however, cannot resolve conflicts that are driven by underlying differences in human values, which also evolve and shift.

- Despite decades of international trade restrictions, curbing poaching remains a substantial challenge. Empowering local communities with stronger property rights and enhanced benefits, can help combat wildlife crime (Di Minin et al. 2022).
- Illegal trafficking and open trade of rhino products has continued as found in a case study in eastern Myanmar between 2015 and 2020 (Vigne and Nijman 2022). Observing over 100 horn items, the study noted asking prices for rhino horn tips were US$10,770 and rhino horn bracelets US$5,385; with prices being stable overall since 2017. Mobile phones and online trading allow customers to order items without having to cross the borders.
- Although legal hunting of rhinos is controversial (‘t Sas-Rolfes 2022b) with ethical objections voiced (‘t Sas-Rolfes and Emslie 2022), less attention has been paid to how hunting (even of threatened species) can be useful as a conservation tool, and likely outcomes if this were stopped. Legal trophy hunting of African rhinos in South Africa and Namibia has been well-managed and sustainable, and greater numbers of both species exist today in these countries than when controlled trophy hunting began (‘t Sas-Rolfes et al. 2022). Provided that there is appropriate governance, conservation of certain highly threatened species can be supported by significant funds from selective and limited legal hunting.

Rhino plans—an update

- White Rhino Conservation and Management Action Plan (2021–2025) in Kenya was published in March 2022.
- Black rhinoceros Management Strategy 2020/21–2030/31. Ministry of Environment, Tourism and Forestry, Namibia.
- Rhino Management Strategy for Zimbabwe 2020–2024 approved and published in

(Nhleko et al. 2022a). Maintenir et améliorer la période reproductive des femelles rhinocéros devrait devenir la première des priorités de gestion puisque cela représente l’un des mécanismes les plus efficaces pour faire tampon avec la mortalité due au braconnage (McCleery et al. 2022).

- La peur de l’humain peut être utilisée pour modifier les mouvements et le comportement des rhinocéros blancs femelles, élément essentiel à un rétablissement de la population. Les femelles ont réduit leurs apparitions de 70 % en réponse à des voix humaines, tandis que la fréquentation de la part des mâles n’a pas changé. Les individus des deux sexes montraient des signes de vigilance accrue (mâles : 69,5 % et femelles : 96 %) envers les voix humaines par rapport aux voix témoins (Nhleko et al. 2022b).
- Une étude au Mozambique démontre comment les axes de trafic se sont déplacés des zones où les tensions étaient les plus violentes, avec une économie illégale assez peu impliquée dans le financement du conflit (Stanyard et al. 2022). Ces résultats remettent en cause les hypothèses selon lesquelles les conflits locaux sont souvent soutenus par le trafic de produits de grande valeur tels que les cornes de rhinocéros.
- Les rhinocéros s’intègrent dans l’économie des espèces sauvages africaines (‘t Sas-Rolfes 2022a), mais une documentation spartiate des leçons du passé nous oblige à conjecturer les tendances futures et les scénarios plausibles. La façon dont les politiques et divers arrangements institutionnels fluctuants affectent les performances est peu évaluée et cela crée des lacunes dans les connaissances, en partie responsables des dissensions politiques actuelles sur divers thèmes. Une meilleure connaissance, en revanche, ne peut pas à elle seule résoudre les désaccords mus par des différences latentes en termes de valeurs humaines, qui elles-mêmes évoluent et se transforment.
- Malgré des décennies de restrictions dans le commerce international, la lutte contre le braconnage demeure un défi de taille. Donner plus de pouvoir aux communautés locales, accompagné de droits de propriété plus affirmés et de bénéfices accrus peut aider à combattre la criminalité envers les espèces sauvages (Di Minin et al. 2022).
- Le trafic illégal et le commerce libre et ouvert de produits dérivés du rhinocéros ont toujours cours, comme une étude l’a démontré dans l’est du

March 2022.
- The draft Black Rhinoceros Custodianship Programme Strategy 2022–2031 for Namibia was circulated in March 2022, to be signed-off after consultation workshops.

Esmond Bradley Martin endowment

In the wake of an endowment by the late Esmond Bradley Martin, the Royal Geographical Society is delighted to announce that nominations are invited for the inaugural Esmond Bradley Martin Royal Geographical Society Prize. One or two annual prizes will be awarded to recognise outstanding achievement by individuals (not organizations) in the pursuit and/or application of geographical research across the breadth of the discipline, with a particular emphasis on wildlife conservation and environmental research studies. A lecture on Monday 3 April 2023 will honour Esmond's achievements and launch the prize. For more information about the Prize, how to make a nomination, and the lecture, please visit https://www.rgs.org/ or email director@rgs.org.

The endowment from Esmond Bradley Martin to the Royal Geographical Society also includes ongoing support for the publication of *Pachyderm*.

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African rhino range States are thanked for their ongoing contribution of information to the Secretariat. The AfRSG is also grateful to Save the Rhino International (SRI), International Rhino Foundation (IRF), US Fish and Wildlife Service's Rhino and Tiger Conservation Fund (USFWS RTC), the Endangered Wildlife Trust (EWT) and Oak Foundation for support provided to the AfRSG Scientific (SO) and Programme (PO) Officers and the Chair to enable them to render this invaluable service to the Group. WWF in Namibia is also thanked for their support to the Chair. The CITES Secretariat is also thanked for support to the SO in collating the joint report with the AsRSG and TRAFFIC in preparation for CITES CoP19.

Myanmar entre 2015 et 2020 (Vigne and Nijman 2022). Avec plus d'une centaine d'échantillons, l'étude a conclu que les prix demandés pour l'extrémité d'une corne de rhinocéros s'élevaient à 10 770 $ et à 5 385 $ pour des bracelets en corne, des prix stables depuis 2017. Les téléphones mobiles et le e-commerce permettent aux clients de passer commande sans avoir à traverser les frontières.
- Bien que la chasse légale du rhinocéros soit controversée ('t Sas-Rolfes 2022b) et que des objections éthiques soient formulées ('t Sas-Rolfes and Emslie 2022), une attention moindre a été accordée au fait que la chasse, y compris d'espèces menacées, peut s'avérer un outil de conservation utile. Peu de réflexions se portent sur les conséquences si cette pratique devait s'arrêter. La chasse aux trophées légale en Afrique du Sud et en Namibie est bien gérée et durable, et le nombre d'individus des deux espèces est plus élevé aujourd'hui dans ces pays que lorsque les restrictions ont été mises en place ('t Sas-Rolfes et al. 2022). Sous réserve d'une gouvernance appropriée, la conservation de certaines espèces en danger d'extinction peut être soutenue par des fonds conséquents provenant d'une chasse légale, limitée et sélective.

Plans pour le rhinocéros : mise à jour

- Le plan d'action pour la gestion et la conservation du rhinocéros blanc (2021–2025) au Kenya a été publié en mars 2022.
- Stratégie de gestion du rhinocéros noir 2020– 2021 – 2030–2031. Ministère de l'Environnement, du Tourisme et des Forêts, Namibie.
- Stratégie de gestion du rhinocéros pour le Zimbabwe 2020–2024 approuvée et publiée en mars 2022.
- Le projet de stratégie du programme de tutelle du rhinocéros noir 2022–2031 pour la Namibie a été diffusé en mars 2022 pour signature après les ateliers de consultation.

Dotation Esmond Bradley Martin

Dans le sillage de la dotation de feu Esmond Bradley Martin, la Royal Geographical Society est ravie d'annoncer que les appels à candidatures sont lancés pour son premier prix. Un ou deux prix annuels seront décernés afin de récompenser les réalisations

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exceptionnelles d'individus (et non d'organisations) dans la conduite et/ou l'application de recherches géographiques dans tous les domaines de la discipline, avec un accent particulier sur la conservation des espèces sauvages et les recherches environnementales. Une conférence se tiendra le 2 avril 2023 pour le lancement du prix et pour rendre hommage au travail d'Esmond Bradley Martin. Pour de plus amples informations au sujet du prix, des candidatures et de la conférence, consulter le site https://www.rgs.org/ ou envoyer un email à director@rgs.org.

La dotation d'Esmond Bradley Martin à la Royal Geographical Society comprend également un soutien continu à la publication de *Pachyderm*.

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

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

The greater one-horned (GOH) rhino population in India has further increased during this reporting period, July 2021–September 2022. In Assam, India, a rhino census was carried out by the Office of the Chief Wildlife Warden of Assam in four rhino bearing areas during March–April 2022. In-service and retired forest officials, as well as representatives from NGOs and local media were engaged for the task. During the rhino count 2,613 rhinos were recorded in Kaziranga National Park (NP), 125 in Orang NP, 40 in Manas NP and 107 in Pabitora Wildlife Sanctuary (WLS) which brings the rhino population in Assam to 2,885. In the province of West Bengal in India, a rhino estimate was carried out in November 2021 where 287 rhinos were recorded in Jaldapara NP, while Gorumara NP recorded 52 rhinos. In Dudhwa NP located in Uttar Pradesh province, 42 rhinos were counted. Currently, the GOH rhino population in India is 3,266.

In Nepal, the four rhino bearing areas hold: 694 rhinos in Chitwan NP, 38 in Bardia NP, 17 in Suklaphanta Wildlife Reserve (WR) and three in Parsa WR bringing Nepal's rhino population to 752. This brings the total wild population of GOH rhino in India and Nepal combined to 4,018.

There were two rhinos poached in India between July 2021 and September 2022, while in Nepal commendably there was no record of a single rhino poaching. Both India and Nepal have initiated stringent protection and conservation measures in recent years leading to the increase in rhino numbers and decline of rhino poaching, which has helped the GOH rhino to reach 4,000 individuals in the wild.

État actuel du rhinocéros indien en Inde et au Népal

La population du rhinocéros indien a encore augmenté durant cette dernière période de juillet 2021 à septembre 2022. Un recensement a été conduit par le chef du département de la protection de la nature d'Assam dans quatre zones d'habitat des rhinocéros en mars et avril 2022. Des officiers des forêts en service et retraités ainsi que des représentants d'ONG et de médias locaux ont été engagés pour cette tâche. 2 613 rhinocéros ont été repérés dans le parc national de Kaziranga, 125 dans celui d'Orang, 40 au Manas et 107 dans le sanctuaire de Pabitora, portant la population d'Assam à 2 885 individus. Dans la province du Bengale occidental en Inde, une estimation a été réalisée en novembre 2021, lors de laquelle 287 rhinocéros ont été référencés dans le parc national de Jaldapara et 52 dans celui de Gorumara. Le comptage effectué dans le parc national de Dudhwa (état de l'Uttar Pradesh) a révélé 42 sujets. La population actuelle de rhinocéros indiens est de 3 266.

Au Népal, les quatre zones d'habitat du rhinocéros comprennent : 694 sujets dans le parc national de Chitwan, 38 dans celui de Bardia, 17 dans la réserve naturelle de Suklaphanta et 3 dans celle de Parsa, portant le nombre de rhinocéros à 752. La population totale des deux pays réunis s'élève à 4 018 têtes.

Deux rhinocéros ont été braconnés en Inde entre juillet 2021 et septembre 2022, tandis qu'au Népal, aucun cas n'est à déplorer. Ces dernières années, les deux nations ont mis en place des mesures de protection et de conservation strictes qui ont favorisé l'augmentation de la population de rhinocéros et la diminution du braconnage, permettant d'atteindre un effectif de 4 000 individus à l'état sauvage.

Lors d'un événement public qui s'est tenu pendant la journée mondiale du rhinocéros le 22 septembre 2021, le gouvernement de l'État d'Assam—qui à

In a public event held on World Rhino Day—22 September 2021, the Government of the State of Assam, which holds the bulk of the total global population of GOH rhino, incinerated a stockpile of 2,479 (1,305.25kg) rhino horns near Kaziranga NP. They were seized/collected over the past four decades. Ninety-four rhino horns were marked for preservation for education purposes and posterity and included a few unique pieces such as the longest and the heaviest on record.

To commemorate World Rhino Day 2022, the Kaziranga NP authorities erected a memorial made out of the 128.56 kg of ash collected from the rhino horn burning event. The memorial named "Abode of the Unicorns" is comprised of three rhino sculptures—an adult male, an adult female and a calf. It also includes three statues of forest guards, created by using different materials. The male rhino is 10.5 feet long and 6 feet tall, the female is 11 feet long and 5.6 feet tall while the calf is 3.5 feet long and 1.5 feet tall, (larger than life-size). Sculptor Biju Das crafted the three rhinos while Biren Singha created the statues of the forest guards. Chief Wildlife Warden (Mahendra Kumar Yadava) said the ash immortalises the efforts of those who selflessly protect the animal. (See Yadava's Field note on the burning event, entitled: *A horn has value only on a living rhino*, pp. 201–204).

Current state of Javan rhino

The current wild population of the critically endangered Javan rhino which is only found in Ujung Kulon NP in Banten province of west Java, Indonesia, has been estimated at 76 by Ujung Kulon NP authorities. The counting methodology relied on camera traps, and marks an increase of three rhinos since the last reporting period, (*Pachyderm*, Vol. 62). Out of the 76 rhinos counted, 37 are female (comprised of 25 adult females, eight sub adult female and four female calves), and 39 are male (comprised of 29 adult males, seven sub adult and three male calves) as per information shared by Ujung Kulon NP authorities. In the earlier reporting period there were 73 Javan rhinos.

Both the Ujung Kulon NP authorities and Yayasan Badak Indonesia with support from the International Rhino Foundation have been

lui seul abrite le plus grand nombre de rhinocéros indiens au monde—a incinéré près du parc national de Kaziranga un stock de 2 479 cornes de rhinocéros (soit 1 305,25 kg), saisies ou collectées ces quarante dernières années. 94 cornes ont été conservées à des fins éducatives et pour la postérité, dont certaines pièces uniques telles que la plus longue et la plus lourde jamais enregistrées.

La commémoration de la journée mondiale du rhinocéros a donné lieu à l'édification d'un mémorial à partir des 128,56 kg de cendre issus de la combustion. Nommé « Demeure des unicornes », il est composé de trois statues de rhinocéros : un mâle et une femelle adultes et un petit, et sont accompagnés de trois statues de gardes forestiers constituées de divers matériaux. Le mâle mesure 3,20 m de long sur 1,80 m de haut et la femelle 3,35 m de long pour 1,70 m de haut. Quant au petit rhinocéros, plus grand que dans la réalité, sa taille est de 1 m de long pour 45 cm de haut. Le sculpteur Biju Das a créé les trois animaux tandis que Biren Singha a réalisé les trois gardes. Le chef du service de protection de la nature Mahendra Kumar Yadava a déclaré que les cendres immortalisent les efforts de ceux qui travaillent sans compter pour défendre cette espèce (voir l'article du carnet de terrain de Yadava intitulé « *A horn has value only on a living rhino* » (« Une corne n'a de valeur que sur un rhinocéros vivant ») pages 201 à 204).

État actuel du rhinocéros de Java

Aujourd'hui, la population du rhinocéros de Java, en danger critique d'extinction et qu'on ne trouve plus que dans le parc national de Ujung Kulon (province de Banten à Java, Indonésie), est estimée à 76 têtes selon les autorités du parc. La méthodologie de recensement s'appuie sur des pièges photographiques et l'on voit une augmentation de trois rhinocéros depuis le dernier rapport (*Pachyderm*, Vol. 62). D'après les informations communiquées par la direction du parc, sur les 76 individus, 37 sont des femelles (dont 25 adultes, 8 subadultes et quatre juvéniles) et 39 sont des mâles (dont 29 adultes, 7 subadultes et 3 juvéniles). Le compte-rendu précédent faisait état de 73 rhinocéros de Java.

Les agents du parc, avec le soutien de l'IRF (Fondation Internationale pour le Rhinocéros) et aidés de la fondation Yayasan Badak Indonesia, ont déployé des interventions afin de contrôler la propagation du palmier Arenga (*Arenga obtusifolia*) dans la zone,

carrying out interventions to control the spread of the Arenga palm (*Arenga obtusifolia*) in the national park to enable rhino food plants to grow naturally. Arenga palms take over the understory and dominate, the canopy blocking sunlight from other plant species including the Javan rhinos' preferred food plants and choking almost all other plant life on the jungle floor. It also spreads rapidly and closes off access to the new habitat for rhinos. Once removed, preferred foods regenerate naturally and quickly, attracting rhinos and helping ensure their continued survival.

Indonesia established an additional 5,100 hectare area in UKNP called the Javan Rhino Study and Conservation Area (JRSCA) to expand the habitat for the rhinos. Rhinos move around in search of food sources and mates and will settle into a new area if both are available.

Current state of the Sumatran rhino

Population survey opportunities for the critically endangered Sumatran rhino have always been challenging. The last estimate of the Sumatran rhino in 2017 notified the world that there were fewer than 80, based on foot print counts, camera trap photos and occupancy analysis. But a new estimate and information compiled by the Asian Rhino Specialist Group (AsRSG) and wildlife trade watchdog TRAFFIC, concludes that the real number of Sumatran rhinos is just 34–47. Therefore, the world's most endangered large mammal is in perilous decline according the new estimate for 2022. The AfRSG and TRAFFIC initiated the gathering of information for a report on the population size of the Sumatran Rhino through its members in preparation of CITES CoP19 as part of the IUCN SSC AfRSG and AsRSG and TRAFFIC report entitled *The Status, Conservation and Trade of African and Asian Rhinoceros* (see next section for link). This new estimate reflects a decline of 13% of the Sumatran rhino population per year since 2017.

The majority of the Sumatran rhino population is now restricted to northern Sumatra in Indonesia. Another nine rhinos currently live in captive-breeding centres in Indonesia, where three calves have been born since 2012. See the Field note by Christopher Whitlatch and Nina

et de permettre aux plantes dont se nourrissent les rhinocéros de pousser naturellement. Ces palmiers envahissent le sous-étage et dominent la canopée en bloquant la lumière du soleil pour les autres végétaux — dont les plantes favorites des rhinocéros — et en étouffant la quasi-totalité de la vie végétale sur le sol de la forêt. De plus, leur croissance est rapide et ferme les accès à de nouveaux habitats. Peu de temps après leur suppression, la nourriture se régénère spontanément, attirant les rhinocéros et participant à leur survie.

L'Indonésie a décidé d'un espace de 5 100 hectares supplémentaires dans le parc, appelé Zone de conservation et d'étude du rhinocéros de Java (JRSCA). Les rhinocéros se déplacent à la recherche de partenaires et de nourriture et s'installent dans un nouveau périmètre si les deux éléments sont réunis.

État actuel du rhinocéros de Sumatra

En ce qui concerne ce rhinocéros en danger critique d'extinction, les études de population ont toujours représenté un défi. La dernière estimation, effectuée en 2017 et basée sur des comptages d'empreintes, des pièges photographiques et des analyses d'occupation, avait révélé un nombre « inférieur à 80 sujets ». Une nouvelle évaluation et des informations compilées par le Groupe de Spécialistes du Rhinocéros d'Asie (GSRAs) et l'organisme de surveillance du commerce d'espèces sauvages TRAFFIC concluent qu'en réalité, il se situe entre 34 et 47 individus. Par conséquent, le grand mammifère le plus menacé d'extinction au monde subit un déclin alarmant selon les données de 2022. Les membres du GSRAf et de TRAFFIC ont commencé à rassembler des éléments pour la mise en œuvre d'un rapport intitulé « *The Status, Conservation and Trade of African and Asian Rhinoceros* » (« La situation, la conservation et le commerce de rhinocéros africains et asiatiques ») traitant de la population du rhinocéros de Sumatra (voir lien ci-dessous). La nouvelle estimation révèle une chute de 13 % par an de la population de rhinocéros de Sumatra depuis 2017.

La majorité des individus de cette espèce sont désormais cantonnés au nord de l'île de Sumatra. Neuf sujets supplémentaires vivent dans des centres de reproduction en captivité, où trois petits ont vu le jour depuis 2012. Voir la note de terrain de Christopher Whitlatch et Nina Fascione intitulée « *Birth of Sumatran Rhinoceros (Dicerorhinus sumatrensis)* » relatant l'événement de la naissance d'un rhinocéros de Sumatra (Dicerorhinus sumatrensis) le 24 mars 2022

Fascione entitled *Birth of Sumatran rhinoceros (Dicerorhinus sumatrensis)* announcing the headline capturing event of the birth of a Sumatran rhino in Way Kambas NP on 24 March 2022 (see pp. 205–206).

The fragmented population of Sumatran rhinos makes it even more difficult to track and estimate the population accurately as the rhinos may have moved further into more concealed areas to avoid human induced disturbances in the rhino bearing areas. The Government of Indonesia is taking initiatives through an emergency plan to recover the Sumatran rhino and are planning to capture isolated rhinos and bring them to centralized conservation breeding facilities.

A planned facility in Aceh province of Indonesia, the third in the Sumatran Rhino Sanctuary (SRS) network, is one of Indonesia's top strategies to help prevent the species from going extinct. The new facility in particular is tailored to the sub-population surviving in the Leuser Ecosystem in northern Sumatra. The first SRS is inside Way Kambas NP in southern Sumatra, and the second is in eastern Indonesian Borneo.

Joint AfRSG, AsRSG and TRAFFIC report to CITES CoP 19

The AsRSG together with the African Rhino Specialist Group (AfRSG) and TRAFFIC has submitted its report on African and Asian rhinos—*The Status, Conservation and Trade of the African and Asian Rhinoceros*, commissioned by the secretariat of CITES pursuant to Resolution Conf. 9.14 (Rev. CoP17) for deliberations at the upcoming CITES CoP19 to be held at Panama City, Panama from 13–25 November 2022. The report may be downloaded from: https://cites.org/sites/default/files/documents/E-CoP19-75.pdf.

Side event of AsRSG at the second Asian Park Congress in Kota Kinabalu

The AsRSG organized a side event at the second Asian Park Congress held at Kota Kinabalu, Malaysia, in May 2022 on "*Sharing experience from Asian rhino conservation aspects*

dans le parc national de Way Kambas (pages 205 à 206).

La fragmentation de la population rend encore plus difficiles la reconnaissance et l'estimation précise du nombre d'individus, puisqu'ils peuvent s'être camouflés dans des zones reculées afin d'éviter les nuisances de la part des humains. Le gouvernement indonésien met en œuvre un plan d'urgence pour sauver le rhinocéros de Sumatra et prévoit de capturer des sujets isolés pour les déplacer vers des centres de reproduction.

Le projet d'une nouvelle installation, implantée dans la province d'Aceh en Indonésie et la troisième de ce type dans le réseau du SRS (Sanctuaire du Rhinocéros de Sumatra), fait partie des stratégies de pointe de l'archipel pour empêcher l'extinction de ce groupe. Ce nouveau dispositif en particulier est adapté à la sous-population qui survit dans l'écosystème de Leuser au nord de Sumatra. Le premier SRS est situé au sein du parc national de Way Kambas dans le sud de Sumatra et le deuxième est établi dans l'est de Bornéo.

Un rapport conjoint GSRAf, GSRAs et TRAFFIC pour la 19e CdP de la CITES

Le GSRAs, avec le Groupe de Spécialistes du Rhinocéros d'Afrique (GSRAf) et TRAFFIC, ont soumis un rapport sur les rhinocéros d'Afrique et d'Asie intitulé « *The Status, Conservation and Trade of the African and Asian Rhinoceros* ». Le compte-rendu a été commandé par le secrétariat de la CITES, conformément à la résolution Conf. 9.14 (Rev. CoP17) pour délibération à la 19e CdP de la CITES qui se tiendra à Panama City du 13 au 22 novembre 2022. Il peut être téléchargé via le lien suivant : https://cites.org/sites/default/files/documents/E-CoP19-75.pdf.

Événement du GSRAs en marge du deuxième congrès des parcs naturels d'Asie à Kota Kinabalu

Le GSRAs a organisé un événement en marge du Congrès des parcs, qui s'est tenu en mai 2022 à Kota Kinabalu (Malaisie). La réunion, sur le thème « *Partage d'expérience sur les aspects de la conservation du rhinocéros asiatique permettant une gouvernance effective dans les zones de préservation et les espaces protégés* », a rassemblé les responsables des zones protégées des États de l'aire de répartition du rhinocéros asiatique.

aiding effective governance in protected and conservation areas" which was attended by Asian rhino range States protected area managers.

Third Asian rhino range States meeting

The third Asian rhino range States meeting shall be held in Chitwan NP of Nepal from 3–5 February 2023 which is being hosted jointly by the Department of National Parks and Wildlife Conservation, Government of Nepal, in association with the AsRSG. The purpose of this meeting is:

1. To facilitate information sharing and to promote collaboration between range States to raise the level of political commitment to save the three species of Asian rhino.
2. To agree on specific priorities and measures to conserve the three Asian rhino species effectively.

It is worth mentioning here that the first Asian rhino range States meeting was held in Bandar Lampung, Indonesia, in October 2013 and the second Asian rhino range States Meeting was held at New Delhi, India, in February 2019.

Join the AsRSG Facebook page here: https://www.facebook.com/asianrhinospecialistgroup

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

Cette réunion se tiendra dans le parc national de Chitwan au Népal, du 3 au 5 février 2023, et est organisée conjointement par le GSRAs et le département des parcs nationaux et de la conservation des espèces du gouvernement népalais. Les objectifs de cette table ronde sont les suivants :

1. Faciliter le partage d'informations et promouvoir la collaboration entre les États de l'aire de répartition afin d'élever le niveau d'engagement politique dans le sauvetage des trois espèces de rhinocéros d'Asie.
2. Trouver un accord sur des priorités et des mesures spécifiques pour une conservation efficace des trois espèces de rhinocéros d'Asie.

Il faut préciser que les premières réunions s'étaient tenues à Bandar Lampung (Indonésie) en octobre 2013 et à New Delhi (Inde) en février 2019.

Abonnez-vous à la page Facebook du GSRAs : https://www.facebook.com/asianrhinospecialistgroup peuvent ne pas être surveillés individuellement).

RESEARCH

The Gorongosa elephants through war and recovery: tusklessness, population size, structure and reproductive parameters

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Abstract

How does an elephant population recover after being pushed to the brink of extinction? In this and a separate paper on behaviour we present an account of war-induced collapse and post-war recovery of an elephant population. Mozambique's 15-year civil war from 1977–1992 had a profound impact on the elephants of Gorongosa National Park. Elephant numbers plummeted from ~2,200 pre-war to <200 post-war impacting the structure of the population and its families, the physical appearance of the elephants, their genetic make-up and behaviour (companion study). Using individual registration, this study aimed to collect baseline data to estimate the population size, reproductive parameters and growth and to document its composition, including age and sex structure, tusk configuration, family and clan membership. A quarter of a century after the war, rapid reproductive rate and growth in numbers are indications of recovery, but the skewed sex ratio among older age classes and the prevalence of tusklessness in post-war generations are evidence of long-lasting scars.

Additional Keywords: Age at first birth, inter-calf interval, growth rate

Résumé

Comment les populations d'éléphants parviennent-elles à se rétablir après avoir été poussées à la limite de l'extinction ? Dans ce document — et dans une seconde publication traitant du comportement — nous présentons un compte-rendu de la chute du nombre d'individus provoquée par le conflit au Mozambique, puis de son rétablissement au lendemain de la guerre. Les quinze ans de guerre civile de 1977 à 1992 ont eu de profondes répercussions sur les éléphants du parc national de Gorongosa. Près de 2200 avant la guerre, leur nombre a chuté en deçà de 200, affectant la structure de la population et les familles qui la composent, l'apparence physique des éléphants, leur constitution génétique et leur comportement (étude parallèle). À l'aide de la reconnaissance individuelle, la présente étude a pour objectif de collecter des données de référence afin d'estimer la densité de cette population, ses paramètres de reproduction et sa croissance. Il s'agit également d'en documenter la composition, notamment la répartition des âges et des sexes, la configuration des défenses, la famille et l'appartenance au clan. Un quart de siècle après la guerre, le taux de reproduction rapide et le nombre croissant d'individus sont des indicateurs de rétablissement, mais un rapport des sexes déséquilibré parmi les classes d'âges les plus avancées et l'absence de défenses dans les

générations nées après la guerre sont les preuves de séquelles durables.

Mot-clés supplémentaires: âge de la première naissance, intervalle entre les naissances, taux de croissance

Introduction

War and other forms of human conflict can disturb ecosystems and cause severe biodiversity loss (Dashkin and Pringle 2018). African elephants (*Loxodonta africana, L. cyclotis*) are particularly vulnerable due to their dependence on large areas of suitable habitat, relatively small population sizes, and long generation times and because of the value of their tusks (Beyers et al. 2011). Killing for ivory, often during civil conflict, has caused catastrophic declines in many savannah and forest elephant populations (Blanc et al. 2007).

Demographic data based on long-term studies of known individuals are critical for evaluating what conservation interventions might be effective in these cases and for estimating time to recovery. While highly valuable, few such studies exist due to the logistical difficulties and lengthy commitment required. Given the number of elephant populations affected by poaching, these studies (e.g. Foley and Faust 2010, Moss and Lee 2011, Wittemyer et al. 2013, 2021, Turkalo et al. 2017, 2018) provide invaluable data on the reproductive responses of elephants to environmental perturbances, such as poaching for ivory. Savannah elephants (*L. africana*) in Tarangire NP (Foley and Faust 2010) and Samburu NR (Wittemyer et al. 2013), for example, showed greater reproductive effort following periods of heavy poaching, while the 31-year generation time documented by Turkalo et al. (2018) in forest elephants (*L. cyclotis*) predicts very slow recovery of populations of this savannah species.

Tusk growth is sexually dimorphic and continues through most of an elephant's life (Laws 1966). Thus, the selective removal of elephants with larger tusks means that heavily poached populations are characterized by relatively few individuals in older age classes and the sex ratio of these individuals skewed toward females (Poole 1989, Wittemyer et al. 2013, 2021, Jones et al. 2018). One consequence is that during recovery, such female bias can drive faster population growth (Slotow et al. 2005).

Another characteristic of populations heavily hunted over time for ivory, is the prevalence of elephants without tusks. Tusklessness occurs naturally; however, high frequencies of tuskless and one-tusked elephants can represent markers of historical loss (Poole 1989, Jones et al. 2018, Campbell-Staton et al. 2021). Due to tusk inheritance patterns consistent with an X chromosome-linked dominant male-lethal trait (i.e. males who are homozygous for the tuskless gene are presumed to die in utero), tuskless individuals are almost entirely female (Campbell-Staton et al. 2021; Poole 1989). For example, Campbell-Staton et al. (2021) illustrated that killing for ivory during Mozambique's civil war resulted in strong selection that favoured tusklessness in females amid rapid population decline. Assessment of historical footage showed that prior to the war 18.5% of adult females were tuskless (n=54), while among survivors of the war the percentage of tuskless females had increased to 50.9%.

In 1972 Gorongosa National Park (GNP), in central Mozambique, held ~2,200 elephants ranging across 3,674 km^2 of protected habitat (Tinley 1977). Together with the surrounding area and the Marromeu area of Zambezi River delta there were an estimated 6,000 elephants (Tinley 1977). In 1977 Mozambique was plunged into a 15-year civil war during which hostilities raged in and around GNP and >90% of the elephant population was extirpated. An aerial survey of the Gorongosa–Marromeu Complex in 1994 estimated only 108 elephants remained, these all within GNP (Cumming et al. 1994).

In 2004 a public–private partnership between the Mozambiquan government and the Greg Carr Foundation was established to restore GNP and began to provide Gorongosa's elephants and other wildlife with protection and stability. Almost three decades after the war elephant numbers are beginning to recover, but the enduring consequences of the violence perpetrated is still visible in the elephants' markedly changed distribution (Stalmans and Peel 2020), degree of tusklessness and underlying genetic make-up (Campbell-Staton et al. 2021), diel activity patterns (Gaynor et al. 2018) and individual and group behaviour (Poole and Granli. In press).

From 2011–2019 we carried out nine month-long field trips to GNP. We used individual registration to document the status of Gorongosa's elephants, to better understand the war's impact on the population and to provide scientific data to help guide strategic conservation measures towards recovery. Almost three decades post war Gorongosa's female elephants were unusually fearful of and aggressive towards vehicles, as we describe in a separate manuscript. (Poole and Granli. In press). In this paper we examine tusk configuration and the prevalence of the tuskless trait across families, age cohorts and generations; population age structure and reproductive parameters; estimated population size and growth. The dense habitat of Gorongosa makes counting elephants challenging and, at different intervals, aerial surveys have indicated both very slow and very explosive growth. We compare our estimates of population size based on individual registration with those achieved through aerial total counts. Based on previously published research and our studies of other populations we predicted: i) older ages classes (survivors of the war) to be skewed toward females; ii) tuskless and one-tusked individuals would be limited almost entirely to females; iii) be more prevalent in some families than in others; iv) be more prevalent among survivors who were adults during the war than among those who were born during the war; v) decline in frequency from the first to second post-war generations; vi) population growth rate to be high; and vii) our estimates of population size to be greater than the those derived from aerial total counts.

Methodology

Study site

GNP covers 3,674 km^2 of Sofala Province, Mozambique. Elephants historically ranged throughout GNP and in the Marromeu area (includes hunting blocks and the Buffalo Reserve) of the Zambezi River delta to the east. After the war (which ended in 1992), 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 settlement south of the Pungue. In recent years there is evidence (dung, footprints, collared elephants) that the Gorongosa elephants are expanding their range again. Separately, there are an estimated 350 elephants in the Marromeu area (Beilfuss et al. 2010). While there is little evidence of regular movement between the two areas, ongoing efforts to restore the greater ecosystem could change that.

Within GNP fifteen 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). Mean annual rainfall is 700–900 mm, with peak rain falling from December to February during which the floodplains around Lake Urema are inundated (Stalmans et al. 2019). By May the roads are usually dry enough to use, although tall grass makes observations difficult. 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). We undertook two field trips in May (5/2015 and 5/2016), but due to better visibility, most of our visits to GNP were in the late dry season (08/2011, 10/2012, 10/2013, 10/2015, 10,11/2016, 10/2017, 10/2019).

Area covered

Due to the thick vegetation our search for elephants was largely limited to the extensive network of roads in the south-central section of GNP (Fig. 1). We used an iPhone app, GPS-Trk2, to record the routes we drove.

Sightings

We collected sightings data via the Gorongosa *EleApp* and uploaded the information to the *Gorongosa Elephants Who's Who & Whereabouts Database* (see Granli and Poole 2022). Sightings consisted of: date, time, location, group type (*family group, family group with associating adult males, all-male group or unknown*), number of individuals, count accuracy (*exact, good estimate or guess*), name of individuals and families present when they could be identified (see below), the presence of musth males and oestrous females, and the occurrence of wounded individuals and mortalities (Granli and Poole 2022). Recording an individual as present depended on it being seen or photographed, which was influenced by the elephant's physical appearance, age and behaviour,

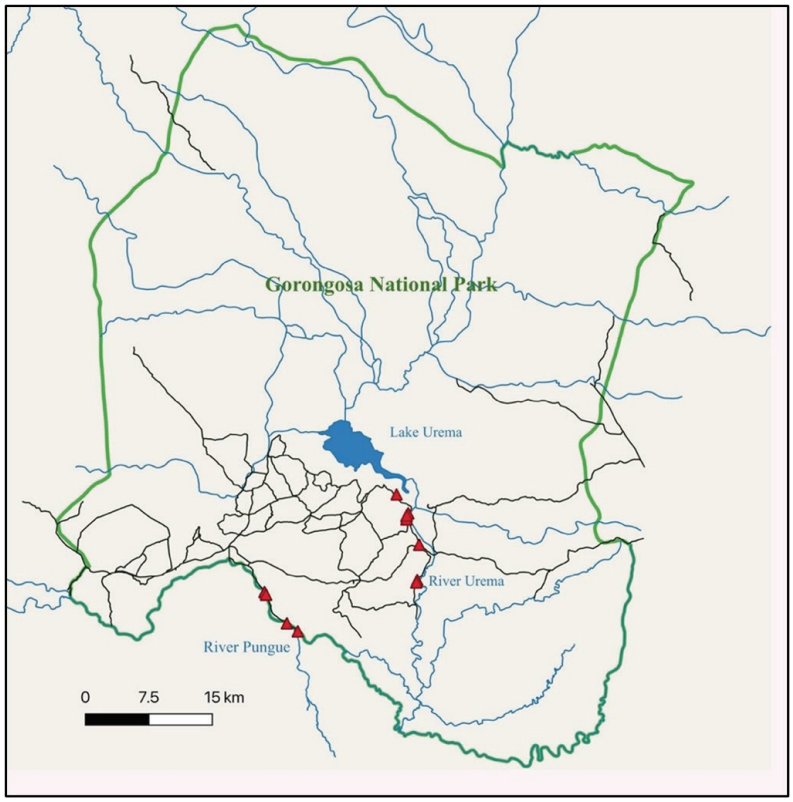

Figure 1. Map of Gorongosa National Park. Blue: Lake Urema, permanent rivers (Urema and Pungue) and seasonal waterways; black: dirt roads; red triangles: positions of trail cameras. (*Map drawn by author JP using QGIS*).

and the observer's skill. Large, demonstrative individuals with characteristic features were more likely to be documented. Groups could represent any number of individuals of either or both sexes in which individuals were coordinated in activity and movement direction, and where no member of the group was located further than the diameter of the aggregation. Detailed field notes on the age, sex and behaviour of individuals were recorded into an iPhone and later transcribed into the uploaded sightings record. The database contains 879 sightings records collected by the authors (n=375), other scientists (n=108), park management officers (n=183), experienced guides (n=207) and tourists (n=6). We specify when we have relied on subsets of these data.

Trail cameras

The Pungue River forms the southern boundary of GNP. A single track runs along the river through dense habitat. Across the river communities are engaged in subsistence agriculture. To monitor the frequency, approximate number, group type and identity of individual elephants using this inaccessible part of the Park, crossing the river and entering farms, we set up a series of Bushnell HD trophy cameras along the Pungue River (May–October 2015: DD01, DD02, DD03; May–October 2016: DD01, DD03, DD04, DD05; October 2017: DD01, DD05) and along the Urema River (October 2016: UR01, UR02, UR03; May 2017 UR04, October 2017 UR05, UR06, UR07, UR08). Fig. 1 shows the locations that we placed cameras.

We entered information collected via cameras into the *Gorongosa Elephants Who's Who & Whereabouts Database* as trail camera sightings in the same manner as sightings (Granli and Poole 2022). We took the date and time of each group from the timestamp of the first elephant photographed. We attempted to mirror how we might score a group in a sightings context, defining individuals as belonging to a group if they were photographed within 15 minutes of one another (Gaynor et al. 2018). We noted the group type, counted

individuals, and entered a count accuracy. Since we were not able to know whether we had photographed every elephant *exact count* was never used. We identified as many elephants as possible and registered new individuals (see below).

Since almost all Pungue trail camera images were infrared photographs taken at night, identifying elephants was time consuming. We have yet to analyse trail camera data after 2016, but photographs from 2017 reveal new individuals and an unregistered family. The database contains 550 trail camera sightings.

Registration and reidentification of elephants

We photographed elephants for individual identification and behaviour with a Canon 6D and a 200-400mm lens with a built-in 1.4 extender (279 groups; ~30,700 photographs) or Bushnell HD Trophy Cameras (550 groups; ~98,000 images). Not all elephants in a group were photographed nor could all be identified. Among adults, young females were less likely to be photographed and registered due to their smaller size and less prominent role in group defence and, therefore, we underestimated them relative to older females and males of the same age.

Each clearly visible adult was checked against already registered elephants by searching a selection of features (e.g. sex, age, tusk configuration, ear notches, tears and holes) in the *Gorongosa Elephants Who's Who* (Granli and Poole 2022). Known individuals were added to the already uploaded sighting. New elephants were registered (Granli and Poole 2022) and added to the sighting. All photographs containing known individuals were key worded with their ID codes.

Elephants were aged according to methods developed in Amboseli (Moss 1996) and analysed within five-year categories. We counted as adults those estimated to be 15+ years. Ageing males is easier than ageing females due to the greater variability in their body size and changes in face contour as tusks become thicker. Ageing GNP females was especially difficult because so many lacked tusks. We included a level of accuracy ranging from +1 month – +10 years, with ages of younger elephants more accurate than older elephants.

Tusk configuration

Tusk configuration (two tusks, one left, one right or no tusks) was coded into our database as part of the registration of each adult elephant. We also noted tusk configuration for the putative offspring of registered adult females. These data were available only for offspring whose tusks had erupted (males:>1.5 yrs; females > 2 yrs) and who were less than five years old when first recorded.

Assigning family membership

We assigned registered adult females to a family with a qualifying level of accuracy (*unknown* if no family could be assigned or *guess, good idea* or *known*). We typically assigned an individual to a family at the level of guess. As our knowledge of that individual grew, we increased the level of accuracy. We considered as belonging to a family those individuals who maintained consistent friendly association with each other, and whose movements were influenced by the oldest female or matriarch. Typically, families contained males prior to dispersal age (<12), as well as immature and other reproductively active females. We used *known* for the matriarch who defined the family, for adult females who were consistently seen with her and for the immature offspring of these individuals. Each Gorongosa family was referred to by a one- or two-letter code. We tended to "lump" regularly associating individuals into families and then "split" them if subsequent observations indicated that they belonged in separate families.

Assigning clan membership

The preferred dry season distribution of elephants can be roughly delineated by areas within ~6 km of permanent water (Kuloba et al. 2010). Within the southern portion of the park used by elephants, suitable dry season habitat lay a) around Lake Urema and either side of the upper Urema River; and b) along the northern side of the River Pungue and either side of the lower Urema River (Fig. 1). For each registered female we calculated how many times she had been sighted within ~6 km of one of these two permanent water systems. We classified those elephants with 90% of their dry season sightings within 6 km of a) as belonging to the Urema clan and those with 90% of their dry season sightings (trail cameras) in the vicinity of b) as the Pungue clan.

Determining intervals between successive calves and age at first birth

Intervals between successive calves were determined in two ways: a) When elephant families were in the open and calves visible we made note of the estimated age and sex of calves suckling or closely following their presumed mothers; b) we went through ~30,700 photographs of 279 groups trail camera images (~98,000) of 550 groups, and 5 TB videos looking for any calves who appeared to belong to known individuals (i.e. a female seen caressing or helping calf, calf suckling, following closely in the video or successive photographs, or standing by her side in images from different dates). The age of each calf was estimated, and the sex was determined where possible. Since we did not have accurate mortality records, the intervals derived cannot be considered inter-birth intervals in the normal use of the term, as some calves may have died without being recorded.

We noted young females with budding breasts, indicating a first gestation. Females in the youngest adult age classes (10–20) followed by single calves were given an estimated age at the birth of their known calf, with a ~6 month–1 year error. Age at first birth represent best estimates based on many years of experience ageing elephants.

Estimating population size and growth

To calculate the minimum number of elephants in the population from January 1994 to December 2002 we used the estimated year of birth of registered individuals. For example, based on the estimated ages of registered elephants we calculated that there were at least 161 elephants alive during the first post-war aerial survey in 1994 rather than the 108 counted by Cumming et al. (1994). Since we registered very few individuals under 15 years old, the accuracy of this method declined for elephants born after 2002. Instead, for elephants born between January 2003 and December 2019, we used our findings of an age of first birth of ~14 years and an inter-calf interval of three years to calculate additions to the population by assuming that ⅓ of registered adult females gave birth each year. These estimates fit closely with those we made in 2017 and 2019 by using the number of registered adults and an estimated number of immatures (calculated from a known 2.4:1 immature to adult female ratio). The figures do not take mortalities into consideration, nor do they account for remaining unregistered individuals.

We compared our figures to counts of elephants from aerial surveys (Tinley 1977; Cummings et al. 1994; Stalmans 2012; Stalmans et al. 2014; Stalmans and Peel 2016; Stalmans et al. 2018; Stalmans and Peel 2020).

Results

Elephant groups

The Gorongosa Elephant DB holds 1,429 records of elephant groups (sightings n=879, trail camera sightings n=550), of which 574 were all-male, 790 were one or more families with (n=286) or without (n=504) associating males and 65 were of unknown type. Using only data we collected, the median size of all-male groups was 2 (IQR=1–3, range=1–17, n=300), that for groups with one or more families present was 10 (IQR=8–15, range=2–60, n=297) and that for one or more family groups with associating males was 20 (IQR=12–34, range=4–00, n=168).

Individuals registered and age/sex structure

We registered the identities and estimated the ages of 396 elephants: 194 adult females and 142 adult males. In support of our first prediction, among elephants who lived through the civil war (those estimated >30 years), the population was heavily biased toward females (Fig. 2).

Elephant families and clans

We assigned identified females and their immature offspring to 27 putative families based on their association. As expected, due to ranging strategies and observer confidence, some adult females were recorded relatively frequently, while others were not (median=4, IQR=2–10, range=1–40, N=179 females >15 years in 2017). The median number of records was > 10 for all adult female members in only five families (C, D, I, M, V).

Trail cameras were instrumental for documenting families whose range was not easily accessible by vehicle or who were only in the vicinity of roads at night (Gaynor et al. 2019). Our knowledge of the Urema clan was almost solely based on photographs of individuals from the road network, while our understanding of the Pungue Clan was primarily based on data gleaned from trail cameras set along the Pungue River (Fig. 3). Elephants documented by trail cameras along the

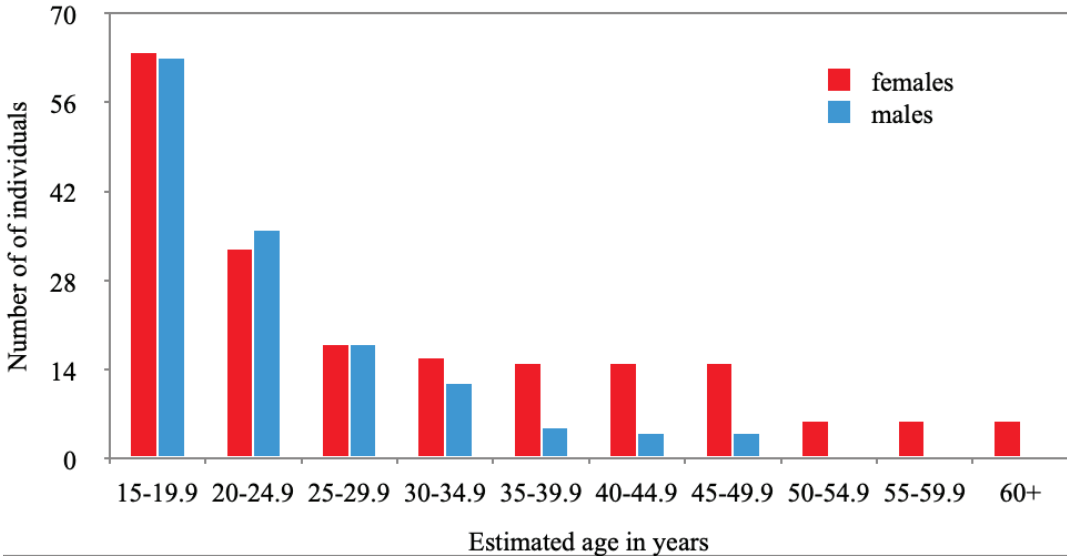

Figure 2. The age sex structure of registered adults >15 years of age in 2017.

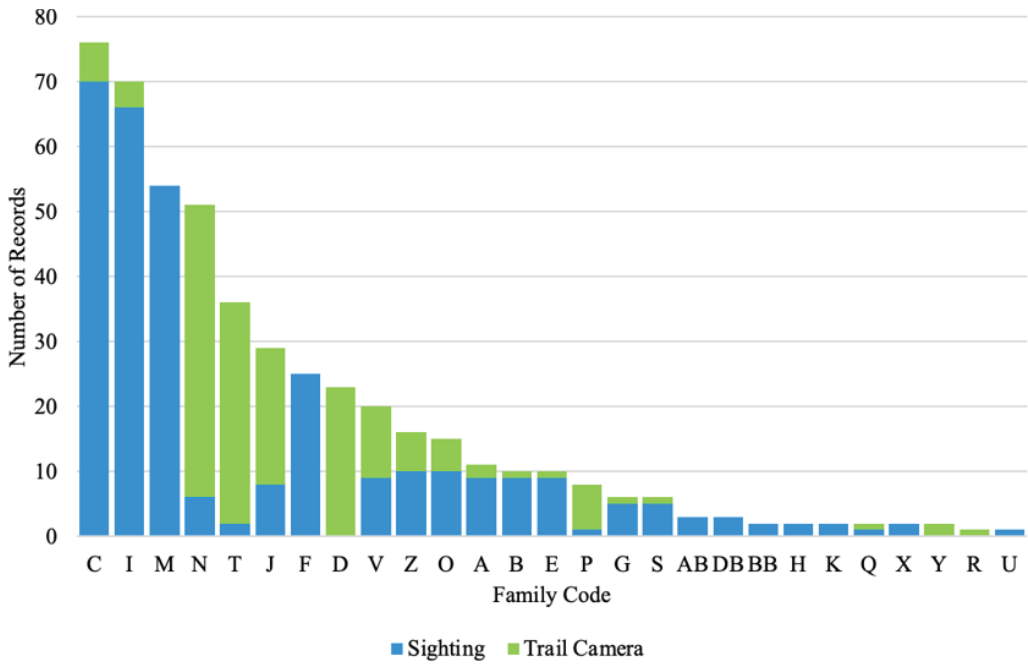

Figure 3. Frequency distribution illustrating the number of times families were recorded by regular sightings or via trail camera photographs (data up to end 2017).

Pungue River were unlikely to be sighted in the vicinity of Lake Urema and vice versa.

Tusk configuration by sex and across families, female age cohorts and generations

We examined tusk configuration and the pervasiveness of the tuskless trait across families, age cohorts and generations, since tuskless and one-tusked individuals can represent markers of historical loss and fragmentation of families and can, therefore, indicate population disruption and possible recovery.

In support of our second prediction, all tuskless individuals were female and one-tusked individuals were more common among females than among males. Across adult females 43% were tuskless and 8.7% were one-tusked (N=194), while among adult males none were tuskless and only three (2%) were one-tusked, although a fourth was documented to lose a misshapen right tusk (N=142).

The majority of families contained tuskless females. Among the 27 putative families only six did not contain tuskless or one-tusked females and only one of these (D) was known well enough to be sure that all were two-tusked (Fig. 4). The tuskless and one-tusked trait was more prevalent in some families than in others. In seven families over 70% of adult females were either tuskless or one-tusked.

Prior to the war 68.5% of adult females were two-tusked (n=54; (Campbell-Staton et al. 2021). In support of our fourth prediction, only 31% (n=39) of female survivors who were born prior to the war had two tusks, while among the cohort of females born during the war 42% (n=24) were two-tusked.

Among the first generation born after the war (daughters of survivors) 58% (n=120) were two-tusked (Fig. 5). Since tuskless females produce equal numbers of tusked and tuskless female offspring and tusked females produce predominantly tusked female offspring (see below), we expected to observe an increase in the proportion of two-tusked female offspring among the second generation. However, contrary to our expectations, we found the proportion of two-tusked females remained the same (57%; n=23).

For daughters whose mother accuracy was categorized as *known* or *highly likely* we examined tusk configuration of 81 mother-daughter pairs (mothers: 21 two-tusked, 7 one-tusked, 32 tuskless). Two-tusked mothers produced almost entirely two-tusked daughters and only rarely one-tusked or tuskless daughters. Tuskless mothers produced 42% two-tusked, 14% one-tusked and 44% tuskless daughters (Fig 6). The sample of one-tusked mother-daughter pairs was small (n=8), but 75% of daughters were two-tusked.

Intervals between successive calves

The interval between successive surviving calves ranged from 2 to16 years. We truncated the intervals at eight years as it is highly likely that those longer (n=5) represent mortalities (i.e., calves that were not recorded). The median interval between calves was three years (IQR: 2–4; range: 2–8; N=124; Fig. 7). Remarkably, almost a quarter of all recorded intervals between successive calves was less than 2.5 years. Taking the inter-calf intervals of the I family for which we had the best records over time and using only those intervals recorded between 2011 and 2019 (n=18), the median inter-calf interval was 2.5 years (IQR: 2–3; range: 2–4). Between 2009 and 2018 one adult female, Iria, produced 5 calves, thus conceiving within a couple of months of giving birth.

The breasts of Gorongosa mothers appeared fuller than those we have observed elsewhere, and it was not uncommon to observe mothers double-suckling their calves of rather similar size (Fig. 8). Juveniles of six and even seven years of age were also observed to suckle. In 2017 we observed Iria suckling her three different aged offspring and, on one occasion, we observed three calves alternatively suckling from two different mothers. Shared suckling of different calves by lactating mothers has only rarely been observed elsewhere, and then typically occurring between grandmothers and grand-calves.

Age at first birth

Females observed with what we presumed were their first calves ranged from an estimated 10–17 years. The median age at first birth was 14 years (IQR: 13–14; N=45; Fig. 9). The median estimated age at first birth in the family with best records (I) was 14 years (IQR: 12.5–14; range: 11–16; N=8). It is quite possible that females with a recorded first birth at 15+ years may have had first calves at a younger age that died without being recorded.

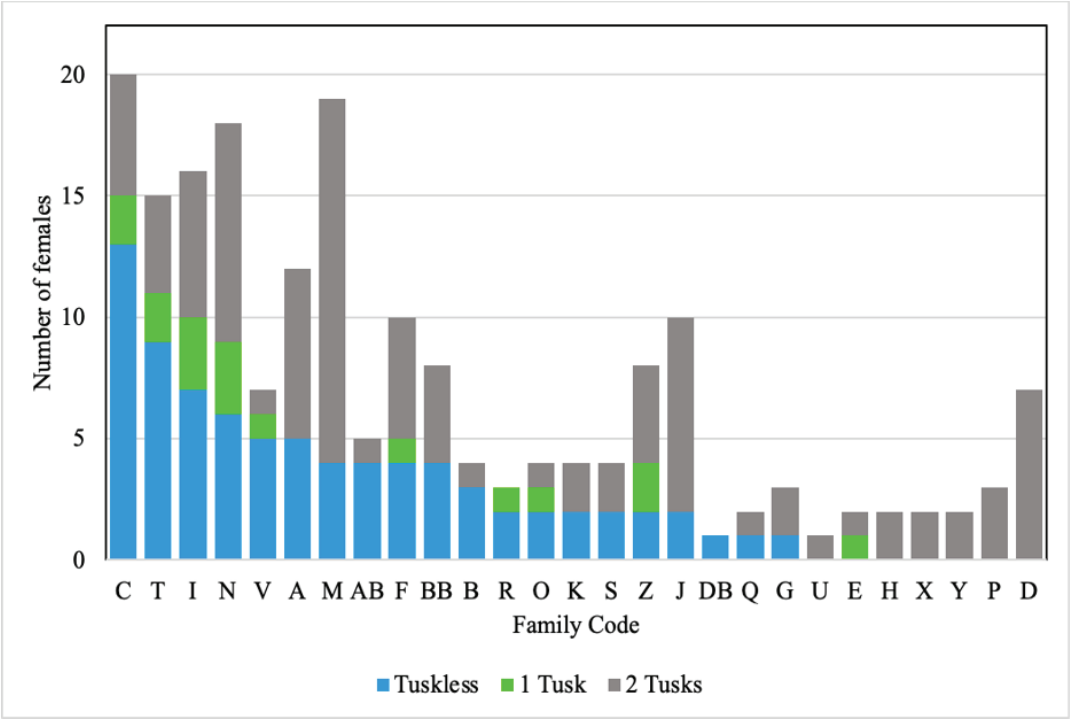

Figure 4. Frequency of two-tusked, one-tusked and tuskless females by family.

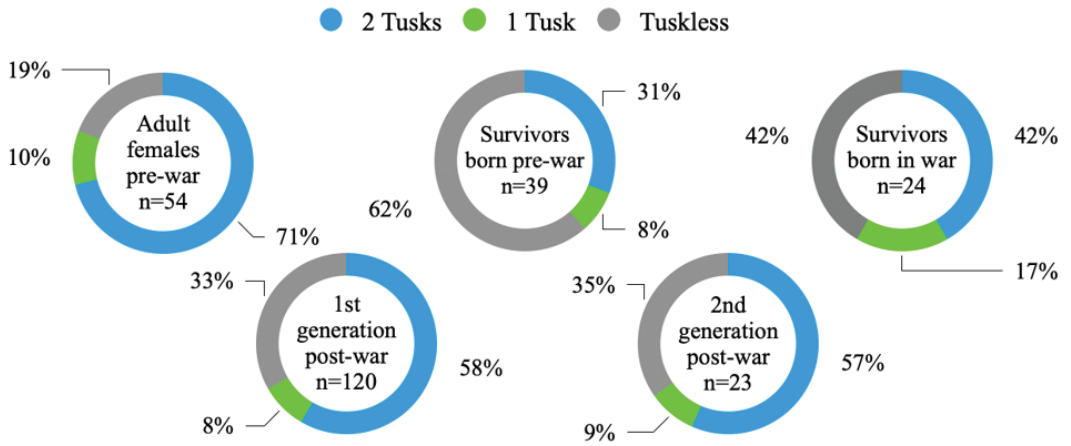

Figure 5. Generational and cohort shifts in tusk configuration.

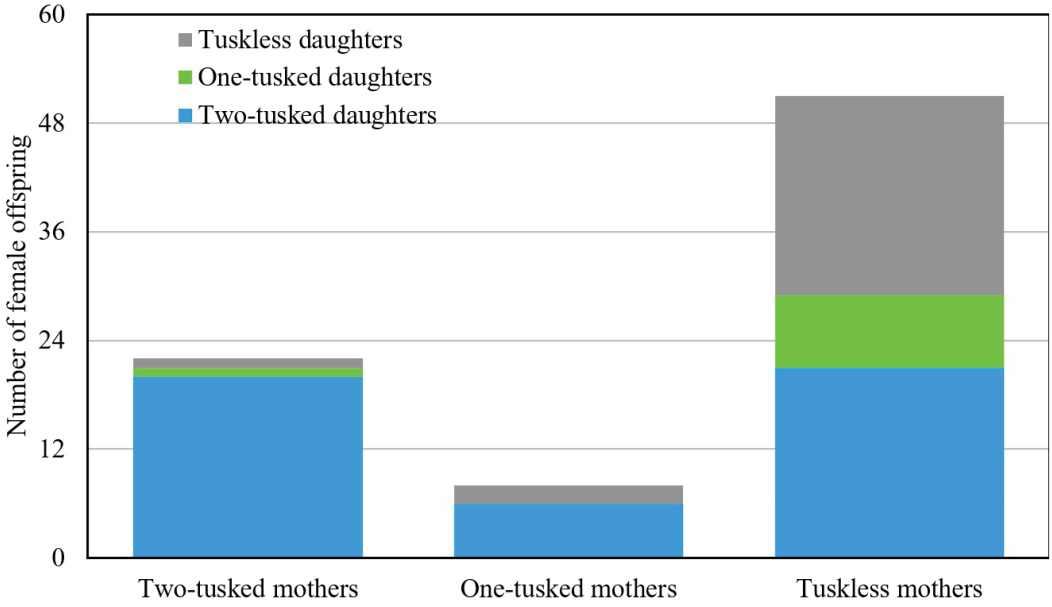

Figure 6. Tusk configuration of mother-daughter pairs.

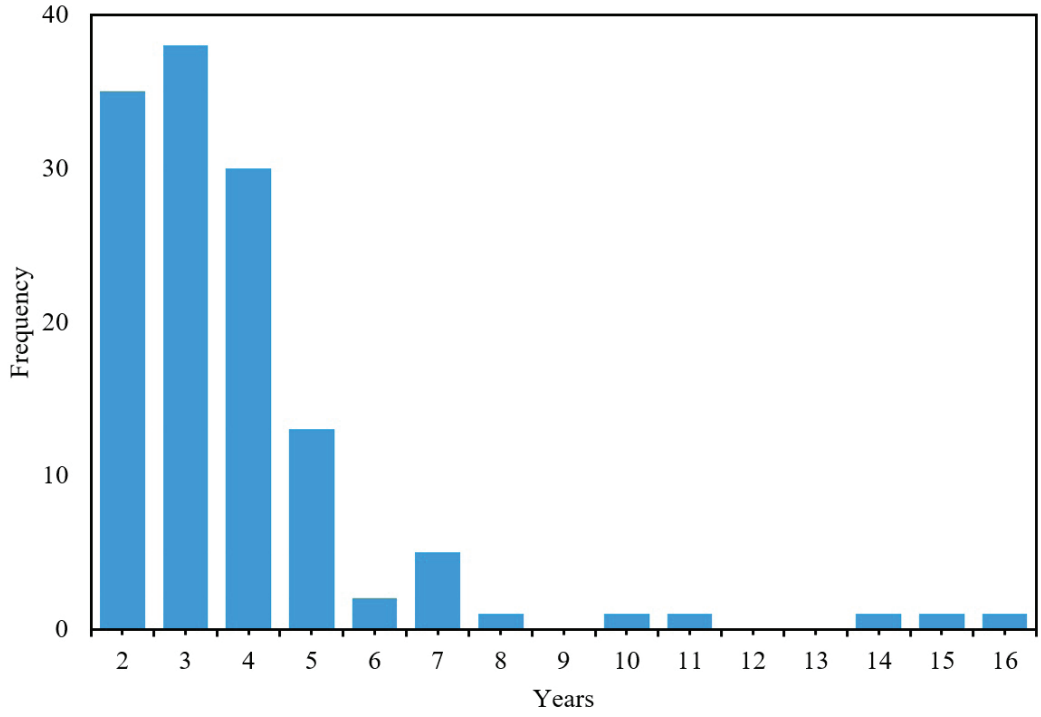

Figure 7. Inter-calf interval.

Figure 8. Isabella of the I family suckles two calves, a female age 3 and a male 5. (© *ElephantVoices*)

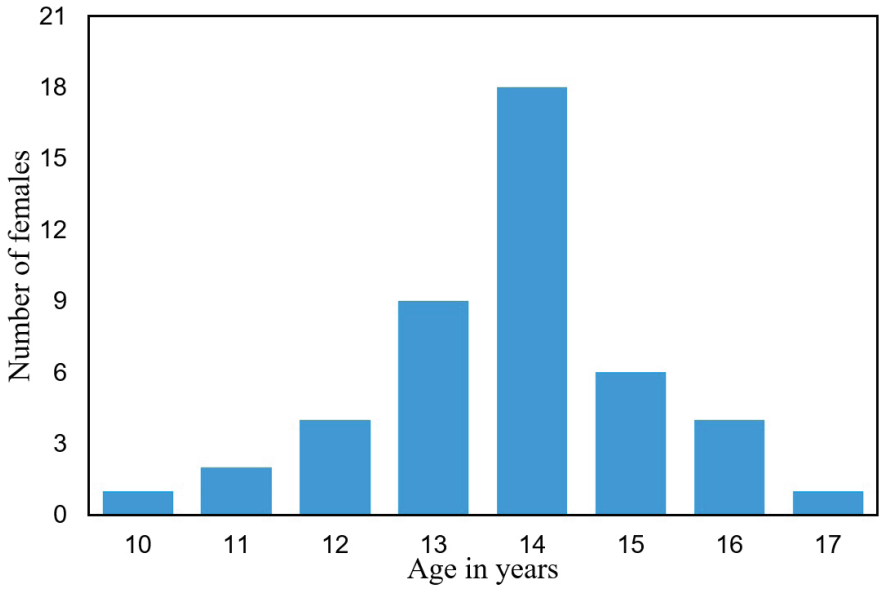

Figure 9. Age at first birth.

Injuries and mortalities

We recorded 38 injuries between 2011 and 2020, 28 caused by snares. Snares were observed around the necks or legs of calves, often leading to death, whereas older elephants were observed with severed or cut trunks and survived. Two adult males with bullet wounds had to be euthanized. There was a surprising number of lame elephants (N=8). While some were likely due to old snare injuries, four were permanently lame apparently with broken or dislocated bones (Fig. 10).

Rangers recorded 24 mortalities between 2014 and 2020. We deduced a further four mortalities from missing individuals. Of these 28 deaths, 14 were illegal (seven adult males were shot, seven calves succumbed to snares), two were natural and 12 were due to unknown causes (Fig. 11). Carcasses were concentrated near the Pungue River park boundary.

Population size and growth

Our estimates of population size based on individual registration fit best with elephant numbers derived from a 9% growth rate from 1994 to 2007 declining to 7% thereafter (Fig. 12). We illustrate our population estimates against aerial surveys carried out in Gorongosa, which were a mix of sample and total counts from fixed-wing aircraft and helicopter.

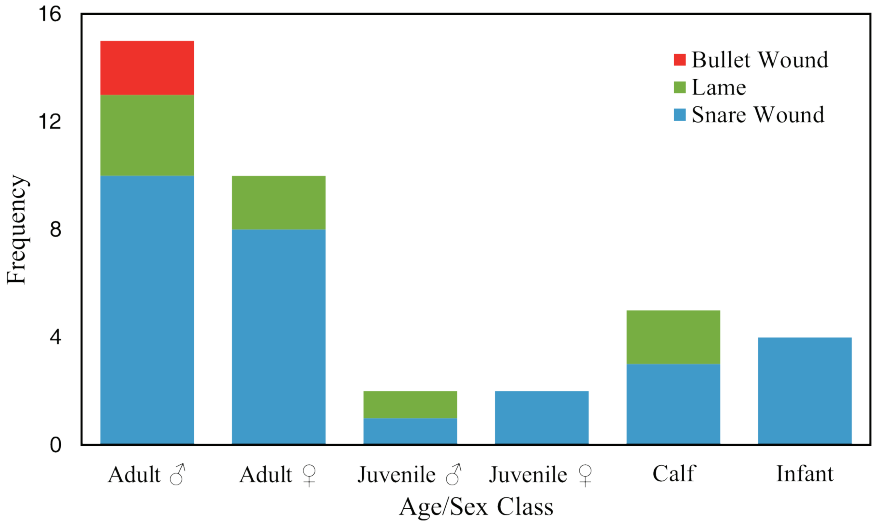

Figure 10. Types of injuries by age/sex class recorded between 2011 and 2020.

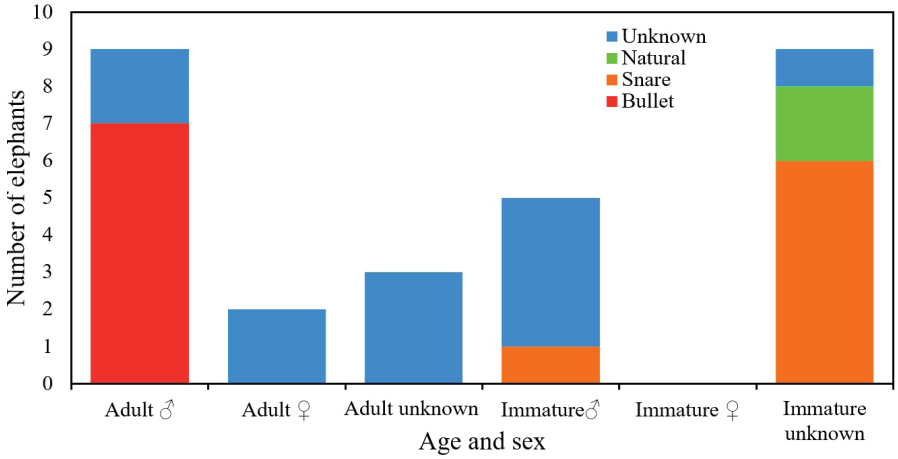

Figure 11. Number and causes of mortality recorded between 2014 and 2020.

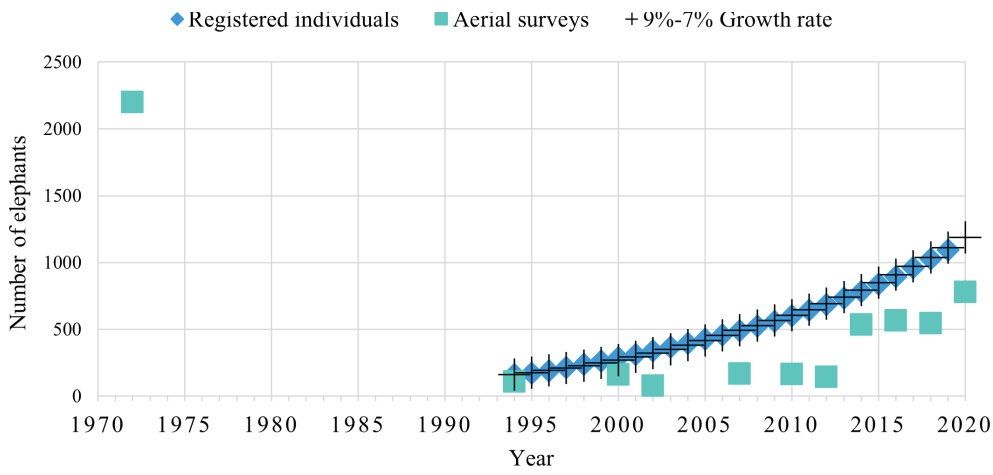

Figure 12. Population size and growth comparing numbers of elephants counted in aerial surveys with our estimates based on registered individuals. The latter fit best with elephant numbers derived from a 9% growth rate from 1994 to 2007 and a 7% growth rate thereafter.

Discussion

Armed conflict in Africa has been associated with wildlife declines of varying degree depending on its frequency and severity (Daskin and Pringle 2018). Elephants are particularly vulnerable due to human demand for ivory and meat, their large-scale habitat needs and long generation times. Mozambique's 15-year civil war had a profound and lasting impact on the Gorongosa elephant population. More than a quarter of a century after the war the population's sex ratio, age structure, and prevalence of tusklessness still bore the hallmarks of killing for ivory.

Like other heavily poached populations (Poole 1989, Wittemyer et al. 2013, Jones et al. 2018) there were relatively few elephants in the older age classes and the sex ratio among individuals over 35 years old was heavily skewed toward females. There were no males over age 50.

As has been documented in other poached populations (Poole 1989, Jones et al. 2018), the selective killing for ivory favoured tusklessness among female survivors. From analysis of historical Gorongosa footage we know that prior to the war a relatively high percentage of Gorongosa females (19%) were tuskless (Campbell-Staton et al. 2021). This was likely due to long exploitation of the population for ivory, first by Indian and Arab traders as early as 1200, followed by the Portuguese in the 1500–1600s (Tinley 1977) and then by slave traders in the 1700–1800s (Machado 2014). In the early 1900s trophy hunters commented on the poor quality of tusks and the presence of tuskless elephants (Vasse 1909). During the war, killing for ivory drove rapid population decline and strong selection favouring tusklessness in females (Campbell-Staton et al. 2021). In this study we found the prevalence of the tuskless trait among female survivors varied by age. Among older female survivors tusklessness increased to 62% (31% two-tusked, 8% one-tusked), while among the cohort of females born during the war, who would have had smaller tusks and therefore been less vulnerable to those killing for ivory, the tuskless trait was 42% (42% two-tusked, 17% one-tusked). Tusklessness among the female offspring born to these survivors remained elevated (35%), indicating a heritable genetic basis for tusklessness and an evolutionary response to poaching-induced selection in Gorongosa (Campbell-Staton et al. 2021).

Our data revealed that tuskless mothers produced near equal numbers of two-tusked (42%) and tuskless (44%) daughters, while 14% were one-tusked. Seventy-five percent of female offspring of one-tusked mothers were two-tusked and 91% of female offspring of two-tusked mothers were two-tusked. These data indicate that the proportion of tuskless females should, theoretically, decline with each generation. We, therefore, expected fewer tuskless females in the second generation post-war. In contrast, the proportion of tuskless females in the second generation remained equally high at 37%, although our sample size was

small (N=23) and tuskless (n=12) and one-tusked (n=3) mothers dominated the sample.

The estimated age of first birth of 14 years was higher than the average 11.2 years reported from Tarangire NP (Foley and Faust 2010) or 11.3 years from Samburu NR (Wittemyer et al. 2013), but not dissimilar to that recorded in Amboseli NP (Moss and Lee 2011) and the 13.4 average across 12 populations compiled by Wittemyer et al. (2013). Since younger age at primiparity has been associated with recovering populations (Wittemyer et al. 2013) and with periods of lower nutritional stress (Moss and Lee 2011), we expected to record a younger age at first birth. It is possible that we overestimated the ages of young females, but due to the high number of tuskless individuals our concern was, instead, that we underestimated their age. It is also possible that some of the females recorded with an age of first birth of between 15 and 17 years of age had had a previous calf that died unrecorded.

Gorongosa's average three-year inter-calf interval was lower than Amboseli NP's 4.2 years (Moss and Lee 2011), Samburu NR's 4.0 years or indeed any populations studied (Wittemyer et al. 2013). In Amboseli intervals of <3 years were associated with increased mortality of either younger or older calf, suggesting that mothers were rarely able to suckle two calves simultaneously. In Gorongosa, whereas, many mothers experienced inter-birth intervals of under 2.5 years and were often observed suckling two, and, on at least one occasion, three offspring.

We do not have good data on mortality, but all indications are that it was relatively low. Seven adult males were shot during a period of political unrest and two adult females died of unknown causes. Seven juveniles/calves succumbed to snares and there were likely others. No elephant carcasses were counted from the air (Stalmans pers. comm.). In Amboseli, a population that has experienced very little poaching, the highest mortality rates were among calves, 13.5% of whom died in the first year on average (Lee et al. 2022). Those who experienced a prolonged dry season were 70% more likely to die than those who experienced a moderate dry season (Lee et al. 2011). Gorongosa's adult females remained in good condition into the late dry season and large, full breasts and frequently observed double suckling suggested they had sufficient milk. In Amboseli, lions and hyenas also took calves, while there were very few lions and no hyenas in Gorongosa during our study.

Tinley (1977) estimated that there were 2,200 elephants in Gorongosa in 1972. In 1994, after the war, only 108 were counted (Cumming et al. 1994) and in 2000, Stalmans et al. (2014) estimated there were <200. The density of vegetation in Gorongosa makes accurate aerial counting difficult. A recent study using an automated "oblique-camera-count" imaging system showed fixed-wing aircraft surveys undercount elephants by 14% and 27% in sample and total counts, respectively (Lamprey et al. 2019). Aerial surveys in Gorongosa have included fixed-wing sample counts (1972, 1994, 2004), helicopter sample counts (2000, 2001, 2002, 2007, 2010, 2012) and helicopter total counts (2014, 2016, 2018, 2020).

Our population estimates based on registered individuals were consistently higher than Gorongosa's aerial sample and total counts. In 2016 and 2018 only 8 of 12 and 6 of 12 elephants with satellite collars, respectively, were detected from the air. Together with their families, at least 114 elephants were undetected. Stalmans and Peel (2020) acknowledge that the "781 elephants that were counted represent the minimum number present" and estimated the population to be between 800 and 1,000 individuals in that year, close to our 2019 estimate of 1,094 using individual registration and estimated number of immatures per adult female. Despite the potential inaccuracies, we believe our figures represent an underestimate of the population size as we have not registered new elephants from trail cameras set in 2017. While individual registration is a long-term commitment, we suggest that it can offer a more accurate method of determining elephant population size and, as our results show, simultaneously provide additional reproductive and life history data critical to elephant conservation.

Based on the estimated ages of individually known elephants, we calculated that Gorongosa contained at least 161 elephants in 1994. Twenty-five years after the war the Gorongosa population had likely experienced a six-fold increase (Stalmans and Peel 2020). Our data and the aerial counts suggest different growth patterns, however. Aerial counts after the war indicate that the population experienced very little growth (~0.01%) up until 2014 after which it appeared to be explosive (~20%). Our data suggests, instead, that the population

grew at a rate of ~9% until around 2007 when it slowed to ~7%.

The average growth rate of the long-studied elephant populations in the arid landscapes of Amboseli and Samburu, Kenya was 2.7% over 46 years (Lee et al. 2022) and 2.9% over 14 years (Wittemyer et al. 2013), respectively. Elsewhere, similar to our findings, Foley and Faust (2010) documented a sustained growth of 7% over a 13-year period in Tarangire, Tanzania, and Slotow et al. (2005) in South Africa documented an average 8.3% growth rate for 58 populations composed of elephants (with a female bias) re-introduced into small, fenced reserves. Foley and Faust (2010) concluded the rapid growth observed was probably influenced by three factors that also apply to Gorongosa: favourable environmental conditions allowing for a short interbirth interval and early reproductive onset, lack of density dependence and release from the mortality of heavy poaching. Further applicable to Gorongosa and other poached populations, Slotow et al. (2005) pointed out that the female bias in their study provided huge growth potential. Fast recovery in elephant numbers after heavy poaching is not always the norm, however. In Mikumi, where 75% of the population had been killed, an unusually high proportion of adult females were observed to be neither lactating nor pregnant, as indicated by shrivelled breasts (Poole 1989). Fifteen years later 33% of the adult females were still non-reproductive (Gobush et al. 2008). Furthermore, orphaning and family fragmentation, both hallmarks of poaching, have detrimental consequences for calf and juvenile survival (Goldenberg and Wittemyer 2018, Lee et al. 2022) and, consequently, for population growth rate (Parker et al. 2021).

All considered, the rapid growth of the Gorongosa population, sustained over close to a quarter of a century, seems remarkable. Our results demonstrate that given sound protected area management, elephants have the potential for relatively rapid post-war recovery in numbers, given advantageous conditions promoting early and rapid reproduction, combined with high infant and adult survival. Nevertheless, attaining pre-war population size will likely take close to half a century, and genetic, social and behavioural recovery may take even longer.

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Process and outcomes of ivory-related trials in Kenya, 2016–2019

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Abstract

This article reviews the process and outcomes of 247 trials, involving 422 persons accused of possession and dealing in ivory, brought before the Kenyan courts between 2016 and 2019. Data were collected by legal interns who visited courts and studied case records. Ivory-related cases were found across Kenya, especially in Tsavo Conservation Area, Nairobi, and southern coastal areas. Most arrests followed seizures of ivory, with total seizure cases estimated at 6,500 kg. Most arrested persons were Kenyan men who pleaded not guilty to the charges. Except in the case of guilty pleas, concluding the trials was slow: more than half the trials of those who pleaded not guilty in 2016 were still unconcluded by January 2020. There were conviction rates of 88% for those pleading guilty and 68% pleading not guilty. Rates of acquittals and withdrawals were high, considering that in most cases prosecutors only have to prove possession of illegal ivory to obtain a conviction. Most convicted persons were sentenced to a fine, with jail in lieu of non-payment, typically of USD 10,000 and five years respectively, but with considerable variation and inconsistency in sentencing. The results highlight the challenges involved in assessing law enforcement efforts. We suggest doing so using intermediate-scale studies that follow selected cases from arrest to sentencing and, where possible, combined with scientific analysis to determine the provenance of seized ivory. We conclude that continued reforms in the judiciary and further strengthening of the prosecution service are required to achieve justice for wildlife in Kenya.

Résumé

Dans cet article, nous relatons le déroulement et les résultats de 247 procès, impliquant 422 personnes accusées de possession et de trafic d'ivoire, traduites devant la justice kényane entre 2016 et 2019. Les données ont été collectées par des stagiaires juridiques, qui se sont rendus dans les tribunaux et ont étudié les dossiers. Cet affaires ont été enregistrées à Nairobi, dans les zones côtières méridionales et dans le périmètre de Tsavo Conservation Area. La plupart des arrestations ont eu lieu suite à des saisies d'ivoire, estimées à un total de 6500 kg. Les personnes arrêtées étaient en majorités des hommes kényans qui ont plaidé non coupable. À l'exception des délibérés concernant les accusés ayant plaidé coupable, les procédures ont été longues : plus de la moitié des procès dont les prévenus avaient plaidé non coupable en 2016 n'avaient toujours pas vu leur conclusion en 2020. Le taux de condamnation a atteint 88 % des individus ayant plaidé coupable et 68 % de ceux ayant plaidé non coupable. Le nombre d'abandons des poursuites et d'acquittements a été élevé, bien que dans la majorité des affaires les procureurs pouvaient facilement obtenir une condamnation en apportant des preuves de possession illégale d'ivoire. La plupart des accusés ont écopé d'une amende de 10 000 $, agrémentée d'une peine de prison de cinq ans en cas de non-paiement, mais l'on observe de grandes disparités et incohérences dans les sentences. Ces résultats soulignent les défis à relever pour la justice kényane en ce qui concerne l'application de la loi. Nous suggérons des études à moyenne échelle des dossiers, depuis l'arrestation jusqu'au jugement, suivie si possible d'une analyse

scientifique afin de déterminer la provenance de l'ivoire saisie. Nos conclusions mettent en évidence le besoin de poursuivre les réformes dans le système judiciaire et de renforcer le ministère public du pays pour rendre justice aux espèces sauvages au Kenya.

Introduction

This article provides an overview of cases related to possession and dealing in ivory brought before 45 courts in Kenya between 2016 and 2019. We describe and discuss the geographical distribution, process, and outcomes of the trials, using data derived from studying court records. The data were collected by courtroom monitors as part of the project *Eyes in the Courtroom*, implemented by the Kenyan NGO WildlifeDirect with funding from the Elephant Crisis Fund[1].

The illegal ivory trade, like trade in other illegal wildlife products, consists of a complex network of interactions linking suppliers, transporters, sellers and consumers (Fukushima et al. 2021, Fig. 1). Trade in ivory is known to be largely controlled by a small number of organized crime syndicates linking suppliers in Africa to traders based in East Asia (UNODC 2020, p 53). Kenya plays multiple roles in this trade both as a source of ivory and as a transit route from other countries, with the port of Mombasa a principal exit point (Weru 2016).

Effective action against the illegal wildlife trade requires a range of complementary and carefully coordinated actions (Hass and Ferreira 2016). Fukushima et al. (2021, Fig. 1) identify "regulation and law enforcement", alongside "knowledge" and "engagement" as the principal actions required to address the international "illegal and unsustainable wildlife trade". Law enforcement is itself a multifaceted process, including crime prevention; detection and investigation of crime; and the arrest, prosecution and sanctioning of offenders. Globally, law enforcement efforts focus on the investigation and dismantling of international organized crime cartels. Publications cover ivory shipments, DNA analysis of tusk origin, and trials of "ivory kingpins" (EIA 2017; Morris 2018; Wasser et al. 2018; Wildlife Justice Commission 2021). From this "top-down" perspective, it is acknowledged that the crime syndicates rely on networks of local accomplices to supply and transport the ivory (Weru 2016; EIA 2017), but few details are available about their operations[2].

In Kenya, field-based elephant conservation projects typically combine actions to combat poaching and increase incentives to conserve elephants. Examples include those implemented by the Big Life Foundation in Amboseli, the Mara Elephant Project in the Masai Mara, and the David Sheldrick Foundation in the Tsavo Conservation Area. Such projects rely on cooperation between the government's Kenya Wildlife Service (KWS) and NGOs with a presence in private and community managed landscapes. The success of these efforts is often measured by amounts of ivory seized and numbers of arrests. Similarly, in a literature review, Kurland et al. (2017, p. 7) find that "the large majority of this research [on law enforcement] relates to patrolling effort and … *strengthening formal surveillance*."

In these local settings, less attention is paid to what happens next: whether arrested persons come to trial and the outcomes of trials that take place. Being arrested is no deterrent to commercial poaching or trafficking if the accused person knows there is a good chance of protection and acquittal. Across Africa, reports abound of individual cases which suggest that this is indeed the case; however, there are few if any studies that quantify the scale and seriousness of the problem. This article contributes towards filling this knowledge gap. We also highlight the potential of study of these cases to contribute to "bottom-up" investigation of the lower echelons of ivory trafficking cartels.

The inadequacy of court records is often the first hurdle confronting studies of law enforcement in African courts. An initial study covering the period 2008–2013 found that 70% of case files were missing. Subsequent baseline surveys by the NGO Space for

[1]The Elephant Crisis Fund is managed by Save the Elephants and the Wildlife Conservation Network, in partnership with the Leonardo DiCaprio Foundation (now known as Re:wild).

[2]A notable exception is the 2016 documentary "The Ivory Game", directed by Kief Davidson and Richard Ladkani (available to view on Netflix).

Giants in Namibia and Botswana also found that courtroom and prosecution records were inadequate (Space for Giants n.d.[a,b]) However, based on records available, the initial scoping study in Kenya concluded "that wildlife related crime in Kenya is treated as a misdemeanour or petty crime and is 'mismanaged' within the Kenyan court systems", leading to "a culture of impunity among the criminal fraternity and even within the government departments responsible for protecting these national assets" (Kahumbu et al. 2014).

This first report was a wake-up call that led quite rapidly to improved management of wildlife crime cases. By 2015, 94% of case files could be accessed (WildlifeDirect 2016). The capacity of the Office of the Director of Public Prosecutions (ODPP) was enhanced by setting up a dedicated Wildlife Crime Prosecution Unit (WCPU) in 2014 and by the development, with the support of the British High Commission, of improved inter-agency protocols and case analysis tools, which were published as a *Rapid Reference Guide for the Investigation and Prosecution of Wildlife Related Offences* (Government of Kenya 2015). Now in its third edition, the Guide is used by the United Nations Office on Drugs and Crime (UNODC) and NGOs for ongoing capacity building and training of magistrates and prosecutors.

Data on trials between 2008 and 2013 also confirmed that the provisions of the Wildlife Conservation and Management Act (1989) were inadequate to deal effectively with an alarming upsurge in serious wildlife crime. Under this Act, unauthorized trade in ivory was punishable by jail terms; however, these were rarely imposed and the maximum fines available as an alternative were derisory: less than KES 100,000 (USD 1,170 in 2013) for unlawful import and only KES 40,000 (USD 470) for unlawful export of ivory. In response to mounting pressure to strengthen penalties, a new Wildlife Conservation Management Act (2013) was approved by Kenyan legislators in 2014. The new Act stipulated penalties of up to life imprisonment for a range of serious crimes involving endangered species, alive or dead, and their products, which are referred to in the Act as "trophies". It was greeted by many with approval and relief. These feelings, however, were short-lived. Within a year, the High Court found, correctly, that the drafting of the key Section 92 covering endangered species was unworkable; thus, the Act *failed* to create any specific offence relating to endangered species and their products or trophies[3]. Ivory traffickers could only be prosecuted under Section 95 of the Act, which stipulated a minimum sentence of five years' imprisonment and/or a minimum fine of KES 1 million (about USD 11,500 at the time) for any trophy-related offence—whether relating to a haul of tusks, an ivory trinket or an antelope skin. Those convicted of trafficking with access to funds to pay the fine could simply pay and walk away.

It took another six years for Kenya to amend the law, in 2019, creating a more robust framework of offences and penalties relating to wildlife crime. Section 92 was reinstated, setting out penalties specifically relating to the killing and trafficking of endangered species. The 2019 amendments also, for the first time, define "unlawful trade" with reference to Kenya's obligations under CITES. Nevertheless, ambiguities remain (see Discussion), which have allowed magistrates to ignore the minimum terms for these crimes set by the 2019 amendments.

WildlifeDirect's *Eyes in the Courtroom* monitoring programme continued throughout this period, expanding in the number of courts monitored and the range of offences. This article covers the period 2016–2019 and focuses on cases related to ivory trafficking. It also draws on data on ivory seizures and arrests near Tsavo and Amboseli from the NGO Big Life Foundation (BLF). The aim is to provide an overview of ivory-related cases in courts from 2016 to 2019 to inform ongoing efforts to enhance law enforcement.

Methodology

Data were collected by teams of courtroom monitors, comprising WildlifeDirect staff and interns with legal training (six in 2016–2017 and eight in 2018–2019), assisted in 2016–2017 by nine advocates of the High Court of Kenya. An authorization letter from the Judiciary Training Institute (JTI) was presented upon arrival to court officials. During the study period, almost all court records were in handwritten files. Monitors noted case numbers and dates and took photos of the corresponding pages of case files and

[3]Mutisya Kiema vs. the Republic of Kenya Criminal Appeal No. 7 of 2014 eKLR.

later transcribed the details onto Excel files. Data were collected for analysis in accordance with the Standard Operating Procedures (SOP) for collection and analysis of court records previously agreed with the JTI (WildlifeDirect n.d.[a], p. 11).

We examined this data, comprising records of cases brought before 123 courts in 2016–2017 and 113 courts (including two mobile courts) in 2018–2019. Cases involving elephants and ivory (henceforth "ivory cases") were identified. Broadly speaking, Kenyan law distinguishes three kinds of unlawful hunting: for subsistence; for the bushmeat trade; and for what are still referred to as "trophies" under Kenyan law, even though all trophy hunting was banned in Kenya in 1977. We first identified trophy related offences and then looked for the words "elephant", "tusk" and "ivory" in the charges[4].

There are some gaps in the data. In all years, courtroom monitors visited courts towards the end of the year and reviewed cases for that current year, so cases near the end of the year were missed. Moreover, some records from 2018 and 2019 failed to record the animal species and/or the amount of ivory presented in court and/or other details such as date of arrest. Prior to publication of the 2018–2019 courtroom monitoring report, 19 courts where most ivory cases were recorded were re-visited in 2020, providing updated information on 162 out of 223 ivory cases analysed (WildlifeDirect n.d.[b]). While preparing this article, with help from staff at the ODPP, we reviewed 42 cases from the original dataset for 2018–2019 that related to "possession of [an unspecified] wildlife trophy" and identified a further 24 ivory-related cases. We also cross-checked our data for these years with data on ivory seizures and arrests by BLF.

The following section presents results for all 247 cases identified. From the partially complete dataset at our disposal, we created partial data sets that could provide valid information on different topics of interest, as explained in the text.

[4]Theoretically, hunting for subsistence or bushmeat trade could also involve killing elephants; however, no such cases were found. Elephants are also killed due to human–elephant conflict (HEC); we identified one (possible) case as described in the text.

Results

Numbers and distribution of cases

In total we identified 247 elephant/ivory cases, representing 12% of all cases reviewed that were brought to court under the WCMA (2013) during 2016–2019 (Table 1).

Table 1. Numbers of cases, persons and offences in ivory cases recorded by courtroom monitors for the years 2016–2019

	2016	2017	2018	2019	Total
Cases	77	57	81	32	247
Persons	119	104	146	53	422
Offences	171	138	187	64	560

Ivory cases were recorded in 45 courts in 2016–2019 (Fig. 1), with little variation in the distribution of cases over the four-year period. The courts with most ivory-related cases were Makindu (42 cases), Kibera (27) and Voi (25), followed by Narok (13), Jomo Kenyatta International Airport (JKIA, 11), Loitokitok (11), Nyahururu, (10) and Mariakani (10). The remaining cases were heard in the other 37 courts.

Most cases were heard in courts in or near the Tsavo Conservation Area (Makindu, Voi), or in the south coastal region (Kwale, Mariakani) on the route from Tsavo to Mombasa. Many cases were also heard in Nairobi, mainly at JKIA and Kibera. Smaller, but still significant numbers were heard in courts near important elephant ranges: Maasai Mara (Kilgoris, Kehancha), Amboseli (Loitokitok) and the Laikipia–Samburu ecosystem (Nyahururu, Nanyuki, Meru).

Arrests and seizures

Most arrests followed seizures of ivory. Most seizures were of "tusks" or "pieces of tusk", with just 13 reported seizures of worked ivory, mostly small pieces of jewellery and bangles seized in or near JKIA. Weights of ivory seized were documented in 209 of the 247 cases (Table 2). The total amount reported as seized was 5,750.3 kg, representing approximately 1,050 pieces of raw ivory and 100 pieces of worked ivory and an average of 27.5 kg per seizure of raw ivory. Weights of ivory are not given for a further 181 tusks; this includes 164 tusks recovered in a major seizure in Mombasa in 2017; and, in a few further cases,

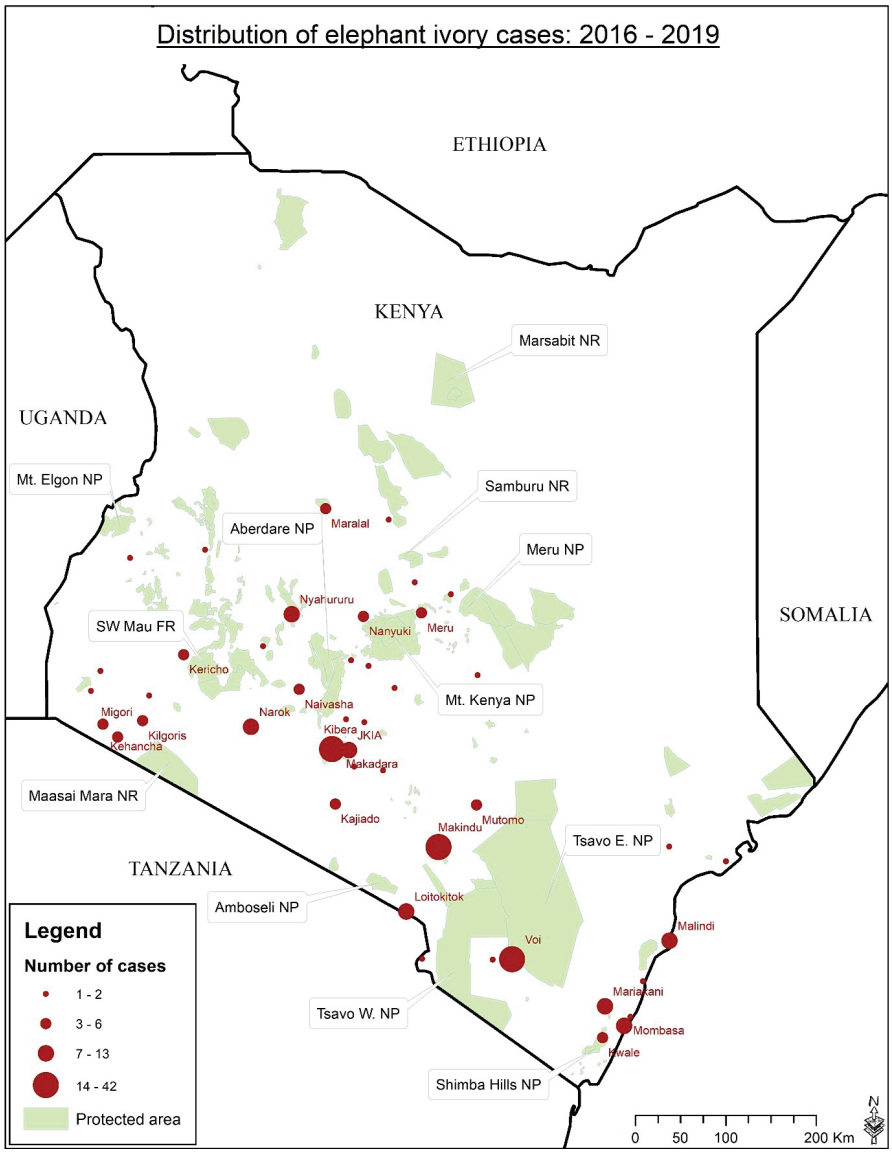

Figure 1. Distribution of elephant and ivory cases brought before courts in Kenya in 2016–2019. The location of the capital, Nairobi is indicated by the court in Kibera and nearby Jomo Kenyatta International Airport (JKIA) (*Map drawn by Save the Elephants using data supplied by the authors*).

only the monetary value of the ivory is given. Taking account of these incomplete records, the total amount of raw ivory seized in the 247 cases between 2016 and 2019 was likely more than 6,500 kg. The largest single seizure was of 1,097.8 kg in Mombasa in December 2016, which led to the arrest and unsuccessful prosecution of Ephantus Gitonga Mbare, who was acquitted at Mombasa Law Court in April 2019.

Analysis of 153 cases where information on the weight of raw ivory and number of tusks/pieces was available showed that the average weight of a (piece of) tusk was 4.42 kg, and the median weight 3.75 kg. There are records of 10 tusks weighing 20–30 kg each (from two seizures in 2016 and one in 2019) and of 12 tusks weighing more than 30 kg each (from four seizures in 2018). The largest tusk recorded weighed 39 kg (Fig. 2).

Table 2. Reported ivory seizures leading to arrests of suspects in 2016–2019. Weights are shown in kilograms

	2016	2017	2018	2019	Total
Total cases	77	57	81	32	**247**
Ivory seizures reported (cases)	65	50	68	26	**209**
Weight	2,041.0	1,576.7	1,582.2	550.4	**5,750.3**
Average	31.4	31.5	23.3	21.2	27.5
Max. weight	1097.8	216.8	234.0	82.0	1097.8
Median weight	7.0	12.2	12.0	15.55	11.95

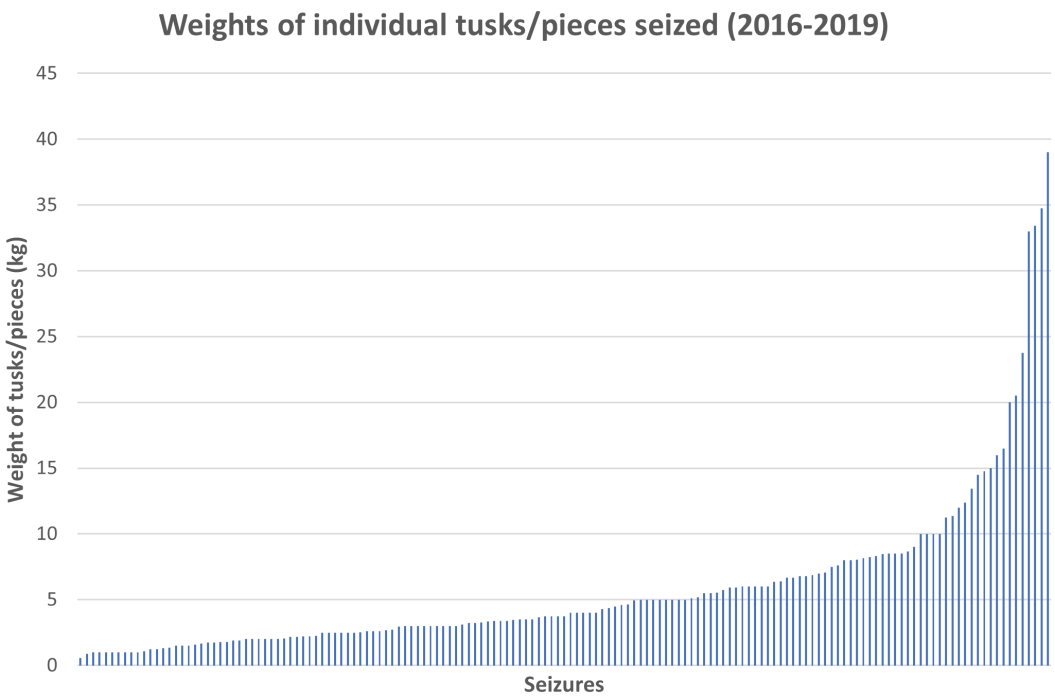

Figure 2. Distribution of seizures by weights of individual (pieces of) tusks, 2016–2019. Each bar shows the average weight of raw ivory items in a single seizure. (For example, a seizure of four items weighing a total of 40 kg is shown as a single bar of 10 kg).

In a few cases, suspects were apprehended in possession of trophies of other species, in addition to elephant, namely: leopard (4 cases), snake (3), pangolin (2), lion, warthog and lesser kudu (1 each).

Most arrests were carried out by KWS, and the remainder by the National Police Service (NPS). As indicated earlier, several NGOs collaborate with KWS in surveillance operations, including tracking, intercepting and seizing poached ivory. For comparison, we retrieved available data on seizures reported by three of these organizations in 2018–2019 (Table 3). It is notable that total ivory seizures reported by these NGOs in 2018 are equivalent to 85% of amounts in all our court records; while seizures reported by these organizations in 2019 were 60% *greater* than seizures in cases reviewed by the courtroom monitors. To further investigate this discrepancy, based on detailed data provided by BLF, we attempted to match seizures and arrests in their records for 2018–2019 with data from the courts (Box 1).

Table 3. Seizures of ivory (kg) reported by Big Life Foundation (BLF), Mara Elephant Project (MEP), and Sheldrick Wildlife Trust (SWT) in 2018 and 2019. Sources: Data supplied by BLF; annual and quarterly reports of MEP and SWT

Year	BLF	MEP	SWT	Total
2018	990.8	356	37	**1346.8**
2019	718.45	183.5	n/a	**901.95**
Total	**1,709.25**	**539.5**	**37**	**2,248.75**

Of the 52 ivory seizures reported by BLF in 2018–2019, 24 were matched to cases in the court records. No cases could be found corresponding to the remaining 28 seizures. However, 15 of these 28 seizures occurred between October and December when our courtroom records are incomplete. Of total ivory seizures of 1,709.25 kg reported by BLF, 862 kg corresponds to 20 cases where there is also information on amounts of ivory in the corresponding court records, where the total amount of ivory is recorded as 831.5 kg. The amounts of ivory are the same in 10 cases, while in eight cases the amount in the court record is between 1 and 10 kg less than the amount reported by BLF. In two cases the amount of ivory in the court record is greater than the seizure reported by BLF (by 2 kg and 15 kg respectively).

Box 1. Comparison of seizures reported by Big Life Foundation and in cases in the court records.

Accused persons, charges and pleas

Most accused persons were Kenyan men; specifically, of 422 accused persons, 394 were men and 400 were Kenyans (Fig. 3a,b). Of the 22 non-Kenyan nationals 12 were Chinese, three were Vietnamese, one was Bangladeshi, four were citizens of other African countries, and two were citizens of European countries. Most of these persons (17 out of 22) were arrested in 2016, and most of the accused (16 out of 22) were arrested at JKIA, usually trying to smuggle small quantities of worked ivory trinkets out of the country. A smaller number were caught in possession of larger amounts of ivory. These included one Italian defendant apprehended in the field by BLF rangers, who was in possession of 234 kg of raw ivory and 700 rounds of ammunition and was charged together with a Kenyan co-defendant. This was the biggest seizure of ivory reported in 2019.

Most defendants were arrested in possession of raw ivory. In 2016–2018, almost all were charged under Section 95 of the WCMA and charged with "possession of wildlife trophy" (Figure 4), since prosecutors were aware that Section 92 was inoperable during this period. In 2019, prosecutors began using the newly reinstated Section 92, although Section 95 continued to appear on many charge sheets. Some defendants were also charged under Section 84 (incorrectly, see Box 2 below) with "dealing in wildlife trophy". The only record of suspects being "caught in the act" is a case of three persons charged in 2019 under Section 92 with "killing two elephants". However, court records do not indicate whether this was an instance of poaching for ivory or, for example, human-elephant conflict (HEC). In four additional cases, suspects who may be presumed to be poachers were arrested in possession of ivory and firearms or ammunition and charged under the Firearms Act, in addition to charges brought under the WCMA. In theory, poachers could also be arrested in the field *before* killing an elephant, in which case they would be charged with possession of a firearm and lesser offences such as illegal entry into a PA. However, we found no cases corresponding to this scenario.

Of the 422 people charged with elephant poaching and/or ivory-related offences in 2016–2019, 372 (88%) pleaded "not guilty" to at least one of the offences they were charged with (Fig. 3c). This compares with guilty pleas of up 95% of defendants with lesser offences under the WCMA such as illegal grazing and entering a PA without a permit.

Process and outcomes of trials

Persons who plead not guilty have the right to apply to be released on bail and/or bond. Our records show that 223 out of 422 persons accused of ivory trafficking during 2016–2019 were granted bail and/or bond. The proportion ranged from 76% of accused persons in 2017 to 24.5% in 2019; however, details of bail and bond were not always recorded by monitors in 2018 and 2019 (or, in some cases, may have been granted subsequently to their perusal of court records). The value of bond plus bail (with amounts of bond

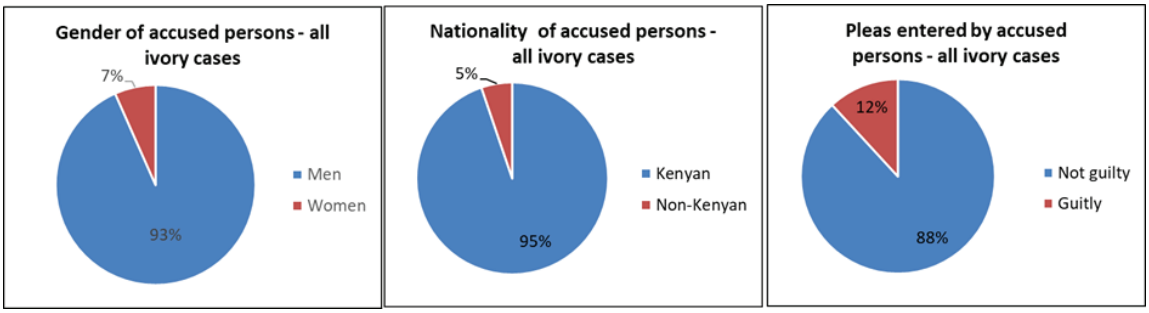

Figure 3. (a) Gender, (b) nationality and (c) pleas of accused persons in ivory case trials, 2016–2019. For persons accused of multiple offences, the plea was recorded as 'not guilty' if a not guilty plea was entered for at least one of these offences.

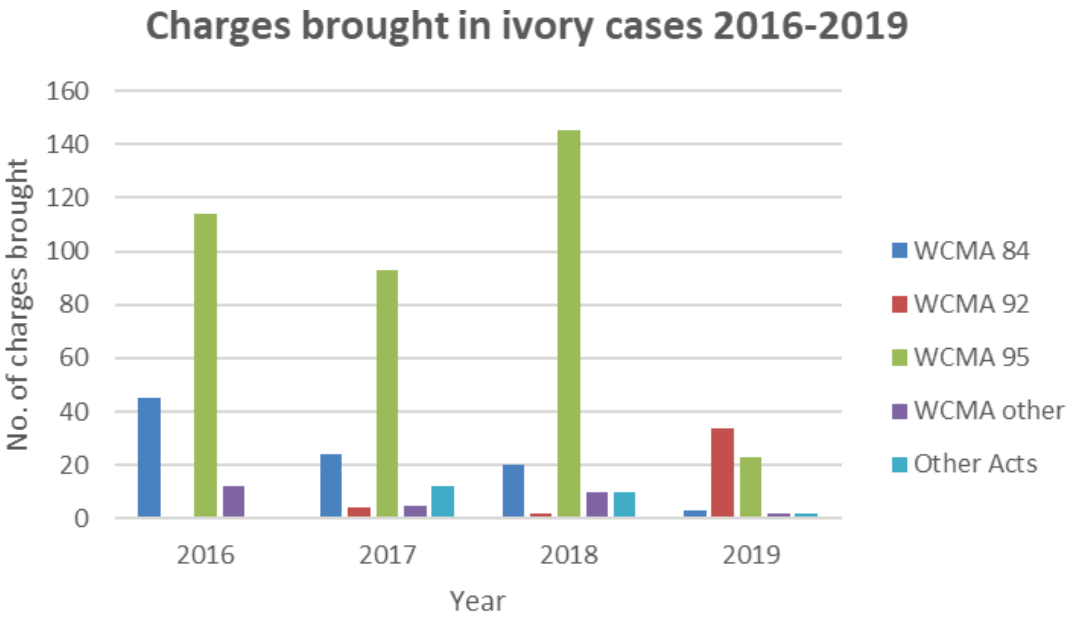

Figure 4. Charges brought against defendants in ivory-related trials, as defined in the Methodology, in the period 2016–2019. Note that some defendants were charged with more than one offence.

typically being much higher than amounts of bail) was more than KES 1,000,000 (USD 10,000[5]) although lower in 2018 compared to other years (Table 4).

Of 247 ivory cases, 117 were recorded as 'concluded' by the courtroom monitors. In terms of the number of accused persons, the trials of 183 persons (out of 422) were concluded while those of 239 persons were still ongoing at the time of the most recent court visit. Analysis of a subset of 202 cases for which information is available up to the end of 2019[6] shows that, although courts made steady progress towards concluding trials, one-third of trials initiated in 2016 (20 cases) and more than half of trials initiated in 2017 (26 cases) still had not been concluded at the end of 2019 (Fig. 5).

To assess outcomes of trials, we considered all persons whose trials are shown as 'concluded' in our records. Of 183 persons whose trials were concluded, 134 (73.2%) were convicted, while 31 (16.9%) were acquitted and 18 (9.8%) had their cases withdrawn (Fig. 6). Conviction rates in the trials of 134 persons

[5]The exchange rate fluctuated near to 100 KES = 1 USD throughout the period under review (2016-2019).

[6]In other words, we ignored trials recorded as "ongoing" if the last visit to the court was before the end of 2019.

Table 4. Details of bail and bond granted to persons accused of ivory trafficking in 2016–2019. Amounts shown are for the sum of values of bail plus bond

	Unit	2016	2017	2018	2019	Total
Bail	No. of persons	0	2	1	0	3
Bond	No. of persons	61	70	41	10	182
Bail+bond	No. of persons	14	7	14	3	38
Total	No. of persons	75	79	56	13	223
% bail/bond	% of persons	63.0	76.0	38.4	24.5	58.0
Average amount	Million KES	2.92	3.06	0.83	2.32	2.41
Median amount	Million KES	2.0	1.0	0.5	1.0	1.0

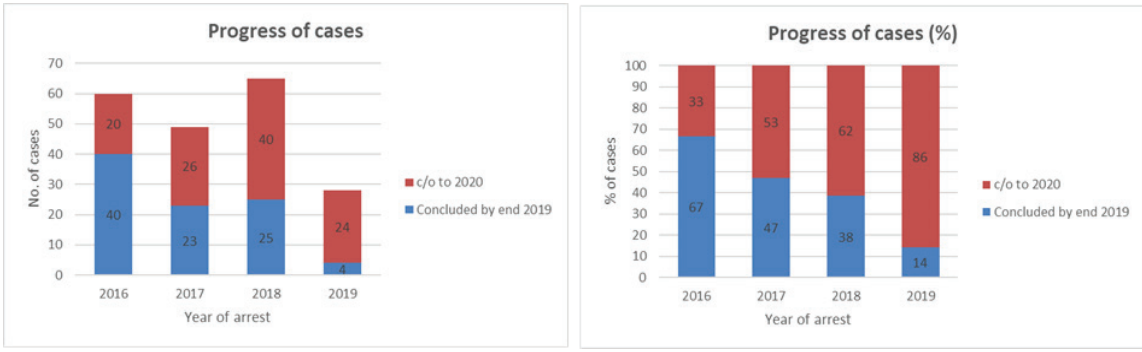

Figure 5. Progress towards concluding trials initiated in 2016–2019.

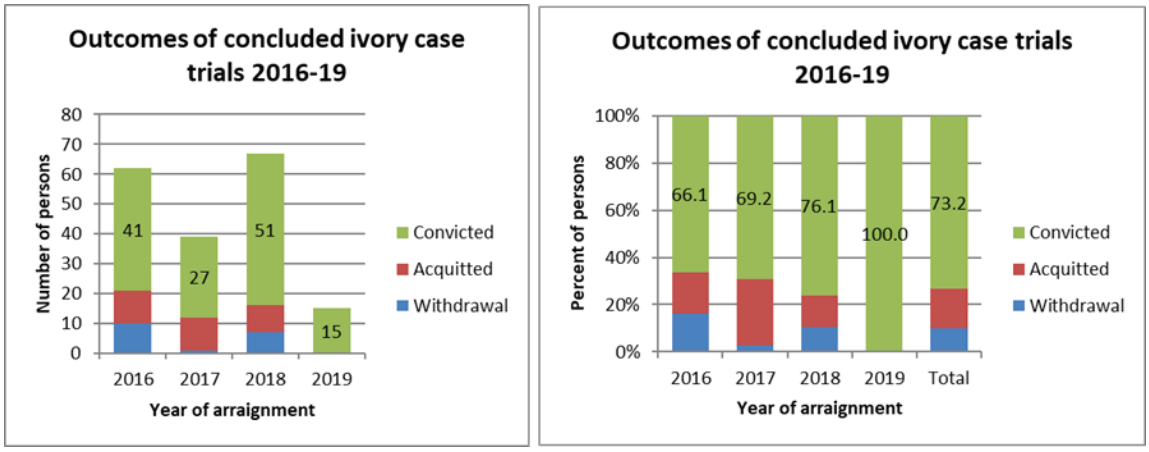

Figure 6. Outcomes of concluded trials initiated between 2016 and 2019: (a) Numbers of persons; and (b) per cent of accused persons. Where the person was accused of multiple offences, the case was counted as a conviction if the accused was found guilty on at least one charge.

Table 5. Outcomes of trials (numbers of accused persons) broken down by year and plea

Guilty plea	Convicted	Acquitted	Withdrawn	Ongoing	Total	% concluded	% convicted
2016	15	3	1	0	19	100	78.9
2018	25	2	0	0	27	100	92.6
2019	4	0	0	0	4	100	100
TOTALS	**44**	**5**	**1**	**0**	**50**	100	88.0

Not Guilty plea	Convicted	Acquitted	Withdrawn	Ongoing	Total	% concluded	% convicted
2016	26	8	9	57	100	43.0	60.5
2017	27	11	1	65	104	37.5	69.2
2018	26	7	7	79	119	33.6	65.0
2019	11	0	0	38	49	22.4	100
TOTALS	**90**	**26**	**17**	**239**	**372**	35.8	67.7

Note: All defendants in ivory trials initiated in 2017 pleaded not guilty.

whose trials were concluded ranged between 100% in 2019 (15 persons) to 66.1% (41 out of 62 persons) in 2016. The falling proportion of acquittals and withdrawals between trials started in 2016 and 2019 suggests that longer-running trials are less likely to result in convictions, as might be expected.

To assess the effect of a plea (guilty or not guilty) on the outcomes of trials, we analysed outcomes of trials broken down by pleas (Table 5). Results show that the main effect of pleading not guilty is to increase the length of the legal process. More surprisingly, not all persons who pleaded guilty were convicted. Overall, about two-thirds of people pleading not guilty in concluded trials from 2016–2018 were found guilty. Notably, a guilty verdict was recorded in 100% of the small number of concluded trials from 2019. This suggests that the effectiveness of prosecutions is improving, although it may in part reflect the fact that short trials are more likely to lead to a guilty verdict.

Sentencing

Our records provide details of sentencing of 134 persons convicted of ivory trafficking in trials brought to court in 2016–2019. Most of these persons (87%) were sentenced to a fine with jail if the fine was not paid (Fig. 7). A small but significant number of convicted persons (7%) were sentenced to a jail sentence without the option of a fine.

The amount of fine to be paid was typically KES 1 million (about USD 10,000), or an alternative of a minimum five years imprisonment, as stipulated under Section 95 of the Act. Smaller and larger fines were also commonly imposed, up to a maximum of KES 20 million for single offences in 2016, 2017 and 2018 (Table 6). Jail terms generally ranged from one to five years or occasionally 10 years (with or without a fine); except in four cases from 2016, when three persons were sentenced to 15 years, one to 20 years, and six to life imprisonment. These heavier sentences

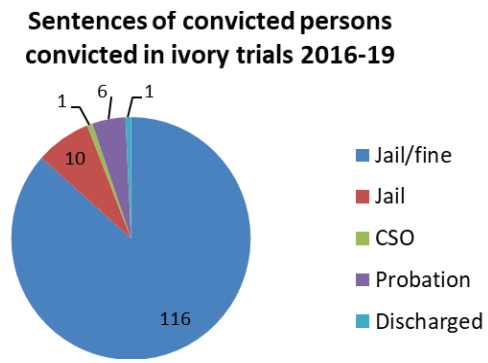

Figure 7. Types of sentences imposed on persons convicted of ivory crimes in cases brought before court in 2016–2019. Figures indicate numbers of persons. CSO = community service order.

possibly reflect the influence of capacity building initiatives for the judiciary which got underway in this year.

There was no consistent relation between the amount of the fine and the length of the corresponding jail sentence: for example, there are instances of a KES 1 million fine in lieu of 15 years' imprisonment, and a KES 2 million fine in lieu of 12 months' imprisonment. Nor was there a consistent relationship between the amount of the fine and the weight of seized ivory, which could be considered an indication of the seriousness of the crime. In cases from 2016, one convicted person was fined KES 50,000 in the case of a seizure of 59 kg ivory, while four persons received fines of KES 20 million and another total fines of KES 23 million in two cases involving 5 kg and 3 kg ivory, respectively. In cases from 2018, fines of KES 21 million were imposed on two persons in a case involving 1.8 kg ivory, while eight persons received fines of KES 1 million (USD 8,270) in four cases all involving more than 60 kg ivory. Fig. 8 illustrates this disconnect.

Table 6. Fines imposed in lieu of jail sentences, for ivory crimes in cases brought to court in 2016–2019. Values are in millions of Kenya shillings (KES 1 million = USD 10,000)

	2016	2017	2018	2019	TOTAL
No. of fines issued	34	25	45	12	116
Total fines	154.05	72.30	60.43	16.00	302.78
Average fine	4.53	2.89	1.34	1.33	2.61
Max fine	23.00[a]	20.00	21.00[b]	3.00	23.00
Median fine	1.00	1.00	1.00	1.00	1.00

[a]Fined KES 20 million for dealing in a wildlife trophy, plus KES 3 million for possession of trophy
[b]Fined KES 20 million for transporting a wildlife trophy plus KES 1 million for possession of wildlife trophy

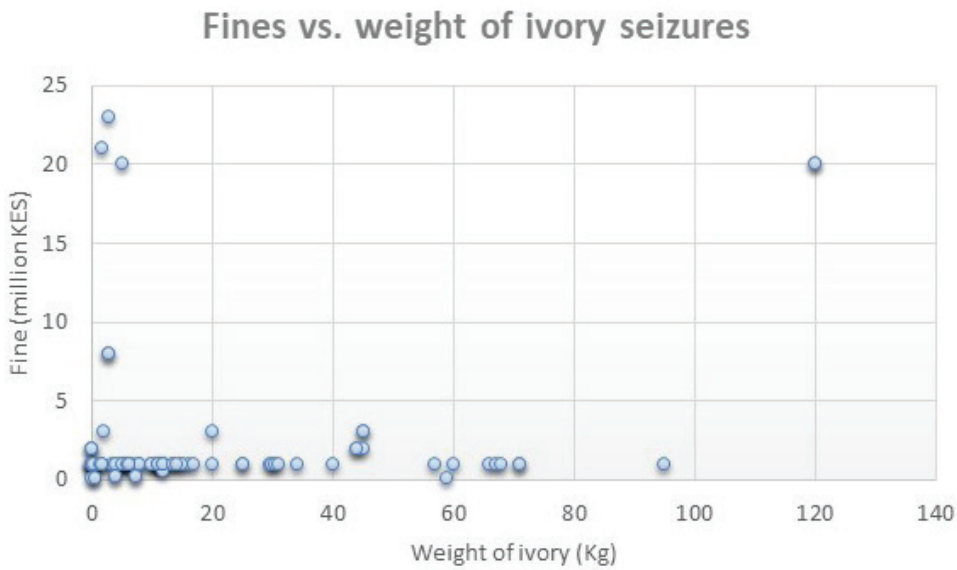

Figure 8. Comparison of fines following conviction with weights of ivory seizures in 83 concluded ivory trials during 2016–2019. If fines were proportional to the weight of ivory seizures, the dots would form a diagonal line from bottom left to top right. Note: only cases are shown; thus, for example, a case where four accused persons received an identical fine is represented by a single dot.

Discussion

The amount of seized ivory presented in Kenyan courts during 2016–2019 is striking, especially since elephant deaths caused by poaching for ivory were declining during this period: Based on public statements by KWS, elephant deaths from poaching declined from 386 in 2013 to less than 100 per year in 2016–2018 and just 34 in 2019[7]. We estimate that around 6,500 kg of ivory were presented at trials analysed in this report. UNODC uses an estimated average tusk weight of 5 kg per tusk or 10 kg per elephant (UNODC 2016); in which case 6,500 kg of ivory would correspond to 650 elephants. The average weight of ivory pieces in the court records was 4.42 kg. However, since many of these "pieces of tusk" were presumably not whole tusks, the average weight of the tusks contained in the mainly small seizures coming before Kenyan courts was almost certainly greater than that of tusks in the large shipments analysed by UNODC. Given that not all cases were captured by courtroom monitors, and that, based on our comparative analysis of BLF data, some seizures may not have led to trials in courts, it is not inconceivable that 10 tonnes of ivory were seized by law enforcement agencies in 2016–2019. This in turn represents an unknown fraction of the total amount of ivory handled by traffickers during this four-year period.

It is clear that very large amounts of raw ivory were "on the move" in Kenya during 2016–2019, considerably more than could be accounted for by reported deaths from poaching. Other possible sources of seizures that took place in Kenya include elephants poached outside Kenya, and ivory stolen from stockpiles in Kenya or in other countries. The courtroom data provides no information on this point. Further information on the provenance of seized ivory could potentially be obtained through interrogation of suspects; identification of markings from government stockpiles[8]; or through (expensive) scientific analysis, using DNA testing to match individual tusks to known populations of elephants (Wasser et al. 2018, 2022), and/or isotope analysis, which provides information of isotopic make-up of the diet which can be matched to likely feeding areas (Cerling et al. 2007).

The evidence on distribution of cases suggests that they were the result of arrests at different points in the supply chain: in elephant ranges where the elephant is poached, in Nairobi, and in transit to Mombasa. Cases in Nairobi involved not only seizures of trinkets at JKIA, but also larger seizures in the city; most of the latter cases were heard in the court in Kibera. It is notable that no cases came to court involving large seizures in Mombasa after 2016. Likewise, seizures of trinkets at JKIA declined markedly after 2016.

These results highlight the difficulty recognized by others in estimating law enforcement adequacy (Hauenstein et al. 2019). At the most basic level, details on numbers and types of arrests are usually not clear. Do falling numbers of arrests indicate success in deterring poaching, or less effective law enforcement, or both? Moreover, to make an effective contribution to reducing illegal trade in ivory, law enforcement efforts should aim to clamp down on both poaching and cross-border trafficking of ivory from other countries, as highlighted by evidence from DNA analysis revealing the interconnectedness of the transnational trade in illegal ivory (Wasser et al. 2018, 2022). The scarcity of information on the provenance of seized ivory makes it difficult to distinguish between progress on these two fronts.

With the above provisos, some elements of "adequate" law enforcement are indicated by our results. These include: an effective legal framework; field operations that, in addition to deterring poaching, have the capacity to not only detect illegal activity and apprehend offenders, but also provide the evidence required for their prosecution; and courts that reach the correct verdicts in a timely manner and impose sentences proportional to the crime. From this perspective, the results presented here highlight several issues.

As outlined in the Introduction, the 2013 Act was

[7]There is no official published data for these years. These figures are from Poaching Facts (www.poachingfacts.com) and the following newspaper article: https://www.npr.org/2020/08/14/902177466/some-good-news-an-elephant-baby-boom-in-one-kenyan-national-park

[8]As in the case of seizures in different parts of Africa that were shown to have come from Burundi government stockpiles (see for example https://intpolicydigest.org/the-enterprise-the-burundi-stockpile-and-other-ivory-behind-the-extradition/)

a great improvement compared to the 1997 Act that it replaced, and the 2019 amendments helped fix some problems in the drafting of the new Act. But ambiguities remain, especially regarding sentencing. The variations in sentencing reported here reflect a lack of oversight over judicial approaches to sentencing that cuts across the entire range of criminal offences. Moreover, a court decision in 2015[9] called into question the lawfulness of mandatory sentences and, by extension, minimum terms. The defence counsel in wildlife crime trials could argue that, until the issue was resolved, magistrates should ignore the minimum term set by statute. These and other inconsistencies mean that the intention of parliament regarding sentencing can be superseded by the judiciary with little comeback. This situation where 'anything goes,' limits the effectiveness of the law.

Comparison of NGOs' field data on arrests with the list of cases brought to court suggests that not all arrests lead to criminal trials. Arrests may not be followed through to prosecution for a variety of reasons, such as insufficient evidence, corruption, poor handling of evidence and failure of arresting officers to properly lodge statements. The same range of reasons could account for the differences between amounts of ivory reported as seized and amounts stated on the corresponding charge sheets (according to NGO field staff). Based on conversations with magistrates and prosecutors during trainings, continuity in the handling of exhibits is a particular cause for concern, and the likely reason for a significant number of failed prosecutions (S. Jayanathan pers. obs. November 2021).

Concerns regarding procedural irregularities are reinforced by numerical analysis of the outcomes of trials (Table 5). Court records show that in almost all cases of acquittals and withdrawals the accused persons (including those who pleaded guilty) were arrested in possession of ivory. Since "unauthorized possession" of ivory is a crime, in accordance with Section 95 of the Act until 2019 and Section 92 thereafter, prosecutors in these cases did not have to prove that accused persons were engaged in dealing in tusks. There is scant evidence of the reasons for these acquittals and withdrawals in the court records. Corruption, either by bribing the magistrate or the prosecutor, or by bribing and/or threatening witnesses, is one possible reason. Based on personal observation and engagement with the judiciary in a professional capacity, others include: 1) faulty charging by prosecutors, although to a decreasing extent between 2016 and 2019 (see Box 2); 2) challenges involved securing admissible evidence, including the handling of exhibits; 3) lack of continuity due to staff turnover of prosecutors and transfer of judicial officers mid-trial; and 4) poor active case management by judicial officers and the culture of adjournments that exists within the criminal courts of Kenya. This is a topic that clearly merits further investigation. Studies could draw on records from the appeals court, which provide details of procedural issues that are not available from a perusal of court records (see Box 2).

The length of the trials was another notable feature of ivory trials highlighted by our data. As shown in Table 5, the trials of less than half of defendants who pleaded not guilty in 2016 had been concluded when our monitors perused the court records in 2020. The existence of a small number of very long running high-profile trials (listed in WildlifeDirect n.d.[b]) may give the impression of a system that is at breaking point. In fact, the length of ivory trials, most of which take between six months and three years (excluding small numbers concluded rapidly after guilty pleas) is in line with the average length of all trials in Kenyan courts, which the Judiciary estimates at 2.5–3 years[10]. This compares with UK averages of 212 days in Adult Magistrates Courts, and 939 days for summons cases in the Crown Court (Department of Justice 2021).

The data analysed in this paper provides scant information on the fate of those arrested in a real, physical sense rather than in purely legal terms. Our data on bail and bond suggests that significant numbers of people are being held in custody for extended periods of time awaiting trial. For example, we have no record of bail or bond being granted to 16 defendants in ongoing trials from 2016. On the other hand, there are cases of persons accused of very serious crimes

[9]Francis Karioko Muruatetu and Another vs the Republic of Kenya; Katiba Institute and five others (Amicus Curiae) Supreme Court of Kenya Petition No. 15 & 16 (Consolidated) of 2015 [2021] eKLR.

[10]https://www.seej-africa.org/commentary/wildlife-crime-how-to-identify-a-corrupted-ivory-trafficking-trial/

Two defendants arrested in possession of five pieces of elephant tusk weighing 17 kg were charged with "possession of wildlife trophy" under Section 95 of the WCMA (2013) and of "dealing in wildlife trophy" under Section 84 the Act. At the trial, case number 297/2018 at Kehancha magistrate's court, the defendants were acquitted of the first count but convicted of the second count and sentenced to a KES I million (USD 10,000) or five years in prison. In February 2020, the court of appeal at Migori ordered the convictions to be thrown out. The judge ruled that the charge sheet was defective since it was invalid to file charges for the same crime under both Sections 84 and 95 of the Act. He argued that *"one must be either a dealer (so as to be charged under Section 84(1) of the WCMA) or not a dealer (so as to be charged Section 95 of the WCMA). An accused person cannot be both at the same time."* He further noted that the charge of dealing was not proved, adding however that *"the Appellants would have been easily found guilty had they been charged with only the first count"* [possession].

The judge's conclusions are questionable. There is nothing wrong in principle in charging dealing with possession as an alternative charge; it is quite common in drugs cases, for example. Moreover, the judge failed to note that suspects cannot be correctly charged under Section 84 at all, since this section of the Act describing dealing does not stipulate a corresponding penalty and therefore in law does not create an offence. The case highlights the potential for ambiguities in the formulation of the law and procedural uncertainties to hamper efficient law enforcement. Combined charges under Sections 95 and 84 of the Act were very common in 2016 and 2017; however, the proportion of defendants charged under Section 84 was much lower by 2019 (Fig. 4), possibly a consequence of improved case handling by prosecutors following training by NGOs and the UNODC.

Box 2. Case study of a successful appeal against conviction.

being released on bail and bond during extended periods, giving them the opportunity, not only to escape, but also potentially to interfere with witnesses and evidence. Moreover, court records do not show how many of the 116 persons sentenced to jail or fine for ivory crimes served a jail sentence and how many paid the fine. The almost ubiquitous practice among magistrates of sentencing convicted persons to a fine, with jail only as a default option, even for the most serious crimes, is cause for concern. One of the conclusions highlighted as alarming by authors of the original 2014 report was that "only 4% of [all] offenders convicted of wildlife crimes went to jail" (Kahumbu et al. 2014, p 5). Our data for 2016–2019 shows that the proportion of mandatory jail sentences for those convicted of *serious offences*, i.e. those involving ivory, was still only 7% of total convictions. For comparison, baseline surveys conducted by Space for Giants found that 4.5% and 13% of those convicted of wildlife crimes received jail sentences in Namibia and Botswana, respectively (Space for Giants n.d. [a,b]). The situation was very different in Zimbabwe's Kaza region, where 25.8% of all those convicted of wildlife crimes, and 96% of those convicted of elephant-related crimes, were sent to jail (Space for Giants n.d.[c]). Clearly there is scope for more in-depth comparative analysis.

More generally, the lack of overall consistency in sentencing is worrying, since it is important for justice to be seen to be done, through the imposition of sentences proportional to the crimes committed. In this respect, much effort has been devoted in recent years to training magistrates on the seriousness of such crimes and the use of the (non-binding) sentencing guidelines in the Rapid Reference Guide. Future studies may provide evidence of a trend towards more consistent sentencing in more recent wildlife trials. However, that there is still some way to go was highlighted by the outcome of a recent long running case, where two defendants were sentenced to a mere two years in jail, after a nine-year trial, for the trafficking of nearly four tonnes of ivory (Jayanathan 2022).

The failure of Kenyan prosecutors to convict suspected high-level traffickers, and especially the overturning, on appeal, of the landmark conviction in the notorious "Feisal case", has been widely reported

and analysed (Morris 2018). The fact that only one other "high-level" trial has resulted in conviction (Jayanathan 2022) has been interpreted as showing that while the law is effective against petty criminals, those guilty of serious crimes are able to evade justice in Kenyan courts. Corruption is often identified as a key component of these disappointing outcomes[11].

The true picture is almost certainly more complicated than this. Our courtroom data provides no evidence that, in the period 2016–2019, cases involving larger amounts of ivory were less likely to end in conviction. On the other hand, there are some discrepancies in the courtroom data that could be explained as instances of corruption, especially the handful of cases referred to above where persons convicted of possession of large amounts of ivory received very light sentences (Fig. 8) and, possibly, the results of our rudimentary triangulation of courtroom data with data on seizures from BLF, indicating that not all those arrested in possession of ivory are brought to trial. Developing this approach, by comparing data from multiple sources, may be the best way to provide more conclusive evidence on the prevalence of corruption, and the extent to which it influences the outcomes of wildlife crime trials.

The period covered by our study was one of rapid change in the Kenyan legal system. In 2011, the appointment of a new Chief Justice, Willy Mutunga, heralded a much needed but slow reform of the judicial sector, which at the time of his appointment held over a million cases in backlog, reflecting a chronic lack of funding and other necessary resources (Government of Kenya 2010; Mutunga 2011). By 2013, Kenya's prosecution service still numbered only around 160 prosecutors for the entire country and police prosecutors were still conducting most prosecutions, including wildlife crime cases (Kahumbu et al. 2014). An important milestone in the prosecution of wildlife crimes was the creation of a dedicated Wildlife Crime Prosecution Unit (WCPU) within the Office of the Director of Public Prosecutions (ODPP) in 2014. By 2019 all wildlife crime cases were prosecuted by the ODPP and, at the time of writing, the prosecution service has swelled to around 900 prosecutors. The results presented here provide some evidence that capacity building efforts may be leading to more effective prosecutions, namely: fewer errors in charging between 2016 and 2019; fewer failures to convict where suspects pleaded guilty, and the 100% conviction rate in 2019.

Going forward, steps are being taken to reduce delays in criminal courts and, in partnership with UNODC, to develop more prescriptive sentencing guidelines. The latter, if adopted, should pave the way to more consistency in sentencing and a more robust approach to prosecution appeal against lenient sentences.

Conclusion

The courtroom monitoring data analysed in this study, although incomplete and faulty in some respects, provide valuable insights into the workings of the Kenyan judicial system. One key lesson learned is the importance of including experts in data collection and analysis in investigative teams from the start, as well as legal specialists. However, some mistakes were perhaps unavoidable considering the sheer volume of data collected. Our paper considers fewer than 250 cases of wildlife crime out of the more than 2,000 records of cases that were collected and logged by courtroom monitors between 2016 and 2019. This hugely ambitious national monitoring programme was complemented by in-depth case tracking of important cases, involving large seizures of ivory. For future studies, we suggest that intermediate scale studies incorporating data from multiple sources may be the best way to assess "law enforcement adequacy", including success in tackling corruption, in relation to ivory poaching and trafficking. Such studies would focus on a selected subset of cases for which reliable information on arrests and seizures is available, following them from the moment of arrest through to imposition of the sentence in the form of payment of a fine or serving of a jail term. If possible, they should also include scientific analysis to determine the provenance of seized ivory, as well as taking account of related data on elephant mortality and HEC, to provide a contextualized picture of the law enforcement process.

[11]See for example: https://www.seej-africa.org/commentary/wildlife-crime-how-to-identify-a-corrupted-ivory-trafficking-trial/

The courtroom monitoring data analysed in this study highlights some weaknesses in handling of wildlife crime cases by the Kenyan Judiciary, including faulty charging, deficient evidence handling, and inconsistent sentencing. However, our results also suggest how improving legal processes can provide greater protection for wildlife. By creating stronger prosecution services and a more efficient judiciary, leading to faster trials and consistency in sentencing, the risk of corruption is mitigated, and the efficiency of the criminal justice system enhanced. For this to occur, a key requirement is commitment by the government to invest in improving the criminal justice system, enabling digitization, performance management, and a centralized intake of cases. Government lawyers need to be paid well to attract and retain professional expertise. However, it should not be forgotten that the cases reviewed here represent only a very small part of illegal ivory trafficked in Kenya during this period. Effective law enforcement in the courts is just one part, albeit a crucial one, of the comprehensive strategy required to end the illegal wildlife trade.

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MANAGEMENT

Who's Who & Whereabouts: an integrated system for reidentifying and monitoring African elephants

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Abstract

Monitoring populations of endangered species is critical to understanding the threats they face and to managing interventions to ensure their long-term survival. Individual recognition further allows for essential studies of life history, home range, population dynamics, social behaviour, and photographic capture-recapture, all of which can make conservation interventions more effective. African elephants (*Loxodonta africana, L. cyclotis*), endangered keystone species, have been subjects of several long-term studies involving individual recognition, yielding critical knowledge for their conservation. Ongoing concern for elephant survival has also led to increased interest in engaging non-scientists in monitoring populations. Tools are therefore needed to easily reidentify individual elephants and to provide user-friendly collection, upload, analysis and sharing of data. We describe the development of the *Elephant Who's Who & Whereabouts*, a relational web-based database (DB) system, for registering, reidentifying and monitoring elephants. We tailored the DB for studying elephants in two populations: Maasai Mara ecosystem, Kenya, and Gorongosa National Park, Mozambique. The main components of the system are: a searchable database (*Who's Who*) of registered adult elephants with administration and user interfaces; a searchable database of observations (*Whereabouts*) including elephant sightings, signs, sick and wounded individuals, and mortalities, with admin and user interfaces; a user interface (*My Observations*) for entering and editing of data; a Smartphone application (*EleApp*) permitting collection and upload of data; a searchable Google-Earth-based Mapping interface with export functionality; a *Features Guide* (photographs and text describing how to identify elephants); a *User Info*. We describe the system's structure, functionality, and ease of use.

Résumé

La surveillance des populations d'espèces menacées est essentielle à la compréhension des dangers qu'elles rencontrent et pour la gestion des interventions mises en place afin d'assurer leur survie à long terme. En outre, la reconnaissance individuelle ouvre la voie à une analyse nécessaire du cycle biologique, du domaine vital, de la dynamique des populations, du comportement social et de la capture-recapture photographique, autant d'éléments qui favorisent une meilleure efficacité des interventions. Les éléphants d'Afrique (*Loxodonta Africana, L. cyclotis*), espèce clé en voie de disparition, ont fait l'objet de plusieurs études de long-terme intégrant la technique de reconnaissance individuelle, qui ont constitué une base de connaissance indispensable à leur protection. Le sujet de la survie des éléphants suscite également un intérêt accru pour l'implication de personnes non-scientifiques dans la surveillance des populations.

Des outils sont donc nécessaires pour une nouvelle identification des éléphants ainsi que pour fournir un environnement facile d'utilisation pour la collecte, le chargement, l'analyse et le partage des données. Nous décrivons ici le développement d'un système de base de données relationnelle en ligne (DB), « *Who's Who & Whereabouts* » (« Qui est qui et où vont-ils ? ») pour la surveillance, la reconnaissance et le recensement des éléphants. Nous avons configuré la base de données en deux catégories de population : l'écosystème Maasai Mara au Kenya et le parc national de Gorongosa au Mozambique. Les principaux éléments de cet outil sont les suivants : deux bases de données consultables avec interface administrateur et utilisateur, l'une répertoriant les éléphants adultes (*Who's who*), l'autre axée sur les observations d'individus, de leurs traces, des sujets malades, blessés, ou morts (*Whereabouts*). On trouve également une interface utilisateur, « My Observations » (*« Mes observations »*), permettant la saisie et la modification de données, une application sur smartphone (*« EleApp »*) pour la collecte et le chargement de données, une interface cartographique (« Mapping ») via Google Earth avec possibilité d'export, un guide des caractéristiques (*« Feature Guide »*) avec photos et textes expliquant comment identifier les éléphants et une information utilisateur (*« User Info »*). Nous détaillons ici la structure du système, ses fonctionnalités et sa simplicité d'utilisation.

Introduction

African elephants (*L. africana and L. cyclotis*) are under increasing threat from habitat loss, human-elephant conflict, civil conflict, and illegal killing (Thouless et al. 2016). Monitoring, the repeated observation of the same population through time using the same protocols, is a critical component of elephant conservation strategies (Blanc et al. 2007, Thouless et al. 2016, CITES MIKE 2021). Monitoring provides methodologically comparable data with which to detect changes in a population and the pressures on it over time, as well as the effectiveness of conservation interventions (Moss et al. 2011; Whitehouse et al. 2001). Near real-time data is especially important to respond to changing threats such as poaching or livestock incursions into protected areas.

Monitoring an elephant population from the ground or air, or through remote sensing, typically involves collecting data such as date, time, location, group size and composition. Data can be captured in the field on laptop computers, hand-held devices such as smartphones, and can include the automatic recording of date, time and precise location data based on built-in Global Positioning System (GPS) technology. Relatively low-cost digital devices increase opportunities to engage non-scientists in data collection. Projects that span large geographic areas and/or are especially labour-intensive can benefit from citizen science, while simultaneously providing opportunities to raise environmental literacy and motivate social change in environmental stewardship.

The emergence of smartphones with built-in GPS technology has led to a burst of publicly available sites permitting the upload of observation data via customizable forms (Magpi Mobile, Movebank, SMART, iNaturalist, Ushahidi crowd mapping platforms). While these off-the-shelf products can be customized for collecting basic data on elephant populations, none of them meet the needs of many biologists who also require an efficient method for identifying the individual elephants they observe and integrating the identified animals with group sightings data.

Monitoring individually known elephants in a population is the gold standard, as this approach yields data on life history events (births, deaths), population structure (age, gender, relatedness), and behavioural data. It is also essential to determine social relationships, measure growth and reproductive success, understand communication, and determine life history parameters, population dynamics (Moss et al. 2011, Goswami et al. 2011) and impacts of poaching (Poole and Granli 2022). Although elephants are easily recognizable, the larger the population the more difficult it becomes to discriminate between individuals. Digital filtering functions (Bedetti et al. 2020) can make reidentifying known individuals easier than manually searching through print-based descriptions and photographs (Moss 1996).

In 2011 we initiated two studies based on individual recognition, one in the Maasai Mara ecosystem, Kenya, and the other in Gorongosa National Park (NP), Mozambique. We created a relational database, the *Elephant Who's Who & Whereabouts*, to house two sets of information from the respective populations to be held in two sub-databases (hereafter DBs): 1) Data

on individually recognized elephants (*Who's Who DB*) and; 2) data on group sightings or "observations" (*Whereabouts DB*). We linked the two DBs via sightings of individually recognized elephants. Each DB was designed with a user interface (referred to as the *Who's Who* and the *Whereabouts*, respectively) and an admin interface (referred to as the *ID Interface* and the *Observation* or *OBS Interface*, respectively).

We built a separate *Who's Who & Whereabouts DB* for each population and developed separate smartphone applications (*EleApp*) to permit the capture and upload of geospatial data from the respective populations. The *Who's Who DB* was populated by the authors, while the *Whereabouts DB* was populated by many individuals, both scientists and others, and administrated by the authors. In the Mara we aimed to involve volunteers, as this was a citizen science initiative. While we designed the *Elephant Who's Who & Whereabouts DB* to function as an integrated method for monitoring a population of individually recognized elephants, the *Who's Who DB* and the *Whereabouts DB* could equally well function as stand-alone tools for identifying elephants in the field or for collecting geospatial data on groups of elephants, respectively. The aim of this paper is to describe the design and functionality of the *Elephant Who's Who & Whereabouts DB* with enough information for others to be able to create similar tools for studying an elephant population.

Methodology

Terms used

Administrator(s): DB-managers (JP, PG) approved data providers/users, verified, corrected and exported data[1].

Admin interface: interface for the managers to administrate the DB.

Observation: a record in the *Whereabouts DB*, which could be a sighting of a group, individuals captured on trail cameras, signs of elephants, sick or wounded individual(s), a mortality.

Register: enter a record of a newly identified elephant in the *Who's Who DB*; give it a unique code number and enter in its attributes.

Reidentify: to match an observed or photographed elephant with one registered in the *Who's Who DB*.

Record: an entry into the DB. In the *Who's Who DB* a record is an elephant; in the *Whereabouts DB* a record is an observation as described above.

Sighting: a record of an elephant or a group of elephants, including those gleaned from trail cameras.

User interface: interface for users to access and query the DB.

Database structure

In 2011 we described the concept and functional design of the relational DB, the *Elephant Who's Who & Whereabouts*, and the smartphone *EleApp* in a comprehensive specification document, which was the basis for coding and design by programmers at Verviant Consulting Services, Kenya. The system consisted of 11 components (Fig. 1).

We created: 1) The *Who's Who DB*, a searchable elephant identification database with 35 tables. 2) An *ID interface* for the authors to register elephants and code in their identifying attributes (see Table 1, 2). 3) A searchable *Who's Who* user interface for querying the registry or reidentifying registered elephants based on their observed attributes (Fig. 2, 3). 4) The *Whereabouts DB* (11 tables), a searchable database of observation events for five types of records (Table 3): Sightings of elephants; records captured from trail cameras; sightings of sick and wounded individuals; signs of elephants; and mortalities. The *Whereabouts DB* included overarching attributes common to each observation event (e.g. date, time, observer, observer type, general area, place name, GPS location) and attributes specific to the record type. We linked the *Whereabouts DB* to the *Who's Who DB* via records of reidentified individuals. 5) *My Observations*, a user

[1]To avoid the possibility that someone might use the database to find elephants with big tusks we had a built-in time lag between observation upload and its online display. We permitted only individuals we knew to use the DB and we required a reasonable written reason for their request.

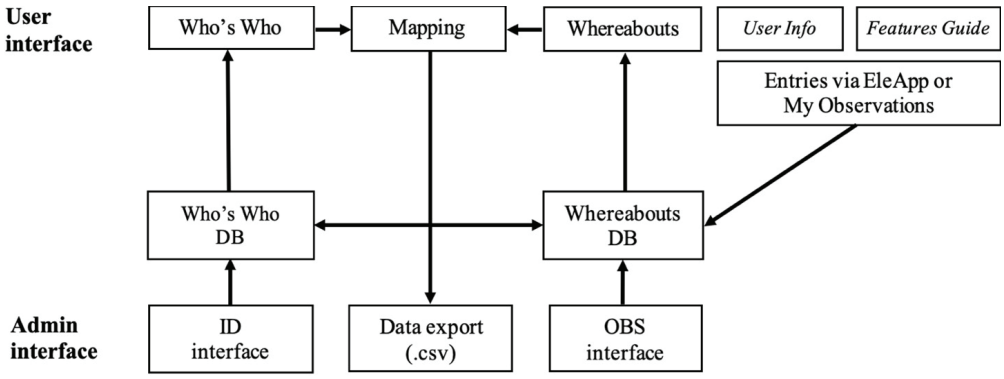


Figure 1. Elephant Who's Who & Whereabouts Database and user information.

interface for computer upload of data by approved users. 6) The *EleApp*, a smartphone application for field data collection and upload that mirrored *My Observations*. 7) An *OBS Interface* for the authors to verify uploaded records. 8) A *Whereabouts* user interface for searching through sightings of elephants. 9) A searchable Google Earth-based *Mapping* interface for geospatial data display and, for approved users, export (.cvs format) of returns from filtered searches. 10) A *Features Guide* with lessons on how to reidentify elephants and illustrations of their characterizing physical attributes. 11) A *User Info* document.

The elephant attributes were developed from those used by the Amboseli Trust for Elephants (ATE) and are common across all African elephant populations (Tables 1, 2). Sightings and Trail Camera Sightings attributes were based on long-term monitoring protocols used by ATE for 50 years (Moss et al. 2011; Table 3). Mortality criteria followed those developed for the Monitoring Illegal Killing of Elephants (MIKE) programme under the Convention on International Trade in Endangered Species (CITES MIKE) (Table 3). Attributes for signs of elephants were developed from our previous work, and we used input from veterinarians to develop criteria for sick and wounded elephants (Table 3). We programmed the DB such that when a record of a dead, sick, or wounded elephant was uploaded, an email with relevant information could be automatically sent to specific recipients (e.g. veterinarian, warden).

The *Mara EleApp* was published on Google Play, while the *Gorongosa EleApp* was distributed by the authors directly to approved users. The *Who's Who & Whereabouts* user interfaces for both Maasai Mara and Gorongosa were accessible via the ElephantVoices website, www.elephantvoices.org, built in a Joomla CMS environment and hosted by www.ciscowebservers.com. Both were password protected.

Results

The Who's Who Database

ID interface

The authors (JP) registered elephants in the *Who's Who DB* via the *ID interface*.[2] Using photographs taken by the authors and other users we registered 1,214 and 396 adult elephants in the Mara and Gorongosa populations, respectively. We populated each record with up to 36 fields of life history and physical attributes (Tables 1, 2) and uploaded up to six annotated photographs (photographer, year) of the face, ears, and tusks (left and right profiles, head-on with ears spread), and special features or alternative views. If we obtained more accurate images, older photographs were archived within the system, thereby keeping IDs accurate and permitting documentation of changes in appearance or the breakage or growth of tusks over time.

Who's Who—The user interface

The *Who's Who* user interface supported two types of queries: Query the registry about the elephant population, and search for an individual under observation to reidentify it.

[2]Mara elephants were registered from 2011-2015 and Gorongosa elephants from 2011-2019

Table 1. Physical attributes in the *Who's Who DB* used to register and reidentify elephants. Illustrations can be found on How to identify African elephants

Sex N=2	Size N=5	Ear right/ left N=28	Ear shape & lobes N=9	Tusks N=21	Body N=4	Trunk/face N=9	Tail N=5
Male	Calf	Completely smooth	Very big ears	No tusks	Head low	One eye blind	Kinky tail
Female	Juvenile	Tiny nicks	Very small ears	One–left	Bump/lump left	Chopped trunk	Short tail
	Small adult	Serrated	Wavy edge	One–right	Bump/lump right	Slit cut trunk	Half tail
	Medium adult	Ragged	Lobes curl outward	Broken left	Permanently lame	Other trunk injury	No tail
	Large adult	2 or more notches	Lobes curve inward	Broken right	Collar	Wart/bump trunk	No tail hairs
		Outstanding notch/tear	Lobes bulge	Equal length		Wart/bump face	
		U-notch	Lobes jut forward	Shorter left		Wrinkled forehead	
		V-notch	Lobes pointed	Shorter right		Pointed forehead	
		Cup-notch	Lobes rounded	Very short			
		Dip-notch		Very long			
		Scoop-notch		Symmetric			
		Square-notch		Higher left			
		Slit from edge		Higher right			
		Finger-flap		Up curved			
		Flap-cut		Straight			
		Unusual notch		Splayed			
		Hole		Convergent			
		2 or more holes		Crossed			
		Slit hole		Skewed			
		Wart/bump		Wonky			
		Prominent veins		Very thick			
		Damaged		Very slender			
		Curtain					
		Flop					
		Droopy					
		Wedge					
		Fold					
		Crinkle					

Table 2. *Who's Who DB* data entry fields coded in to register an elephant via the ID interface (n=number of attributes; Table 1). Dropdown or radio button selections in italics; yr=year, mth=month, wk=week

Name and Photographs	Life-History	Features (see Table 1)
Code	**Sex** (*male, female*)	**Tusk shape and configuration** (n=21)
Name	**Birth year and accuracy** (*within 10, 5, 2 yrs, 6, 1 mth*)	**Right ear** (holes, notches, tears) (n=28)
Home area (if useful)	**Estimated age** (*automatically calculated from birth year*)	**Left ear** (holes, notches, tears) (n=28)
Notes	**Age class** (*0A, 0B, 1A, 1B, 2, 3, 4, 5; calculates from age*)	**Ear shape and lobes** (n=9)
Photo left ear (*date, photographer*)	**Size class** (*large, medium, small adult, juvenile, calf; calculates automatically from age*)	**Trunk and face** (n=8)
Photo right ear (*date, photographer*)	**Mother and accuracy** (*known, good idea, guess, unknown*)	**Body** (n=4)
Photo front (*date, photographer*)	**Family and accuracy** (*known, good idea, guess, unknown*)	**Tail** (n=5)
Photo extra (*date, photographer*)	**Matriarch**	
Photo extra (*date, photographer*)	**Death year and accuracy** (*exact or within 1 wk, within 3 mths, within 1 yr, within 2 yrs, unknown*)	
Photo extra (*date, photographer*)	**Death cause** (*natural, management, illegal*)	
	Motivation (*ivory, bushmeat, conflict, euthanasia, other, unknown*)	
	Death means (*multiple bullets, single bullet, shotgun, poison, spear, arrow, snare, pit trap, other, unknown*)	
	Death reason (*natural injury/ accident, disease, drought, old age, neonatal, predation, other elephant, other, unknown*)	
	Right tusk (*intact, pulled out, chopped out, removed by authorities, naturally absent, unknown*)	
	Left tusk (*intact, pulled out, chopped out, removed by authorities, naturally absent, unknown*)	

Table 3. Whereabouts DB data entry fields: text entry (te), dropdown (dd) menu or radio-button (rb). Dropdown or radio button selections in italics. *Signifies required data

General entry		
Observer (te)*		
Observer type (dd: *researcher, ranger, scout, guide, veterinarian, management, tourist, other*)*		
Date/time (calendar or automatically taken from phone)*		
General area (te)*		
Place name (te)		
Geospatial location in decimal degrees (entered or clicked on map; automatically taken on Smartphone app)*		
Field notes (te)		
Observation type (rb: *sightings, trail cam sightings, sign, mortality*)*		
Sightings and trail cam sightings	**Sick and wounded**	**Mortality**
Group type (dd: *family groups only, family groups with males, males only unknown*)*	**Elephant ID** (te)	**Elephant ID** (te)
Number of individuals (te)*	**Sex** (dd: *male, female, unknown*)	**Sex** (dd: *male, female, unknown*)*
Count accuracy (dd: *exact count, good estimate, guess*)*	**Age sick wounded** (dd: *adult, subadult, juvenile, calf, unknown*)	**Age of elephant at death** (dd: *adult, sub-adult, juvenile, calf, unknown*)*
Families recognized (te)	**Sick type** (dd: *injury, sickness, unknown*)	**Carcass age*** (dd: *fresh–less than 3 weeks, recent–3 weeks to a year, old–greater than 1 year, very old, unknown*)
Names/ID Codes recognized females (te)	**Foraging affected** (rb: *yes, no*)	**Date of death** (select on calendar)
Names/ID Codes recognized males (te)	**Movement affected** (rb: *yes, no*)	**Cause of death** (dd: *natural, management, illegal, other, unknown*)* Once selected brings up relevant death means, motivation (Table 2)
Oestrous female (te and rb: *yes, no*)	**Type of wound** (dd: *abscess, bullet wound, arrow wound, spear wound, snare wire cutting into skin, snare wire loosely attached, chopped off tail, chopped of trunk, lame, predation, tusk wound, other, unknown*)	**Reason for death** (dd: *natural injury/ accident, disease, drought, old age, neonatal, predation, another elephant, other, unknown*)
Musth male (te and rb: *yes, no*)	**Injury status** (dd: *fresh, infected, healing, old, unknown*)	**Status of left and right tusks** (dd: *intact, pulled out, chopped out, removed by authorities, naturally absent, unknown*)*
Sick and wounded (rb: *yes, no*)	**Sign**	**Found by** (dd: *patrol, local community, guide, tourist, scientist, other*)*
	Sign type (rb: *footprints, dung, foraging, rub marks on trees, sounds of elephants*)*	**Specific location** (te)
	Sign age (dd: *fresh–less than 24 hours, recent–1 day up to a week, old–1 week up to a month, very old–more than a month*)*	

a. Query the elephant registry

Query the Elephant Registry allowed users to use life history criteria to search from among all registered elephants living or dead (Fig. 2). A count of the number of animals returned, permitted a user to obtain a demographic report on subsets of the population.

b. Search for an individual

To reidentify an elephant users selected sex and size class (if known) and the most salient physical features of the elephant from among the drop-down menus: tusk shape and configuration; left and right ear holes, notches, and tears; ear shape and size; face and trunk; tail; and body (Table 1, 2).

Users selected multiple attributes under each physical feature, where appropriate, such as under tusks, "one left" and "broken left." The search query used a "combinatorial key" algorithm to simultaneously filter the database by more than one physical attribute such that the following attributes: female + large adult + no tusks + right ear hole + very big ears, returned only those elephants with all these characteristics. The search included a count of the number of animals matching all these characteristics, in this case from Gorongosa, only one (e.g. Fig. 3). The corresponding individuals were listed together with thumbnails of their ID photographs (with mouse hovered over code name) and primary life history information, permitting a quick check for a match. If the individual was not found, an adjustment to the criteria was easily made and another search performed. Clicking on an elephant's code number brought up its digital ID card (Fig. 4) displaying larger photographs; clicking on these enlarged them further. The ID card also included life history information as well as all coded attributes and was printable. Scrolling down below the card revealed basic information from all sightings of the individual.

Functionality of the Who's Who

To test the functionality of the *Who's Who* for reidentifying elephants, we used a Random Number Generator to select 25 adult males and 25 adult females from among the registered Mara elephants. Examining the ID photographs of each individual we performed a search by selecting the most salient and/or unique features and keyed these into the Who's Who user interface and filtered. We noted the number of ID photos available of each elephant, the number of features selected, the number of animals returned and whether the individual was among them. The 50

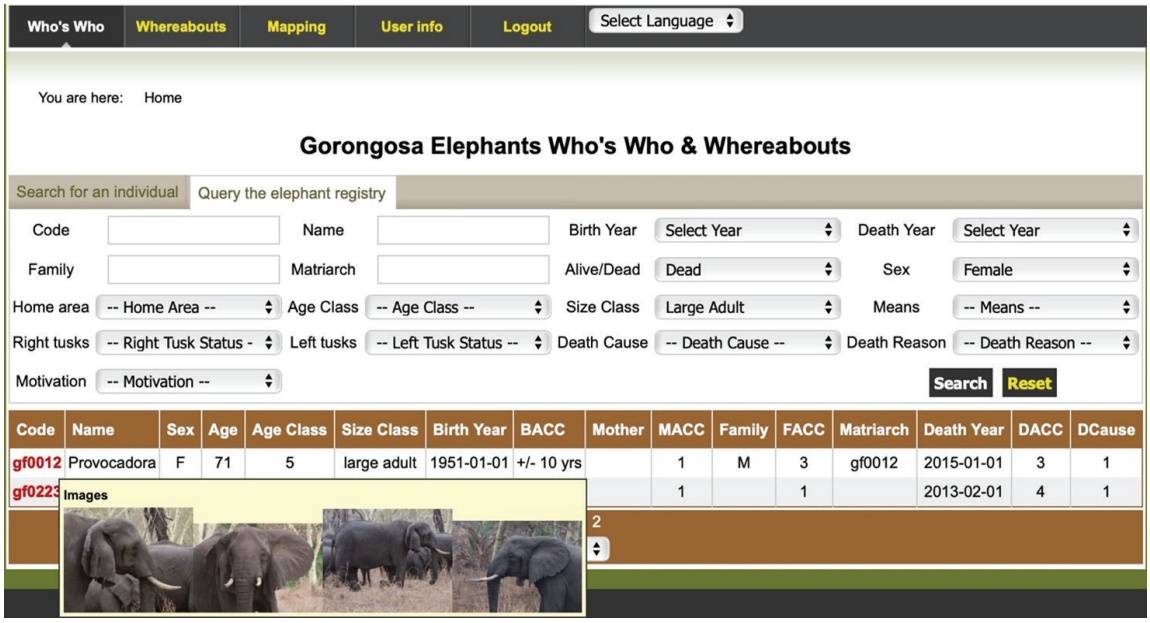


Figure 2. Selections available on Query the Elephant Registry, e.g. Dead, Female, Large Adult; hovering over code gf0012, one of the resulting elephants, shows thumbnails of *Provocadora*.

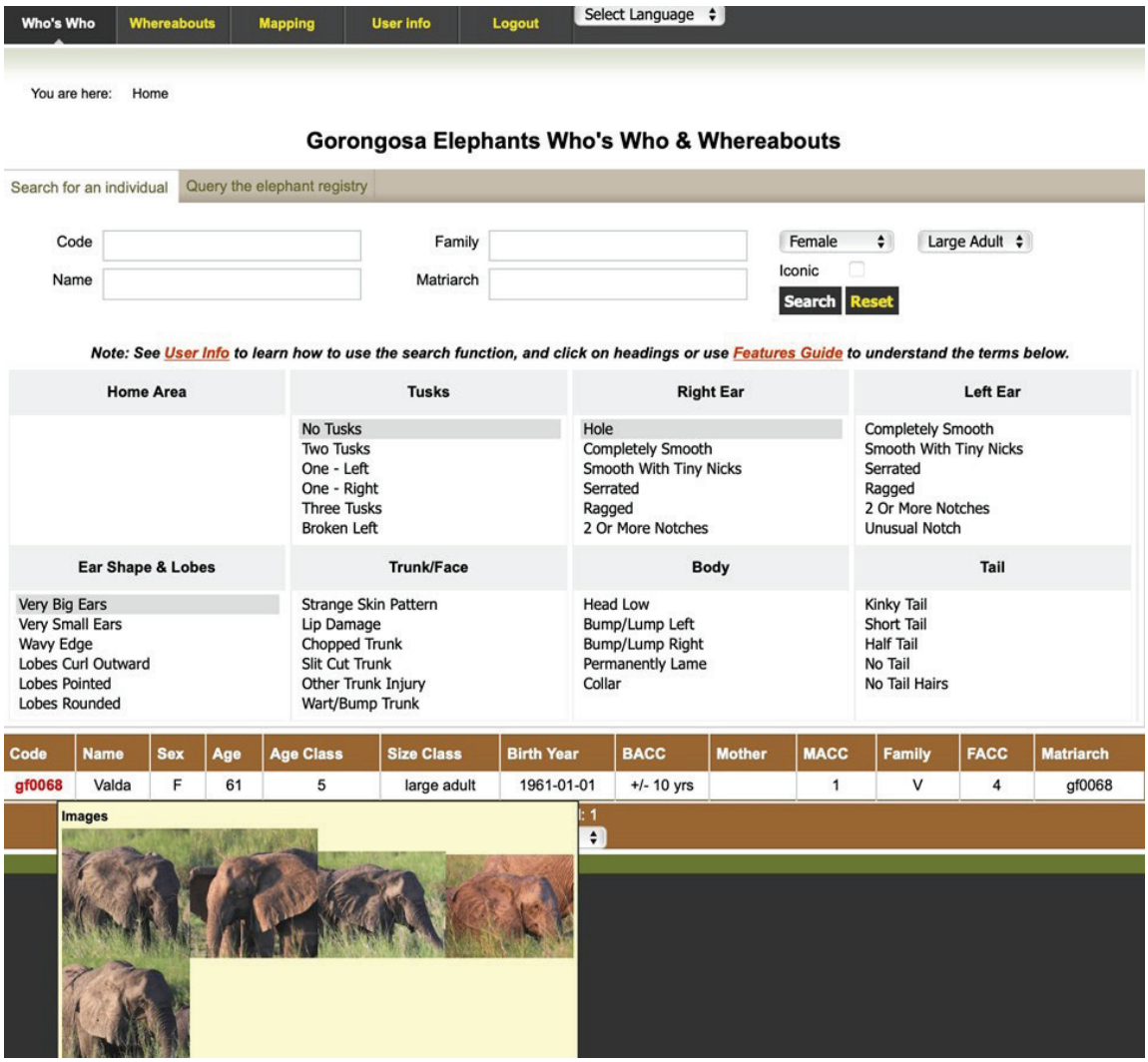


Figure 3. Example of a search on the Gorongosa *Who's Who*. Selecting Large Adult/Female/ Tuskless/Large Ears/Right Ear Hole returns one individual, Valda. Note: there are many more options under the features drop-downs that are not visible in the figure.

ID Card for gf0013

Elephant Details — Add observation | Print ID card

Code	Name	Sex	Age	Age Class	Size Class	Birth Year	BACC	Mother	MACC	Family	FACC	Matriarch
gf0013	Valente	F	56	5	large adult	1966-01-01	+/- 10 yrs		1	M	2	gf0012

Notes

First recorded 2012. She has been seen with gf0012 a few times and looks very similar to her. Could be a sister, perhaps. She is part of the Terrible Trio who charged us. Collared by Dominique in 2018

Home area	Tusks	Right Ear	Left Ear
	Two tusks Higher right	2 or more holes Flap-cut	Scoop-notch 2 or more notches
Ear shape & lobes	**Trunk/Face**	**Body**	**Tail**
Lobes curve inward		Collar	

Photos

Right Ear

Left Ear

Front

Observer	Seen on	General area	Place Name	Group type	Group Size	Females recognized	Males recognized	Field notes
Joyce Poole	01 November 2016		picada 4	Family Group(s) with Adult Males	63	gf0001, gf0013, gf0014, gf0016, gf0017, gf0018, gf0020, gf0021, gf0022, gf0023, gf0024, gf0025, gf0056, gf0058, gf0079, gf0088, gf0164, gf0190	gm0045, gm0057, gm0124, gm0141	Picada 4 we stopped at 250m from the elephants and sat there. We heard vocalisations as if there was a mating but we didn't see one. Then the elephants came toward us. They came to within 5m (Viajante...

Figure 4. Illustration of the individual Valente's digital ID card. Below the card all sightings of her are listed and linked via the observation date. We provide one sighting as an example. Note that her associates are also linked to their respective ID cards.

individuals had a mean of 2.36 (range 1–6) ID photographs. In all but six cases the first search returned a list of individuals that included the sought-after elephant. The average number of animals returned was 5.2 with a range of 1–56; 16 of the 44 successful searches returned only the sought-after individual (Fig. 5).

The Whereabouts database

OBS interface—The admin interface

Only approved users could see or upload data to the *Whereabouts DB*. The authors verified and edited uploaded records via the *OBS Interface*. If, for example, we found a record of an all-male group of 60 elephants (an unlikely sighting) we contacted the observer to verify that he or she intended to select that group type or enter that number. We checked to ensure that the general area selected, or place name entered matched the GPS data acquired. If redundant data were found—such as when two observers uploaded a record of the same individual or group on the same day in the same location, we kept the first or most complete record.

We also checked any uploaded photographs, identified elephants, and added their code numbers to the record. Unknown elephants were registered if the photographs were good enough to clearly distinguish identifying features. If uploaded photographs showed that features of a registered elephant had changed, we updated the record in the *Who's Who DB* and archived

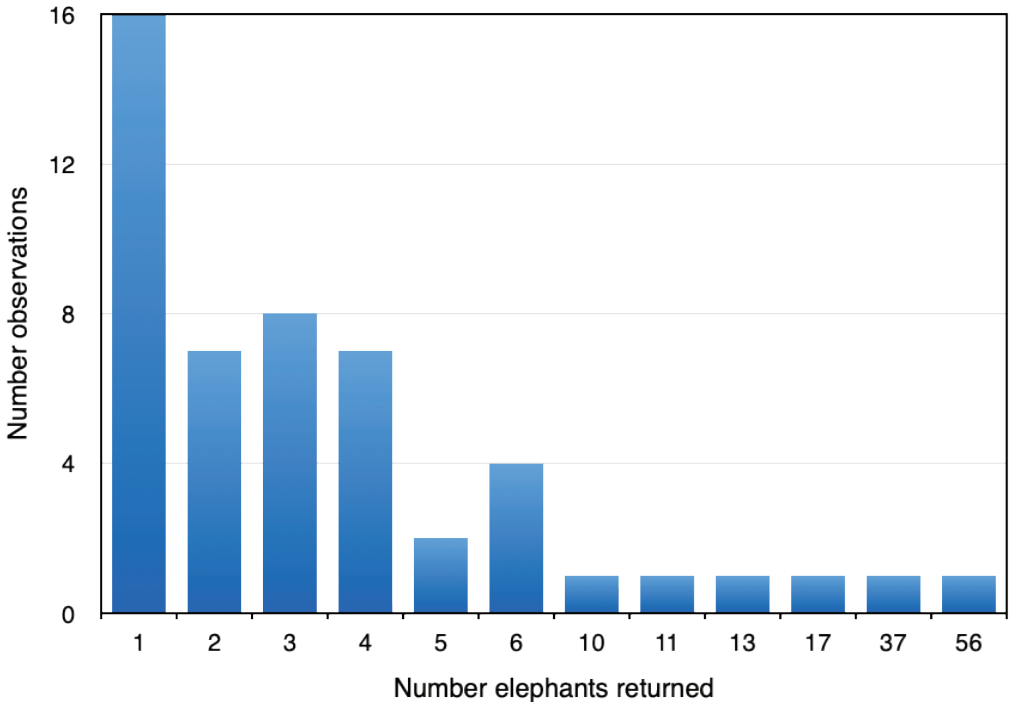


Figure 5. Number elephants returned on 44 successful searches.

the out-of-date photograph.

My Observations—entering, uploading and editing data

My Observations was the web interface to the *Whereabouts DB* where a user could enter, upload, and edit his or her record. Records were either collected with the *EleApp* and uploaded directly (see below) or entered via *My Observations*. General data (Table 3) were entered first and then the type of observation was selected, which prompted a specific sub-set of data entry queries (Table 3). Submitting a record with an elephant ID code or name automatically linked the entry to the ID card(s) of the relevant elephant(s). All required data (* Table 3) had to be entered to save a record. Once saved online, the user could edit or delete the record.

The EleApp smartphone application

The *EleApp* consisted of an easy-to-use form (mirroring the online data entry described above; Fig. 6) for the collection, preliminary storage, and upload of observations to the *Whereabouts DB*. The record date/time and GPS location were automatically acquired from the Smartphone itself. Photographs could be taken within the *EleApp* and be included in the record. Data were saved and uploaded in real-time or uploaded once Internet connectivity was available. The *Gorongosa EleApp* included a bi-lingual (English, Portuguese) interface.

The Whereabouts—The user interface

The *Whereabouts* user interface listed uploaded observations by date and included basic information: Observer, date, time, number of photographs uploaded, general area, place name, females or males recognized and field notes. The date offered a link to the full observation where photographs, GPS coordinates and a map of the location could be seen.

The *Whereabouts* could be queried to produce a report of observations by type, general area, type of observer, elephant group type, and group size range. A search box permitted a free text submission, which allowed a user to search for all observations by a particular observer, elephant name or code, place name or any word that may have been included in the comment field, such as “musth” (Fig. 7).

Table 4. *Who's Who DB* data entry fields coded in to register an elephant via the ID interface (n=number of attributes; Table 1). Dropdown or radio button selections in italics; yr=year, mth=month, wk=week

Group type	Number of records Mara	Number of records Gorongosa
Total	**4,038**	**1,574**
Elephant sightings	**3,073**	**867**
Single males and bull groups	*738*	*350*
Family groups with or without associating males	*2,277*	*485*
Unknown type	*51*	*31*
Trail camera sightings	**-**	**455**
Single males and bull groups	-	193
Family groups with or without associating males	-	250
Unknown type	-	12
Sick and wounded		**37**
Elephant mortalities	**106**	**24**
Elephant signs	**859**	**215**

Number of Records and Participants

By April 2015 the Mara *Whereabouts DB* held 4,000 records collected by 251 individuals and the Gorongosa *Whereabouts DB* held 1,671 records collected by 32 individuals. In addition to ourselves, data contributors included scientists, guides, photographers, rangers, tourists, veterinarians, and members of the local community (Table 4).

The Mapping Interface

The *Mapping* interface included a Google-Earth map with full filtering and export (.csv) functionality that showed the locations of the uploaded observations. Geospatial layers (e.g. conservancy, protected area and forest boundaries, human settlements) were added where available and helpful. Users could filter by time frame, observer, elephant ID code or name, or observation type. By selecting Sighting, Trail Cam Sighting, Sign, or Mortality offered full selection and filtering possibilities under each type. Hovering over a single observation revealed a link to the record in the Whereabouts user interface (Fig. 8). Administrators could export filtered results as a .csv file for further analysis or to share with collaborators.

Features Guide: How to identify African elephants

The *Who's Who & Whereabouts* section on www.elephantvoices.org included a Features Guide on How to identify African elephants with illustrative photographs and written descriptions of the physical attributes used (Fig. 9). The guide included eight sections: How to (1) sex; and (2) age African elephants; how to use characteristics of the (3) tusks; (4) ear notches, tears and holes; (5) ear lobe size and shape; (6) trunk and face; (7) body; and (8) tail to identify individuals.

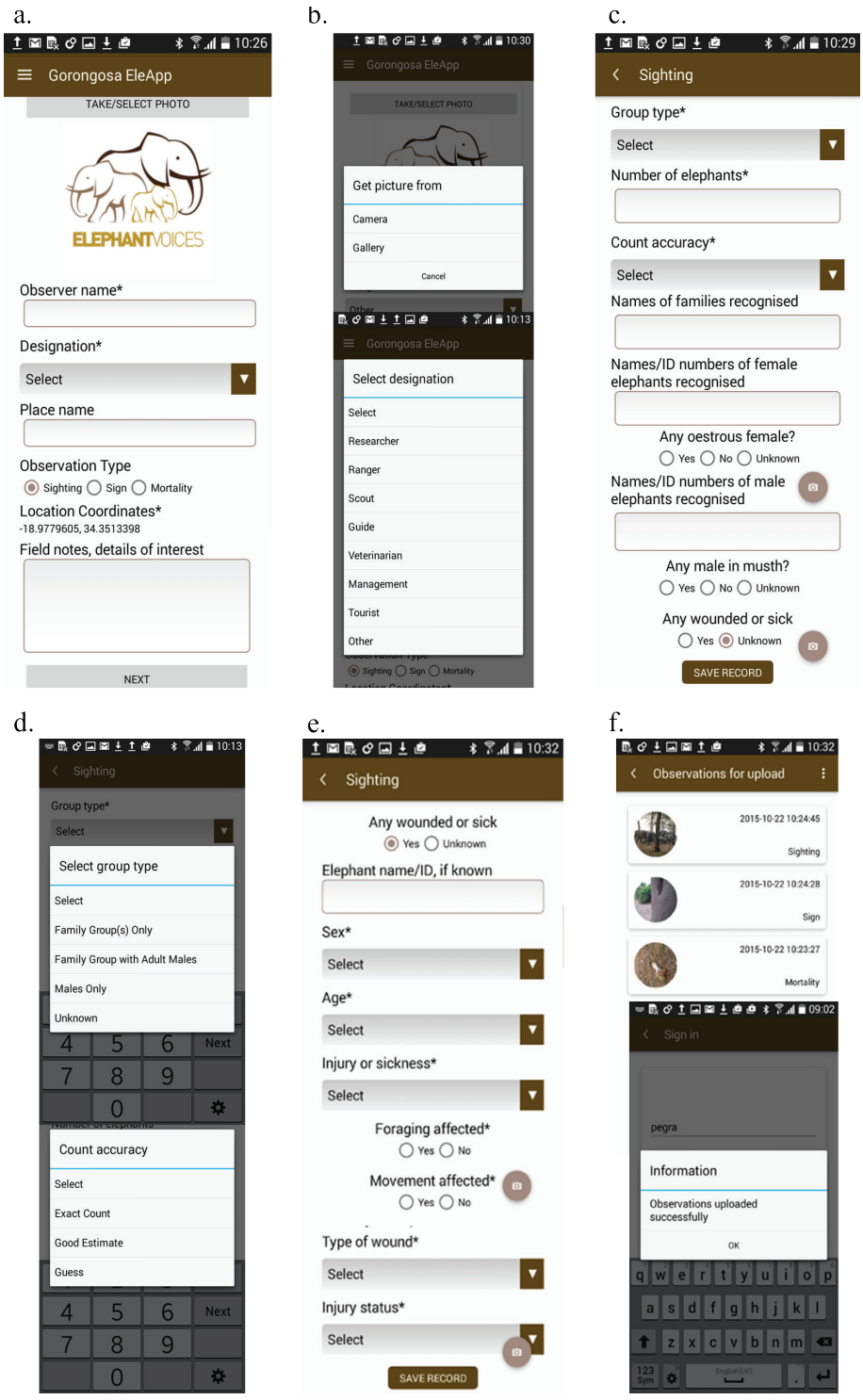
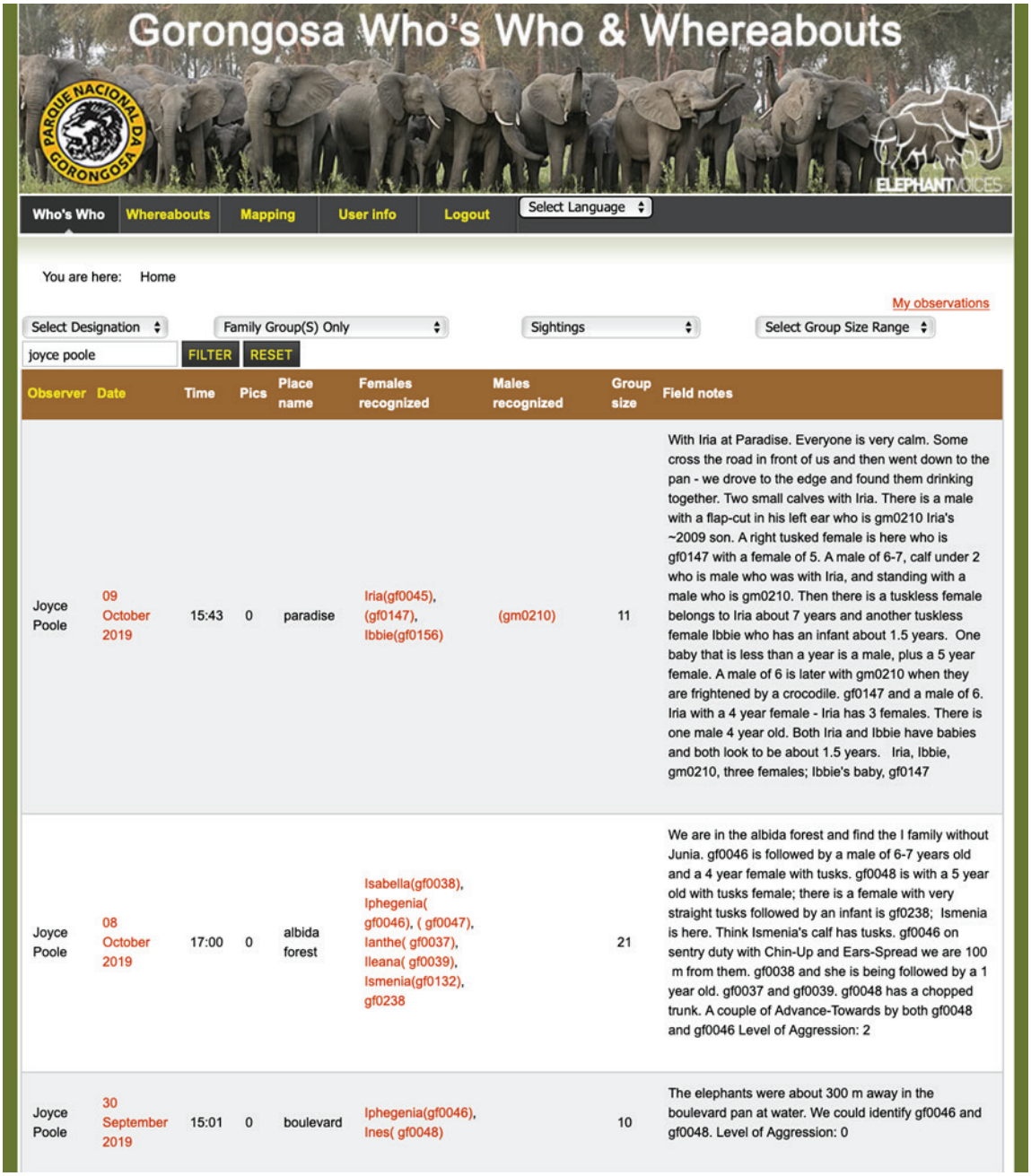


Figure 6. Screenshots a–f taken from the *EleApp* (as seen when a user scrolled through entering data), include the main entry (a, c and e) and upload (f) pages, some of the dropdown selections (e.g. b and d), and illustrate the ease of entering elephant sightings data. Date, time and location were taken automatically from the Smartphone. Entries marked with an * must be completed to upload.



Observer	Date	Time	Pics	Place name	Females recognized	Males recognized	Group size	Field notes
Joyce Poole	09 October 2019	15:43	0	paradise	Iria(gf0045), (gf0147), Ibbie(gf0156)	(gm0210)	11	With Iria at Paradise. Everyone is very calm. Some cross the road in front of us and then went down to the pan - we drove to the edge and found them drinking together. Two small calves with Iria. There is a male with a flap-cut in his left ear who is gm0210 Iria's ~2009 son. A right tusked female is here who is gf0147 with a female of 5. A male of 6-7, calf under 2 who is male who was with Iria, and standing with a male who is gm0210. Then there is a tuskless female belongs to Iria about 7 years and another tuskless female Ibbie who has an infant about 1.5 years. One baby that is less than a year is a male, plus a 5 year female. A male of 6 is later with gm0210 when they are frightened by a crocodile. gf0147 and a male of 6. Iria with a 4 year female - Iria has 3 females. There is one male 4 year old. Both Iria and Ibbie have babies and both look to be about 1.5 years. Iria, Ibbie, gm0210, three females; Ibbie's baby, gf0147
Joyce Poole	08 October 2019	17:00	0	albida forest	Isabella(gf0038), Iphegenia(gf0046), (gf0047), Ianthe(gf0037), Ileana(gf0039), Ismenia(gf0132), gf0238		21	We are in the albida forest and find the I family without Junia. gf0046 is followed by a male of 6-7 years old and a 4 year female with tusks. gf0048 is with a 5 year old with tusks female; there is a female with very straight tusks followed by an infant is gf0238; Ismenia is here. Think Ismenia's calf has tusks. gf0046 on sentry duty with Chin-Up and Ears-Spread we are 100 m from them. gf0038 and she is being followed by a 1 year old. gf0037 and gf0039. gf0048 has a chopped trunk. A couple of Advance-Towards by both gf0048 and gf0046 Level of Aggression: 2
Joyce Poole	30 September 2019	15:01	0	boulevard	Iphegenia(gf0046), Ines(gf0048)		10	The elephants were about 300 m away in the boulevard pan at water. We could identify gf0046 and gf0048. Level of Aggression: 0

Figure 7. The Whereabouts user interface showing a few records when filtered for "Sightings" of "Family Groups Only" by "Researcher" Joyce Poole.

Figure 8. The Gorongosa Mapping Interface filtered for sightings of family groups with associating adult males.

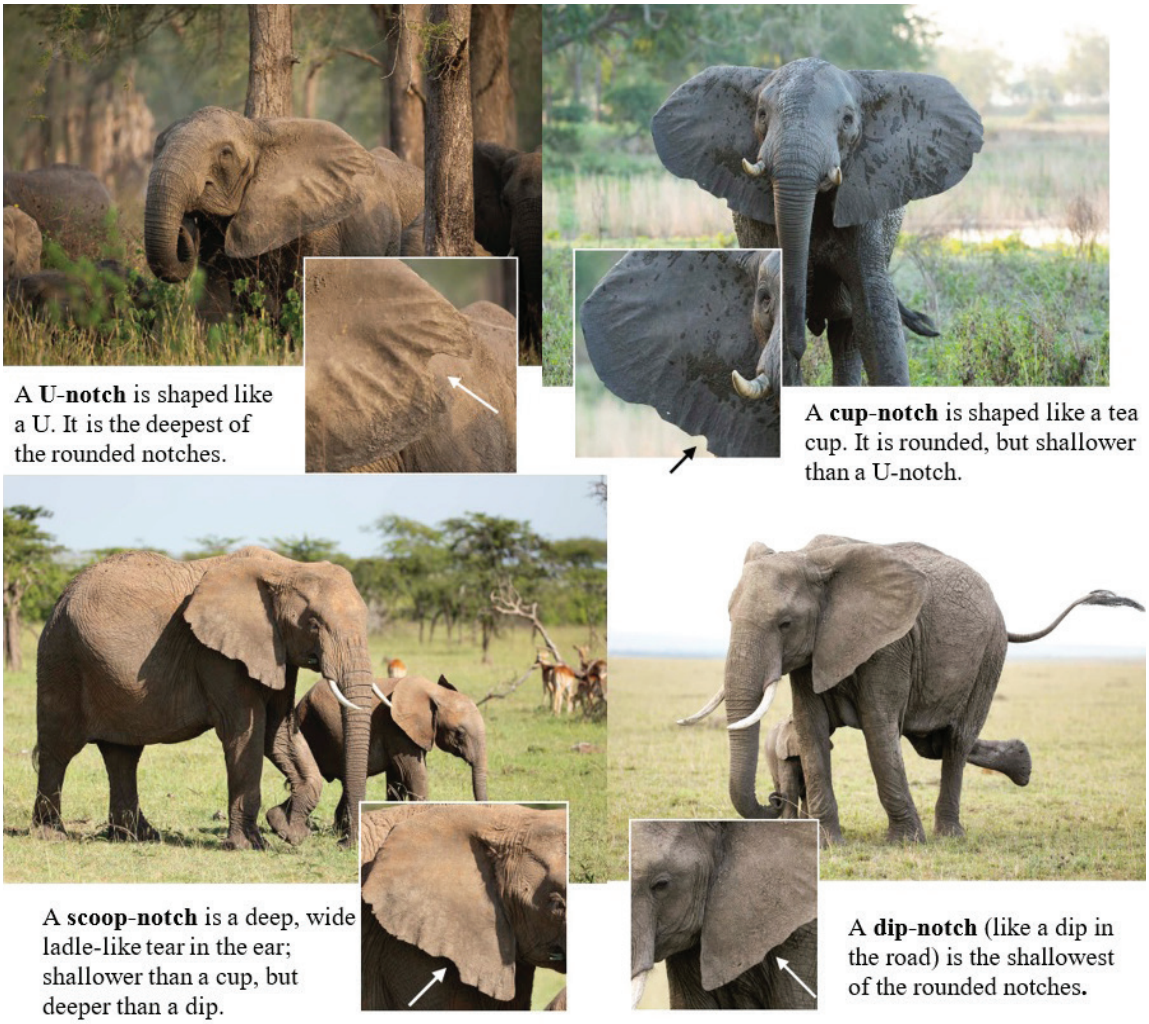


Figure 9. How to identify elephants on www.elephantvoices.org offers illustrative and written descriptions of all the attributes we used to identify elephants. Here, for example, are the rounded notches U, cup, scoop and dip shape. (*All images © ElephantVoices*)

Discussion

In this study we designed, built, and deployed a set of digital tools for individual registration, reidentification and monitoring of elephants. The combined effort of specialists and others yielded an extensive dataset of individual elephants, their families, associations, mean group size and distribution for both the Mara and Gorongosa populations. Filtered searches from the *Who's Who & Whereabouts* and *Mapping* interfaces yielded data for reports to wildlife authorities (Poole et al. 2015) and scientific publications (Gaynor et al. 2021; Campbell-Staton et al. 2021; Poole and Granli 2022).

Computer-aided image-recognition (pattern-matching) or machine learning software has been developed to quicken the matching process between an observed and registered individual for a few species that have distinct contours, spots or stripes (e.g. cheetahs, zebras, giraffes, tigers, sharks, seals, whales) allowing discrimination between individuals (Bergur-Wolf et al. 2017; Bolger et al. 2012). Attempts to develop an automated system for recognition of elephants have met with limited success because elephant skin does not exhibit a salient pattern and because skin wrinkle patterns and ear notches take on different shapes when viewed or photographed from different angles. Bedetti et al. (2020) describe a code-based reidentification system (SEEK; *Pachyderm* Vol. 61) for non-experts that uses a basic software application to search a database of known elephants for potential matches based on a code that combines age, sex, and the location of basic ear attributes of an observed elephant. The potential matches can then be checked against photographic records. Others have developed and tested automated reidentification approaches using computer vision algorithms for multi-curve matching to identify individuals through the contours of ears (Ardovini et al. 2008; Weideman et al. 2020), but these still require refinement. Most recently Kultis et al. (2021) developed a semi-automated hybrid system, ElephantBook, that relies on both computer vision and manual matching of physical attributes (SEEK), showing promising results for use by untrained observers, but requires the user to upload photographs to match an individual.

For observers with some elephant experience, the *Who's Who* offers a quick, intuitive, and reliable search function with immediate photographic returns that contains easily visible life history and social relationship data that makes reidentification simple. While our DB was web-based, an offline version on a tablet would provide an extremely efficient field tool. Computer and especially cloud-based data storage minimizes the risk of critical ID cards being lost, damaged, or stolen.

There is, undoubtedly, a degree of subjectivity inherent in classifying the features of elephants, for example, whether ears are defined as "very big" or "very small" or whether a notch is a "dip", "scoop", "cup" or "U." The size of elephant ears and tusks differ by individual as well as by population, thus what is considered big or small, long or short will also be influenced by local variation.

Furthermore, since the features of an elephant that stand out to an observer will vary from person to person, all salient characteristics must be coded in. For example, if an elephant has a **U-notch** and a **flap-cut** in the left ear, both plus **two or more notches** should be coded in for that ear. Likewise, if one feature might be confused for another (e.g. a **scoop** versus a **dip**) both should be coded. The key is to select only the most salient/least ambiguous features in a search. If too many individuals are returned, additional features can then be added to narrow the search. If no match is found after the resulting thumbnails are scanned, changes can be made to the selection.

The technique utilized by SEEK aims to avoid subjectivity by noting only whether a notch (of any type) occurred in upper, middle, or lower section of the left or right ear. Earlier versions of our technique also incorporated notch location, but we found that it created more ambiguity, as without accurate measurement it was often difficult to quickly "eyeball" in which third of the ear a notch was located.

While populating a *Who's Who DB* is a time-consuming job for a skilled person, once done it is relatively easy to keep updated. The *Who's Who* combinatorial key significantly reduces the time it takes to match an observed elephant with one in the database, compared to the process of searching through possibly hundreds of ID cards. Combined with the Features Guide, new researchers could learn to reidentify elephants without expert assistance. The *Who's Who* has the added benefit that life-history data and associations are stored together

with an individual's identifying characteristics, so that once an easily recognizable elephant is reidentified family members or regular associates can also easily be recognized.

Furthermore, our experience confirms that the *Who's Who & Whereabouts Database*, together with the *EleApp*, can be used by minimally trained citizen scientists to effectively contribute meaningful results to a larger effort to monitor an elephant population. Identifying elephants takes both patience, time and experience. In our projects most citizen scientists collected data that did not include individual identification but still provided valuable data on group size, type and location. There were, however, always a few highly dedicated people who learned to distinguish one elephant from another, or submitted photographs to us, and thus contributed valuable sightings of known elephants.

Collecting mortality data is a critical component of monitoring an elephant population. We modelled the collection of mortality data on the MIKE system so that it could be comparable to data from other populations or, if collected in a MIKE site, could contribute to MIKE data. Elephant deaths must be reported to the responsible wildlife authorities and, if collected by a citizen scientist, must be verified on site by a trained research officer.

The *Who's Who & Whereabouts Database* and *EleApp* provided a reliable, user-friendly, and productive way of building up comprehensive information on an elephant population. The data entry tools were adopted by a range of participants with different skill levels and motivations including scientists, guides, rangers, and other professionals, as well as by volunteers and others. Furthermore, tracking data from collars could also easily be integrated in the database.

Depending on the requirements of a study, the *Who's Who* and *Whereabouts DBs* could be used as stand-alone offline tools.

When we prepared the databases for our Mara and Gorongosa research we did not set out to build an off-the-shelf solution for others. This was primarily due to challenges related to customization, programming language, software, and hosting environment. We hope, however, that the structure, characteristics, menus and additional content described in this document will be useful to others who may wish to replicate the database or aspects of it.

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The outcome of an elephant translocation from Isiolo to Tsavo East National Park, Kenya

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Abstract

This management piece documents the outcome of an elephant translocation from Isiolo to Tsavo East National Park, Kenya in November 2021. The translocation aimed to reduce human-elephant conflict in the area and to prevent any retaliation toward the elephants. This was achieved by removing the 'problem elephant group', however the aim of resettling the elephants in Tsavo was not achieved, as the group fragmented and some swiftly moved far outside the release site. Two elephants, which we were able to monitor through satellite collars, exhibited homing behaviour and both left Tsavo East National Park within 1–7 weeks of being released. If translocation continues to be the method of choice for problem elephants, there is a need for thorough planning and sound science to inform future operations, which should include collaring of each individual. Trained personnel and substantial budgeting for post release monitoring, and any potential conflict-reduction interventions, are therefore key management considerations for ensuring the health and wellbeing of translocated elephants in the future. In the long-term, focusing mitigation management on a larger number of habitual crop-raiders will have more impact and be a more effective approach for elephant managers. This could involve better spatial land-use planning, maintenance of corridors between protected areas, negative conditioning tactics and maintenance and upgrading of barriers.

Résumé

Ce document relatif à la gestion des éléphants rend compte du bilan de la translocation de plusieurs sujets depuis Isiolo jusqu'au parc national de Tsavo Est au Kenya en novembre 2021. L'objectif était de réduire les conflits humains-éléphants dans la zone et d'éviter toute forme de représailles de la part des habitants. Les « éléphants problématiques » ont donc été délocalisés, mais l'ambition initiale de les établir dans Tsavo Est n'a pu être finalisée du fait de la fragmentation du groupe après la remise en liberté et de certains éléments s'étant rapidement déplacés loin du site de lâcher. Deux sujets, que nous avons pu suivre grâce à leur collier GPS, ont montré un comportement instinctif de retour vers leur habitat précédent et tous deux ont quitté le parc national de Tsavo Est dans les sept semaines suivant leur introduction. Si la méthode de la translocation continue d'être privilégiée pour les éléphants problématiques, il sera nécessaire de s'appuyer sur une planification rigoureuse et des données scientifiques solides pour les prochaines opérations, ainsi que sur la mise en place de colliers émetteurs sur chacun des individus. Du personnel formé et un budget substantiel, pour la post-introduction des animaux et les interventions potentielles de réduction des conflits, sont donc les clefs pour une gestion de qualité et pour assurer le bien-être et la bonne santé des éléphants transférés à l'avenir. À long terme, il convient d'accentuer les interventions d'atténuation envers un plus grand nombre

d'éléphants habitués à piller les cultures, afin d'avoir un réel impact et une approche plus efficace pour les personnes chargées de leur gestion. Cela peut se traduire par une meilleure planification de l'usage des terres, l'entretien des couloirs biologiques entre les zones protégées, des tactiques de conditionnement négatif et la maintenance ou l'amélioration des barrières.

Introduction

Translocation is a management tool involving relocation of wild animals from one part of their range to another. It is often used to re-establish or boost a population that is considered too small. Elephant translocations are also used to reduce the population in small areas and to mitigate human-elephant conflict (HEC), when a small number of individual elephants are responsible for many conflict incidents (IUCN 1998). Translocations are challenging and often fail or see limited success, documented in a number of case studies from Asia and Africa (Fernando et al. 2012; Pinter-Wollman 2009; Tiller et al. 2022). The success of translocating animals depends on the ability of the individual to survive by finding key resources, avoiding predation and human settlement, and later on reproducing in an unfamiliar environment (Berger-Tal et al. 2020).

In East Africa, elephant translocations are still relatively rare compared to South Africa, where the first translocation was in the 1970's and, since then, has been fairly common practice because of the large number of small, highly managed populations (Dublin and Niskanen 2003). The first translocation in Kenya took place in September 1995 when Kenya Wildlife Service (KWS) moved 26 elephants during five different operations from Mwea National Reserve (NR) to Tsavo East National Park (TENP), a largely unfenced area. Since then, TENP has become the main release site for other elephant translocations in Kenya (Table 1).

During the first translocations in Kenya in 1995 and 1996, five of the elephants died (three during immobilisation and two a few days after release). Monitoring of the remaining 21 elephants was not undertaken and so the success of the operation post-release remains unclear (Njumbi et al. 1996). Since then, there have been at least 18 other elephant translocation events in Kenya, with release sites of seven being Tsavo East NP (Table 1). Most of these translocations were a response to overpopulations of elephants in certain areas and to HEC.

Within these translocation operations in Kenya, there are several documented cases of mortality (Muir 2000; Pinter-Wollman et al. 2009; Tiller et al. 2022), a continuation of 'problem' behaviours such as crop raiding and fence breaking (Pinter-Wollman et al. 2009; Tiller et al. 2022) and 'homing behaviour', where the elephants reject their release site and try to return home to their home location or natal territory, often moving through human dominated landscapes in the process (Muir 2000; Pinter-Wollman et al. 2009).

This short paper documents the outcome of an elephant translocation from Kithima in Isiolo County

Table 1. Elephant translocations in Kenya where the release site was in Tsavo East National Park (NP)

Year	From	To	Total	Source
1995–1996	Mwea NR	Tsavo East NP	16	Njumbi et al. 1996
1999	Mwaluganje Elephant Sanctuary	Tsavo East NP	28	Muir 2000
2000	Shimba Hills NR	Tsavo East NP	4	Litoroh et al. 2001
2005	himba Hills NR	Tsavo East NP	150	Pinter-Wollman 2009
2006	Shimba Hills NR	Tsavo East NP	76	KWS darting protocol
2006	Ngulia, rhino Valley	Tsavo East NP	220	Okita 2008
2016	Chyulu Hills	Tsavo East NP	1	Lala pers. comm. 2022
2018	Borana/Lewa/Solio conservancies	Tsavo East NP	5	Tiller et al .2022

to Tsavo East NP on 26 November 2021. Two elephants were fitted with satellite collars and were part of a group of seven elephants that was designated for translocation. They had been identified as 'problem elephants' by the KWS, based on reported incidents of crop raiding, and had been observed 'roaming' through human settlements. The elephants were also reported walking within the busy town of Isiolo. KWS carried out several mitigation operations to chase away the elephants from the community, but to no avail as the elephants frequently returned. Consequently, community members were becoming angry about the situation and threatened to poison the elephants. Thus, with mounting tensions and the threats the elephants posed to human livelihoods and life, the decision was made to capture and translocate the elephants to Tsavo East NP. The fate of the other five elephants (three that were translocated and two that were not found before the translocation operation) remains unknown.

Methods

Five of seven target elephants (three sub-adult males, one male calf and one female adult) were located, tranquilised from helicopters, loaded into crates, and then transported separately by road to TENP in a journey that took between 12 and 18 hours. Upon arrival in TENP, all five were released immediately on the 28 November 2022. All national protocols on capture and animal handling were followed (KWS 2016). The translocation was to be carried out in two operations due to limited space in the transport vehicles, but upon return for the second phase of the operation the two remaining elephants could not be found. Two of the sub-adult male elephants, named *Isiolo* and *Njoroge*, were fitted with satellite collars (Savannah Tracking GL200 GPS). These collars consisted of a GPS unit, a VHF transmitter beacon and a battery integrated into one unit. The collars were fitted by a team including a veterinarian from the KWS. All the tracking collars were set to acquire GPS fixes at 1–hour intervals. Movement data were projected on the Universal Transverse Mercator (UTM) WGS-84 reference system.

Isiolo was observed twice during a collared elephant aerial monitoring exercise undertaken by the Tsavo Trust, where photos were taken and observations recorded. However, *Njoroge* was not observed whilst in TENP, as he left the park shortly after release.

Results

The sub-adult elephant *Njoroge* was hard-released near Gazi on the eastern side of the Yatta Plateau, north of the Galana river, in TENP. This area at the time had adequate vegetation and is near two rivers, the Galana and the Tiva. As soon as *Njoroge* was released, he exhibited homing behaviour, as he started to travel north-east through the park in the direction of Isiolo. He was observed during this time without any other members of his group or other individuals. Five days after release, *Njoroge* had left TENP. He continued to travel north crossing the Tiva river and three roads, including a main tarmac road (Thika-Garissa highway) before reaching Garissa, an area of historical insecurity challenges. Unfortunately, *Njoroge's* collar stopped reporting on 5 February 2022 when he was approximately 370 km from the release site, 31 km from Kora NP, 38 km from Rahole NR and 100 km from Meru NP (Figure 1). Several attempts have been made to find *Njoroge* and remove or replace his collar, though have so far all have been unsuccessful.

The other sub-adult male, *Isiolo*, was released at the same location as *Njoroge*, and from day one he also exhibited homing behaviour, as he started to travel north-west within TENP. He was observed during this time without any of the members of the group with whom he was translocated. However, his movements north were prevented by an electric fence on the park boundary. He then walked up and down the fence repeatedly until, in early January, he set off south and west of the Yatta Plateau, crossing the Tiva river.

On 7 January 2022, *Isiolo* left the park and entered community farmland in the Ngiluni area. He was initially unable to leave this area, as he could not cross the two-strand electric fence that had been recently erected between the community area and national park. He walked along the fence line trying to find a way back into TENP (Figure 1). On 18 January 2022, there was an attempt by KWS, Tsavo Trust and the Sheldrick Wildlife Trust to push *Isiolo* back into the park using helicopters (Fig. 2). However, this attempt was unsuccessful. *Isiolo* eventually made his way into TENP by crossing back over the Tiva river.

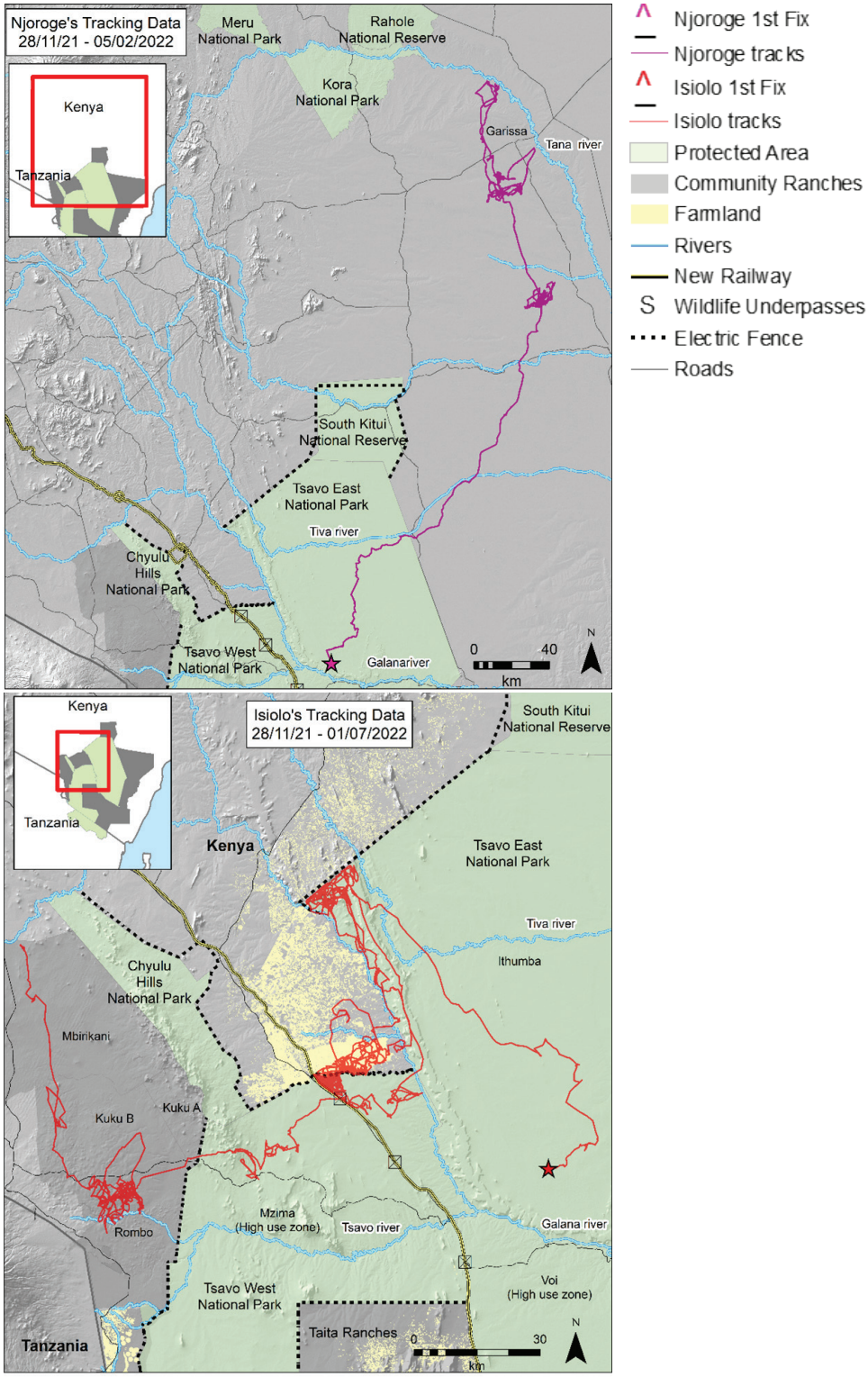

Figure 1. Movement tracks of the two translocated bull elephants, *Isiolo* and *Njoroge*, after translocation from northern Kenya to the Tsavo East National Park. (© *Maps drawn by Lydia Tiller*)

Figure 2. Helicopter trying to push *Isiolo* back into Tsavo East National Park on 18 January 2022. This management intervention attempt was unsuccessful. (© *Image courtesy of Tsavo Trust*)

He then stayed on the west of the Yatta Plateau and travelled west. He spent time close to the Standard Gauge Railway (SGR) and walked up and down, presumably looking for a place to cross. On 18 April 2022 at around 11pm, he crossed under the SGR railway using one of the wildlife underpasses (called Kanga corridor) and also crossed the tarmac of the busy Mombasa highway. He then entered and traversed Tsavo West NP, travelling west before he left the Tsavo West NP on 24 April 2022. He then spent time in the Rombo community grazing area, close to the Tsavo river. He then travelled north again to Mbirikani community area where he stayed in grazing areas, and at times walked close to agricultural land. Here, he was approximately 138 km west from his translocation drop-off location.

Discussion

This short paper describes the elephant translocation operation from Isiolo to TENP in Kenya and documents the interesting behaviour displayed by the two translocated elephants, who were collared. The translocation aimed to prevent the local community from taking retaliatory action toward 'problem elephants' and to reduce HEC, which was achieved in terms of removing this elephant group. However, the objectives of the mission in terms of the group settling in the designated area was not achieved. The elephant group separated and two elephants, which we were able to monitor through the satellite collars, exhibited homing behaviour and both left TENP within 1–7 weeks of being released. The elephant *Njoroge* is now many kilometres away from his release site, probably getting closer to his original home territory, but is unable to be monitored due to the collar failing. *Isiolo* also left the park and spent time in the community ranching area of the Amboseli ecosystem. The fate of the other five elephants (three that were translocated and two that were not found before the translocation operation) is unknown.

TENP has been the release site for a majority of the translocations in Kenya, as it constitutes part of the largest conservation area in Kenya, and until recently was considered underpopulated by elephants (Table 1). However, the suitability of this site for future translocations should be reconsidered, due to the homing behaviour documented in this case study and others (Muir 2000; Pinter-Wollman et al. 2009), high

mortality rates (Muir 2000; Pinter-Wollman et al. 2009; Tiller et al. 2022) and the continuation of problem behaviours, such as crop raiding and fence breaking (Pinter-Wollman et al. 2009; Tiller et al. 2022). Additionally, much of TENP to the north and east is unfenced, meaning elephants are able to walk back towards their original range, but often having to traverse community and agricultural areas.

Homing behaviour, seen in these two elephants, has also been documented in other elephant translocations in Kenya (Pinter-Wollman 2009); South Africa (Garai and Car 2001; Viljoen et al. 2015), Sri Lanka (Fernando et al. 2012) and India (Lahiri-Choudhury 1993). In a translocation of 150 elephants from the Shimba Hills NR to TENP, 11 of the elephants left TENP and either returned back to the Shimba Hills or went to other sites (Pinter-Wollman et al. 2009). The elephants *Isiolo* and *Njoroge* showed homing behaviours as it appeared they "collected their thoughts" and then set out in a direction that led towards home. When *Isiolo* encountered physical barriers (electric fence) he made two attempts to cross, and then seemed to give up and embark on an exploratory course that took him to new areas. This has been observed with an elephant named *Lugard* who was captured in an area named Hunter's Lodge in Kenya and translocated to Lugaard's Falls in TENP. He first moved quickly back towards Hunter's Lodge, but after entering dense settlement, he gave up and went on a circuitous route south of the Chyulu Hills and eventually habituated to that area and switched from mainly nocturnal movements to mainly diurnal (Dr. Iain Douglas-Hamilton 2022, pers. Comm.). In *Njoroge's* case, he broke free quite quickly after translocation and made an epic journey of over 370 kilometres towards his original homeland. The longest previously documented homing distance achieved by an elephant was approximately 300 km following translocation in South Africa (Viljoen et al. 2015).

Fortunately, the two elephants in this report survived the first few months after translocation, although we are now only able to monitor one of them. In other elephant translocations to TENP, success rates have been low due to mortality; for example, in 1999, 30 bull elephants were translocated from Mwalugange Elephant Sanctuary (MES) in the Shimba Hills to TENP. Of these elephants, two died from shock and internal injuries during the translocation itself, and one elephant died after leaving the park and walking to a place called Kilifi in coast province, where he got stuck in the mud. The fate of the other elephants is unknown, as only four the elephants were spotted in TENP after the translocation (Muir 2000). Another example of mortality occurring during translocation is of the 150 elephants translocated from the Shimba Hills NR to TENP in 2005. While the operation was considered successful at mitigating HEC in the Shimba Hills vicinity, of the 109 translocated elephants with a known fate over two months, 85 elephants survived while 24 elephants died. This was due to a variety of reasons: one was killed by poaching; two were shot by the KWS; six died during transit; three died from unknown causes; and 12 calves went missing and presumably died. The study also found that, following translocation, bulls and calves were more likely to die than females (Pinter-Wollman et al. 2009). In a 2018 translocation of five elephants from Lewa Conservancy to TENP, three of these elephants were killed (two were poached and one died due to conflict). Two of the elephants were killed within four months after being translocated, and the third elephant within a year (Tiller et al. 2022).

Translocation of problem male elephants is unlikely to be the most effective and humane method to mitigate conflict between people and elephants (Boast et al. 2016; Massei et al. 2010). Translocating problem elephants may simply shift the problem elsewhere (Fernando et al. 2012). In a number of studies, there has been a reported continuation of problem behaviours such as crop raiding and fence breaking in the new area in which the elephants have been released. For example, in Sri Lanka, Fernando et al. (2012) studied tracking data from 12 male Asian elephants, who were classified as 'problem animals'. These elephants were captured in community areas and translocated into national parks. All 12 elephants left the protected areas and became involved in incidents of HEC (fence breaking and crop raiding).

In a 2018 translocation from Lewa Conservancy to TENP one of the elephants broke out of an electric fence eight months after being released and spent 2% of his time in farmland, most likely crop raiding (Tiller et al. 2022). Crop raiding behaviour can be a trait found in a high percentage of individuals of both

sexes in a population. Thus, removing a few habitual raiders will not necessarily solve the problem at the source (Hahn et al. 2022). It is also documented that crop raiding behaviour can be passed down to younger elephants through social learning (Chiyo et al. 2011; 2012; Evans 2015).

When translocating elephants, we must also consider the welfare of the animals. Translocation is likely to cause a high level of stress, including the trauma of the translocation experience itself and of being left alone in a new ecosystem with unfamiliar elephants and resources (Pinter-Wollman et al. 2009). However, a soft release, where elephants are held in a large enclosure for some time prior to release, may be a way of reducing post-translocation stress and may prevent elephants from breaking electric fences (Dublin and Niskanen 2003; Garai and Carr 2001).

Conclusion

HEC continues to increase across much of the African savannah elephant range, as the rapid conversion of elephant habitat into agriculture puts people on the frontline of conflict with wildlife. There is mounting political pressure to address this conflict, as tensions are rising in communities impacted by the elephants that are causing damage to crops or causing injury to, and death of, people and livestock. Where large scale fencing or installation of barriers is not feasible or practical, translocation has often been used to address these issues and show communities that action is being taken. However, the relatively low success rate of documented translocations suggest that it is not necessarily the most effective solution for problem elephants: financial costs are incurred, welfare concerns are created, and problems may be translocated along with the elephant. Focusing mitigation management on a larger number of elephant habitual raiders will have more impact in the long-term and be a more effective management tactic for elephant managers. This could involve better spatial land-use planning, maintenance of corridors between protected areas, negative conditioning tactics and the maintenance and upgrading of barriers.

If translocation continues to be the method of choice for problem elephants, there is a need for thorough planning and sound science to inform future operations, which should include collaring of each individual. Trained personnel and a substantial budget for post release monitoring, and any potential conflict-reduction interventions, are therefore key management considerations for ensuring the health and wellbeing of translocated elephants in the future.

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REVIEW

A systematic review of the success and unintended consequences of management interventions on African elephants

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Abstract

With elephant numbers increasing in some parts of their range, and related conservation concerns including elephants' impact on vegetation and human–elephant conflict, management interventions have been used to artificially reduce elephant numbers, to stabilize populations locally and regionally, or to affect their spatial distribution. Interventions may have environmental, demographic, or social impacts, often unintended. We evaluated elephant management interventions, including both direct (contraception, vasectomy, translocation, hunting, culling) and indirect interventions (fencing, range expansion, corridors, water provision, and fire management). The study draws on evidence from across the range of African and Asian elephants, but with a focus on South Africa, through a systematic literature review using Science Direct, Web of Science, Scopus, Google Scholar, and Google from 2007 onwards, i.e. covering the period since the publication of the 2008 Assessment of South African Elephant Management. We focus on the effects of management on elephants, and present information on success of each method, as well as its demographic effects. We also identified unintended consequences of the interventions, such as increased human–elephant conflict, irruptive growth rates, social disruption, inbreeding depression, truncation of migratory routes, excessive vegetation damage, and breakdown in social structure. Culling and trophy hunting had the most unintended consequences, and evoked the most negative sentiments among tourists. There was a large disparity in the research effort directed towards different interventions, and we highlight gaps where additional research is needed. Elephant management can be contentious, with polarized views, and the broader social and economic elements need consideration. Disservices such as human–elephant conflict need to be reduced, and increased attention paid to animal welfare, and the broader expectations of society in this regard.

Despite the review not being restricted, our study is informed mainly by research carried out in South Africa, drawing in large part on the base created by the 2008 assessment, as well as the norms and standards for management interventions formalized in South African regulations. Furthermore, the aim of the review was to produce information that could be used to update current approaches to elephant management in South Africa. The review draws on publications outside South Africa where they are available, as knowledge gained elsewhere is crucial for improving management decisions. We believe that our study has wider application for use throughout the African savannah elephant range.

Résumé

Du fait du nombre d'éléphants en augmentation dans certains territoires et des inquiétudes relatives à leur conservation — dont les répercussions sur la végétation et les conflits humains-éléphants — des interventions de gestion ont été mises en place afin de réduire artificiellement les populations et les stabiliser localement et régionalement, ou pour agir sur leur répartition dans ces espaces. Des impacts environnementaux, démographiques ou sociaux, souvent imprévus, peuvent découler de ces opérations. Nous avons évalué ces interventions de gestion, qu'elles soient directes (contraception, vasectomie, transferts, chasse, abattage) ou indirectes (clôtures, agrandissement des aires de répartition, couloirs biologiques, approvisionnement en eau ou gestion des incendies). L'étude s'appuie sur des données provenant de l'ensemble des aires de répartition des éléphants d'Afrique et d'Asie avec un gros plan sur les individus sud-africains, grâce à une analyse systématique de la littérature sur le sujet en utilisant Science Direct, Web of Science, Scopus, Google Scholar et Google à partir de 2007, soit toute la période depuis le 2008 Assessment of South African Elephant Management (Évaluation de la gestion de l'éléphant sud-africain en 2008). Nous avons ciblé les effets immédiats de ces interventions sur les éléphants et nous présentons ici les réussites de chaque méthode, ainsi que leur impact sur la démographie. Nous avons également identifié les conséquences involontaires de ces initiatives, telles que l'augmentation des conflits humains-éléphants, des croissances soudaines de certaines populations, des perturbations sociales, dépression consanguine, routes migratoires tronquées, dommages excessifs dans la végétation et dégradation des structures sociales. L'abattage et la chasse au trophée ont causé les retombées les plus inattendues et ont suscité les sentiments les plus négatifs parmi les touristes. D'importantes disparités ont été constatées dans l'effort de recherche consacré aux différentes interventions et nous soulignons les lacunes lorsque de plus amples informations sont nécessaires. La gestion des éléphants peut être controversée et soulever des points de vue opposés, et les composantes sociales et économiques plus générales doivent être prises en compte. Il convient de réduire les torts causés par les conflits humain-éléphant et d'accorder une plus grande attention au bien-être des animaux et aux attentes de la société à cet égard.

Bien que le rapport ne soit pas restrictif, notre étude se base principalement sur les recherches menées en Afrique du Sud, plus précisément sur les éléments rassemblés lors de l'évaluation de 2008, ainsi que sur les normes et critères des interventions de gestion formalisés dans la réglementation sud-africaine. De plus, l'objectif du rapport était de produire des informations pouvant être utilisées pour une nouvelle approche de la gestion de l'éléphant en Afrique du Sud. Le compte-rendu fait appel à certaines publications autres que sud-africaines lorsqu'elles étaient disponibles, car indépendamment de leur origine, les données sont essentielles pour renseigner les décisions dans le domaine de la gestion. Nous considérons que notre étude sera utile dans toutes les aires de répartition de l'éléphant de savane.

Introduction

A key tenet of wildlife management is a requirement to assess the effectiveness of past conservation management approaches, as this provides a foundation for improving future effort (Pullin and Knight 2001). This relies on scientific evaluation of the effectiveness of previous approaches in achieving objectives, and then basing future decisions on the resulting evidence (Pullin et al. 2004; Lim et al. 2017). In so doing, conservation management can move away from decision making based on the personal opinions of practitioners or scientific experts, towards science-based management (Pullin et al. 2004). Despite the best intentions of managers, conservation management often has indirect and unintended consequences. The latter are often overlooked when assessing the effectiveness of biodiversity conservation actions, in part because they generally derive from indirect effects, and, therefore, typically take a long time to manifest (Larrosa et al 2016). Unintended consequences can have both positive and negative effects on the overall (net) outcomes of management interventions, and thus significantly affect management outcomes (Larrosa et al. 2016). Negative effects are particularly important from a management perspective, as they can seriously compromise the effectiveness of management interventions. Therefore, for conservation management to be effective, due attention should be given to potential unintended consequences, as these

can lead to waste of already limited conservation resources (Primack 2002).

As the largest extant land mammals, elephants have attracted human attention for millennia (Riddle et al. 2010). The African savannah elephant (*Loxodonta africana*) is a highly valued species and has a major ecological influence on savannah dynamics (Kerley et al. 2008), playing significant roles in nutrient cycling and seed dispersal (Dudley 2000; Blake et al. 2009). As a result, elephants are considered as a keystone or flagship species (Shoshani et al. 2004). African elephants (hereafter 'elephants') are water-dependent, bulk feeders that are not very selective, preferring grazing to browsing (van Wijngaarden 1985). However, elephants tend to shift from grazing to browsing in response to seasonal changes in food quality (Codron et al. 2006; Woolley et al. 2009; Kos et al. 2012). Because of their large ecological impacts, elephants are considered as habitat modifiers or ecological engineers (Jones et al. 1994) that physically alter patterns of resource availability in ecosystems, triggering cascading effects on other trophic levels (Smallie and O'Connor 2000; Shannon et al. 2008; Lagendijk et al. 2011). Due to their large body size, the scale of elephant impacts is usually large, with the potential to completely alter ecosystem dynamics (Skarpe et al. 2004), but also disperse seeds and distribute nutrients (Calenge et al. 2002; Kerley et al. 2008). As a result of these behaviours, the vegetation structure can undergo significant changes in terms of tree height, canopy cover and species composition, with consequences for fauna coexisting with elephants (Smallie and O'Connor 2000; Lagendijk et al. 2011).

Across large parts of the African savannah elephant range, early management interventions on elephants were focused principally on manipulating numbers (Pienaar and van Niekerk 1963; Whyte et al. 1998). The provision of artificial water points is an example of a management approach aimed at increasing elephant numbers (Pienaar and van Niekerk 1963; Croze and Lindsay 2011) by buffering populations against potential negative effects of droughts (Pienaar 1983). This can result in large increases in elephant numbers as a demographic response to the increased availability of a limiting resource (Chamaille-Jammes et al. 2007a; Shrader et al. 2010). However, this may pose a problem for management, as the increase in elephant numbers may be detrimental to vegetation, and the conservation of other species (Owen-Smith 1996). In areas where elephant densities are high, tree-dominated (closed) savannahs can be converted to a grass-dominated (open) state (Owen-Smith et al. 2006; Guldemond and van Aarde 2008). This modification, commonly termed 'elephant impact', mostly takes place through elephants toppling whole trees, or pollarding trees by breaking and removing branches from their canopies, and by preventing or reducing recruitment and regeneration (Balfour et al. 2007). Noticeable impacts of elephants on plants are broadly referred to as 'elephant damage' (Campbell et al. 1996). In response, various options (e.g. contraception, vasectomy, translocation, hunting, culling, fencing, range expansion, corridors, water provision, and fire management) have been explored to artificially reduce elephant population densities and stabilize them at levels considered appropriate based on the available resources (van Aarde et al. 1999; Kerley and Shrader 2007) and ecological carrying capacity (ECC). Previously, subjective opinions, not necessarily evidence-based, dominated management approaches to reduce elephant impacts (van Aarde et al. 2006; van Aarde and Jackson 2007). Currently, elephant management approaches are becoming more integrated, with ecological theory being at the epicentre of management decisions (van Aarde and Jackson, 2007; Robson and van Aarde 2018), through promoting ecological processes to regulate elephant numbers naturally (Owen-Smith et al. 2006; van Aarde and Jackson 2007). For example, in many protected areas (PAs) where elephants occur, managers have increased the area available to elephants by dropping fences, while limiting resource availability by closing artificial water points, so that elephant numbers can fluctuate naturally (Owen-Smith et al. 2006; Chamaille-Jammes et al. 2007a; 2007b; Smit et al. 2007a; 2007b; Druce et al. 2008).

A comprehensive assessment of elephant management interventions was published in 2008 as the Assessment of South African Elephant Management (ASAEM) (Scholes and Mennell 2008). However, there has been no comprehensive evaluation of the unintended consequences of different elephant management interventions on ecological systems (Scholes and Mennell 2008; DEA 2014). As already mentioned above, over time, elephant impacts can

transform a landscape dominated by large trees into one dominated by thicket areas (Owen-Smith et al. 2006), which could have serious negative consequences for the rest of biodiversity (Skarpe et al. 2004). This, in turn, may affect tourist perceptions of healthy ecosystems. Thus, tourist perceptions of landscapes provide land managers with a window through which they can obtain useful information for balancing wildlife numbers, ecosystem function, and the aesthetic appeal of the habitat. It has been suggested that tourism may play an important role in elephant conservation as generally elephants in popular tourism areas (i.e. PAs) are safer than elephants in places less frequented by tourists (Chiyo et al. 2014). Thus, from a landscape management perspective, management plans predicated on the presence of elephants in landscapes may attract more revenue from visiting tourists and help conservation of elephant populations (Edge et al. 2017). However, this perspective is unlikely to apply in areas where elephants have become overly abundant as their impacts on vegetation could detract from the aesthetic appeal of the habitat, leading to negative tourist perceptions, which can translate into reduced tourism revenues (Edge et al. 2017). The effects of elephants on biodiversity features of landscapes as well as their aesthetic appeal is a key aspect of elephant management that has hitherto received scant attention.

This paper evaluates the success and unintended consequences of various elephant management interventions as provided for in the Norms and Standards for the Management of Elephants in South Africa (SA). We consider interventions that are directed at the elephants themselves, namely contraception, vasectomy, translocation, hunting, and culling (direct interventions), as well as interventions in the landscape that indirectly effect the elephants, namely fencing, range expansion, corridors, water provision, and fire management (DEAT 2008). Among elephant range states, SA is the only country to have promulgated such regulations, which are primarily aimed at management of elephants in areas confined by fencing. While fenced PAs have long existed in other southern African countries, more and more countries in other parts of Africa are erecting fences to constrain movements of elephants to reduce conflicts with people.

While the review draws on literature on these interventions from across the elephants' range, it does not address additional interventions, such as those to manage human–elephant conflict (HEC) in free-roaming elephants moving through human-dominated landscapes. This review does not discuss comprehensive, integrated elephant management approaches, but focuses on the implementation of specific management tools and interventions. We conducted a systematic literature review of published and grey literature on the use of these methods, and their effectiveness (positive outcome) and demographic consequences (whether positive or negative), as well as their indirect effects and unintended consequences. Since a previous comprehensive assessment was published in 2008 (Scholes and Mennell 2008), we focused on literature published since 2007. While the review is based around the South African regulations, we hope that our results and conclusions will be more widely applicable, and inform implementation of these interventions across the range states.

Methodology

A systematic literature search, following the principles of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) method (Moher et al. 2009; O'Dea et al. 2021), was carried out on databases of scientific, peer-reviewed literature, followed by manual searches on Google for relevant papers, theses, and grey literature. Firstly, Science Direct, Web of Science, and Scopus databases were searched for published articles on elephant management interventions. All types of research articles (review articles, research articles, book chapters, etc.) were included in the search. The following keywords and Boolean operators were entered separately in combination with the word "elephant", into the databases to retrieve relevant publications,: "AND contraception", "AND vasectomy", "AND water provision", "AND fire", "AND fencing OR fence", "AND corridor OR connectivity", "AND range expansion", "AND translocation", "AND culling OR hunting", or "AND tourism OR tourist experience" (11 different search combinations). Articles relating to each management strategy were searched for separately, with the number of hits generated recorded

at each time. This study follows up on the ASAEM (Scholes and Mennell 2008) published in 2008, and the search period was set to 2007–2021 so as to pick up all relevant literature not evaluated by the initial assessment. The search of the relevant literature was conducted in April 2019, with another updated search conducted in October 2021. Papers whose titles included any of the key words were retained for inclusion in the review. However, as using only the title as a selection criterion may miss potentially useful articles, the abstract of articles that came up in the search whose titles did not contain the key words were also read to confirm their relevance to the topic. Finally, a search was conducted for literature reviews and meta-analyses on the subject, in order to source relevant publications that were missed in the initial search.

For an article to be included in the initial phase of the elimination process, it had to present results of the application of a particular management intervention in the field (studies conducted on captive elephants were not considered) and to be published in the English language. Conceptual/modelling articles and reviews were, however, retained. To increase the comprehensiveness of the review, in addition to articles on the savannah elephant (*Loxodonta africana*), articles on the African forest elephant (*L. cyclotis*) and the Asian elephant (*Elephas maximus*) were also retained. After following these steps, a total of 221 publications were identified and retained.

Additional searches were conducted to uncover potentially eligible published work that was missed by the database search. In this study, the Reference sections of all articles considered suitable for inclusion were read to identify: 1) potentially relevant articles; and 2) journals which frequently publish relevant studies. Potentially relevant articles were then manually searched using the Google Scholar search engine. An additional 90 articles were added to the database following this step.

Journals were also manually searched to identify articles (and other work, e.g. letters, comments, notes, opinions) which had not yet been included in electronic databases, and those which were not indexed, or indexed incorrectly, but that met the criteria for inclusion listed above. There were 19 additional articles included in this step; however, these publications were flagged as not peer-reviewed, and any information was included with caution.

Although systematic reviews aim to be as comprehensive and representative of the literature as possible, publication bias can still occur when not all authors submit their results for publication (Borenstein et al. 2009; Lipsey and Wilson 2001). A reason frequently given for excluding unpublished research from systematic reviews is that it is often of lesser quality than published research (Borenstein et al. 2009; Corlett 2011). However, some research associated with degree requirements is conducted by individuals who do not seek academic careers (authors' *pers. obs.*). Moreover, many research programs are conducted as evaluations for agencies making internal decisions about program effectiveness, and such research typically never gets published (Cooper 2003). Also, research is often turned down for publication for reasons other than quality, such as the failure to obtain results that reject the null hypothesis (Cooper 2003). Thus, a search was conducted for unpublished work (conference papers, reports, abstracts, newspaper articles, project reports, social media posts, etc.) using Google search. Thirty-one (31) articles were identified in this manner, and labelled as grey literature, and included with the necessary caution.

To search for postgraduate theses, online theses databases at universities were visited and searched. Firstly, for each thesis that came out in the original search using the search terms for the review, we noted the institution where the corresponding post-graduate degree was awarded, and then compiled a list of these institutions. We then investigated (mainly by sending emails to administrative staff) whether the institution concerned has an online database where theses are available for download. If so, we searched for the thesis of interest and downloaded it. We further searched for other theses on elephants in the database using the search term "elephant". For universities where theses were not available for download, emails were sent to the authors to request copies. To increase the comprehensiveness of the search, further searches were conducted on Google using phrases such as "MSc or PhD thesis on elephants". Thirty-five (35) theses with additional information that was not published in the peer-reviewed literature were included.

All of these searches yielded a total of 306 publications for inclusion in the review. Duplications were then excluded (19), resulting in a total of 287

publications. The remaining publications were then read and assessed for eligibility, of which 104 were removed for not meeting the criteria for inclusion, leaving a total of 183 publications. Of these, 148 were published research papers, 24 were unpublished theses, and eight were unpublished material (conference papers and project reports).

Selected publications were read and any information about the implementation of the technique, the success or not in achieving the intended outcome, and demographic responses (intended or unintended), and/or any unintended consequences was extracted for inclusion in the review. Extracted information was summarized and populated into a Microsoft Excel sheet for ease of reference.

Results

A total of 183 publications met our criteria for inclusion. Amongst these, an overwhelming majority (71%) were experimental/research papers and reviews/conceptual papers (16%), while only a few were theses (7%) and grey literature/project reports (6%) (Table 1).

Birth/population control through contraception or vasectomy

Due to the controversy associated with lethal elephant management approaches, non-lethal control measures are being increasingly sought and utilized (Garai et al. 2018). Birth/population control is now considered an important alternative avenue for controlling South Africa's increasing elephant population (Fayrer-Hosken et al. 2000), and has been incorporated into the Norms and Standards as an approved intervention to control population size and distribution of elephants since 2008 (DEAT 2008). Four methods of contraception have been explored for elephants, three of which are applied to females, including estrodiol treatment, immunocontraception with porcine zona pellucida (pZP) and, more recently, immunocontraception using gonadotropin-releasing hormone (GnRH) (Bertschinger et al. 2008, Bertschinger and Caldwell 2016, Delsink et al. 2013; Garai et al. 2018). For males, two methods of contraception are available: the use of GnRH and vasectomy (Bertschinger et al. 2008, Bertschinger and Caldwell 2016, Lueders et al. 2017). The various contraception options for elephants are reviewed in Chapter 6 of the 2008 elephant assessment (Bertschinger et al. 2008).

The results of estrodiol treatments of 10 cows in Kruger National Park (NP) are summarized in

Table 1. Summary of number and types of research publications on elephant management interventions

Topic	Number of papers in initial search	Number of publications retained	Experimental	Reviews/ conceptual	Theses	Grey literature
Birth control (contraception and vasectomy)	309	32	16	9	4	3
Corridors	253	28	24	0	2	2
Culling	192	10	8	1	0	1
Hunting	27	6	6	0	0	0
Fencing	407	22	6	14	2	0
Range expansion	350	9	4	5	0	0
Translocation	380	23	20	0	3	0
Water provision	430	45	38	0	2	5
Fire management	231	4	4	0	0	0
Tourism	189	4	4	0	0	0

Bertschinger et al. (2008), where cows did not fall pregnant for a year, but, unfortunately, they were in oestrus for 12 months, which created behavioural problems in the herds. This option was discontinued and is no longer considered a safe choice for contraception of elephants (Bertschinger et al. 2008).

Among the remaining methods, immunocontraception is considered the least invasive way of controlling elephant fertility, and has shown the most promise (Delsink and Kirkpatrick 2012). As a non-hormonal measure, immunocontraception is less likely to lead to problems associated with hormonal imbalances, which can lead to aggressive behaviours, especially among bulls (Fayrer-Hosken et al. 2000). This method relies on inducing immune responses to specific proteins (antigens) that are involved in critical stages of animal reproduction. When these antigens are injected into the body, they cause a release of antibodies which either neutralize the antigen or block a process such as fertilization (Bertschinger and Caldwell 2016; Bertschinger et al. 2018). The pZP vaccine works by binding with zona proteins which surround the oocyte of the female, thereby blocking sperm-zona binding, thereby preventing of fertilization from taking place (Bertschinger and Caldwell 2016). The GnRH vaccine induces antibodies which neutralize GnRH in the target animal, blocking the ability of this hormone to stimulate gonadotropin release from the adenohypophysis in both males and females (Bertschinger and Caldwell 2016).

The first case of pZP application in free-ranging elephants in South Africa was conducted in the Kruger National Park in 1995 (Fayrer-Hoskin et al. 2000). Treatment of elephants with pZP was found to successfully control their birth rates, with reported efficacies of up to 80% (Delsink et al. 2007). Even better results were obtained in the Greater Makalali Private Game Reserve (GR), with pZP demonstrated to be 100% effective in reducing population growth, with no calves born (Delsink et al. 2006; Bertschinger and Caldwell 2016). In a long term pZP application programme in Makalali, both the effectiveness and the reversibility of the pZP technique were confirmed (Delsink et al. 2013). Initially, the efficacy of the approach for large populations, where individuals cannot be individually marked, was questioned (Kerley and Shrader 2007). However, pZP has been applied in a number of larger populations (Druce et al. 2011; Bertschinger et al. 2018). Aerial administration of the pZP vaccine reduces the need to individually monitor each elephant, and to hire people to do that, thus making the procedure feasible even for large populations (Delsink et al. 2007). Furthermore, administration of pZP from helicopters makes the method very time-effective, allowing elephants in small populations to be contracepted in 30 minutes (Delsink and Kirkpatrick 2012). In 2017, pZP was applied to 811 cows across 27 reserves, with 34 reserves in SA having participated in the programme over the years (Nolan 2019).

At the time of the elephant assessment (Bertchinger et al. 2008), GnRH was emerging as a potential option for contraception in both male and female elephants, but little work had yet been done. Since then, studies have been published on the use of GnRH on both wild and captive elephants (for reviews see Bertschinger and Caldwell (2016; Bertschinger and Lueders 2018). GnRH has been shown to contracept male elephants, effectively acting as a chemical castration (Bertschinger and Caldwell 2016, Lueders et al. 2017, Bertschinger and Lueders 2018). In terms of female contraception, Valades et al. (2012) reported that GnRH was not able to induce anoestrus in wild female elephants. Subsequently, increasing the dosage to 1000 mg has shown success in inducing anoestrus in captive females (Bertschinger and Lueders 2018). We are aware that GnRH has been used for both males and females in a number of reserves and captive populations; however, the results have not yet been reported in the literature (see also Bertschinger and Caldwell 2016). Currently GnRH is used more to manage the behaviour of problem male elephants (see Bertschinger and Caldwell 2016, Bertschinger and Lueders, 2018) rather than for contraception, with PZP used for the contraception of females.

Vasectomy is another potential elephant population management approach (Zitzer and Boult 2018). Among 45 free-ranging elephants in SA subjected to vasectomy in seven nature reserves, one died and two others had surgery complications, but recovered and showed no abnormal behaviour (Marais et al. 2013). In another study, large intestine lacerations (a common occurrence in vasectomies and castration) were seen after vasectomy; however, the elephants healed without any incident (Rubio-Martinez et al.

2014). Overall, it appears that vasectomy can be implemented on wild males with no serious complications in anaesthesia, during surgery, or in the postoperative period (Marais et al. 2013). While vasectomies have been performed on bulls up to 40 years old (Marais et al. 2013), it may be challenging to vasectomize older males, as vets could not find the vas deferens in a 40 to 45-year-old male because of fat deposits around the testes (Zitzer and Voult 2018). The main advantage of this procedure is that it has to be done only once, whereas with immunocontraception, animals have to be treated several times, raising costs as well as the levels of stress the animals are subjected to (Marais et al. 2013; Rubio-Martinez et al. 2014). Vasectomies have, to date, only been applied in reserves with few adult males, and, in at least two, new calves were born, presumably sired by younger bulls (Doughty et al. 2014; Nolan 2019).

Demographic responses to contraception

Non-lethal control methods are considered to be more effective than lethal methods (see below) as they do not directly reduce population numbers but rather lower the reproductive rate (Delsink et al. 2006). Modelled effects of immunocontraception over a period of 20 years of application showed that it can reduce elephant population growth rates by up to 64% (Mackey et al. 2009). Indeed, field studies have found significant declines in population growth rates after immunocontraception application. For example, after 22 months of pZP application, no pregnancies were reported in the elephant population in Thornybush Private GR, SA (Ahlers et al. 2012). In small GRs, where cows can be individually vaccinated, the pZP vaccine was found to be 100% efficient in reducing population growth rate (Bertschinger and Caldwell 2016), an efficacy level never recorded before in any free-ranging species (Kirkpatrick et al. 2011). Even in larger elephant populations, high levels of efficacy (>95%) have been observed (Bertschinger et al. 2018). However, increased use of contraception will result in an aging population, in which females become dominant (Bertschinger et al. 2008).

There is no study, to our knowledge, that assesses demographic responses to vasectomy or GnRH. However, given that calving has been observed to occur after dominant males were treated with GnRH or vasectomized (Doughty et al. 2014), the demographic effect of these treatments is likely to be minimal unless they are applied to all mature males in a population (for vasectomy, see Garai et al. 2018). If all males are contracepted or vasectomized, this will lead to an aging population.

Unintended consequences of birth/population control

Two opinion papers in 2007 raised concerns over the potential unintended consequences of contraception (Kerley and Schrader 2007; Perdock et al. 2007). Kerley and Schrader (2007) raised concerns based on their understanding of elephant biology, and not on any evidence collected from contracepted females, which included: physical harm to adult elephants from males pursuing females in oestrus, or fighting over adult females; the absence of calves reducing herd cohesion, and families without calves joining others, creating larger herds; calves from first-time mothers having greater mortality; calves potentially suffering fatal harassment from females without calves; mothers distracted from feeding and producing less milk, leading to calf mortality; kidnapping of calves increasing; more male bias in offspring; contracepted females changing their ranging behaviour, becoming less selective in food choices, and altering their ecological impact.

Perdock et al. (2007) were concerned over some potential long-term effects, including that contraception would favour weaker animals; and that immunity to vaccine may arise. They also raised concerns over reversibility, lack of young in the herds, ongoing oestrus among females affecting male behaviour, and effects of repeat darting (making elephants more wary or nervous). Kerley and Schrader (2007) note that contraception requires repeated treatment of animals; up to 75% of animals would need to be contracepted annually to achieve negative population growth; and that contraception would not reduce population size in the short term.

When injected into pregnant elephants, pZP has no negative effects on the foetus, on gestation or on parturition (Bertschinger et al. 2008). Thus, pZP appears to cause no harm to the pregnant females or foetuses at any stage of their development (Bertschinger et al. 2018), suggesting that it is unlikely to have negative effects when applied inadvertently

on already pregnant females. Furthermore, the vaccine can be delivered remotely, without the need for immobilization or animal capture (Bertschinger et al. 2018). An 11–year study in the Greater Makalali Private GR found that contraception did not have long-term effects on social or spatial aspects of elephant behaviour (Delsink et al. 2013). Furthermore, it had no effect on male–male competitive interactions or female mate choice (Delsink et al. 2013). At Phinda Private GR, South Africa (SA), the disruptive effect of immunocontraception darting on the family groups within the population was minimal, with no significant changes found in the mobility of family groups (Druce et al. 2013). There was no significant relationship between bulls' association with family groups and the number of oestrous females present in the group (Druce et al. 2013). At Thornybush Private Nature Reserve (NR) SA, two years after the initiation of pZP vaccination, eight of the 14 elephant females exhibited a cyclic pattern: two exhibited an irregular cyclic pattern lasting longer than is natural, while the remaining six underwent at least one complete oestrus cycle (Ahlers et al. 2012). Furthermore, elephants showed a lack of anoestrus, suggesting pZP does not interfere with normal follicular development and ovulation, in a study that took place during a drought, which reduces body condition and normally increases anoestrus (Ahlers et al. 2012).

Nevertheless, the limited knowledge of elephant reproductive behaviour makes it difficult to determine the unconfounded effects of pZP on elephants (Ahlers et al. 2012). One issue with pZP vaccination is that boosters are necessary to maintain the effects of contraception, which may increase the costs associated with this procedure (Delsink et al. 2013). Nevertheless, from years of application to wildlife, the pZP vaccine appears to come reasonably close to displaying the characteristics of an ideal wildlife contraceptive (sensu Kirkpatrick and Turner 1991; Berchert and Fracker 2016). These include remote delivery, contraceptive reversibility, safety in pregnant animals, lack of behavioural effects, no passage through the food chain, no debilitating long-term health effects, relatively low cost, and at least 90% efficacy (Kirkpatrick and Turner 1991; Kirkpatrick et al. 2011). Note that, although medium-term studies indicate reversibility, the effect of application for more than a decade on reversibility is not known (Garai et al. 2018). Garai et al. (2018) indicate that physical effects of pZP are unclear; however, neither of the only two post-mortems conducted on contracepted females found evidence of adverse pathology.

An unintended population level consequence of pZP immunocontraception could be an increased adult female to male ratio due to disproportionate male mortality from various causes (Bertchinger et al. 2008). An intended or unintended consequence of population-level pZP immunocontraception is an aging population (Bertchinger 2008); importantly, the subsequent increased population-level mortality from senescence would contribute to the goal of long-term population reduction, but this should be planned for so that it is understood as an intended result of management. In populations where all females are continually contracepted, the absence of calves may change social behaviour, and this, as well as any long-term demographic effects, should be investigated. Ideally, provision should be made for some births to take place in the population. There may be unintended effects of pZP immunocontraception on genetic diversity, and monitoring and research on this is required (Bertschinger et al. 2008).

GnRH, on the other hand, is associated with a number of problems, including acute swelling and inflammation post-surgery (Lueders et al. 2014). GnRH was not developed to be reversible, and the threshold application level at which it will produce permanent infertility males is unknown (Lueders et al. 2014). Furthermore, in the captive Asian elephant, reduced testosterone due to GnRH administration resulted in reduced muscle gain, which may affect the ability of elephants to defend themselves, and to handle and mate with females (Lueders et al. 2014). The effect on bone density also needs to be investigated (Lueders et al. 2017). However, the main problem with GnRH is that, when applied to males, it represents a non-surgical castration, raising issues with regards to reversibility (Kirkpatrick et al. 2011). Moreover, GnRH application to pregnant females may lead to abortion, given that elephants rely on the luteinizing hormone (LH) for maintaining corpus luteum during pregnancy (Kirkpatrick et al. 2011). In males, GnRH also causes significant reduction in testosterone levels and other androgens, and also leads to decreases in testicular and accessory organ sizes (Garai et al. 2018). The ultimate

result of this is the feminization of males, if they are treated before reaching puberty (Garai et al. 2018). Consequently, the vaccine should not be administered to near pubertal bulls as it could lead to permanent suppression of reproductive organ development (Bertschinger and Lueders 2018). Doughty et al. (2014) studied the behavioural responses of elephants treated with GnRH in Pongola GR, SA, and found that, following a decline in elephant births after treatment, males were spending more time with female herds, leading to more harassment of females. While the vaccine was applied to dominant males, the authors also found that calving continued to occur in the population, suggesting that subordinate sub-adults were fathering the calves, raising concerns about the future fitness of the population (Doughty et al. 2014).

Other troubling issues have emerged with the use of vaccines that block GnRH production in other species. For example, it has been demonstrated that GnRH receptors exist in various tissues throughout the mammalian bodies, including the cerebellum, bladder, and the cerebrospinal fluid (Bahk et al. 2008). Thus, GnRH has physiological effects throughout the central nervous system, suggesting that unintended outcomes are likely to affect a range of bodily functions, with serious consequences for individual health and reproduction (Kirkpatrick et al. 2011). Moreover, GnRH activity can affect olfactory function (Kirkpatrick et al. 2011), which is an important part of the reproductive process in many species. In the cerebral cortex, GnRH can lead to depressed activity, and, in the cerebellum, GnRH has been linked to two genetically-based disorders; Gordon–Holmes Syndrome and Boucher–Neuhauser Syndrome (Kirkpatrick et al. 2011). cardiac tissue has a high concentration of GnRH receptors, and GnRH can have a serious negative impact on cardiac function in male humans, blocking GnRH production can increase the risk of coronary infarction (Schofield et al. 2002). Whether or not these issues have clinical relevance for free-ranging elephants is still unknown, but the fact that GnRH exerts its influence far 'upstream' in the reproductive process, raises issues concerning target tissue function; more so than with vaccines that exert their effects further 'downstream' in the reproductive process (e.g. pZP). Furthermore, the consequences of younger males becoming dominant (Slotow et al. 2000) as a result of GnRH treatment of dominant males are unknown, but could be important (Doughty et al. 2014; Garai et al. 2018).

Vasectomies are not known to affect the behaviour of treated males, although the reversibility of the approach is yet to be determined (Garai et al. 2018). Lacerations in the large intestine occurred after vasectomy in some elephants, but these healed without any incident (Rubio-Martinez et al. 2014). Moreover, this is not only an issue with vasectomy, as accidental intestinal lacerations are a common occurrence following other similar surgeries such as castration (Rubio-Martinez et al. 2014). Further studies confirm that elephants subjected to vasectomy recovered quickly and showed no abnormal behaviours, suggesting that the procedure causes no anaesthetic, surgical and postoperative complications (Marais et al. 2013; Zitzer and Voult 2018). If only dominant males, and not all mature males, are vasectomized, sub-adult males may succeed in breeding (Garai et al. 2018), which may reduce population fitness (Doughty et al. 2014). If all males are vasectomised (or contracepted with GnRH), this will lead to an ageing population, and may result in social problems for herds experiencing 'calfless-ness' for extended periods.

Translocation

Translocation means the removal by human and mechanical means of a wild elephants from one location to another (DEAT 2008). Translocation has been used for a wide range of wildlife management applications, such as reducing human–wildlife conflicts, reintroducing rare species, and reintroducing species to former ranges (Fischer and Lindenmayer 2000). In southern Africa, the main aim of elephant translocation is to reduce numbers of over-abundant populations in order to reduce negative ecological impacts (Grobler et al. 2008). In other parts of the world, such as East Africa and Asia, elephant translocation is restricted to individuals, usually problem elephants (i.e. those that repeatedly raid crops and cause damage to property or human life) (Fernando et al. 2008; Pinter-Wollman 2009; Fernando 2015). Occasionally, elephant translocation is used to remove small groups isolated within developed landscapes (Fernando et al. 2008). For example, as a result of the increase in agricultural and infrastructural development, elephant populations may become 'pocketed elephant herds'

(Daim 1995). These herds are confined within ecological islands and/or isolated habitats, which represent 'leftovers of development', and are unlikely to be viable in the long term (Daim 1995). Limited home range size, low food availability, and unfavourable habitat conditions cause these elephants to encroach into surrounding farmland, as there are no corridors through which they can move safely and free from human disturbance (Daim 1995). Translocation has been proposed to avert these problems (Wambwa et al. 2001). In addition, when elephants are restricted into a limited area, their impact on the vegetation is likely to increase, and translocation has been used to lessen this impact by reducing population size (Grobler et al. 2008; Morrison et al. 2018).

Another use of elephant translocation is to improve the age structure of the population (Slotow et al. 2000). For example, Slotow et al. (2000) found that young male bulls exhibited a heightened and prolonged state of musth when older bulls were not around to suppress their musth patterns. These bulls exhibited aggressive behaviours towards other species, especially rhinos. The introduction of older males to reduce the duration and onset of musth has thus become an established intervention to reduce the occurrence of these abnormal behaviours (Slotow et al. 2005). Translocation was reviewed as part of the South African elephant assessment (Grobler et al. 2008). The techniques are well known and documented, and it is a relatively routine procedure (Grobler et al. 2008).

Demographic responses to translocation

Although translocation is ethically appealing, this approach is not considered a practical solution to reduce elephant numbers in large populations, because translocation is expensive and cumbersome to conduct (Daim 1995). Moreover, there are few areas in southern Africa in a position to accommodate extra elephants (Whyte 2004), and translocation of elephants across continents raises a range of ethical and logistical issues (Wambwa et al. 2001). Furthermore, populations founded on translocated individuals tend to show abnormal population structures (e.g. unbalanced sex ratios, disproportionately high proportions of adults and sub-adults, etc.) (Slotow et al. 2005). Slotow et al. (2005) studied introduced elephant populations across South Africa and found that these populations reproduced at rates far above average. Similarly, Kuiper et al. (2018) found that introduced/translocated elephants in Hluhluwe-Imfolozi Park showed rapid (exponential) population growth, with the elephant population size doubling every 10 years.

Unintended consequences of translocation

During translocation, animals are inevitably subjected to chronic stress (where the stress response system is pushed beyond normal levels such that it becomes dysregulated) (Dickens et al. 2010). When an animal is exposed to chronic stress levels, the physiological and behavioural responses to stress cease to be beneficial, and become detrimental to survival (Dickens et al. 2010). Chronic stress can cause immune system suppression, changes in cardiac function, and reduced ability to respond to threats, as well as disrupting the reproductive hormone axis and reproductive behaviour (Teixeira et al. 2007; Dickens et al. 2010). Chronic stress does not prevent translocation; however, it is a consequence of the translocation process (Dickens et al. 2010). Moreover, stress may increase the vulnerability of individuals to other stressors, such as disease, predation or starvation. This, in turn, may result in translocation failure, through decreased reproductive capacity or dispersal away from the release site (Teixeira et al. 2007; Hambrecht et al. 2020). During translocation, faecal glucocorticoid levels increase significantly, indicating stress (Millspaugh et al. 2007; Viljoen et al. 2008; Fanson et al. 2013; Viljoen et al. 2015). Fanson et al. (2013) found variation among individuals in hormonal responses to stress, with individuals with a pre-existing high basal faecal glucocorticoid concentration showing a prolonged elevation of faecal glucocorticoid production following release. The authors found that the behavioural traits ('personality' types) of individuals affected their responses to stress associated with translocation: 'social' elephants showed a smaller increase in faecal glucocorticoid concentrations than 'reclusive' individuals (Fanson et al. 2013).

Another issue with translocation of elephants is 'homing' behaviour, whereby translocated individuals return to the initial capture site (Fernando 2015). On their return journey, individuals may experience stress as they move over unfamiliar territory (Hambrecht et al. 2020), and there have been reports of aggressive behaviour which resulted in human deaths (Fernando,

2015). This suggests that, for translocation to be effective, elephants must be transported a large distance away from the capture area. However, studies conducted in Sri Lanka and Kenya report that all translocated individuals left the areas they were translocated to, with some returning to a capture site more than 100 km away (Pinter-Wollman 2009; Fernando et al. 2012). Furthermore, some of these translocated elephants spent some time wandering about in the release site, and many moved into adjacent highly populated areas, elevating the level of HEC there (Fernando et al. 2012; Fernando 2015). The longest documented homing distance made by an elephant was approximately 300 km from an elephant translocation in South Africa (Viljoen et al. 2015). In addition, translocated elephants have been shown to kill a far more people than non-translocated elephants, and, consequently, they also experience a higher mortality rate (Fernando et al. 2012; Fernando 2015). Thus, it appears that translocation, instead of solving HEC, amplifies it and spreads it over larger areas, compromizing both HEC mediation and elephant conservation (Fernando et al. 2012).

Jachowski et al. (2013b) studied the physiological responses of reintroduced elephants in five reserves in South Africa. Elevated stress hormone levels were reported in these elephants even 24 years after the initial release, suggesting that, following release, animals require a long period to acclimatize to the new conditions (Jachowski et al. 2013b). Elephants with elevated stress responses were shown to use a smaller part of their home range than non-stressed ones, confining their movements to within areas they identify as safer 'refugia' for extended periods, suggesting that stressors were likely persistent (Jachowski et al. 2012). Thus, chronic stress leads to reduced space use and altered habitat preferences in elephants, which can affect their nutritional state (Jachowski et al. 2012). Furthermore, one young elephant was reported to have died following release, likely due to the stress associated with translocation, and long, continuous movements of the family group after release (Jachowski et al. 2012). Elephants with an elevated stress response exhibit 'refuge behaviour' (Woolley et al. 2008b; Jachowski et al. 2012), which can affect their ecology, worsen tourist viewing experiences, lead to aggressive encounters with humans (Jachowski et al. 2012), and cause extensive habitat degradation (Lagendijk et al. 2011). There is also a risk of breakout from the reserve, after release, especially if the translocated elephants are not used to electric fences (Grobler et al. 2008). (The translocated elephants are free to roam across the whole reserve, but they select some areas where they feel safer, and use these as refuge areas when stressed. The refuge areas are not fenced and are part of the larger reserve.)

Another cause for concern associated with elephant reintroduction is the increase in vegetation damage at the release site. Studies of the responses of plant populations to elephant reintroduction in Venetia–Limpopo Nature Reserve, South Africa (O'Connor and Page 2014; O'Connor 2017) found that, following elephant introduction, elephants accounted for more than 63% of tree loss (O'Connor 2017). Uprooting, pollarding and ring barking were the main elephant impacts leading to tree mortality. One population of trees was completely eliminated, with many others remaining vulnerable to extirpation due to high adult tree mortality and poor regeneration (O'Connor 2017). Furthermore, elephant impacts completely changed the plant community, which shifted towards dominance by species that can regenerate rapidly to compensate for high mortality, resulting in a simplified community structure (O'Connor 2017). Thus, composition, structure and diversity of woody vegetation was transformed by elephant impacts, leading to a less complex natural community (O'Connor and Page 2014; O'Connor 2017; Howes et al. 2020). In an enclosure experiment at Phinda, reintroduced elephants, in combination with Nyala (*Tragelaphus angasii*), strongly reduced recruitment of threatened sand forest species (Lagendijk et al. 2011). The only behavioural study of elephants on the donor reserve from which they were translocated detected no unintended consequences from two removals of family groups (Druce 2012).

Hunting

In the South African context, there are various types of elephant hunting, including trophy hunting by international/local clients, commercial hunting by South African residents (often, but not always of problem animals), and hunting for non-commercial purposes by the owner or manager of the elephants.

Trophy hunting of elephants has been used to reduce

elephant numbers in over-abundant populations, but primarily to generate financial revenue, including for surrounding rural communities (Burke et al. 2008; Mbaiwa 2018; Di Minin et al. 2021a). Trophy hunting can become more profitable than tourism when fees for hunting are high (de Boer et al. 2007). However, there are concerns about whether trophy hunting revenue can provide adequate, long-term benefits to communities, and over inequity in the distribution of money (Dellinger 2019; Di Minin et al. 2021a; Wasser and Gobush 2019). Trophy hunting may not be able to offset the costs of coexisting with elephants (e.g. injury or death, crop losses, or infrastructure damage) (Drake et al. 2021).

Demographic responses to hunting

Trophy hunting of males is an inefficient mechanism to reduce population size and is more appropriate for other management objectives such as removal of problem animals (Slotow et al. 2008). Trophy hunting results in high ratios of females relative to males due to selective hunting of lone bulls resulting in depressed levels of fecundity, due to insufficient male breeding capacity (Selier et al. 2014; Puyravaud et al. 2017).

Unintended consequences of hunting

Burke et al. (2008) studied the behavioural and physiological responses of elephants to trophy hunting in Pilanesberg NP, South Africa. The authors found no significant behavioural responses to hunting or significant changes in the occurrence of elephant breakouts or attacks on infrastructure (Burke et al. 2008). Initially, elephants exhibited a heightened flight response (i.e. they moved away from the hunting area), but their movement stabilized by the next day (Burke et al. 2008). Selier et al. (2014) also found that both male and female elephants moved out of the areas where hunting occurred, and females took longer to return to the area than males. Moreover, elephants subjected to hunting exhibited increased stress hormone levels, even those not directly affected by hunting, suggesting that the stress was transmitted from stressed individuals to the rest of the population (Burke et al. 2008). Although Burke et al. (2008) found that these effects were not strong enough to elicit strong behavioural responses the authors suggested that bulls should be hunted alone in order to minimize any negative effects (Burke et al. 2008). Garaï et al. (2022) found higher negative welfare indicators in a reserve where hunting takes place, although the reserve also has high tourism levels, and they suggest that additional research is required. McComb et al. (2001) demonstrated that elephants responded as if to a threat to playbacks of recorded voices of Maasai men, who traditionally hunted elephant, than to voices of Maasai women or boys, or other ethnic groups that never hunted elephants (see also https://www.nature.com/articles/nature.2014.14846). Selective removal of older males leads to reduction in tusk size (Chiyo et al. 2015; Muposhi et al. 2016), or tusklessness (Whitehouse 2002), which may impact negatively on ecotourism in adjacent areas (Selier et al. 2015), distort the male dominance hierarchy, and reduce genetic fitness (Slotow et al. 2008). A final welfare issue to consider is that achieving "clean/outright" kills is difficult, even in controlled hunting situations (Slotow et al. 2021).

Culling

The ASAEM reviewed the history of culling, the methods used, the economics of possible exploitation of tusks, elephant feet, tails and hides, as well as challenges and consequences of culling (Slotow et al. 2008). For a long time, managers of reserves in many parts of southern Africa advocated culling as a management tool for elephant populations confined to PAs (van Aarde et al. 1999). For example, in SA's Kruger NP, between 1967 and 1994, culling remained the principal management strategy for maintaining the elephant population around a set population size (~7,000 individuals) in order to avert the destruction of vegetation at high elephant densities (Owen-Smith et al. 2006). Nevertheless, increasing public pressure, and lack of unequivocal evidence of the damaging effects of high elephant densities on vegetation, resulted in culling being temporarily discontinued in Kruger NP in 1995. The Minister of Environmental Affairs and Tourism convened a Scientific Round Table to consider the matter in 2006, which concluded culling was not necessary in Kruger NP (Owen-Smith et al. 2006). The Norms and Standards for the management of elephants in South Africa (DEAT 2008) provide for culling as a management option of last resort for reducing or maintaining elephant populations, but not for influencing the spatial

distribution of elephants. Despite the conclusions of the Scientific Round Table (Owen-Smith et al. 2006), and the prohibition on the use of culling to influence the spatial distribution of wild elephant populations (DEAT 2008), the current Kruger NP Elephant Management Plan indicates "SANParks will, at appropriate places, implement: … Lethal induction of spatial and temporal variation in elephant numbers (e.g. culling) (Ferreira et al. 2013). Proposed methods to induce spatial variation include "lethal shooting, helicopter shooting, and elephant pitfalls" ("Establish traditional elephant pitfalls in areas of concern. Distress calls must be allowed to be uttered"). (Map 8, Table 4 and Box 15 in Ferreira et al. 2013). Culling, therefore, remains a contentious issue, with discrepancies between what managers propose to do (Ferreira et al. 2013), and what scientists deem necessary (Owen-Smith 2006), or society deems acceptable (DEAT 2008). The issue of culling brings up other related issues such as the continent-wide decline in elephant numbers and proposal for lifting of the ban on ivory trade, which complicates the debate even further (Dickson and Adams 2009; Biggs et al. 2017). In several East African States and Asia, culling is considered an unacceptable elephant management strategy, reflecting cultural attitudes in these regions and the lower number of elephants, although the killing of elephants for crop raiding was formerly considered acceptable in Asia (Fernando et al. 2008). When translocation, capture and domestication, or capture and semi-captive management of Asian elephants are not options, culling may be considered a better and more humane management approach than deaths of elephants at the hands of enraged farmers (Fernando et al. 2008); but see Slotow et al. (2021) for counter arguments. Consequently, culling is generally considered as the last option among elephant control measures (Koenig 2007; DEAT 2008). Many elephant specialists are, moreover, sceptical about culling, as it fails to limit elephant numbers in the long run (Koenig 2007; Slotow et al. 2008).

A recent evaluation of the legal context for culling concluded that the method of culling family groups by first killing the matriarch, and then subsequent group members with the youngest last, is likely inhumane. This method is illegal in South Africa (Slotow et al. 2021). Although this has not yet been tested in court, legal costs and reputational risks may also be considered a potential unintended consequence affecting organizations that implement culling. It should be noted that, although the option of culling of family units to control elephant populations is retained in some management plans in South Africa, such culling has not been carried out since 1995 (R. Slotow, *pers. obs.*). Consequently, a moratorium has been recommended on culling of elephant family units, as well as of lone bulls, be put into effect until more humane methods ensuring an extremely high probability of instantaneous kill are available and approved by the regulatory authorities (Slotow et al. 2021).

Demographic responses to culling

Culling is the only intervention that can directly and substantially reduce population size in the short term; however, it leads to irruptive growth when culling is stopped (Slotow et al. 2008), as the predominance of young elephants in the population, and relatively high availability of resources, allow reproductive rates to increase (van Aarde et al. 1999; Slotow et al. 2008, Mackey et al. 2009). Thus, lethal population control methods (e.g. culling), in addition to their controversial nature, are ineffective in reducing elephant numbers without future interventions as needed (Foley and Faust 2010). Culling can also lead to abnormal social structures, with populations characterized by smaller family units with the age structure skewed towards younger individuals (Gobush et al. 2008; Slotow et al. 2008; Selier et al. 2014).

While poaching, whether for bushmeat or illegal wildlife trade, has many undesirable consequences, not least because it is unplanned, it is a form of lethal control and, as such, can provide information on potential consequences of culling. Gobush et al. (2008) studied the reproductive correlates of a disturbed social structure of an elephant population in Mikumi NP in Tanzania, and found that family groups exposed to poaching and trophy hunting in the past showed low group relatedness (i.e. a low number of first-order adult relatives) and weak social bonds. Females in groups displaying these characteristics were shown to have significantly higher faecal glucocorticoid levels, and, consequently, lower reproductive output (Gobush et al. 2008). Poaching in Ruaha NP led to lower group sizes and caused reproductive suppression (Mkuburo et al. 2020).

In a retrospective analysis of historical Kruger NP census information, Smit and Ferreira (2010) concluded that culling reduced the density of elephants along the major rivers. This effect eroded following the moratorium on culling (Smit and Ferreira 2010). Van Aarde et al. (1999) found that high-density elephant populations declined naturally without the need for culling, suggesting that density-dependent population dynamics alone may be enough to control elephant numbers (Robson and van Aarde 2018). Slotow et al. (2008) surmised that irruptive growth can persist for at least one generation, after which a new stable age structure will gradually establish itself; thus, the effects of culling could last for generations.

Goldenburg and Wittemyr (2017) found that orphans from poaching may experience decreased access to resources and reduced fitness in this matriarchal society. In a recent investigation, Parker et al. (2021) found that orphans had lower survival rates compared to non-orphaned age-mates, with population growth rates negatively correlated with orphaning probability and positively correlated with orphan survival. These results showed that adult elephant death, in addition to its direct effects, also indirectly decreases population growth through orphaning. These results demonstrate the detrimental impacts of orphaning on elephant survival and suggest that it should not be overlooked when quantifying the impacts of poaching. Similarly, Wittemyer et al. (2021) showed that elephant population growth was most sensitive to survival in young adults in the population. This suggests that enhanced parental care in elephants is key towards the attainment of high population growth, by increasing the probability of juvenile survival.

Unintended consequences of culling

When culling is implemented as a management approach, this may lead to the impression that regulators are encouraging the killing of elephants, leading to upsurges in killings of elephants by other people, potentially leading to crashes in elephant numbers (Fernando et al. 2008).

Here again we draw on the literature from studies of the consequences of elephant poaching, which provides insights into potential outcomes of culling. Like poaching, culling may lead to a breakdown in the social structure of elephants (Slotow et al. 2008). For example, poached elephant populations are characterized by smaller family units with a disproportionately high proportion of calves (Gobush et al. 2008). Also, poached populations often aggregate into large groups due to coalescing of family units, perhaps as a collective defence mechanism (Nyakaana et al. 2001). The indirect effect of this increase in group size is accelerated habitat degradation. Also, the death of matriarchs due to poaching causes disarray among family units, affecting a younger herd's ability to respond to threatening situations such as predation (McComb et al. 2011; Shannon et al. 2013) or drought (Foley et al. 2008).

Poaching also reduces heterozygous alleles, leaving the population susceptible to inbreeding depression (Gobush et al. 2009). Genetic effects of poaching on a large scale in Gorongosa NP led to large scale tusklessness (Campbell-Staton et al. 2021). Logically, intentionally removing entire groups through culling will remove the genetic material of that matriline from the population.

In a comparative study of elephant populations in Amboseli NP (Kenya) and Pilanesberg NP (South Africa), Shannon et al. (2013) found that elephants that experienced separation from family members when young (Pilanesberg) exhibited poor social knowledge, as they failed to distinguish calls from elephants they were familiar with from those they were not (Shannon et al. 2013). Furthermore, they were unable to separate calls from individuals of high social standing from those of low standing (Shannon et al. 2013). Thus, important decision-making abilities are impaired in elephants exposed to poaching, culling (the latter only in SA and not in Kenya) and translocation (Shannon et al. 2013). These elephants may also be affected by loss of cultural information and population-level experience (McComb et al. 2001).

There may be unintended consequences of culling on tourism. For example, a study of tourist and resident perspectives in the Associated Private Nature Reserves, adjacent to Kruger NP, found that tourists preferred non-intrusive interventions (Edge et al. 2017). Similarly, a social media sentiment analysis found a high negative sentiment towards trophy hunting and culling of elephants (Hammond et al. 2022).

Interventions such as culling that increase stress in elephants may result in elephants changing their patterns of spatial use, for example, moving away from prime tourism areas and retreating to refugia (Jachowski et al. 2012), or moving faster through

corridors (Jachowski et al. 2013a). In response to poaching, both male and, more so, female elephants moved more at night than during the day (Ihwagi et al. 2018). Refuge areas tend to be those that are less frequented by people, and, hence, not prime tourist areas (R. Slotow, *pers. obs.*). Chronic stress and subsequent refuge behaviour displayed by elephants following culling may lead to elephant aggression towards humans, although the link between the two is still unsubstantiated (Jachowski et al. 2013a). Furthermore, the refuge behaviour of elephants may reduce their tourism value and, thus, reduce the ecotourism potential of PAs for elephant enthusiasts.

Fencing

Fencing is used primarily to influence the ranging of elephants; the many different types and their effectiveness are reviewed in Grant et al. (2008), with elements updated in Slotow (2012). More generally, wildlife fences are constructed for a variety of reasons but mainly to control access (Hayward and Kerley 2009). The benefits of wildlife fencing include increased landscape productivity (by controlling the timing and duration of landscape use by herbivores); reduced conflicts between wildlife and humans; prevention of mixing between wildlife and livestock (which reduces the risk of disease spread and livestock depredation); exclusion of wildlife from particular areas that are sensitive to disturbance; reduced encroachment by humans and poaching for bushmeat and other wildlife products; and increased landscape heterogeneity, achieved by inducing differential temporal use of certain parts of the landscape (Hayward and Kerley 2009; Pekor et al. 2019). In SA, fencing is regarded as the most effective method for containing of elephant populations within certain ranges, and thus as an important component of their management (Grant et al. 2008; Slotow 2012). Fences influence the ranging of elephants and make their use of the landscape more heterogeneous (Slotow 2012).

Besides boundary fences, internal fences can also be erected to exclude elephants from sensitive areas of reserves. This could be either to protect infrastructure and people, for example around camps, or to protect important habitats and areas set aside for habitat rehabilitation (Slotow 2012). For example, exclosure fences have been used in Addo Elephant NP to create botanical reserves (Lombard et al. 2001), and to protect key areas of sand forest in Phinda Private GR and Tembe Elephant Park (both in SA) (Lagendijk et al. 2011), as well as in Amboseli NP, Kenya (Barnosky et al. 2015).

PAs in SA are required to have electrified perimeter fences meeting minimum standards to ensure that it is effective against elephants (DEAT 2008; Grant et al. 2008; Slotow 2012). Di Minin et al. (2021b) identified hotspots of elephant and lion (*Panthera leo*) conflict with humans and identified priority areas where fencing could potentially be used to mitigate such conflicts, taking account of the capital and maintenance costs of fencing. They concluded that it may be possible to reduce the use of fencing in some areas in southern Africa, including SA (Di Minin et al. 2021b). Fencing high-conflict areas could reduce human mortality, costs to communities (such as time spent on crop and/or livestock protection), and risks of infectious diseases (Di Minin et al. 2021b). Such approaches may also include not fencing areas, or leaving gaps in fences where HEC is lower (Di Minin et al. 2021b). It should be noted that the high capital and maintenance costs of fencing may not repay themselves in countries with lower levels of human–wildlife conflict (Di Minin et al. 2021b).

Demographic responses to fencing

Elephants exhibit a range of migratory patterns; populations may be sedentary, nomadic, or exhibit partial migration patterns (Purdon et al. 2018). The maintenance of landscape connectivity is key for allowing elephants to maintain their normal yearly ranging patterns (Ngene et al. 2009; Purdon et al. 2018). However, fences fragment landscapes and limit the mobility of elephants (Boone and Hobbs 2004). Shrader et al. (2010) found that fencing restricted elephant movement mostly in the wet season, when they are able to move widely across the landscape as their ranging patterns are less limited by water and forage availability. However, Owens and Owens (1993) noted that drought conditions also cause elephants to migrate. Thus the prevention of dispersal of individuals from populations may inhibit the natural processes that regulate population levels in response to resource availability (Grant et al. 2008). Consequently, populations may overuse the resources within the fenced area, leading to declines

of other species and even local extinctions within the fenced area (Hayward and Kerley 2009). Conversely, fences may restrict the immigration of individuals into the population, leading to a collapse in gene flow between populations, and threatening the genetic processes critical to the maintenance of heterozygosity and evolution of such populations (Hayward and Kerley 2009). This exposes populations to all the problems associated with insularity and a small population size (e.g. demographic, genetic and environmental stochasticity, and, ultimately, the 'extinction vortex'), threatening the future prospects of such populations (Pekor et al. 2019).

Fencing may also threaten metapopulation level processes whereby local population extinction is offset by recolonization and gene flow maintains high levels of heterozygosity (Hayward and Kerley 2009). This would reduce the probability of persistence of isolated populations compared to connected ones, increasing the risk of extinction for isolated fenced populations, which is opposite to the intended functions of fencing. Nevertheless, this requires further investigation as, to our knowledge, there are no studies of the demographic responses of elephants to fencing *per se*.

Unintended consequences of fencing

In a large-scale study across a range of study sites, Loarie et al. (2009) demonstrated that fences cause elephants to bunch up against them, which may increase their local impact on vegetation. In smaller reserves, however, the opposite may occur because of the fence edge effect; at Pilanesberg NP, feeding intensity was lower close to the fence, and increased as elephants moved away from the fence (Vanak et al. 2010). This can have a major impact in smaller reserves: At Pilanesberg NP, 26 km in diameter (Vanak et al. 2010), the effect began 3.8 km from the boundary fence, potentially concentrating the impact of elephants on vegetation towards the centre of the PA.

Many species of wildlife have to move between different habitats at different times of the year in order to satisfy their nutritional requirements; thus, the confinement of herbivores to small sections of the broader landscapes can reduce the ecological carrying capacity (ECC) of the area, potentially leading to massive population declines and ultimately extirpation (Pekor et al. 2019).

Fences do not represent absolute barriers to megaherbivores such as elephants. Elephants are very good at breaking fences by snapping or pushing over poles, and even use their tusks to snap electrical wires (Grant et al. 2008; Slotow 2012). Poor fence maintenance, often due to shortage of funds or human resources, is a particular issue, as elephants first learn to break out through weak points, and then use their acquired skills to break through fully functional fences (Grant et al. 2008; Slotow 2012). Internal fences, which may be needed to protect lodges or other infrastructure, are often where the first incidences of fence-breaking occur (R. Slotow *pers. obs.*). Learned fence-breaking behaviour is difficult to correct, and the animal becomes a habitual fence-breaker, and may then need to be euthanized as a problem animal (Slotow et al. 2008). Fence-breaking necessitates repair, capturing of escaped animals, and may be costly in terms of subsequent incursions by problem elephants who raid crops in neighbouring communities, thus exacerbating HEC (Hayward and Kerley 2009). In some areas, use of two-strand electric fences that prevent elephants from entering, but allow other animals to do so, can be effective (Slotow 2012). However, this can have unintended consequences in that, in the absence of elephants, increasing meso-herbivore numbers can have cascading effects on other species (Lagendijk et al. 2011; 2012). As fencing confines elephants to small areas, they are unable to offset local food shortages by shifting their spatial distribution (Shrader et al. 2010). Consequently, their survival becomes more dependent on rainfall patterns, potentially leading to mass mortalities during periods of drought (Wato et al. 2016).

By preventing migratory movements, fencing can inhibit natural processes that regulate populations of species within bounds set by resource availability (ECC) (Hayward and Kerley 2009). This may result in over-use of an area, causing declines or extirpation within closed areas (Hayward and Kerley 2009). Erection of fences between communities and wildlife areas can cause conflict if proper consultation is not undertaken (Di Minin et al. 2021b). Moreover, fencing one area to mitigate HEC may transfer that conflict to another location (Osipova et al. 2018).

Range expansion

Fragmentation of ecosystems, especially due to fences, has reduced migrations, leading to population declines of migratory species (Bartlam-Brooks et al. 2011). Elephant ranges are rarely fully incorporated within PAs (Douglas-Hamilton et al. 2005; Graham et al. 2009); indeed, Thouless et al. (2016) suggest that only 30% of elephant ranges are within PAs. Thus, providing access to additional land is viewed as key to ensuring the long-term sustainability of elephant populations within areas enclosed by fences, by reducing their relative density and, therefore, their impact on ecosystems (van Aarde and Jackson 2007). Besides increasing the area of the reserve, a second objective of range expansion that relates specifically to the management of elephants in the SA context is the removal of bottleneck areas, and sharp angles into which animals may be directed as they move along the fence, increasing the risk of breakouts in these areas (R. Slotow, *pers. obs.*). While many reserves have increased elephant range areas by incorporating neighbouring areas, or straightened fence lines to reduce bottlenecks and breakouts (Druce et al. 2008; R. Slotow, *pers. obs.*), this has not been well documented in the literature. The largest incorporation of areas into a fenced reserve occurred in the Greater Kruger ecosystem, where adjacent private reserves were incorporated into the NP by shifting the boundary fence westward (Grant et al. 2008; R. Slotow unpublished data). This range expansion was further increased through the removal of the eastern boundary fence along the international boundary, connecting Kruger NP to Limpopo NP in Mozambique.

Demographic responses to range expansion

The human alteration of the global environment has led to significant reduction in the amount of habitat available to elephants and has simultaneously curtailed their migratory movements (Purdon et al. 2018). This has made the provision of access to additional land a key aspect of conservation strategies. By reconnecting habitats, it is possible to re-establish past migratory routes of species, once physical barriers are removed, and to augment local populations (e.g. Bartlam-Brooks et al. 2011). Nevertheless, there is currently no published literature, to our knowledge, on the demographic responses of elephants to range expansion, pointing to the need for more studies.

Unintended consequences of range expansion

Dropping of fences has expanded the range available to elephants; however, there is little published literature on the subject (Druce et al. 2008). Druce et al. (2008) studied the response of elephants to fence removal between Phinda Private GR, SA and two neighbouring communal reserves. After fence removal, older, recently introduced bulls responded quickly and moved into a new area, whereas young bulls and family groups took a long time to do so (Druce et al. 2008). However, more than a year after fence removal, most elephants had only expanded their ranges slightly into the new area. While this may have been because they were not under strong pressure to do so (Druce et al. 2008), these observations suggest that elephants are cautious about exploring new areas moving into them over a long time (Druce et al. 2008). Bulls are more tolerant of low-quality diets and are exposed to less risk by exploring unknown ranges (Druce et al. 2008; Woolley et al. 2009).

Thus, before fences are removed, the movement ranges of elephant groups in the area should be taken into consideration. For example, opening up fences for sedentary populations may lead to mixed results, as groups may be unlikely to incorporate new areas into their ranges. However, they may do so if population density is very high, or if the new area contains features that are attractive to elephants, such as water points, rivers, or preferred habitat or tree species, as has been observed in areas incorporated to the west of Kruger NP (R. Slotow, *pers. obs.*). There are also other challenges, for example, elephants may move into a new area of the reserve that is not set up for tourism, or further from established lodges (R. Slotow, *pers. obs.*). Furthermore, elephants moving into new areas that previously had no resident elephants may selectively feed on at-risk species of trees, rapidly reducing their abundance in these areas (O'Connor and Page 2014; O'Connor 2017). In addition, when new areas include a large river, elephants may spend a substantial amount of time there, impacting on high-value riverine vegetation (R. Slotow, *pers. obs.*). All these effects require further investigation, so that plans can be made for future mitigation measures.

Corridors

Elephants are wide-ranging species, with distinct wet and dry season ranges (Ngene et al. 2010; Kaszta et al. 2021). When moving between these seasonal ranges, elephants use corridors (Douglas-Hamilton et al. 2005; Ngene et al. 2010). Increasing connectivity between elephant ranges is seen as one way to reduce the impacts of elephants in areas where they have become over-abundant, as well as being a strategy to stabilize regional elephant populations (Douglas-Hamilton et al. 2005; Roever et al. 2013; Green et al. 2018). At an individual level, corridors allow elephants to meet their nutritional requirements by providing access to key resources which are otherwise scarce in space and/or time (Ngene et al. 2010). At a population level, corridors allow elephants to respond to stochastic events such as drought or threats such as poaching, via dispersal or migration (Shrader et al. 2010).

Moreover, corridors allow elephants to exist as a metapopulation, reducing the minimum size of each subpopulation necessary to be viable through the genetic and demographic contributions of immigrants (Graham et al. 2009). A land-use planning study across northern Kwazulu-Natal, SA, demonstrated the potential importance of elephant corridors (Di Minin et al. 2013). Corridors can also serve to increase connectivity for other wildlife, as elephant occurrence (both inside and outside PAs) is strongly associated with that of other large mammals (i.e. ungulates and large carnivores) (Crego et al. 2021). Furthermore, elephant corridors benefit communities surrounding elephant ranges by reducing HEC and increasing tourism revenue (Osborn and Parker 2003). Lastly, corridors can allow elephants to adapt to climate change by providing access to suitable habitat areas (Zacarias and Loyola 2018).

As elephants show differential use of habitat across space, the existence of movement corridors has been demonstrated both between (Douglas-Hamilton et al. 2005) and within PAs (Jachowski et al. 2013a). However, elephant distribution across landscapes is likely determined by a trade-off between human disturbance and forage availability (Graham et al. 2009). When moving through human-dominated landscapes, elephants experience a range of negative effects, such as reduced foraging and resting time, increased agitation (Kumar and Singh 2011), and even mortality. Elephants use avoidance tactics to reduce contact with people; these include: reducing movements in areas close to human settlements; moving through human-dominated landscapes at night; increasing the speed of transit in areas close to human development; and completely abandoning areas when human densities reach a certain threshold (Blake et al. 2008; Graham et al. 2009; Ngene et al. 2010; Jachowski et al. 2013a). In particular, roads and highways may serve as a barrier to elephant movement (Green et al. 2018, but see Okita-Ouma et al. 2021 for a different view), although elephants may use habitats near secondary roads, especially if these roads are located closer to water sources, when human disturbance is low at night, or when the vegetation on road edges is of higher quality than in areas far from roads (Green et al. 2018). In order to maintain the integrity of elephant movement across landscapes, future human development within areas identified as elephant corridors should be avoided, and instead located in areas that are less important for habitat connectivity (Ngene et al. 2010). In 2017, when the new Mombasa–Nairobi railway was built between the Tsavo East and Tsavo West NPs, insufficient mega-fauna passages and underpasses were constructed for elephants to compensate for restrictions on movements between ancestral ranges caused by the presence of the railway (Okita-Ouma et al. 2016, 2021).

Demographic responses to corridors

Van Aarde and Jackson (2007) proposed adoption of a metapopulation approach towards elephant management. However, the metapopulation as a whole remains stable, because immigrants from one population are likely to re-colonize habitat left open by the extinction of another (Pulliam 1988). Moreover, individuals may also emigrate from a large to a small population, thereby rescuing the small population from extinction ('rescue effect') (Brown and Kodric-Brown 1977). Managing elephants using this approach depends on the linkages provided by corridors to allow the dispersal of individuals among populations (Douglas-Hamilton et al. 2005). Despite the interest in the metapopulation approach, and widespread acceptance of the importance of elephant corridors in general, we are not aware of any study on the demographic responses of elephants

to movement corridors. Nevertheless, since corridors increase the overall amount of habitat available to elephants (Ngene et al. 2010; Roever et al. 2013; Adams et al. 2017), and also reduce their susceptibility to stochastic events (Shrader et al. 2010), the presence of elephant corridors may be expected to lead to an increase in elephant population numbers regionally, as well as enhancing genetic processes (gene flow, heterozygosity etc.), thereby reducing the requirement for translocation of elephants for genetic management . Both of these elements should be prioritized for further investigation.

Unintended consequences of elephant corridors

A risk associated with elephant corridors is that elephants can move into surrounding human settlements, causing damage to crops and endangering human life, thereby exacerbating HEC (Kikoti et al. 2010). For example, Kikoti et al. (2010) found that two villages bordering an elephant corridor connecting Kilimanjaro NP (Tanzania) to the Amboseli NP (Kenya) experienced increased rates of crop-raiding by elephants. This problem was particularly acute during the wet season, which is the main crop-growing season in the region (Kikoti et al. 2010). Secondly, elephants moving through corridors, which are unsafe areas from their perspective, exhibit elevated stress levels which may lead to aggressive behaviours, increasing HEC in human settlements bordering corridor areas, or in corridor areas within reserves themselves (Jachowski et al. 2013a; Ahlering et al. 2013; Tingvold et al. 2013; Hunninck et al. 2017). High levels of HEC may lead to negative attitudes towards conservation among members of surrounding villages, and even elephant deaths as a result of retaliatory killings (Kikoti et al. 2010; Selier et al. 2016).

However, corridors are still used by elephants when their stress levels are elevated (Jachowski et al. 2013a). Elephants move faster through corridors than in PAs and display reduced tortuosity of movement (Douglas-Hamilton et al. 2005; Ngene et al. 2010; Jachowski et al., 2013a). (There is no set width or length for corridors. They are areas through which elephants move between two core areas and vary according to the local situation. Neither is there a specific design for them (R. Slotow, *pers. obs.*). Thus, although corridors expose elephants to high levels of stress, this is unlikely to compromize their ability to connect disparate populations, or refuge areas within reserves. Furthermore, Munshi-South et al. (2008) found that elephants in a corridor which was being subjected to oil exploration in Gabon did not show an elevated stress hormone response, as the management of the oil concession had made efforts to minimize stressful interactions between humans and elephants. This suggests that if disturbance from humans is limited and their lives are not threatened, elephants adapt to living with humans, without elevated stress levels and associated HEC (Munshi-South et al. 2008). A specific unintended consequence of corridors between refuge areas within reserves is an increased risk of HEC, if people are not aware that they are in an elephant corridor and simply it as part of the larger PA (Jachowski et al. 2013a). In these cases, consideration should be given to signage and raising awareness among visitors to reduce the risk of HEC.

A further consideration is that corridor presence does not mean use, leading to a potential mismatch between corridor use and corridor function (Horskins et al. 2006), whereby the effort made to protect the corridor may not achieve the intended outcome. For example, Green et al. (2018) found that only 50% of elephants that entered the Mount Kenya Elephant Corridor in Kenya traversed its entire length, with many coming back to the same entry point they used, and others taking much longer than envisaged to move through the corridor. Studies also report differential use of corridor areas by elephants (Gangadharan et al. 2017; Green et al. 2018; Osipova et al. 2019), suggesting that elephants use some parts of corridor areas simply as an extension of habitat, and other parts for transit (Green et al. 2018; Williams et al. 2018). Generally, elephants were found to spend more time in areas with extensive woody cover and low human disturbance levels, while using the more open parts of the corridor for transit (Green et al. 2018). Heavily utilized areas may be more subjected to habitat degradation, undermining the role of corridors in reducing elephant impact on vegetation (Green et al. 2018). However, the primary purpose of setting aside corridors is to provide an identified passage through which elephants move between protected areas that avoids human settlements, thereby reducing HEC (Kikoti et al. 2010).

Moreover, corridors may only exist on paper (similarly to 'paper parks') if measures to protect them from human development are not put in place (Midha et al. 2018; Schussler et al. 2018). If elephant corridors are identified, but left unprotected, inevitably development will occur, undermining their effectiveness (Schussler et al. 2018). Fortunately, elephants are long-living species, with genetic differentiation of populations taking a long time to occur (Lobora et al. 2018). This suggests that the effects of isolation on elephant populations will take time to manifest, buying crucial time for conservationists to create elephant corridors, or to use other management approaches to avert habitat fragmentation and consequent isolation of elephant populations.

Artificial water provision

Surface water distribution is one of the most important factors, if not the prime factor, affecting the distribution of elephants across landscapes (Chamaille-Jammes et al. 2007a; Smit et al. 2007a, 2007b; Ngene et al. 2009). Thus, the availability and distribution of surface water affects the impacts of elephants on vegetation (Fullham and Child 2013). Provision of artificial water supply causes high local elephant densities; thus, water supply management is an important tool for managing elephant density and distribution (Chamaille-Jammes et al. 2007a). In Kruger NP, it was hypothesized that the removal of artificial water supply would reduce elephant impacts on the system, primarily through increasing the heterogeneity of their habitat use (Owen-Smith et al. 2006; Smit et al. 2007a; Purdon and van Aarde 2017). However, in PAs, particularly smaller ones, artificial water points may represent the main sources of water, and artificial water sources are often installed in front of tourist lodges to attract elephants and other wildlife (R. Slotow, *pers. obs.*). Moreover, the effects of water manipulation are likely to be dependent upon context, especially reserve size and management objectives (Smit et al. 2007a).

Closure of artificial water points away from rivers may not reduce elephant numbers, and could, consequently, result in negative impacts on the vegetation and biodiversity if elephants concentrate along rivers (Chamaille-Jammes et al. 2007a). Provision of artificial water sources may increase elephant numbers where surface water is limited or non-existent in the dry season, suggesting that reduction of some artificial water point is going to be effective mostly as a means of controlling elephants numbers in areas where population numbers are severely limited by water availability (Chamaille-Jammes et al. 2007). Furthermore, most elephant control measures assume that elephant numbers are above the ECC of reserves. If populations do not decline following water point closure, this suggests that the elephant population has yet to reach ECC, i.e. levels where resource availability starts to have a noticeable effect on demography (Chamaille-Jammes et al. 2007a).

Demographic responses of artificial water provision

Elephants are water-dependent species, requiring access to water every two to three days (Smit et al. 2007a, 2007b). Consequently, their distribution and abundance across landscapes are determined by surface water availability (Smit et al. 2007a, 2007b; Ngene et al. 2009). There is a large body of literature showing that artificial water provisioning leads to a significant increase in elephant numbers at a local level, especially in areas where water is limited or non-existent in the dry season (Chamaille-Jammes et al, 2007a, 2007b; Smit et al. 2007a, 2007b; Smit and Ferreira 2010). However, Chamaille-Jammes et al. (2007b) reported the relationship between surface water density and elephant densities reached an asymptote at densities of 3 individuals/km2. They suggested that, at densities above this threshold, food availability becomes the principal limiting factor for elephant densities (Chamaille-Jammes et al. 2007b). A corollary to this would be that the removal of artificial water points would reduce elephant numbers in areas where they are over-abundant (Smit et al. 2007a; 2007b), but this does not appear to be the case (Chamaille-Jammes et al. 2007a; Franz et al. 2010; Robson and van Aarde 2018).

Elephants not only use water for drinking, but also for thermoregulation, and change their speed of movement towards and away from water at high temperatures (Thaker et al. 2019). Providing artificial water points decreases the distance elephants have to travel to access water, which may reduce stress levels and, potentially, mortality among young elephants

in times of drought (Woolley et al. 2008a). Additional research on this is required, especially given the potential increase in temperatures and heat stress due to climate change (Ncongwane et al. 2021).

Unintended consequences of artificial water provision

The presence of artificial water points causes intense and localized impact on vegetation close to water, leading to a piosphere effect (heightened impact on vegetation close to the water point) (Kerley et al. 2008), which is more intense around artificial than natural water sources (Chamaille-Jammes et al. 2009). Along a 60–km transect in Chobe NP, Botswana, there was a piosphere effect at the local scale, with vegetation impact decreasing with distance from water, but at the larger landscape scale this piosphere effect disappeared (Fullman and Child 2013). There was a strong piosphere effect of elephant impact on succulent thicket vegetation in Addo Elephant NP, SA, close to water (Landman et al. 2012). Researchers advised against the establishment of artificial water points in the thicket habitat because of this. Piosphere effects may only emerge over a long period, and there may not have been enough time for such effects to become manifest in some smaller reserves and PAs where elephants have been reintroduced (Kerley et al. 2008). Nevertheless, vegetation utilization gradients by elephants in areas close to water points is a controversial conservation issue (Smit et al. 2007a, 2007b, 2007c; Chamaille-Jammes et al. 2007b). This is because savannah ecosystems are complex, and it is not easy to separate the effects of elephant impacts from those of fire management, disease, rainfall, soil mineral content, grazing by other herbivores, human activities, etc. (Shannon et al. 2008; Vanak et al. 2012; Guldemond et al. 2017). For example, the proportion of large trees that were utilized and pushed over in southern Kruger NP increased with distance from permanent water, and this effect would be heightened by artificial water provision (Shannon et al. 2008).

Hayward and Zawazdka (2010) showed that elephants generally exert more influence than rainfall on vegetation condition, although in some studies both elephants and rainfall combined to drive vegetation dynamics. Contrastingly, among the factors considered in a study by Guldemond et al. (2017) (elephant numbers, study duration, rainfall, tree cover, primary productivity, and presence of artificial water points), only primary productivity was found to influence elephant impacts on vegetation. This suggests that elephant impacts may be site-specific, and that applying uniform management measures across sites with varying environmental conditions may be inappropriate. Therefore, tailor-made solutions are required. Most studies on elephant impacts have focused on individual sites, with limited replication, lack of suitable controls, and incorrectly assigned response variables, leading to contradictory results (Hayward and Zawazdka 2010; Guldemond et al. 2017). While there is some understanding of local piosphere effects, further research is needed on spatial and temporal scaling in relation to piospheres, as well as their influence on the broader landscape.

An aspect to take into consideration with regards to potential unintended consequences of artificial water point provision is that it not only affects elephants, but also other herbivores, especially water-dependent species (De Beer and van Aarde 2008). For example, at high densities, elephants monopolize water resources while they are using them, leading to marked temporal partitioning in water point use between elephants and other species (Valeix et al. 2007). Sutherland et al. (2018) however, indicated a weak, positive effect of elephants on other species. This may disrupt the time investment of other species, leaving less time available for engaging in fitness-enhancing activities (Valeix et al. 2007). Furthermore, increased elephant densities may have cascading effects on other species by causing shifts in herbivore community structure. For example, in three protected areas in Namibia, the biomass of grazers increased more than browsers with increased density of elephants due to artificial water provisioning, shifting the community towards one dominated by grazers, particularly mega-grazers (white rhinoceros *Ceratotherium simum*, African buffalo *Syncerus caffer*, and hippo *Hippopotamus amphibius*) (De Beer and van Aarde 2008).

Fire management

Prescribed burning (fire management) is widely used especially with southern Africa, as an intervention to increase grazing quality, or to prevent or reduce

woody plant encroachment (Bond and Archibald 2003). Fires are intentionally started by managers to achieve specific aims, and different approaches have been used over time, from burning grasslands after a set time, towards a more natural approach to simulate natural fire return periods (van Wilgen et al. 2003). We are not aware of any NPs or PAs that currently implement burning for the specific purpose of providing additional food resources to elephants. Nevertheless, there is a large literature of the relative effects of elephants and fire on savannah vegetation (Smit and Prins 2016). Elephant herbivory and fire are major drivers of vegetation and biodiversity dynamics in savannah, with elephant herbivory considered the predominant driver of large tree dynamics, and fire being secondary (Vanak et al. 2012; Morrison et al. 2016).

These drivers, however, interact with each other in complex ways (Shannon et al. 2011; Vanak et al. 2012; Pellegrini et al. 2017). The probability of mortality of the ten most common tree species in the study area in Kruger NP depended not only on the type and intensity of elephant-induced damage and fire, but also on the historical sequence of damage by these agents, extending over 12 years (Das et al. 2021). Fire increases the incidence of elephant damage to trees by increasing the frequency and intensity of herbivory due to vegetative regrowth following fire (Pringle et al. 2015). On the other hand, elephant grazing and browsing affect fuel loads, leading to changes in fire intensity (Pringle et al. 2015; Morrison et al. 2016). Fire also affects herbivore spatial distribution at various scales. For example, elephants tend to be found more frequently in areas recently subjected to burns as there is a more vegetative regrowth (Shannon et al. 2011; Pringle et al. 2015). Despite the interactions between fire and herbivory, it is hard to separate the effect of elephants from those of other herbivores, and the effects of fire, soil, and rainfall (Smit and Prins 2016).

Demographic responses to fire management

The only paper we are aware of that considers the demographic effects of fire on elephants is that of Woolley et al. (2008b). This documents an unusual event, when a large portion of Pilanesberg NP was consumed by fires over a short period, and herds of elephants were caught up in the fires, with some dying and others being severely injured (Woolley et al. 2008b). Severely affected breeding herds reduced daily displacement, with increased daily variability; reduced home range size; spent more time in non-tourist areas; and associated less with other herds (Woolley et al. 2008b). Most mortality occurred in the juvenile age class, causing a change in post-fire population age structure (Woolley et al. 2008b).

Unintended consequences of fire management

After the Pilanesberg NP fire, there was a strong flight response, with elephants that were injured moving into non-tourist areas (Woolley et al. 2008b). As discussed above, such refuge behaviour may lead to aggressive encounters with humans and extensive habitat degradation in the refuge areas (Jachowski et al. 2012). A possible unintended consequence of high elephant densities in interaction with fire is high levels of tree death, which has the potential to transform savannah ecosystems from a closed to an open shrubby vegetation (Shannon et al. 2011). For example, by ringbarking trees, elephants make trees more susceptible to damage by fire, especially by exposing the xylem to intense heat, and subsequent damage, leading to reduced water conductivity in the stem, resulting in high stem mortality (Moncrief et al. 2008; Holdo et al. 2009). The impact of subsequent fire was higher on trees previously browsed by elephants than on undamaged trees (Shannon et al. 2011). Thus, the sequence of fire and elephant damage, and interval between them, are important (Das et al. 2022).

Consequences of elephant management on tourism

The burgeoning southern African elephant population, and the intervention strategies to deal with it, is one of the most hotly debated and emotionally charged contemporary conservation issues (Owen-Smith et al. 2006; Dickson and Adams 2009). Edge et al. (2017) found that visitors to PAs reported a high level of attraction to vegetation not impacted by elephants, and considered impacted habitat to be less attractive. This suggests that the impacts of elephants may affect the aesthetics of vegetation, with consequences for visitor attractiveness and, consequently, tourism potential

of PAs. In contrast, Arbieu et al. (2017) found that tourist experiences in PAs decline in areas with high vegetation density, with a positive relationship between mammal densities and tourists' experiences. In particular, tourists showed a dislike for areas with high vegetation density (Arbieu et al. 2017). Moreover, it became harder to spot mammals above certain thresholds of vegetation density, especially where mammal densities were low. Arbieu et al. (2017) concluded that the openness of grass-dominated savannah ecosystems provided excellent wildlife viewing opportunities, with tourist satisfaction linked to their wildlife viewing success. Similarly, Gray and Bond (2013) found that herd sizes, densities and, therefore visibility of animals in PAs were reduced in densely wooded areas, due to reduced habitat heterogeneity and possibly as a predation risk avoidance strategy. Visitor satisfaction declined with reduced visibility of wildlife (Gray and Bond, 2013). Other studies found higher density and richness of mammalian herbivores in areas with more grass cover relative to shrub cover, with herbivores distributed largely in open areas (Gandiwa 2014; Soto-Shoender et al. 2018). Combined, these results suggest that elephant impacts on vegetation may positively affect visitor satisfaction by increasing vegetation openness, leading to improved wildlife viewing experiences, and creating a more aesthetically pleasing environment than densely wooded areas (Gray and Bond 2013). Areas of high aesthetic value to tourists, such as along riverine areas, may be compromized by fencing (Slotow 2012).

Tourists prefer indirect forms of elephant management, whereas local residents prefer more direct methods of culling and translocation, but not contraception (Edge et al. 2017). Similarly, people from non-range States evinced highly negative sentiments to trophy hunting and culling of elephants, whereas people from range States were more concerned about HEC, poaching, and promoting elephant tourism (Hammond et al. 2022). As international tourists generally contribute more than domestic tourists towards tourism revenues in African PAs (Lindsey et al. 2007), the implications of these results are that intrusive elephant management approaches are more likely to reduce tourism revenues than non-intrusive ones (Edge et al., 2017). In addition, some interventions increase stress in elephants, leading them to change their spatial use of habitats, generally by retreating to refugia (Jachowski et al. 2012) away from prime tourist areas reducing the opportunity to view elephants (R. Slotow, *pers. obs.*). The corollary is that areas free of tourists play an important role by providing elephants with opportunities to reduce their stress levels.

Studies have demonstrated that tourism may have a direct negative effect on elephants (Pretorius 2003; Burke et al. 2004). For example, elephant stress hormones are higher in areas with game drives, and stress levels reach a peak while the game drives are taking place (Pretorius 2003). Moreover, if tourist vehicles come too close to elephants, or if there are too many vehicles, elephants display behaviours associated with risk avoidance and stress (e.g. bunching, moving further away, moving to thick vegetation, and moving to safe areas away from tourists) (Pretorius 2003; Burke 2004). In addition, Szott et al. (2019a, 2019b) found that as tourist pressure increased, elephant aggression towards conspecifics increased, especially by male elephants. Furthermore, they found that elephant herds were increasingly likely to move away when more vehicles were present. As tourism activities and vehicle presence increased, elephants altered their behaviour from feeding to fearful, alert, stress-related or aggressive behaviours (Szott et al. 2019a). Thus, although tourism viewing experiences are important for revenue generation, tourists themselves negatively affect future sightings of elephants for others, reducing future tourism potential.

Overall, these results suggest that managers of areas where elephants are present should train staff (e.g. guides) to monitor elephant behaviour to identify potential negative effects of tourism pressure on elephant welfare, as well as ensuring that tourists/tourist vehicles maintain the minimum distances from elephants required to meet high standards both for elephant welfare and tourist safety (Szott et al. 2019a; 2019b). The closure of artificial water points is likely to have negative impacts on the tourism potential of PAs by restricting elephant movement to areas with high natural water availability (e.g. Smit et al. 2007a, 2007b), but this important issue is yet to be investigated.

Discussion

A range of interventions has been implemented to reduce elephant numbers, population growth rates, density, or movement in regions where they are, or potentially could become locally over-abundant, or to contribute to conservation goals. These interventions include contraception, vasectomy, translocation, hunting, culling, fencing, range expansion, connectivity, water provision, and fire management (Owen-Smith et al. 2006; van Aarde and Jackson 2007; Scholes and Mennell 2008). In this study, we conducted a systematic literature review to update our understanding of these interventions in the 2008 assessment by Scholes and Mennell (2008), including demographic responses to the interventions their unintended consequences, and interactions with tourism. Interventions that are effective in achieving intended outcomes may also be associated with a range of unintended consequences. We found large disparities between the amounts of research effort directed towards the different approaches, with, overall, very few studies that explicitly investigated their unintended consequences.

In general, the research published since 2007 has contributed to increased understanding of the effectiveness of the various interventions. It should be borne in mind that we only reviewed papers dealing with elephants, and there has been substantial other work published on some of the indirect management interventions, such as water provisioning, fire management, corridors etc. However, it should be noted that, in addition to assessing the method in the context of elephants, we also examined it effects on elephants, especially on their ranging and on elephant population demographics.

We found that there is minimal information available on the demographic effects of indirect interventions (such as fire management, fencing, range expansion, and corridors) on elephants, or on how they affect local spatial use by elephants. However, there is a good body of literature on the demographic and spatial effects of water point provisioning and closure of water points. Water provisioning increases numbers locally, reduces mortality, for example from drought, and may increase population growth rates (Chamaille-Jammes et al. 2007a, 2007b; Smit et al. 2007a, 2007b; Smit and Ferreira 2010), as well as greatly influencing spatial use by elephants (Chamaille-Jammes et al. 2007a; Smit et al. 2007a; 2007b; Ngene et al. 2009). Conversely, closure of water points can reduce growth rates, and increase heterogeneity in spatial use and impacts (Owen-Smith et al. 2006; Smit et al. 2007a; Purdon and van Aarde 2017). Water provisioning is, therefore, the most effective indirect intervention if the aim is to influence elephant spatial use and increase population growth rates; however, it is not clear that closure of water points leads to a reduction in population (Chamaille-Jammes et al. 2007a; Franz et al. 2010; Robson and van Aarde 2018). It should be noted that severe droughts can cause mortality even when water is available, as food near water may be depleted; however, there would need to be very high mortality of infants and just weaned calves (85% mortality of calves at least every eight years) for this to lead to a persistent decline in population size (Woolley et al. 2008a).

Excluding elephants from potential high-conflict areas using fences is effective in mitigating risks associated with HEC (Di Minin et al. 2021b). These are not necessarily conceptualized as continuous barriers around PAs in the traditional sense, but rather target the immediate area of conflict, using a risk assessment approach (Di Minin et al. 2021b). Innovations in approaches to fencing under such circumstances are necessary, such as the recent work of La Grange et al. (2022), who tested a soft virtual boundary, placing deterrent scents along habitual pathways of elephants from natural areas to croplands, thereby deterring them from leaving their daytime refugia. While Di Minin et al. (2021b) factored in the capital and maintenance costs of fencing in their economic analysis of where to consider fencing, the high costs of fence maintenance are challenging at a time of declining conservation budgets (Grant et al. 2008). Additional research is needed on approaches to fencing for specific purposes (Slotow 2012), including non-continuous fencing to allow natural movement of elephants across broader landscapes. In general, work on HEC, or human–elephant co-existence (HECx), in the unfenced landscapes that characterize many elephant ranges across Africa has long been a focus of research (Hoare 2015). The different elements of HECx were reviewed by Shaffer et al. (2019), who also emphasize the need to apply ecological, anthropological, and geographical knowledge and

tools for long-term sustainable solutions. In their review of HECx, Gross et al. (2022) identify six strategic areas that need to be considered, one being technical, which covers the types of interventions we have reviewed here. Others address monitoring, legislative, social, spatial management, and financial issues. Van de Water et al. (2022a) set out the TUSKER framework for more sustainable people–nature interactions in the context of elephant conservation, emphasizing the need to balance integrity of nature with social cohesion and human well-being, as well as moderating the use of nature in accordance with widely accepted values, aspirations and rights. Such holistic approaches address conflicts arising from interactions with many animals, as opposed to the targeted management of habitual crop raiders (Hahn et al. 2022) reviewed here under the culling section. Clearly, more research is needed on the demographic and spatial effects of some of the indirect interventions, to gain a better understanding of elephant behaviour under different circumstances.

Among direct interventions, there has been substantial work on the various forms of contraception, such that these methodologies are becoming refined and well understood. The impact of direct interventions on demography and spatial use is well understood. In this context, further research on their technical aspects is less important than addressing the urgent need to better understand the impacts of indirect interventions, as indicated above.

Importantly, this review identified a range of unintended and undesirable consequences of the interventions, but, again, there has been more research on some of these than others. Although the provision of access to additional habitat for elephants is a key management approach to reduce the local impacts of elephants on the environment, this aspect has received only scant research attention. Of particular concern is the increase in HEC in communities surrounding corridor areas which can lead to the development of negative attitudes towards conservation among community members (e.g. Kikoti et al. 2010). An unintended consequence of fire management occurs when fire combines with damage caused by elephants increase tree mortality (Shannon et al. 2011, Vanak et al. 2012, Das et al. 2022). The potential unintended consequence of fire killing trees that were previously damaged by elephants needs to be considered in further studies.

Although translocation is an important part of elephant management approaches, few studies have assessed its unintended consequences. In addition, very few studies have conducted long-term post-release monitoring of the translocated elephants, which means that little is known about the success or otherwise of this approach.

In addition to its controversial nature, as well as its ineffectiveness (in the long term) in reducing elephant numbers, culling is the elephant management approach associated with the highest number of unintended consequences. More clarity is required on the fact that trophy hunting is primarily for economic benefit, and that selective removal of adult males is ineffective in reducing population size except in very small populations.

Importantly, this review also assessed perceptions of tourism and the potential impact of tourism on elephants. Elephant impacts on habitat may alter the sense of place (Hausmann et al. 2016), as will some management interventions, including provision of water which creates artificial landscape effects through piospheres (Kerley et al. 2008). Conversely, provision of water attracts animals in general, making them more accessible and visible to tourists (Sutherland et al. 2018). There may be interactions between management interventions and tourism satisfaction, which require further investigation. Tourists prefer non-lethal interventionist approaches (Edge et al. 2017), and the potential negative effect of resuming mass culling on ecotourism revenues has not been investigated. Harvey (2020) estimated the potential cost of reputation damage from the captive lion industry in South Africa to be USD 2.79 billion, and a similar risk would need to be considered in decisions around mass culling of elephants.

Different aspects of elephant management can evoke different reactions from people in general, and specifically from tourists, and more research is needed to understand these important dynamics. Social media analysis provides an opportunity to collect data from a range of people, although it does exclude those without internet access (Hausmann et al. 2020). The word elephant appears frequently in tourist social media, and the sentiment associated with seeing them can be interpreted; for example, in Addo Elephant NP, joy is associated with elephants (Haussmann et al.

2020). Management interventions such as trophy hunting and culling evoke the strongest negative sentiment among potential tourists from non-range states, while people in range States have positive sentiment towards promoting tourism (Hammond et al. 2022). People from non-range States were more concerned than those within range States about elephant welfare issues (Hammond et al. 2022). Given its importance in supporting elephant conservation on the ground (Naidoo et al. 2016), more research is required on the potential effects of elephant management on tourism.

The results make clear that the 'elephant problem' brings to the fore the issue of equilibrium versus non-equilibrium control of ecosystem dynamics. In the 'equilibrium' school of thought, density-dependent population regulation factors are prime determinants of animal population size (Sinclair and Krebs 2002). Based on a perspective of ecosystems dominated by equilibrium dynamics, high densities of elephants and the resultant habitat change are perceived as an undesirable disruption of equilibrium conditions (Gillson and Lindsay 2003). This perspective is associated with a 'command and control' management style (e.g. culling, translocation, contraception, etc.) that aims to maintain animal numbers at levels compatible with the steady state (Gillson and Lindsay 2003; Owen-Smith et al. 2006; Guldemond and van Aarde 2008).

The 'non-equilibrium' school of thought, on the other hand, predicts that plant composition and biomass are primarily driven by rainfall rather than by grazing/browsing pressure (Vetter 2005). Thus, animal numbers are maintained at low densities by frequent droughts and have little impact on vegetation change (Ellis and Swift 1988; Illius and O'Connor 1999). From this perspective, variability in rainfall is an important driver of ecosystem dynamics and determines the spatial and temporal heterogeneity required for ecosystem diversity, stability, and resilience (McNaughton et al. 1988). This perspective is associated with a "laissez-faire" (i.e. non-intervention) management style (van Aarde and Jackson 2007; Guldemond and van Aarde 2008).

Nevertheless, elephant management approaches are becoming more centred on promoting ecological processes to regulate elephant numbers naturally (Owen-Smith et al. 2006; van Aarde and Jackson 2007; Ferreira et al. 2013). Clearly, such an approach requires areas large enough for natural processes to play out; the issues of reserve size and the need for management interventions to control elephants or their impact are poorly understood, and remain a priority for future research (Kerley et al. 2008; Delsink et al. 2013). In addition, increased consideration is being given to inclusion of broader social and economic elements into decision-making, emphasizing the need to reduce disservices such as HEC, and achieve a better balance between the integrity of nature and social cohesion and human well-being (van de Water et al. 2022a, and references therein).

Artificial water provisioning may have the largest unintended consequences on elephant demographics (reduced mortality during drought or heatwaves), and the greatest impact on vegetation from higher elephant densities (Smit et al. 2007a). It will become more important to understand this as elephant densities increase in some parts of their range, such as southern Africa, especially with the anticipated large temperature increases caused by global warming (IPCC 2019), and associated effects such as heat stress (Ncongwane et al. 2021). Water provisioning may mitigate the natural mortality that would occur under such conditions, preventing natural population reduction, but may also, potentially, increase the need for other management interventions to deal with the consequence of water provisioning (Chamaille-Jammes et al. 2007a; 2007b; Smit et al., 2007a; 2007b).

Finally, Slotow et al. (2021)'s assessment of the legal context for culling emphasizes the importance of considering elephant welfare and wellbeing in management, as this is both a legal obligation in South Africa (and many other countries), but also linked to the Human Environmental Right in the South African Constitution. The importance of animal welfare is also highlighted in the sentiment analysis conducted by Hammond et al. (2022). Slotow et al. (2021) recommend requiring an ethics review process for all conservation management implementations and interventions involving well-being risk to animals, such as is required for animal research. This is an aspect that has, to date, received scant consideration in elephant management, and should be given more prominence.

A key element missing in decision-making from elephant conservation and management is moderating the use of nature in accordance with widely accepted values, aspirations and rights, and applying the moderating

filters of good governance, environmental justice, intergenerational legacy, and human rights (van de Water et al. 2022a). Elephant conservation and management strategies can be contentious, and discussions are often polarized as views and values of stakeholders diverge widely (van de Water et al. 2022a, and references therein). Given the increasing human population, habitat loss, increasing HEC, and shifting local community and global sentiments towards elephant conservation and management, careful consideration needs to be given to the use of direct relative to indirect management interventions. Broader scale planning, including measures to increase the connectivity of fragmented populations, and combined with indirect interventions, may be more environmentally, socially, and economically sustainable than direct interventions. More meaningful and structured engagement by all stakeholders is needed to resolve contentious issues in elephant management (Biggs et al. 2017).

Lastly, there are many beneficial consequences of elephants for humans (van de Water et al. 2022b); and as many of these are poorly documented we suggest this as a focus for future research.

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Ivory trafficking, transnational organized criminal networks in eastern and southern Africa, 2009–2020, and the emerging new threat

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Abstract

Beginning in 2008 the poaching rate of elephants and rhinos began to rise noticeably in eastern and southern Africa. The poaching intensified considerably 2010–2014. Along with the poaching increase, illegal exports of ivory and rhino horn also surged. Pangolin scales and parts of predator cats were often included with ivory and/or rhino horn exports. The great majority of these products were smuggled to Southeast Asia and China.

To extract in the field or acquire illegally from government stockpiles and transport increasingly large quantities of ivory and rhino horn to exit ports in all four subregions of sub-Saharan Africa required considerable organization and logistical capabilities on the part of the traffickers. The transnational organized crime (TOC) networks became more organized and larger from about 2009 to late 2014, when significant arrests began of key actors. This review describes five of the main networks, key actors in each and their disruption.

These arrests and sometimes prosecutions disrupted the operations of the networks and even caused shifts in some cases of home bases and export ports. These disruptions have resulted in significant declines in poaching rates of both elephants and rhinos and product prices in recent years from the 2011–2015 peak years, although other factors were also at play. There is evidence that some members of the networks cooperated with more than one network in supplying products and enabling export and transport to destinations in eastern Asia, indicating that the networks are fluid and adaptable.

A new TOC network is emerging that operates in southern, Central and West Africa. Investigations are urgently needed to identify key members and disrupt it in order to avoid a renewed pachyderm holocaust.

Résumé

Depuis 2008, le taux de braconnage d'éléphants et de rhinocéros a ostensiblement augmenté dans les régions du sud et de l'est de l'Afrique. Il s'est considérablement intensifié entre 2010 et 2014 et s'est accompagné d'une hausse du commerce illicite d'ivoire et de cornes de rhinocéros. Des écailles de pangolin et diverses parties du corps de grands félins complétaient souvent les exportations d'ivoire et de cornes de rhinocéros. La majorité de ces produits étaient de la contrebande à destination de l'Asie du Sud et de la Chine.

Les extraire en quantités toujours plus grandes sur le terrain ou les acquérir illégalement dans les stocks gouvernementaux, puis les transporter vers les ports de sortie des quatre sous-régions d'Afrique subsaharienne nécessite une organisation et des capacités logistiques considérables de la part des trafiquants. Les réseaux du crime organisé transnational (COT) se sont beaucoup structurés et développés entre 2009 et fin 2014, date à laquelle ont eu lieu les arrestations de certains acteurs clef. Cet article décrit cinq des réseaux majeurs, ainsi que les principaux protagonistes de chacun d'entre eux et les perturbations qu'ils ont connues.

Les arrestations—et parfois les poursuites judiciaires—ont déstabilisé leurs activités jusqu'à, dans certains cas, causer le déplacement des bases d'opérations et des ports de sortie. Les résultats sont significatifs : le taux de braconnage d'éléphants et de rhinocéros a nettement baissé ces dernières années, ainsi que le prix des produits par rapport au pic atteint entre 2011 et 2015, bien que d'autres facteurs soient à prendre en

compte. Des preuves ont indiqué que certains membres de ces réseaux coopéraient avec plus d'un groupe pour fournir les marchandises et permettre l'exportation vers des destinations en Asie de l'Est, montrant la fluidité et l'adaptabilité de ces organisations.

Une nouvelle section de COT émerge actuellement dans les régions du sud, de l'ouest et du centre de l'Afrique. Il est urgent de lancer des investigations afin d'identifier les acteurs clefs et entraver le commerce pour éviter le retour des massacres de pachydermes.

Introduction

Ivory has been moving out of eastern Africa for many centuries. Ancient Egyptians, Greco-Romans, southern Arabians, south Asians and finally what have been called the 'Swahili', an East African coastal people of mixed indigenous African and Middle Eastern immigrants, have been trading natural product commodities transported from the hinterland to port towns along the 4,000 km-long coast from Somalia to Mozambique for more than two millennia (see Figs. 1–3) (Stiles 1992).

During most of this > 2,000-year history of ivory trade there were no legal restrictions, except for local laws that may have applied to commerce in this commodity. With the advent of CITES in 1975 and the listing of the Asian elephant on Appendix I and the African elephant on Appendix II, the first trade restrictions were applied the same year. In addition, some African countries such as Kenya, one of the largest ivory exporters at the time, prohibited trade in all wildlife products in 1978.

Increasing ivory trade restrictions in the 1970s up to 1989 and the almost total ban on all international ivory trade by CITES resulted in the old trading networks undergoing a profound transformation. Up to 1989 there was a mixture of 'legal' ivory, which was acquired by governments and licensed traders from natural mortality, problem animal control and culling, plus illegal ivory pouring into the trade chain from escalating poaching (Parker and Graham 2020).

As with rhino horn, with increasing trade restrictions in the 1970s came price rises. The average raw ivory export price in 1970 was only USD 7.5/kg, jumping ten-fold to USD 74/kg in 1978 after Kenya banned the ivory trade. Just as demand was rising in eastern Asia with their fast growing economies, the supply spigot was being turned off. The traders saw the writing on the wall and began to stockpile, especially in Hong Kong and Japan, at the time the two largest ivory markets in the world.

The skyrocketing prices attracted new players and even influential African political and business interests began muscling in exploiting their elephants. Political elites and even presidents and their families began dealing in large quantities of ivory and other wildlife products (Hornsby 2011). Kenya's elephants plummeted from 167,000 in 1970 to 16,000 in 1989. Investigative journalists revealed that the President's family was deeply involved, even using government vehicles to ferry the ivory to the Mombasa port (Hoyt 1994).

The legal ivory in eastern Africa was being supplied through government-authorized auctions in Mombasa, Dar es-Salaam and Zanzibar from ivory provided by game departments, national park services and other authorized sources (Parker and Graham 2020).

It is quite possible that some of these same legal dealers purchased the poached illegal ivory from the Kenyatta family and politicians. After all, it was the Mombasa dealers who had the knowledge of the Kilindini Port operations in Mombasa and network of buyers in Asia. Perhaps the Mombasa families that were involved in the legal trade carried on with the illegal trade. The traders knew that even if legal trade stopped, the black market would react to future consumer demand. They were prepared to respond to the 1989 CITES ban on international ivory trade.

According to informants in the ivory industry 1999–2003 in the respective countries surveyed in Africa and Asia, ivory trade activity and prices dropped for a few years after the 1989 CITES trade ban, but in the late 1990s, after the new trafficking supply chains and trading networks were organized, trade—now largely illegal–was picking up again. The pre-1989 raw ivory stockpiles in Hong Kong, Japan and elsewhere were also running low, so needed to be replenished (Stiles and Martin 2001, 2002, 2003).

Methodology

The information and data presented here were selected and analysed from published reports, research and press articles and monograph reports that are cited in the references. In addition, the results of twenty years of research by the author with TRAFFIC, the United Nations Environment Programme (UNEP), International Union for Conservation of Nature and Natural Resources (IUCN), the UN Office of Drugs and Crime (UNODC), the Freeland Foundation and the Global Initiative Against Transnational Organized Crime (GI–TOC) allowed the author to interview many knowledgeable informants in the ivory industry, UN and government agencies and NGOs concerning trafficking networks and their organization and operations.

Results and Discussion

In the 1990s and 2000s the criminal elements who were running poaching networks throughout eastern and southern Africa—continued to be the politically connected people, consisting of trade chains from poachers to exporters, and operating in most of the elephant-rich habitats (EIA 2014). Tusks flowed into the main cities with strategic international airports or seaports imitating a water drainage system, beginning with rivulets running into streams, which joined into rivers and eventually entering into the sea. The ivory was then prepared for export using various camouflaging materials and packing methods in collusion with bribed shipping and customs agents, and were dispatched on their way by sea or air.

In Africa, it was common to have corrupt units within the military, police and even the wildlife protection authorities involved in elephant poaching and other illegal wildlife trafficking businesses. They either worked for protected elites or became rogue entrepreneurs.

Different networks displayed varied degrees of vertical integration through the trade chain from the field poachers through brokers and transporters to the exporters and on to the importers and their facilitators. The relationships of all were fluid and based on opportunism, a perception of where the most profit with lowest risk were to be found.

The identities and operational details up to 2014 were shrouded in mystery, because no arrests and successful prosecutions were made of the "big fish" or "kingpins", as the media like to call network heads (Kahumbu 2016). The triggermen and their accomplices in the bush collecting tusks were killed or caught in the thousands, and hundreds of wildlife rangers were unfortunate casualties as well, with no apparent effect on poaching rates (Global Conservation 2018).

In the 1990s, with economic growth and freedom of movement increasing in China along with globalization, Chinese began emigrating in ever-larger numbers abroad seeking business opportunities. Families that had been involved in the fishing industry for generations in Shuidong, Guangdong Province, found good opportunities in Zanzibar for various seafood products, such as sea cucumbers, fish maws and shark fins, and established themselves. There was a nice little port with cooperative port officials and, more importantly, Zanzibar's local laws regarding wildlife applied only to native species. Elephants were not native to Zanzibar.

The infamous "Ivory Queen", Yang Fenglan, ran probably the biggest TOC enterprise trafficking ivory in Africa between 2006 and 2015 from Dar es-Salaam, Tanzania. There is evidence that Yang supplied the Chinese Shuidong Network that operated out of nearby Zanzibar (EIA 2014, 2017), cooperated with the Sheikh–Feisal group based in Mombasa and with the Moazu "Kampala Man" Kromah's network based in Kampala, Uganda, which operated in Mozambique, Tanzania, Kenya, Guinea, Togo, Senegal and elsewhere.

Together, these three trafficking TOCs ran the trade chains that scooped up and shipped out hundreds of tonnes of poached tusks from a wide area from northern Zambia, eastern Democratic Republic of the Congo (DRC), north and west Mozambique, Tanzania, Uganda and Kenya between 2006 and about 2016, with some shifting of activity depending on arrests and court cases. The tusk origins of 49 ivory seizures determined by DNA analysis supports this scenario (Wasser et al. 2022).

Yang Fenglan depended on field operatives such as Tanzanian Mateso "Chupi" Kasian, who ran poaching gangs in the Selous–Mikumi area of southern Tanzania and Niassa National Park (NP) in northern Mozambique, and Burundian Boniface "Shetani" Malyango, who operated more widely, running at least 15 poaching gangs to the west and north of Chupi's operations in Mozambique, Tanzania and southern

Kenya, and also getting tusks from Zambia and DRC via Burundi. Two lieutenants of Yang, Salivius Matembo and Manase Philemon, would travel from Dar es Salaam to pick up tusk aggregations from Mateso and Malyango, and other suppliers, pay them off, and return to Dar es-Salaam to turn the tusks over to Yang.

It is not clear where the Kromah network was getting its ivory and rhino horn and where they fit in with the Mombasa, Dar es-Salaam and Zanzibar based networks, but seizure DNA shows his exports contained large quantities of ivory from Tanzania and Mozambique, and four ivory seizures contained leaked Burundi old government stockpiled ivory (Stiles 2022). Chris Morris, who was tracking the Kromah and Shuidong networks told the author in an email in June 2019, "Kromah has been supplying the Sheikh's, Feisal and Abdinoor Ibrahim Ali with ivory/rhino horn. This case dwarfs Feisal or the Sheikh's as this West African cartel has been supplying Keosavang[1], the Vietnamese, the Chinese Shuidong connection and others over the years."

None of these networks were operating in 2022. The key players of each have either been arrested and prosecuted or have fled the sub-region. Fig. 1 shows their approximate areas of operations. Two other Chinese TOCs also operated during this period, one based in Malawi and one in Nigeria, described below.

The networks

The Sheikhs—Not a network in isolation, but rather a large group of facilitators to other TOC networks. The key players currently known who were involved in transporting at least some of the poached ivory to Mombasa, aggregating and storing it, packing it into containers, getting it through port security undetected, loaded on board a freighter and preparing the "road" to get it safely to Asia are Kenyans Abdulrahman Sheikh, Sheikh Abdulrahman, Mahmoud Abdulrahman Sheikh (aka Said Juma Said, of Tanzanian nationality). The Sheikhs were working mainly with Kromah, but also with the Shuidong network for at least one confirmed seized 3.7–tonne ivory shipment from Mombasa to Singapore in 2015 (Chris Morris, pers. comm.). Other important players connected with the network acting as fixers were Samuel and Nicholas Jefwa. Jefwa and his brother Nicholas are still on the run six years after two large ivory seizures totaling 7.8 tonnes were made in Singapore and Thailand in 2015 (Business Daily Africa 2015a and 2015b).

Feisal Mohammed Ali was also probably working with this group, acting as liaison between Mombasa and Dar es-Salaam and transporting ivory from Tanzania to Mombasa. Feisal was arrested in 2014 in connection with a 2.1–tonne ivory seizure in Mombasa— of Tanzanian and Kenyan ivory originating in Kampala, Kromah's base. He was sentenced to 20 years imprisonment in 2016, but was later freed on appeal (Karani 2018).

This network is linked with the Akasha narcotic drug trafficking syndicate, which was also based in Mombasa. Although the exact relationship has never been made clear,[2] the Akashas most likely assisted the ivory traffickers through their connections with politicians and police for protection and port officials to ensure that proper inspections of the cargo were not made and bribing judges when prosecutions started.

The Akasha ring was arrested and extradited to the USA in 2017 and are now in prison there (ECF 2018).

Tommy Cindric, a former U.S. Drug Enforcement Administration (DEA) Special Agent, told the author in emails in December, 2018, that "We have no knowledge of the Akashas ever shipping ivory. We do know from undercover meetings that they could get us ivory… I do firmly believe it [ivory and rhino horn] is a facet of their overarching family business like drugs, guns, extortion, bribery. I believe they probably take a cut and provide protection for the people in their organization engaged in ivory trafficking".

No large ivory seizure has been made in Mombasa since 2016, indicating that the arrests of Feisal, the Sheikhs and the Akashas disrupted the trafficking operations of this major export port.

The Shuidong network and Yang "Ivory Queen" Fenglan networks—These notorious linked networks operated from Dar es-Salaam and Zanzibar up to 2015. Yang ran her own operation from a two-story building

[1]Vixay Keosavang was trafficking wildlife up to 2014 with no known links to Kromah. Morris probably meant Vannaseng Trading, also operating out of Laos. They sent USD 190,000 to Kromah in Kampala (The Monitor 2017).

[2]At the time of the Feisal ivory seizure and arrest, Feisal was in close communication (supported in phone data) with Mohamed Tenge, half-brother to one of the Akasha's.

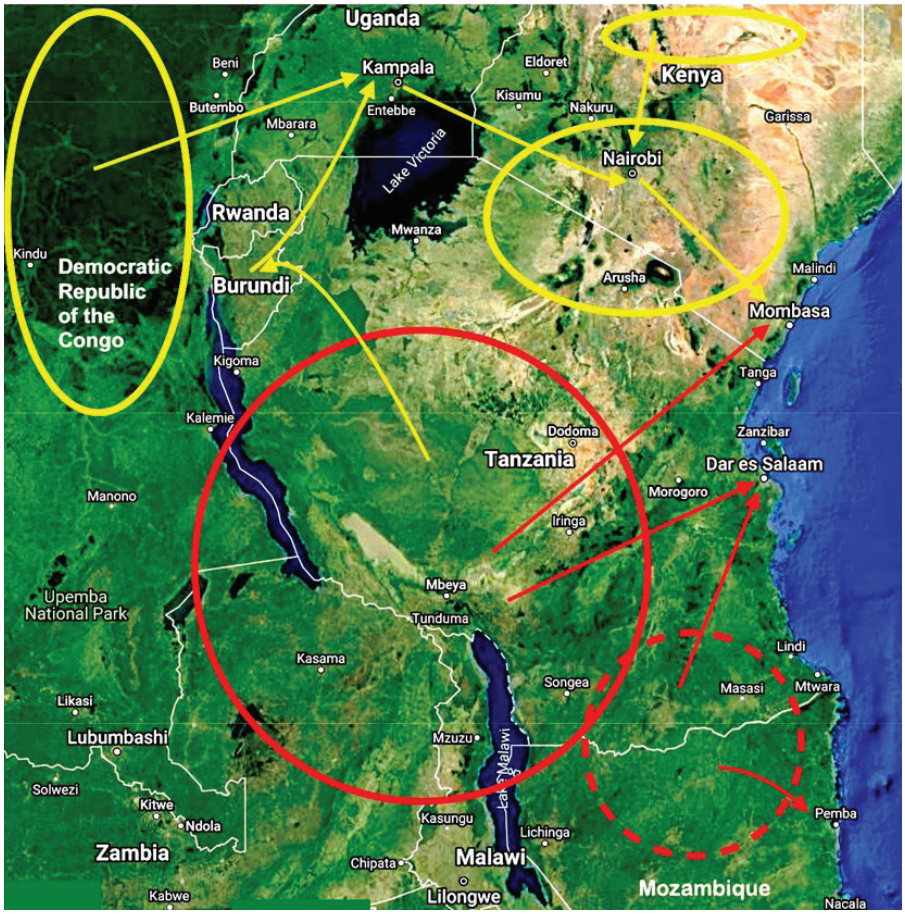

Figure 1. The elephant poaching areas feeding the three main ivory trafficking networks operating in eastern Africa during the 2006–2016 period.
(The dashed red oval in the figure above shows the approximate area where Chupi Mateso operated and the solid red oval shows Shetani Malyango's approximate area of operations. The yellow oval is the main Kenya supply area and exiting the port of Mombasa which was Kromah's network, along with the Burundi stockpile). Red ovals and arrows = Yang-Shuidong, yellow = Kromah. See more explanations in the text "The networks" below).

Figure 2. Thai customs officers inspect confiscated elephant tusks during a press conference at the Customs Bureau in Bangkok on 27April, 2015. The haul was traced back to the Sheikhs and their facilitators. (© *Pornchai Kittiwongsakul AFP*).

in Dar with her Chinese restaurant on the ground floor and Beijing Great Wall Investment company on the floor above, where she also stored her tusks on occasion in a small apartment (Linah Clifford, TRAFFIC, pers. comm. 18 July 2018). The Shuidong group in Zanzibar was one of her main customers for ivory. She first came to Tanzania in 1975 to act as a Kiswahili–Chinese translator during the building of the TAZARA rail line from Dar es-Salaam to Zambia, returning to Beijing afterwards. In 1997, she went back to Tanzania and set up her two businesses. She also served as vice-chairwoman and secretary-general of the China-Africa Business Council of Tanzania, where she met and cultivated important business and political personalities. Yang and her Beijing restaurant became active in bringing together Tanzanian and Chinese business interests.

In November 2013 three Chinese nationals were arrested in Mikocheni, Dar es-Salaam—near Yang's Beijing restaurant—packing 1.9 tonnes of ivory into a container. The Chinese worked for the Shuidong Network, who had bought the ivory from Yang. Shortly afterwards, investigators seized a container belonging to Shuidong traffickers in Zanzibar linked to the Mikocheni bust with almost 3 tonnes of ivory. The three Chinese were tried and two were sentenced to long prison terms (EIA 2014).

In 2014 the Protected Area Management Solutions (PAMS) Foundation teamed up with the Tanzanian National and Transnational Serious Crimes Investigation Unit (NTSCIU) to investigate Yang. They gathered enough information to charge her and two accomplices, Salivius Matembo and Manase Philemon, in October 2015 with specific cases of ivory trafficking, including some involving Shuidong Network members. Following a dramatic car chase through the streets of Dar es-Salaam, Yang was apprehended. She and her two accomplices were eventually convicted and sentenced in February 2019 to 15 years' imprisonment for "leading an organized criminal gang" by the Tanzanian court (AFP 2019).

From 2009 to 2014, 22.6 tonnes of ivory were seized inside Tanzania while 40.7 tonnes of ivory linked to Tanzania were intercepted outside the country, indicating that corruption in Tanzania's ports was allowing most of the ivory to be shipped out (EIA 2014). In 2014 a Zanzibar-based sea cucumber trader called Wei Ronglu, from Shuidong, told Environmental Investigation Agency (EIA) undercover investigators that 20 containers with ivory hidden inside were shipped to the Chinese mainland, usually via Hong Kong, in 2013. Wei claimed that

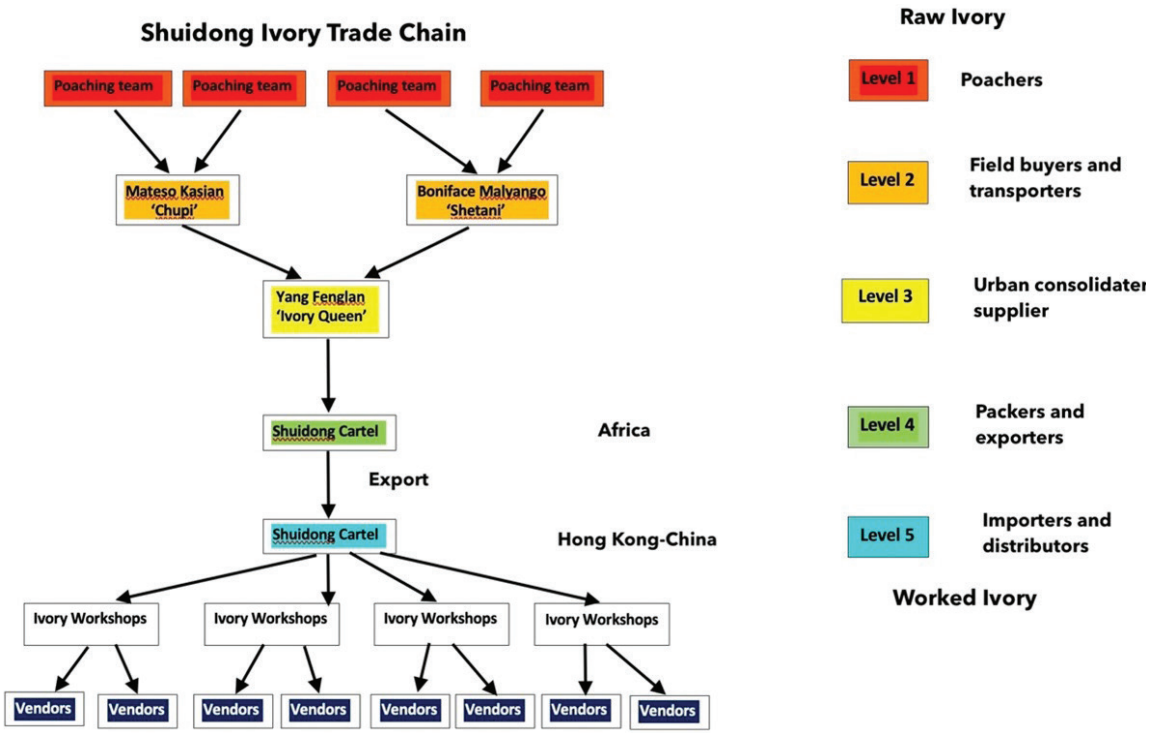

Figure 3. A simplified Shuidong trade chain in 2014, at the peak of the elephant poaching crisis, before Yang Fenglan was removed. By 2017 the operations of Chupi and Shetani were severely disrupted, leading to Shuidong moving to Lagos.[3]

on average, one out of 20 containers of ivory is seized. Each container usually holds between 2 and 3 tonnes of ivory inside, packed with low value goods such as shells and dried fish used for concealment (EIA 2014). In 2013 alone, some 40 to 60 tonnes of ivory were shipped to China by the Shuidong syndicate.

Soon after Yang's arrest, the NTSCIU arrested Boniface Matthew Malyango, aka Shetani (Satan), on 29 October, 2015, on the outskirts of Dar es-Salaam. In March 2017 he, his brother and his traditional doctor were sentenced to 12 years imprisonment (BBC 2017). Malyango, like Feisal, got off on appeal and is now free (Stiles 2021b).

Following previous arrests and convictions in Mozambique in 2013 and 2014, Mateso Kasian was arrested again in July 2017 in northern Mozambique. Mozambique's National Administration of Conservation Areas (ANAC) and the NTSCIU, with the support of the PAMS Foundation as well as the Wildlife Conservation Society, have been cooperating since 2014 to track Mateso's movements. He managed as many as seven armed poaching gangs in southern Tanzania in 2013, hitting Selous NP, Mikumi and others, and moved his operations to northern Mozambique in 2013–14 where his poaching gangs decimated elephants in Niassa National Reserve (GI–TOC 2020). He was extradited to Dar es-Salaam in 2018 and convicted in 2019. His sentence, including jail time and the forfeiture of two houses, was quashed on appeal and he was let go after paying a fine equivalent of USD 215 (GI–TOC 2021).

Figure 3 shows a schematic diagram of the Shuidong trade chain before the arrests of Yang, Malyango and Kasian.

With PAMS and the NTSCIU on the job, things were getting too dangerous for the Shuidong people in Zanzibar, and there was no Ivory Queen to supply them, so they shifted operations to Pemba in northern Mozambique during 2014 and 2015. Here was a

[3]The situation was more dynamic and complex than this schematic diagram presents it. For instance, there was a connection between Yang and the Kromah network (~2012–2015) and earlier to Hsieh-Wang and later to Lin-Zhang.

small port with cooperative officials not unlike Zanzibar and initially they had Mateso Kasian to supply them directly. They made several ivory shipments from Pemba before the Mozambique authorities, with international pressure, made the ivory business unprofitable. After Mateso's arrest and the disruption of the poaching gangs' supply chains, the Shuidong Network moved their ivory operations to Lagos, Nigeria, in 2017 and added pangolin scales to their trafficking ventures (EIA 2017). Several seizures of ivory and pangolin scales have been made there, although not all linked to the Shuidong syndicate.

China began taking an interest in the well-publicized ivory trafficking activities of its citizens abroad, and with its own domestic ivory market about to close at the end of 2017, they took action. Chinese law enforcement raided the syndicate's operations in Shuidong and arrested 27 suspects, charging 16 of them. Of the three main players running the Shuidong syndicate, one was arrested during the raid and a second was located in Tanzania, from where he voluntarily returned to face justice. The third was eventually found in Nigeria and repatriated for trial in 2019. They were sentenced to several years in prison in 2019, unlike the Feisal, Shetani and Chupi cases, which fell apart in African courts. Oddly, the Ivory Queen lost her appeal and still has a 15-year prison sentence. This might be because of Chinese government pressure (Chen 2019).

Kromah network—Moazu Kromah operated from Kampala in Uganda. Kromah ran a crew assisted by Amara Cherif, from Guinea, Kromah's two sons of Guinean nationality and two Kenyans from Mombasa named Mansur Mohamed Surur and Abdi Hussein Ahmed. Kromah was arrested in Uganda on 12 June 2019 and "expelled" to New York City the next day where he was charged with smuggling at least 190 kg of rhino horn and 10 tonnes of ivory between 2012 and May 2019 from Eastern Africa, a massive underestimate (SeeJ Africa 2022a). Amara Cherif had been arrested five days previously in Senegal and later extradited to New York, while Surur fled to Yemen and was only arrested in July 2019 in Mombasa, when returning on a charter flight. He was extradited to New York in January 2021 and pleaded guilty. Abi Hussein Ahmed was arrested in Kenya in 2022 and was also extradited to New York. In addition, Kromah, Cherif and Surur were charged with conspiracy to commit money laundering, and Surur and Ahmed were charged with participating in a conspiracy to distribute and possess with intent to distribute more than 10 kilograms of heroin (Morris 2019, 2020). All three have pleaded guilty. So far, Kromah has been sentenced to 63 months (Department of Justice 2022) and Surur to 54 months in prison (Bruce Ohr, pers. comm., 28 October 2022).

Little is known about where and from whom they purchased their ivory and rhino horn. Amara Cherif had been on Interpol's Red Notice list for wildlife offenses in Tanzania, so that is a logical source, plus Tanzania was the biggest poaching hotspot 2009–2014 (Stiles 2021a). The New York indictment also mentions Uganda, the DRC, Guinea, Kenya, Mozambique and Senegal as the Kromah Network's area of operations, but no details are given.

Sam Wasser's DNA work shows the great majority of tusks seized exiting Kampala, Uganda, which is assumed to be ivory obtained by the Kromah Network, originated from elephants poached in Tanzania and Kenya with a few from northern Mozambique, northeastern DRC, Zambia and Uganda (Wasser et al. 2022). The Tanzania and Mozambique ivory would suggest links with Yang, until her arrest, and Shuidong after that.

The Kromah Network extended to West Africa, Kromah's original home, with numerous ivory seizures made between 2012 and 2022 in, originating from or in transit from Togo, Côte d'Ivoire, Nigeria and the DRC. There are links to Vietnamese in these seizures (Morris 2019). Fig. 4 shows the Kromah "social" network analysis reconstructed from seized mobile phone dumps (Costa 2021). Reconstructing a trade chain for this network, which obtained its ivory from a variety of sources throughout Africa, and employed a number of export ports including Mombasa, Pemba (Mozambique), Abidjan (Côte d'Ivoire), Lome (Togo) and Lagos (Nigeria), poses certain challenges. Kromah appears to have worked with Southeast Asian buyers and import facilitators while the others described here involved mainly Chinese buyers and import facilitators.

Other operators

Hsieh-Wang /Lin-Zhang syndicate in Lilongwe, Malawi—In June 2002 over 6 tonnes of raw ivory

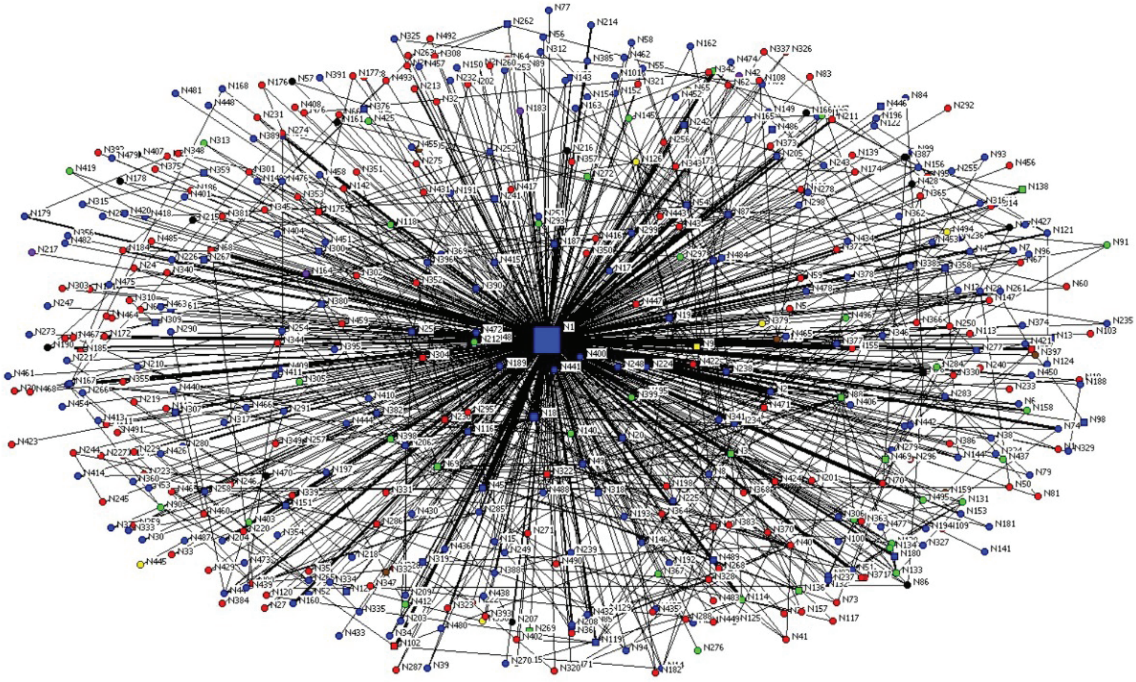

Figure 4. The members of the Kromah network range throughout much of Africa, south-east Asia and elsewhere. The blue square at the centre is Moazu Kromah. (*Source: The Basel Institute for Governance*)

and 40,000 seal blanks (*hankos*) were seized in Singapore, the first seizure anywhere near that weight size since the CITES ivory trade ban came into effect in 1990 (EIA 2002). EIA investigations established that the ivory originating in Zambia, had been handled by a Chinese trafficking ring based in Lilongwe, Malawi, and smuggled from there by road to the Mozambican port of Beira and on to Durban, South Africa by feeder ship, where it was exported in a freighter bound for Japan via Singapore. The *hankos* had probably been manufactured in Allena Handicrafts, an ivory workshop in Lilongwe, run by the Gwedeza family, who were the exporters of the shipment. Before the CITES ban, Allena Handicrafts were working with a Taiwanese named Fong Ken Hsieh to sell and export legal worked ivory to Chinese buyers. After the ban in the 1990s a Malaysian Chinese named Wang Yong Sai, more commonly called Peter Wang, began working with Hsieh and the Gwedezas to smuggle mainly raw ivory in large shipments to China and Japan (Newman 2022).

EIA established that since 1994, the syndicate had made at least 19 previous ivory shipments (EIA 2002). Even if the average weight of the 20 shipments had been half that of the 2002 seizure, 60 tonnes of ivory would have been shipped out in the eight years, a massive amount equalling the deaths of up to 6,000 elephants. Global ivory seizures known from the years 2000 to 2002 totalled only 5.9 tonnes, which included the largest of 1,255 tusks from a house in Dar es-Salaam (Astill 2002). The 5.9 tonne seizures were before the 6.2 tonnes Singapore seizure, so at least 12.1 tonnes were seized from 2000 to mid–2002. No one was ever charged in either the Singapore or Dar es-Salaam seizure.

Nothing further was detected from this syndicate until May 2013 when a random inspection of a truck by a customs unit in northern Malawi was to show the resiliency of the Hsieh-Wang syndicate. The truck was transporting 2.6 tonnes of ivory tusks found hidden by cement bags coming from Dar es-Salaam. Brothers Charles and Patrick Kaunda in the truck were arrested, tried and convicted in 2015, but only received a fine equivalent to about USD 5,400 at the time, far below the state prosecutor's requested penalty of 18 years in jail and a fine of approximately USD 9,800. On appeal by the State, they were sentenced to eight years in jail. Unfortunately, the authorities had not detained

the brothers and they promptly absconded and remain at large to this day (Newman 2022).

Shipping records analysed by EIA also showed that Charles Kaunda had shipped 14 containers along the Lilongwe–Beira route to East Asia between 2010–15, using the same freight agent, a relative, each time. The containers were either declared as sawn wood or semi-precious stones and the destinations were Singapore, Malaysia and Indonesia (Newman 2022). No seizures of these earlier shipments are known. Therefore, in addition to the roughly 60 tonnes shipped 1994–2002, another perhaps 45 tonnes of ivory of unknown origin was smuggled 2010–2015, the peak of the elephant poaching crisis years, totalling possibly 105 tonnes of ivory for the Hsieh-Wang syndicate, although the margin of potential error is great.

Peter Wang disappeared, thought now to be deceased, and Hsieh brought in Lin Yunhua and his wife Zhang Quinhua around 2014 to take over operations, launching the Lin–Zhang syndicate. Hsieh died soon after. It is not known how much ivory was successfully exported, but they also smuggled out poached rhino horns, pangolin scales and hippo teeth (EIA 2021). They also engaged in illicit mining and money laundering (Matonga 2022). The syndicate was broken up in 2019–2020 and 10 Chinese and four Malawians were sentenced to long terms in prison (EIA 2021).

The Chen family in Lagos, Nigeria—The Chen family from Shanting Town in Putian, Fujian province founded this TOC. It was led by the father, Chen Jiancheng, and his two sons, Chen Chengguang and Chen Chengzong. The family created a TOC network consisting of members working along the entire Africa–China supply chain, with contacts inside and outside China, and in Customs (WJC 2022a), which was typical of all of the syndicates described here. They operated out of Lagos, Nigeria, and exported to Hong Kong via Singapore in 2013 and thereafter up to 2018 to Yantai port in northeast China via Busan, South Korea.

The Chen TOC network operated from at least 2013 until their eventual arrests in March 2019. The Wildlife Justice Commission (WJC) found that South Korea "appears to be increasingly popular among wildlife smuggling networks as a transit location", where 26 seizures of shipments destined for China have been recorded since 2013, involving more than 23 tonnes of ivory and 10 tonnes of pangolin scales (Chik 2022).

In November 2018 Chen Chengzong was found and arrested in China and four months later, on 30 March 2019, police followed up by arresting 20 suspects and seizing 2,748 pieces of ivory weighing 7.48 tonnes at the Changfeng Cable Factory in Anhui province. The arrests included network members along the whole supply chain. Chen Jiancheng and Hu Juqiang, a senior ivory buyer in Nigeria, evaded arrest and were wanted persons, both becoming subjects of an INTERPOL Red Notice. They were both later arrested and escorted back to China through collaboration with Ghanaian and Malaysian law enforcement partners (WJC 2022a).

In December 2020, the Chen family TOC network in China ended with 17 people jailed, including Chen Jiancheng and Chen Chengzong—for life.

Conclusions

The arrests and prosecutions of key members of the Sheikhs group, Yang, Shuidong, Kromah, Lin-Zhang and Chen networks had a profound effect on ivory and rhino horn trafficking out of Africa. The arrest and extradition in 2022 of Teo Boon Ching from Thailand to New York for prosecution disrupted even more ivory, pangolin scale and rhino horn trafficking (Al Jazeera News 2022). Ching handled large numbers of shipments from Mombasa, Lagos and elsewhere in Malaysia, Laos and Thailand for onward transport to Vietnam and China (SeeJ–Africa 2022b).

After continued drops in African elephant and rhino poaching from 2016 to 2020 thanks in large part to the TOC network disruptions, 2021 showed an uptick in the poaching of both types of pachyderms (CITES 2022a and b).

Large seizures of ivory and pangolin scales in or exported from Lagos in West Africa, seizures in the DRC and Cameroon destined for Lagos, and DNA evidence point to an emerging TOC network that is trafficking southern and central African ivory and pangolin scales out of Nigeria. It could be remnants of the Kromah network, as Vietnamese and Guineans have been implicated, or an entirely new one. The large number of seizures and arrests in Lagos indicates

that the operations have been penetrated by law enforcement and it is likely that a new export port will be found (WJC 2022b).

With restrictions to transport coming to an apparent end with the increasing control of the Covid–19 pandemic, and if the emerging TOC network becomes established throughout the trade chain from origin to destination, a new wave of poaching and trafficking could be just on the horizon. Investigations are urgently needed to identify the members and operations of this or these network(s) so that they can be disrupted before tens of thousands of pachyderms are poached, and not disrupted after the poaching spree as it was in the 2009–2015 period.

In addition, an analysis of the broader political, economic, social and institutional contexts in which these networks were created is needed to advance a deeper understanding of how best to prevent the creation of TOC trafficking networks in the first place. This could begin with an analysis of the causes behind the high level of elephant poaching in the 1980s that led to the CITES 1989 international ivory trade ban, followed by the renewed poaching crisis that began in 2008. In addition, a detailed description of how these TOC networks operated from poachers to foreign importers and distributors and the intelligence-led investigations and subsequent law enforcement actions that disrupted them is needed to gain a complete understanding. I hope to present these in a second article in *Pachyderm*.

Acknowledgements

I am indebted to Chris Morris of SeeJ–Africa for sharing his rich volume of accumulated information and data on the Kromah and Shuidong networks and for the numerous long meetings sharing information and discussing the operations of these wildlife trafficking networks.

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FIELD NOTES

Part I: Development of a new Human–Elephant Coexistence Toolbox for communities living with African savannah elephants (*Loxodonta africana*)

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Introduction

This field note is to invite our colleagues to peer review and test a new illustrated Human-Elephant Coexistence (HEC) Toolbox that is being developed in Kenya by Save the Elephants (STE) under the organizations' mission to secure a future for elephants and to develop a tolerant relationship between humans and elephants. Through presenting the first edition here (Fig. 1), we are inviting our elephant colleagues and community leaders from across the African savannah elephant range States to provide feedback, or any corrections, on the tools, as well as sharing content for additional methods not yet represented. By publishing our process and methods for how we are compiling this encyclopaedia of HEC tools and this novel approach to the peer review process, we hope to provide a transparent process to gauging the validity of the methods presented. This is particularly important because some of the technical advice around the conflict reduction tools presented are not published formally in the scientific literature.

Why do we need a new HEC Toolbox?

Human-elephant conflict is on the rise across much of the African savanna elephant range (Di Minin et al. 2021). Exactly why this is happening varies between sites but opinions gathered from the field include: a) a reduction in elephant poaching has provided an elevated sense of security for elephants to expand out of protected areas (PAs) and across community boundaries (Stoldt et al. 2020; Foley and Faust 2010); b) reduced budgets for mitigating community conflict due to Covid-19 restrictions on tourist income for PA management (Smith et al. 2021; Ndlovu et al. 2021; Spenceley et al. 2021); c) an increasing human population paired with an increase in infrastructure and development around and between PAs (Schlossberg et al. 2018; Okita-Ouma et al. 2021); and d) a decrease in traditional tolerance for elephants by communities due to food security issues and cultural shifts in attitudes (Salerno et al. 2020).

Although the reasons for an increase in conflict at the grassroots level may vary at the site level, the reality is that some of the poorest people on the continent are often left to deal with elephants on their own with very few material resources or educational support. As conflict escalates through crop damage, or injury/death of people and livestock, there is a tangible increase in political pressure to "deal with the problem of elephants". This escalating pressure is leading to renewed calls for culling, costly translocations, and sales of wild elephants to zoos. These methods are unlikely to reduce human-elephant conflict in the long term but are being used as short-term schemes

to try to placate an increasingly intolerant voting populace. It is critical that the scientific and wildlife conservation community step up to help communities live in better harmony with elephants so that the worst level of elephant conflict is lowered to a tolerable level.

The perception that there is more than one mitigation method or "tool" to help deter elephants from human structures, food or water resources is widely acknowledged, and there are already various "toolbox" documents available that showcase clusters of methods. The challenge is that information is poor in these compilation documents, which are often either lacking in depth, text-dense, or come with little or no visual aids to guide farmers on how to create or build these deterrents step by step. Our new HEC Toolbox is designed to broaden access to existing and effective methods and to ensure that farmers, community leaders and wildlife managers are implementing the methods correctly and effectively so that the tools can be used with minimal errors creeping in. While in some instances farmers may have the capacity and resources to implement solutions directly from the toolbox, we envisage that it will have the most impact through a training-of-trainers approach.

Methodology—the process of compilation

In order to develop this toolbox, and for recipients of the document to be reassured of the process that our team has gone through, these are the stages of development we have undertaken:

Stage 1—Review of existing literature

During our research and development period, an extensive review was undertaken to compile as many scientific publications on HEC mitigation methods that we could find, including delving into the grey literature such as field assessment reports, online field blogs, YouTube videos and NGO/wildlife department annual reports. Existing HEC Toolboxes from different organizations were also reviewed and every effort was made to find and allocate credits to individuals or organizations who invented each method to ensure credits were accurately assigned, particularly if a peer review publication in a scientific journal was not available.

This review includes our own field testing of multiple mitigation ideas from our study site in Sagalla Community, Southern Kenya, where Save the Elephants has been testing various farm-based mitigation tools over the last 13 years (see www.elephantsandbees.com for more information on this field site).

Additionally, we reviewed some of the HEC literature from Sri Lanka, India and Thailand to find commonly used methods from Asia that could help inform or advise on new techniques being implemented in Asia that *might* contribute some fresh technical ideas for managers of African elephant conflict sites. This extensive list of over 300 articles from the HEC literature reviewed is available for viewing on the web platform and is hosted in a live format that enables it to be constantly updated.

Stage 2—Compilation of methods

Methods or concepts seen to be effective or helpful were compiled into group themes; for example, four umbrella methods using chilli as a base ingredient were compiled into one document 'Chilli deterrents' and then each of the nine tools within these four methods were broken down into a step by step guide on how to make the individual tool (i.e. barrier crops, chilli rags fence, chilli rope fence, chilli briquettes, chilli balls, tin chilli smoke, chilli bombs, chilli aerosols, chilli beeswax, (Fig. 2, 3). This compilation system proved more space efficient than producing nine separate documents on how chilli can be used in different deterrent techniques.

Additionally, our second tier of compilation took all the farm boundary/barrier tools and compiled them into grouped deterrent categories. For example, chilli deterrent tools were grouped with other farm deterrents such as noise creators, organic repellent, trenches, metal strip fences, safe food storage, night guarding methods, beehive fences, bio fences, and electric fencing. Similarly, in our introductory 'Understanding Elephants' chapter, multiple tips and information on safety around elephants were grouped into one 'Elephant aware behaviour' document.

We developed seven of these chapter categories for the toolbox: 1) Understanding Elephants, 2) Farm and Boundary Protection, 3) Early Warning Systems, 4) Elephant Compatible Farming, 5) Elephant-Compatible Income Generating Activities, 6) Biodiversity, Habitats and Tree protection, and finally 7) Pastoralists/Schools; Living in Shared Spaces with Elephants. We also designed an advice process and a simple decision tree

to help guide the user to choose the right methods within their financial and time constraints.

Stage 3—Illustrations

To improve on weaknesses identified in past toolboxes, we wanted our toolbox to rely heavily on illustrations to guide the step-by-step vision we had for explaining how to do each of the methods effectively. Visual information can help aid understanding, and knowledge transfer, dispensing with the need of translation to many different languages across range States, especially in the initial stages of the roll out.

Figure 1. Front and back covers of Save the Elephants' new Human-Elephant Coexistence Toolbox - https://ste-coexistence-toolbox.info. The artwork depicts a traditional toolbox that might be found in a vehicle—with the idea that one tool is often not enough to fix a broken car, multiple tools are sometimes needed at different intervals, and/or rotated for the best result. Additionally, a toolbox suggests that constant maintenance is needed for any human-elephant conflict deterrent method to work, just like a vehicle needs constant upkeep and care to run efficiently.

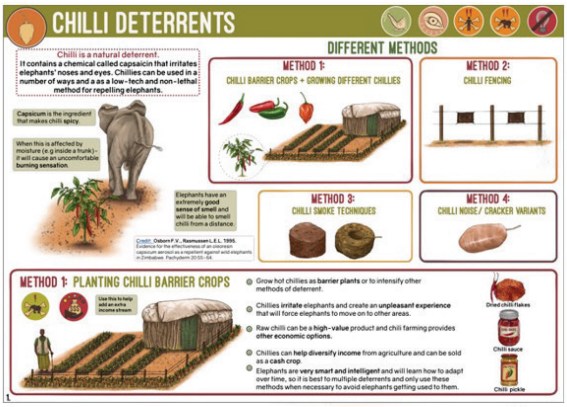
These illustrations were purposefully designed to be as technically accurate as possible, but they also were consciously created to be culturally respectful and visually engaging. Furthermore, we chose a Kenyan illustrator who lived in the country and was able to instinctively incorporate cultural nuances that would be more difficult to articulate to an illustrator living outside of the African context. This illustration strategy includes a library of icons and method drawings that should help guide the understanding of each tool visually and that we hope will aid less literate users, particularly as we move to translate the text into different languages in the future.

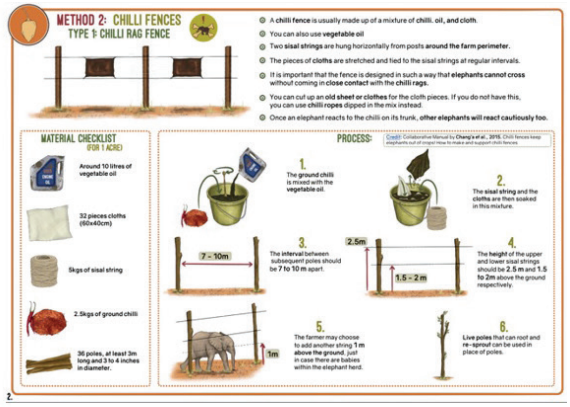
Stage 4—Internal and external expert review process

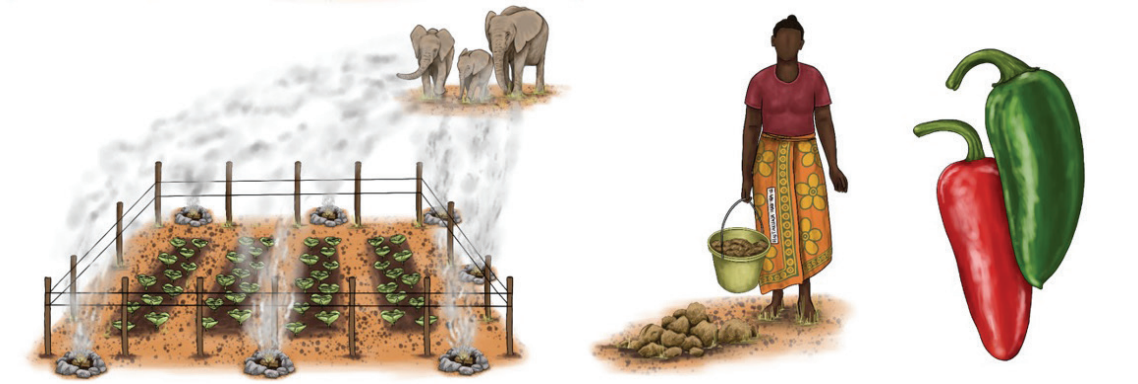
Once illustrated and compiled, the toolbox documents were sent to 14 senior staff members internally within Save the Elephants. Six of these staff members were also members of IUCN's African Elephant Specialist Group. This internal review process provided African elephant expert technical advice on content, any errors in technical drawings/scientific accuracy and tweaks to text to ensure the context of certain words matched the description as clearly as possible and to avoid using English words that invited misinterpretation. These edited documents were then sent out for additional feedback and edits to six external NGO partners in east and southern Africa working with elephant conflict and included other individual members of the African Elephant Specialist Group. These helpful, voluntary members helped reassure us that the documents were as accurate as possible and ready for field testing.

Stage 5—Community and field site review process

The first edition of the toolbox documents ready for field testing (16 compiled chapters in total) were then







Above. Figure 2. Example sheets showing the first two pages of the nine-page chilli deterrent tool chapter. Each tool type has an ingredients list, a step-by-step guide for each method and ends in a list of credits and references used to create each. **Below.** Figure 3. document. Shows some of the details from the chilli chapter that the illustrator was able to showcase in her work.

taken into the field in the Tsavo area between May and June 2022 to sync with an STE field team measuring the impact of showing *The Elephant Queen* Film to community members across the Tsavo and Amboseli ecosystem (see Part II note by Williams et al. 2022 pp. 158–164), in this edition of *Pachyderm*. Both the Impact Assessment team and the Education Team showing the film to communities are experiencing a significant level of feedback from the communities watching the film on the increase in HEC around Tsavo and Amboseli. This team introduced the Toolbox (in print form) to a dozen community leaders, some farmers, and several NGO staff managing conflict and community issues. This response to the toolbox and feedback on the methods has also been woven back into final edits for the toolbox now available on the publicly available (and free) web-hosting platform.

Next steps

We now welcome our fellow *Pachyderm* readers, scientific colleagues, and wildlife managers to review the Toolbox as a final stage of continental peer review and to send us your suggested edits and experienced advice as we try to finalize the document for full roll out. Once Edition 1 is completed, the toolbox will be translated from English into additional languages (starting with Kiswahili, Shona and French) so it can be further field tested across the African countries needing the most urgent assistance with HEC mitigation methods. We also welcome feedback from our colleagues working with forest elephants (*Loxodonta cyclotis*) to discuss how we might adapt this manual for communities living with conflict in forest elephant range States.

Access to every compiled tool can be found on the website and a full PDF of the entire 150+ page book can be emailed on request to the lead author at lucy@savetheelephants.org. Both the website and the compiled book will be continually updated as edits and recommendations come in, and so it is worth tapping into the site frequently as this process is underway to download the latest versions of each tool.

References

All 300+ scientific papers, popular articles, reports, videos and guides that have helped us compile STE's new HEC Toolbox can be found at this website link: https://docs.google.com/document/d/1sKkhlLv4CSV7maTkAVdxqPBND0wRlCqd/edit

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Part II: Using cinema, theatre and a virtual toolbox to address the conflict between humans and elephants

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Introduction

The value of art in science is undisputed. From Da Vinci's drawings came a plethora of inventions, most notable is arguably his "aerial screw" which is highly suggestive of the helicopter we know today (Da Vinci 1894), and the night skies of Charles Mezzier who, through his drawings documented countless formerly undocumented celestial bodies (Messier 1781). In these and many other cases great art has undoubtedly gone on to aid science. Within the field of conservation the benefits of art are more nuanced. Recently art in its modern forms has been proven to be impactful in terms of attitudes to nature, with multiple nature documentaries being empirically proven to have a range of impacts (Jones et al. 2019; Silk et al. 2021). For example, the film Blackfish caused a decrease in the market value of Seaworld (Boissat et al. 2021) but viewing Blue Planet II was found to yield knowledge gains that did not translate into a reduction in plastic usage (Dunn et al. 2020). Animal imagery including photos and drawings as well as movies have also been shown to generally improve attitudes to nature (Thomas-Walters et al. 2020). But does art really have a place in modern day conservation approaches where more species than ever before are on the brink of extinction due to human activities (Barnosky et al. 2011)?

The Elephant Queen

The Elephant Queen (www.elephant.co.ke) is a feature-length documentary film released in 2019. It was filmed in the greater Tsavo ecosystem and directed by award-winning team Mark Deeble, Victoria Stone and Assistant Director Etienne Oliff. It follows the life of Athena, an elephant matriarch, and her family as they attempt to survive a severe drought. It shows elephants in nature unadulterated by the blight of humanity. The film highlights the gentle, engaging, and human-like characteristics of elephants and places elephants as keystone species at the centre of a wider eco-system–a contrast to the perception of some of the communities that live alongside them, who too often only see highly aggressive creatures in tense conflict situations.

The authors of this field note are currently undertaking an in-depth impact assessment of whether the film does have an impact on attitudes to elephants or not. Viewers of *The Elephant Queen* film are taken through a questionnaire, and answers are compared to a control group. Our control group carry out the exact same questionnaires but undertake a snakebite awareness activity (Fig. 2), while others view *The Elephant Queen* allowing a direct comparison on attitude towards elephants to be made between the two groups before and after their respective treatments. Interviews with elders, chiefs and wardens are also conducted to better understand the conservation impact this film might have on communities viewing it. We expect to see a nuanced impact, but every community is already demonstrating slightly different responses to the film depending on their location, socio-economic status and cultural circumstance.

Since November 2021 a team of six education engagement specialists have been driving through Kenya delivering *The Elephant Queen* to communities in human-elephant conflict (HEC) hotspots (Fig. 1). The

film in being shown to communities via projection onto a 12-metre-wide inflatable screen and to schools on a smaller classroom sized model. So far, the team has shown the film to communities surrounding the Shimba Hills, Arabuko-Sokoke forest, the greater Tsavo ecosystem, and Amboseli, all of which have communities living with different types of experiences of elephants. The goal of the programme is to bring awareness to the biology of elephants, how similar their family lives are structured to human families and to increase empathy for these misunderstood creatures. The engagement aspect has brought to light the wide range of perceptions of elephants, with conversations before and after the screening intended to initiate a dialogue surrounding the issues of living with elephants and pave the way for other organizations to engage more deeply with mitigating these issues.

Preliminary observations

Alongside the common response of viewers seeing a sudden likeness between humans and elephants there have been a multitude of surprising observations. We have learnt first-hand that screening documentaries can have unexpected impacts, with audience members noticing unexpected levels of detail. One viewer, for example, noticed that the green seedlings sprouting from elephant dung (and being fed on by a tortoise) were young green grams, leading the individual to conclude that the elephant must have been raiding crops. For a small proportion of viewers we are finding that the film is triggering much more basic insights, such as the realization that elephants do not eat meat.

The tribal influences on responses to the film have also been revealing. The Taita communities of central Tsavo face some of the greatest conflict with elephants and it was here that we experienced the toughest crowd reception, exacerbated by alcohol consumption.

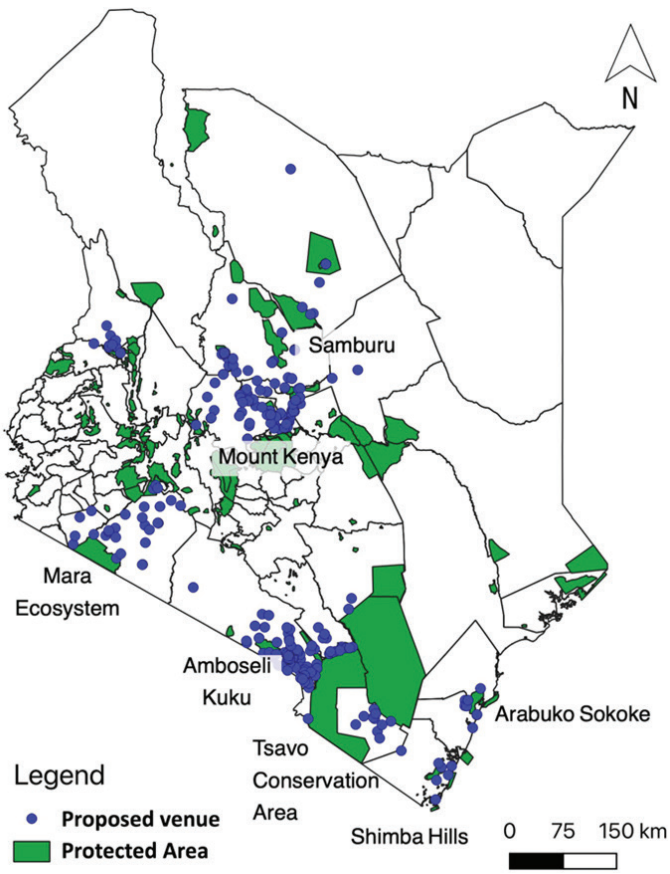


Figure 1. Protected areas throughout Kenya in relation to the intended screening venues for The Elephant Queen mobile cinema.

Historically, a Taita person who killed an elephant was considered a murderer and underwent a ritual of cleansing as elephants were revered (Kamau and Sluyter 2018). But more recently defending crops from elephants has led to anti-elephant behaviour becoming normalized. The Digo and Kigiriama tribal strongholds of the coast are now mostly fenced off from elephants but a bitterness towards elephants seems to remain to some extent. The historically pastoral Maasai still have positive relations with elephants for the most part and the role of elephants as a sacred creature still holds firm in their culture. There are variations: the Maasai of northern Tanzania (Kioko et al. 2015) have a fairly utilitarian relationship with elephants, while the closely related Samburu of northern Kenya in general maintain a strong tradition of conserving elephants (Kuriyan 2002). The Kamba still appear to see elephants as a potential food source and show a level of irritation at their inability to tap into this historically important protein source. These cultural influences appear to be one important variable affecting reactions to the film. Those who are struggling to live with elephant damage to their property or crops are clear in expressing that they just want mitigation solutions that work.

Through the full impact assessment, we hope to disentangle the nuance of these relationships, but initial indications are that such outreach activities may be most effective on those who have never suffered losses to elephants or on younger generations but that older generations who suffer from elephants are unlikely to change their attitudes based on a film. Without doubt those suffering most from elephant conflict are also those most deserving of the benefits of this country-wide educational effort. (Fig. 2, 3, 4).

The Trial of Athena

At the beginning of May 2022 a theatrical production written by Lizzie Jago with Victoria Stone and Etienne Oliff and named *The Trial of Athena* was added to the programme. This is set in a court where Athena, the matriarch from *The Elephant Queen*, is being tried for the killing of a child and engages the audience to play the role of the jury in deciding her fate. It aims to disentangle some of the intricacies of this complex conflict and initiate empathy for elephants, especially those elephants acting in self-defence (Fig. 5 a, b). The benefit of a stage play as a conservation tool is that it enables the script to be adapted for every audience depending on the conflict factors in a location (for example crop raiding in agricultural areas or competition for water in pastoral regions), and sensitivity around recent events (such as deaths of young children in each community). This enables the directors to adapt the play for increased impact as it moves through Kenya. One character called by the prosecutor says “Is it our mistake to be on this land or should we step aside and leave it for the elephants”, a line which is met with much agreement in areas experiencing conflict and appears to capture the zeitgeist for these communities.

Communities have shown a diversity of responses to the two artistic aspects of the programme. A very small minority show signs of resentment at perceived insensitivity shown by those deciding to bring a film about elephants to a community whose livelihoods are put in jeopardy by elephants. However, results so far show that 100% of individuals involved in the study enjoy the experience with many never having seen a film before, let alone on a huge 12 metre wide blow-up screen. Whether the film actually has conservation impact and increases human tolerance for elephants remains under study with our results expected to be published in early 2023. However, for entertainment value alone there appears already to be evidence for such outreach activities to be undertaken following the creation of high calibre conservation films. A documentary can do what many other forms of education cannot, that is to provide a level of verisimilitude, leaving viewers unable to deny what they have witnessed first-hand—in this case the indisputable similarities between humans and elephants.

The Human-Elephant Coexistence Toolbox

The final element of this triad of unusual conflict mitigation education efforts by Save the Elephants is a new human-elephant coexistence (HECex) toolbox also reported on in this current issue of *Pachyderm* (King et al. 2022, pp. 153–157). A common reaction to the film and the play has been to the effect of “we would love to live in harmony with elephants, but how? We need solutions”. In response to this, a team from Save the Elephants has expedited the publication of Edition 1 of the Human-Elephant Coexistence Toolbox (King et al. 2022). The open-source and updateable web platform, https://ste-coexistence-

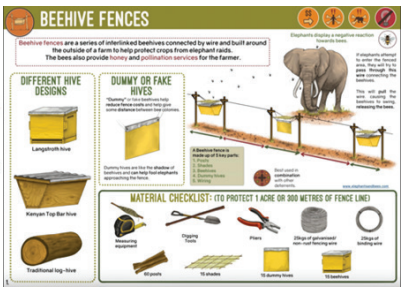
Above. Figure 2. A school screening of *The Elephant Queen*.

Centre left and right. Figure 3. Community screenings of *The Elephant Queen*.

Below. Figure 4. The control activity; snakes and snakebite awareness.

Figure 5a. The *Trial of Athena*, being shown at one of the communities surrounding Lake Jipe, within Tsavo West, on the border of Tanzania.

Figure 5b. The giant puppet of Athena requires two actors inside controlling trunk, tusks, tail and grumbles.



Above left. Figure 6a. A Big Life Foundation ranger reading through a physical copy of the toolbox;
Above centre. Figure 6b. The ToolBox logo; and
Above right. Figure 6c. An example of one of the methods found within the toolbox with a breakdown of materials and step by step instructions in the subsequent pages of the toolbox.

toolbox.info/, has a series of "how to" tools that are now being introduced to partner organisations across the country as a library of methods aimed at promoting coexistence with elephants (Fig. 6 a, b, c). The highly illustrated toolbox provides step by step instructions for every known method of conflict mitigation that has proved to be effective. Including sections on understanding elephants, farm and boundary protection methods, early warning systems, non-palatable crops, elephant-compatible income generating activities, tree protection and school protection methodologies.

Methods of coexistence brings an unintended consequence to conservation. While they undoubtedly have the power to reduce conflict with elephants if used appropriately, they also provide farmers with methods by which to expand even further into wild land with a reduced fear of retribution by elephants, thereby having the potential for further diminishing elephant habitat. The toolbox must be used with caution and educated judgement in its application. For example, the rise of pesticides in farming in certain regions are making bee-based methodologies (King et al. 2017) impossible to implement due to bees dying from harmful pesticides. However, the smelly elephant repellent methodology has the power to act as a pesticide, fertilizer, and elephant repellent all in one (Oniba and Robertson 2019). Communities forced to coexist with elephants know well the importance of banging and fire in deterring elephants, but modern equivalents such as solar spot lights (Davies et al. 2011) and Buzz Boxes (an automated bee sound playback system created by Wild Survivors), provide solutions most communities will be unaware even exist but can also rarely afford.

Conclusion

Whether the use of these combined interventions in conservation are effective as a HEC mitigation strategy remains in question. However, responses from audiences to both *The Elephant Queen* and the *Trial of Athena* would leave no observer in doubt that such activities bring wildlife and conservation education enveloped in a form of welcome entertainment to communities that can feel marginalized and all but forgotten by the State. Such programmes also have the potential to help fill the gap left by traditional storytelling, which modernisation is continuing to erode (Michuki 2020) and historically played a key role in shaping the folklore and taboos of old that often maintained the balance between humans and nature (Colding and Folke 2001; Riley 2010). Responses to Save the Elephants' new HECex Toolbox and its illustrations have also been highly positive. We look forward to assessing the uptake and efficacy of the methods as the programme continues to roll out.

The Elephant Queen film is accessible in Kenya as an educational tool along with a number of other materials and the team's programme at www.elephant.co.ke. There you can track their progress and identify a screening near you.

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Building sustainable ecosystems through community education

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Introduction

Borana Conservancy lies in the Ewaso Nyiro ecosystem in Laikipia County, just north of the Equator in Kenya. Borana, together with its neighbour Lewa Wildlife Conservancy (LWC), is now home to 132 eastern black rhinos (*Diceros bicornis michaeli*) and 122 southern white rhinos (*Ceratotherium simum simum*). The population of black rhinos represents at least 13% of Kenya's black rhino population. Borana's work revolves around 'the four Cs': conservation, community, culture and commerce, showcasing best practices for sustainable living. The long-term goal of the Conservancy is to provide a sustainable ecosystem, in partnership with its neighbours and community, for critically endangered species on the brink of extinction.

However, the survival of Borana's rhinos and other wildlife, is threatened by the unsustainable utilization of natural resources and rangelands across Laikipia County. Expanding human populations are placing significant pressures on these rangelands, exacerbating years of over-utilization and poor management. According to Dr Dino Martins formerly of Mpala Research Centre in Laikipia, livestock stocking rates on many communally owned ranches and conservancies are estimated to be 50 times higher than the recommended ecological carrying capacity (ECC). Many of the current generation of pastoralists believe that the degraded rangelands in their landscape are normal, not realizing that the rangelands should be covered with grass that would retain moisture, sequester carbon, secure water sources, and support biodiversity, if properly utilized and the livestock carrying capacity were reduced to the ideal balance. Although the local schools teach theoretical environmental science, there is no exposure, at a practical level, to how essential intact, functioning ecosystems serve for both humanity and biodiversity.

There is an increasing acknowledgement of the value of targeted, practical conservation education programmes in helping communities living adjacent to protected areas (PAs) to develop sustainable livelihoods and allow the effective, long-term conservation of wildlife and ecosystems. The future of Borana Conservancy, and of all PAs across Laikipia, Kenya and Africa as a whole, will depend on people placing a high natural-capital value on conservation and wildlife habitats, and on their having the skills to manage the wider environment in ways that support both human livelihoods and wildlife.

Establishing a contextual education programme

In 2009, Borana initiated the Borana Education Support Programme (BESP), which had the twin aims of lifting people living around the Conservancy out of poverty by providing better access to higher-quality education via scholarships, and of raising awareness of conservation issues to nurture a deep appreciation of wildlife and natural habitats. Despite its significant successes, the BESP could support only a relatively small proportion of children and young adults. Further outreach was needed to offer conservation education to a greater number of students and adults.

To that end in 2022 Borana, in partnership with Save the Rhino International, significantly expanded the BESP to address the unsustainable utilization of natural resources in the Ewaso Nyiro

ecosystem. *Mazingira Yetu* (our environment in Kiswahili) will engage the communities living around Borana Conservancy by providing an environment for learning about the importance of natural wilderness, together with understanding the role of soil, hydrology, grasslands and forests, and how these elements are inter-dependent and form a cooperative biotic completeness and contribute to sustaining life.

Mazingira Yetu has three strategic objectives:

1. To build knowledge about conservation issues, including the black rhino, among the BESP's primary audiences, i.e. schoolchildren and adults.
2. To inspire participants to spread key conservation messages to secondary audiences, i.e. family and community members.
3. To enable the wider community to take positive action to conserve the conservancies surrounding the Lewa-Borana Landscape.

Pedagogy

Mazingira Yetu's strategic objectives represent a process model of 'head' (instil knowledge), 'heart' (inspire) and 'hands' (empower). The programme's pedagogy (theory of teaching and learning) focuses on place-and enquiry-based methods i.e. learners will: see conservation in action, dictate the learning journey and have ownership of their learning; feel inspired to take action; and understand the practical ways in which to apply this learning within their own community and environment. *Mazingira Yetu* accomplishes the 'head' and 'heart' levels of the process through structured field trips into the Conservancy for programme participants. These Conservancy trips build foundational knowledge of conservation techniques, exposing participants to thriving wildlife and a well-managed landscape. The Elaboration Likelihood Model of persuasion proposes direct encounters with Borana Conservancy and its wildlife that are likely to facilitate 'deeper message processing and subsequent changes in attitude and behaviour' (Skupien 2016) among *Mazingira Yetu* participants. The 'hands' level is fostered through the provision of a 6-step practical framework for designing and engaging community action projects.

Key messages

Borana's conservation education team identified several aspects that *Mazingira Yetu* should address:

1. Conservation: the interdependence of organisms within the ecosystem—so that learners understand the value themselves, of their wildlife and landscapes.
2. Community: the governance of Borana—so learners know about communal responsibility, transparency, principles of good governance, why certain security measures are in place, what the long-term strategy and goals are etc.
3. Commerce: the ways in which conservation can develop livelihoods—so that learners know how to make conservation work for them in the short-, medium- and long-term, to diversify their income, create new sustainable career paths, benefit from their positive actions and spark meaningful changes within their communities.
4. Culture: the ownership of knowledge—so learners feel empowered to blend indigenous-knowledge systems with more modern explanatory, science-based knowledge to create holistic approaches to learning that encourage participatory dialogue and design of curricula.

Overt messages will focus upon the value of intact natural resources and wildlife. In 2019, Borana Conservancy conducted a survey process called the Social Assessment of Protected Areas (SAPA), developed by the International Institute for Environment and Development. More than 350 interviews were carried out with households in communities neighbouring Borana, and the process gave a clear indication of the priority issues on which the communities would like to work with the Conservancy. These included environmental degradation, erosion and deforestation, and the issues of land use and other activities that threaten the stability of natural resources and wildlife in the Laikipia County.

The findings of the SAPA, particularly the aspects that Borana's neighbours see as the most positive and negative impacts of their proximity to the Conservancy, have directly informed the design of *Mazingira Yetu*. For example, *Mazingira Yetu* aims to deliver a better understanding of Laikipia's semi-arid environment and the importance of water management and retention in soil, given that in degraded environments 90% of precipitation is lost as run off. It will also cover how to manage finite resources and how the strategic use of livestock and physical interventions (such as the creation of swales and tree planting) can contribute positively to improving the quality of rangelands and help in reversing degradation. Black rhinos are examined as a flagship species, together with the financial opportunities they bring through tourism; while further discussion will focus on human-wildlife conflict (HWC), whether in terms of crop-raiding elephants or predation from leopards, lions or hyenas.

In terms of covert messaging, learners will gain an understanding into the levels of security that are in place to protect Borana's rhinos and wildlife. They will learn that every rhino is named and known individually. Finally, they will meet role models within the Borana team and, it is hoped, be inspired to pursue careers in sustainable livelihoods or conservation.

Target audiences

Mazingira Yetu will focus on the schools and local communities in the seven neighbourhoods surrounding Borana Conservancy. It is well understood by sociologists that numerous cultural influences/norms around attitudes and behavioural values are absorbed and embedded in childhood (enculturation) by the age 10 (Geertz 1973). If young people develop an affinity with nature early on, they will value nature throughout their lives. Age-groups between 10 and 12 were chosen for direct engagement after considering prior knowledge levels, national curriculum exam periods and household impact / ability to make change. Adults are also targeted by the programme, particularly young adults, women, elders, forest users and pastoralists. With adults who have become disconnected from the natural wilderness, conservation education programmes provide a means by which to reconnect them and an opportunity to change perceptions.

Programme design and delivery

Having identified the overall conservation goal, the difference that Borana wishes to make, the key messages and the target audience, the project team then focused on *Mazingira Yetu's* implementation, i.e. the 'how'.

A key first step was to employ a consultant, Richard Hennery, who had previously worked in North Luangwa National Park on another black-rhino-focused conservation education programme, to support Borana's head of education, Ochen Mayaini, and Conservation and Sustainability Officer, Isabelle Voorspuy, in developing the detailed plan for and rollout of *Mazingira Yetu*. Richard brings valuable academic, formal knowledge combined with practical field experience of targeted environmental education, while Ochen and Isabelle have a deep understanding of the particular issues and challenges in the Ewaso Nyiro ecosystem. This collaboration resulted in the formulation of the aforementioned pedagogy, which informed the refinement of objectives, content creation, and the acquisition of key resources to implement a programme that would support the theoretical framework and theory of change.

Terms of Reference were drawn up for a conservation education officer (CEO) and education assistant (CEA). Recruitment was informed by Borana's gender and local employment policies, prioritizing the recruitment of women and people from the surrounding neighbourhoods; every effort will be made, through all elements of the project, to break down gender and other stereotypes and demonstrate that conservation opportunities are open to everyone. Stephen Gachagua, who previously worked at nearby Ol Pejeta Conservancy, was appointed CEO, and Jedidah Kamoiro, who speaks Maa, as CEA, i.e. the two positions were filled by individuals known to and trusted by the local community.

Stephen and Jedidah held inception meetings with all the head teachers and environmental teachers from the schools participating in the BESP; the name *Mazingira Yetu* was chosen through this consultation. The inception meetings also informed the development

of different curricula for conservancy trips: day-long visits into Borana aboard a modified bus known as the Mazingira Express, capable of holding 28 schoolchildren and two teachers (or 30 adults).

Beginning in mid–2022, the conservancy trips for schoolchildren introduced cohorts of students to Borana Conservancy and help them understand the importance of a healthy environment while they studied the different wild animals, conservation activities and eco-friendly livelihood opportunities. A two-year rolling curriculum will see Grade 5 students gain an immersive conservation experience through experiential learning activities that offers a 'scaffolding' of knowledge, leading to the introduction of a 6-step action project framework in Grade 6. The 6-step tool encourages learners to take the lessons explored during conservancy trips and apply their understanding into contextual school level eco-projects; conducting a site review, creating a conservation code and implementing an eco-action such as community gardening, a livestock-grazing scheme, a litter-management plan or a water-harvesting strategy. Each cohort will undergo two conservancy trips facilitated by the CEO and CEA, before receiving follow-up visits that offer support for school level eco-projects.

Adult conservancy trips will feature content that is more adaptable than the schedules for Grades 5 and 6 learners. Initially, established community groups will be targeted to capitalize on pre-existing governance structures and motivations. These groups will be engaged with a pre-conservancy trip focus group session in their communities. The purpose of the focus group is to uncover key conservation concerns held by the group, and identify potential problems they could address. The conservancy trip will then feature tailored sessions that respond directly to the needs of that particular group (as well as consistent messaging and education around key concepts such as ecosystems and 'the four Cs'). For example, a community group that is interested in gardening may visit the organic farm, while a group concerned with HWC may receive presentations on chili-fencing construction or beekeeping. This approach results in a more targeted conservancy trip that responds to individual and collective needs and culture. A similar 6-step action project framework will be introduced as part of these trips, to enable the 'hands' level of *Mazingira Yetu's* process model.

To provide a learning space to implement the conservancy rips, a disused building—a former tannery—was identified as the site for a new education centre. An asset-based community development (ABCD) (Nurture Development 2022) approach was blended with Moussa et al.'s (2017) school site selection process to analyse the old tannery's suitability. ABCD utilizes a strength-based approach that builds on the assets found in an area, and categorizes assets into six groups: individuals, associations, institutions, place-based, local economies and connections. The predicted content of the education programme was considered, as the activities need to be based in a suitable environment to support learning. Technical requirements including size, shape, location, utilities, security, noise, cost, topography and soil were then discussed in relation to the old tannery's location. A decision was then made on the suitability of the old tannery for a conversion project by examining the key technical requirements and how they capitalized on existing assets in the area. Finally, construction and design plans were begun and documented. When finished, the *Mazingira Yetu* Education Centre will comprise a large classroom, a multi-media area, an education office, storage room, accommodation for the CEO, CEA, housekeeper and cook, kitchen and dining area. A second phase of construction will include accommodation for up to six visiting researchers or academics, who will interact with visiting groups of children and adults.

In Year 2 (calendar year 2023), *Mazingira Yetu* will deliver a series of Conservation Celebration Days (CCDs) in the villages surrounding Borana Conservancy: large community events/campaigns that will allow for dialogue and wide-spread engagement with conservation. These CCDs provide a context for message multiplying, spreading awareness and enabling wider action. In an effort to increase the scope for participatory design processes, local teachers from *Mazingira Yetu's* target schools will be engaged to co-design the CCD content and planning. The various school sites will act as community hubs during the CCDs, providing a space for school learners and adult participants of *Mazingira Yetu* to showcase their projects and progression along the 6-step framework.

Monitoring and evaluation

The programme has created a monitoring and evaluation (M&E) plan that will find out whether *Mazingira Yetu* is meeting its objectives and test whether the participants benefiting. The project team began by carrying out a pre-evaluation study or needs assessment in the schools and communities, which will be used to enrich the curriculum and the delivery of activities.

Year 1 of the project will involve trials of five different evaluation techniques, allowing the education team to gain feedback on these tools from learners and make an informed decision as to which methods work best for the Borana context. Year 1's M&E will include: a summary of accomplishments for Year 1, followed by discussion of the components of the programme: education centre construction; *Mazingira Yetu* Express acquisition and adaptation; the development of the programme's framework; the creation of the 2–year rolling curriculum; the hiring of the education team; consultant's field trips; needs analysis; analysis of the conservancy trips for the 10–12 year-old learners, and for adults; and the trial of the different M&E methods.

Year 2 will see an expansion of the activities and evaluation methods, exploring both what sharing and learning has taken place and why/how certain teaching methods were effective. To guide this deeper Year 2 exploration, a more comprehensive theoretical model will be developed which explicitly links context to outcome: a Participatory realist impact model.

Conclusion

Mazingira Yetu's development has highlighted the importance of context for community conservation education. By paying close attention to the needs of its stakeholders, Borana Conservancy has capitalised on its strengths and assets to develop a pedagogy that increases access to important conservation sites and creates a space for community action. By expanding participatory and collaborative planning processes, it is hoped that the Conservancy's education efforts will, over time, contribute to a healthy, functioning ecosystem, in which people, livestock and wildlife can co-exist in harmony.

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Habitat conversion intensifies human–elephant conflict in the Eastern Wildlife Corridor, Ghana

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Introduction

Ghana was ranged by fairly large herds of elephants up until the 1970s (Douglas-Hamilton 1979). At one time elephants were found throughout the country but, as elsewhere on the continent, elephant habitat contracted during the 20th century. Today both the African savannah elephant (*Loxodonta africana*) and the African forest elephant (*L. cyclotis*) are still found, respectively, in the savannah and forest zones of Ghana. However, the populations are now confined to a few Protected Areas (PAs) and isolated remnant habitats, mainly due to human population pressure and related land use and land cover changes (AfESG 2000). Elephants are also killed illegally by poachers for the ivory trade, which dates back to ancient times (Parker 1973). By 2000, there were only eleven elephant population ranges in the country, with an estimated population of 1,000–2,000 individuals (WD 2000). These trends call for drastic and far-reaching elephant conservation efforts, including effective anti-poaching measures with more supportive legislation, and community-based land-use planning to foster harmonious human–elephant coexistence (HECx) in the country.

Ghana has exhibited zeal for the conservation of the African elephant, both domestically and on the international front. Ghana was the first country to propose listing of African elephants in Appendix 1 of CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora). The country is also signatory to other international conventions, including the Convention on Biological Diversity (CBD), Ramsar Convention on Wetlands of International Importance, Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) and the United Nations Framework Convention on Climate Change (UNFCCC), among others. In July 2008, Ghana entered into a bilateral cooperation agreement in the form of a memorandum of understanding (MOU) with the Republic of Burkina Faso for the purpose of conserving natural resources shared by the two countries, including savannah elephants.

In 2000, the Wildlife Division of the Forestry Commission of Ghana, in collaboration with the World Wide Fund for Nature (WWF) and IUCN's African Elephant Specialist Group (AfESG), developed an Elephant Conservation Strategy as a guide to ensure the conservation and survival of viable elephant populations and their habitats throughout the country. This strategy informed studies conducted of elephant migratory corridors by the Northern Savannah Biodiversity Conservation Project (NSBCP), under the auspices of the Global Environment Facility (GEF) and the World Bank, between 2002 and 2009. These studies identified two main elephant migratory routes between Burkina Faso and northern Ghana, which were designated the Eastern and Western Wildlife Corridors (EWWC). The forests and wildlife in the corridors are jointly managed by the Forest Services Division (FSD) and Wildlife Division (WD) of the Forestry Commission.

This article provides a summary description of the EWWC, presents data on human–elephant conflict in the Eastern Wildlife Corridor, and discusses approaches to mitigate conflicts and ensure the survival of the elephant population in the corridor.

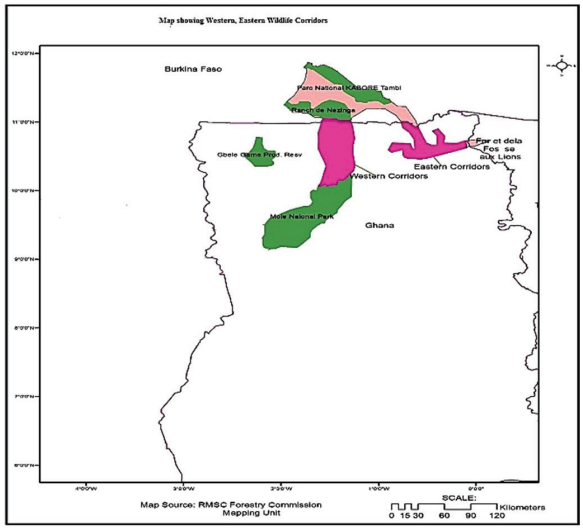
The Eastern and Western Wildlife Corridors

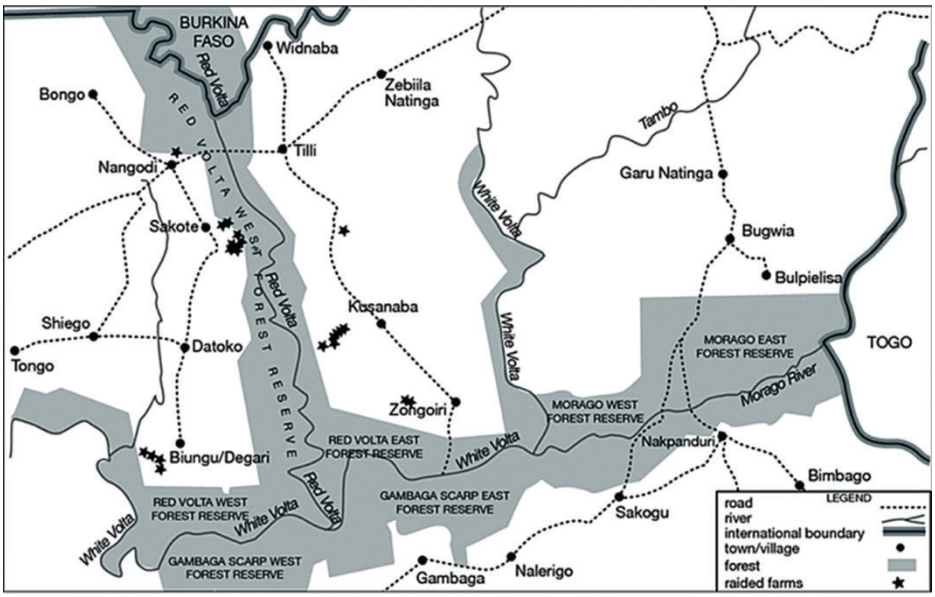
The Northern Savannah Biodiversity Conservation Project (NSBCP) was designed with the primary purpose of improving the environment, livelihoods and health of the people of the northern savannah ecological zone of the country through the conservation and sustainable use of natural resources (NSBCP 2000).

Studies conducted during the implementation of the NSBCP demonstrated that savannah elephants and other species of ungulates migrate between conservation areas in southern Burkina Faso and the northern savannah ecological zone of Ghana. These studies confirmed the accounts of chiefs and local people (Adjewodah 2004), and earlier research by the Wildlife Division's Elephant Conservation Strategy (WD 2000). The studies further identified two main elephant migratory corridors within northern Ghana that were designated as the Eastern and Western Wildlife Corridor (EWWC).

The Western Wildlife Corridor (WWC) covers a length of approximately 143 km within Ghana, connecting Nazinga Game Ranch in southern Burkina Faso through Gbele Resource Reserve to Mole National Park (NP), the country's largest protected area (PA). The WWC incorporates the watersheds of the main tributaries of the Sissili and Kulpawn Rivers that flow into northern Ghana from Burkina Faso and encloses several gazetted forest Reserves (FRs) in the areas of habitat that span these two PAs. The corridor encompasses nineteen traditional community areas in four regions of Northern Ghana. The Eastern Wildlife Corridor (EWC) covers approximately 80 km, from Kaboré Tambi NP in Burkina Faso along the Red Volta River Valley as far as its confluence with the White Volta River. Here the corridor branches out, westwards and eastwards, encompassing parts of the watersheds of the White Volta and of its tributary, the Morago River, which connects in the east with Fôret de la Fosse aux Lions NP in the Republic of Togo. The whole area of these river valleys comprises gazetted FRs, which are bordered by community-owned lands, and is collectively often referred to as the Red Volta Valley (Fig. 1).

The ecological corridors and adjoining landscapes are bio-networks, containing major river bodies, gallery





Above and Below. Figure 1. Location of the Eastern and Western Wildlife Corridors of northern Ghana and southern Burkina Faso (*Source: RMSC, Mapping Unit, FC and Adjewodah 2014*).

Above left. Figure 2. WD field rangers on patrol in the corridor (*these and following photos taken by WD Rangers, 2021*). **Above right.** Figure 3. Savannah Elephants in the Eastern Wildlife Corridor.

forest and savannah, and other natural ecosystems that bridge PAs, FRs and isolated remnant habitats. Three of the four of the elephant ranges in the northern savannah overlap with the Corridors: the Sissili and Tumu, and Mole NP ranges in the WWC, and the Red Volta Valley range in the EWC. These corridors facilitate connectivity among these elephant populations that seasonally migrate across northern Ghana and southern Burkina Faso, and occasionally into the Republic of Togo, thereby facilitating rescue efforts to enhance gene flow (Sam 1994).

The corridors are also agrarian landscapes containing community-owned lands on which the local communities largely depend for their livelihood and sustenance. They constitute a human–elephant interface that requires careful management to achieve a viable balance between development, food security and biodiversity conservation. This is the task facing the Forest Services and Wildlife Divisions of the Forestry Commission that jointly manage the landscapes as ecological corridors (Fig. 2).

Human–elephant conflict in the Eastern Wildlife Corridor

Scientific data on elephant population numbers in the Eastern Wildlife Corridor in the last century seem to be lacking; however contemporary accounts of hunters and the local people in the area suggest that the corridor contained fairly large numbers of migratory elephants during the 1970s (pers. comms. 2021). The EWC, or Red Volta Valley range, currently harbours the third most abundant savannah elephant population in Ghana, estimated at 80–120 individuals (WD Field Staff estimation 2021), and is considered to be one of the few viable populations of savannah elephants remaining in the country (Fig. 3).

However, the elephant population in the EWC is affected by human–elephant conflict (HEC) that continues to undermine elephant conservation efforts by the WD. According to IUCN, HEC is mainly caused by competition for natural resources and space between humans and elephants, where elephants and humans happen to share the same landscape (IUCN 2003). HEC in the EWC is not so different; the conflicts are mainly caused by competition over natural resources between humans and elephants due partly to the rapid transformation of the landscape for human livelihood needs. HEC in the corridor is a threat to food security for the people living in and around the corridor, as well as a major threat to the survival and conservation of the elephants in the area.

As elsewhere in Africa and Asia, HEC in the EWC seems to have intensified in recent years, primarily due to increasing human population pressure, expanding human settlements and other infrastructure into traditional elephant habitat, and associated conversion of the landscape for cultivation and pastoral activities. Other impactful human activities include illegal logging for lumber, cutting of trees for charcoal burning and fuelwood (Fig. 4), annual bushfires, slash and burn agriculture, and the cutting and harvesting of grasses, medicinal herbs, straw and canes for various domestic uses. The area is also affected by small-scale artisanal mining and mineral prospecting activities (known locally as *galamsey*) and the attendant habitat depletion, including pollution of rivers (through panning and mineral processing activities). Residual mining pits (Fig. 5), vestiges of past *galamsey* activities, are hazards for elephants and restrict their movement within the

Above left. Figure 4. Trees cut and piled to be burnt into charcoal;
Above right. Figure 5. Impact of galamsey: residual mining pit holes.

corridor.

Furthermore, there is apprehension that the construction, currently underway, of the Pwalugu Multipurpose Dam across the White Volta River could further escalate HEC, in addition to its unavoidable negative impacts on ecological networks and biotopes, and their animal populations, including elephants.

Crop raiding by elephants is known to be the most prevalent form of HEC, and can result in devastating economic losses for farmers, loss of human lives and killing of elephants (Parker, 2001). Table 1 shows incidents of crop raiding in the EWC in 2017–2021, based on reports received by WD staff. In addition to damage to crops, elephant raids can reduce farm productivity for farmers who have to spend more time guarding their crops. Elephants in the EWC also cause destruction of economic trees, including shea (*Vitellaria paradoxa*) and dawadawa (*Parkia biglobosa*). Added to these, there are the fear and panic among the locals caused by unexpected encounters with elephants, and in extreme situations unfortunate loss of human lives resulting from elephant attacks (with four fatalities recorded during 2017–2020).

In retaliation, affected farmers are reported to liaise with elephant hunters, some of whom are believed to have links to the illegal wildlife trade. Seven elephants were illegally killed by poachers in 2017–2021. If not checked, this cycle of elephant crop raiding and apparent retaliatory killings has the potential to decimate the elephant population in the Red Volta Valley range, to the detriment of the country's efforts to conserve its remnant elephant stocks.

Table 1. Incidents on elephant crop raiding in the Eastern Wildlife Corridor (EWC). The districts affected are indicated by stars on the inset map in Figure 1

Year	No. of incidents reported	No. of farmers affected	Estimated area affected (ha)	Crops most affected	Theses
2017	75	51	39.7	Maize, guinea corn, rice, groundnut, sweet potato	Nabdam, Bawku West Talensi
2018	86	66	44.2	Maize, guinea corn, rice, potato	Nabdam, Talensi, Bawku West, Garu
2019	95	51	32.8	Maize, guinea corn, rice, cowpea	Nabdam, Talensi, Bawku West
2020	71	25	39.4	Maize, guinea corn, cowpea	Nabdam, Bawku West, Talensi, Garu and Tempane
2021	64	52	25.9	Maize, guinea corn, cowpea, rice, groundnut, millet	Bawku West, Talensi
Total	**391**	**211**	**182.0**		

Note: All defendants in ivory trials initiated in 2017 pleaded not guilty.

Discussion and recommendations

HEC constitutes both a major security threat for local people living in and around the corridor, and a major threat to the survival and conservation of elephant population in the transfrontier landscape. Negative interaction between the local community in the corridor and the elephants increasingly and unavoidably undermines elephant conservation efforts by the WD.

While much of the conflict occurs on community-owned lands, an increasing number of incidents are recorded on the adjoining gazetted FRs, both in Ghana and Burkina Faso, indicating a growing problem of illegal human encroachment into these reserves. The occupation of forest reserves that were supposed to be core biodiversity conservation zones in the corridor and safe havens for elephants is resulting in the rapid transformation of the entire landscape in the EWC. The degradation, loss and/or fragmentation of habitats in the FRs is exacerbating conflicts within the landscape. Elephants are long-lived animals, with their survival depending to a large extent on regular migration over large distances to search for preferred diet, water and social, as well as reproductive partners (Barnes 1999). It is estimated that an African elephant family herd requires, on average, a home range size of 11–500 km² (Roth and Douglas-Hamilton 1991). The degradation of FRs is rapidly reducing the elephants' home range, cutting off ancient migratory pathways, and reducing the availability of their traditional diet.

In a study promoting carbon services produced by wild animals, the authors forecast that if current populations of African elephants are protected, their services to African economies will be worth $20.8 billion and $25.9 billion for the next 10 and 30 years respectively; with the possibility of financing anti-poaching and conservation programmes (Berzaghi et al. 2022).

Certainly, in response to the above threats, wildlife legislation in the country ought to be improved, to provide the basis for effective law enforcement, and active community involvement in wildlife and natural resources management. Accurate and up-to-date information on population and habitat variables for all elephant population ranges is required for effective management and decision-making, as well as improved awareness of elephant conservation issues at all levels in the country. Many of these measures are envisaged in the new Wildlife Resources Management Bill (2014). Unfortunately, the passage of the Bill into an Act of Parliament has been long delayed and, at the time of writing, it is still undergoing parliamentary review.

The EWC is a wildlife–agrarian landscape, and as such a promising way forward for conservation of elephants could be the adoption of a more dynamic and harmonious human-elephant co-habitation approach (HECx). This will involve concerted efforts to safeguard both habitat for elephants and farmers' livelihoods from elephant attack. One way could be through the establishment of community resource management areas (CREMAs) in the corridor. CREMAs aim at encouraging and empowering community resource governance and ownership towards sustainable resource utilization. The concept was developed by the Wildlife Division of the Forestry Commission of Ghana to promote collaborative and participatory wildlife management in the country (Balaya et al. 2020) and has been recognized by IUCN as fulfilling the criteria for 'other effective area-based conservation measures' (OECMs) for effective in-situ conservation of biodiversity outside PAs (Dudley et al. 2018). The establishment of CREMAs in the EWC would facilitate creation of additional livelihood sources for communities in the corridor that are resilient to elephant attacks. In this regard the plan to establish three CREMAs in the EWC as part of the World Bank's ongoing Ghana Landscape Restoration and Small-Scale Mining Project (GLRSSMP) is a step in the right direction. Another HECx strategy could be the establishment of viable community-based ecotourism schemes leveraging the presence of elephants to attract tourists and generate revenue to offset the effects of elephant attacks on farmers' livelihoods. In the longer term, adoption of this approach aims to create adequate habitat for elephants by curtailing all forms of encroachment and illegal activities in FRs in the corridor.

Additionally, farmers must be encouraged to continue with the adoption of simple traditional methods, introduced by the WD, to guard their farms and crops and deter marauding elephants. These methods include use of carbide cannons, clashing metal objects together, lighting bonfires, flashing lights during the night, applying chilli grease to fences, and placing elephant dung laced with chili around cultivated areas, among others. Modern surveillance techniques that involve the combined usage of elephant infrasonic call detectors with mobile phones for rapid communication among farmers and between farmers and WD officials may also

have to be explored in the future. Looking forward, long-term capital-intensive mitigation strategies could include translocation of affected farmers, with an appropriate compensation package, similar to a scheme which has been operating in the Chyulu Hills/Tsavo West/Amboseli complex in Kenya for several years (Okello et al. 2016). All such measures should form part of an integrated landscape management approach that involves engaging all relevant stakeholders at the national and local levels in managing and mitigating HEC in the EWC. Ultimately, a resilient community livelihood base is needed to ensure both food security and elephant conservation in the corridor and other similar elephant ranges across the country.

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The population status of the greater one-horned rhino in India and Nepal, and the importance of regular monitoring

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The greater one-horned rhino (GOH), (*Rhinoceros unicornis*) is one of the largest in number of the five existing rhino species. Until recently the GOH rhino was prominently found to occupy areas along the Indus-Ganges-Brahmaputra valley. The GOH is an iconic species in India, and currently even though the population numbers seem to be healthy, the distribution is mainly confined to small pockets in Nepal and India with the majority of the population confined to a single protected area (PA). Hunting and habitat destruction pushed the species to the brink of extinction, and by the early 20th century only around 200 were found (Rookmaaker et al. 2016). However, effective protection and conservation measures along with active population management including range expansion programmes have helped the species recover to its present status.

The species is found in limited areas selecting specific habitat and is still under significant threat of poaching. As such it is vital to put in place a regular monitoring system to understand population trends, demographics, habitat availability and usage, genetic and health dynamics and other related parameters within and between populations. With climate change it will now be more important than ever to put in place appropriate monitoring mechanisms as scientists are predicting weather conditions which will have a detrimental impact on the eastern Himalayan region which is likely to affect the water catchment of the area, and the grassland and wetland habitats preferred by the rhinos.

The importance of monitoring the GoH rhino was realized in the 1950s and 1960s and initiatives were taken by the various forest authorities which hold rhinos to provide as accurately as possible the population estimates. The time intervals between censuses had not been standardized however, and were anywhere between two and five years.

Jaldapara National Park (NP) in West Bengal reports having begun counting its rhinos from 1957 when it found 57 individuals with an adult sex ratio of 1.33 females for every male. Kaziranga NP in Assam has records of rhino censuses being conducted systematically since 1966 when 366 individuals were counted. The counts have been taking place more regularly in Kaziranga starting in 2006 when the results yielded an adult sex ratio of 1:1.2 (male to female). We have records of systematic rhino counts in Orang NP from 1985, Pobitora WLS from 1987 (Assam Forest Department 2014) and Gorumara from 1998 (CCF Wildlife North 2019). Nepal is the second country that has a GOH population and records indicate that rhino censuses there started in detail from 1994 which detected 466 rhinos in the country (Department of National Parks and Wildlife Conservation, Nepal, 2006). Realizing the importance of putting in place robust and uniform rhino monitoring systems, the Ministry of Environment and Forests, Government of India, established the standard operating protocol (SoP) for its GoH rhino population monitoring in 2020. It advocates taking a uniform approach for conducting rhino censuses and repeating the count of the same population every fourth year in all the rhino bearing areas of India. The SoP suggests the continuation of the traditional total count method as well as testing out new methodologies to make the approach scientifically more robust so that the efficacy of methods can be compared to make appropriate changes in the monitoring methods in future (MoEFCC, WII and WWF 2020).

After the adoption of the SoP, the first uniform census was carried out in 2022 by all three rhino bearing states of India and which determined the

presence of 3,282 rhinos. Nepal conducted its latest count in 2021, which yielded a population of 752 (NTNC 2021), indicating there are 4,034 rhinos in the wild spread over eleven PAs within India and Nepal.

The total or direct count method was continued for the population census of 2022 in India. For undertaking this exercise, the entire PA is divided into enumeration blocks, and the sizes and shapes of the blocks are determined by on-the-ground conditions. Every enumeration block is traversed in a forward moving pattern and each rhino individual encountered is recorded in a pre-designed data format. A team is allotted to every enumeration block to conduct the count and the exercise is done in a zig-zag pattern to maximize the coverage of the area; this optimizes not missing any individual and care is also taken to avoid double counting of individuals. The team is usually comprised of three members with one lead enumerator, and they traverse the block ideally on trained elephants and in some instances on foot to look for the rhinos. The exercise is usually completed in a single day if the geographic size of the PA is small like that of Pobitora WLS (38.5 km^2) and is continued over two days dividing the PA into distinct parts like in Kaziranga NP and its additions (~889 km^2). This time, a double count approach was also tested in Orang NP and Pobitora WLS in Assam and Dudhwa NP in Uttar Pradesh, and the outcome has been found to be satisfactory. In Dudhwa, where the rhino population is confined to two areas, the count was done by dividing each area into uniformly sized grids of 5 km^2. In all cases the enumerators started the surveys in the early morning, between 5.00 am and 7.00 am and the teams on average took around three hours to cover a single block; and in some instances, where the terrain was more difficult, it took them more than eight hours.

In addition to the above PAs, there are also rhinos in Manas NP in Assam where they were reintroduced under the Indian Rhino Vision 2020 programme after intense poaching decimated them in the 1990s.

Here the direct count method revealed 40 rhinos in a 1:1 sex ratio, however, the day of counting was affected by heavy rains and waterlogging making the census operations difficult to cover the entire area thoroughly. As this is a newly introduced population, a regular monitoring and recording exercise is carried out by the NP authorities which indicates that there are approximately 50 rhinos. In addition to the direct count method, the line transect method was also tested in the NP which indicates the population estimate to be 49 rhinos (Manas Tiger Reserve 2022).

Scientists and researchers are wary about the direct count method due to various limitations, but this has been successfully used to monitor the GOH rhino. The biggest benefit is that the numbers are comparable over a timeline to understand the performance of the population as well as check the robustness of PA management, and interventions. The method is resource intensive, laborious, needs numerous skilled teams and adequate numbers of trained elephants,

Table 1. The 2022 census revealed the current status of the Greater one-horned rhinoceros in India

Protected area	Size of PA (km^2)	Population	Adult sex ratio (M:F)	Population trend (compared to previous direct count census)
Orang NP, Assam	78.81	125	1:1.18	5.9% annual growth
Pobitora WLS, Assam	38.85	107	1:1.65	1.5% annual growth
Kaziranga NP (and additions), Assam	889.51	2613	1:1.20	2% annual growth
Jaldapara NP, West Bengal	216.5	292	1:1.33	7.7% annual growth
Gorumara NP, West Bengal	80	55	1:1.54	1.9% annual growth
Dudhwa NP, Uttar Pradesh	680.32	40	1:2.28	3.5% annual growth

Source: https://forest.assam.gov.in/information-services/detail/data-of-wildlife
https://www.dudhwanationalpark.in/

yet it is facilitating keeping track of the rhino population in the PAs of India and Nepal and has been contributing towards the successful conservation of the species in both countries. The increasing population trend is no doubt an indicator of success, but it also raises the need for better and more holistic monitoring of the species as well as its pro-active management as the highest proportion of the population in Asia (~65%) is still concentrated within Kaziranga NP in Assam. There is also a need to expand the scope of monitoring to include demographic and health parameters and also include habitat performance and viability analysis to develop conservation plans.

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Towards a new rhino conservation landscape in Assam for the increasing population of the greater one-horned rhino (*Rhinoceros unicornis*)

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Introduction

The recent census or estimation of the greater one-horned rhino (GOH), (*Rhinoceros unicornis*) undertaken in Assam in 2022 has shown a continued upward trend (Table 1). There is also some increase in habitat in protected areas such as Kaziranga, Manas and Orang National Parks (NP) and Tiger Reserves (Table 2). Owing to improved vigilance the poaching has come down drastically. (Figs. 1, 2, 3).

There is growing awareness among villagers living in close proximity to the NPs of the earning potential from tourist-related activities: motels, safari vehicles, local guides, cafés and restaurants, and souvenir shops that cater to tourists and provide employment for villagers. An increase in tourism, especially in Kaziranga and Manas, has given rise to many new stakeholders. Long-distance travel by tourists has helped many in Guwahati, the capital of Assam, and other towns such as Jorhat and Tezpur to earn extra income, partially meeting their livelihood needs. In the case of Pobitora Wildlife Sanctuary (WLS), numbers of tourists is virtually uncontrolled during winter, the closest city impacted is Guwahati city.

Detailed accounts on the distribution, natural history and other aspects of the rhinos is well documented, some notable being Gee (1964), Rookmaaker (1980), Choudhury (1985) and Rookmaaker et al. (2017).

Creation of first rhino conservation landscape: Kaziranga—Orang

Like several other threatened species one of the limiting factors of conservation for the greater one-horned rhinos is its fragmented habitat. Starting from Shuklaphanta NP, Nepal in the west to Kaziranga NP, Assam in the east, GOH habitat is fragmented into at least 11 disjunct areas. The concept of landscape

Table 1. Rhinoceros numbers in different protected areas in India

ASSAM	**Year**	**1999**	**2006**	**2009**	**2012**	**2018**	**2022**
Kaziranga National Park		1,552	1,855	2,048	2,290	2,413	2,613
Orang National Park		46	68	64	100	101	125
Pobitora Wildlife Sanctuary		74	81	84	93	102	107
Manas National Park		–	–	2	22	41	48 (estimate from 2021)
WEST BENGAL	**Year**	**2008**	**2010**	**2013**	**2015**	**2019**	**2022**
Jaldapara National Park		192	155	186	204	237	292
Gorumara National Park		31	35	43	49	52	No census

Sources: Environment and Forest Department, Assam; Forest Department, West Bengal

Figure 1. Effective conservation of GOH rhinos requires good quality population data in order to make effective management decisions. Elephant-back patrols are ideal for both anti-poaching and monitoring. The Monitoring manual prepared by the AsRSG recommends, that three people (a mahout, a game scout and an armed guard) are the standard protocol for this. (*Source: https://www.academia.edu/26316629/The_Greater_One_Horned_Rhinoceros_Monitoring_Instructors_Training_Manual*). (© *Rituraj Konwar*).

Figure 2. Greater one-horned rhino (© *Anwaruddin Choudhury*).

Figure 3. Kaziranga NP in north-central Assam, India is situated on the south bank of the Brahmaputra River. Sightings of the rare GoH rhino in the Brahmaputra River such as these is a growing tourist attraction (© *Anwaruddin Choudhury*).

Table 2. Some reserves with rhino populations in Assam where the area has been increased

Protected Area	Pre-2000 area in km²	Current area in km²
Kaziranga National Park	430	915
Manas National Park	500	850
Orang National Park	78.8	279*
Burhachapori Wildlife Sanctuary#	44	239*

*Process of local claims and objections, if any, in the "addition areas" is ongoing.

level conservation has not been applied to date. In Assam a landscape level conservation unit has recently been formed, which connects Orang NP with Laokhowa and Burhachapori WLSs and Kaziranga NP. This was made possible owing to the declaration of the expansion of the Brahmaputra riverine tract as the second addition to Orang NP in 2021 (notification issued on 3 January 2022, for an area of 200.13 km^2). (The "name" in the notification of the second addition was inadvertently not mentioned, the author has written to the Environment and Forest Department for necessary corrections to include the name of the second addition). With all the additions, the total area of Kaziranga NP comes to 915 km^2, which includes the original park area of 430 km^2 and all the additions. The second addition to Orang NP will be finalized after determining and resolving any claims from the public through a final notification (the author was deputy secretary to the Government of Assam, Forest Department and had the opportunity to finalize the notification of Orang and issue it as a national park in 1999).

Laokhowa and Burhachapori WLS are adjacent and contiguous (author assisted in including these two sanctuaries in Kaziranga as a tiger reserve, while he was joint secretary in 2007). However, there was a gap in connectivity between the easternmost point of Burhachapori WLS and the westernmost area of the sixth addition to Kaziranga NP. An area of 195 km^2 was notified as the first addition to Burhachapori WLS in 2016. This addition has not only linked Burhachapori WLS with the sixth addition to Kaziranga NP but also connected it with Orang NP. Thus, a relatively larger conservation landscape has been established with four protected areas, including two tiger reserves (forested and grassland areas) covering an area of around 1,600 km^2 of prime rhino habitat with very good connectivity that will remain as the most important and long-term viable rhino landscape. Of the several new areas, the tenth addition to Kaziranga NP will act as a natural highland providing a safe habitat for rhinos and other wildlife crossing the river and during the monsoon. This landscape is home to around 68 per cent of the world population of the greater one-horned rhinoceros (Fig. 4).

New poaching technique

A sub-adult male rhino was found injured having had its horn removed in Orang NP and found by a patrol party on elephant-back in May 2022. According to Forest Department sources, they initially thought that it had been injured during fighting with other males but later on after tranquilization it was confirmed that the horn had been cut by poachers probably after sedating the animal (the last time the author had enquired about it was on 14 June 2022 (P. Baruah, Divisional Forest Officer, pers. comm. 2022). This precedent sets a new and dangerous record. Fortunately, the rhino survived after being provided with veterinary care. Earlier in around 2005 a tranquilizer gun was recovered from the fringe of Kaziranga NP but nothing more could be gathered on that (R. Sharma, Research Officer, pers. comm. 2005).

This new poaching technique has raised several questions and the anti-poaching strategy should be revised. It seems that people with technical knowledge are involved, showing skilled marksmanship, using the appropriate dosage of a tranquilizing drug and removing the horn without killing the rhino. The tranquilizing drugs are not normally available in India

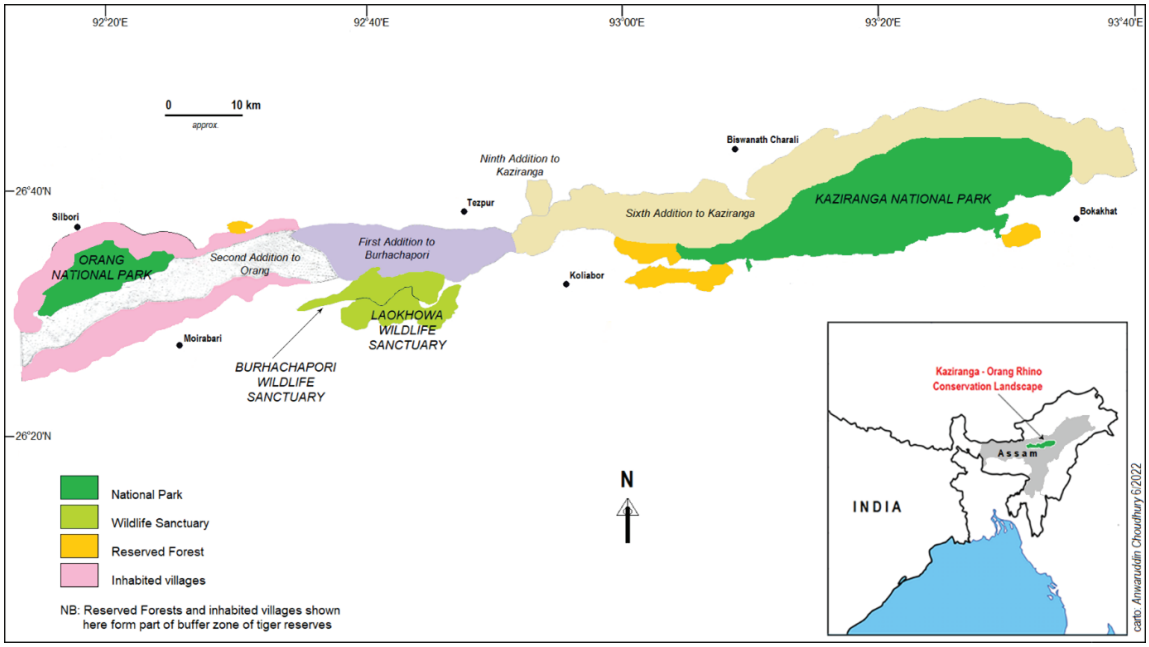

Figure 4. The Assam government has approved the tenth addition to Kaziranga NP and Tiger Reserves, creating a contiguous and connected landscape from Orang NP to Kaziranga NP to further improve the viability of the GOH rhino affected by annual flooding and poaching.

thus it is assumed that these were brought in from abroad by those involved or bought on the black market. To date a breakthrough in the case has not been made. It is strongly recommended that a global investigation on this new technique is needed and given the highest priority to avoid a South African style situation.

Acknowledgements

I thank Kees Rookmaaker, P. Shivkumar, Jatindra Sarma, Ramesh Gogoi, Pradipto Baruah, Rabin Sharma and many other officials including field staff of Environment and Forest Department, Assam, and Hasim Choudhury and Bikash Singh.

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Developing a user-centred system for long-term elephant monitoring

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Introduction

Originally envisaged as a three-year project, the Amboseli Elephant Research Project (AERP) has proved a labour of love for a small, dedicated team who have followed the life trajectories of more than 3,900 individual elephants over five decades. AERP's unique knowledge base is derived from tracking individually recognized animals in a small well-protected population studied continuously since 1972, providing an important baseline for a free-ranging elephant population with an intact age structure. This dataset forms the basis of our demographic analyses (Moss 2001; Lee et al. 2013), and through training, research, books and films has contributed to global understanding of elephant reproductive biology and behaviour; *musth*: (Poole and Moss 1981; Poole 1987: Poole 1989; Hollister-Smith et al. 2007); *oestrus*: (Moss 1983); *mothering and grandmothering*: (Lee et al. 2016; Lee et al. 2022), *elephant cognition*: (McComb et al. 2001; Bates et al. 2008; McComb et al. 2014) and communication: (Poole et al. 1988; McComb et al. 2000; McComb et al. 2003).

How can we now, after a half century of effort, make our data accessible and of continued use to the global elephant community? To try to answer this demand, AERP has moved beyond a simple relational database into a data management system that allows users to add, map, inspect, edit, and extract data. Here we share some of the key concepts that drove this process and outline our hopes for making elements of the system available to other projects that may benefit from similar capacities.

Problem statement

In such a long-term study we have faced many challenges in maintaining records on individual elephants, due to changing technologies (from hand-tallied summaries to IBM punch cards to cloud storage, each with a finite lifespan) and the sheer volume of data collected. Inevitably, data protocols evolved to encompass more elements of elephant biology, although the basic type of records made, and our definitions of behaviour have remained consistent. This consistency is vital for long-term monitoring (LTM) and is in part thanks to long-serving team members making many of those records; it is also due to careful training of research collaborators and their inclusion in LTM record-keeping alongside their specific research projects.

Technology has been the largest transformation challenge over the project's lifetime. Landsat for satellite imaging the earth's habitats was launched in the same year as the project began, and its resolution has been continually upgraded. Computing has evolved from room-sized mainframes to nanochips in smartphones. And, like any project spanning decades, we have had to balance new technology with investment in financial and staff resources that major system changes entail. Growing apace with technology was the elephant population itself; thanks to community endeavour and research presence, the number of elephants has increased slowly over the decades (Moss et al. 2011). This conservation success has presented new challenges; elephants have shifted their ranging patterns to take advantage of the larger safe landscape, while high survivorship has meant that the overall number of individuals to be tracked

has increased significantly from ~700 early on to over 1,900 in 2022. Individual elephant identification lies at the very heart of the project and is constantly updated through a photographic dataset of ears, tusks, tails and body markings. Maintaining identifications, and transmitting this knowledge to others, is key to the project's enduring success.

In 1997 AERP constructed the first Access database, capturing the elephant sightings data (Table 1), enabling tracking and analysis of elephant occupancy of the ecosystem in time and space, and the varied social opportunities these groups represent for elephants over the ecological year. This huge step nonetheless left out key LTM components, namely demographic data (births, deaths, musth, oestrus and mating), within-family dynamics, and key ecosystem variables (rainfall and vegetation), because computers of the time simply could not cope with the size and complexity of the full dataset. By 2015 computing power had advanced and the size and ranging patterns of our study population made it clear we needed a data management system that integrated all LTM elements and followed our actual data structure, with individuals at the heart (Fig. 1).

The build process

We rebuilt the entire data capture system (Fig. 1) using Microsoft Access and Excel interfaced with QGIS open-source GIS software (https://www.qgis.org). Given unpredictable and unstable internet access in the field, we retained an offline system that has slightly more complex file sharing and backup procedures, but which allows AERP users to work on data regardless of network connectivity. Key to our needs is the flexibility to build multiple databases that interact with each other, allowing the system to grow and change; and separating the user interface from the raw data (an early step in the process; Fig. 2) allows for constant design improvements without interrupting data flow for users in the field.

We followed a collaborative process between the designer (FR) and project manager (VF), coordinating each stage to include end-user feedback (Fig. 2). We used feedback at the design stage to determine what users felt was missing from the previous database, and in the build and launch stages to build and refine the queries (data inspection tools) that users needed. Some of these tools were only possible for users to

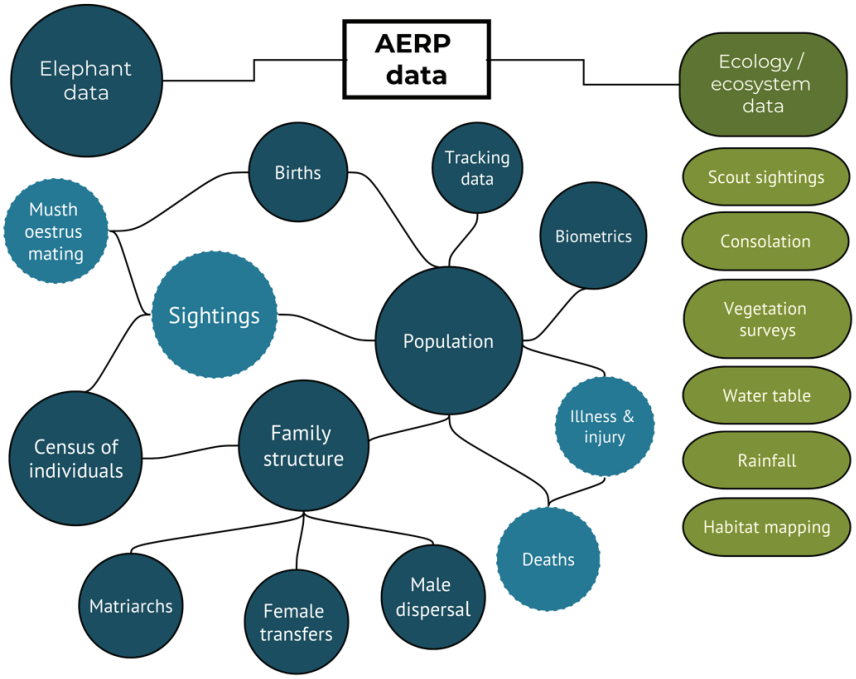

Figure 1: The data types included in the AERP long-term dataset. Dark blue circles show ID-dependent data areas, light blue circles with dotted borders indicate elephant data not dependent on known IDs. See also Table 1 for some data definitions and sample sizes.

Table 1. Details of selected data sections from Fig. 1, and current dataset sizes

Data Area	Details	Current Dataset Size
Encounter Data	**Sightings:** • Date, time, location, observer • Group type - male-only, female-only, mixed • Group activity - travelling, feeding, socialising, etc. • Group size and quality of count (exact, good estimate, approximate) • Quality of recognition, for males and females separately • Independent males present • Musth and oestrus individuals present (yes/no, and identity) • Families present, and portion present (all, >half, < half)	N = 54,244
	Musth, oestrus, mating • dyadic male-female interactions (guard, mount, successful mate)	N = 2,215 males for 1,884 oestrus females
	Census (of families) • Presence/absence data for all family individuals • Demographic event reporting e.g. birth, missing individuals (inferred mortality)	N = 10,989 census groups for 3,012 individuals since 1999
Life History Tracking	**Population** • ID code • Birth family • Sex • Birth month, year and accuracy (within 1mo, 6mo, 2yrs, 5yrs, 10yrs) • Mother ID, accuracy (unknown, estimated, good estimate, known) • Grandmother ID • Death month, year, and accuracy (unknown, within 2 yrs, 1yr, 3mo, 1wk) • Death cause, and accuracy (unknown, estimate, good estimate, known)	Total N= 3,906, then per population item; • 3,906 • 3,719 • 1,949 females, 1,910 males, 44 unknown • 2712, 577, 270, 243, 204 • 466, 77, 77, 3286 • 2,478 • 1,891 (216, 171, 351, 753, 398) • 1,891 (496, 293, 551, 549)
	Mortality Data • inferred i.e. missing from family, or disappearance • carcass (identified/not)	• 1,176 • 782

visualize once they had seen earlier versions of the system, so building and integrating the data entry and outputs was a stepwise process, which we continue to refine. Two key parts of our success to date were that the designer had a full understanding of the data flow from field to computer, and that the data capture forms we designed for the system always mirrored datasheets used in the field, to make it easier for users to become familiar and confident with the new system.

Key system features

Data entry is as simple as possible for users with data categories separated into different areas with "Add", "View" or "Edit" options available once users navigate into the chosen area (Fig. 3). A series of controls reduce user errors and streamline workflows, e.g. when entering elephant ID code, the elephant's name is always displayed so users can immediately recognize and correct typos. Where connections exist between different data areas, background code creates automatic lists of pending entries, so users can complete one data type at a time, e.g. when a family census is recorded during a sighting, the system allows the users to complete all the sightings data first, then go to the census area and select from a list of groups where census data is pending. The system also pulls real-time information on births and deaths, allowing for reliable and fast entry of individuals present in a census (Fig. 4).

Change log

Data can change as further observations are made on individuals, or input errors are corrected. Although all users can see the full population list, free editing is not permitted by all users, instead changes to key data are requested and then approved by an administrative user. We therefore built a Change Log, where changes to key fields are logged with the user's identity, date, and the old and new values. For example, if the sex of a calf was incorrectly logged or initially unknown, users can

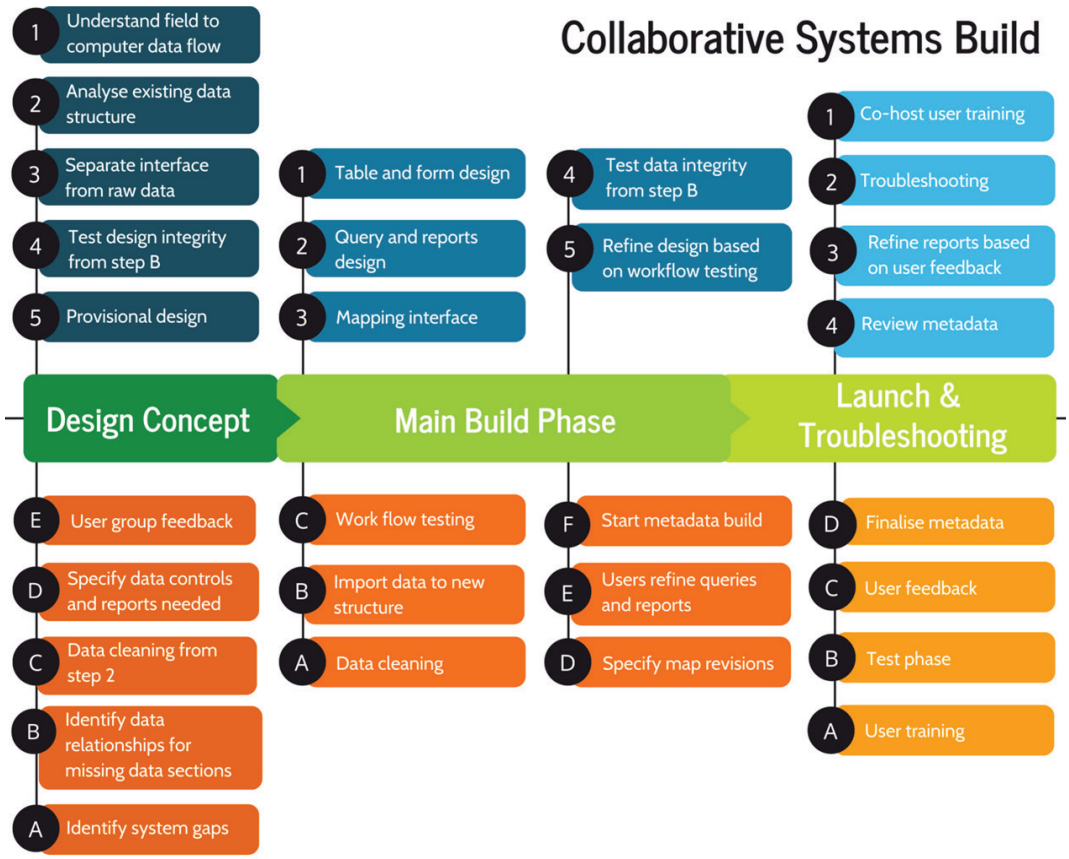

Figure 2. The interaction between the systems designer (top section, numbered 1, 2, 3) and the data users (bottom section, marked A, B, C) ensured user needs remained at the heart of the process. 'Metadata' is a full description of how the system uses and stores data, and creates a reference manual for the system, including a definition of each data type and the relationships between data sections.

report the change and the old values are preserved. This kind of logging makes it possible to examine conflicting observations and reconstruct data sequences rather than have them overwritten.

Reporting functions

To enable users to interact with the data we built an extensive set of pre-defined reports, allowing users to interrogate the dataset without having any programming knowledge. These reports include, for example, population size over time, sightings of families and individuals and ecological data (Fig. 5). For each report or query, users can select the desired time range, individual or other parameters of interest, and the results can be exported to Excel or as a PDF. Users can thus produce regular reports easily and examine individual life history data whenever they wish, without having to ask for technical assistance. Administration users also have a special set of data management queries. We expect to further refine all the reports and queries as part of the ongoing evolution of our system.

Further work

Our data management system is still evolving with aims to integrate tracking data (from live GSM collars and historical datasets), remote sensing (NDVI) and photo datasets. Functionality for photos of carcasses, wounds or treatments is already built in and will be tested over the following months. We have not yet embarked on integrating a photo identification library with our database, although we are aware that others are tackling these questions (Poole et al. 2022; this volume pp 72–90). The database developed by Poole et al. shares much of the AERP approach on capturing

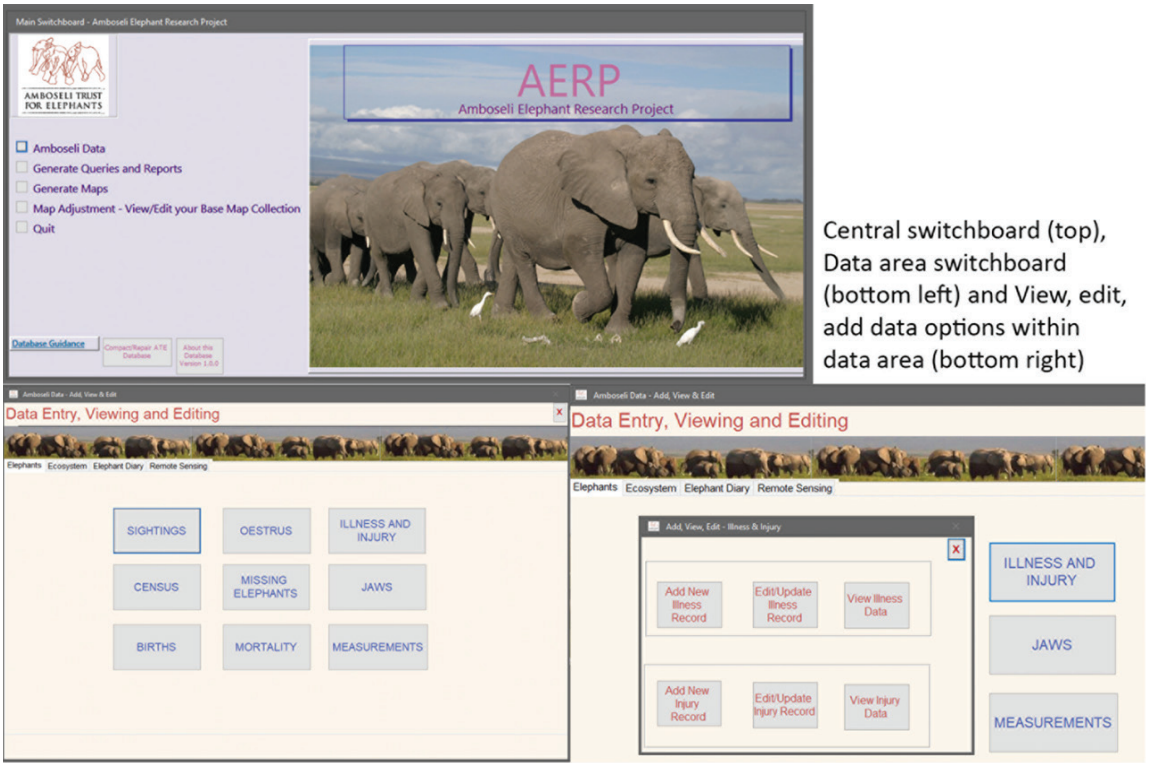

Figure 3. Screenshots of the main switchboard and system organization by data category. Above. Central switchboard; (Below left) Data area switchboard and; (Below right) view, edit add data options within data area.

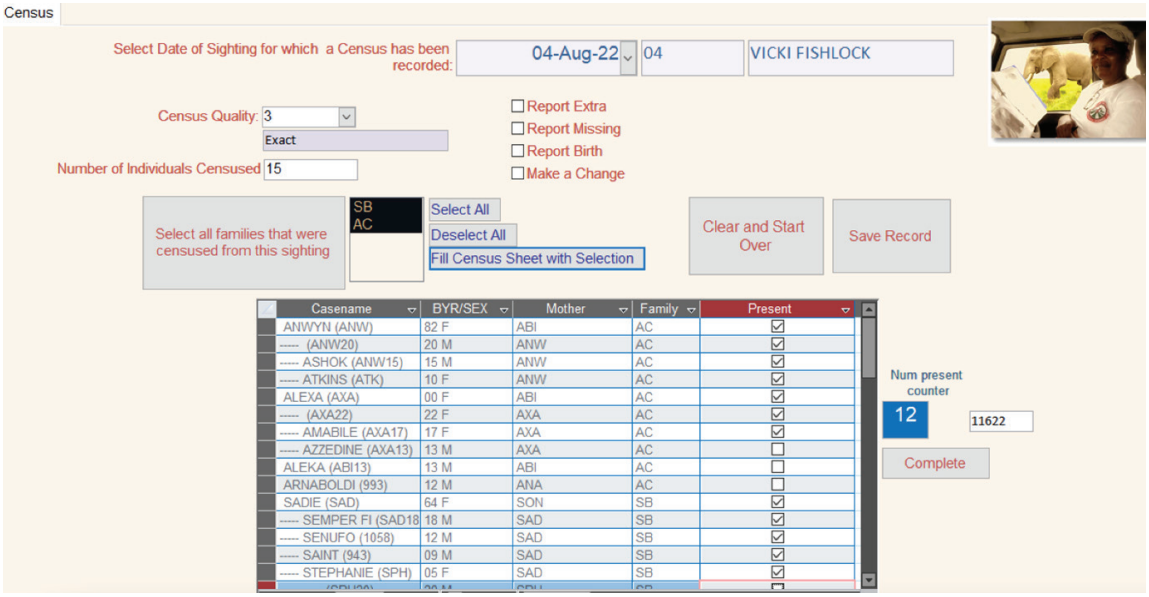

Figure 4. Census data entry form, where a group is from an auto populated drop-down list (top), users select those families censused, and then the "fill census" command draws up-to-date information from the population Table. A counter (blue box) helps users quickly stay on track with the number of individuals identified.

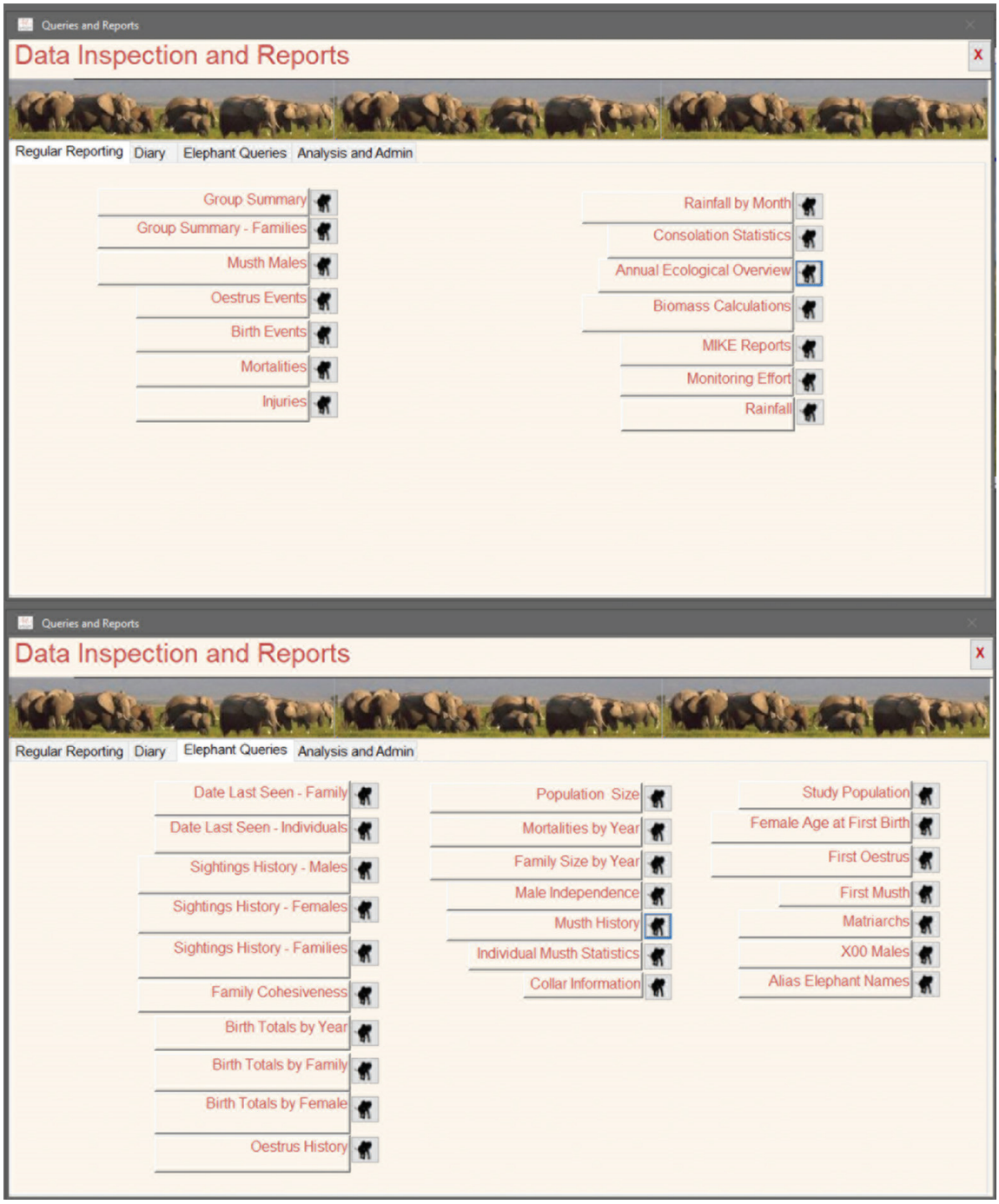

Figure 5. Examples of the query and reporting areas of the system; clicking on the desired report brings further pop-up boxes asking users to specify the time range or individual(s) of interest. Reports can be exported to Excel or PDF.

encounter data, thanks to our shared history, and integrates ID management (photographs and ID characteristics) with basic life history data, whereas the AERP design captures detailed demographic data at the individual and population levels and allows users to interrogate through pre-defined reports that don't require programming expertise. Some of the system's design complexity is generated by the way data protocols have evolved for our project, e.g. sightings data are taken at the level of family, and then detailed information on which females and offspring are present is added when possible (a census). However, we also recognize that many of the challenges that we have faced will be shared by colleagues with shorter-duration projects, where multi-level datasets on elephant sightings and life history data are maintained for and by multiple user groups. We would therefore like to appeal to any others who would be interested in collaborating to build a simple, standardized and freely available version of our system, using the framework of solutions that we have developed here.

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The Rhino Resource Center: accessing and utilizing a unique digital database

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Introduction

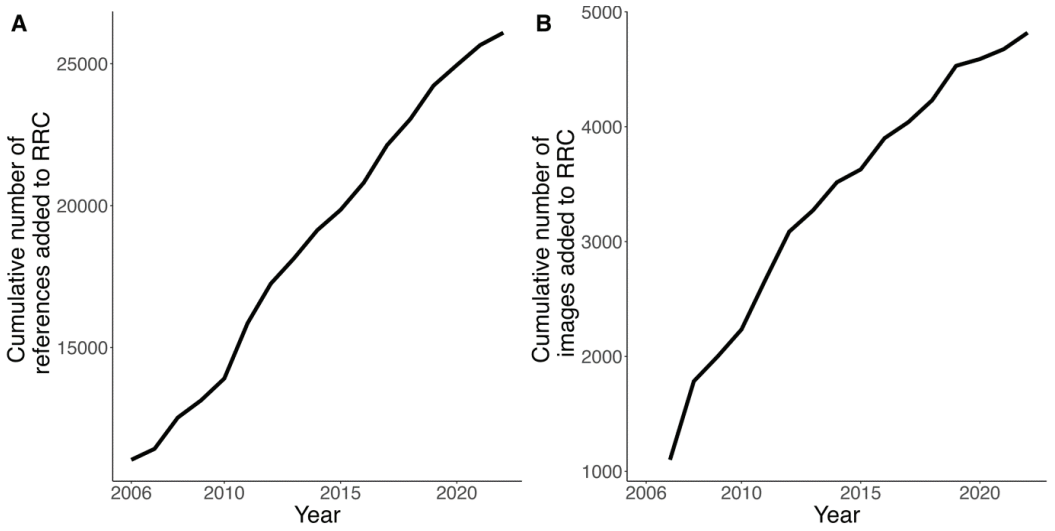
Rhinos have a long history in European art and literature, having captivated the public for over 500 years. In China and India, this is even longer (Bishop 1933, Bose 2020). This long-term record means that there is a wealth of rhino imagery and publications available for researchers. The Rhino Resource Center (RRC) is a repository of such information. Whilst the power of the RRC's literature database has been documented, we consider that the image gallery has thus far been underappreciated by researchers. To complement a recent publication that made use of the images in the RRC to investigate changing human perceptions of rhinos and morphological changes in rhinos over time, we describe the volume and type of data available on the RRC and the images it contains and how to access these, including thematic information, time and location data, ecological data and morphology. We hope that this paper will facilitate rhino researchers making greater use of this information and we strongly encourage uptake of this resource for future rhino research.

The Rhino Resource Center

The Rhino Resource Center (RRC) (available at rhinoresourcecenter.com) was registered on the 1 August 2003, following the International Elephant and Rhino Research Symposium in 2001, where it was proposed that a single repository for rhino information (Rookmaaker 2003) was necessary. The potential value of the RRC to rhino researchers has been documented previously (Rookmaaker 2010) and continues to grow, with 26,092 references in the literature database at the time of writing this paper, and over 5,000 images in the associated image database (titled the RRC Image Gallery) (Rookmaaker 2022), representing the world's largest collection of information on rhinos and, as far as we are aware, the largest repository of data on any given single group of mammals (Fig. 1).

Previous publications promoting the RRC have focused on the utility of the literature database (e.g. Rookmaaker 2003; 2010), which covers every rhino species, and includes information on publication type, date and locality. The literature database is user-friendly with a search facility and contains PDFs of over 26,000 references, so that authors have access to full texts, as well as titles. In a recent paper (Wilson et al. 2022) we have—for the first time—documented the usefulness of the RRC Image Gallery. The aim of that study was to demonstrate the potential advantage of image repositories in conservation research (in particular the changing relationship between people and rhinos, and the use of photographs for assessing changes in species morphology over time) and to provide recommendations for those interested in starting comparable databases that focus on other taxa. We intend this natural history note as a companion to Wilson et al. 2022 detailing the types of data that are available within the RRC and providing guidance on how to use this database specifically.

The RRC Image Gallery is searchable (like the literature collection) but can also be browsed, either in full or by locality, subject or taxon. Each image, when clicked, is displayed in the same format (Fig. 2). Each image is given a distinct title, searchable in the gallery, and information is given on the author, year of production, origin of the image, location, subject and species. This information is added by the editors of



Above left (A). Figure 1. Growth of the Rhino Resource Center since it was first established. A. Cumulative number of references in the literature collection

Above right (B). Cumulative number of images in the Image Gallery. Values taken from the electronic newsletter of the Rhino Resource Center, published every quarter since 2005 and available in the Rhino Resource Center literature database. Although the RRC was founded in 2003, the number of references and images was not included in the newsletter until 2006.

the RRC who upload each image. Images include both artwork and photographs featuring a rhino/s (depending on whether or not a camera has been used to produce them) and are sourced from the literature database, collected by the editors separately or provided by those with an interest in rhinos. Each image is then checked by the editors to reduce the chance of repeats within the gallery. The associated literature database means that further context (e.g. location, date, purpose of image) for many images is available.

Range of data in the RRC Image Gallery

Every image in the RRC Image Gallery is ascribed a date of production. Where dates are unknown, editors provide a best estimate given the context. These dates allow for trends in rhino images to be examined over time, with the RRC showing a near exponential increase in the number of images with each year (Fig. 3). Locality data to a country level are not always recorded for each image, where location is unknown or identifiable only to a regional level (39% of images for artwork), but for photographs, each image usually has an associated country designation (95.2%) (Fig. 4, Fig. 5). Mapping the distribution of photographs shows that there is a high number from the USA, these are typically of captive rhinos.

One stated goal of the RRC Image Gallery is to act as a virtual studbook, featuring photographs of every rhino ever kept in captivity (Rookmaaker 2007), so the high number of photographs of captive rhinos helps build towards this goal. The location information associated with each image also describes the captivity status of each rhino. Captive and wild rhinos can show differences in morphology (Groves 1982) so differentiating between these conditions is critical for assessment of morphological trends over time. Finally, the associated data includes the species of rhino pictured. The five different rhino species have had different relationships with humans over time (Wilson et al. 2022; Wilson 2019) and separate treatment of these species allows for improved investigation of species-specific conservation trends.

Both photographs and artwork on the RRC are representations of the way that the authors (and society more widely) viewed rhinos at the time that each image was produced. While photographs provide a 'true' image of a rhino, artwork can subjectively portray rhinos according to the desires of the artist (Clarke 1986), therefore providing insight into society's

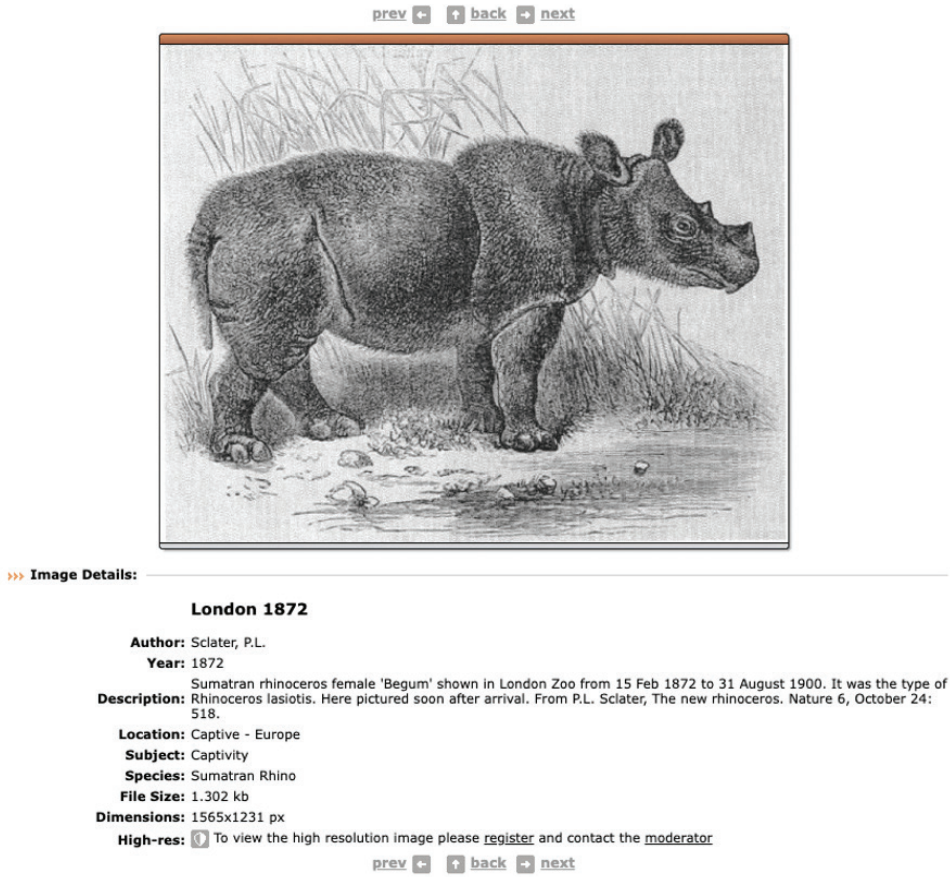


Figure 2. Example image from the Rhino Resource Center showing the data associated with each image in the gallery. Image shows the female Sumatran rhino (named "Begum") in London Zoo and is taken from PL Sclater, 1872, The new rhinoceros. *Nature: 6 October 24: 518*.

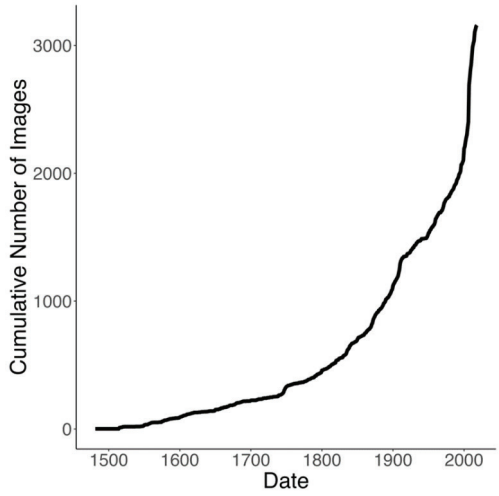


Figure 3. Cumulative number of images from each year between 1481–2019 available on the Rhino Resource Center Image Gallery as of 19 March 2019.

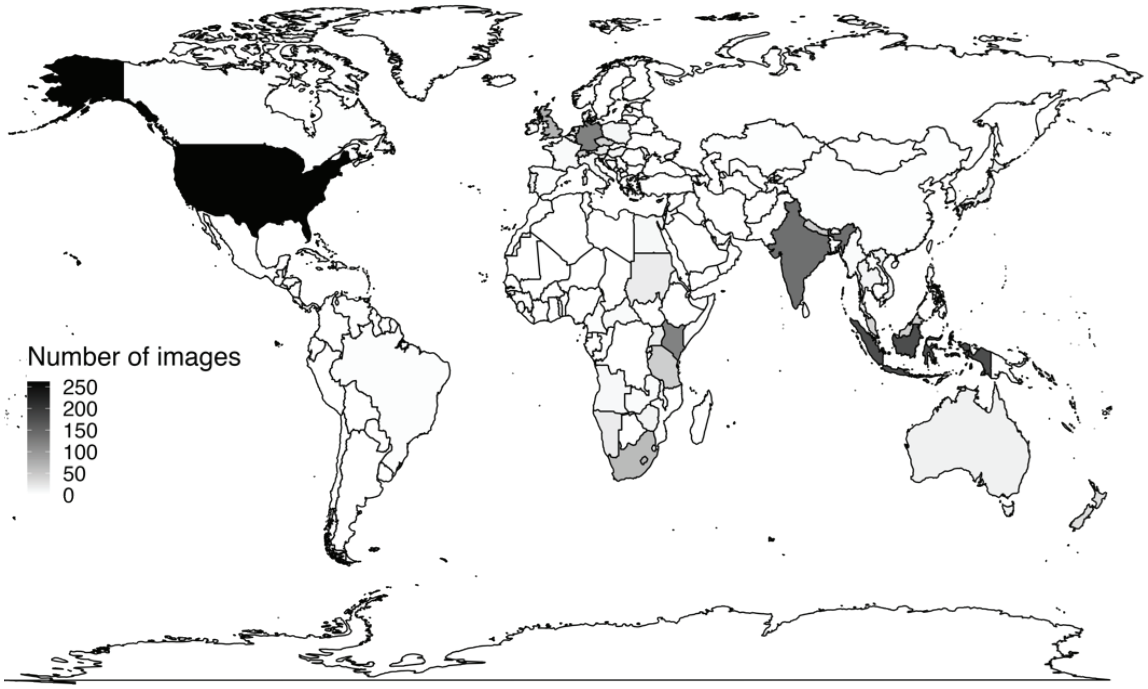


Figure 4. Number of photographs available on the Rhino Resource Center Image Gallery per country as of 19 March 2019.

perception of rhinos at the time. When adding an image to the RRC, editors assign one of 23 subjects to the image, depending on the context in which it is placed (General, Distribution, Taxonomy, Morphology, Anatomy, Physiology, Reproduction, Genetics, Ecology, Behaviour, Diseases, Management, Conservation, Captivity, Translocation, Value, Trade, History, Culture, Organizations, Museums, Bibliography, Text as original), providing important background information to facilitate image interpretation. This requires information on the source of the image, also available in the literature collection.

Potential future uses of the RRC for research

The differing nature of artwork and photographs, paired with published research on the RRC, means that these three types of information could be applied in unique ways to answer research questions and gain a deeper understanding of changes through time. In our paper (Wilson et al. 2022), we showed that photographs from the RRC Image Gallery could be used to assess how morphology changes between species and how horn morphology has changed over time. Given that high demand for horns has been a major driver of rhino population declines (Di Minin et al. 2015; Gao et al. 2016; Cheung et al. 2018; Shepherd et al. 2018), we believe that investigations into changing horn morphology could be vital for rhino conservation. Other morphological features could be similarly analysed using the RRC as a large and long-term dataset. Soft tissue characters have been used for taxonomic distinction in rhinos (C. Groves and Grubb 2011). For example, the 'drooping hairs' on the ears of Begum, a female Sumatran rhino living in London Zoo (Rookmaaker and Edwards 2022. In press) were used as evidence of the existence of a distinct species, the hairy-eared rhino, ('*Rhinoceros lasiotis*') by Sclater in 1872 (Sclater 1872b; 1872c; 1872a; 1872d; 1873;1876), but later analysis revealed that Begum's ear tufts had disappeared (Thomas, 1901). The species is now considered a northern subspecies of the Sumatran rhino, *Dicerorhinus sumatrensis lasiotis*, mainly differentiated by its larger size (Groves,1967; Rookmaaker 1984). Given the high number of images available on the RRC, including highly threatened taxa and even subspecies which are now presumed extinct (including *D.s.lasiotis*), the RRC has the potential to act as a valuable tool in providing data on disputed morphological characters for taxonomic study (Fig. 6).

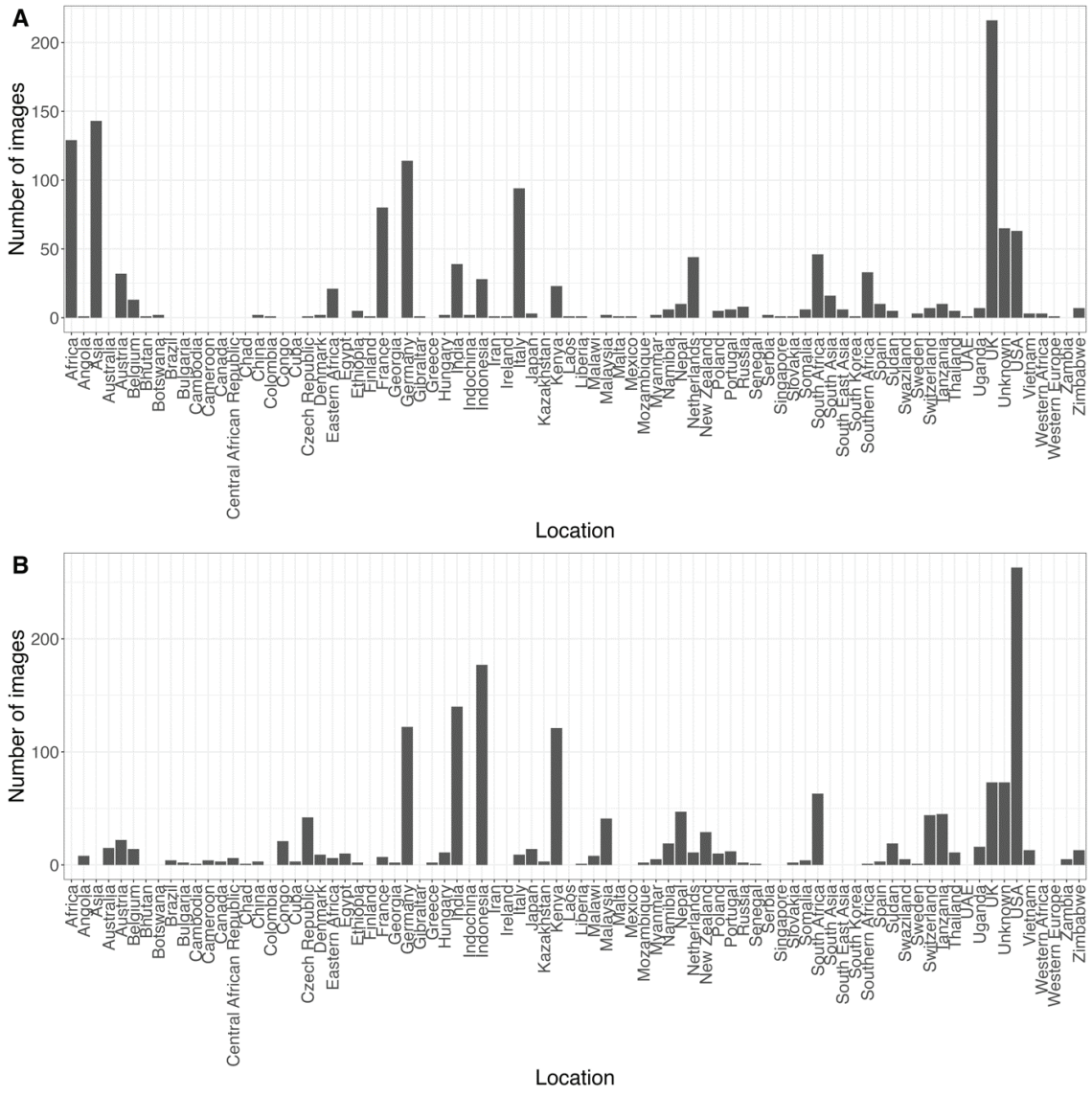
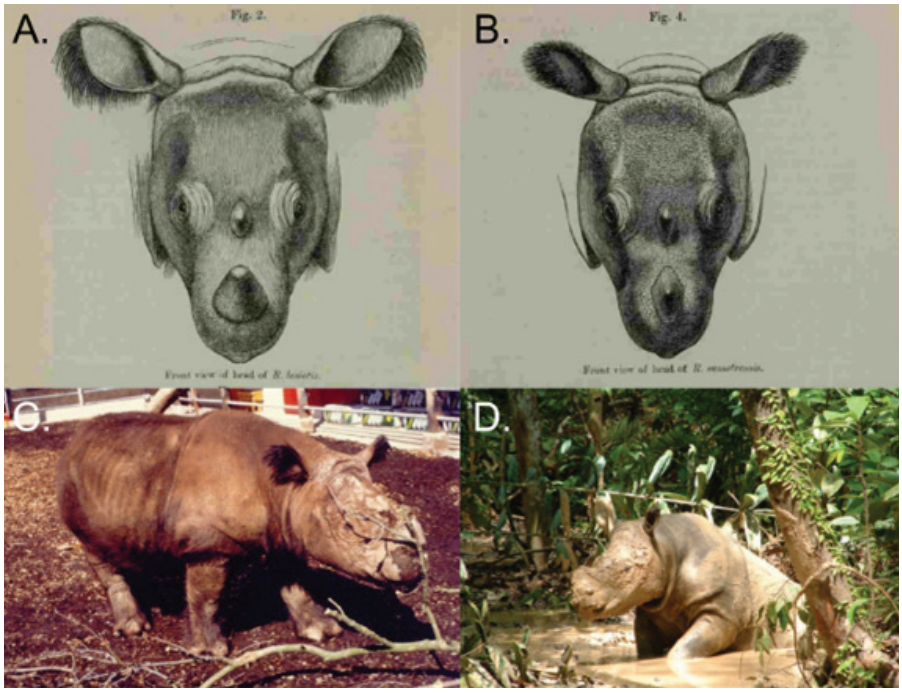


Figure 5. Bar plot showing the number of images available on the Rhino Resource Center Image Gallery for each location (either region or country) as of 19 March 2019. A. Number of pieces of artwork by region and B. Number of photographs by region.

Similar morphometric approaches could also be applied to non-photograph images on the RRC to investigate any potential changes in human perceptions of how rhinos look, with implications for how they have been perceived over time. For example, a recent study on artwork featuring dodos showed that there has been an increase through time in depictions of the dodo with a cartoonishly large anterior part of the beak since 1865, reflecting its perception as an ungainly taxon (van der Geer et al. 2022).

It is not just in examining the 'focal rhino' where images in the RRC may be useful. For example, photographs of captive rhinos could provide data on enclosure design, allowing assessment of how rhinos have been kept in captivity over time. Background vegetation in images of wild rhinos could provide information on habitat choice. Finally, images of wild rhinos could also provide information on group sizes, which are variable across the RRC image database (Fig. 7). Such habitat and group information could also be relevant to conservation. For example, while rhinos are generally considered asocial, interactions between conspecifics in both black and white rhinos have been found to improve chances of survival (Shrader and Owen-Smith 2002; Linklater et al. 2012). Consequently, any changes in group size from RRC images could be important for understanding changing selective pressures on species over time.

Another promising application of the data contained in the RRC is to specifically bring together information from images and publications, to gain a deeper understanding of rhinos. For example, data on how rhinos are written about in publications could be linked with information on how they are portrayed in images for a given time or location, to gain a broader understanding of human perceptions of rhinos, as well



Above left (A). Figure 6. Presence and absence of 'long drooping ear hairs' in Sumatran rhinos (*Dicerorhinus sumatrensis*). Ear morphology used by Sclater to define '*Rhinoceros lasiotis*' (now *D.s. lasiotis*) (from Sclater 1872).
Above right (B). Ear morphology without drooping ear hairs which Sclater used as an example of the condition in '*Rhinoceros sumatrensis*' (now *D.s. sumatrensis*)((from Sclater 1872).
Below left (C). Male Sumatran rhino (*D.s. sumatrensis*), named Torgamba at Port Lympne, 1986, showing long drooping ear hairs (image by Kees Rookmaaker 5 April 1986).
Below right (D). Male Sumatran rhino (*D.s. sumatrensis*), named Torgamba at a reserve in Way Kambas National Park with no visible long drooping ear hairs (image by Nico van Strien 2003). All images available to view on the Rhino Resource Center.

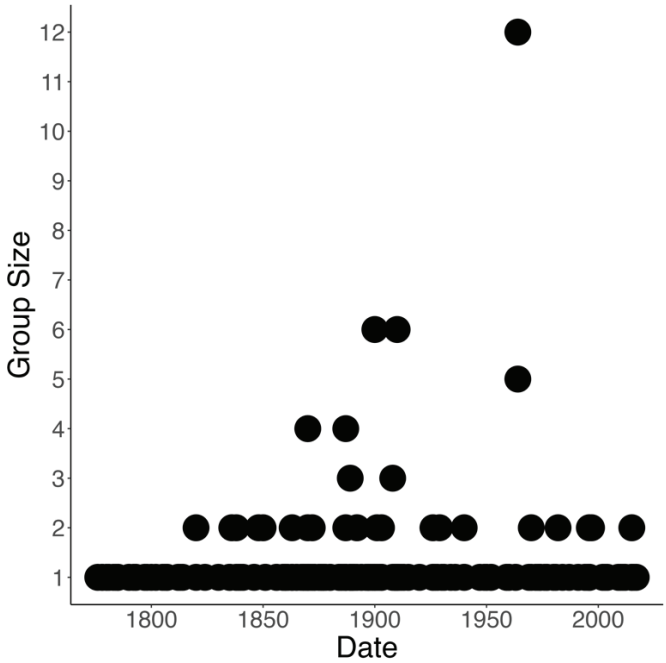


Figure 7. Black rhino (*Diceros bicornis*) group size through time, estimated using the number of conspecifics in the background of artwork featuring wild black rhinos.

as validating any single approach. Similarly, literature in publications on hunting pressure or levels of poaching could be linked to number or proportion of hunting pictures over time, to assess whether images provide information on hunting pressure.

Conclusions

The RRC is an information repository that is currently unique in its ability to contribute to rhino research. The utility of the literature collection has been documented previously and remains invaluable, but we argue that the information content contained within the RRC Image Gallery has so far been underappreciated. Here we have outlined some of the potential for data analysis contained within each image and suggested approaches that could be applied by future researchers from a variety of disciplines. A wide variety of questions could be answered using this image database (in combination with more traditional approaches), and we strongly suggest that researchers with an interest in rhinos consider engaging with it.

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Rhinoceros borili Blyth, 1870, a forgotten name for the black rhinoceros

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Borili, or Boreli, was the Ndebele (Matabili) name for a type of black rhinoceros in South Africa, recorded by the explorer-zoologist Andrew Smith (1797–1872) and the engineer-hunter William Cornwallis Harris (1807–1848) in their books published in 1838 (Rookmaaker 2008: 33, 52). As the name was associated with the usual black rhinoceros found in South Africa showing a posterior horn much smaller than the anterior one, it was only used as a common name for *Rhinoceros bicornis*, now *Diceros bicornis*. During much of the 19th century it was separated from the black rhinoceros with horns of equal lengths known as *Rhinoceros keitloa*, which should now be used as the name for the south-eastern sub-species as *Diceros bicornis keitloa* (Rookmaaker 2016).

Although Borili and Keitloa appear in 19th century literature, there was never a need to provide a scientific name for the Borili. However, such a name was indeed provided once, in a popular book of natural history, and subsequently overlooked even by authors (like myself) who have perused this well-known publication. It is necessary to discuss the author and date, and interesting to look at the history of the accompanying engraved image of the black rhinoceros.

The French naturalist Louis Figuier (1819–1894) wrote many books popularizing science, among which one on mammals aimed at younger people in 1869. His approach was definitely conventional and greatly outdated, recognizing just two species shown in two figures, the one-horned Indian and the two-horned African rhinos (Figuier 1869: 119). The second edition of 1873 was unchanged.

Figuier's book was rather quickly published in English in 1870, translated by the popular author Parker Gillmore (1835–1900). As stated in the translator's "Note" dated 12 March 1870, "the early portion was edited by E. Blythe [sic], Esq., F.Z.S. This acknowledgement is necessary, as that part was remodelled and considerably augmented" (Figuier 1870: v). Edward Blyth (1810–1873) was the former Curator of the Asiatic Society in Calcutta, India, who had returned home due to sickness in 1862. He had certainly greatly changed the section on the Rhinocerotidae with text originally four pages in extent augmented to 27 pages but still with only two illustrations (Figuier 1870: 139–160). Repeating his discussion on the rhinoceros written in India (Blyth 1862a, 1862b), Blyth now recognized three Asian species and three African species, almost like our modern classification except for accepting two types of black rhinoceros (*R. bicornis* and *R. keitloa*). It may be noted that Blyth used the generic names advocated by John Edward Gray (1868): *Ceratotherium* for the white rhino and *Rhinaster* for the two black rhino species, the latter spelled *Rhinoster* (p.155), which may be regarded as an incorrect subsequent spelling in terms of the International Commission on Zoological Nomenclature (ICZN).

The two illustrations of rhinos in the original French edition of 1869 were also replaced in the English edition of 1870, with new captions for "Fig. 35. – Indian one-horned Rhinoceros (*R. indicus*)" (p.139) and "Fig. 36. – Two-horned African Rhinoceros (*R. Borili*)" (p.142) (Fig. 1). The latter species, clearly the black rhinoceros, was called Borèlè in vernacular and *Rhinoster bicornis* taxonomically in the general discussion (Blyth 1870: 155). The name *R. Borili* in the caption has never been formally noticed anywhere in any other work about rhinos. It is a valid name, because there is an illustration and because the book was doubtlessly a normal publication. The name cannot be attributed to Louis Figuier, leaving Parker Gillmore or Edward Blyth as contenders. I believe that

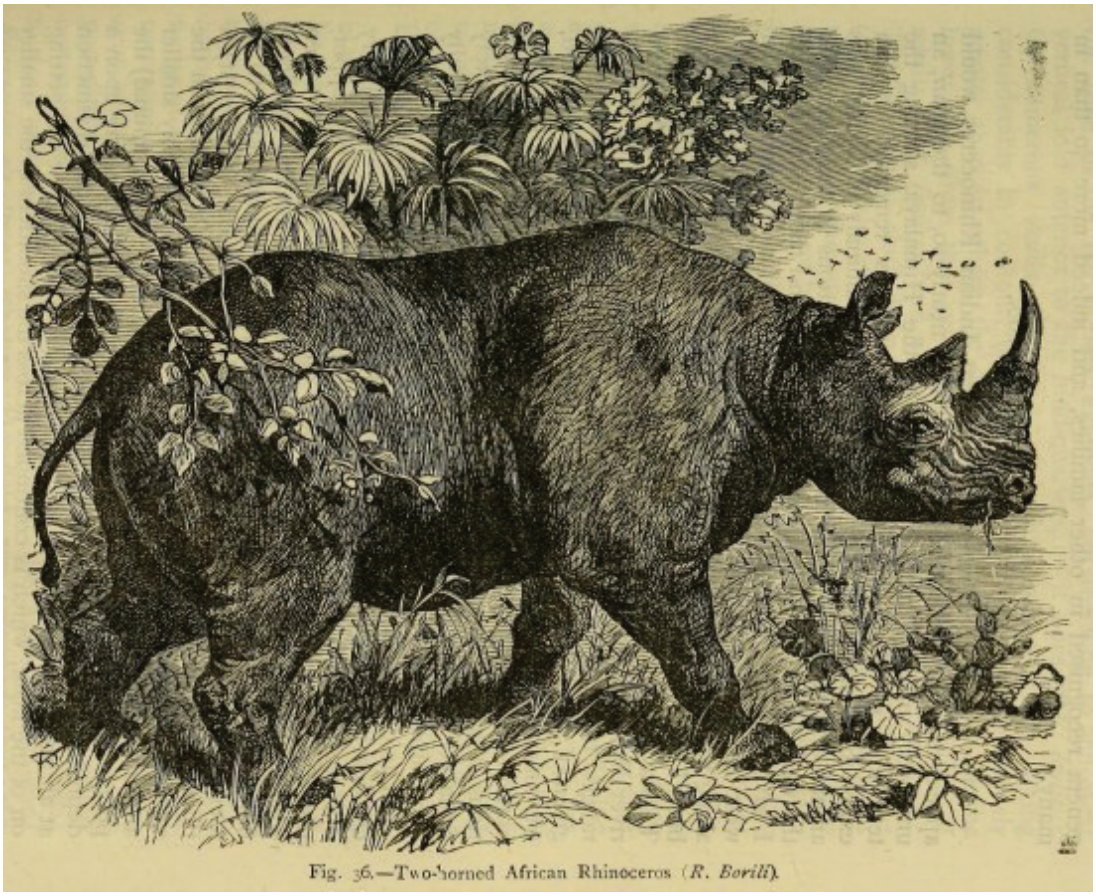

Figure 1. The black rhinoceros drawn by W.S. Coleman as found in the English editions of the Mammalia by Louis Figuier of 1870, 1875 and 1883 with the caption "Two-horned African Rhinoceros (*R. Borili*)."

it is best to credit Blyth with this name. It needs no explanation that *R. borili* should be regarded as a *nomen oblitum*, a forgotten name, because it has not been used again, except in reprints of the same work (as below). A *nomen oblitum* remains valid and available, but being unused after 1899, does not take precedence over a younger synonym or homonym.

The illustration used here for the African rhinoceros was not original. It was earlier published in another popular book on the animal kingdom authored by Rev. John George Wood (1827–1875), an immensely prolific author on science and nature topics whose works were regularly reprinted both in the UK and in the USA. The figure of the "Rhinaster or Borele—*Rhinoceros bicornis*" first appeared (as far as I can verify) in the multi-volume edition of Wood's *Illustrated Natural History* of 1859 (Wood 1859, vol.1: 757). In some editions of this work, this engraving is signed in the lower left corner "W.S. Coleman" identifying William Stephen Coleman (1829–1904) as the draughtsman, and in the lower right corner by the engraver which might read (but it is almost illegible) "Mesnel sc." for Albin Mesnel (1830–1875). Considering that the first black rhinoceros was exhibited in a zoological garden as late as 1868 (Rookmaaker 1998: 164), the animal that inspired Coleman's drawing can no longer be identified. The animal in this figure is clearly the type-specimen of *R. borili* and the locality where the animal was seen is the type-locality. Although South Africa is the most likely location, this cannot be verified.

There were three further editions in English of Figuier's *Mammalia*, dated 1875, 1883 and 1892, for which the translation and revision was credited to the Irish zoologist Edward Perceval Wright (1834–1910). The illustration of 1870 with *R. borili* in the caption

was repeated in 1875 and 1883, but reversed back to *R. bicornis* in 1892. Coleman's drawing first seen in J.G. Wood's work in 1859 was repeated in various works and editions by this author until 1885, always as *R. bicornis*.

This investigation has found two new names relating to recent rhinoceros:

Rhinoster Blyth, 1870 (in Figuier's *Mammalia*, p.155), incorrect subsequent spelling of *Rhinaster* Gray, 1842.

Rhinoceros [or *Rhinoster*] *borili* Blyth, 1870 (in Figuier's *Mammalia*, caption to Fig. 36 on p.142). Type-specimen: the animal depicted by William Stephen Coleman as found in Wood (1859, vol.1: 757) and later works until 1885, and in Figuier (1870: 142, 1875: 141, 1883: 141). Type-locality: unknown, probably South Africa.

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In Assam, a horn has value only on a living rhino

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On 22 September 2021 coinciding with World Rhino Day, 2,479 greater one-horned rhino horns were incinerated in Assam with full public participation in accordance with a decision taken by the State Government of Assam. The State government took this historic decision to send a strong message against wildlife crime and the illegal wildlife trade, especially the poaching of rhinos, and to strengthen the belief of the Assamese people that a rhino horn holds value only on a living rhino.

The State government is committed to the conservation of the rhinos, which is recognized as a protected species and is working together with all stakeholders and local communities for the better conservation of the species. This is evident by recent successes in tackling poaching. The most recent rhino census in 2022 revealed that numbers in Assam have increased to 2,895 which represents about 72% of the total global greater one-horned rhino population. Manas National Park (NP), a protected area where the rhino population has been recently restored through translocations, now holds 50 rhinos. The aim is to establish more new populations in the State following a collaborative model. The species is listed as vulnerable by IUCN. While population numbers are improving, the species is still strongly dependent on conservation and protection (Rookmaaker et al. 2017).

The rhino horn destruction in Assam was carried out as per the provisions listed in the Wildlife Protection Act 1972, under Section 39 (3) (c). The Government of India in their letter no. 1-60/89-WL dated 4 November 1994 had advised the State to dispose of old stock of wildlife trophies, animal parts and products, where no court proceedings were pending, and to retain just a few for educational and awareness-generation purposes. The horns had mostly been seized during anti-poaching operations and had been held for several decades, some had also been recovered by the wildlife authorities from rhinos which had died from natural causes. The State government constituted a committee under the Chairmanship of the Chief Wildlife Warden, Assam for "Reconciling of the trophies, animal articles etc. derived from scheduled animals and destruction of the same thereof". The horn destruction work was planned and executed in accordance with notification FRM.29/2020/47 of 29 July 2021.

Prior to this, government notification FRW.31/99/89, of 27 January 2010 had authorized setting up a committee mandated to destroy rhino horns by burning in full public view and in the presence of press and media. However, the work could not be completed at that time due to legal issues and to meet the demand from the people of Assam to verify the authenticity of the horns. Subsequently in 2016, a committee was set up to examine and re-verify the rhino horns under the custody of the forest department in accordance with notification FRW.93/2015/Pt/628, of 29 July 2016. This committee completed the verification work finding that almost all of the horns in the stockpile were genuine except for a few which were in doubt and were subsequently verified through genetic analysis; very few were fake.

The committee formed by the State government in 2021, prepared a protocol for re-verification of the horns in the stockpile and subsequent destruction of the horns by burning after selecting a few for preservation which were deemed necessary for ongoing legal cases against suspected poachers/smugglers, as well as for academic purposes. To execute the horn re-verification, a single Technical Committee was formed made up of people with a range of relevant expertise. To support the technical committee, seven zonal committees were formed to cover various parts of Assam where most of the rhino horns were stored in high security government treasuries.

The horn re-verification work (Figs. 1, 2 and 3) was

carried out in the different locations by a single technical team and followed a fixed protocol that comprised of the following broad procedures: a) opening of locked boxes holding horns, verifying records and cleaning of the horns; b) physical and microscopic verification; c) issue and printing of new labels for each horn; d) morphometric measurements using tape to determine size and initial weight; e) morphometric scale documentation through photography; f) sample collection for genetic analysis and recording weight; g) recording post-sampling closing weight; h) packaging of the horn and final labelling; i) re-storing horns and samples in secured boxes; j) proper disposal through burning of any waste matter generated during the exercise.

The entire process was video recorded and there was a live streaming of the re-verification procedure outside the secured room for public viewing.

Once the re-verification of all 2,623 horns was completed, the necessary approvals were accorded for destruction of 2,479 horns by burning and preservation of 94 horns that included a few unique pieces such as the longest and the heaviest on record, (see Tables 1 and 2).

Figure 1. Specially formed team members verifying the rhino horns in their stores in 2021 (© *Assam Forest Department*).

Figure 2. Rhino horns are categorized and inventoried ahead of the burning exercise on 22 September 2021 (© *Assam Forest Department*).

Figure 3. The longest horn of the greater one-horned rhinoceros found in Assam (© *Assam Forest Department*).

Table 1. Some of the findings from the re-verification exercise

Heaviest rhino horn in the stockpile	3.051 kg
Longest standing height recorded in the stockpile	42.5 cm
Average weight of a rhino horn	560 gm
Average basal circumference	43.47 cm

Table 2. Profile of two unique horn pieces found during the exercise

Sl. No.	Uniqueness	Height (cm)	Weight (kg)	Outer curve length (cm)	Inner curve length (cm)
1	Longest	42.5	2.57	57	47
2	Heaviest	36.0	3.051	50	40

Figure 4. View of specially made furnaces with burning pyres destroying rhino horn stockpile in Assam (© *Assam Forest Department*).

Figure 5. "Abode of the Rhinoceros" constructed from the ashes of horns burnt in 2021 and unveiled in September 2022 in Kaziranga National Park. (© *Chandana Sarma*).

The heaviest horn in the stockpile weighed 3.051 kg, while the longest had an outer curvature length of 57 cm. (See Tables 1, 2, and Fig. 3 above). The latter is most likely the second longest greater one-horned rhino horn presently existing in the world, following the one preserved at the Natural History Museum in London which was also from Assam (a horn of 61 cm, shot by Thomas Briscoe in Assam in 1909, the longest trophy still known to exist, see Rookmaaker 2020).

Upon completion of the re-verification exercise the horns were incinerated at a ceremony held at Bokhat town, close to Kaziranga NP. Following Hindu rituals, the burning of the horns was done in specially designed gas-powered furnaces, by a special Burning Committee with the support of six dedicated teams during a day long programme. All 2,479 horns were arranged in iron trays and placed in six specially designed iron furnaces before being set alight. (Fig. 4) It took around four hours for the horns to completely disintegrate and 157.02 kg of burnt horn ash was later derived from the horns that weighed 1,305.25 kg. Three rhino statues entitled "Abode of the Rhinoceros" and constructed from the ashes of the horns burnt in 2021 were installed and unveiled in September 2022 in Kaziranga NP by Assam Chief Minister Himanta Biswa Sarma. (Fig. 5)

This was the first instance of horn destruction to take place in Assam and is shared for a wider audience through this field note to expand learning.

Acknowledgements

I thank all the individuals and organizations for extending support for accomplishing this significant and historical event. Special thanks to the Chief Minister, Government of Assam, Himanta Biswa Sarma, for his support and advice to send out this very strong message.

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Birth of Sumatran Rhinoceros (*Dicerorhinus sumatrensis*) in Way Kambas National Park

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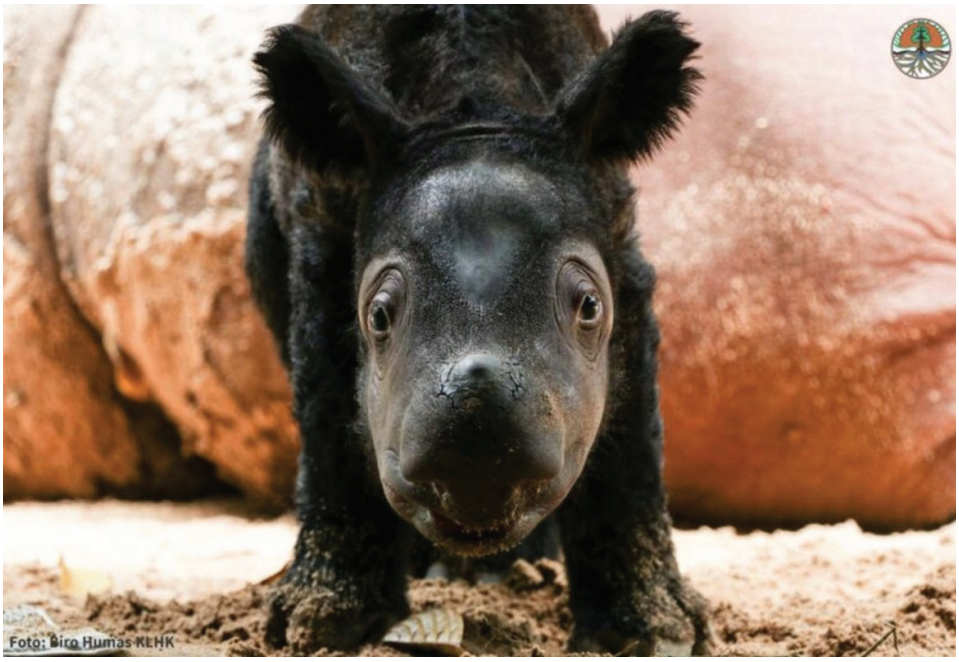
The Government of Indonesia (GoI) announced the birth of a Sumatran rhino at the Sumatran Rhino Sanctuary, Way Kambas National Park (SRS), Lampung Province on 24 March 2022. The mother is Rosa, approximately 20 years old and the father is Andatu, who was the first rhino ever born at the Sumatran Rhino Sanctuary. The birth of Rosa's calf, a female, has increased the number of rhinos at the SRS to eight.

"The birth of the Sumatran rhino is good news amid the efforts of the Indonesian government and partners to increase the Sumatran rhino population," said Wiratno, former Director General of Natural Resources and Ecosystem Conservation of the Indonesia Ministry of Environment and Forestry. "My deep gratitude for the work of the team of veterinarians and keepers who have continuously monitored the development of rhino Rosa's pregnancy and postnatal care."

Mother and calf are both healthy. The GoI will name the calf at a ceremony to be held at a later date.



Above, center and below. Figure 1–3. *All images courtesy of the Indonesia Ministry of Environment and Forestry.*

Aspects of white rhino movement over a 12-month period based on hourly GPS location data

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Introduction

Eight female southern white rhinos were monitored by ranger teams at the 64 km^2 Ziwa Rhino Sanctuary (ZRS), Uganda, 24 hours per day, seven days per week for the year 1 May 2020–30 April 2021. The teams kept the monitored rhinos in view at all times, albeit from a safe distance. In bushier habitat, the rangers would be within 50 metres of the rhinos while in open habitat the rangers could be as much as 150 metres from them. Each ranger team had a smartphone installed with Cybertracker software. These were used to record various details of rhino behaviour including which sector and block the rhino had spent time in, and their GPS location; both on an hourly basis. Such detailed data for free ranging white rhinos has not been published before.

The distance between the GPS locations which changed every two hours represents the positioning made by the ranger team rather than that of the rhinos being monitored but in our opinion is a good representation of the movements of rhinos being monitored. It does not show the distance moved by the rhinos where the ranger did not have to move at all or repositioned just slightly. This occurs when, for example, feeding takes place in a small area with the rhinos slowly moving around but with the ranger remaining in one place.

We recognize that there are gaps in the data collection, for example when the battery of the smartphone failed or where a ranger forgot to enter information. While analysis showed that these technical/human errors were rare, occasionally they impacted all or part of one 12-hour shift.

The ages of the eight rhinos varied from 21 to 7 years: Bella and Kori were estimated to be 21 years/4 months; Malaika 9 years/11 months, Donna and Laloyo 9 years/4 months; Uhuru 7 years/11 months, Waribe 7 years/4 months, Luna 7 years/1 month.

Bella is the mother of Donna and Luna. Kori is the mother of Laloyo and Waribe. Malaika and Uhuru are the offspring of the deceased female Nandi.

Results

Figure 1, a-h, show the 95% home range (convex polygons) and 66% core areas for the eight rhinos. These show a variation from the largest home range of Bella at 41.6 km^2, core area at 5.4 km^2 to the smallest of Laloyo at 5.6 km^2, and a core of 1.1 km^2.

Table 1 shows the 95% home ranges, 66% being core areas and number of core areas for the eight rhinos. Bella with the largest home range covered some 65% of the sanctuary. Laloyo with the smallest home range covered only 8.8%. The core of Bella is the largest and made up of 12 areas and represented 13% of the home range. Laloyo with the smallest core covered only two areas which represented some 19.6% of her home range.

Table 2 shows the monthly average, daily average and hourly average movement of each of the eight female white rhinos over the 12-month period under study. The average movement of the eight rhinos was 1,707 kilometres (km) over the year, 142 km over a month, 5 km per day and 200 metres per hour. Donna moved the greatest distances at 2,071 km (year), 173 km (month), 6 km (day) and 240 m (hour). Laloyo moved the least distance at 1,311 km (year), 109 km (month), 4 km (day) and 150 m (hour).

Table 3 shows the monthly distance moved for each of the eight female white rhinos by each month, from 1 May 2020 to 30 April 2021. Donna moved the largest distance in any one month at 202 km

Table 1. The 95% home range (HR), 66% core areas and number of cores for eight female rhinos

Rhino	Home range (km²)	Core area (km²)	Number of core areas	Home range (%)[a]	Core area (%)[b]
Bella	41.6	5.4	10	65.0	13.0
Kori	29.6	5.2	9	46.0	17.6
Donna	16.4	1.5	2	25.6	9.1
Malaika	9.9	1.7	4	15.5	17.2
Laloyo	5.6	1.1	2	8.8	19.6
Uhuru	9.2	1.5	3	14.4	16.3
Luna	10.3	1.7	3	16.1	16.5
Waribe	7.1	1.4	2	11.1	19.7

(a) HR percentage of total sanctuary area, (b) Core percentage of home range

Table 2. Movement of eight female white rhinos over twelve months, in km

	Year total	Month average	Range	Daily average	Range	Hourly average
Bella	2006	167	142–190	6	2–14	0.23
Kori	1687	141	118–172	5	1–11	0.20
Donna	2071	173	140–202	6	1–15	0.24
Malaika	1759	147	100–169	5	1–10	0.21
Laloyo	1311	109	85–130	4	1–7	0.15
Uhuru	1680	140	110–160	5	1–11	0.20
Luna	1561	130	116–140	4	2–8	0.18
Waribe	1583	132	121–142	4	2–10	0.18

Table 3. Movement of eight female white rhinos by month, 1 May 2020 to 30 April 2021, in km

	Bella	Kori	Donna	Malaika	Laloyo	Uhuru	Luna	Waribe	average	Range
May	185	134	159	149	126	160	125	136	147	125–160
June	179	137	157	153	118	143	138	136	145	118–157
July	184	135	153	161	130	155	138	125	148	125–161
August	163	123	140	156	85	147	125	130	134	85–156
September	142	126	192	140	97	144	121	129	136	97–192
October	150	142	194	144	104	133	139	135	143	104–194
November	159	155	184	157	108	137	126	131	145	108–184
December	161	145	188	169	119	110	135	141	146	110–188
January	190	143	167	151	110	126	136	142	146	110–167
February	144	118	142	100	87	124	122	121	120	87–142
March	171	157	192	148	122	160	140	132	153	122–192
April	179	172	202	128	106	139	116	124	146	106–202
Average	167	141	173	147	109	140	130	132	142	139–134
Lowest	142	118	140	100	85	110	116	121	120	85–140
Highest	190	172	202	169	130	160	140	142	153	130–202
Difference	48	54	62	69	45	51	24	21	33	21–69

while Laloyo at 85 km, the least. The greatest variation between least and most travelled monthly distance was 69 km for Malaika while the smallest variation was for Waribe at 21 km.

Table 4 shows the number of movements over 10 km in one day for each month of the year and the longest movement. Donna moved the most (15) over the most months (9) with the longest single distance in a day of 14.9 km. Laloyo showed no movements over 10 kms with the longest made of 7.2 km, the least travelled distance among the eight females.

Table 5 shows the extent of movement of all eight rhinos in each hour of the day, in kilometres. The data is used to derive that for Table 6 which shows the data represented by three "intensity" categories—low, medium and high. The most movement was recorded between 7am and 10am and 4pm and 10pm which corresponds with times when rhinos are feeding (see details of the '24 hour clock', Patton et al. 2018).

Table 7 shows the distance moved by each rhino over the year and the size of their home range in the same period and the relationship (proportion) between the two. Laloyo showed the most movement in relation to her home range with Bella moving the least. While Kori and Uhuru moved almost the same distance, Kori had a home range 3.2 times the size of Uhuru. Similarly, Bella had a home range 2.5 times that of Donna while moving only slightly less distance.

Table 4. Number of movements and highest distance over 10 km in one day, by month

Month		Bella	Kori	Donna	Malaika	Laloyo	Uhuru	Luna	Waribe	All
May	number highest									0
June	number highest									0
July	number highest			1 11.5						1
August	number highest	1 11.2								1
September	number highest			2 10.5						2
October	number highest	1 10.2		1 10.8						2
November	number highest	1 10.1	1 10.0	2 11.2						4
December	number highest	1 10.6	1 10.1	1 14.9	1 10.2					4
January	number highest	5 13.9		1 10.5						6
February	number highest			1 11.7						1
March	number highest	1 10.0		2 10.7			1 11.0			4
April	number highest	1 11.6	3 11.0	4 12.6						8
Total	number highest	**11** **13.9**	**5** **11.0**	**15** **14.9**	**1** **10.2**	**0** **7.2**	**1** **11.0**	**0** **7.5**	**0** **9.8**	**33**

Discussion

One aim of the analysis was to attempt to demonstrate graphically the way a home range (in a relatively small area such as the ZRS at 64 km²) is used/built up over time. This was not achieved as there were too many data points per month (over 700) within the home ranges. Even when applying the Douglas-Peucker location reduction method (Douglas and Peucker 1973), with the tolerance set at 500 metres, there were still around 90 points. All the rhinos

Table 5: Movement of eight female white rhinos by hour by month, 1 May 2020–30 April 2021, in km

	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Average	Range
HOUR														
24-1	19	25	18	17	14	17	15	17	23	20	23	29	**20**	**14–29**
1-2	19	23	14	11	9	18	12	24	16	22	15	23	**17**	**9–24**
2-3	16	12	11	10	11	15	12	15	14	19	20	16	**14**	**10–20**
3-4	12	13	12	10	10	13	10	11	21	25	20	16	**14**	**10–25**
4-5	13	11	8	10	9	11	13	10	23	17	15	27	**14**	**8–27**
5-6	16	17	9	17	18	14	21	21	21	16	29	40	**20**	**9–40**
6-7	41	35	34	47	69	77	65	62	46	40	74	123	**59**	**34–123**
7-8	76	76	74	73	82	90	66	85	78	81	86	115	**82**	**66–115**
8-9	104	109	118	121	106	135	135	141	128	95	130	109	**119**	**95–141**
9-10	68	67	71	69	66	68	62	78	98	70	114	65	**75**	**62–114**
10-11	54	53	57	45	54	44	48	52	64	52	67	50	**53**	**44–67**
11-12	35	46	37	30	37	35	37	32	41	28	34	32	**35**	**28–46**
12-13	25	32	21	19	30	30	29	23	29	11	21	21	**24**	**11–32**
13-14	31	24	28	26	32	35	41	29	18	14	18	44	**28**	**14–44**
14-15	44	36	42	43	38	45	45	41	27	14	31	42	**37**	**14–45**
15-16	58	53	59	53	52	59	52	45	41	28	48	63	**51**	**28–63**
16-17	79	72	80	66	66	83	83	79	65	52	77	88	**74**	**52–88**
17-18	91	99	95	84	89	98	125	110	112	90	100	96	**99**	**84–125**
18-19	109	111	111	84	90	100	104	101	106	82	98	88	**99**	**82–111**
19-20	96	103	101	107	90	95	90	93	113	92	108	97	**99**	**90–113**
20-21	88	87	95	74	72	69	76	91	100	72	90	112	**86**	**69–112**
21-22	69	72	69	46	54	31	45	63	68	66	76	67	**61**	**31–76**
22-23	39	41	31	26	24	25	30	33	41	48	51	38	**36**	**24–51**
23-24	34	19	16	20	15	15	18	38	24	19	24	17	**22**	**15–38**

Table 6. Intensity of movement categorised for a 24-hour period

START hour	FINISH hour	INTENSITY
23:00	06:00	low
06:00	07:00	medium
07:00	10:00	high
10:00	16:00	medium
16:00	22:00	high
22:00	23:00	medium

Table 7. The relationship between annual distance moved and home range

	Distance moved (km)	Home range (km^2)	Relationship (d/hr)
Laloyo	1311	5.6	234
Waribe	1583	7.1	223
Uhuru	1680	9.2	183
Malaika	1759	9.9	178
Luna	1561	10.3	152
Donna	2071	16.4	126
Kori	1687	29.6	57
Bella	2006	41.6	48

criss-crossed their ranges and went backwards and forwards to favoured areas (such as water points and preferred grazing areas) on a daily basis, preventing any useful graphic illustration of the general direction of travel over time.

However, the monitoring team recorded the sector/block for each rhino—analysed to show the percentage of time each rhino spent in each sector/block on a monthly basis. From this some general observations could be made.

The two oldest females, Bella and Kori, had the largest home ranges with 10 and 9 core areas respectively. Bella had previously shown an apparent aversion to contact with adult males by moving around a large area, 65% of the sanctuary during the year, making it hard for the males to find her. The considered reasons for this are that Bella avoided mating or attempted mating thereby avoiding any potential conflict. This was supported by longer inter-calving intervals than the other females, (Fig. 1a).

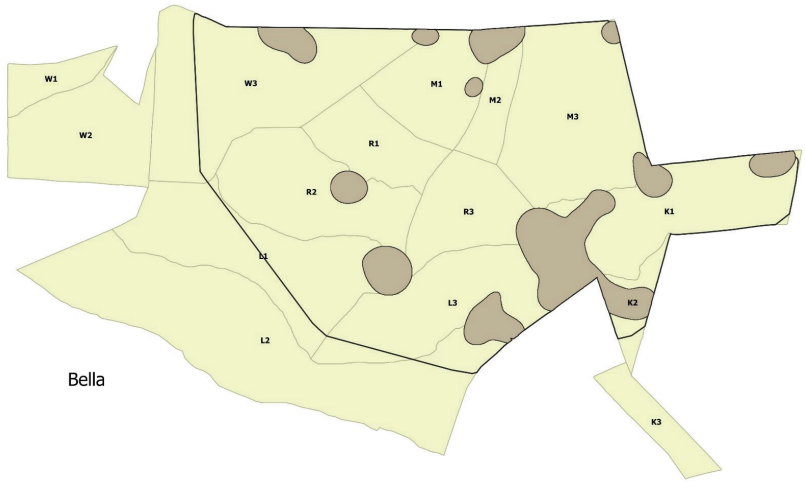
Kori was found mostly in the far west of the sanctuary but started to move across the sanctuary from September 2020 (See Fig 1b). This may have been due to her wanting to avoid the attention of the breeding male Taleo who had fathered five of her seven calves. Taleo was recorded by monitors trying to prevent Kori leaving his territory.

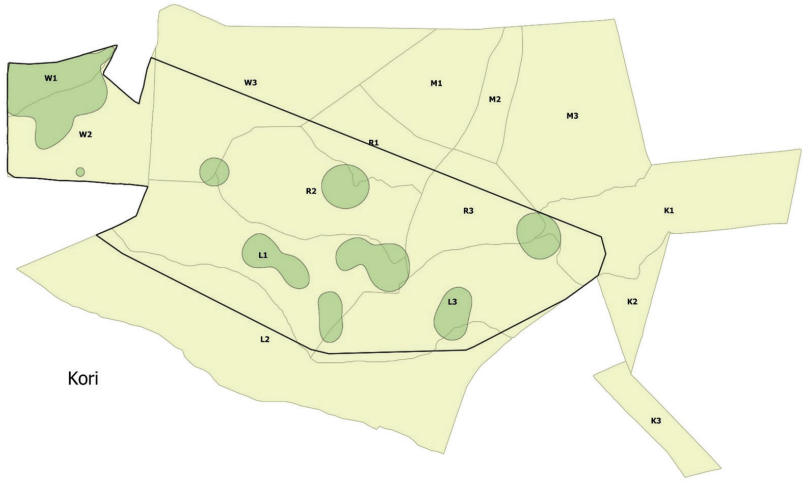
Donna, a younger female, spent her time in the far west of ZWS until February when, during a drought period, she moved into the areas of L1 and R2 where there was a regular water supply, (Fig. 1c).

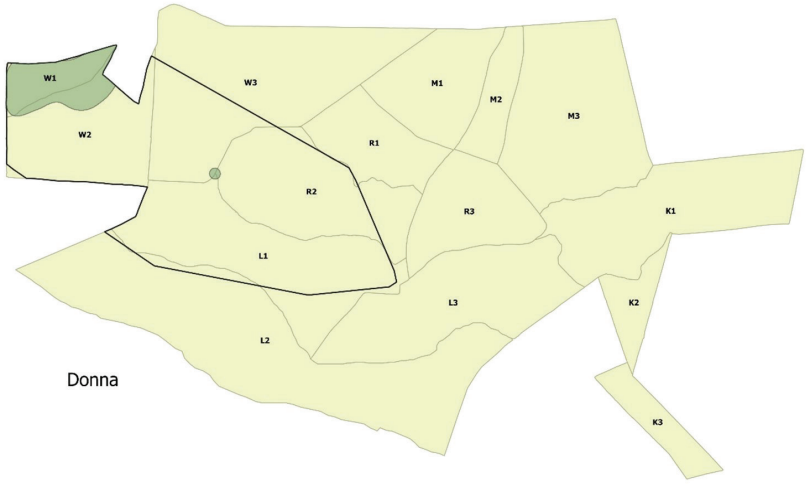
The other five younger females all maintained their relatively small home ranges which overlapped in the middle of the sanctuary. Throughout the year, they spent most time in an area around the border of L1 and L3 with easy access to water and good grazing.

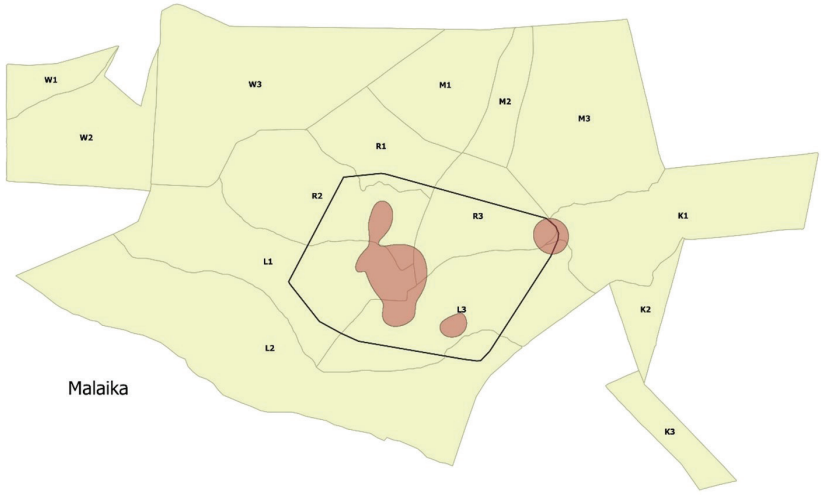
It might have been expected that rhinos with a larger home range would move a greater distance than those with a smaller range. The analysis of the

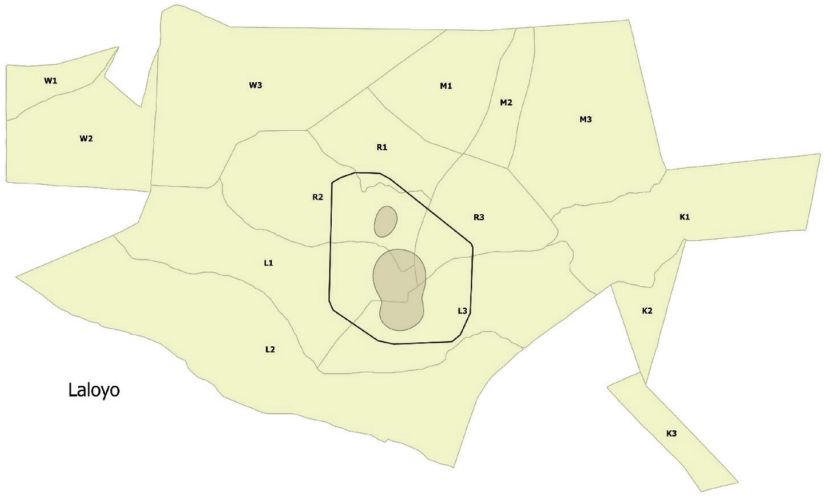
Figures a-h:


W1
W2
W3
M1
M2
M3
R1
R2
R3
K1
L1
L3
K2
L2
K3
Bella


W1
W2
W3
M1
M2
M3
R1
R2
R3
K1
L1
L3
K2
L2
K3
Kori


W1
W2
W3
M1
M2
M3
R1
R2
R3
K1
L1
L3
K2
L2
K3
Donna


W1
W3
M1
M2
M3
W2
R1
R2
R3
K1
L1
L3
K2
L2
K3
Malaika


W1
W3
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M3
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R1
R2
R3
K1
L1
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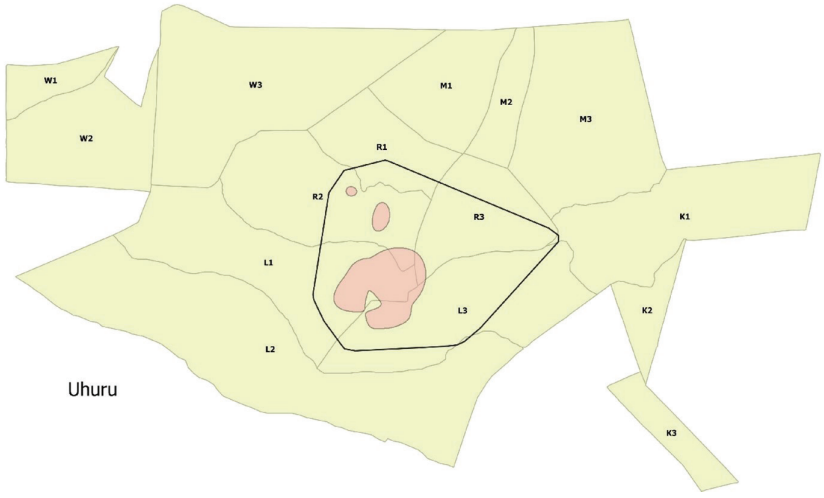
K2
L2
K3
Laloyo


W1
W3
M1
M2
M3
W2
R1
R2
R3
K1
L1
L3
K2
L2
K3
Uhuru

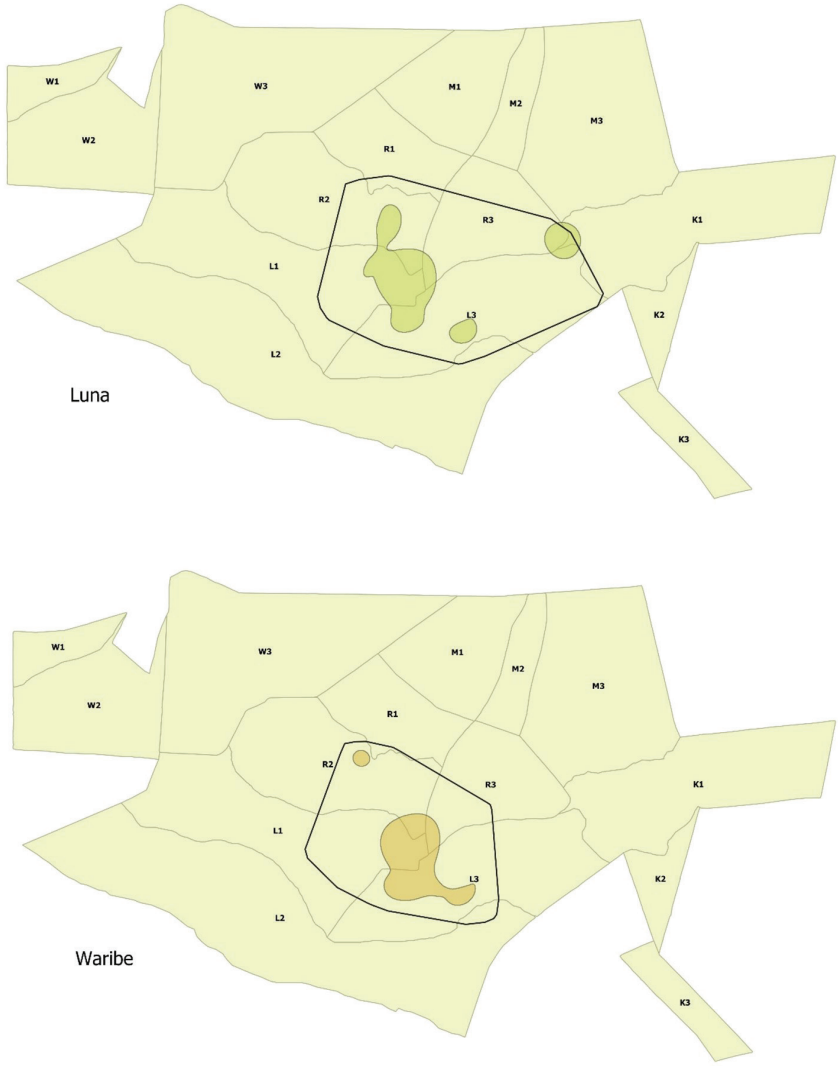


Figure 1. a-h. The 95% home range and 66% core areas of eight female white rhinos for the year 1 May 2020 to 30 April 2021.

(a) **Bella**: home range 41.6 km^2, core area 5.4 km^2; (b) **Kori**: home range 29.6 km^2, core area 5.2 km^2; (c) **Donna**: home range 16.4 km^2, core area 1.5 km^2; (d) **Malaika**: home range 9.9 km^2, core area 1.7 km^2; (e) **Laloyo**: home range 5.6 km^2, core area 1.1 km^2; (f) **Uhuru**: home range 9.2 km^2, core area 1.5 km^2; (g) **Luna**: home range 10.3 km^2, core area 1.7 km^2; (h) **Waribe**: home range 7.1 km^2, core area 1.4 km^2.

distance moved compared to the home range area showed there was no such correlation.

A literature search was unable to find any similar hourly-based data for comparison.

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BOOK REVIEW

The hairy rhinoceros. History, ecology and some lessons for management of the last Asian megafauna

John Payne

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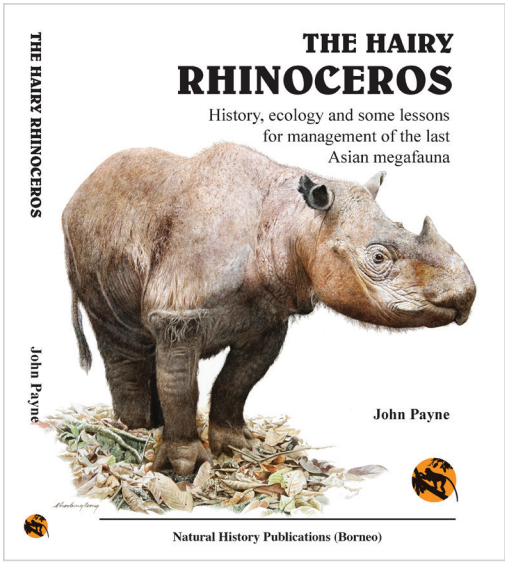

This is a curious, sad and, I think, important book that deserves the attention not just of rhino specialists but of conservationists at large.

Curious, because it reads in places more like a set of notes and appendices than a structured narrative. These summarise the evolution, biology and ecology of what John Payne takes care to call the hairy (rather than Sumatran) rhinoceros; then recap the species' history—including a diary-like chronology of events since 2005; a review of what is known about how to capture, translocate and care for captive animals; and in the most interesting final third, the author's views on why conservation has failed *Dicerorhinus*, and what lessons might be learnt.

The book is unremittingly sad. It describes the inexorable decline to now near-inevitable extinction of an extraordinary animal. It also argues that while habitat loss and hunting have clearly been the long-run threats to hairy rhinos, conservationists and conservation organizations are to blame for our inability to stem their slide into oblivion. By the 19th century hunting had greatly reduced the abundance and range of a creature once found from India and China down to the Greater Sundas. By the 1930s concerns were already being raised about the species heading towards extinction. In the 1980s a bold strategy of bringing isolated rhinos into captivity while protecting 12 or so remaining clusters of wild animals was agreed. Yet despite dozens of international meetings and workshops involving many hundreds of stakeholders, the hairy rhino's decline has gone unchecked. It turned out that isolated female rhinos commonly develop uterine cysts and fibroids, probably as a consequence of repeatedly failing to find mates. By deliberately focusing on stragglers, captive breeding has thus proved exceptionally difficult, with the capture of more than 50 animals yielding just six births. Meanwhile numbers in the wild have continued to collapse. By 2021 it seems that free-ranging rhinos persisted in just one cluster in Gunung Leuser, Aceh, northern Sumatra, with scattered individuals in three or four sites elsewhere in Indonesia. And the captive population now stands at only nine animals, again entirely in Indonesia. The extinction of the hairy rhinoceros and with it this century's first

loss of an entire mammal genus may be just a few years away.

John Payne's book is important, in my view, because of what he says about why, over four decades, conservation efforts have so consistently failed hairy rhinos, and what this might mean for the conservation enterprise more broadly. On the specifics of the ongoing freefall of the species, he advances two sets of arguments. First, that there has been a long-run strategic failure to accept that regardless of the historic importance of habitat loss and hunting, the overwhelming contemporary threat is the collapse of recruitment as a result of reproductive pathology. Not recognising this decisive threat, he argues, has perpetuated the misplaced notion that already-reduced clusters of wild rhinos could, if protected, recover their numbers; and undermined the idea of instead drawing on those clusters for young, still-fertile females for captive breeding. Beyond the biology, Payne also takes aim squarely at the conservation processes that have enabled such consistently flawed decision making. Whereas successful recoveries of critically endangered large mammals like European bison and Przewalski's horses have typically been driven by nimble groups of passionate individuals, he believes attempts to save hairy rhinos have become bogged-down in vast, multi-stakeholder meetings where the views of local experts are drowned-out by those of a rolling cast of people with limited experience of the species. Key decisions have been made by politicians fearful of public criticism by loud yet unrepresentative lobby groups. And international rivalries have repeatedly hampered urgently needed international cooperation.

I know very little about hairy rhino politics or conservation, so can't meaningfully comment on these arguments. But Payne's book goes beyond these specific points to offer insights for conservation more generally. He makes the case, from exploring prospects for a dozen or so other endangered south-east Asian mammals, that hands-on population management—moving animals between clusters, captive-breeding, assisted reproductive technologies—will be essential for these species' persistence. The era of protected area expansion, he suggests, is drawing to a close, yet reserve coverage is insufficient, so without additional, intensive interventions the rhino's fate "will befall all large vertebrates. It is just a matter of time." The reproductive pathology that underpins this argument for rhinos may be unusual, but Payne makes a reasonable case that under laissez-faire conservation some other species may face be equally doomed. Good examples are isolated groups of wild cattle (for which relevant technologies are already well-developed), and pangolins (which might prove easier to protect in private oil palm and forest landscapes than in government nature reserves).

This book calls for changes too in how we go about achieving conservation in general. Payne makes a clear case for returning to a species rather than habitat or ecosystem-service basis for conservation (though I personally would argue, as Georgina Mace has done, that each approach deserves support [Mace 2014]). He sets out a series of aspects of human psychology—risk aversion, temporally shifting baselines, nationalism, distraction by fashions, and an alarming suite of cognitive biases—which we need to be much more aware of if we are to improve our ability to diagnose and respond effectively to the extinction crisis. And he argues for far more weight in designing interventions to be given to well-informed experts, who provide clear technical direction prior to consultation with government and civil society.

In closing, Payne argues than even now, the fate of the hairy rhino is not irreversible. If the entire population—all wild as well as remaining captive animals—is brought together and managed intensively as a single unit, and if full use is made of international expertise in delivering advanced reproductive technologies, the genus may yet be saved. Just weeks before her death, eggs were being harvested from Imam, the last-surviving Malaysian female, and used for attempted IVF. In June 2021 a German team successfully created pluripotent stem cells from a skin biopsy of a captive animal that had died four years earlier. Whether these frenzied efforts will succeed is far from clear. But either way, it seems inescapable that to date conservation has not helped the hairy rhinoceros very much. This book provides some provocative suggestions about how we might do better in future—let us hope that we still have time!

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Mace GM. 2014. Whose conservation? *Science* 345: 1558–1560.

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OBITUARIES

Richard Leakey—exploring the past to shape a better future

Born: 19 December 1944
Died: 2 January 2022

Tribute by Delta Willis

Langata, Kenya
email: deltawillis@gmail.com

© *Jonathan and Angela Scott*

*"The **good** men do is often interred with their bones"; adapted from Shakespeare's play: Julius Cesar.*

Richard Leakey was often photographed holding aloft skulls of human ancestors, but during my first visit to Koobi Fora in 1982 he carried a fossilized elephant skull. The heavy discovery sat behind us in his single-engine Cessna. Lumbering down the strip, kept a short 468 yards to discourage visitors, the wheels lifted at the very end, brushing pale grasses. Leakey liked to press his luck, to confront challenges cocksure, and this worked well for the better part of his extraordinary life.

Born in 1944, the second son of Louis and Mary Leakey, he held the same enthusiasm for classrooms as demonstrated by his mother; both Mary and Richard Leakey's doctorates were bestowed; Richard's were begrudged. Critics sneered at "the deficiencies of his education."

Yet his matriculation could not have been more perfectly suited. The most practical tutelage available anywhere was endowed by his parents, who debated with learned visitors, including Philip Tobias from South Africa, who championed the discovery of the Taung child. Ignored in favour of the Piltdown Hoax (planted on British soil) the little *australopithecine* suggested our ancestors began in Africa. The Leakey Family excelled at proving this.

Louis would pull fossils out of his pocket, or from a shelf, dramatically lifting the lid off a tin container marked for tea. Late at night in camps at Olduvai and Rusinga, a lone lantern seemed to emit a new language, words like *Australopithecus africanus* and *Homo habilis*, words that confront students in cold text, with none of the uncovering in situ as happened on Richard's boyhood digs. He unearthed his first discovery at the age of six.

Following a stint as a safari guide, partnering with Alan and Joan Root, the potential of the Richard Leakey Legacy switched on after an expedition to Lake Natron. Richard took along Kamoya Kimeu, who his parents had trained to find fossils. Kimeu discovered an early lower jaw, and his career began to soar alongside Rochard's.

Leakey managed he said, "through unfair means, I think," to be appointed administrative director of the Kenya Museum at the age of twenty-three. The previous

British director was asked to resign in favour of Africanization. Kenya-born, Richard stepped in.

In 1967 museum staff numbered twenty-two; during Leakey's tenure this grew to over 600 employees and annex museums dotted the country. What began as a small natural history museum it had no role in archeology or anthropology, but through a series of bills submitted to Kenya parliament, he began to control research, antiquities, and archeological sites. "For example, Olorgesaillie was under national parks, but we got it back" he said; "it's all part of the game plan".

Some of Leakey's plans were contrary to his father's. "He wanted to send fossils to England for casting; I suggested we bring in some English technicians and teach our own people how to do it. I persuaded the minister; my father didn't."

Richard's powers of persuasion benefitted Kenyans enormously. "The Hominid Gang" blossomed with training and laboratories, and their leader Kamoya Kimeu went on to find the Turkana Boy, an exceptional skeleton that remains the most complete early human ever discovered. So, *while the good men do is often interred with their bones*, the Leakey Legacy will live on because of the hundreds of Kenyans he inspired.

But it was his war on elephant poaching that brought him greater instant fame than fossils.

According to Iain Douglas-Hamilton, founder of Save the Elephants, "After a census of Kenya's biggest wildlife area revealed the scale of the ongoing elephant slaughter and the involvement of rangers, Richard confronted the relevant minister during a press conference. Not long afterwards, President Moi appointed him to lead the Kenya Wildlife Service." The 1989 appointment suited his leadership style; he had pushed researchers to work as hard as he did, rising at 4:30 a.m. Now he sacked slackers and dared confront the corrupt.

His passion to protect pachyderms was not a surprise to anyone familiar with his personal history. In 1969 he founded the Wildlife Clubs of Kenya, and later on relished watching elephants with researcher Joyce Poole, whose studies of their intelligence would impress anyone. His mission at KWS was to protect these "sentient creatures" he wrote in *Wildlife Wars*.

First he had to pull up KWS by its bootstraps. Few rangers had boots or fuel to patrol the 51 parks and reserves they were meant to protect. Poachers slaughtered on average three elephants a day. Leakey procured boots and fuel, boosted morale, and began to stem poaching with a shoot to kill order on poachers.

"Richard soon saw an opportunity for a characteristically bold statement; "Douglas-Hamilton continued. "When Kenya set fire to a 12-tonne stockpile of ivory in 1989, the symbolism was so powerful that it helped turn the tide against ivory poaching and create a respite across the continent that lasted almost two decades."

Over those two decades, Leakey's focus shifted to climate change, which he warned would do more damage to wildlife than poaching. In 2005 he founded the Turkana Basin Institute with Stony Brook University, New York. His wife Meave and daughter Louise continue to search for fossils, unearthing more ancestors. But the fossil hunter, Richard, known as 'Ostrich' for his long strides could no longer endure this arid terrain or the African sun.

Leakey's health problems began with kidney failure, but the pivotal twist of fate was a near-fatal crash in his Cessna. I stopped flying with him when he received death threats, a wise but terrible sacrifice, because there was nothing as thrilling as seeing Africa from his point of view.

When he first began to fly on his own, he noticed the outcrops surrounding Lake Natron. A chance flight in a chopper gave him a glimpse of East Turkana. On every flight he took across Kenya, he studied the terrain. He flew to numerous sites, to annex museums, northwest to Kitale, west to Rusinga near Lake Victoria, to Mount Elgon, east to Lamu, to the Maasai Mara, with excursions into Ethiopia, and across Tanzania, beyond Olduvai to Dar es Salaam.

Once, when I asked him to show me what he had seen from the air on his pivotal flight over East Turkana, he flew northwest, then just south of the Omo River, dipped his starboard wing toward long sections of earth burned red, eroded, and stratified, saying simply: "It looked like that." There was a lot of "that" below. Finally, he commented on the potential, shouting over his shoulder, "Kamoya! We are going to die in these mountains!"

So when you think about being a tool-user, don't replay the old song about chimps and birds having accomplished this before we did. Consider instead, that Leakey's best tool was his Cessna, tragically

though his 1993 crash resulted in the loss of both legs below the knee. While he learned to walk quickly on artificial legs, circulation problems ensued, as did skin cancer, another kidney, then a liver transplant. He tripled in girth, lost his balance, and his patience. The man who said, "I always take time for students, because I saw so many go so far on my father's words," ridiculed a teen for asking about methane after a lecture on climate change. "You conservationists lay off!" he told a board member of the East African Wild Life Society who questioned his acquiescence for a Chinese-built railroad across Nairobi National Park. The railroad was completed, but the tracks are elevated per Leakey's suggestion.

A planned movie described as a "blockbuster" (before it was never filmed) inspired a pre-emptive quip: "Leakey said moviegoers could expect …pretty women getting in and out of beds"… so, it won't all be true [to my life]." Brad Pitt was to portray Leakey.

The cascade Leakey described in *The Sixth Extinction* is now upon us, with floods, droughts, wildfires, warming oceans, and the terrible decline of biodiversity he feared. How a single species could devastate life on earth is to be the focus of Ngaren, a museum he was planning, on the edge of the Ngong Hills, and the subject of his final lecture at Nairobi's Muthaiga Club in October, 2021. He apologized he would not stand, but sat in a wheelchair, he explained, because he had contracted Covid-19. Leakey had described the potential for just such a pandemic during a 2009 lecture. He presciently compared it to influenza and the quest for a vaccine. But his sticking point was how fast a virus could evolve into variants.

He died only months after his Muthaiga Club lecture in 2021, not in the mountains of Turkana—where his dear friend Kamoya Kimeu was buried in July. What they found together goes beyond fascinating fossil discoveries, but the greater gift of camaraderie that is color-blind. Friends have laid a stone on Leakey's simple grave in tribute, a custom normally reserved for African chiefs.

Delta Willis wrote *The Hominid Gang: Behind the Scenes in the Search for Human Origins, and The Leakey Family: Leaders in the Search for Human Origins (Makers of Modern Science)*.

Tony Fitzjohn—a voice for wildlife with a determination to restore degraded habitat for eastern black rhinos and other endangered species

Born: 7 July 1945
Died: 20 May 2022

Tribute by Lucy Vigne

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There are people who we have had the privilege to know, Tony Fitzjohn is truly one of them. Originally from England, his childhood left a lasting impression on him of the drab, dull suburban life of north London. He knew he wanted to get away, to find a home among wildlife that matched his wild spirit. He was adopted as a baby, and never fitted into an urban life. He preferred to identify with the character Tarzan and his love of the African wild. A scholarship to Mill Hill School allowed him to discover some adventure in the Boy Scouts. In 1968, Tony, known as 'Fitz' to many was in his early twenties when he left England taking the steamer to South Africa but finding that too tame, made his way north, reaching Kenya where he met the famous George Adamson. George, a retired senior wildlife warden lived in the remote Kora National Reserve, an area of 1,788 km^2, situated 125 km east of Mount Kenya. George and his wife Joy were renowned for reintroducing captive lions and leopards into the wild, and their first book, *Born Free*, originally published in 1960 and made into a film in 1966, captivated the attention of audiences around the world.

George had settled down in Kora, happily in a camp with his brother Terrence. Their simple home had a dirt floor and I remember the outside loo seat was an elephant's jaw bone. Fitz was captivated by George and chose him as his mentor for life. George embraced Fitz for his courage and stamina. They made a strong working team with Fitz living in Kora for 18 years, rescuing and patiently, sympathetically rehabilitating large cats and taking care of the wild dry bush country of Kora which they both loved.

The year 1989 was a turning point for Fitz. He moved from Kenya to Tanzania where the government had asked him to restore what was then the derelict Mkomazi Game Reserve, a 3,270 km^2 area of dry degraded land in north Tanzania, the southern end of the vast Tsavo ecosystem. Some felt it was a mission against the odds. Fitz, however, had guts and great talent in building infrastructure. He was also a powerful and charismatic personality and could relate to high-powered donors and officialdom as well as his workforce and the people of the area who all supported him. He was determined to make the daunting project work. But during his absence from Kora, George Adamson was murdered near his camp by Somali bandits on 20 August 1989. Fitz struggled with George's murder and resorted to drinking heavily. He ended up in rehab. He emerged with even more drive and determination, and his life was to be transformed. A confirmed bachelor, he fell in love with Lucy Melotte, a young and beautiful English woman, and they married in 1997 and had four children—Alexander (Mukka), Jemima and twins Imogen and Tilly. He brought up his family in the bush, far from

the dreary trappings and hectic pace of modern-day life, and even further from favoured hospitals and schools. Together Fitz and Lucy were to restore Mkomazi Game Reserve from a desolate overgrazed tract of arid land, with nearly all its large animals wiped out by poaching, to a healthy acacia-commiphora habitat which once again attracted herds of elephants in the rainy season and enabled plains game to flourish. Fitz, with full scientific backing, reintroduced both African wild dogs and black rhinos into Mkomazi.

The eastern black rhino, *Diceros bicornis michaeli*, in the 1960s had numbered about 200 in the area, but by 1985 every rhino had been poached for its horns. Fitz embarked on an ambitious project to bring back the same rhino subspecies from a variety of locations, to improve breeding and genetic diversity. From 1997 to 2016, the first 15 rhinos were translocated long distances from Addo National Park in South Africa, and from European zoos and the UK under Fitz's watch, with their numbers growing to 35 by 2021. No poaching occurred during Fitz's tenure, thanks to his excellent motivated and skillfully trained staff who supported the involvement of local communities nearby. The villages received clean water, education and health facilities. The local people, thanks to Fitz's efforts, understand the value of Mkomazi and the rhino sanctuary within it, with benefit-sharing and projects that include *Rafiki Wa Faru* (Friends of the Rhino).

Fitz recognized the importance of wild landscapes and biodiversity in East Africa. He helped to secure two important areas that he cherished. The Kenya government gazetted Kora to national park status in 1989 and the Tanzania government gazetted Mkomazi to become a national park in 2008, so both are protected in perpetuity for their nations.

Fitz left Mkomazi National Park quietly in January 2020—the Tanzanian government had decided that his job was done, and that it was time for the government, with NGO support, to take over.

When I last stayed with him in Kenya a year before he died, Fitz, with his son Mukka was initiating the rehabilitation of Kora National Park. In the previous 30 years Kora had been devastated by uncontrolled grazing, poaching and deforestation for charcoal. He had travelled full circle— back to the Kora he respected so deeply. He showed me his official papers allowing him to start this immense task, and he talked compellingly and with enthusiasm about this project as only Fitz could. Only three months later, in late July 2021, he was admitted to Nairobi hospital where they discovered a tumour on his brain. From there to England and finally to California, he was given the best and most recent cutting-edge treatment to fight the disease. As a friend remarked to me, if anyone could have beaten the tumour, Fitz would beat it. But it was not to be.

The Tony Fitzjohn George Adamson Wildlife Preservation Trust will continue his life's work helping to restore barren wastelands to magnificent landscapes for the benefit of large mammals—rhinos, elephants and of course people and biodiversity. Films and books about Tony Fitzjohn's remarkable legacy include *To Walk With Lions* (1999) and *Born Wild* (2010). No doubt he will inspire many, who will in the years to come, build on his amazing contribution to Africa's wild.

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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' (free access to published scientific works for readers with no publication fees for the authors to publish). All research, management, and history papers are peer-reviewed.

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The journal welcomes notes from the field. They may contain figures and tables but should be a maximum of 2,500 words, including references.

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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.

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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.

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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 Concise Oxford Dictionary or the Oxford English Dictionary, using 'z' instead of 's' in words like 'recognize', 'organization', 'immobilized'; but 'analyse', 'paralyse'.

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.

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:

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).

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The headwaters of the Chobe River–Victoria Falls is a distance of 136.3 km.

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Journal names in full without leading article. Book titles are italicised. Journal titles are italicised.

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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