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July 2020—June 2021 Number 62

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Cover caption: "Waiwai" a black rhino mother and her four-month old calf. Waiwai has successfully raised seven other calves, although one was lost to poachers, aged nine in 2013.

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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

The last three years as the co-Chairs of the IUCN–SSC–African Elephant Specialist Group (AfESG/ or referred to here as 'the Group') has been extremely busy but enjoyable and fulfilling. We feel indebted to our highly skilled and dedicated Group members who are always supportive and on their toes to promote our mission of conserving Africa's elephants throughout their range. The Group's input coupled with the unwavering support of the governments of range states, donors and multi-lateral agencies has enabled us to make significant strides as a Group in the last three years. We therefore begin the new 2021–2024 IUCN quadrennium on a strong footing. More so, we have strengthened our membership in 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 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.

Here, we further elaborate on our targets and plans for 2021–2024 quadrennium and provide updates on the progress of some of the issues we reported on in *Pachyderm* 61. Key among them include AfESG's decision in 2021 to treat the African elephants as two separate species and the subsequent reflection of this shift in the recently

Introduction

Les trois dernières années en tant que coprésidents du Groupe UICN-CSE-Groupe de Spécialistes de l'Éléphant d'Afrique (GSEAf/ou appelé ici « le Groupe ») ont été extrêmement chargées mais agréables et enrichissantes. Nous nous sentons redevables à nos membres du Groupe hautement qualifiés et dévoués qui sont toujours solidaires et prêts à promouvoir notre mission de conservation des éléphants d'Afrique dans toute leur aire de répartition. La contribution du Groupe, associée au soutien indéfectible des gouvernements des États de l'aire de répartition, des donateurs et des agences multilatérales, nous a permis de faire des progrès significatifs en tant que Groupe au cours des trois dernières années. Nous commençons donc le nouveau quadriennat 2021–2024 de l'UICN sur des bases solides. Plus encore, nous avons renforcé le Groupe par le nombre d'adhésion, par des compétences supplémentaires et en renforçant la collégialité avec les gouvernements et les agences multilatérales. Nos neuf groupes de travail et groupes d'étude sont prêts à s'attaquer à une trentaine d'objectifs que nous avons développés autour de nos buts et alignés sur les cinq composantes clés d'Évaluation, Planification, Action, Communication et Réseau dans le Plan stratégique de l'UICN pour les espèces.

Ici, nous expliquons plus en détail nos objectifs et nos plans pour le quadriennat 2021–2024 et fournissons des mises à jour sur les progrès sur certains problèmes que nous avons signalés dans Pachyderm 61. Parmi eux, citons la décision du GSEAf en 2021

published IUCN Red List re-assessments of African elephants. The two species are also under consideration in the ongoing iteration of the next African Elephant Status Report. We hope these approaches will help users focus appropriate conservation attention/measures for the critically endangered forest elephant and the endangered savannah elephant and to put both their numbers and habitats back on a thriving trajectory. There are of course imminent implications and consequences of this shift that we will have to identify and deal with. We highlight the long-term sustainability and revamping plans for the African Elephant Database (AED)—our official repository and most authoritative source of information on African elephant surveys. We also report on the appointment of the Red List Authority Coordinator for African elephants.

2021–2024 quadrennium targets and strategy for achieving them

As one of the requirements for all Specialist Groups within the IUCN Species Survival Commission (SSC), we began the 2021–2024 IUCN quadrennium in January 2021 by finalizing, with our membership, the development of the four-year quadrennial targets with multiple measures of success for our Group. The AfESG's targets align with the five key components of the IUCN Species Strategic Plan 2021–2024 (https://www.iucn.org/sites/dev/files/content/documents/ssc-iucn-components-a4-digital_0.pdf). We listed eleven targets 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 all of the targets under each key component. Some of the targets are already underway in their implementations and their progress are reported in other sections of this report.

Under the Assess component, we will compile, review and synthesize information on African elephant numbers and distribution; publish the Red List assessments; participate in the MIKES-ETIS-Technical Advisory Group processes; identify areas/regions of success and where appropriate conduct a Green List assessment for African elephants. Additionally we aim to update AfESG's position statement on

de traiter les éléphants d'Afrique comme deux espèces distinctes et la réflexion ultérieure de ce changement dans les réévaluations de la Liste rouge de l'UICN récemment publiées sur les éléphants d'Afrique. Les deux espèces sont également à l'étude dans l'itération en cours du prochain Rapport sur l'état de l'éléphant d'Afrique. Nous espérons que ces approches aideront les utilisateurs à porter l'attention appropriée sur la conservation de l'éléphant de forêt et de l'éléphant de savane en danger critique d'extinction et à remettre à la fois leur nombre et leurs habitats sur une trajectoire florissante. Il y a bien sûr des implications et des conséquences imminentes liées à ce changement et que nous devrons identifier et gérer. Nous soulignons les plans durables à long terme de restructuration de la Base de données sur l'éléphant d'Afrique (BDEA) - notre référentiel officiel et la source d'informations la plus fiable sur les relevés des éléphants d'Afrique. Nous rendons également compte de la nomination du Coordinateur de l'autorité de la Liste rouge pour les éléphants d'Afrique.

Objectifs du quadriennat 2021-2024 et stratégie pour les atteindre

En tant que l'une des exigences pour tous les Groupes de spécialistes au sein de la Commission de la survie des espèces (CSE) de l'UICN, nous avons commencé le quadriennat 2021-2024 de l'UICN en janvier 2021 en finalisant, avec nos membres, l'élaboration des objectifs quadriennaux avec de multiples mesures de succès pour notre Groupe. Les objectifs du GSEAf s'alignent sur les cinq composantes clés du Plan stratégique pour les espèces de l'UICN 2021-2024 (https://www.iucn.org/sites/dev/files/content/documents/ssc-iucn-components-a4-digital_0.pdf). Nous avons répertorié onze cibles sous la composante Évaluation, huit cibles sous la composante Planification, deux cibles sous la composante Action, cinq cibles sous la composante Communication et quatre cibles sous la composante Réseau. Nous résumons ici toutes les cibles sous chaque composante clé. Certaines des cibles sont déjà en cours de mise en œuvre et leurs progrès sont rapportés dans d'autres sections de ce rapport.

Dans le cadre de la composante Évaluation, nous compilerons, examinerons et synthétiserons les informations sur le nombre et la répartition des éléphants d'Afrique; nous publierons les évaluations de la Liste rouge; nous participerons aux processus du Groupe consultatif technique MIKES-ETIS; nous

the in situ to ex situ elephant movements; revise the IUCN Guidelines for the in situ translocation of elephants in line with the IUCN broader conservation translocation guidelines; develop guidelines/criteria for prioritizing sites for survey support; continue to determine the genetic identity of taxonomically undefined elephant populations; fulfil the AfESG's reporting obligations to CITES; provide technical guidance for the management of elephants as requested and advise on the conservation and management of elephant range and critical habitats.

In the Plan component, we will enhance the functionality and capacity of the AED and form a consortium for its technical and financial support; re-invigorate the African Elephant Library (AEL), build the capacity to curate historical survey information and investigate gaps; update guidelines on population survey methods by incorporating newly emerging techniques; continue with the provision of technical input into the revision of the African Elephant Action Plan (AEAP); support strategic and action planning processes at national, regional, and continental levels, including assisting with the production of National Elephant Action Plans (NEAPs); help in evaluating the progress of the AEAP and NEAPs if called upon. Also, under this component to update the AfESG guidelines on human-elephant co-existence (HECex) and develop innovative new approaches based on landscape-level spatial planning, known elephant behaviours and community-based conservation approaches and importantly fundraise for the running of the AfESG secretariat and for the AfESG activities.

In the Act component, the Group will develop a community of practitioners through the HECex working group, exchanging information on best practice and successes and failures of appropriate tools in different contexts across Africa and Asia; additionally will create a community of young innovative local people to participate in elephant management and conservation issues.

Under the Communicate component, we will enhance communication within and outside of our membership on key issues about African elephants, through the establishment of a task force on this component; publish an updated African Elephant Status Report; promote the creation and maintenance of linkages/connectivity between

identifierons les zones/régions de réussite et, le cas échéant, effectuerons une évaluation de la Liste verte pour les éléphants d'Afrique. De plus, nous visons à mettre à jour la déclaration de position du GSEAf sur les mouvements d'éléphants in situ à ex situ; à réviser les Lignes directrices de l'UICN pour la translocation in situ des éléphants conformément aux lignes directrices plus larges de l'UICN pour la conservation et la translocation; à élaborer des lignes directrices/critères pour hiérarchiser les sites pour le soutien à l'enquête; à continuer à déterminer l'identité génétique des populations d'éléphants non-définies sur le plan taxonomique; à remplir les obligations de rapport du GSEAf à la CITES; à fournir des conseils techniques pour la gestion des éléphants comme demandé et donner des conseils sur la conservation et la gestion de l'aire de répartition des éléphants et des habitats critiques.

Dans la composante Planification, nous améliorerons la fonctionnalité et la capacité du BDEA et formerons un consortium pour son soutien technique et financier; redynamiserons la Bibliothèque de l'éléphant d'Afrique (BEA); renforcerons les capacités de conservation des informations d'enquête historiques et enquêterons sur les lacunes; mettrons à jour les directives sur les méthodes d'enquête sur la population en incorporant de nouvelles techniques émergentes; continuerons à fournir une contribution technique à la révision de Plans d'action pour l'éléphant d'Afrique (PAEA); soutiendrons les processus de planification stratégique et d'action aux niveaux national, régional et continental, notamment en aidant à la production de Plans d'action nationaux pour les éléphants (PANE); aiderons à évaluer l'état d'avancement des PAEA et des PANE s'il y a lieu. En outre, dans le cadre de cette composante, se trouve la mise à jour des directives du GSEAf sur la coexistence homme-éléphant (CeHE) et le développement de nouvelles approches innovantes basées sur la planification spatiale au niveau du paysage, les comportements connus des éléphants et les approches de conservation communautaires et la collecte de fonds pour le fonctionnement du secrétariat du GSEAf et pour les activités du GSEAf.

Dans la composante Action, le groupe développera une communauté de praticiens à travers le groupe de travail CeHE, échangeant des informations sur les meilleures pratiques et les succès et échecs des outils appropriés dans différents contextes en Afrique et en Asie; et créera une communauté de jeunes locaux innovants pour participer aux questions de gestion et

elephant habitats; promote our international peer-reviewed *Pachyderm* journal; release a statement on the AfESG's position on IUCN's recent mandate of the two species issue. Finally, under the Network component, we will promote and where appropriate establish collaborations with relevant IUCN SSC Specialist Groups; establish relevant working groups to engage with key issues; respond to emerging issues and changing priorities; hold AfESG members' meeting sessions in 2022 and in 2024/2025 and where appropriate or necessary hold brief inter-session online meetings.

Strategy for achieving the targets

We formed taskforces and working groups in February 2021 to address various objectives as reported in *Pachyderm* 61. Some have convened and are carrying out their work while others are still in the process of planning their work in this quadrennium. We thank and motivate the memberships of these taskforces and groups to continue volunteering their support to deliver on their goals. We also thank the volunteer conveners including Dr Ferrell Osborn (Human-Elephant Coexistence Taskforce), Dr John Hart (African Elephant Taxonomy Taskforce), Dr Dave Balfour (African Elephant Sustainable Use Taskforce), Dr Jeanetta Selier (African Elephant Action Plan Taskforce), Dr Anna Estes (African Elephant Library Taskforce), Dr Lucy Vigne (Communications Taskforce) and Dr Kathleen Gobush (African elephant Red List team). We are also convening on the interim, Taskforce on the movement of elephants from in situ to ex situ (Rob Slotow) and AED and Data Review Working Group (Ben Okita). We believe that these taskforces and working groups coupled with a strengthened AfESG secretariat will deliver on the 2021–2024 quadrennium targets.

African Elephant Database sustainability plans

We are pleased that in May 2021, Vulcan Inc., the Paul G. Allen Family Foundation (PGAFF) considered our proposal on the technical and financial requirement for the longer-term sustainability of the AED and production of the

de conservation des éléphants.

Dans la composante Communication, nous améliorerons la communication au sein et en dehors de nos membres sur les questions clés concernant les éléphants d'Afrique, grâce à la création d'un groupe d'étude sur cette composante; publierons un Rapport actualisé sur la situation de l'éléphant d'Afrique; encouragerons la création et le maintien de liens/connectivité entre les différents habitats des éléphants; ferons la promotion de notre revue internationale à comité de lecture *Pachyderm*; et publierons une déclaration sur la position du GSEAf sur la question des deux espèces. Enfin, dans le cadre de la composante Réseau, nous encouragerons et, le cas échéant, établirons des collaborations avec les Groupes de spécialistes pertinents de la CSE de l'UICN; établirons des groupes de travail pertinents pour s'engager sur les questions clés; répondrons aux problèmes émergents et aux priorités changeantes; organiserons des sessions de réunion des membres du GSEAf en 2022 et en 2024/2025 et, le cas échéant ou nécessaire, organiserons de brèves réunions intersessions en ligne.

Stratégie pour atteindre les objectifs

Nous avons formé des groupes d'étude et des groupes de travail en février 2021 pour aborder divers objectifs, comme indiqué dans *Pachyderm* 61. Certains se sont réunis et effectuent leur travail tandis que d'autres sont encore en train de planifier leur travail au cours de ce quadriennat. Nous remercions et motivons les membres de ces groupes d'étude et groupes de travail à continuer à offrir leur soutien pour atteindre leurs objectifs. Nous remercions également les organisateurs bénévoles, notamment le Dr Ferrell Osborn (Groupe d'étude pour la coexistence entre les humains et les éléphants), le Dr John Hart (Groupe d'étude sur la taxonomie des éléphants d'Afrique), le Dr Dave Balfour (Groupe d'étude sur l'utilisation durable des éléphants d'Afrique), le Dr Jeanetta Selier (Groupe d'étude sur le plan d'action pour l'éléphant d'Afrique), le Dr Anna Estes (Groupe d'étude de la Bibliothèque des éléphants d'Afrique), Dr Lucy Vigne (Groupe d'étude des communications) et le Dr Kathleen Gobush (Équipe de la Liste rouge des éléphants d'Afrique). Nous réunissons également entretemps, le Groupe d'étude sur le mouvement des éléphants d'in situ à ex situ (Rob Slotow) et BDEA et le Groupe d'étude sur l'examen des données (Ben Okita). Nous pensons que

African Elephant Status Report (AESR). As reported in the previous volume, *Pachyderm* 61, the co-Chairs in consultation with the Data Review working group of AfESG and with the support of Save the Elephants and IUCN–Global Species Programme (GSP), prepared and submitted the proposal in May 2020. Vulcan Inc. the PGAFF approved USD 571,000 for three years of the USD 1.016 million request over five years. IUCN-US office and Save the Elephants will administer the funds.

The AED is the official 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 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 the African elephant. The AESR, which is largely derived from the AED, provides necessary information for the CITES Monitoring the Illegal Killing of Elephants (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 management activities.

The AfESG has not had the uninterrupted resources necessary to maintain the updating of the AED and meet the desired cadence of producing an AESR every three years. This lack of capacity, the software complexity of the AED, and the lack of AED governance and subsequent ad hoc funding of the programme has caused a backlog of un-catalogued elephant survey data and limitations to AED and AESR sustainability. The three years of funding will support the production of a new AESR in 2022 and support the development and implementation of a long-term plan for a functional AED including the formation of an AED governance group/consortium and allied institutions.

Production of African Elephant Status Report

The Data Review working group (DRWG) held eight technical meetings between March 2020

ces groupes d'étude et groupes de travail, associés à un secrétariat renforcé du GSEAf, permettront d'atteindre les objectifs du quadriennat 2021-2024.

Plans de durabilité de la base de données sur l'éléphant d'Afrique

Nous sommes heureux qu'en mai 2021, Vulcan Inc., la Fondation de la famille Paul G. Allen (PGAFF - Paul G. Allen Family Foundation) ait examiné notre proposition sur les exigences techniques et financières pour la durabilité à long terme du BDEA et la production du Rapport sur le statut de l'éléphant d'Afrique (RSEA). Comme indiqué dans le volume précédent, *Pachyderm* 61, les coprésidents, en consultation avec le Groupe de travail sur l'examen des données du GSEAf et avec le soutien de Save the Elephants et du Programme mondial des espèces (PME) de l'UICN, ont préparé et soumis la proposition en mai 2020. Vulcan Inc. PGAFF a approuvé 571 000 USD pour trois ans sur la demande de 1,016 million USD sur cinq ans. Le bureau de l'UICN aux États-Unis et Save the Elephants administreront les fonds.

La BDEA est le référentiel officiel des données d'enquête sur l'éléphant d'Afrique et est la source de connaissances la plus fiable et la plus à jour sur les populations et la répartition des éléphants d'Afrique. Le GSEAf utilise les données de la BDEA pour remplir son mandat de l'UICN lié aux espèces telles que le processus de la Liste rouge. La BDEA est également la principale source de données pour les rapports du GSEAf à la CITES sur l'état de conservation de l'éléphant d'Afrique. Le RSEA, qui est largement dérivé de la BDEA, fournit les informations nécessaires pour les analyses du programme CITES de Surveillance de l'abattage illégal d'éléphants (MIKE - Monitoring of the Illegal Killing of Elephants) et du Système d'information sur le commerce des éléphants (ETIS - Elephant Trade Information System). Il est également utilisé par les États de l'aire de répartition des éléphants dans leurs plans d'action continentaux, régionaux et dans le développement de plans d'action nationaux pour les éléphants et d'autres activités de gestion.

Le GSEAf n'a pas eu les ressources ininterrompues nécessaires pour maintenir la mise à jour du BDEA et respecter la cadence souhaitée de production d'un RSEA tous les trois ans. Ce manque de capacité, la complexité du logiciel de la BDEA et le manque de gouvernance de la BDEA et du financement ad

and June 2021 to review data and assess the processes of producing the next iteration of the African Elephant Status Report (AESR). This next AESR is planned for production in 2022 and will be a full update of the AESR 2016 subject to availability of funds and the necessary data. Vulcan Inc., PGAFF has committed to financial and technical support while the DRWG is collating as much recent elephant survey data as possible. The Data Review working group (DRWG) held eight technical meetings between March 2020 and June 2021 to review data and assess the processes of producing the next iteration of the African Elephant Status Report (AESR). As of June 2021, we had collated new survey reports for 279 input zones out of a possible 492 input zones (averaging 57%) in Africa since 2016 when the last status report was produced. These consisted of 90 out of 162 input zones (56%) in Central Africa, 57 out of 98 (58%) in Eastern Africa, 120 out of 141 (85%) in Southern Africa, but only 12 out of 91 input zones (13%) in West Africa.

The DRWG decided to conduct a dry run for the Central Africa populations in order to better understand the realistic time, resource and expertise requirements. The dry run process has so far revealed issues that would require decisions and resolutions to guide the subsequent data reviews. These include for example: a decision to structure AESR either as two separate reports for forest and savannah or as one report with tables and maps distinguishing forest, savannah, mixed, hybrid and unknown populations; a resolution to develop a criterion for these classifications; a decision on how to assess and admit estimates from surveys that used dung decay rates from other surveys/sites as a calibration. DRWG has also set up a Gantt chart and knowledge management tool on Google sites to enable the review of documentation, incoming surveys and ancillary information.

These latter activities are coordinated with the assistance of a full-time AED officer. We will be recruiting both a part time Programme Officer and a dedicated AESR productions manager in June/July 2021 in order to maintain momentum for a timely production of AESR.

hoc ultérieur du programme ont entraîné un arriéré de données d'étude des éléphants non cataloguées et des limitations à la durabilité de la BDEA et du RSEA. Les trois années de financement soutiendront la production d'un nouveau RSEA en 2022 et soutiendront l'élaboration et la mise en œuvre d'un plan à long terme pour une BDEA fonctionnelle, y compris la formation d'un groupe/consortium de gouvernance BDEA et d'institutions alliées.

Production du rapport sur l'état de l'éléphant d'Afrique

Le Groupe de travail sur l'examen des données (GTED) a tenu huit réunions techniques entre mars 2020 et juin 2021 pour examiner les données et évaluer les processus de production de la prochaine itération du Rapport sur l'état de l'éléphant d'Afrique (RSEA). Ce prochain RSEA est prévu pour la production en 2022 et sera une mise à jour complète du RSEA 2016 sous réserve de la disponibilité des fonds et des données nécessaires. Vulcan Inc., PGAFF s'est engagé à fournir un soutien financier et technique pendant que le GTED rassemble autant de données récentes que possible sur les relevés d'éléphants. Le GTED a tenu huit réunions techniques entre mars 2020 et juin 2021 pour examiner les données et évaluer les processus de production de la prochaine itération du RSEA. Ce prochain RSEA est prévu pour la production et la diffusion en 2022 et sera une mise à jour complète du RSEA 2016 sous réserve de la disponibilité des fonds et des données nécessaires. Vulcan Inc., PGAFF s'est engagé à fournir un soutien financier et technique pendant que le GTED rassemble autant de données récentes que possible sur les relevés d'éléphants. En juin 2021, nous avons rassemblé de nouveaux rapports d'enquête pour 279 zones d'entrée sur 492 zones d'entrée possibles (en moyenne 57%) en Afrique depuis 2016, date à laquelle le dernier rapport de statut a été produit. Celles-ci comprenaient 90 des 162 zones d'entrée (56 %) en Afrique centrale, 57 sur 98 (58 %) en Afrique de l'Est, 120 sur 141 (85 %) en Afrique australe, mais seulement 12 des 91 zones d'entrée (13 %) en Afrique de l'Ouest.

Le GTED a décidé d'effectuer un essai à blanc pour les populations d'Afrique centrale afin de mieux comprendre les besoins réalistes en temps, en ressources et en expertise. Le processus d'essai à blanc a jusqu'à présent révélé des problèmes qui nécessiteraient des décisions et des résolutions pour

African forest and savannah elephants treated as separate species

The AfESG now treats the African elephants as two distinct species: African forest elephant (*Loxodonta cyclotis*) and African savannah elephant (*Loxodonta africana*). Published in March 2021, the IUCN's Red List Assessment update for African elephants mandated the separation, as reported already by the AfESG, and this will be reflected in the next iteration of the AESR.

While there has long been consensus on the significant ecological, behavioural and morphological differences between forest and savannah elephants, abundant genetic evidence has emerged over the last ten years to further indicate that they are two separate species. Some of the key differences are: *L. cyclotis* have smaller, rounded ears, than *L. africana*, their tusks point downwards, and their bodies are higher over their back legs. *L. cyclotis* live in smaller family groups and have longer gestation periods than *L. africana*. Their diet is dominated by fruit but they can also eat grasses, foliage and tree bark while savannah elephants graze on grasses and can feed on a variety of trees, shrubs and fruits. Genetic findings indicate that the forest elephant could have been a separate species for millions of years.

After careful consideration by the AfESG, at its members' meeting in 2019, this information as well as the results of a study it commissioned (iucn.org/sites/dev/files/content/documents/2019-03-15-final-taxanomy_report-african-elephant-sg.pdf) found hybridization between the two species to be restricted. Hybridization was evident at only 14 of the more than 100 localities examined across the vast forest-savannah ecotone. There is only one exception, this is the hybrid hotspot identified along the Democratic Republic of Congo (DRC) and Uganda border, thought to be a consequence of human pressure having pushed individual elephants into the range of the other species (Mondol et al. 2015)[1]. Recognition of the

[1]Mondol S, Moltke I, Hart J, Keigwin M, Brown L, Stephens M, and Wasser SK. 2015. New evidence for hybrid zones of forest and savannah elephants in Central and West Africa. *Molecular ecology*, 24(24), 6134-6147. https://doi.org/10.1111/mec.13472

guider les examens de données ultérieurs. Celles-ci incluent par exemple : une décision de structurer de RSEA soit en deux rapports distincts pour la forêt et la savane, soit en un seul rapport avec des tableaux et des cartes distinguant les populations de forêt, de savane, mixtes, hybrides et inconnues ; une résolution pour développer un critère pour ces classifications ; une décision sur la façon d'évaluer et d'admettre les estimations des enquêtes qui ont utilisé les taux de décomposition des excréments d'autres enquêtes/sites comme étalonnage. GTED a également mis en place un diagramme de Gantt et un outil de gestion des connaissances sur les sites Google pour permettre l'examen de la documentation, des enquêtes entrantes et des informations auxiliaires.

Ces dernières activités sont coordonnées avec l'aide d'un agent BDEA à plein temps. Nous recruterons à la fois un agent de Programmes à temps partiel et un responsable de production RSEA dédié en juin/juillet 2021 afin de maintenir l'élan pour une production RSEA en temps opportun.

Éléphants africains de forêt et de savane traités comme des espèces distinctes

Le GSEAf traite désormais les éléphants d'Afrique comme deux espèces distinctes : l'éléphant de forêt d'Afrique (*Loxodonta cyclotis*) et l'éléphant de savane d'Afrique (*Loxodonta africana*). Publiée en mars 2021, la mise à jour de l'évaluation de la Liste rouge de l'UICN pour les éléphants d'Afrique a rendu obligatoire la séparation, comme cela a déjà été signalé par le GSEAf, et cela sera reflété dans la prochaine itération du RSEA.

Alors qu'il existe depuis longtemps un consensus sur les différences écologiques, comportementales et morphologiques importantes entre les éléphants de forêt et ceux de savane, de nombreuses preuves génétiques ont émergé au cours des dix dernières années pour indiquer davantage qu'il s'agit de deux espèces distinctes. Certaines des principales différences sont les suivantes : *L. cyclotis* a des oreilles plus petites et arrondies que *L. africana*, leurs défenses sont dirigées vers le bas et leur corps est plus haut sur leurs pattes arrière. *L. cyclotis* vit en petits groupes familiaux et a des périodes de gestation plus longues que *L. africana*. Leur régime alimentaire est dominé par les fruits, mais ils peuvent également manger des herbes, du feuillage et de l'écorce d'arbre, tandis que

two distinct species is supported by the Mammals of the World (Wilson and Reeder, 2005)[2] which provides the primary IUCN mammal taxonomy.

There will be imminent implications and consequences of this shift to identify and attend to. A taxonomy taskforce convened by Dr John Hart is in the process of developing the necessary documentation and processes of engagement as well as tailored support for range states. Hart et al. 2021[3] lists some of them; for example, *L. cyclotis* is currently not listed in CITES documents. A suggested solution may be to list "*Loxodonta spp.*" under Appendix I or II (depending on range state), as is the case for *Monachus* (monk seals) and *Eubalena* (right whales). CMS, UNEP, and NGOs such as TRAFFIC, could approach this in a similar manner where necessary. Secondly, the Red List assessments provide species-specific lists of range states, based on the best current information. Legislative nomenclature varies by country. For example, the Republic of Congo uses "*Loxodonta africana cyclotis*" in national laws and other documents. Other countries (such as Cameroon and Democratic Republic of Congo (DRC) use "*Loxodonta cyclotis*" and "*Loxodonta africana*". There may also be uncertainty as to whether one or both species occur in a country.

Multi-lateral discussions on the implications of the two species treatment by the AfESG

We initiated discussions on the implications of the two species treatment by AfESG by engaging the IUCN SSC leadership, CITES, CMS, MIKE Central Coordination Unit (CCU), Red List Authority and Global Species Programme, at a meeting on 24th February 2021 convened by the Chair of SSC, Dr JonPaul Rodriguez. The meeting noted that CMS already list the two species separately on its Appendix II, which covers migratory species that have an unfavourable conservation status

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

[3]Hart J, Gobush K, Maisels F, Wasser S, Okita-Ouma B, and Slotow R. 2021. African forest and savannah elephants treated as separate species. *Oryx, 55*(2), 170–171. https://doi.org/10.1017/S0030605320001386

les éléphants de savane broutent des herbes et peuvent se nourrir d'une variété d'arbres, d'arbustes et de fruits. Les découvertes génétiques indiquent que l'éléphant de forêt aurait pu être une espèce distincte depuis des millions d'années.

Après un examen attentif par le GSEAf, lors de la réunion de ses membres en 2019, ces informations ainsi que les résultats d'une étude qu'il a commandée (iucn.org/sites/dev/files/content/documents/2019-03-15-final-taxanomy_report-african-elephant-sg.pdf) ont trouvé que l'hybridation entre les deux espèces était limitée. L'hybridation n'était évidente que dans 14 des plus de 100 localités examinées dans le vaste écotone forêt-savane. Il n'y a qu'une seule exception, il s'agit du hotspot hybride identifié le long de la frontière entre la RDC et l'Ouganda, considéré comme une conséquence de la pression humaine ayant poussé des éléphants individuels dans l'aire de répartition des autres espèces (Mondol et al. 2015)[1]. La reconnaissance des deux espèces distinctes est étayée par les Mammifères du monde (Wilson et Reeder, 2005)[2] qui fournissent la principale taxonomie des mammifères de l'UICN.

Il y aura des implications et des conséquences imminentes liées à ce changement à identifier et à gérer. Un groupe d'étude sur la taxonomie convoqué par le Dr John Hart est en train de développer la documentation et les processus d'engagement nécessaires ainsi qu'un soutien sur mesure pour les États de l'aire de répartition. Hart et al. 2021[3] en énumère certains ; par exemple, *L. cyclotis* n'est actuellement pas répertorié dans les documents CITES. Une solution suggérée pourrait être de lister "*Loxodonta spp.*" à l'Annexe I ou II (selon l'état de l'aire de répartition), comme c'est le cas pour *Monachus* (phoques moines) et *Eubalena* (baleines noires). La CMS, le PNUE et des ONG telles que TRAFFIC pourraient aborder cela de la même manière si nécessaire. Deuxièmement, les évaluations de la Liste rouge fournissent des listes d'états de l'aire de répartition spécifiques aux espèces, basées sur les meilleures informations actuelles. La nomenclature législative varie selon les pays. Par exemple, la République du Congo utilise « *Loxodonta africana cyclotis* » dans les lois nationales et autres documents. D'autres pays (comme le Cameroun et la RDC) utilisent « *Loxodonta cyclotis* » et « *Loxodonta africana* ». Il peut également exister une incertitude quant à la présence d'une ou des deux espèces dans un pays.

and that require international agreements for their conservation and management, as well as those that have a conservation threatened status, and which would significantly benefit from international cooperation that could be achieved by an international agreement. Prior to AfESG treating the two species separately, it has been challenging to assess the practical implications for the MOU between CMS, Western African elephant range states and the IUCN–SSC–AfESG on the Conservation Measures for the West African Populations of the African Elephant. The separation of the two species by AfESG provides an opportunity to revise the MoU, and prioritize specific elements to enhance the conservation of both species for implementation.

On the CITES front, listing African elephants as two species was discussed in 2007 but shelved by Parties to CITES citing complications including amending resolutions. However, from the perspective of the Animals Committee nomenclature specialist, splits happen regularly but require the academic justification and implications. MIKE/ETIS species wide trends and analyses would be challenging to tease out, whereas the African elephant range states would require incorporating this species separation into the revision of the AEAP. Therefore, CITES Parties will have to consider many consequences before adopting the new listings under CITES. We will consider notifying Parties at the next CITES CoP19 in 2022, and suggested that the Animals Committee consider inter-sessional preparations on this issue to hone at CoP20 in 2025, for parties to debate.

Appointment of the Red List Authority lead for African elephants

We wish to congratulate Dr Kathleen Gobush on her appointment in February 2021 as the Red List Assessment Coordinator for African elephants. This followed our recommendation to the Chair of IUCN/SSC and to the SSC Red List Committee to consider her for this role. Kathleen has been leading and coordinating a team of assessors composed of Dr David Balfour, Dr Fiona Maisels, Dr Russell Taylor and Prof. George Wittemyer of the AfESG, and an expert modeller, Dr Charles Edwards, since July 2017, in reassessing the Red List status of African

Discussions multilatérales sur les implications du traitement des deux espèces par le GSEAf

Nous avons entamé des discussions sur les implications du traitement des deux espèces par le GSEAf en engageant la direction de la CSE de l'UICN, la CITES, la CMS, la CCU de MIKE, l'Autorité de la Liste rouge et le Programme mondial des espèces, lors d'une réunion le 24 février 2021 convoquée par le président de la CSE, Dr. Jon Paul Rodriguez. La réunion a noté que la CMS a déjà inscrit les deux espèces séparément sur son Annexe II, qui couvre les espèces migratrices qui ont un statut de conservation défavorable et qui nécessitent des accords internationaux pour leur conservation et leur gestion, ainsi que celles qui ont un statut de conservation menacée, et qui bénéficieraient considérablement d'une coopération internationale qui pourrait être réalisée par un accord international. Avant que le GSEAf traite les deux espèces séparément, il était difficile d'évaluer les implications pratiques pour le Memorandum d'accord entre la CMS, les États de l'aire de répartition de l'éléphant d'Afrique de l'Ouest et l'UICN-CSE-GSEAf sur les mesures de conservation pour les populations d'Afrique de l'Ouest de l'éléphant d'Afrique. La séparation des deux espèces par GSEAf offre l'occasion de réviser le protocole d'accord et de hiérarchiser des éléments spécifiques pour améliorer la conservation des deux espèces pour la mise en œuvre.

Du côté de la CITES, l'inscription des éléphants d'Afrique en tant que deux espèces a été discutée en 2007, mais abandonnée par les Parties à la CITES en raison de complications, notamment l'amendement de résolutions. Cependant, du point de vue du spécialiste de la nomenclature du Comité pour les animaux, des scissions se produisent régulièrement mais nécessitent une justification académique et des implications. Les tendances et les analyses à l'échelle des espèces MIKE/ETIS seraient difficiles à déterminer, tandis que les États de l'aire de répartition de l'éléphant d'Afrique nécessiteraient d'incorporer cette séparation des espèces dans la révision du PAEA. Par conséquent, les Parties à la CITES devront tenir compte de nombreuses conséquences avant d'adopter les nouvelles inscriptions à la CITES. Nous envisagerons de notifier les Parties lors de la prochaine CdP 19 de la CITES en 2022, et avons suggéré que le Comité pour les animaux envisage les préparatifs intersessions sur cette question à perfectionner à la CdP20 en 2025 pour que les Parties puissent en débattre.

elephants. They delivered a revised assessment in August 2020 after addressing all the issues raised by the IUCN Red List Standards and Petitions Committee (SPC) and the members of AfESG at their meeting in Pretoria in 2019. The Red List SPC accepted the re-assessments in November 2020 with minor changes and results published on 25 March 2021. We wish Kathleen every success in this new role.

Red List re-assessment results of the African elephants

In the same breath, we acknowledge the huge contribution and investment made by the team of assessors in completing the Red-Listing re-assessment exercise. This was not only a milestone achievement for the team, but also the entire AfESG. The Red List assessment was conducted separately for the two species of the African elephant, with the forest *Loxodonta cyclotis* listed as Critically Endangered and the savannah *Loxodonta africana* listed as Endangered on the IUCN Red List of Threatened Species. Before this update, African elephants were treated as a single species, listed as Vulnerable. This was the first time the two species were assessed separately for the IUCN Red List, following the emergence of new genetic evidence. The assessments highlighted a broad scale decline by more than 86% over a period of 31 years in the numbers of African forest elephants, and at least 60% over the last 50 years in the African savannah elephants across Africa. Both species have suffered sharp declines since 2008 due to a significant increase in poaching, which peaked in 2011, and continues to threaten populations. The ongoing conversion of their habitats, primarily to agricultural and other land uses, is another significant threat.

The outcome of Critically Endangered for forest elephant and Endangered for savannah elephant reflect the dire situation that these species face, despite the conservation successes in some sites in southern Africa, eastern African, and some sites in Gabon and Republic of Congo in Central Africa. We hope that these assessments will focus conservation attention on these species, in order to turn around the population declines throughout their range.

The process was an extremely rigorous one,

Nomination du responsable de l'Autorité de la Liste rouge pour les éléphants d'Afrique

Nous souhaitons féliciter le Dr Kathleen Gobush pour sa nomination en février 2021 en tant que Coordinatrice de l'évaluation de la Liste rouge pour les éléphants d'Afrique. Cela a suivi notre recommandation à la Présidente de l'UICN/CSE et au Comité de la Liste rouge de la CSE à la considérer pour ce rôle. Kathleen dirige et coordonne une équipe d'évaluateurs composée du Dr David Balfour, du Dr Fiona Maisels, du Dr Russell Taylor et du professeur George Wittemyer du GSEAf, et d'un expert en modélisation, le Dr Charles Edwards, depuis juillet 2017 pour réévaluer le statut des éléphants d'Afrique dans la Liste rouge. Ils ont remis une évaluation révisée en août 2020 après avoir abordé toutes les questions soulevées par le Comité des normes et des pétitions (SPC - Standards and Petitions Committee) de la Liste rouge de l'UICN et les membres du GSEAf lors de leur réunion à Pretoria en 2019. Le SPC de la Liste rouge a accepté les réévaluations en novembre 2020 avec des changements mineurs et des résultats publiés le 25 mars 2021. Nous souhaitons à Kathleen tout le succès dans ce nouveau rôle.

Résultats de la réévaluation de la Liste rouge des éléphants d'Afrique

Dans le même souffle, nous reconnaissons l'énorme contribution et l'investissement fait par l'équipe d'évaluateurs dans la réalisation de l'exercice de réévaluation de la Liste rouge. Ce n'était pas seulement une réalisation marquante pour l'équipe, mais aussi pour l'ensemble du GSEAf. L'évaluation de la Liste rouge a été menée séparément pour les deux espèces d'éléphants d'Afrique, avec celle de forêt *Loxodonta cyclotis* classée en danger critique d'extinction et celle de la savane *Loxodonta africana* classée en danger sur la Liste rouge de l'UICN des espèces menacées™. Avant cette mise à jour, les éléphants d'Afrique étaient traités comme une seule espèce, répertoriée comme vulnérable. C'était la première fois que les deux espèces étaient évaluées séparément pour la Liste rouge de l'UICN, suite à l'émergence de nouvelles preuves génétiques. Les évaluations ont mis en évidence un déclin à grande échelle de plus de 86 % du nombre d'éléphants d'Afrique de forêt sur une période de 31 ans, et d'au moins 60 % des éléphants d'Afrique de savane au cours des 50 dernières années à travers l'Afrique. Les deux espèces ont subi de fortes

taking the best part of four years to complete, with a comprehensive modelling approach and navigation through the complex datasets and species differences. There were high levels of scrutiny at different stages, including by the IUCN Red List SPC. Despite the challenges of compiling and incorporating historical datasets, the outcomes of the model are robust and provide a sound assessment. More details on the assessment of the forest and savannah elephants can be found by following these links https://www.iucnredlist.org/species/181007989/181019888 and https://www.iucnredlist.org/species/181008073/181022663.

We would like to thank the former Chair of AfESG, Holly Dublin, who initiated and supported the process in 2017 before handing over to us in 2018, and for assembling an extremely competent team for this work. As such, we the co-Chairs only needed to continue to support the work of the team, engaging through the lead, and liaising with the broader IUCN team as necessary. We also thank the two independent reviewers who provided inputs to the team, Nokuthaba Sibanda and Jeanetta Selier, as well as Craig Hilton Taylor and the IUCN Red List team at Rome, for their assistance.

News coverage of the African elephant Red List reassessment

The IUCN's Global Communications Unit (GCU) lauded the news coverage of this re-assessment as historical in its broadcast. The press release was sent under embargo to global media contacts in English, French, Spanish, and Japanese. It was published on the IUCN website and linked to the Red List website (https://www.iucn.org/news/species/202103/african-elephant-species-now-endangered-and-critically-endangered-iucn-red-list). The IUCN Japanese National Committee also provided a translation. Over the week analysed, at least 1,145 articles were published online in 99 countries worldwide, including stories by most major news agencies. At least 17 top quality media—or target media—outlets prioritized by GCU, covered the update. The release generated a large amount of high-quality coverage around the world, including articles in the *New York Times*, *New Scientist*, *National Geographic*, *Washington Post*, *Nikkei*,

baisses depuis 2008 en raison d'une augmentation significative du braconnage, qui a culminé en 2011 et continue de menacer les populations. La conversion continue de leurs habitats, principalement à des fins agricoles et autres, est une autre menace importante.

Le fait d'être classifiés En danger critique pour l'éléphant de forêt et En danger pour l'éléphant de savane reflète la situation désastreuse à laquelle ces espèces sont confrontées, malgré les succès de conservation dans certains sites d'Afrique australe, d'Afrique de l'Est et certains sites au Gabon et en République du Congo en Afrique centrale. Nous espérons que ces évaluations concentreront l'attention sur la conservation de ces espèces, afin d'inverser le déclin des populations dans toute leur aire de répartition.

Le processus a été extrêmement rigoureux et a duré presque quatre ans, avec une approche de modélisation complète et une navigation à travers les ensembles de données complexes et les différences entre les espèces. Il y a eu des niveaux élevés de contrôle à différentes étapes, y compris par le Comité des normes et des pétitions de la Liste rouge de l'UICN. Malgré les défis de la compilation et de l'intégration des ensembles de données historiques, les résultats du modèle sont robustes et fournissent une évaluation solide. Plus de détails sur l'évaluation des éléphants de forêt et de savane peuvent être trouvés en suivant ces liens https://www.iucnredlist.org/species/181007989/181019888 et https://www.iucnredlist.org/species/181008073/181022663.

Nous tenons à remercier l'ancienne présidente du GSEAf, Holly Dublin, qui a initié et soutenu le processus en 2017 avant de nous passer le relais en 2018, et d'avoir constitué une équipe extrêmement compétente pour ce travail. En tant que tel, nous, les coprésidents, n'avions qu'à continuer à soutenir le travail de l'équipe, en nous engageant par le biais de la direction et en assurant la liaison avec l'ensemble de l'équipe de l'UICN si nécessaire. Nous remercions également les deux évaluateurs indépendants qui ont apporté leur contribution à l'équipe, Nokuthaba Sibanda et Jeanetta Selier, ainsi que Craig Hilton Taylor et l'équipe de la Liste rouge de l'UICN à Rome pour leur aide.

Couverture médiatique de la réévaluation de la Liste rouge de l'éléphant d'Afrique

L'Unité de communication mondiale (GCU - Global Communications Unit) de l'UICN a salué la couverture médiatique de cette réévaluation comme

Le Monde, *El Pais*, and several articles in *the Guardian* (UK); as well as the BBC, ABC News, PBS, Sky news, FAZ, press agencies including Reuters (article and video report), AP, AFP; broadcast media coverage included TV coverage by Al Jazeera, the BBC, ARD, RTS and France Info, among many others. The update reached a large audience on social media, with the video produced in-house generating a particularly high level of engagement. On Twitter, this was the best performing Red List update since records began in 2017. We specially thank Matthias Fiechter and Harriet Brooker of the IUCN GCU for their super coordination of the new coverage. A more detailed report on this coverage can be found by following this link: (https://portals.iucn.org/union/sites/union/files/doc/communications_report_-_iucn_red_list_update_march_2021_final.pdf).

Movement of elephants from in situ to ex situ

A taskforce was formed to be responsible for leading the review of the existing AfESG statement on the removal of elephants from the wild for captive use. The taskforce will also consider principles or positions of the AfESG, and whether these should be reconsidered or revised with reference Resolution Conf. 11.20 (Rev. CoP18), in order to respond to requests relating to 'appropriate and acceptable destinations', this in reference to the trade in live elephants taken from the wild.

As a follow-up to our report in the previous *Pachyderm* 61, this taskforce led by Rob Slotow, responded to the CITES Notification to the Parties No. 2019/070 as contained in CITES document AC31 Doc 18.1 Annex 2, pages 67 to 76 (https://cites.org/sites/default/files/eng/com/ac/31/Docs/E-AC31-18-01-A2.pdf). The AfESG's taskforce provided inputs based on its experience and expertise with wild elephants, and in line with its mission of promoting the long-term conservation of Africa's elephants throughout their range. AfESG also responded on the two specific components of the non-binding guidelines: dietary needs (species-specific food and nutritional requirements, access to portable water); and social well-being and animal

historique dans sa diffusion. Le communiqué de presse a été envoyé sous embargo aux contacts des médias mondiaux en anglais, français, espagnol et japonais. Il a été publié sur le site Web de l'UICN et lié au site Web de la Liste rouge (https://www.iucn.org/news/species/202103/african-elephant-species-now-endangered-and-critically-endangered-iucn-red -liste). Le Comité national japonais de l'UICN a également fourni une traduction. Au cours de la semaine analysée, au moins 1 145 articles ont été publiés en ligne dans 99 pays du monde, y compris des articles de la plupart des grandes agences de presse. Au moins 17 médias de qualité supérieure—ou médias cibles — priorisés par GCU ont couvert la mise à jour. Le communiqué a généré une grande quantité de couverture de haute qualité dans le monde entier, y compris des articles dans le *New York Times*, *New Scientist*, *National Geographic*, *Washington Post*, *Nikkei*, *Le Monde*, *El Pais* et plusieurs articles dans *the Guardian* (Royaume-Uni) ; ainsi que la BBC, ABC News, PBS, Sky news, FAZ, agences de presse dont Reuters (article et reportage vidéo), AP, AFP ; la couverture médiatique de diffusion comprenait une couverture télévisée d'Al Jazeera, de la BBC, de l'ARD, de la RTS et de France Info, entre autres. La mise à jour a touché un large public sur les réseaux sociaux, la vidéo produite en interne générant un niveau d'engagement particulièrement élevé. Sur Twitter, il s'agissait de la mise à jour de la Liste rouge la plus performante depuis le début des enregistrements en 2017. Nous remercions spécialement Matthias Fiechter et Harriet Brooker de l'UICN GCU pour leur super coordination de la nouvelle couverture. Un rapport plus détaillé sur cette couverture peut être trouvé en suivant ce lien : (https://portals.iucn.org/union/sites/union/files/doc/communications_report_-_iucn_red_list_update_march_2021_final.pdf).

Déplacement des éléphants d'in situ à ex situ

Un groupe d'étude a été formé pour être chargé de diriger l'examen de la déclaration existante du GSEAf sur le retrait des éléphants de la nature à des fins d'utilisation en captivité. Le groupe de travail examinera également les principes ou les positions du GSEAf et déterminera si ceux-ci doivent être réexaminés ou révisés en référence à la résolution Conf. 11.20 (Rev. CdP18), afin de répondre aux demandes relatives aux « destinations appropriées

behaviour (appropriate social groupings for the species, methods of integration, appropriate social and behavioural enrichment, ability to separate the group where needed).

Without prejudice to the captive facilities that keep African elephants, the taskforce concluded that the needs of African elephants, as studied in the wild, cannot be met in the captive facilities. We have since received a letter from the European Association of Zoos and Aquaria regarding the taskforce's response to the CITES notification, which urges collegiality and cooperation between AfESG and the professional zoo and aquarium community, which we are currently pursuing.

MIKE–ETIS Technical Advisory Group meeting

The MIKE CCU convened the 16th meeting of the MIKE–ETIS–TAG virtually on 1st and 2nd July 2020. Co-Chair, Ben Okita represented the AfESG as a co-opted member to the TAG. Some AfESG members are also members of the TAG in their individual capacity either as technical experts in MIKE and ETIS, or as MIKE regional representatives. Discussions were held on PIKE estimates with and without management related deaths, MIKE analyses for Africa, ETIS analyses, carcass detection probability, and the range of natural mortality rates based on a literature review in determining poaching rates.

As a follow-up to the actions of the 15th meeting of MIKE–ETIS–TAG, we responded to MIKE CCU's request to identify 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. In addition, the experts would help document alternative elephant survey techniques in gallery forests/canopy forests and advise on the integration of the AED and MIKE (PIKE trend analysis) (including estimates to be used, means to address uncertainties in estimates and interpolation between estimates).

We produced a report on the status, threats, conservation strategies, and action plan for African elephants, and submitted to MIKE CCU

et acceptables », ceci en référence au commerce des éléphants vivants prélevés dans la nature.

Suite à notre rapport dans le précédent *Pachyderm* 61, ce groupe d'étude dirigé par le professeur Rob Slotow, a répondu à la notification CITES aux Parties n° 2019/070 contenue dans le document CITES AC31 Doc 18.1 Annexe 2, pages 67 à 76 (https://cites.org/sites/default/files/eng/com/ac/31/Docs/E-AC31-18-01-A2.pdf). Le groupe d'étude du GSEAf a fourni des contributions basées sur son expérience et son expertise avec les éléphants sauvages, et conformément à sa mission de promouvoir la conservation à long terme des éléphants d'Afrique dans toute leur aire de répartition. Le GSEAf a également répondu sur les deux composantes spécifiques des directives non contraignantes: les besoins alimentaires (besoins alimentaires et nutritionnels spécifiques à l'espèce, accès à l'eau potable); et le bien-être social et le comportement animal (groupements sociaux adaptés à l'espèce, modalités d'intégration, enrichissement social et comportemental approprié, capacité à séparer le groupe en cas de besoin).

Sans préjudice des installations captives qui gardent des éléphants d'Afrique, le groupe d'étude a conclu que les besoins des éléphants d'Afrique, tels qu'étudiés dans la nature, ne peuvent pas être satisfaits dans les installations captives. Depuis, nous avons reçu une lettre de l'Association européenne des zoos et aquariums concernant la réponse du groupe d'étude à la notification CITES, qui appelle à la collégialité et à la coopération entre le GSEAf et la communauté professionnelle des zoos et aquariums, que nous poursuivons actuellement.

Réunion du groupe consultatif technique MIKE-ETIS

L'Unité centrale de coordination (CCU–Central Coordination Unit) de MIKE a convoqué virtuellement la 16e réunion du MIKE-ETIS-TAG les1er et 2 juillet 2020. Le coprésident, le Ben Okita, a représenté le GSEAf en tant que membre coopté du TAG. Certains membres du GSEAf sont également membres du TAG à titre individuel, soit en tant qu'experts techniques dans MIKE et ETIS, soit en tant que représentants régionaux de MIKE. Des discussions ont eu lieu sur les estimations PIKE avec et sans décès liés à la gestion, les analyses MIKE pour l'Afrique, les analyses ETIS, la probabilité de détection des carcasses et la fourchette des taux de mortalité naturelle sur la base d'une revue

for compilation into a joint report with MIKE and ETIS reports for CITES Standing Committee 73. However, due to the Covid-19 pandemic the SC73 meeting did not take place in October 2020 as scheduled but reports could be (and were) dealt with inter-sessionally. We will have to update its report in 2021 in preparation for the SC meeting on a date yet to be determined.

The next MIKE–ETIS–TAG meeting was scheduled for June 2021, the last one Ben Okita attended as a co-opted AfESG co-Chair. This follows the *modus operandi* of the TAG where representation of AfESG by co-opted co-Chairs is rotated between them at three-year intervals. Rob Slotow will therefore be representing AfESG in subsequent meetings for the next three years. More information about MIKE–ETIS–TAG and previous records of the meetings can be found at https://cites.org/eng/prog/mike/index.php/portal.

Pachyderm 62: In this Issue

We welcome you to the latest edition of *Pachyderm*, (Vol. 62) and trust that you will find this an informative and useful read. In the research section, the study by Craig et al. reveals that Namibia's elephants have been increasing at a rate of 5.36% (between 4.20% and 6.53%) since 1995; the trend is statistically highly significant. (See *Namibia's elephants—population, distribution and trends;* pp.35–52). The focus of Adams' manuscript on elephant movements in the Chobe District investigated how elephants move through different human-dominated landscapes. The results indicate that elephants may be adjusting their movement behaviour based on different types of human activity and disturbance, (see *Elephant movements in different land-uses in Chobe District, Botswana*; pp 74–86). Poole and Granli's paper on the Elephant Ethogram, describes the purpose and scope of their comprehensive, publicly-accessible database of savannah elephant behaviour. The Ethogram is an outstanding resource, documenting the complex, diverse and nuanced repertoire of savannah elephants' behaviour and communication, with links to locate information. Poole and Granli also invite readers, members and researchers to "contribute undocumented, rare, novel or cultural behaviour" of the savannah elephant so that the

de la littérature pour déterminer les taux de braconnage.

Dans le cadre du suivi des actions de la 15e réunion de MIKE-ETIS-TAG, nous avons répondu à la demande de MIKE CCU d'identifier des experts qui pourraient compiler les méthodologies actuelles utilisées par les États de l'aire de répartition pour estimer la taille des populations dans les zones forestières et pour déterminer si les normes d'enquête sur les excréments par MIKE (https://cites.org/sites/default/files/common/prog/mike/survey/dung_standards.pdf) nécessitaient une mise à jour. En outre, les experts aideraient à documenter les techniques alternatives d'étude des éléphants dans les forêts-galeries/canopée forestière et donneraient des conseils sur l'intégration de la DBEA et de MIKE (analyse des tendances PIKE) (y compris les estimations à utiliser, les moyens de traiter les incertitudes dans les estimations et l'interpolation entre estimations).

Nous avons produit un rapport sur l'état, les menaces, les stratégies de conservation et le plan d'action pour les éléphants d'Afrique, et soumis à MIKE CCU pour compilation dans un rapport conjoint avec les rapports MIKE et ETIS pour le Comité permanent CITES 73. Cependant, en raison de la pandémie due au Covid-19, la réunion du CP73 n'a pas eu lieu en octobre 2020 comme prévu, mais les rapports pourraient être (et ont été) traités entre les sessions. Nous devrons mettre à jour son rapport en 2021 en vue de la réunion du CP à une date encore à déterminer.

La prochaine réunion MIKE-ETIS-TAG était prévue pour juin 2021, la dernière à laquelle Ben Okita devait assister en tant que coprésident coopté du GSEAf. Cela suit le modus operandii du TAG où la représentation du GSEAf par des coprésidents cooptés est alternée entre eux à des intervalles de trois ans. Le professeur Rob Slotow représentera donc le GSEAf lors des prochaines réunions au cours des trois prochaines années. Plus d'informations sur MIKE-ETIS-TAG et les comptes rendus précédents des réunions sont disponibles sur https://cites.org/eng/prog/mike/index.php/portal.

Pachyderm 62 : dans ce numéro

Nous vous souhaitons la bienvenue à la dernière édition de Pachyderm, (vol. 62) et espérons que vous trouverez cette lecture informative et utile. Dans la section recherche, l'étude de Craig et al. révèle que les éléphants de Namibie ont augmenté à un taux de 5,36 % (entre 4,20 % et 6,53 %) depuis 1995 ; la

Elephant Ethogram can continue to be updated and expanded. (See pp. 105–111).

As always, we invite submission of relevant manuscripts for consideration in a future issue, please see our "guidelines to authors" here: https://pachydermjournal.org/index.php/pachyderm/about/submissions.

Acknowledgements

We are very appreciative to the financial grants from the European Union CITES MIKES+, Vulcan Inc., the Paul G. Allen Family Foundation, and Save the Elephants. Your support is going a long way 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, for her support to AfESG that goes well beyond her paid duties. We thank Lydia Tiller for voluntarily helping with editing documents upon our request.

tendance est statistiquement très significative. (Voir Éléphants de Namibie – répartitions et tendances des populations; pp.35–52). Le manuscrit d'Adams sur les mouvements des éléphants dans le District de Chobe a étudié comment les éléphants se déplacent dans différents paysages dominés par l'homme. Les résultats indiquent que les éléphants peuvent ajuster leur comportement de mouvement en fonction de différents types de développement humain et de perturbations (voir Mouvements des éléphants dans différentes utilisations des terres dans le District de Chobe, Botswana; pp 74–86). La note de terrain de Poole et Granli sur l'éthogramme des éléphants décrit le but et la portée de cette base de données complète et accessible au public sur le comportement des éléphants de savane africaine. L'éthogramme documente le répertoire complexe, diversifié et nuancé du comportement et de la communication des éléphants de la savane africaine, et il y a des liens dans la note de terrain pour vous diriger vers cette information. Poole et Granli invitent également les lecteurs/membres et chercheurs à « contribuer au comportement non documenté, rare, nouveau ou culturel » de l'éléphant de savane africaine afin qu'il puisse continuer à être mis à jour et étendu. (Voir pp. 105–111). Nous vous invitons à soumettre des manuscrits pertinents pour examen dans un prochain numéro, veuillez consulter nos « directives aux auteurs » ici: https://pachydermjournal.org/index.php/pachyderm/about/submissions.

Remerciements

Nous sommes très reconnaissants des subventions financières de l'Union européenne CITES MIKES+, de Vulcan Inc., de la Paul G. Allen Family Foundation et de Save the Elephants. Votre soutien contribue grandement à assurer la survie des éléphants d'Afrique. Nous encourageons les autres donateurs et agences à se joindre à nous pour soutenir nos objectifs quadriennaux 2021–2024. Nous remercions sincèrement Rose Mayienda, la responsable de la BDEA, pour son soutien au GSEAf qui va bien au-delà de ses fonctions rémunérées. Nous remercions le Lydia Tiller d'avoir volontairement aidé à éditer des documents à notre demande.

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

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Status and trends in rhino poaching

Table 1 shows that since the upsurge in continental poaching levels started in 2008 over 10,000 rhinos have been poached. Encouragingly, the overall recorded poaching numbers in 2020 have continued to decline for the fifth year in a row, with 1.35 rhinos reported poached per day in 2020 compared to a peak of 3.70 per day in 2015. However, lower recorded poaching in 2020 will likely have been influenced by the difficulties of exporting illegal horn caused by lockdowns and international travel restrictions in the wake of Covid-19. It remains to be seen what will happen

Statut et tendances du braconnage de rhinocéros

Le Tableau 1 montre que depuis le début de la recrudescence du braconnage continental en 2008, plus de 10 000 rhinocéros ont été braconnés. Il est encourageant de constater que le nombre global de braconnages enregistrés en 2020 a continué à diminuer pour la cinquième année consécutive, avec 1,35 rhinocéros signalés braconnés par jour en 2020, contre un pic de 3,70 par jour en 2015. Cependant, la baisse du braconnage enregistrée en 2020 a probablement été influencée par les difficultés d'exporter les cornes illégales, difficultés causées par les confinements et les restrictions des voyages internationaux à la suite du

Table 1. Poaching of African rhinos from 2006 to 2020

Tableau 1. Braconnage des rhinocéros africains de 2006 à 2020

Country	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total (2008–2020)
Botswana	0	0	0	0	0	0	2	2	1	0	1	0	18	31	55	110
Chad													0	0	0	0
DR Congo	0	0	2	2									2	?	?	6
Eswatini	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	3
Kenya	3	1	6	21	22	27	29	59	35	11	10	9	4	4	0	237
Malawi	0	0	0	0	0	0	2	1	1	1	1	1	0	0	0	7
Mozambique	0	9	5	15	16	10	16	15	19	13	5	5	8	6	2	135
Namibia	0	0	0	2	2	1	1	4	30	97	61	44	57	45	31	382
Rwanda												0	0	0	0	0
South Africa	36	13	83	122	333	448	668	1004	1215	1175	1054	1028	769	594	394	8887
Tanzania	0	0	2	0	1	2	2	0	2	2	0	2	0	0	0	13
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	2
Zimbabwe	21	38	164	39	52	42	31	38	20	50	35	36	34	82	12	635
Total	**60**	**62**	**262**	**201**	**426**	**532**	**751**	**1123**	**1324**	**1349**	**1167**	**1125**	**894**	**762**	**494**	**10417**
Poached/ day	**0.16**	**0.17**	**0.72**	**0.55**	**1.17**	**1.46**	**2.05**	**3.08**	**3.63**	**3.70**	**3.19**	**3.08**	**2.45**	**2.11**	**1.35**	

when travel restrictions ease. The figures in Table 1 also represent minimums, as it is likely that not all poached carcasses were detected (especially in some very large areas with lower field ranger densities and where rhinos may not be monitored individually).

The increase in poaching losses in Botswana has also been of great concern. The Botswana authorities have responded by relocating black rhinos from the Okavango Delta to a secure fenced sanctuary and dehorning a large number of white rhinos in the Delta.

While *absolute* numbers of rhinos recorded poached have continued to decline significantly in Kruger National Park (NP), block counts show that the estimated number of white rhinos in the Park has also continued to decline. This has largely been because the reduction in the *relative* percentage of the population poached each year has been limited and because relative poaching levels have remained at unsustainable levels (especially when one considers that some carcasses are likely to remain undetected in such a huge area). There have been some misleading comments in the media and social media where some have claimed there is a big mismatch between reported poaching and estimated rhino numbers in Kruger and that numbers of white rhinos in the Park may have been overestimated in the past. However, if one assumes a 20% poaching underdetection rate, and takes into account the translocation of some animals to safer sites, the recorded impact of the severe drought in 2015–18 (on calving rates and mortalities) and allow for reduced recruitment possible with fewer rhinos remaining, the Kruger population estimates and scale of estmated decline in numbers is approximately in line with what would be expected given reported poaching figures, removals and drought impacts.

CITES

CITES CoP19 was to be held in Costa Rica but following the Covid-19 outbreak, the country withdrew as host. Currently it looks likely that it will be held in Geneva from 9 to 21 July 2022. If the CITES Secretariat receives a firm offer from any Party to host CoP19, the venue and dates may change, but should such an offer be received,

Covid-19. Il reste à voir ce qui se passera lorsque les restrictions de voyage seront assouplies. Les chiffres du Tableau 1 représentent également des minimums, car il est probable que toutes les carcasses braconnées n'aient pas été détectées (en particulier dans certaines grandes zones avec des densités de rangers plus faibles et où les rhinocéros peuvent ne pas être surveillés individuellement).

L'augmentation des pertes dues au braconnage au Botswana a également été très préoccupante. Les autorités du Botswana ont réagi en déplaçant des rhinocéros noirs du Delta de l'Okavango vers un sanctuaire clôturé sécurisé et en écornant un grand nombre de rhinocéros blancs dans le Delta.

Alors que le nombre *absolu* de rhinocéros braconnés enregistrés a continué de baisser de manière significative dans le parc national (PN) Kruger, le décompte des blocs montre que le nombre estimé de rhinocéros blancs dans le parc a également continué à baisser. Cela s'explique en grande partie par le fait que la réduction du pourcentage *relatif* de la population braconnée chaque année a été limitée et que les niveaux de braconnage relatifs sont restés à des niveaux non viables (surtout si l'on considère que certaines carcasses sont susceptibles de ne pas être détectées dans une zone aussi vaste). Il y a eu des commentaires trompeurs dans les médias et les réseaux sociaux où certains ont affirmé qu'il y avait un grand décalage entre le braconnage signalé et le nombre estimé de rhinocéros à Kruger et que le nombre de rhinocéros blancs dans le parc pourrait avoir été surestimé dans le passé. Cependant, si l'on suppose un taux de sous-détection de braconnage de 20 %, et prend en compte la translocation de certains animaux vers des sites plus sûrs, l'impact enregistré de la grave sécheresse en 2015-18 (sur les taux de natalité et les mortalités) et si l'on prend en compte un recrutement possible réduit avec moins de rhinocéros restants, les estimations de la population Kruger et l'ampleur du déclin estimé du nombre sont approximativement conformes à ce à quoi on s'attendrait compte tenu des chiffres de braconnage signalés, des prélèvements et des impacts de la sécheresse.

CITES

La CITES CdP19 devait se tenir au Costa Rica, mais à la suite de la vague de Covid-19, le pays s'est retiré en tant qu'hôte. Actuellement, il semble probable qu'elle se tiendra à Genève du 9 au 21 juillet 2022. Si le

CoP19 will likely take place in the second half of 2022.

The outgoing European Association of Zoos and Aquaria (EAZA) rhino Taxon Advisory Group (TAG) Chair, and AfRSG member Friederike von Houwald also gave input to a working group (WG) examining definitions of what constitutes approved and acceptable destinations.

Latest conservation news

Lessons from Zakouma deaths in Chad

With the unfortunate post release deaths of four of the six founder black rhino reintroduced into Zakouma National Park, African Parks (AP) are to be congratulated for their open approach and determination to learn as much as possible from what happened. To try to determine what might have caused the post release deaths they undertook a detailed review including analysing rhino and vegetation samples. They have consulted widely and a number of AfRSG members have reviewed and commented on what happened and the detailed report that AP produced. Lessons learned have been used to develop a revised plan to enhance the next founder introduction's chances of success. The two surviving rhinos appear to be doing fine. The supplementation of the Park with further animals is now in the planning phase.

Kenyan response to the Covid-19 pandemic

To offset the revenue loss from tourism as a result of the Covid-19 pandemic, the Kenyan Association of Private and Community Land Rhino Sanctuaries (APLRS), launched a collaborative appeal referred to as 'Core Critical Operating Costs' (CCOC). This involved the collective comparison of pre and post Covid-19 budgets to demonstrate cost cutting measures and opportunity lost from reduced tourism income. Based upon a number of criteria (land area, the number of rhinos, the number of rangers, tourism dependence etc.) an independent panel allocated the collective funds to each rhino conservancy that was restricted to "conservation costs only" as a percentage derived from the criteria. About USD 800,000 was raised and divided amongst

Secrétariat CITES reçoit une offre ferme d'une Partie pour accueillir la CdP19, le lieu et les dates peuvent changer, mais si une telle offre est reçue, la CdP19 aura probablement lieu au second semestre 2022.

La présidente sortante du Groupe consultatif sur les taxons (TAG - Taxon Advisory Group) de rhinocéros de l'Association européenne des zoos et aquariums (EAZA - European Association of Zoos and Aquaria) et Friederike von Houwald, membre du GSRAf, ont également apporté leur contribution à un groupe de travail (GT) examinant les définitions de ce qui constitue des destinations approuvées et acceptables.

Dernières nouvelles de la conservation

Les leçons de la mort de Zakouma au Tchad

Avec la mort regrettable après la libération de quatre des six rhinocéros noirs fondateurs réintroduits dans le PN de Zakouma, African Parks (AP) doit être félicité pour son approche ouverte et sa détermination à apprendre autant que possible suivant ce qui s'est passé. Pour essayer de déterminer ce qui pourrait avoir causé les décès après la libération, ils ont entrepris un examen détaillé, notamment en analysant des échantillons de rhinocéros et de végétation. Ils ont largement consulté et un certain nombre de membres du GSRAf ont examiné et commenté sur ce qui s'est passé et sur le rapport détaillé produit par AP. Les leçons apprises ont été utilisées pour développer un plan révisé afin d'améliorer les chances de succès de la prochaine introduction de fondateurs. Les deux rhinocéros survivants semblent aller bien. L'ajout d'autres animaux au parc est maintenant en phase de planification.

Réponse du Kenya à la pandémie de Covid-19

Pour compenser la perte de revenus du tourisme à la suite de la pandémie de Covid-19, l'Association kenyane des sanctuaires de rhinocéros privés et communautaires (APLRS - Kenyan Association of Private and Community Land Rhino Sanctuaries), a lancé un appel collaboratif appelé « Coûts d'exploitation essentiels » (CCOC - Core Critical Operating Costs). Cela impliquait la comparaison collective des budgets pré et post Covid-19 pour démontrer les mesures de réduction des coûts et les opportunités perdues en raison de la réduction des revenus du tourisme. Sur la base d'un certain nombre de critères (superficie des terres, nombre de rhinocéros, nombre de rangers,

the seven rhino conservancies to ensure that the conservation integrity was not compromised. This technique proposes a collaborative approach rather than competing for the same resources to achieve a single objective.

The Black Rhino Range Expansion Project (BRREP)

WWF South Africa's Black Rhino Range Expansion Project (BRREP) aims to increase the range and numbers of black rhino in southern Africa in partnership with Ezemvelo KZN Wildlife, the Eastern Cape Parks and Tourism Agency and the 13 project sites created in the last 17 years. This year the BRREP was negatively impacted by the Covid-19 pandemic in that its partners (state, private and community landowners) no longer received income from their normal tourism activities. Research activities, including genetics work were also retarded. The BRREP thus spent much of its financial resources in providing support to those partners in the form of purchasing equipment, fuel or helicopter time for security operations or for monitoring the black rhinos on their properties. Range expansion activities have also slowed down due to limitations on BRREP staff's ability to travel for much of the year. Nevertheless, enthusiasm continued with a number of new properties keen and being prepared to receive black rhinos, notably in Mozambique and the northern KwaZulu province of South Africa. The plan for the coming year is to move about 40 black rhinos to create two new populations.

Rifa Valley, Zimbabwe as a potential reintroduction site for black rhinos

On request from Hemmersbach Rhino Force, the AfRSG Scientific Officer (SO) provided some comments and suggestions to their initial black rhino reintroduction proposal that formed part of their plans to secure and rehabilitate the Rifa section of the middle Zambezi valley. These initial comments were based entirely on a rapid desktop assessment. They were made with reference to current recommended best reintroduction and biological management practices. The AfRSG expressed concerns about the carrying capacity of the proposed site as well as some other aspects such as security. Following recommendations

dépendance au tourisme, etc.), un panel indépendant a alloué les fonds collectifs à chaque réserve de rhinocéros qui étaient limités aux « seuls coûts de conservation » en tant que pourcentage dérivé du critère. Environ 800 000 USD ont été collectés et répartis entre les sept réserves de rhinocéros pour garantir que l'intégrité de la conservation ne soit pas compromise. Cette technique propose une approche collaborative plutôt que de se disputer les mêmes ressources pour atteindre un objectif unique.

Le Projet d'extension de l'aire de répartition du rhinocéros noir (BRREP- The Black Rhino Range Expansion Project)

Le projet d'extension de l'aire de répartition du rhinocéros noir (BRREP) du WWF en Afrique du Sud vise à augmenter l'aire de répartition et le nombre de rhinocéros noirs en Afrique australe en partenariat avec Ezemvelo KZN Wildlife, l'Agence des parcs et du tourisme du Eastern Cape et les 13 sites de projet créés au cours des 17 dernières années. Cette année, le BRREP a été impacté négativement par la pandémie de Covid-19 dans la mesure où ses partenaires (propriétaires étatiques, privés et communautaires) ne percevaient plus de revenus de leurs activités touristiques normales. Les activités de recherche, y compris les travaux de génétique, ont également été retardées. Le BRREP a ainsi consacré une grande partie de ses ressources financières à apporter un soutien à ces partenaires sous forme d'achat d'équipements, de carburant ou de temps d'hélicoptère pour des opérations de sécurité ou pour la surveillance du rhinocéros noir sur leurs propriétés. Les activités d'extension de l'aire de répartition ont également ralenti en raison des limitations de la capacité du personnel du BRREP à voyager pendant une grande partie de l'année. Néanmoins, l'enthousiasme s'est poursuivi avec un certain nombre de nouvelles propriétés désireuses et prêtes à recevoir des rhinocéros noirs, notamment au Mozambique et dans la province du nord du KwaZulu en Afrique du Sud. Le plan pour l'année à venir est de déplacer environ 40 rhinocéros noirs pour créer deux nouvelles populations.

La vallée du Rifa, au Zimbabwe, en tant que site potentiel de réintroduction du rhinocéros noir

À la demande de la Hemmersbach Rhino Force, l'agent scientifique (AS) du GSRAf a fourni quelques commentaires et suggestions à lewur proposition initiale de réintroduction du rhinocéros noir qui faisait partie de

from the initial study a more comprehensive desktop assessment was undertaken by very experienced local consultants drawing upon the best habitat data, historical rhino reports and maps of the area to give revised initial estimates of the carrying capacity of not just the proposed reintroduction sites but also the Rifa area as a whole. This assessment further confirmed initial concerns around the suitability of the site. A site visit together with an ecologist from the Zimbabwe Parks and Wildlife Management Authority supported these concerns.

This confirmed the value of detailed desktop studies drawing upon a suite of habitat and historical rhino data in providing informed preliminary recommendations. It also reiterates the importance that any reintroduction of animals from elsewhere in the country should be based upon the best criteria with a high probability of success and that it should be fully aligned with the approved National Rhino Plan and with the full support of the national conservation authority.

Mkomazi Rhino Sanctuary, Tanzania

Members of the AfRSG have been involved in undertaking and reviewing a due diligence assessment of the Mkomazi Rhino Sanctuary. The Sanctuary was established with eight founders introduced from South Africa in 1997 and 2001 and a later supplement of seven zoo-bred animals over a number of years. The sanctuary consisted of a number of fenced camps that largely kept the 'wild' South African animals from the 'captive' zoo animals. With the management of the Sanctuary transferred from the private conservation organization (which has managed the Sanctuary from its inception) to TANAPA, there was an ideal opportunity to assess the situation and make recommendations with regards to mixing the two groups through a fencing dropping exercise and strategic removals of individuals that are genetically well represented in the population. These recommendations are still being considered by TANAPA.

Northern White Rhino project, Kenya

The collection of oocytes from the last two remaining Northern White Rhino (NWR) females (Fatu, Najin) has continued on fairly regular intervals through the course of the year,

leur plans pour sécuriser et réhabiliter la section Rifa de la vallée du Zambèze moyen. Ces commentaires initiaux étaient entièrement basés sur une évaluation préliminaire rapide. Ils ont été faits en référence aux meilleures pratiques de réintroduction et de gestion biologique actuellement recommandées. Le GSRAf a fait part de ses préoccupations concernant la capacité de charge du site proposé ainsi que d'autres aspects tels que la sécurité. Suite aux recommandations de l'étude initiale, une évaluation documentaire plus complète a été entreprise par des consultants locaux très expérimentés en s'appuyant sur les meilleures données d'habitat, des rapports historiques sur les rhinocéros et des cartes de la région pour donner des estimations initiales révisées de la capacité de charge, non seulement des sites de réintroduction proposés, mais aussi de la région de Rifa dans son ensemble. Cette évaluation a en outre confirmé les inquiétudes initiales concernant l'adéquation du site. Une visite du site avec un écologiste de l'Autorité de gestion des parcs et de la faune du Zimbabwe a confirmé ces inquiétudes.

Cela a confirmé l'importance d'études documentaires détaillées s'appuyant sur une série de données sur l'habitat et l'historique des rhinocéros pour fournir des recommandations préliminaires éclairées. Il réitère également l'importance que toute réintroduction d'animaux dans le pays doit être basée sur les meilleurs critères avec une forte probabilité de succès et qu'elle doit être pleinement alignée sur le Plan national des rhinos approuvé et avec le plein soutien de l'autorité nationale de la conservation.

Sanctuaire de rhinocéros de Mkomazi, Tanzanie

Les membres du GSRAf ont été impliqués dans la réalisation et l'examen d'une évaluation de diligence raisonnable du sanctuaire de rhinocéros de Mkomazi. Le sanctuaire a été créé avec huit fondateurs introduits d'Afrique du Sud en 1997 et 2001 et un supplément ultérieur de sept animaux élevés en zoo pendant plusieurs années. Le sanctuaire se composait d'un nombre de camps clôturés qui gardaient en grande partie les animaux sud-africains «sauvages» séparés des animaux de zoo «captifs». Avec le transfert de la gestion du sanctuaire de l'organisation de conservation privée (qui gère le Sanctuaire depuis sa création) à la TANAPA, il s'agissait d'une occasion idéale d'évaluer la situation et de faire des recommandations concernant le mélange des deux groupes à travers un exercice de

despite complications associated with Covid-19 travel restrictions. Fatu continues to provide the most oocytes, while Najin who has a tumour next to one of her ovaries has been officially retired from the programme. In order to stimulate reproductive cycling in the females a sterilized male southern white rhino (that is known to have already produced eight calves) was introduced to the two females as a teaser bull.

A number of embryos have been successfully grown in the lab in Cremona, Italy using sperm straws from a number of NWR males collected from animals once held in San Diego and Dvůr Králové.

Other conservation activities

Comments were provided on a proposed introduction of black rhinos to Zinave National Park, Mozambique. It was recommended that any introduction should be informed by a national plan to ensure national government support and a detailed assessment of its potential to support either black or white rhinos, or both.

The AfRSG also provided comments on the proposed genetic supplementation of Eastern black rhinos from EAZA zoos to Ikorongo Grumeti Game Reserve in Tanzania. As the AfRSG in principle supports this type of activity and encourages the repatriation of zoo-bred and orphaned rhino of the correct genetic origin to appropriate and secure rhino ranges, it was supportive of this particular repatriation of three EAZA member zoo-bred animals to the Reserve. This is subject to agreement and authorisation by Tanzanian wildlife authorities and implementation of current best practice for such operations. It also opened the discussion on the need for a framework (logical or otherwise) to assist with the identification and prioritization of areas suitable for rhino repatriation in the East African range states. There is a need to synthesize experiences from historical repatriation programmes and develop repatriation guidelines (or broadening it to 'Best practice guidelines for the capture, care, translocation and naturalization of African rhino species') for future programmes.

Discussions have continued around the possible introduction of black rhinos into Pendjare National Park, Benin.

démontage des clôtures et prélèvements stratégiques d'individus génétiquement bien représentés dans la population. Ces recommandations sont toujours en cours d'examen par la TANAPA.

Projet de rhinocéros blanc du Nord, Kenya

La collecte d'ovocytes des deux dernières femelles de rhinocéros blanc du Nord (RBN) (Fatu, Najin) s'est poursuivie à intervalles assez réguliers au cours de l'année, malgré les complications liées aux restrictions de voyage dues au Covid-19. Fatu continue de fournir le plus d'ovocytes, tandis que Najin, qui a une tumeur à côté de l'un de ses ovaires, a été officiellement retirée du programme. Afin de stimuler le cycle reproducteur chez les femelles, un rhinocéros blanc mâle stérilisé (connu pour avoir déjà produit huit jeunes) a été présenté aux deux femelles en tant que taureau teaser.

Un certain nombre d'embryons ont été cultivés avec succès dans le laboratoire de Crémone, en Italie, en utilisant des paillettes de sperme provenant d'un certain nombre de RBN mâles collectés sur des animaux autrefois détenus à San Diego et à Dvůr Králové.

Autres activités de conservation

Des commentaires ont été fournis sur une proposition d'introduction de rhinocéros noirs dans le parc national de Zinave, au Mozambique. Il a été recommandé que toute introduction soit informée par un plan national pour assurer le soutien du gouvernement national et une évaluation détaillée de son potentiel à soutenir les rhinocéros noirs ou blancs, ou les deux.

Le GSRAf a également fourni des commentaires sur la proposition de supplémentation génétique du rhinocéros noir de l'Est des zoos de l'EAZA à la Réserve de chasse d'Ikorongo Grumeti en Tanzanie. Comme le GSRAf soutient en principe ce type d'activité et encourage le rapatriement des rhinocéros élevés en zoo et des orphelins avec une origine génétique appropriée vers des aires de répartition appropriées et sécurisées, il a soutenu ce rapatriement particulier de trois animaux d'élevage de zoo membres de l'EAZA vers la réserve. Ceci est soumis à l'accord et à l'autorisation des autorités tanzaniennes de la faune sauvage et à la mise en œuvre des meilleures pratiques actuelles pour de telles opérations. Ceci a également ouvert la discussion sur la nécessité d'un cadre (logique ou autre) pour aider à l'identification et à la hiérarchisation des zones propices au rapatriement

Plans

Tanzania

Building upon the discussions on how possibly to integrate the Mkomazi black rhino individuals into the larger Tanzanian rhino populations, consideration is being given to help develop a national metapopulation plan for its black rhino populations.

Mozambique

A national rhino strategy for Mozambique is being drafted and is expected to be completed in late 2021. Numerous national and continental plans and lessons learnt have been shared with the compiler as part of this process. The plan emphasizes the need for the repatriation of rhinos to be based upon best practice, with a focus on restocking the country's numerous national parks that offer suitable habitat and security prospects.

Kenya White Rhinoceros Plan

In response to a request from the Kenya Wildlife Service (KWS), the AfRSG provided comments on its latest national white rhino conservation Plan that had been produced at a stakeholders workshop. (See Khayale et al: *Kenya's first White Rhino Conservation and Action Plan*; pp. 110–116).

Review of the national Botswana rhino Plan

The AfRSG has been approached to participate in the review process of the national rhino Plan for Botswana. We await further details on this.

Feedback on working groups

In order to broaden the involvement of the AfRSG membership and draw upon the groups's collective expertise, the Chair has made extensive use of taskforces and working groups (WGs), with the former pulled together to address urgent and short term issues while the latter adresses more ongoing issues. These are briefly discussed below:

Governance working group

A small team of members helped the Chair develop the '*Governance procedures within*

des rhinocéros dans les États de l'aire de répartition d'Afrique de l'Est. Il est nécessaire de synthétiser les expériences des programmes de rapatriement historiques et d'élaborer des directives de rapatriement (ou de les élargir aux « Directives des meilleures pratiques pour la capture, les soins, la translocation et la naturalisation des espèces de rhinocéros africains ») pour les programmes futurs.

Les discussions se sont poursuivies autour d'une éventuelle introduction de rhinocéros noirs dans le parc national de la Pendjare, au Bénin.

Plans pour le futur

Tanzanie

En s'appuyant sur les discussions sur la manière d'intégrer éventuellement les individus de rhinocéros noirs de Mkomazi dans les populations de rhinocéros tanzaniennes plus vastes, il est envisagé d'aider à développer un plan national de métapopulation pour sa population de rhinocéros noirs.

Mozambique

Une stratégie nationale sur les rhinocéros pour le Mozambique est en cours d'élaboration et devrait être achevée à la fin de 2021. De nombreux plans nationaux et continentaux et des leçons apprises ont été partagés avec le compilateur dans le cadre de ce processus. Le plan souligne la nécessité pour le rapatriement des rhinocéros d'être basé sur les meilleures pratiques, en mettant l'accent sur le repeuplement des nombreux parcs nationaux du pays qui offrent des perspectives d'habitat et de sécurité appropriées.

Plan du rhinocéros blanc du Kenya

En réponse à une demande du Kenya Wildlife Service (KWS), le GSRAf a fourni des commentaires sur son dernier plan national de conservation du rhinocéros blanc qui avait été produit lors d'un atelier des parties prenantes. (Voir Khayale et al: *Kenya's first White Rhino Conservation and Action Plan* ; pp. 110–116).

Examen du plan national du rhinocéros du Botswana

Le GSRAf a été approché pour participer au processus d'examen du plan national sur les rhinocéros pour le Botswana. Nous attendons de plus amples détails à ce sujet.

the IUCN SSC African Rhino Specialist Group (AfRSG)'. This document provides a summary of: The AfRSG's Vision, Mission and Objectives; the terms of reference (TOR) for the Chair, scientific offer (SO) and Programme Officer (PO); criteria by which members are selected; The structure of the Group; The roles and responsibility of the AfRSG and Procedures for decision making. It also provides insights on how the AfRSG links to the umbrella Vision and Mission of IUCN and its operating principles.

In addition, a '*Conflict of Interest (CoI) Policy*' has been developed that all members have updated and this will have to be reconsidered on an annual basis.

With the pending retirement of Dr Richard Emslie from the SO position, the Governance WG has helped with finalizing the job descriptions, the advertisement and interview process for a replacement SO and the new position of PO. The successful candidates will be appointed in the second half of 2021.

Membership working group

The Membership WG activities have overlapped with that of the above Governance WG. However, there have been useful discussions on the value of the skills audit, addressing skills shortfalls in the Group, and potential new members.

Data working group

Rhino conservation is not simply a numbers game as some populations have greater population viability and are of greater conservation value than others. In recognition of this, a WG, has been developing and trialing a possible system for rating and scoring rhino populations for their viability/conservation value (see above). This could possibly also be used by some funders to assess changes in rhino conservation value scores at sites they have been supporting. These conservation value scores also offer the potential to adjust the system of rating ***Key*** and ***Important*** populations so that it reflects more than just numbers and recent population trends (after allowing for translocations). The overall objectives of this scoring system is to: 1) Improve current AfRSG population rating by drawing attention to unproductive populations while still identifying key/important populations as the

Rapports sur les groupes de travail

Afin d'élargir l'implication des membres du GSRAf et de tirer parti de l'expertise collective des groupes, la présidence a largement utilisé des forces opérationnelles et des groupes de travail (GT), les premiers se sont regroupés pour traiter des problèmes urgents et à court terme tandis que les seconds abordent des problèmes plus récurrents. Ceux-ci sont brièvement discutés ci-dessous:

Groupe de travail sur la Gouvernance

Une petite équipe de membres a aidé le président à développer les « Procédures de gouvernance au sein du Groupe de spécialistes du rhinocéros d'Afrique (GSRAf) de la CSE de l'UICN ». Ce document fournit un résumé de: La vision, la mission et les objectifs du GSRAf; Les termes de référence du président, du AS et de l'Agent de programme (AP); Critères de sélection des membres; La structure du Groupe; Les rôles et la responsabilité du GSRAf et; Les procédures de prise de décision. Il fournit également des informations sur la manière dont le GSRAf est lié à la vision et à la mission de l'UICN et à ses principes de fonctionnement.

En outre, une « Politique de conflit d'intérêts (CoI – Conflict of Interest) » que tous les membres ont mise à jour a été élaborée et qui devra être réexaminée chaque année.

Avec le départ à la retraite imminent du Dr Richard Emslie du poste d'AS, le GT sur la gouvernance a aidé à finaliser les descriptions de poste, le processus d'annonce et d'entretien pour un remplaçant d'AS et le nouveau poste d'AP. Les candidats retenus seront nommés au second semestre 2021.

Groupe de travail sur l'adhésion

Les activités du GT sur l'adhésion ont chevauché celles du GT sur la gouvernance ci-dessus. Cependant, il y a eu des discussions utiles sur la valeur de l'audit des compétences, la résolution des pénuries de compétences dans le Groupe et les nouveaux membres potentiels.

Données

La conservation des rhinocéros n'est pas simplement un jeu de nombres, car certaines populations ont une plus grande viabilité et ont une plus grande valeur de conservation que d'autres. En reconnaissance de cela, un GT a développé et testé un système possible d'évaluation et de notation des populations de rhinocéros pour leur viabilité/valeur de conservation (voir ci-dessus). Cela pourrait également être utilisé

current rating system does, and: 2) Provide key metrics for Monitoring and Evaluation of rhino conservation projects (such as required by the US Fish and Wildlife Service). It will likely need to be finalized following discussions with the wider AfRSG membership at the next AfRSG meeting.

The proposed scoring system starts with rhino numbers and then adjusts these taking into account possible growth in numbers over the next five years based on average net growth (after allowing for translocations) in recent years, data reliability and a number of factors relating to population expansion potential, wildness and genetic status. Final scores can potentially be higher (for populations of highest conservation status) or lower than current rhino numbers (when of lower conservation status).

Bigger populations are scored highest (due to the better genetic diverse spread) with populations being downweighted more as they get smaller. Also, the greater the founder numbers in a population, the better (ideally 20+ unrelated founders). The faster the underlying and net biological growth rates the better—both for demographic (thanks to compounding, boosting rhino numbers and increasing a population's ability to withstand poaching) and genetic reasons (conservation for more genetic diversity in rapidly breeding populations due to lower levels of genetic drift). Active metapopulation management of smaller populations can also improve their genetic conservation value. Other factors considered included the ability of populations to grow, trends and levels of poaching and the degree of unnatural manipulation and management of rhinos (opposing natural selection) and risks of inbreeding.

At times there may also be a need to score reserves/PAs based on the total conservation value of both species of rhinos they contain (for example, to prioritize which populations might qualify for additional security efforts that will enhance protection of both species). This can be achieved by adjusting the scores of one species based on the relative numbers of the two species (effectively giving greater weight to scores for the rarer black rhino) while leaving the scores for the other species unchanged. The resultant scores for both species can then be summed to get a combined total rhino conservation score for a reserve/PA.

par certains bailleurs de fonds pour évaluer les changements dans les scores de valeur de conservation des rhinocéros sur les sites qu'ils soutiennent. Ces scores de valeur de conservation offrent également la possibilité d'ajuster le système d'évaluation des populations ***Clés*** et ***Importantes*** afin qu'il reflète plus que les chiffres et les tendances récentes des populations (après avoir permis les translocations). Les objectifs généraux de ce système de notation sont de 1) Améliorer la notation actuelle de la population par le GSRAf en attirant l'attention sur les populations improductives tout en identifiant les populations clés/importantes comme le fait le système de notation actuel et ; 2) Fournir des paramètres clés pour le Suivi et l'Évaluation des projets de conservation des rhinocéros (tels que requis par le US Fish and Wildlife Service). Il devra probablement être finalisé à la suite de discussions avec l'ensemble des membres du GSRAf lors de la prochaine réunion du GSRAf.

Le système de notation proposé commence par les nombres de rhinocéros, puis les ajuste en tenant compte de la croissance possible du nombre au cours des cinq prochaines années en fonction de la croissance nette moyenne (après avoir tenu compte des translocations) au cours des dernières années, de la fiabilité des données et d'un certain nombre de facteurs liés au potentiel d'expansion de la population, de sa nature sauvage et son statut génétique. Les scores finaux peuvent potentiellement être plus élevés (pour les populations dont l'état de conservation est le plus élevé) ou inférieurs aux nombres actuels de rhinocéros (lorsque l'état de conservation est inférieur).

Les plus grandes populations sont les mieux notées (en raison d'une meilleure diversité génétique), les populations étant d'autant moins notées qu'elles deviennent plus petites. De plus, plus le nombre de fondateurs dans une population est grand, mieux c'est (idéalement 20+ fondateurs indépendants). Plus les taux de croissance biologique sous-jacents et nets sont rapides, mieux c'est— à la fois pour des raisons démographiques (grâce à l'augmentation du nombre de rhinocéros et à l'augmentation de la capacité d'une population à résister au braconnage) et pour des raisons génétiques (conservation d'une plus grande diversité génétique dans les populations qui se reproduisent rapidement en raison de niveaux inférieurs de dérive génétique). La gestion active des métapopulations de populations plus réduites peut également améliorer leur valeur génétique de conservation. D'autres facteurs pris en compte comprenaient la capacité des

Adequate Financing working group

This WG expanded their discussion beyond the initial intention of exploring and developing financing mechanisms and structures to adequately and sustainably fund rhino conservation to include a suite of issues, such as: basic fund-raising needs and opportunities for rhino conservation; "the need to change our narrative" to bring rhino conservation into the broader more landscape-level approaches currently being developed that are based on more people-orientated/sustainable development/climate change approaches.

It concluded that the WG should focus its initial efforts on innovative, more broadly-based mechanisms and structures for funding rhino conservation needs that go beyond traditional funding sources and are designed to embed resources needed to conserve rhinos within more contemporary and broader funding approaches.

Noteworthy meetings and contributions

Rhino Impact Investment Project (RIIP)

The Rhino Impact Investment Project (RIIP) final evaluation took place at the beginning of the reporting period. It concluded that the project was highly relevant for rhino conservation efforts at the site level, as well as national, regional and global scale. The project´s pioneering nature transcends conservation finance and species conservation with potential long-term impact in terms of how species conservation is managed and measured.

Work has continued getting the first South African RIIP Bond ready for launch. This innovative wildlife conservation bond financing mechanism plans to use a World Bank, International Bank for Reconstruction and Development IBRD AAA-rated bond. Covid-19 has however delayed its launch.

High Level Panel (South Africa)

In October 2019 the South African Department of Forestry, Fisheries and Environment (DFFE) established the Advisory Committee (High Level Panel (HLP)) to investigate the handling and management, breeding, hunting and trade of elephant, lion, leopard and rhinoceros. One

populations à croître, les tendances et les niveaux de braconnage et le degré de manipulation et de gestion non naturelle des rhinocéros (s'opposant à la sélection naturelle) et les risques de consanguinité. Parfois, il peut également être nécessaire de noter les réserves/AP sur la base de la valeur de conservation totale des deux espèces de rhinocéros qu'elles contiennent (par exemple, pour prioriser les populations susceptibles de bénéficier d'efforts de sécurité supplémentaires qui amélioreront la protection des deux espèces). Cela peut être atteint en ajustant les scores d'une espèce sur la base des nombres relatifs des deux espèces (ce qui donne effectivement plus de poids aux scores pour le rhinocéros noir plus rare) tout en laissant les scores pour les autres espèces inchangés. Les scores résultants pour les deux espèces peuvent alors être additionnés pour obtenir un score total combiné de conservation des rhinocéros pour une réserve/AP.

Groupe de travail sur le financement adéquat

Ce groupe a élargi sa discussion au-delà de l'intention initiale d'explorer et de développer des mécanismes et des structures de financement pour financer de manière adéquate et durable la conservation des rhinocéros pour inclure une série de questions, telles que: les besoins de base en matière de collecte de fonds et les opportunités pour la conservation des rhinocéros; « la nécessité de changer notre récit » pour intégrer la conservation des rhinocéros dans les approches plus larges au niveau du paysage actuellement développées et basées sur des approches davantage axées sur les personnes/développement durable/changement climatique.

Il a conclu que le GT devrait concentrer ses efforts initiaux sur des mécanismes et des structures innovants et plus larges pour financer les besoins de conservation des rhinocéros qui vont au-delà des sources de financement traditionnelles et sont conçus pour intégrer les ressources nécessaires à la conservation des rhinocéros dans des approches de financement plus contemporaines et plus larges.

Réunions et contributions marquantes

Projet d'investissement d'impact des Rhinocéros (RIIP - Rhino Impact Investment Project)

L'évaluation finale du Rhino Impact Investment Project (RIIP) a eu lieu au début de la période de référence.

member of the AfRSG sat on the panel.

During the course of 2020 and 2021, the AfRSG has engaged with the HLP on several occasions. We provided a written submission and an oral presentation in June 2020 with scientific or other relevant information concerning the review of policies, legislation and practices relating to the management, handling, breeding, hunting and trade of rhinos. The HLP members reflected that the AfRSG presentation was one of the most neutral and useful made to the panel.

Furthermore, the AfRSG has also provided a detailed response in July 2021 to the HLP report released in December 2020, the 'Draft Policy Position on the Conservation and Ecologically Sustainable Use of Elephant, Lion, Leopard and Rhinoceros' release in June 2021 and a virtual meeting on 28 June 2021 hosted by DFFE with invited members of the rhino 'community' ostensibly to discuss 'Developing an Integrated and Sustainable Conservation Strategy for Rhino'. The AfRSG recommended the following:

- The development of the policy as it relates to rhinos needs to have a more inclusive consultation process, especially from recognized rhino experts, state conservation agencies, private sector and communities, allowing time to discuss fully the findings and implications of the HLP report.
- Every effort should be made to build trust with the private sector, ideally through professional mediation. Ways in which this sector could be incentivized to assist with achieving greater transformation of the wildlife economy including rhinos should also be thoroughly explored.
- Inputs and recommendations from the CITES Scientific Authority on CITES related trade issues and the management of semi-intensive rhino operations need to be included.
- It would be better to split policies by species to reduce challenging issues associated with controversial issues such as intensive lion breeding and confounding of issues that are different such as ivory and rhino horn disposal. This would also allow for more time to be allocated to rhino related issues.

Elle a conclu que le projet était très pertinent pour les efforts de conservation des rhinocéros au niveau du site, ainsi qu'à l'échelle nationale, régionale et mondiale. La nature pionnière du projet transcende le financement de la conservation et la conservation des espèces avec un impact potentiel à long terme en termes de gestion et de mesure de la conservation des espèces.

Les travaux se sont poursuivis pour préparer le lancement du premier RIIP Bond sud-africain. Le mécanisme innovant de financement des obligations pour la conservation de la faune prévoit d'utiliser une obligation notée AAA de la Banque mondiale et de la Banque internationale pour la reconstruction et le développement BIRD. Le Covid-19 a cependant retardé son lancement.

Panel de haut niveau (Afrique du Sud)

En octobre 2019, le Département sud-africain des forêts, des pêches et de l'environnement (DFFE—Department of Forestry, Fisheries and Environment) a créé le comité consultatif (Panel de haut niveau (HLP—High Level Panel)) pour enquêter sur la manipulation et la gestion, l'élevage, la chasse et le commerce des éléphants, des lions, des léopards et des rhinocéros. Un membre du GSRAf siégeait au panel.

Au cours des années 2020 et 2021, le GSRAf s'est engagé à plusieurs reprises avec le HLP. Nous avons fourni une soumission écrite et une présentation orale en juin 2020 avec des informations scientifiques et autres informations pertinentes concernant l'examen des stratégies, législations et pratiques relatives à la gestion, la manipulation, l'élevage, la chasse et le commerce des rhinocéros. Les membres du HLP ont indiqué que la présentation du GSRAf était l'une des plus neutres et utiles faites au panel.

En outre, le GSRAf a également fourni une réponse détaillée en juillet 2021 au rapport du HLP publié en décembre 2020, le « Projet de position politique sur la conservation et l'utilisation écologiquement durable de l'éléphant, du lion, du léopard et du rhinocéros » publié en juin 2021 et à une réunion le 28 juin 2021 organisée par le DFFE avec des membres invités de la "communauté" des rhinocéros, ostensiblement pour discuter du « Développement d'une stratégie de conservation intégrée et durable pour les rhinocéros ». Le GSRAf a recommandé ce qui suit :

- Le développement de la stratégie en ce qui concerne les rhinocéros doit avoir un processus de consultation plus inclusif, en particulier avec

- A population viability assessment (PVA) should be undertaken as an objective tool to consider the role of /need for and desired extent of captive breeding operations (CBOs) and semi-intensive white rhino operations as part of an overall white rhino conservation strategy. This could feed into AfRSG's weighted prioritization of rhino populations.
- The need for greater clarity on 1) how a move to greater 'wildness' will actually be achieved in practice whilst not negatively impacting the national population at a time of heavy poaching pressure (albeit partially reduced recently due to Covid-19 travel restrictions impacting on the transport of horn to end user markets in SE Asia); and 2) how substantially broader inclusiveness in the natural economy can be achieved, encouraged and funded without negatively impacting on rhino numbers.
- That South Africa needs to always distinguish between species and subspecies of rhino in its reporting on population sizes and poaching data.
- That current reporting of rhino numbers (especially on some private properties) needs to be improved and the need for rhino numbers from Kruger National Park (with confidence levels) to be released timeously.

Presentations, papers, TV and Radio

Some AfRSG members assisted the *Economist* that was making a film outlining the conservation benefits and rationale for controlled ethical hunting. In addition the Chair provided comments on the rhino population status in Kruger National Park to the *Mail & Guardian (SA)* and *National Geographic*. In addition, I have also directed inquries from independent journalists on subjects such as captive breeding of rhinos to AfRSG members with the skills and experience to answer it. The Chair has also provided comments to journalistrs regarding the poaching crisis in Botswana.

During the reporting period some virtual IUCN SSC meetings were attended.

des experts en rhinocéros reconnus, des agences de conservation de l'État, du secteur privé et des communautés, laissant le temps de discuter pleinement des conclusions et des implications du rapport HLP.

- Tous les efforts doivent être faits pour établir la confiance avec le secteur privé, idéalement par le biais d'une médiation professionnelle. Les moyens par lesquels ce secteur pourrait être incité à contribuer à une plus grande transformation de l'économie de la faune, y compris des rhinocéros, devraient également être explorés en profondeur.
- Les contributions et recommandations de l'autorité scientifique sur les questions commerciales liées à la CITES et la gestion des opérations semi-intensives de rhinocéros doivent être incluses.
- Il serait préférable de séparer les stratégies par espèces pour réduire les problèmes de confusion associés à des questions controversées telles que l'élevage intensif de lions et la confusion de problèmes différents tels que la mise au rebut de l'ivoire et de la corne de rhinocéros. Cela permettrait également d'allouer plus de temps aux problèmes liés aux rhinocéros.
- Une évaluation de la viabilité de la population (PVA - population viability assessment) devrait être entreprise comme un outil objectif pour considérer le rôle/ la nécessité et l'étendue souhaitée des CBO et des opérations semi-intensives de rhinocéros blancs dans le cadre d'une stratégie globale de conservation du rhinocéros blanc. Cela pourrait alimenter la hiérarchisation pondérée des populations de rhinocéros par le GSRAf.
- La nécessité d'une plus grande clarté sur 1) comment un passage à une plus grande « nature sauvage » sera réellement réalisé dans la pratique tout en n'ayant pas d'impact négatif sur le troupeau national à une époque de forte pression de braconnage (bien que partiellement réduit récemment en raison des restrictions de voyage dues au Covid qui ont un impact sur les transports des cornes aux marchés d'utilisateurs finaux en Asie du Sud-Est); et 2) comment une inclusion sensiblement plus large dans l'économie naturelle peut être atteinte, encouragée et financée sans avoir d'impact négatif sur le nombre de rhinocéros.
- Que l'Afrique du Sud doit toujours faire la distinction entre les espèces et les sous-espèces de rhinocéros dans ses rapports sur la taille des populations et les données de braconnage.

Acknowledgements

Rhino range states in Africa 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), the US Fish and Wildlife Service's Rhino and Tiger Conservation Fund (USFWS RTC), Safari Club International (SCI) and the Endangered Wildlife Trust (EWT) for support provided to the AfRSG SO and Chair to enable them to render service to the Group. WWF in Namibia is also thanked for their support to the Chair.

Much appreciative thanks to Richard Emslie our SO for his constant invaluable service and insightful support to the Secretariat. I also thank our rhino Section Editor of *Pachyderm* Kees Rookmaaker for his untiring support to the journal and maintaining the invaluable Rhino Resource Centre: http://www.rhinoresourcecenter.com/.

- Que les rapports actuels sur les nombres de rhinocéros (en particulier sur certaines propriétés privées) doivent être améliorés et que les nombres de rhinocéros du PN Kruger (avec des niveaux de confiance) doivent être publiés en temps voulu.

Présentations, communications, TV et radio

Certains membres du GSRAf ont aidé l'Économiste qui réalisait un film décrivant les avantages de la conservation et la justification d'une chasse éthique contrôlée. De plus, le président a fourni des commentaires sur l'état de la population de rhinocéros dans le PN Kruger au *Mail & Guardian (Afrique du Sud)* et au *National Geographic*. En outre, j'ai également dirigé des demandes de journalistes indépendants sur des sujets tels que l'élevage en captivité de rhinocéros aux membres du GSRAf ayant les compétences et l'expérience pour y répondre. Le président a également fourni des commentaires aux journalistes concernant la crise du braconnage au Botswana.

Au cours de la période considérée, certaines réunions virtuelles de la CSS de l'UICN ont été suivies.

Remerciements

Les États de l'aire de répartition du rhinocéros en Afrique sont remerciés pour leur contribution d'informations continues au Secrétariat. Le GSRAf remercie également Save the Rhino International (SRI), International Rhino Foundation (IRF), le Rhino and Tiger Conservation Fund du US Fish and Wildlife Service (USFWS RTC), le Safaris Club International (SCI) et l'Endangered Wildlife Trust (EWT) pour le soutien apporté au AS et au président du GSRAf pour leur permettre de rendre ses précieux services au groupe. Le WWF en Namibie est également remercié pour son soutien à la présidence.

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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

Nepal

During March 2021, the Department of National Parks and Wildlife Conservation, Government of Nepal, carried out a nation-wide estimate of greater one-horned (GOH) rhinos (*Rhinoceros unicornis*) covering four Protected Areas (PAs). According to the survey, Nepal's rhino population has risen to 752 from 645 since the last census was conducted in 2015, marking a promising milestone. Chitwan National Park (NP) which holds 90%, accounted for an increase of 89 rhinos up from 605 rhinos to 694, Bardiya NP recorded 38 rhinos, Shuklaphanta NP, 17 and Parsa NP three. These three NPs in Nepal had 29, eight and three rhinos in 2015, respectively. While the increase in rhino population is remarkable, moving the GOH rhino's status from Endangered to Vulnerable, the AsRSG still agrees that the situation remains fragile. The latest rhino census, which took place after an interval of six years, shows that the annual growth rate has remained below three per cent. From 2011 to 2015, the growth rate was five per cent for that period. Experts attribute this mainly to an unprecedented increase in the number of deaths due to natural causes: old age, territorial fights, disease and even drowning during flooding. (See Dutta et al.'s study entitled: *Greater one-horned rhinoceros behaviour during high floods at Kaziranga National Park and the Burhachapori Wildlife Sanctuary, Assam, India*; pp. 63–73).

In the fiscal year from 16 July 2016 to 15 July 2017, 24 rhinos were reported to have died from natural causes, another was killed by poachers.

État actuel des rhinocéros indiens en Inde et au Népal

Népal

En mars 2021, le Département des parcs nationaux et de la conservation de la faune, du gouvernement du Népal, a réalisé une estimation du grand rhinocéros indien (*Rhinoceros unicornis*) à l'échelle nationale, couvrant quatre aires protégées (AP). Selon l'enquête, la population de rhinocéros du Népal est passée de 645 à 752 depuis le dernier recensement effectué en 2015, marquant une étape prometteuse. Le parc national (PN) de Chitwan qui détient 90%, a représenté une augmentation de 89 rhinocéros, passant de 605 rhinocéros à 694, le PN de Bardiya a enregistré 38 rhinocéros, le PN de Shuklaphanta, 17 et le PN de Parsa, trois. Ces trois parcs au Népal comptaient respectivement 29, huit et trois rhinocéros en 2015. Bien que l'augmentation de la population de rhinocéros soit remarquable, faisant passer le statut du rhinocéros indien d'en danger à vulnérable, le GSRAs est toujours d'accord pour dire que la situation reste fragile. Le dernier recensement des rhinocéros, qui a eu lieu après un intervalle de six ans, montre que le taux de croissance annuel est resté inférieur à 3 pourcent. De 2011 à 2015, le taux de croissance était de 5 pourcent pour cette période. Les experts attribuent cela principalement à une augmentation sans précédent du nombre de décès dus à des causes naturelles: vieillesse, luttes territoriales, maladies et même noyades lors des inondations. (Voir l'étude de Dutta et al. intitulée: *The behaviour of greater one-horned rhinoceros during high floods at Kaziranga National Park and the Laokhowa-Burhachapori Wildlife Sanctuary Complex.* (pp. 63–73)).

Au cours de l'exercice budgétaire du 16 juillet 2016 au 15 juillet 2017, 24 rhinocéros seraient morts de causes naturelles et un rhinocéros a été tué par des braconniers. Vingt-six rhinocéros sont morts au cours

Twenty–six rhinos died in the fiscal year 2017–18; 43 in 2018–19; and 26 in 2019-20. In the fiscal year 2020–2021, 22 rhinos have died in Chitwan National Park, four of them were killed by poachers.

India

A rhino survey was conducted in the state of Assam for Manas National Park in March 2020 and 44 rhinos were counted. Since 2018, there have been no further GoH rhino population surveys for Kaziranga National Park, Orang National Park and Pabitora Wildlife Sanctuary (WLS). The populations of GoH rhinos at that time were: 2,413 rhinos for Kaziranga National Park, 101 in Orang National Park and 102 Pabitora WLS.

In West Bengal, another rhino bearing state in India, 237 rhinos were counted in Jaldapara National Park in 2019, while in Gorumara National Park the rhino population was 52. The last count in Gorumara National Park took place in 2015.

In Uttar Pradesh in northern India, the Dudhwa National Park holds about 38 rhinos as per DNA based non-invasive rhino dung analysis.

In the reporting period, July 2020 to the end of June 2021 Assam lost two rhinos to poaching in Kaziranga National Park. Other rhino bearing areas in Assam namely Manas NP, Orang NP and Pabitora WLS have achieved zero rhino poaching in the past year. In West Bengal, India, only one female rhino was killed by suspected poachers in early April 2021. This marks an achievement in the recovery of the species.

Overall scenario of Javan and Sumatran rhino

Javan rhino

The Ministry of Environment and Forestry, Indonesia, revealed that there are now 73 Javan rhinos (*Rhinoceros sondaicus*) in Ujung Kulon National Park (UKNP) in west Java, after sightings of two new rhino calves by camera trap. UKNP holds the last known population of Javan rhinos in the world. The addition of the two calves brings the species' balance to 40 males and 33 females.

de l'exercice 2017-2018; 43 en 2018-2019; et 26 en 2019-2020. Au cours de l'exercice 2020-2021, 22 rhinocéros sont morts dans le PN de Chitwan, dont quatre ont été tués par des braconniers.

Inde

Une enquête sur les rhinocéros a été menée dans l'État d'Assam pour le PN de Manas en mars 2020 et 44 rhinocéros ont été dénombrés. Depuis 2018, il n'y a plus eu d'enquêtes sur les populations de rhinocéros indiens pour le PN de Kaziranga, le PN d'Orang et le Sanctuaire de faune (SF) de Pabitora. Les populations de rhinocéros du GoH à cette époque étaient dO: 2,413 rhinocéros pour le PN de Kaziranga, 101 dans le PN d'Orang et 102 dans le SF de Pabitora.

Au Bengale Occidental, un autre État indien où vivent des rhinocéros, 237 rhinocéros ont été dénombrés dans le PN de Jaldapara en 2019, tandis que dans le PN de Gorumara, la population de rhinocéros était de 52. Le dernier dénombrement dans le PN de Gorumara a eu lieu en 2015.

Dans l'Uttar Pradesh, dans le nord de l'Inde, le PN de Dudhwa abrite environ 38 rhinocéros selon l'analyse non invasive des excréments de rhinocéros basée sur l'ADN.

Au cours de la période considérée, de juillet 2020 à fin juin 2021, l'Assam a perdu deux rhinocéros à cause du braconnage dans le PN de Kaziranga. D'autres zones où vivent des rhinocéros dans l'Assam, à savoir le PN de Manas, le PN d'Orang et le SF de Pabitora, ont atteint un taux de zéro braconnage de rhinocéros au cours de la dernière année. Au Bengale Occidental, en Inde, une seule femelle rhinocéros a été tuée par des braconniers présumés début avril 2021. Ceci démontre un succès dans le rétablissement de l'espèce.

Scénario global des rhinocéros de Java et de Sumatra

Rhinocéros de Java

Le ministère indonésien de l'Environnement et des Forêts a révélé qu'il y avait maintenant 73 rhinocéros de Java (*Rhinoceros sondaicus*) dans le parc national d'Ujung Kulon (PNUK) dans l'ouest de Java, après l'observation par piège photographique, de deux nouveaux jeunes rhinocéros. PNUK détient la dernière population connue de rhinocéros de Java dans le monde. L'ajout des deux jeunes porte le ratio

The AsRSG has been informed that at least one new calf a year has increased the population since 2012, boosting hopes for a stable population of the Javan rhino which remains Critically Endangered on the IUCN Red List. Despite the stable population (the birth rate and death rate are in stasis) the rhinos remain under the ongoing threat of disease, natural disaster, and a resurgence of encroachment affecting the Javan rhinos' last remaining habitat on the planet.

To enhance Javan rhino conservation, Rhino Protection Units (RPUs), International Rhino Foundation (IRF), Yayasan Badak Indonesia (YABI) and Park staff operate five terrestrial and two marine law enforcement surveying and monitoring teams for the rhino populations in UKNP. RPUs are highly-trained, four-person anti-poaching teams that intensively patrol key areas within UKNP. The goal of the RPU programme is to prevent the extinction of Javan rhinos and other threatened species and to protect critical habitats in Java through proactive prevention of poaching and habitat destruction. RPUs track each individual rhino with camera traps, ensuring an accurate count of the population. If appropriate, the RPUs then collect evidence and help make arrests.

In addition to enhancing protection efforts, the UKNP and YABI have developed the 5,000 hectare Javan Rhino Study and Conservation Area (JRSCA) in the Gunung Honje area, along UKNP's eastern boundary. Ensuring the survival of the Javan rhino depends on their population increasing in numbers as rapidly as possible, and this new designated area would provide more habitat to allow the population to increase under intensified management and protection. A safe haven and staging ground is also part of the plan before translocations commence.

Sumatran rhino

The current population of Sumatran rhino (*Dicerorhinus sumatrensis*) is not known as it continues to be challenging to carry out population estimates. However, the recent trend of sightings of Sumatran rhinos in the wild, based on direct sightings, footprints and camera traps does indicate that the populations of Sumatran rhino may reflect a decreasing trend and it could be much below the earlier global estimates of

de l'espèce à 40 mâles et 33 femelles.

Le GSRAs a été informé qu'au moins un nouveau jeune rhinocéros par an a fait grandir la population depuis 2012, renforçant les espoirs d'une population stable de rhinocéros de Java qui reste « en danger critique d'extinction » sur la Liste rouge de l'UICN. Malgré la population stable (le taux de natalité et le taux de mortalité sont en stagnation), les rhinocéros restent sous la menace permanente de la maladie, des catastrophes naturelles et d'une résurgence de l'empiètement du dernier habitat des rhinocéros de Java restant sur la planète.

Afin d'améliorer la conservation du rhinocéros de Java, les Unités de protection des rhinocéros (RPU – Rhino Protection Units), la Fondation internationale du rhinocéros (IRF – International Rhino Foundation), Yayasan Badak Indonesia (YABI) et le personnel du parc mènent cinq enquêtes terrestres et deux marines pour l'application de la loi et le suivi des populations de rhinocéros dans le PNUK. Les RPU sont des équipes anti-braconnage de quatre personnes hautement qualifiées qui patrouillent intensivement dans les zones clés du PNUK. L'objectif du programme RPU est d'empêcher l'extinction des rhinocéros de Java et d'autres espèces menacées et de protéger les habitats critiques de Java grâce à une prévention proactive du braconnage et de la destruction de l'habitat. Les RPU suivent chaque rhinocéros individuel avec des pièges photographiques, assurant un décompte précis de la population. Le cas échéant, les RPU recueillent ensuite des preuves et aident à procéder aux arrestations.

En plus de renforcer les efforts de protection, le PNUK et YABI ont développé les 5,000 ha de la Zone d'étude et de conservation du rhinocéros de Java (JRSCA – Javan Rhino Study and Conservation Area) dans la région de Gunung Honje, le long de la limite est du PNUK. Pour assurer la survie du rhinocéros de Java, il est nécessaire d'augmenter le nombre de sa population aussi rapidement que possible, et cette nouvelle zone désignée fournirait plus d'habitat pour permettre à la population d'augmenter dans le cadre d'une gestion et d'une protection intensifiées. Un havre de paix et un lieu de rassemblement font également partie du plan avant le début des translocations.

Rhinocéros de Sumatra

La population actuelle du rhinocéros de Sumatra (*Dicerorhinus sumatrensis*) n'est pas connue car

80 individuals. More field survey efforts are ongoing to ascertain an accurate count and current status in the few forest areas in Indonesia and other range countries in South and Southeast Asia which are Sumatran rhino habitat.

The Sumatran rhinos survive in very small and highly fragmented populations in Indonesia preventing their ability to meet for breeding opportunities. Rhino habitat is also continuously encroached by humans. The largest populations of wild rhinos are found in Bukit Barisan Selatan, Gunung Leuser, and Way Kambas National Parks in Sumatra, Indonesia; there is also a tiny population in Kalimantan, Borneo. In 2015 the species was declared extinct in the wild in Malaysia.

A captive-breeding facility for Sumatran rhinos in Indonesia's Aceh province is advancing as part of conservation efforts to save the nearly extinct species, with rhinos which were captured or are to be captured in Aceh province, Indonesia.

The planned facility, the third in the Sumatran Rhino Sanctuary (SRS) network, is one of Indonesia's top strategies to help prevent the global population of the Sumatran rhino from going extinct in the wild. 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 National Park in southern Sumatra, and the second in eastern Indonesian Borneo.

Updates on Indian Rhino Vision 2020

In mid–April 2021, two rhinos (one male and one female) rhinos were captured in Assam's Pabitora WLS and translocated and released in Manas NP, Assam. In total since 2008, 22 wild rhinos have been captured from Kaziranga National Park and Pabitora WLS and translocated and released in Manas National Park. The Indian Rhino Vision (IRV2020) has formally come to a close with the translocation of these two rhinos to Manas National Park. Plans for the next programme are underway and will be announced in the next edition of *Pachyderm*, in 2022. The new arrivals increased the population of GoH rhinos in Manas National Park to 49. The goal of IRV2020 was to

il reste difficile d'effectuer des estimations de population. Cependant, la tendance d'observations récente de rhinocéros de Sumatra dans la nature, basée sur des observations directes, des traces et des pièges photographiques, indique que les populations de ces rhinocéros semblent refléter une tendance à la baisse qui pourrait être bien inférieure aux estimations mondiales antérieures de 80 individus. D'autres efforts d'enquête sur le terrain sont en cours pour déterminer son statut actuel dans les quelques zones forestières d'Indonésie et d'autres pays de l'aire de répartition en Asie du Sud et du Sud-Est qui constituent l'habitat du rhinocéros de Sumatra.

Les rhinocéros de Sumatra survivent en populations très réduites et fragmentées en Indonésie, ce qui limite les possibilités de reproduction. L'habitat du rhinocéros est également continuellement empiété par les humains. Les plus grandes populations de rhinocéros sauvages se trouvent dans les parcs nationaux de Bukit Barisan Selatan, Gunung Leuser et Way Kambas à Sumatra, en Indonésie; il y a aussi une petite population à Kalimantan, Bornéo. L'espèce a récemment été déclarée éteinte à l'état sauvage en Malaisie.

Une installation d'élevage de rhinocéros de Sumatra en captivité est en progrès dans la province indonésienne d'Aceh, dans le cadre des efforts de conservation visant à sauver les espèces presque éteintes qui ont été capturées ou à capturer dans la province d'Aceh en Indonésie.

L'installation prévue, la troisième du réseau du Sanctuaire du Rhino de Sumatra (SRS - Sumatran Rhino Sanctuary), est l'une des principales stratégies de l'Indonésie pour aider à empêcher la population mondiale de rhinocéros de Sumatra de s'éteindre à l'état sauvage. La nouvelle installation est en particulier adaptée à la sous-population survivante dans l'écosystème de Leuser dans le nord de Sumatra. Le premier SRS se trouve à l'intérieur du PN de Way Kambas, dans le sud de Sumatra, et le second dans l'est de Bornéo indonésien.

Mises à jour sur Indian Rhino Vision 2020

À la mi-avril 2021, deux rhinocéros (un mâle et une femelle) ont été capturés dans le SF de Pabitora de l'Assam et transférés et relâchés dans le PN de Manas, Assam. Au total depuis 2008, 22 rhinocéros sauvages ont été capturés dans le PN de Kaziranga et dans le SF

increase the rhino population in Assam to 3,000 by re-establishing populations in certain areas.

Follow up steps on 2nd Asian Rhino Range States meeting

The second Asian Rhino Range States meeting was held in New Delhi, India from 26 to 28 February 2019 where the Ministry of Environment, Forests and Climate Change (MoEFCC), Government of India (GoI) launched the "National Conservation Strategy for the Indian One Horned Rhinoceros" to usher renewed hope to secure the future of the GOH rhino in India. During 2020–2021, the MoEFCC, GoI, initiated a series of virtual meetings to prepare standard operating procedures (SOP) for the GOH rhinos in India which includes a SOP for rhino carcass disposal, and a SOP for rhino estimations.

Read more here: https://www.iucn.org/sites/dev/files/content/documents/2019_asian_rhino_sg_report-publication.pdf

Engaging AsRSG members through webinar during the Covid-19 Pandemic

During the past fifteen months, due to the prevailing Covid-19 pandemic throughout the globe, AsRSG members have also faced challenging times. To keep members updated on the current status of Asian Rhinos, one webinar on the "Current Status of Sumatran Rhino" was organized in September 2020 which over 60 members and special invitees attended.

We also take this opportunity to thank our partners: World Wide Fund for Nature, the International Rhino Foundation, Aaranyak and Save the Rhino International.

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

Obituaries

AsRSG deeply mourns the untimely death of two of its active members—Mr Widodo Ramono and Dr Marcellus Adi in Indonesia due to Covid-19 related complications.

de Pabitora et relâchés dans le PN de Manas. L'Indian Rhino Vision (IRV2020) a officiellement pris fin avec la translocation de ces deux rhinocéros vers le PN de Manas. Les plans pour le prochain programme sont en cours et seront annoncés dans la prochaine édition de *Pachyderm*, en 2022. Les nouveaux arrivants ont agrandi la population de rhinocéros indiens dans le PN de Manas à 49. L'objectif d'IRV2020 était d'augmenter la population de rhinocéros dans l'Assam à 3,000 individus en établissant des populations dans de nouvelles zones.

Étapes de suivi de la 2e réunion des États de l'aire de répartition du rhinocéros d'Asie

La deuxième réunion des États de l'aire de répartition du rhinocéros d'Asie s'est tenue à New Delhi, en Inde, du 26 au 28 février 2019, où le Ministère de l'Environnement, des Forêts et du Changement climatique (MoEFCC – Ministry of Environment, Forests and Climate Change) du gouvernement indien a lancé la « Stratégie nationale de conservation pour le rhinocéros indien unicorne » pour inaugurer l'espoir renouvelé d'assurer l'avenir du rhinocéros indien en Inde. En 2020-2021, le MoEFCC du gouvernement indien, a lancé une série de réunions virtuelles pour préparer des instructions permanentes d'opération (IPO) pour le rhinocéros indien en Inde, qui comprend une IPO pour l'élimination des carcasses de rhinocéros et une IPO pour les estimations de rhinocéros.

Pour en savoir plus: https://www.iucn.org/sites/dev/files/content/documents/2019_asian_rhino_sg_report-publication.pdf

Engagement des membres du GSRAs via un webinaire pendant la pandémie de Covid-19

Au cours des quinze derniers mois, en raison de la pandémie de Covid-19 qui prévaut dans le monde entier, les membres du GSRAs ont également fait face à des moments difficiles. Pour tenir les membres informés de l'état actuel des rhinocéros d'Asie, un webinaire sur « Le statut actuel du rhinocéros de Sumatra » a été organisé en septembre 2020 auquel ont participé 60 membres et invités spéciaux.

Nous profitons également de cette occasion pour remercier nos partenaires: World Wide Fund for Nature, International Rhino Foundation, Aaranyak et

Save the Rhino International.

Rejoignez la page Facebook GSRAs ici : https://www.facebook.com/asianrhinospecialistgroup.

Nécrologie

Le GSRAs est profondément désolé suite à la mort prématurée de deux de ses membres actifs—M. Widodo Ramono et le Dr Marcellus Adi en Indonésie en raison de complications liées au Covid-19.

RESEARCH

Namibia's elephants—population, distribution and trends

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Abstract

Namibia's elephants extend across the north of the country. They occur in six main areas of the known Namibian range—the north-west, Etosha National Park (NP), Mangetti National Park, northern Kavango, Khaudum National Park/Nyae Nyae Conservancy and Zambezi Region. Seasonal changes in distribution are related to water availability. There are movements of elephants between Namibia and its neighbours, particularly Botswana, and mainly from Zambezi Region. The largest populations are found in the north-east of the country, in Khaudum/Nyae Nyae and Zambezi Region. Densities are very low in the extremely arid north-west and Etosha National Park but have recovered from historical over-hunting that almost exterminated them.

The estimated rate of change for the north-west population is 3.86% per annum between -0.08% and 7.95%), which is not statistically significant. Since 1998, surveys have shown that the elephant population has been increasing slowly in Etosha National Park at an estimated annual rate of 1.75% (between 0.65% and 2.87%). The trend is statistically significant. There has been a consistent and significant increase in the Zambezi population at an estimated and biologically realistic annual rate of 4.76% (between 2.73% and 6.84%) since 1995. This trend is statistically very highly significant. The population of elephants in Khaudum National Park and Nyae Nyae Conservancy has increased at a very highly significant rate of 4.85% (between 3.24% and 6.48%).

As a total population, Namibia's elephants have been increasing at a rate of 5.36% (between 4.20% and 6.53%) since 1995. This is also statistically very highly significant.

Résumé

Les éléphants de Namibie sont présents dans tout le nord du pays. Ils sont répartis dans six zones principales de l'aire de répartition namibienne connue: le nord-ouest, le parc national d'Etosha, le parc national de Mangetti, le nord de Kavango, le parc national de Khaudum/Nyae Nyae Conservancy et la région de Zambezi. Les changements de cette distribution selon les saisons sont liés à l'existence d'eau. Il y a des mouvements d'éléphants entre la Namibie et ses voisins, en particulier le Botswana, et principalement depuis la région de Zambezi. Les populations les plus importantes se trouvent dans le nord-est du pays, dans la région de Khaudum/Nyae Nyae et de Zambezi. Les densités sont très faibles dans les zones extrêmement arides du nord-ouest et d'Etosha, mais se sont rétablies de la sur-chasse historique qui les a presque exterminés.

Le taux de changement estimé pour la population du nord-ouest est de 3,86 % par an (entre - 0,08 % et 7,95

%), ce qui n'est pas statistiquement significatif. Depuis 1998, des enquêtes ont montré que la population d'éléphants augmente lentement dans le parc national d'Etosha à un taux annuel estimé à 1,75 % (entre 0,65 % et 2,87 %). La tendance est statistiquement significative. Il y a eu une augmentation constante et significative de la population de Zambezi à un taux annuel estimé et biologiquement réaliste de 4,76 % (entre 2,73 % et 6,84 %) depuis 1995. Cette tendance est statistiquement très significative. La population d'éléphants du parc national de Khaudum et de la réserve de Nyae Nyae a augmenté avec un taux très hautement significatif de 4,85 % (entre 3,24 % et 6,48 %).

En tant que population totale, les éléphants de Namibie ont augmenté à un taux de 5,36 % (entre 4,20 % et 6,53 %) depuis 1995.

Introduction

Recently there has been concern about the decline in African elephant populations caused by an upsurge of illegal hunting for ivory which began, continentally, in about 2007 (Chase et al. 2016). This concern underlies the process that led to the reclassification of elephants as Endangered in the 2021–1 IUCN Red List of Threatened Species. However, the rate of change in elephant populations is not uniform across range states within Africa or even within those range states. The present paper sets out to report the distribution, numbers and trends and in one country, Namibia, south-western Africa.

According to the African Elephant Database (AED) 2016, the present distribution of elephants in Namibia is as shown in Figure 1 (Thouless et al. 2016). It can be seen that elephants are at present restricted to the north of the country. Figure 1 also makes it clear that elephant range in the far north-east of the country is contiguous and probably continuous with elephant range in adjacent countries—Angola, Botswana, Zambia and Zimbabwe.

Elephants in the known range within Namibia can conveniently be separated into six components (loosely referred to here as populations) that are treated as distinct units for management purposes. These have always been surveyed and reported separately or as distinct units within a nation-wide survey. Figure 2 illustrates the relevant areas, which are the basis for population estimates reported here. The boundaries represent the maximum extent of locations of elephants from recent surveys or from satellite telemetry.

The approximate number of elephants (rounded off to reflect uncertainty) in each area is shown in Table 1 (See Tables at end of manuscript). The elephant densities in Table 1 are crude densities calculated from the numbers and areas in the Table. East-west differences in density are apparent: Zambezi Region (6) has an average elephant density of over 1 elephant/km^2, while elephants in the large range in the north-west (1) have only a fiftieth of that density on average. These differences are largely the result of ecology: the north-east (6), where annual rainfall averages over 550mm, supports savanna woodland, while the western extreme of the north-west is desert, with less than 30mm. Anthropogenic factors also play a part in the variation. For example, Etosha National Park (NP) (2) has a history of protection from the early 1900s, while the small areas of range (Mangetti area and northern Kavango: 3 and 4) in Kavango region are in agricultural areas.

Historically, elephants were probably distributed across Namibia wherever there was surface water—from the Namib Desert (Kinahan et al. 1991; Viljoen 1987) in the west through Etosha and east to the more productive woodlands of the north-east. The original size of the population is not known, but it is thought that there was a major decline during the 19th century, largely due to ivory hunting (Bollig and Olwage 2016). Viljoen (1987) speculates an over-hunting outbreak in the north-west from 1890 to the early 1900's. By 1881 they had been exterminated in Etosha and Namibian elephants were limited to small numbers in north-western and north-central Namibia (Hahn 1925; Nelson 1926, Shortridge 1934). Wartime poaching during the 1980s (Owen-Smith 1996; Ramey and Brown 2019) kept the numbers of elephants in the north-west very low and the increase since then has been very gradual. The arid environment cannot support large populations but there are additional factors that prevent greater increase in numbers—reproductive rates are low, and natural mortality is higher than in less harsh conditions. Elephants started

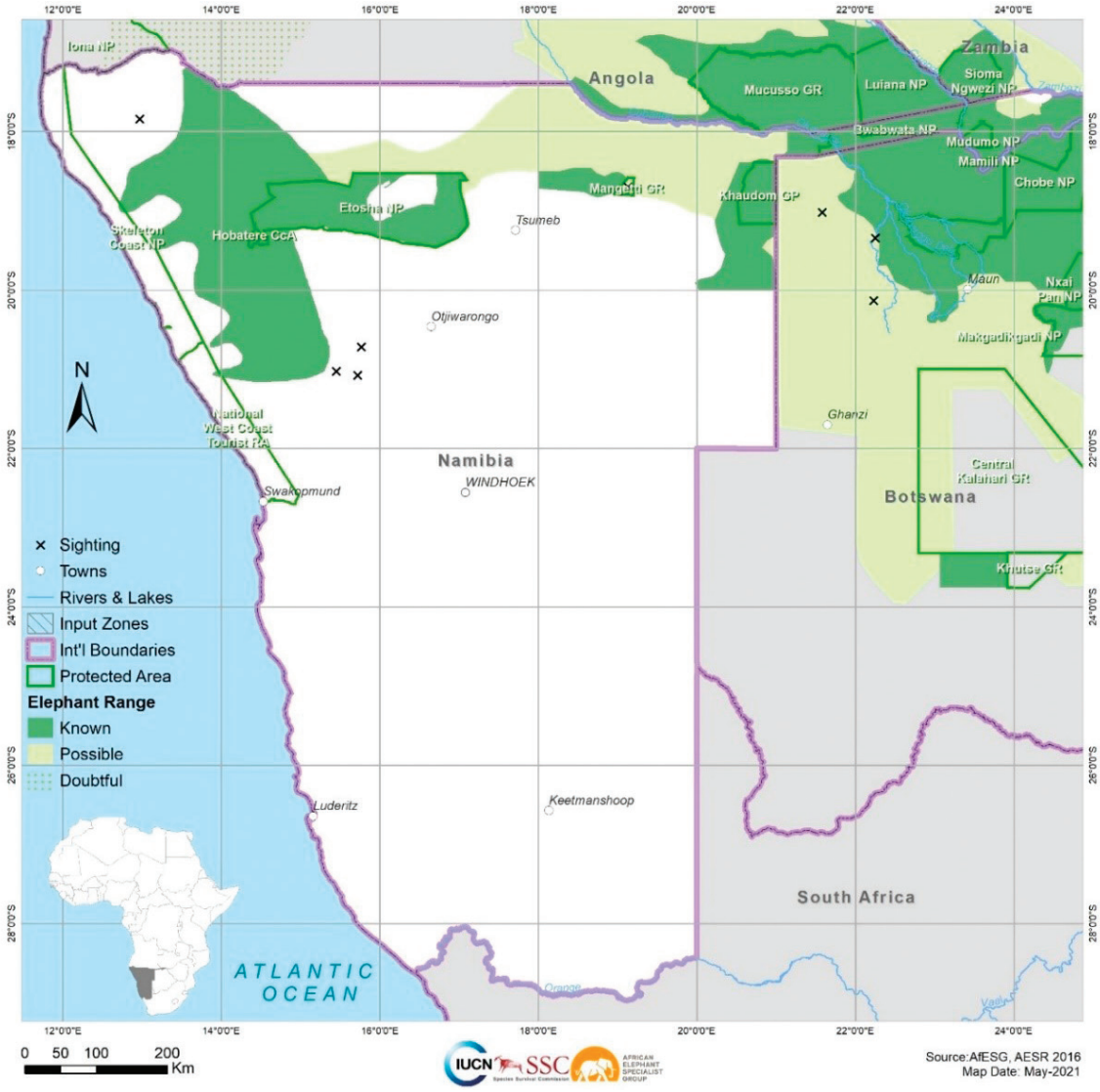

Figure 1. Known and possible ranges of elephants in Namibia (Reproduced from Thouless et al. 2016).

returning to Etosha in the 1950s (Lindeque 1988). At this time, waterholes were being installed for wildlife. It is likely that these not only attracted elephants into the Park but also allowed them to survive in the area through dry seasons and droughts. Regular monitoring dates from around this time. (Etosha was gazetted as a national park in 1967).

In Namibia, elephants have been counted using a variety of aerial and ground-based methods, mainly by the Namibian Ministry of Environment, Forestry & Tourism (MEFT) or its predecessors. These have included reconnaissance flights (Owen-Smith 1983), total counts, and transect or block sample counts while on the ground, wild animals are monitored through methods such as the Event Book System (Stuart-Hill et al. 2005) and ground transects. Aerial counts have provided estimates since around 1950 but have not always covered the same areas or used the same methods, so many early surveys are not strictly comparable. More recently however, internationally accepted and consistent standards (Craig 2012; CITES 2020) are employed for Namibia's aerial surveys using

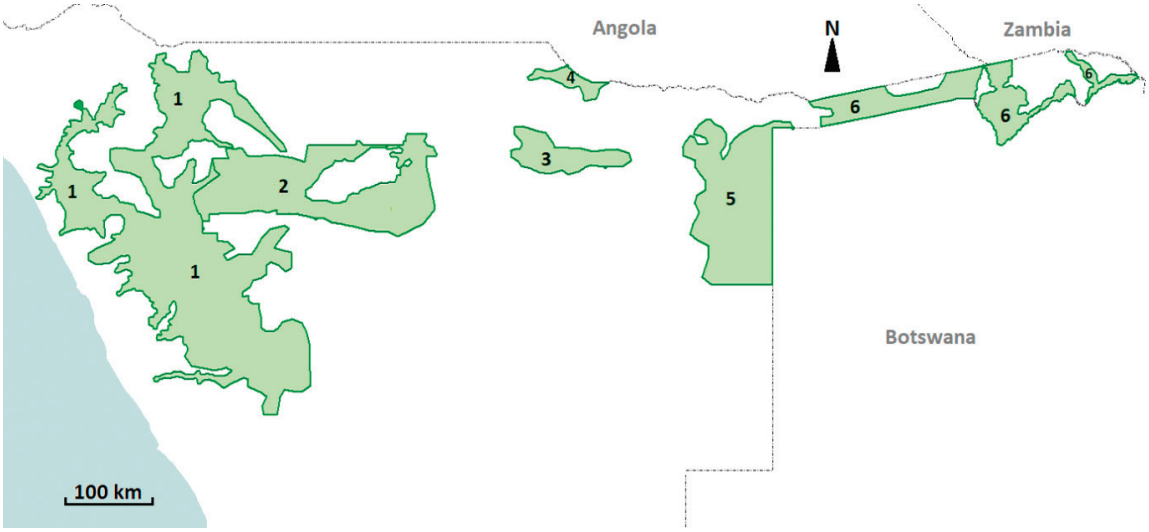

Figure 2. Components of elephant population distributions (numerical labels refer to Table 1).

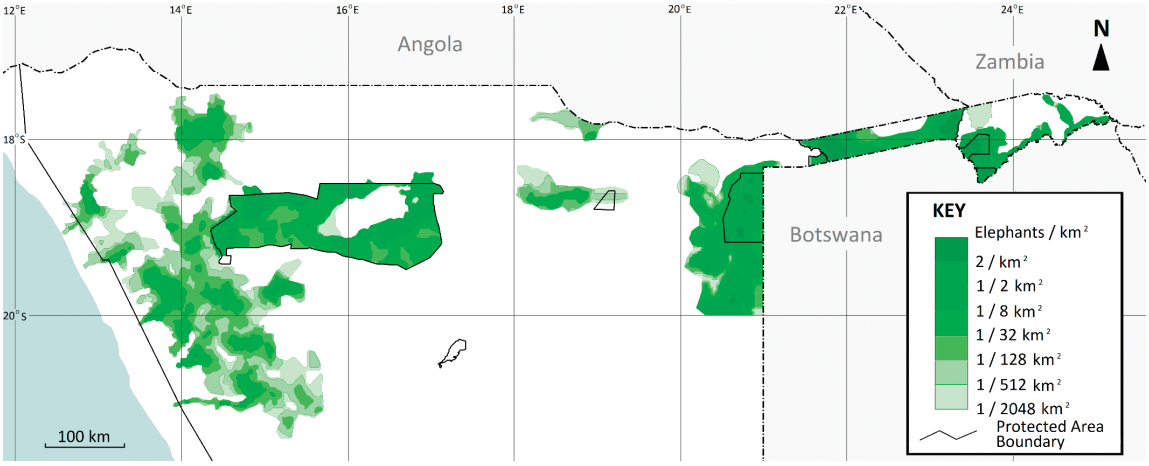

Figure 3. Density distribution of elephants/dry season.

transect or block sample counts (Norton-Griffiths 1978; Jolly 1969; Gasaway et al. 1986). These provide estimates of numbers that can be used to determine population trends and distributions.

Distribution

Knowledge of distribution is important for determining areas of range, understanding seasonal and cross border movements, prioritizing management and for planning further monitoring.

Methods

Distributions of elephants have been described by density contour maps constructed using a combination of dry season (May to October) aerial survey results and satellite telemetry locations. These maps are based on those prepared for the Namibian elephant conservation and management plan (MEFT 2020).

Sightings of elephants during aerial surveys from 2011 to 2019 provided the basis for the density distribution map (Fig. 3). Daily locations from dry season satellite tracking, where available, were added to improve peripheral detail where survey sightings were sparse or where there had been no

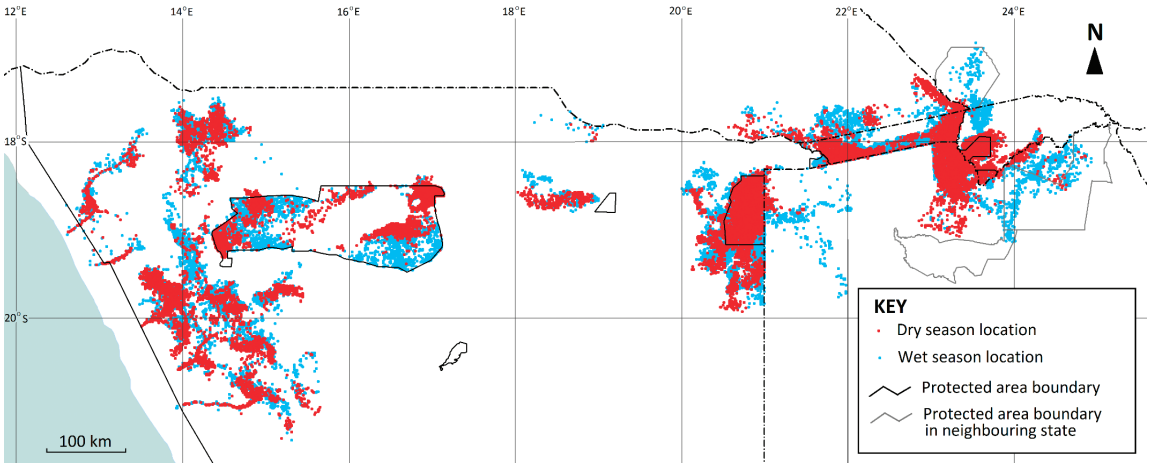

Figure 4. Seasonal Distribution: dry (red dots) overlaid on wet (blue dots) sightings.

survey. Satellite tracking data further provided the information for illustrating range expansion during the wet season (Fig. 4).

Tracking data included the wet and dry season locations of collared elephants made up as shown in Table 2.

Density distribution mapping

Densities for contour mapping were calculated from recent aerial survey results using sightings weighted by number seen and sampling intensity. These are summarized into a grid and filtered by moving averages and voronoi polygons to give smoothed contours. Satellite telemetry sightings were simplified to contain only one sighting for each day of tracking and separated into wet and dry season records. The survey grid and the telemetry grid were combined by addition, then divided by a constant to reduce the number in the resultant grid to the correct population size.

Seasonal distribution mapping

Population estimates from which densities can be derived are limited to the dry season when aerial surveys are conducted, and the wet season satellite tracking data lack information for some areas. Nevertheless, comparing the extent of wet season locations with that of dry season locations provides an estimate of the wet season range relative to the dry season range (MEFT 2020).

To do this, the tracking data set for each individual was simplified to contain only one sighting for each day of tracking. Sightings for all individuals were combined into one file. The range was divided up into polygons to which estimates of numbers could be allocated based on the most recent survey data. Sighting locations were overlaid on the polygons so that a determination could be made for the polygon in which it occurred. The points were then allocated weights so that the sum of the weights in a polygon equalled the estimate of elephants within the polygon. Points were added to a grid and filtered in the same way as for the aerial survey sightings.

For the purposes of comparison, the areas of the distributions are taken to be the number of grid cells containing one or more locations when the cell size is two minutes on a side (13 km^2 at 18.5° S).

Countrywide distribution

The distribution of Namibia's elephants across northern Namibia presented in Figure 3 corresponds to the "known" distribution reported to the IUCN 2016 African Elephant Status Report (AESR) (Thouless et al. 2016) shown in Figure 1.

The AESR also shows "possible" range filling much of the rest of the north central parts of Namibia, in which occasional sightings have been made. There have been no systematic surveys in most of that range although a survey in 1998 (Craig 1999) covered the area north of Etosha National Park to the Angola border. There were no sightings of elephants then and it is likely that the very few elephants that are there only visit the area fleetingly, amounting to an occupancy on average of fewer than one in 2,000 km^2 (less than the outer contour of the density distribution

map in Fig. 3). None of the elephants fitted with collars have been tracked into this range to date.

Although there are records of sighting of individual animals or groups in areas well outside the usual range, there is otherwise little evidence of range expansion. The AESR (Thouless et al. 2016) reports 112,471 km^2 of "known" range in 2016 while the outer limits of range calculated from survey and telemetry data shown in Figure 3 covers 98,000 km^2. This merely illustrates the difficulty of measuring an area of range which grades into extremely low densities at the edge so that the true extent is indeterminate. Any estimate of the maximum area is necessarily speculative. Apparent expansion of the range may represent real changes, or increase in density, and hence detectability, within pre-existing range.

Seasonal distribution changes

As in other parts of the continental elephant range (e.g. ULG 1995), there are seasonal differences in the distribution of elephants in Namibia (Leggett 2006). Dry season distribution is smaller than wet season distribution with which it mostly overlaps, although there are small areas which are exclusively dry season range. Table 3 summarizes the wet and dry ranges as exclusively dry range, overlap and exclusively wet range for each regional range component.

The highest densities of elephants are reached during the dry season when they are aggregated in response to reduced water and resource availability. In Zambezi Region, some aerial surveys have recorded local densities of >8 elephants/km^{-2}. Such levels may be temporary as animals move around, reducing the mean density at a point; the aerial surveys are, after all, based on the locations of animals on a single day. However, the density distributions illustrated in Figure 3 are based partly on locations throughout the dry season over several years and still represent impressive densities: in Zambezi Region, the 2 km^{-2} density contour contains an area of 2,100 km^2. Increased range during the wet season obviously would result in lower overall densities: for example, in Zambezi Region, with an increase of 42%, the average density must be (1/1.42). 100% = 70% of its dry season value.

Figure 4 shows the distributions of dry and wet season telemetry locations for all collars (see Table 2) in the data set. Locations outside Namibia have been included in the map.

Population trends

Methods

The populations reported on here (MEFT 2020) each appear a reasonable fit to a model of exponential growth. While the real situation could be different, e.g. with per capita increase slowly declining or setbacks such as illegal hunting disturbing the underlying trend, there is insufficient information to justify a less parsimonious approach for any of these populations.

Regression parameters were calculated using MS Excel© Analysis tools (MEFT 2020). The F ratio is from an ANOVA performed to determine the significance of the variance due to regression.

The population trends are presented with lines above and below (here coloured red) to represent the 95% range within which the true numbers would lie.

Countrywide estimates

Because there are fewer surveys in some areas than others and only a few cases of surveys being carried out simultaneously countrywide, it is necessary to combine some of the estimates from consecutive years to provide enough points to conduct a trend analysis for the entire country. These are summarized in Table 4.

There is a clear upward trend in the overall number of elephants since the 1990s.

The estimated rate of population increase p.a. for Namibia's elephant is 5.36% (between 4.20% and 6.53%). The trend is statistically very highly significant (F=225.29, p = 0.00064***).

Although the countrywide trend is positive, the rates vary from west to east. Tables in each of the following sections present the sources of survey data with as many estimates of elephant numbers as possible even where they are not strictly comparable. Data that are not used in trend analyses are shown as open circles on the graphs.

North-west Namibia

Information about elephant numbers in north-west Namibia is patchy largely because of the difficulties of conducting surveys in the area due to the terrain and the extremely low densities of elephant (see Table 1). A variety of methods have been used over the

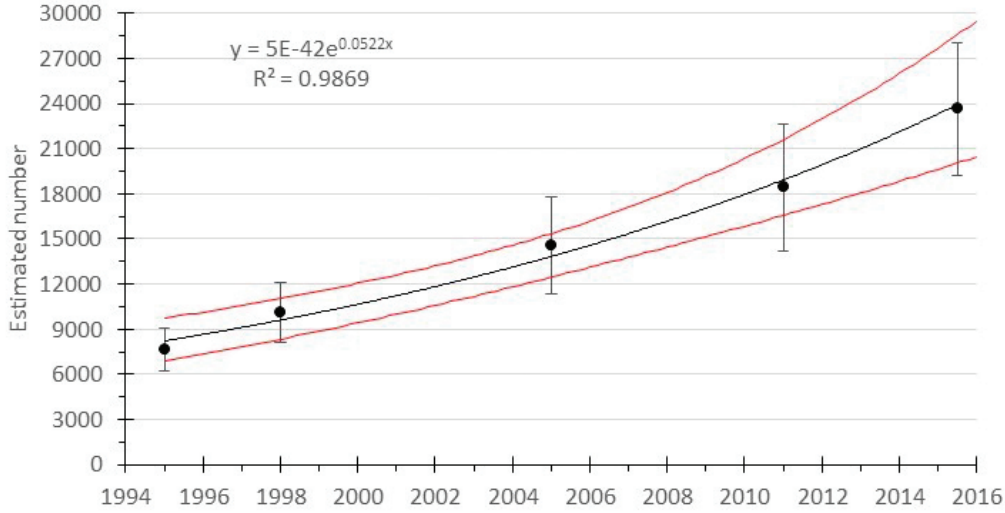

Figure 5. Elephant population trend for Namibia (red lines show the 95% confidence limits on the trend line).

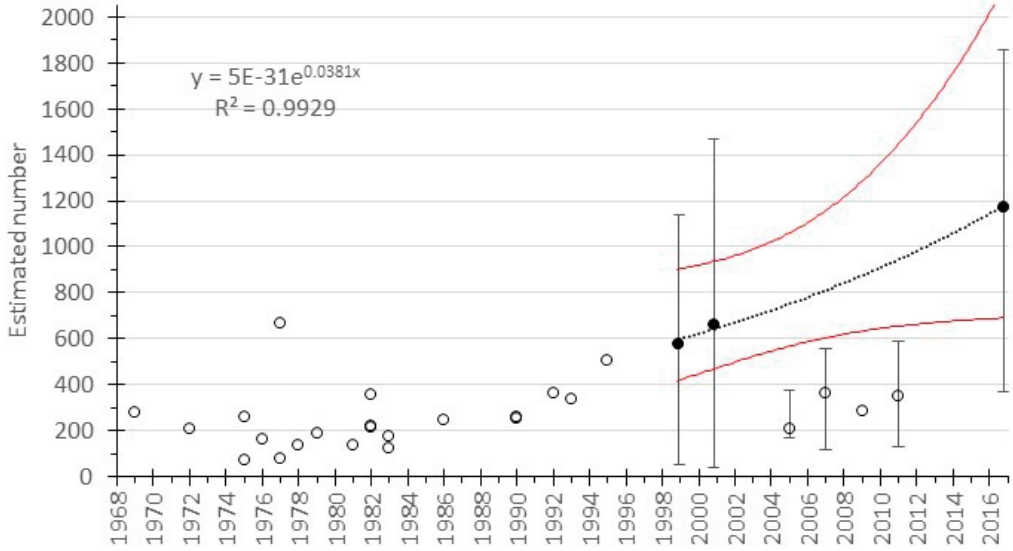

Figure 6. Elephant population trend for north-west Namibia (red lines show the 95% confidence limits on the trend line).

years and surveys have seldom covered the same parts of the elephant range (Gibson 2001) and as a result, only a few are strictly comparable.

Correctly conducted total counts of north-west Namibia (i.e. with a search rate of less than 1.5 km^2 per minute) would require around 2,000 flying hours. Sample counts are therefore the best option—and because transect counts are unsuitable (as it is impossible to maintain a fixed height above ground level in the mountainous terrain), block counts (Craig 2012; CITES 2020) are used for much of the area.

As the number of elephants in this population is of the order of 1,000 in an area exceeding 50,000 km^2, sample counts result in extremely low precision. Greater sampling effort might improve this, but, for example, the 2016 survey took around 140 flying hours—more than is

normally expended on the whole of the north-east, and which has 20 times the elephant population. Improving the north-west estimates to a similar level of precision as the north-eastern estimates would require five times the effort employed in 2016 and considerably more resources. Since the population contributes little to the national total, the poor precision of estimates for the north-west is of little importance nationally, although a very important issue at the local level.

Until 1995, reconnaissance flights attempting to conduct total counts seem to have been reasonably effective due to good local knowledge (the estimates are not far below subsequent sample counts).

Surveys that took place between 2005 and 2011 were inadequate for a number of reasons. The sample counts with adequate coverage and search effort conducted in 1998, 2000 and 2016 suggest a greater number, but with very low precision.

The intention with the 2011 and 2016 surveys was to obtain a good sample count in the overall range while maximising the number seen by total counting areas, especially along rivers, in order to produce an estimate which might be imprecise but backed by a good minimum number seen. The 2011 survey counted 133 as a minimum number but the sampling intensity was inadequate in one of the sample strata. The 2016 survey gave 373 as a minimum count with an overall estimate of 1,700 but adjusted down to 1,100 as a result of one outlying value.

Although the 2016 number has increased since the previous comparable surveys in 1998 and 2000, there are insufficient surveys to demonstrate change or to obtain an estimate of it. The estimated rate of change for the north-west population is 3.86% per annum (between -0.08% and 7.95%). However, this is not statistically significant (F=154.63, p = 0.0511 n.s.).

Etosha National Park

The trend analysis used estimated numbers of elephants from 1998 onward. The estimate for 1995 was omitted from the trend. It was clearly an outlier because the deviation of that year's result from the trend line was close to two standard deviations (derived from the residual variance about the line). Removing that point markedly improved the fit of the other points. In 2011, the estimate for one of the strata was based on a single sighting of 30 animals which resulted in an extremely wide confidence interval. For the trend analysis, the overall estimate therefore excluded the estimate (899 ± 2,365) for this stratum and simply added the number seen to the total estimate.

Early surveys of Etosha National Park have produced extremely variable counts of elephants which are not strictly comparable (Table 6 and Fig. 7).

Numbers increased by a factor of about eight between 1970 and 1980. This is too high to have resulted from natural increase although immigration is a possibility. Most likely, however, is a change in survey methods or quality over that period. Since 1998, surveys have shown that the elephant population has been increasing slowly. The estimated rate of population increase p.a. for Etosha National Park's elephant population is 1.75% (between 0.65% and 2.87%). The trend is statistically highly significant (F=16.71, p = 0.0095**).

Zambezi Region

The largest of Namibia's elephant populations is found in Zambezi Region where between 9,400 and 14,600 animals were estimated in the 2019 dry season. The population is not closed and there is considerable movement between Namibia and Botswana and to a lesser extent with Angola and Zambia.

Numbers within Zambezi Region may be subject to some fluctuations on account of cross-border movement. The estimate for 2013 was unusually low probably because the survey was conducted earlier in the year (May/June) when the vegetation was still dense and the flooding in the Zambezi catchment was extensive. Nevertheless, there has been a consistent and significant increase in the population at an estimated and biologically realistic annual rate of 4.76% (between 2.73% and 6.84%). This trend is statistically very highly significant (F=29.88, p = 0.0006***).

The wave of illegal hunting which has afflicted elephant populations in many parts of Africa has not spared Namibia. Of all the areas inhabited by elephants in Namibia, Zambezi Region has been most affected (Craig and Gibson 2013, 2014, 2019; Gibson and Craig 2015) as suggested by increasing carcass ratios (Table 8) (Douglas-Hamilton and Hillman 1981; Douglas-Hamilton and Burrill 1991). Reduction of the population in Zambezi Region may have occurred recently as a result, but the population estimates for

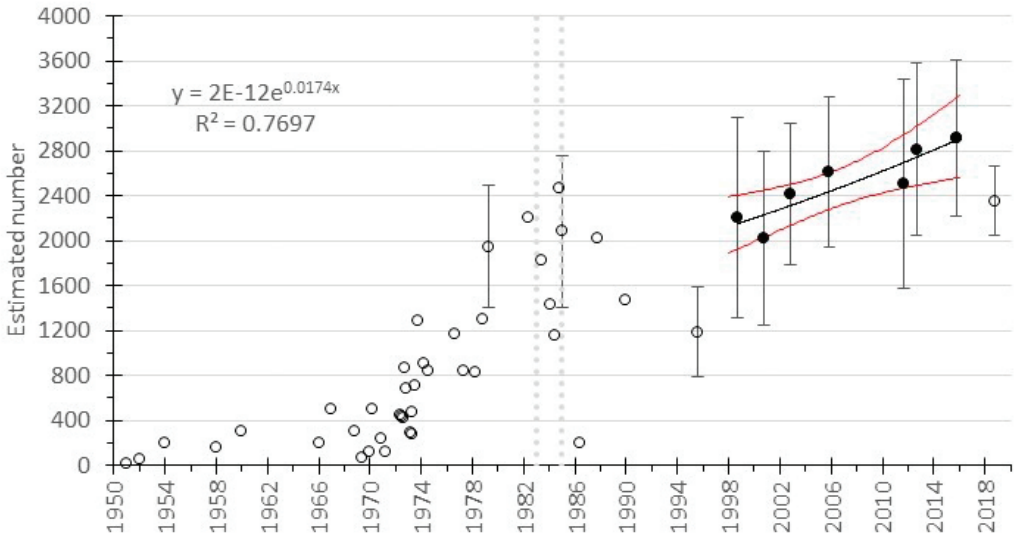

Figure 7. Elephant population trend for Etosha National Park (red lines show the 95% confidence limits on the trend line). Culls are indicated by vertical dotted lines: 220 in 1983, 350 in 1985.

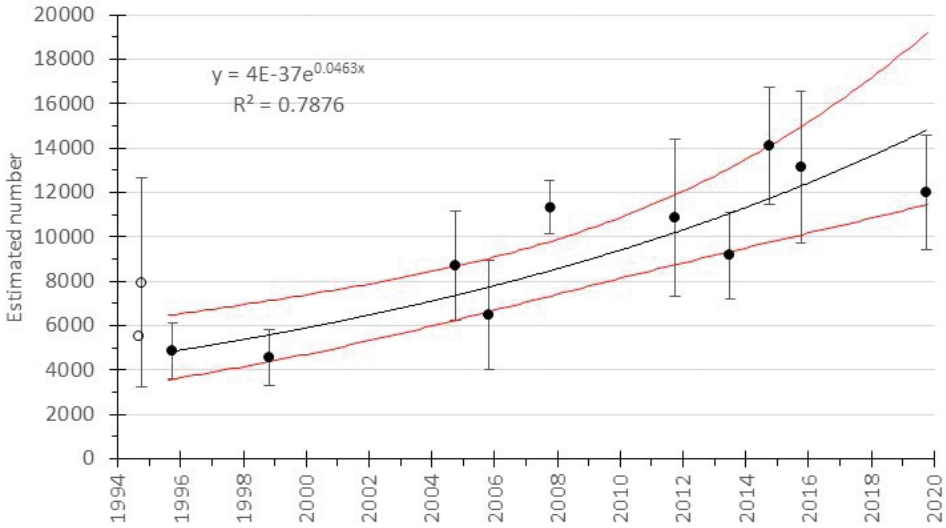

Figure 8. Elephant population trend for Zambezi Region (red lines show the 95% confidence limits on the trend line).

the region are currently within the confidence interval of the long-term growth curve. The last three points on the graph in Figure 8 show a consistent decline, which is not statistically significant but a real effect cannot be ruled out (Craig and Gibson 2019).

There is also a possibility, because of the connectedness of the populations, of the Zambezi Region population being impacted by illegal hunting in neighbouring states. That this was occurring, and continues, in adjacent areas of Botswana was recorded on the 2014, 2015 and 2019 Zambezi surveys (Craig and Gibson 2019) and surveys in Botswana (Chase et al. 2018). There are no later estimates of carcass ratios but there is evidence to suggest that after 2015, elephant poaching had been decreasing (MEFT 2020; Craig and Gibson 2019).

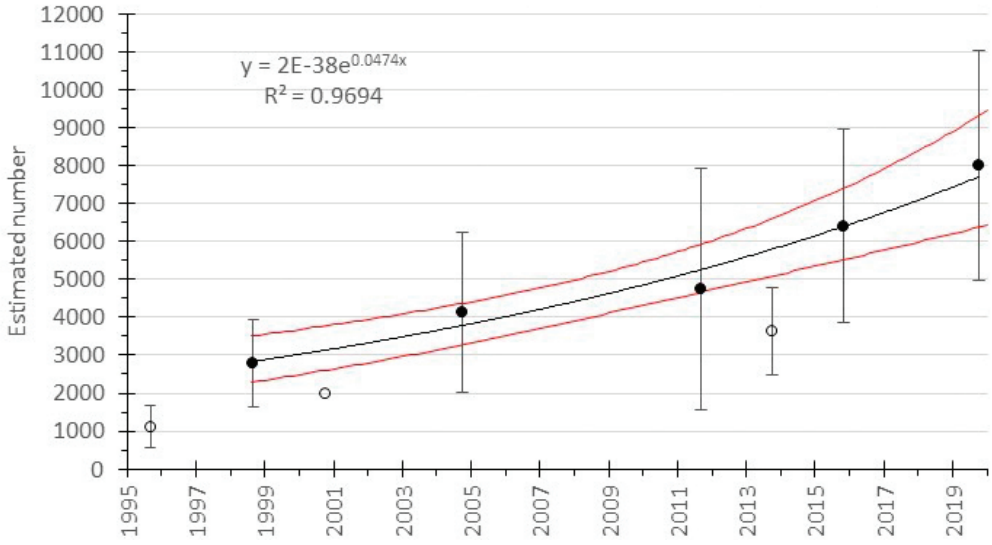

Figure 9. Elephant population trend for Khaudum National Park/Nyae Nyae Conservancy (red lines show the 95% confidence limits on the trend line).

Khaudum National Park/Nyae Nyae Conservancy

Khaudum National Park and Nyae Nyae Conservancy have been combined for the purposes of estimating numbers of elephants as there is no barrier to movements between the two.

Three estimates were omitted from the trend analysis:

- The 1995 survey employed a non-standard approach to sampling.
- The 2000 report was incompletely reported.
- The estimate for 2013 is an outlier. There was an elephant capture operation in the area at the same time as the aerial survey which disturbed the animals and may have caused them to move away leading to a low estimate.

The population has increased at a very highly significant rate (F=95.16, p= 0.0023***) of 4.85% (between 3.24% and 6.48%).

Cross-border movement with Botswana is small compared with Zambezi Region. Links to Zambezi Region are limited and have not been detected by telemetry of Namibian elephants. Numbers are therefore unlikely to be greatly affected by population movements.

There has been little poaching of elephants in the area up to 2019.

Discussion

Since 1990, when comparable surveys began, there is strong evidence of increase, at a rate of between 4.20% and 6.53% per annum, in the total number of elephants in Namibia. A supporting indicator of this is the increasing numbers of incidents of elephants being found well outside the recognized range. With the increase in numbers there has also been an increase in human elephant conflict (HEC) (irdnc.org.na 2021; Jones 2006).

The continental spike in illegal hunting that started in 2007 and is said to have peaked around 2011 (Chase et al. 2016, CITES Secretariat 2013) has been a setback to that growth in Zambezi Region. This has been the only area of concern, but the impact does not appear to have been severe up to end of 2019.

It is important to place the conservation success represented by Namibia's increasing elephant population in a wider historical perspective. That the history of population growth extends further back than the 1990–2019 time-window we have concentrated on here is suggested by the generally upward trend of earlier survey estimates (see Figures 6 and 7) where these are available. The record becomes less reliable the further back one goes, however. This is particularly true for the north-east, the area where most of Namibia's elephants are. Clues to the past come from Botswana.

Satellite telemetry enables a measure of relative

time spent in neighbouring countries by animals collared within Namibia. In particular there are cross-border movements associated with the Zambezi Region population. With the collared animals spending about 40% of the time outside Namibia (see earlier Figure 4). It is clear that this population is one shared with neighbouring states, particularly Botswana, and it is therefore likely that the elephants of Namibia's north-east and of northern Botswana have a shared history.

In Botswana elephants were believed to be numerous and widespread until 1800, when the climate was wetter than now (Campbell 1990). By the time the country began to dry up, around 1870, uncontrolled commercial hunting for ivory had reduced elephants to a small remnant population in the north (Campbell 1990). Once controls were put in place in 1893, elephants began to recover and surveys between 1973 and 1975 showed that there were over 10,000 (Campbell 1990).

Available historical accounts suggest that a similar major decline in elephant range and numbers in Namibia took place. By the middle of the century, numbers began to increase in Etosha and after independence in 1990, elephants began to recover also in the north-west. Although there is little historical information on elephants in north-eastern Namibia, reports of increasing HEC after 1962 (Spinage 1990) suggest recovery of numbers there may have mirrored that in Botswana.

The account given here shows the increase of elephant populations within Namibia from the mid 1990s until the present. Evidence from other sources suggests that this may just be the latest stage of a longer-term recovery from low numbers that began in the mid-20th century.

Acknowledgements

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M. Lindeque stimulated a review of elephant distributions and trends under the development of the elephant management plan (MEFT 2020). P. Lindeque provided this information as well as many of the references to early surveys.

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Table 1. Namibian elephant populations, approximate numbers and densities*

Population	Number	Area km²	Density no/km²
1 North-west	1,200	50,000	0.024
2 Etosha National Park	2,900	19,000	0.153
3 Mangetti area	90	4,000	0.025
4 Northern Kavango	50	1,500	0.033
5 Khaudum National Park/Nyae Nyae Conservancy	8,000	13,000	0.615
6 Zambezi Region	12,000	10,000	1.200

*Note that populations 3 and 4 have not been surveyed systematically. The numbers given are guesses and are not dealt with further in this paper.

Table 2. Satellite collars

Range	Number of daily locations	Number of collars	Period
North-west	22,000	42	Oct 2002–May 2013
Etosha	16,000	22	Sep 2009–Oct 2014
Kavango	730	3	Jan 2017–Apr 2020
Khaudum/Nyae Nyae	22,000	30	Sep 2012–Nov 2019
Zambezi Region	21,000	64	Oct 2010–Jan 2020

Table 3. Seasonal areas of range and wet season range expansion from telemetry

Population	Seasonal range component (km²)			Overall seasonal area		Seasonal increase (%)
	Dry only	Overlap	Wet only	Dry	Wet	
North-west	5,538	13,884	8,801	19,422	22,685	17
Etosha National Park	1,794	5,915	6,084	7,709	11,999	56
Kavango/Mangetti	741	858	832	1,599	1,690	6
Khaudum National Park/Nyae Nyae Conservancy	1,287	7,735	4,563	9,022	12,298	36
Zambezi Region	4,368	10,764	10,764	15,132	21,528	42

Table 4. Estimates of numbers of elephants for countrywide total (cl = confidence limits)

Year	North-west		Etosha National Park		Zambezi Region		Khaudum National Park /Nyae Nyae Conservancy		Country	
	Estimate	95% cl	Estimate	95% cl	Estimate	95% cl	Estimate	95% cl	Estimate	95% cl
1995	508	0	1,188	405	4,883	1,248	1,104	555	7,683	1,425
1998	579	560	2,206	893	4,576	1,248	2,776	1,158	10,137	2,008
2004					8,725	2,251	4,127	2,125	14,548	3,242
2005	210	164	2,611	671	6,474	2,445				
2011	351	240	2,509	930	10,847	3,619	4,731	1,955	18,438	4,224
2015			2,911	697	13,136	3,435	6,413	2,566	2,3633	4,397
2016	1,173	681								

Table 5. Numbers of elephants in north-west Namibia

Year	Estimate	95% cl	Survey method	Author/s
1969	279		not stated	Joubert. 1972.
1972	211		not stated	Joubert. 1972.
1975	260		not stated	de Villiers PA In: Viljoen. 1987.
1975	70			Kolberg et al. 2009.
1976	162			Viljoen PJ In: Loutit R. 1995.
1977	82			Visage GP. 1977.
1977	667			Viljoen PJ. In: Loutit R. 1995.
1978	135			Kolberg et al. 2009.
1979	192		transect?	Mulder LK. 1979.
1981	138			Kolberg et al. 2009.
1982	214			Loutit R. 1995.
1982	220			Kolberg et al. 2009.
1982	357		total count	Viljoen PJ. 1982.
1983	126		random strip	Owen-Smith G. 1983 (a).
1983	178		recon	Owen-Smith G. 1983 (b).
1986	247		total	Britz et al. 1986.
1990	260		?total	Carter LA. 1990.
1990	253		not stated	Loutit R. 1995.
1992	366		recon	Loutit R. and Douglas-Hamilton I. 1992.
1993	340		transects and reconnaissance	Loutit R. 1995.
1995	508		recon	Craig GC. 1996.
1998	579	560	block and transect	Craig GC. 1999.
1998	50		block	Kolberg et al. 2009 no. seen reported.
1999	56		recon	Leggett K. 2000.
2000	663	122	block and transect	MET. 2000.
2005	210	164	transect	Unknown 2005 (?MET).
2005	169		transect	Kolberg et al. 2009 no. seen reported.
2007	365	193	transect	Unknown 2007 (?MET).
2007	117		transect	Kolberg et al. 2009 no. seen reported.
2009	352	243	total	Kolberg et al. 2009.
2011	351	240	block	Craig GC. 2011.
2014			block	Craig GC. and Gibson DStC. 2014.
2016	1,173*	681	block and transect	Craig GC. and Gibson DStC. 2016.

*2016 estimate 1,716 ± 1,299. One outlier removed

Table 6. Numbers of elephants in Etosha National Park

Year	Estimate	95% cl	Method	Author/s
1951	20		not stated	Erb KP. 1995.
1952	60		not stated	Erb KP. 1995.
1954	200		not stated	Erb KP. 1995.
1958	160		not stated	Erb KP. 1995.
1960	300		not stated	Erb KP. 1995.
1966	200		not stated	Erb KP. 1995.
1968	301		Total	Bredes et al. 1970.
1969	64		Total	Bredes et al. 1970.
1969	116		not stated	du Preez JS. 1971.
1970	494		?Total with strips	Bredes et al. 1970.
1970	550		not stated	Bredes et al. 1970.
1970	232		not stated	du Preez JS. 1971.
1971	124		not stated	du Preez JS. 1971.
1972	447		Total and recon	du Preez JS. 1972 (a).
1972	433		not stated	du Preez JS. 1972 (b).
1972	419		recon	du Preez JS. 1972 (c).
1972	863		not stated	Reid R and du Preez JS. 1972 (a).
1972	686		totals from Sep "repeated"	Reid R and du Preez JS. 1972 (b).
1973	292		not stated	du Preez JS. 1973 (a).
1973	477		not stated	du Preez JS. 1973 (b).
1973	281		not stated	du Preez JS. 1973 (c).
1973	715	560	not stated	du Preez JS. 1973 (d).
1973	1,293		transects and recon	Joubert et al. 1973.
1974	904		not stated	du Preez JS. 1974.
1974	835	122	transects and recon	Berry HH. 1974.
1976	1,170	164	transects	Berry HH. 1976.
1977	836		transects	Berry HH. 1977.
1978	824	193	not stated	Berry HH. 1978.
1978	1,298		total and transects	de Villiers P and Kyle R. 1978.
	1,947	243	block and transect	de Villiers P and Kyle R. 1979.
1982	2,202	240	total	Berry H and de Villiers P. 1982.
1983	1,819		total and ground	Berry H and Nott T. 1983.
1983	1,437	681	total	Lindeque M. 1984.
1984	364		total	Berry HH. 1984.
1984	1,158		total	Lindeque M. 1984.
1984	2,464		total	Berry H. 1984.
1984	2,081		total	Lindeque M. 1984.
1986	196		total (partial survey)	Scheepers L. 1986.
1987	2,021		total	Lindeque M and Lindeque PM. 1987.
1990	1,469		not stated	Erb KP. 1995.
1995	1,188.2		transect	Erb KP. 1995.
1998	2,206		transect and block	Craig GC. 1999.
2000	2,018		transect	Erb KP. 2000.
2002	2,417		transect	Kilian JW. 2002.
2005	2,611		transect	MET. 2005.

*2011	2,509		transect	Craig GC. 2011.
2012	2,810		transect	Kolberg H. 2012.
2015	2,911		transect	Kilian JW. 2015.
2018	2,355		not stated	Kilian JW. (pers. comm.) 2020.

*2011 estimate 3,378 ± 1,757. Outlier removed.

Table 7. Numbers of elephants in Zambezi Region

Year	Estimate	95% cl	Survey type	Author/s
1994	7,950	4,695	Sample	ULG. 1994.
1994	5,556		Sample	Rodwell et al. 1994.
1995	4,883	1,248	Sample	Lindeque et al. 1995
1998	4,576	1,249	Sample	MET. 1999.
2004	8,725	2,467	Sample	Kolberg H. 2004.
2005	6,474	2,445	Sample	Chase MJ and Griffin CR. 2006.
2007	3,062	0	Total	Chase M. 2007.
2007	11,339	1,178	Sample + total	Chase MJ. 2008.
2009	3,450		Total	Chase M. 2009.
2011	10,847	3,547	Sample	Craig GC. 2011.
2013	9,165	1,967	Sample	Craig GC and Gibson DStC. 2013.
2014	14,097	2,636	Sample	Craig GC and Gibson DStC. 2014.
2015	13,136	3,428	Sample	Gibson GC and Gibson DStC. 2015.
2019	12,008	2,594	Sample	Craig GC and Gibson DStC. 2019.

Table 8. Carcass ratios in Zambezi Region

Year	% Carcass Ratio
1994	3.93
2011	2.63
2013	7.98
2014	5.12
2015	8.27

Table 9. Numbers of elephants in Khaudum/Nyae Nyae

Year	Estimate	95% cl	Method	Author/s
1995	1,104	555	Transect	Craig GC. 1995.
1998	2,777	1,158	Transect	Craig GC. 1998.
2000	663	808	Transect	Craig GC. 2000.
2004	4,127	2,125	Transect	Kolberg H. 2004.
2011	4,731	3,185	Transect	Craig GC. 2012.
2013	3,638	1,148	Transect	Craig GC. and Gibson DStC. 2013.
2015	6,413	2,566	Transect	Gibson DStC. and Craig GC. 2015.
2019	7,999	3,028	Transect	Craig GC. and Gibson DStC. 2019.

Rhinoceros from the Middle Stone Age in the Eastern and Western Cape of South Africa

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Abstract

In southern Africa, the Middle Stone Age (MSA), spanning more than 200,000 years, is a critical time period, in which *Homo sapiens* first appears. MSA sites located in the Eastern and Western Cape provinces of South Africa have yielded extensive faunal assemblages accumulated by anatomically modern humans. Many of these faunal assemblages include evidence of rhinoceros. To investigate how rhinoceros were potentially hunted/scavenged, we compare the representation of rhinoceros with that of large bovids and zebras in these faunal assemblages across seven sites in the region. All sites contain individual specimens of rhinoceros; however most faunal assemblages yielded only a few isolated specimens (201 specimens in total, representing 5% of the total sample). Similarly low representation was found for elephant and hippopotamus. In total, 60% of all the remains of rhinoceros accumulated during the MSA were found at a single site, Die Kelders. This indicates that people rarely brought back portions of rhinoceros carcasses containing bones to cave and shelter sites. The low frequency of rhinoceros findings suggests that people either did not regularly hunt or scavenge carcasses of these large ungulates, which are known for their aggressive behaviour; or, due to their large size inhibiting portability, they camped and feasted on rhino carcasses at sites where the animals were killed. In the latter scenario, meat containing a few bones could have been dried and brought to caves.

Résumé

En Afrique australe, l'âge de pierre moyen (MSA), qui s'étend sur plus de 200 000 ans, est une période critique, au cours de laquelle *l'Homo sapiens* apparaît pour la première fois. Les sites MSA situés dans les provinces du Cap oriental et occidental en Afrique du Sud ont produit de vastes assemblages fauniques accumulés par des humains anatomiquement modernes. Beaucoup de ces assemblages fauniques contiennent des preuves de rhinocéros. Pour étudier comment les rhinocéros ont été potentiellement chassés / récupérés, nous comparons la représentation des rhinocéros avec celle des grands bovidés et zèbres dans ces assemblages fauniques sur sept sites de la région. Tous les sites contiennent des spécimens individuels de rhinocéros; cependant, la plupart des assemblages fauniques n'ont donné que quelques spécimens isolés (201 spécimens au total, représentant 5% de l'échantillon total). Une représentation également faible a été trouvée pour les éléphants et les hippopotames. Au total, 60% de tous les restes de rhinocéros accumulés pendant la MSA ont été retrouvés sur un seul site, Die Kelders. Cela indique que les gens rapportaient rarement des parties de carcasses de rhinocéros contenant des os dans des grottes et des abris. La faible fréquence des découvertes de rhinocéros suggère que les gens ne chassaient pas régulièrement ou ne récupéraient pas les carcasses de ces grands ongulés, qui sont connus pour leur comportement agressif; ou, en raison de leur

grande taille empêchant la portabilité, ils campaient et se régalaient de carcasses de rhinocéros sur les sites où les animaux étaient tués. Dans ce dernier scénario, la viande contenant quelques os aurait pu être séchée et amenée dans des grottes.

Introduction

The conservation of rhinoceros (*Diceros bicornis* and *Ceratotherium simum*) remains an ongoing concern in Africa, and numerous studies have focussed on biological and zoological aspects of these large pachyderms (for a summary, see Skinner and Chimimba 2005). In southern Africa, recent studies on rhinoceros increasingly make use of archaeological information to gain an understanding over greater time scales (Boeyens and Van der Ryst 2014). In this paper, we trace the potential exploitation of rhinoceros in South Africa during the Middle Stone Age (MSA), a critical time in the evolution of *Homo sapiens* spanning more than 200,000 years.

Hominins hunted and consumed megafauna throughout the Pleistocene. The nature of hunting by early humans during the MSA in southern Africa has long been debated. Initial research suggested that people of the MSA were mainly scavengers who engaged in limited hunting of small bovids, and that they were less competent than hunters of the Later Stone Age (Klein and Cruz-Uribe 1996). More recently, it has become widely accepted that people were able to successfully hunt large, dangerous prey like the extinct giant buffalo (*Syncerus antiquus*) during the MSA (Milo 1998).

The MSA is a cultural period that persisted from approximately 280 to 50 thousand years ago (kya) in Africa and is associated with the appearance of anatomically modern humans in southern Africa. Various innovations became widespread during the MSA, such as ornaments made from seashells and ostrich eggshells engraved with intricate patterns. These innovations are linked with greater cognitive ability in humans. A number of MSA sites have been excavated in the Eastern and Western Cape of South Africa, providing large archaeological faunal assemblages. Many of these sites are currently located at the coast, but during glacial events, areas now close to the coast were further inland during the MSA (Wadley 2015). At the time, the region mainly comprised extensive plains and marshes, ideal for hunting wild animals. From early historical accounts of both groups in South Africa (San hunter-gatherers and early historical farming communities), pits were often used to hunt pachyderms and buffalo (Andersson 1856:455; Hall 1977). These pits were often located near water sources and once trapped, a large dangerous animal could be dispatched with spears (Hall 1977). The practice of constructing such pits is thought to date back to the MSA (Milo 1998). In coastal areas, people in the MSA also likely scavenged carcasses of beached whales, similarly to historical accounts (Smith and Kinahan 1984); while circumstantial evidence, although ambiguous, suggests that they used snares to obtain meat of smaller animals (Wadley 2015). Many of the faunal assemblages from MSA sites in the Eastern and Western Cape of South Africa have yielded remains of large mammals, including rhinoceroses.

Rhinos are large ungulates, and today two species are found in South Africa. The black rhinoceros (*Diceros bicornis*) weighs between 800 and 1,400 kg and the white rhinoceros (*Ceratotherium simum*) weighs between 1,700 and 2,300 kg (Skinner and Chimimba 2005). The black rhinoceros occurred in the Eastern and Western Cape provinces during the Pleistocene and Holocene. During the Holocene, white rhinoceros were absent from the area (Plug and Badenhorst 2001; Rookmaaker 2008; Skead et al. 2007), but their skeletal remains have been found in various Pleistocene deposits of the Western Cape (Avery 2019) including Sea Harvest (Grine and Klein 1993), Duinefontein 2 (Cruz-Uribe et al. 2003), Hoedjiespunt 1 (Stynder 1997) and Swartklip 1 (Klein 1983).

Methodology

Several MSA faunal assemblages from the Eastern and Western Cape of South Africa have been studied, notably Blombos Cave, Die Kelders Cave, Diepkloof Rock Shelter, Klipdrift Shelter, Pinnacle Point, Ysterfontein Rock Shelter (all in the Western Cape), and Klasies River Main Site (Eastern Cape). These seven sites (Table 1, Fig. 1) fall broadly in the Cape Floristic Region, in which extensive scrublands are

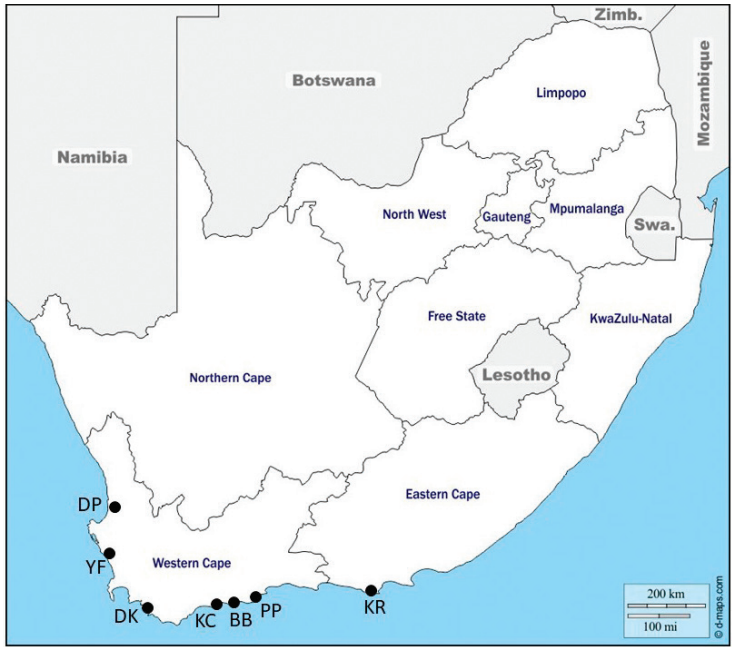

Figure 1. Location of MSA sites in the Eastern and Western Cape of South Africa (Map adapted from: https://d-maps.com/carte.php?num_car=4414&lang=en). YF (Ysterfontein), DK (Die Kelders), BB (Blombos Cave), DP (Diepkloof), PP (Pinnacle Point), KC (Klipdrift Shelter), KR (Klasies River).

Table 1. Faunal assemblages used in this study (also Wadley 2015 for dates)

Sites	Age Ranges (kya)	Reference(s)
Blombos Cave	(101 ± 4) – (73.3 ± 4.4)	Henshilwood et al. 2001; Badenhorst et al. 2016; Reynard and Henshilwood 2019
Die Kelders Cave	(79.7 ± 15.6) – (50.6 ± 4.6)	Klein and Cruz-Uribe 2000
Diepkloof Rock Shelter	107–46	Steele and Klein 2013
Klasies River Main Site Cave 1 and 1A	110–43	Van Pletzen et al. 2019
Klipdrift Shelter	(65.5 ± 4.8) – (59.4 ± 4.6)	Reynard et al. 2016
Pinnacle Point	174–35	Rector and Reed 2010
Ysterfontein Rock Shelter	(132.1 ± 8.0) – (120.6 ± 6.6)	Avery et al. 2008

interspersed with coastal forests, and thus have a relatively similar animal biodiversity (Skinner and Chimimba 2005), making the faunal assemblages suitable for comparative analysis. While there may have been some sporadic carnivore activity at these sites during the MSA, the vast majority of animal remains (from these sites) were collected by humans (Van Pletzen et al. 2019; Badenhorst et al. 2016). We used the faunal assemblages discovered at these sites for this study.

We grouped all rhinoceros remains (recorded as black rhinoceros, white rhinoceros, or indeterminate rhinoceros) from these sites together into a single category. In order to investigate the possible uses made of these large animals, we compared these data to data for large ungulates and zebras. The vast majority of large animal remains were large ungulates. Most of these were apparently hunted and then brought to cave and shelter sites by hominins during the MSA to be butchered and eaten. These large ungulates weigh from several hundred kilograms to more than one tonne. They belong to Bovid Size Class III and IV (Brain 1974). They include red hartebeest (*Alcelaphus buselaphus*), African buffalo (*Syncerus caffer*), giant

buffalo (*Syncerus antiquus*), eland (*Tragelaphus oryx*), kudu (*Tragelaphus strepsiceros*), black wildebeest (*Connochaetes gnou*), giant wildebeest (*Megalotragus priscus*) and waterbuck (*Kobus sp.*). We included all large ungulates identified to the genus or family level (e.g. *Alcelaphinae sp.*, *Alcelaphus/Connochaetes sp.*, etc.) and all those specimens identified as indeterminate Bovid Size Class III and IV (Brain 1974), as well as indeterminate remains described as Large and Very Large Bovids. Also included in this category are zebras (*Equus capensis*, *Equus quagga*, *Equus sp.*). Collectively, we refer to the above group as 'Large Bovids and Equids' (LBE).

The Number of Identified Specimens (NISP) is the preferred quantification method used by most zoo-archaeologists (Lyman 2008). All publications of faunal assemblages reported NISPs, except in the case of Klein's (1976) analysis of Klasies River Mouth, which was excluded from our calculations due to the use of the problematic Minimum Number of Individuals (MNI; Lyman 2008). However, we included the more recent analyses of fauna from the latter site (Van Pletzen et al. 2019; Reynard and Wurz 2020). We assumed all 'cf.' identifications (meaning 'possibly') were correctly assigned to the relevant species.

Results

Assemblages from all seven sites yielded remains of rhinoceros, except for those associated with recent analyses of samples from Klasies River Mouth (Table 2). However, the initial analysis from the latter site yielded remains of rhinoceros (Klein 1976). It can therefore be said that remains of rhinoceros are present in all the faunal assemblages. Overall, remains of rhinoceros only account for 5% of total specimens (i.e. rhinoceros plus LBE), based on analysis of 53 discrete samples from the seven sites shown in Table 1. The highest percentages of rhinoceros remains, are from samples at two sites, Ysterfontein Rock Shelter (44% of the total, from the 'Middle' component, dating to between 120 and 132 kya[1]) and Die Kelders (34% of the total from layer 'MSA 4/5', possibly dating to between 64 and 51 kya). However, the sample for Ysterfontein is small and, overall, the specimens from Die Kelders (n = 121) represent 60% of all rhinoceros remains identified from all MSA assemblages in the Eastern and Western Cape. These finding indicate that, in general, with the exception of Die Kelders (during the period corresponding to layer MSA 4/5) and Ysterfontein, few rhinoceros were brought back to cave sites in the Eastern and Western Cape during the MSA.

Most of the rhinoceros remains (from the MSA assemblages) were identified as black rhinoceros, which was found at Blombos Cave (Henshilwood et al. 2001; Badenhorst et al. 2016;), Ysterfontein (Avery et al. 2008), Klipdrift (Reynard et al. 2016), Pinnacle Point (Rector and Reed 2010), Klasies River (Klein 1976) and Die Kelders (Klein and Cruz-Uribe 2000). Indeterminate rhinoceros were identified at Blombos Cave (Henshilwood et al. 2001; Badenhorst et al. 2016; Reynard and Henshilwood 2019), Diepkloof (Steele and Klein 2013), Ysterfontein (Avery et al. 2008) and Die Kelders (Klein and Cruz-Uribe 2000), while white rhinoceros were found only at Die Kelders (Klein and Cruz-Uribe 2000). None of the studies listed above that identified rhinoceros remains provided details of the skeletal elements used for identification.

Thus, low numbers of rhinoceros remains were found in the MSA faunal assemblages from the Eastern and Western Cape. Similarly low numbers of remains are reported for other megafauna, namely hippopotamus (*Hippopotamus amphibius*) and elephant (*Loxodonta africana*), indicating that few remains of these species were brought back to cave sites by people during the MSA (Table 3). This is a notable result, since both hippopotamus and elephants occurred widely during the Holocene and Pleistocene over southern Africa, including the Eastern and Western Cape (Plug and Badenhorst 2001; Skinner and Chimimba 2005; Avery 2019).

Some additional faunal assemblages from the region were unambiguously collected largely by carnivores, and date to the Middle and Late Pleistocene (Table 4). Three of the assemblages, namely those from Boomplaas Cave, Pinnacle Point PP30 and Herolds Bay, lack remains of rhinoceros; while the largest number of rhinoceros remains in a carnivore assemblage was discovered at Swartklip. Overall, however, the representation of rhinoceros among large fauna in carnivore assemblages is similar to that found in anthropogenic faunal accumulations.

[1]Researchers use a variety of different terms to distinguish layers of remains they excavated, as shown in Table 2.

Table 2. Representation of rhinoceroses and Large Bovid and Equids (LBE), reported as Number of Identified Specimens (NISP), in anthropogenic MSA assemblages from the Eastern and Western Cape

Sites	Layer/Phase	Age (kya)	Rhino	LBE	Total	% rhino
Blombos	M1	(74.9 ± 4.3) – (73.3 ± 4.4)	18	418	436	**4**
	M2	(85 ± 6) – (75 ± 2)	6	203	209	**3**
	M3	(101 ± 4) – (94 ± 4)	5	219	224	**2**
Die Kelders	MSA 4/5	(63.9 ± 4.8) – (50.7 ± 4.7)	85	168	253	**34**
	MSA 6	-	27	576	603	**5**
	MSA 7	(75.3 ± 6.8) – (63.9 ± 7.0)	0	13	13	**0**
	MSA 8	-	0	24	24	**0**
	MSA 9	(79.7 ± 15.6) – (63.0 ± 5·7)	0	23	23	**0**
	MSA 10	-	0	103	103	**0**
	MSA 11	(70.3 ± 5.8) – (59.4 ± 5.0)	0	32	32	**0**
	MSA 12	-	1	178	179	**1**
	MSA 13	(59.8 ± 4.7) – (50.6 ± 4.6)	0	13	13	**0**
	MSA 14	-	4	122	126	**3**
	MSA 15	-	4	68	72	**6**
Diep–kloof	Post-HP	57–46	7	76	83	**8**
	Late-HP	52 ± 5	9	78	87	**10**
	Inter HP	(85 ± 9) – (65 ± 8)	10	33	43	**23**
	MSA–Jack	89 ± 8	1	12	13	**8**
	Early HP	(109 ± 10) – (105 ± 10)	2	27	29	**7**
	Still Bay	109	8	24	32	**25**
	Pre–SB Lynn	100 ± 10	1	5	6	**17**
	MSA–Mike	-	1	7	8	**13**
	Lower MSA	107–100	0	8	8	**0**
Klasies River	MSA II 1A	43.4 ± 3.0, 57.0 ± 4.0	0	68	68	**0**
	HP 1A	63.2 ± 2.7, 65.6 ± 5.3, 53 ± 3	0	77	77	**0**
	Upper	70	0	117	117	**0**
	Top SAS	77	0	44	44	**0**
	Middle SAS	-	0	52	52	**0**
	MSA II U 1 and 1A	100.8 ± 7.5, 85.2 ± 2.1, 77.4 ± 7.0	0	107	107	**0**
	MSA II L 1/1A AA43/Z44	101 ± 12	0	376	376	**0**
	MSA I 1/1A AA43/Z44	106.8 ± 12.6, 108.6 ± 3.4	0	45	45	**0**
	Bottom SAS	126	0	262	262	**0**
	LBS member	110	0	69	69	**0**
Klipdrift	PAY	60.0 ± 4.0	0	7	7	**0**
	PAZ	-	0	12	12	**0**
	PBA/PBB	59.4 ± 4.6	0	50	50	**0**
	PBC	65.5 ± 4.8	2	65	67	**3**
	PBD	64.6 ± 4.2	0	65	65	**0**
	PBE	-	0	8	8	**0**
	PCA	63.5 ± 4.7	0	77	77	**0**

Pinnacle Point	LB SAND 1	90–89	0	3	3	**0**
	DB SAND	102–91	1	12	13	**8**
	LB SAND 2	102–91	0	1	1	**0**
	LBG SAND	134–94	0	14	14	**0**
	4aDB SAND	166–117	0	1	1	**0**
	LBS	112–110	0	0	0	**0**
	FILL	39–35	0	2	2	**0**
	SB SAND	98–96	0	2	2	**0**
	URS	98–91	0	12	12	**0**
	LRS	112–110	0	3	3	**0**
	LC–MSA	174–153	0	7	7	**0**
Ysterfontein	Upper	128.6 ± 6.3	0	17	17	**0**
	Middle	-	4	5	9	**44**
	Lower	(132.1 ± 8.0)–(120.6 ± 6.6)	5	10	15	**33**
Total			**201**	**4020**	**4221**	**5**

Table 3. Numbers of hippopotamus and elephant remains from MSA sites, reported as Number of Identified Specimens (NISP)

Site	Hippopotamus	Elephant	Indeterminate very large mammal
Blombos Cave	5	0	4
Die Kelders Cave	154	0	0
Diepkloof Cave	19	0	0
Klasies River Mouth	28	0*	0
Klipdrift Shelter	0	0	1
Pinnacle Point Cave	0	0	0
Ysterfontein Rock Shelter	0	0	0
Total	206	0	5

*Hippopotamus and elephant remains were present in previous study sample (Klein 1976).

Table 4. Representation of rhinoceroses and Large Bovid and Equids (LBE) in carnivore accumulated assemblages from the Eastern and Western Cape. Numbers were reported as Number of Identified Specimens (NISP), except at Herolds Bay, where Brink and Deacon (1982) reported Minimum Number of Individuals (MNI)

Site	Rhino	LBE	% rhino	Reference
Sea Harvest	10	311	3	Grine and Klein 1993
Boomplaas	0	125	0	Faith 2013
Herolds Bay	0	17	0	Brink and Deacon 1982
Pinnacle Point PP30	0	189	0	Rector and Reed 2010
Elandsfontein Bone Circle	2	350	1	Klein 1983
Duinefontein 2	53	1902	3	Cruz-Uribe et al. 2003
Hoedjiespunt 1	5	698	1	Stynder 1997
Swartklip 1	63	362	15	Klein 1983
Total	**133**	**3937**	**3**	

Discussion and Conclusion

The presence of large bovid and equid remains in MSA faunal assemblages, in combination with the presence of hunting tools, suggest hominins in southern Africa during this period had the skill and ability to hunt or trap large, dangerous prey (Milo 1998; Van Pletzen et al. 2019). Yet, despite their hunting capabilities, and the availability of large quantities of meat on the carcass of a single rhinoceros, bone remains of these large animals are not common at MSA sites in the Eastern and Western Cape.

Three potential reasons could be offered for the low frequency of rhinoceros remains in the MSA samples. First, it is possible that people did not hunt rhinoceros during the MSA. Given the abundance of other easily accessible resources, such as shellfish and tortoises (Klein and Cruz-Uribe 2000; Steele and Klein 2013), people may have been disinclined to exploit large mammals that were potentially dangerous to hunt or trap. Historical descriptions of hunter-gatherers mention that some preyed on rhinoceroses (Alexander 1838; Andersson 1856), but this does not necessarily imply that this happened during the MSA. Despite the important cultural and symbolic meaning of rhinoceros among early historical farming communities in southern Africa (e.g. drawing parallels in rhino behaviour to leadership qualities, using figurines during initiation schools, ascribing a complex folk taxonomy, utilizing remains of these pachyderms in rainmaking rituals), remains of these animals are also meagre at late Holocene farming sites (Boeyens and Van der Ryst 2014). Some early historical accounts from southern Africa report that the meat of black rhinoceros has an acrid and bitter flavour (Delegorgue 1997; Andersson 1856:395). However, this is unconvincing as an explanation for the consistently low representation of these large mammals in faunal assemblages from the MSA. The meat of white rhinoceros reportedly contains substantial fat and has an agreeable taste (Andersson 1856:395), yet white rhinoceroses are even more poorly represented in the faunal assemblages than black rhinoceroses.

A second possible explanation for the low number of rhinoceros remains is that people hunted these animals, but that few skeletal remains were brought back to cave sites. Rhinoceroses are very large mammals with heavy bones, and it is unlikely that an entire carcass would have been brought back to camp sites. Even transporting portions of dismembered limbs would have been challenging owing to the weight of meat and bones. Larger animals were often butchered at kill sites, and only some parts returned to camp sites (Klein 1976). Black and white rhinoceroses are creatures of habit, and repeatedly use the same paths to and from water sources (Skinner and Chimimba 2005), making it possible to hunt them using pits and traps. If feasting took place at camp sites where the animals were slaughtered, then few if any remains of these animals would have been transported back to cave sites. While the excess meat may have been dried and then brought back to caves, this meat would have contained few, if any bones.

Thirdly, the low numbers of rhinoceros at these sites may be a result of a low abundance or complete absence of rhinoceros across the landscape during the MSA. A low abundance would have resulted in low encounter rates, limiting the possibilities for people to hunt or scavenge these large herbivores. Notwithstanding the complexities of using modern census data from national parks and reserves, it may be presumed that rhinoceros generally occur in low numbers compared to other large ungulates (Table 5). However, travellers during the early historical period frequently encountered rhinoceros (Harris 1840; Andersson 1856), suggesting that their low natural population numbers, compared to large bovids and

Table 5. Census data from two large game reserves in southern Africa, showing the representation of rhinoceroses and other large ungulates

Nature Reserve	Number of rhinoceros	Numbe of LBE	% Rhinoceros	Reference
Kruger National Park (South Africa)	11,129	67,640	14	Ferreira et al. 2017; Sanparks.org. 2020
Etosha National Park (Namibia)	20	66,600	<1	Odendaal et al. 1964

zebras, are an unlikely explanation for scarcity of remains at MSA sites. While it is possible that at times rhinoceroses were completely absent from the area, the presence of specimens in deposits indicates that they were present in the region during the MSA.

Potentially, analyses of the skeletal parts and taphonomy of rhinoceros remains from MSA sites could provide clues as to their role in the past. However, obtaining such data, which are not generally available in the literature, would require re-analysis of faunal assemblages containing thousands of specimens. Moreover, this type of analyses might not provide conclusive results, for a number of reasons. The skeletons of rhinoceros are particularly porous (Alexander and Pond 1992), so that their remains are likely to be severely affected by post-depositional processes. Remains of rhinoceros could therefore be under-represented in the archaeological faunal assemblages due to taphonomic factors, but the extent of this cannot be determined by studies of skeletal parts. It should be borne in mind that skeletal part profiles of animal remains in faunal samples only reflect the identified component. However, most faunal assemblages are dominated by unidentified specimens, which simply cannot be identified as they lack morphological features (Badenhorst and Plug 2011). The consequence of this for zoo-archaeology is that skeletal part profiles are biased and provide information on only a small component of the overall assemblage. Taphonomic modifications like evidence for butchering are generally rare on archaeological bones from the MSA, even on remains of hunted animals.

Data on the species of rhinoceroses hunted is insufficient to draw any firm conclusions. However, it is notable that while white rhinoceroses are found at Die Kelders in the lowermost layers MSA 14 and MSA 15 (Klein and Cruz-Uribe 2000), black rhinoceroses occur in the upper layers of the same site, namely MSA 4/5 and 6 (Klein and Cruz-Uribe 2000). White rhinoceroses are exclusively grazers, whereas the black rhinoceroses are browsers. Thus, while the dating of Die Kelders is problematic (Wadley 2015), this data suggests a change in vegetation type from open to bushy environments, leading to a change in the species composition around the site over time.

People evidently had the skills to hunt large ungulates during the MSA in the Eastern and Western Cape of South Africa. Despite this, few remains of rhinoceros are present in MSA faunal assemblages. It is possible that people either did not hunt rhinoceros on a regular basis, or that they camped and consumed the meat at carcass sites. In this case, if they brought meat back to caves and shelter sites, the meat contained few if any bones.

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Greater one-horned rhino (*Rhinoceros unicornis*) behaviour during high floods at Kaziranga National Park and the Burhachapori Wildlife Sanctuary, Assam, India

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Abstract

The behaviour of the greater one-horned rhinoceros (*Rhinoceros unicornis*) (GOH) in response to exposure to natural hazards like floods is poorly understood. This study recorded the behaviour of GOH in highland refuges during periods of seasonal and extreme flooding in two protected areas in the Brahmaputra River valley (Assam, India): Kaziranga National Park (KNP) and Burhachapori Wildlife Sanctuary (BWS). Following the death after monsoon floods in 2016 of a lone sub-adult female translocated to BWS from KNP, the study compared the behaviour of this individual during high flood periods to that of other adults, sub-adults and calves in KNP in 2017. Adult rhinos of KNP spent most of the time resting during high flood periods, which may be a behavioural response to overcome stress. By contrast, both calves and sub-adult rhinos in KNP and especially the lone BWS sub-adult female rhino were observed swimming from one highland to another, despite the heavy floodwater current. Sub-adults in KNP dedicated considerable time to feeding; however, the sub-adult in BWS spent less time feeding than any of the age groups in KNP, and her weakened state from starvation may have contributed to her death after the floods receded. The study concludes by offering recommendations to help rhinos survive and recover from seasonal flooding. Adult animals may be the better choice for future rhino translocations from KNP to other flood plain habitats than sub-adult rhinos or a mother with calf.

Keywords: Translocation, Indian Rhino Vision 2020, climate change, protected area management, adaptive behaviour.

Résumé

Le comportement du rhinocéros indien (*Rhinoceros unicornis*), suite à l'exposition aux risques naturels tels que les inondations, est mal compris. Cette étude a enregistré le comportement du rhinocéros indien dans les refuges des hauts-plateaux pendant les périodes d'inondations saisonnières et extrêmes, dans deux aires

protégées de la vallée du Brahmapoutre (Assam, Inde): le Parc national de Kaziranga (PNK) et le Sanctuaire de faune de Burhachapori (SFB). Suite à de graves inondations de mousson en 2016, qui ont causé la mort d'une femelle sub-adulte transférée seule au SFB depuis le PNK, l'étude a comparé le comportement de cet individu pendant les périodes d'inondations à celui d'autres adultes, sub-adultes et jeunes dans le PNK en 2017. Les rhinocéros adultes du PNK, pendant les périodes de fortes crues, passaient la plupart du temps au repos, ce qui peut être une réponse comportementale pour surmonter le stress. Par contre, autant les rhinocéros jeunes que les sub-adultes du PNK, et en particulier la femelle sub-adulte du SFB, ont été observés en train de nager d'un haut-plateau à l'autre, malgré le fort courant dû aux inondations. Les sub-adultes du PNK consacrent un temps considérable à l'alimentation; cependant, la sub-adulte du SFB a passé moins de temps à se nourrir que n'importe quel groupe d'âge du PNK, et son état d'affaiblissement dû à la famine a peut-être contribué à sa mort après le retrait des inondations. L'étude conclut en proposant des recommandations pour aider les rhinocéros à survivre et à se remettre des inondations saisonnières. Les animaux adultes sont probablement les individus les plus indiqués pour les futurs transferts de rhinocéros du KNP vers d'autres habitats de plaine inondable, plutôt que les rhinocéros sub-adultes ou qu'une mère avec un jeune.

Mots clés: Translocation, Indian Rhino Vision 2020, changement climatique, gestion des aires protégées, comportement adaptatif.

Introduction

The understanding of animal behaviour is crucial to wildlife conservation practices and management. However, knowledge of behavioural traits is seldom incorporated into the design and implementation of conservation programmes at the regional or the global scale (Tobias and Pigot 2019). This may be because the relevant behavioural traits are poorly understood, as is the case of the behaviour of the greater one-horned rhinoceros (*Rhinoceros unicornis*) (GOH) in response to exposure to natural hazards like floods (Gaucherel et al. 2016). This paper addresses this knowledge gap by presenting the results of a study of the behaviour of GOH during seasonal flooding of the Brahmaputra River basin in Assam, India. The study provides crucial information for better management of the species.

The study was carried out in two protected areas in the Brahmaputra River Valley: Kaziranga National Park (KNP) and Burhachapori Wildlife Sanctuary (BWS). The history of the KNP dates back to 1905. It was officially recognized as a national park in 1974 and was declared a UNESCO World Heritage Site in 1985. KNP currently holds the largest population of GOH in the world, comprising 2,413 individuals in 2018.

BWS was designated as a Proposed Forest Reserve in 1974 and was recategorized as a Sanctuary in 1995. BWS is contiguous with the Laokhowa Wildlife Sanctuary (LWS) to the south, and the two areas are known collectively as the Laokhowa and Burhachapori Wildlife Sanctuaries (LBWS). The LBWS area first attracted the attention of wildlife conservation more than a hundred years ago due to the presence of rhinos (Ellis et al. 2015). However, the entire resident rhino population of LBWS was wiped out by poaching in the mid-1980s and rhinos were declared locally extinct (Menon 1996; Sivakumar et al. 2013).

To revive the rhino population in the LBWS area, a rhino reintroduction plan was developed under the Indian Rhino Vision 2020 (IRV2020) programme of the Government of Assam (Bonal et al. 2009; Ellis et al. 2015). The rhino reintroduction plan incorporates a post-translocation holding phase (Bonal et al. 2009; Sivakumar et al. 2013), during which rhinos are kept in a 1.5 km^2 fenced enclosure in the BWS prior to releasing them in the wild (Emslie et al. 2009; Sivakumar et al. 2013).

As a part of the rhino reintroduction programme, two rhinos (mother and sub-adult female) were translocated from the Western Range (Bagori) of KNP to BWS on 29 March 2016. Unfortunately, the adult female died of natural causes on 22 May 2016 after 54 days of translocation, leaving her calf alone inside the enclosure. This sub-adult female had to withstand three waves of high floods in June, July, and September 2016. She died shortly afterwards on 26 October 2016, 211 days post-translocation to BWS.

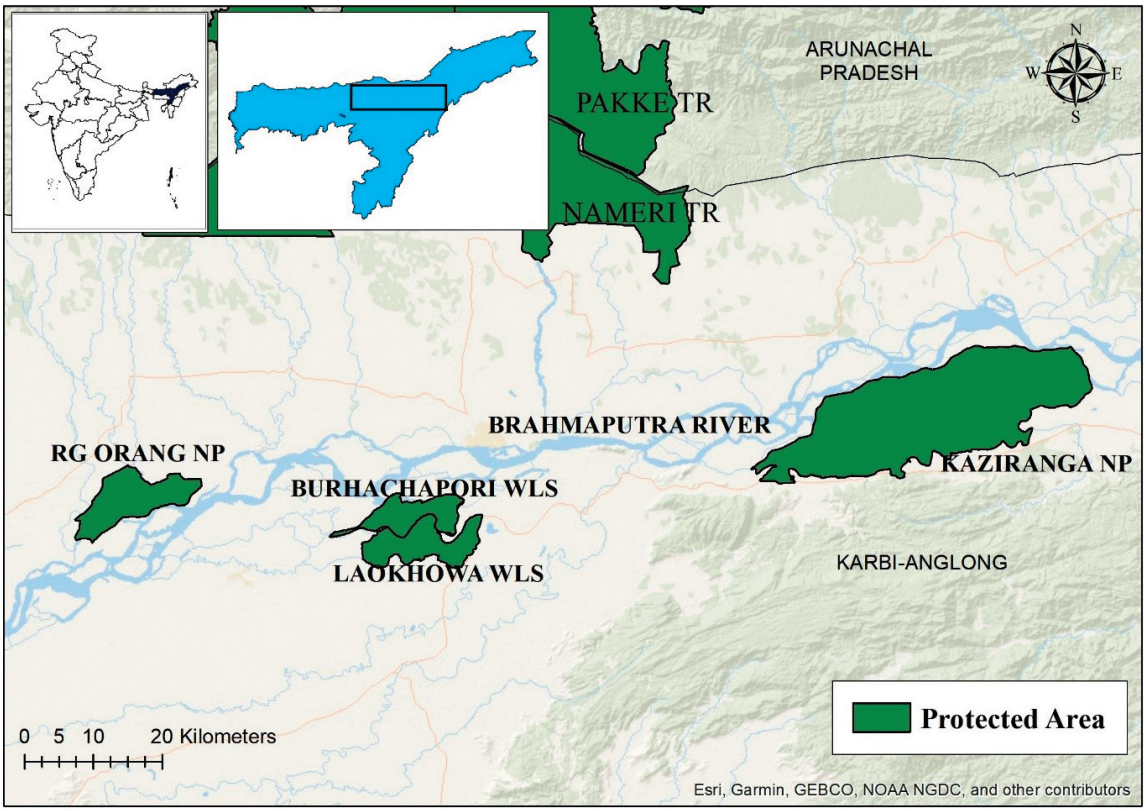

Figure 1. Location of protected areas in the Brahmaputra Valley, Assam.
Note the text in the map for Rajiv Ghandi Orang National Park. is RG Orang NP, NP: National Park; WLS: Wildlife Sanctuary.

During June–September 2016, floodwater submerged the entire rhino enclosure for periods of five to six days, causing acute stress to the lone female sub-adult rhino. The floods were observed to influence the behaviour of the rhino and it was conjectured that an inappropriate behavioural response to the floods may have contributed to her death. Therefore, following a suggestion by the Translocation Core Committee (TCC) of Assam, a research programme was initiated under IRV2020 to study the behaviour of rhinos in KNP during high floods in 2017 and to compare this to the behaviour of the lone sub-adult in BWS in 2016.

Study area

KNP is situated in the Biswanath, Golaghat, Nagaon, and Sonitpur districts of Assam. Its highly fertile habitats include extensive grassland areas, numerous water bodies, and mixed woodlands. In addition to rhinos, the diverse habitats of KNP are home to 34 other species of mammals, including other endangered species, namely tiger (*Panthera tigris tigris*) river dolphin (*Platansita gangetica*) and slow loris (*Nycticebus bengalensis*); as well as 480 species of birds, 60 species of reptiles, 24 species of amphibians, 42 species of fishes, and 491 species of butterflies (Sivakumar et al. 2013).

LBWS is situated on the south bank of the river Brahmaputra, between KNP to the east and Rajiv Gandhi Orang National Park (RGONP) to the west. It is considered a key habitat in the riverine corridor connecting RGONP and KNP (Sivakumar et al. 2013; Areendran et al. 2020) (Fig. 1). The alluvial wetland and grassland habitats of LBWS are similar to those of KNP.

The riverine landscape comprises—in addition to the main water course—flood-formed lakes known as beels, and sandbars known as *chapories* which provide retreats and shelter for animals during floods. In addition, artificial elevated areas, known as 'highlands', have been built with the help of the

different government agencies. These highlands provide refuges for animals, particularly rhinos (Patar 2005; Barman et al. 2014) within the KNP, so that they do not have to leave the protected area to find safety during high flood periods. Usually, groups of rhinos stay on the same highland for the duration of the high flood period, typically two to three days.

Both KNP and LBWS have a subtropical monsoon climate with annual temperatures of 5–25°C and three seasons: summer, monsoon, and winter. November–February is the winter or dry season, while monsoon rains occur mainly in July–September. Around 95% of both areas are submerged by floodwater every year at the peak of the monsoon (Areendran et al. 2020). If the floods are sustained for a longer period than normal, they can cause heavy losses of Park infrastructure, habitats, and wildlife (Vasu and Singh 2015). With a changing climate, weather patterns could become more extreme and the situation could escalate (Save The Rhino 2019).

Methodology

This study was carried out during the high flood periods (June, July, and September) of 2016 in BWS and 2017 at KNP. Rhino behaviour was recorded using focal sampling in BWS and scan sampling in KNP (Altman 1974). Scan sampling focused on a particular behaviour rather than a particular animal, while in focal sampling the behaviour of one individual was recorded throughout the predetermined period (Dutta 2018).

The behaviour of the lone female sub-adult at BWS was observed as part of ongoing monitoring of the individual. Efforts were made to observe the rhino from a small wooden boat as there were no other means of transportation available. Due to the fast-flowing flood water current, it was impossible to observe the rhino from stationary locations. The rhino was observed during the daytime between 06:00 and 17:00 hours, usually for periods of 20–30 minutes. Altogether 191 behaviour samples were recorded over 12 days of observation.

Single rhinos and groups of rhinos were observed in KNP during three high flood waves (each lasting two to three days) in 2017, when they took refuge on elevated land, i.e. roads, embankments, or on the highland refuges inside the Park. The rhinos were observed from a boat, or from observatory towers between 06:00 and 14:00 hours for periods of 20–45 minutes. It was not possible to make observations after 14:00 hours due to the unavailability of transportation and support staff. Altogether 207 behaviour samples of the KNP rhinos were recorded during 10 days of observation.

Following descriptions and procedures used in previous studies (Kandel and Jhala 2008; Dutta et al. 2017; Dutta 2018), types of behaviour were broadly categorized as grazing, wallowing, walking, browsing, and resting. We also observed an additional behavioural category, swimming, not recorded in previous studies (Table 1). Behavioural states were recorded if they lasted more than one minute. All observations were done by using binoculars (Nikon 10×40) and data were recorded and analysed using MS Excel.

Table 1. Ethogram of rhino behaviour

	Type of behaviour	Description	References
1.	Grazing	Approaches grasses and takes into the mouth	Laurie 1982; Dutta 2018
2.	Browsing	Approaches bush, tree twigs, takes into the mouth	Laurie 1982; Owen-Smith 1988; Dutta 2018
3.	Wallowing	Almost all parts of the body dip into mud and water	Laurie 1982; Dinerstein 2003; Dutta 2018
4.	Resting	The animal is in a resting position (lying and sitting, standing) inactive and relaxed	Dutta 2018
5.	Walking	The animal moves forward attentively	Laurie 1982; Dinerstein 2003; Dutta 2018
6.	Swimming	The animal uses its limbs for propulsion in the water	(Defined by the authors of this study)

Results

We compared the behaviour of rhinos in KNP in 2017 to that of the translocated rhino in BWS in 2016.

The lone sub-adult female rhino took shelter on two elevated areas within the 1.5 km^2 enclosure that remained just above the water line during high flood days. During the floods, the enclosure gates were opened and the animal had the opportunity to swim approximately 2 km distance to LWS to find a better refuge. But she remained on the elevated areas within the enclosure until the floodwater receded.

From the 191 behaviour samples collected, it can be inferred that, during daylight hours, the rhino spent almost half the time resting (45% of samples). It was notable that, during periods of activity, the rhino spent most time swimming (31%), although the proportion of time spent swimming declined in September. The rhino also spent a small but significant amount of time walking (6%). No wallowing was observed during the entire period of observation. This was probably caused by the ambient temperature decrease due to rain and wind. The water current may also have deterred wallowing.

Feeding accounted for only 18% of observed samples, and was almost exclusively by browsing, with very little time spent grazing, although it was observed that there were still areas with grass cover on some of the highlands (Table 2, Fig. 2).

In KNP in 2017, we observed the behaviour of 30 individuals in June, 29 individuals in July and 23 individuals in September, recording a total of 207 behaviour samples (Table 3). Of these observations, 37, 20 and 25 were of rhinos in Bagori (Western Range), Kohora (Central Range) and Agoratoli (Eastern Range), respectively.

Adult rhinos taking refuge from floods spent almost all of the time resting (73% of samples) and feeding (23%). Feeding was mainly by browsing. Animals were observed wallowing on two occasions and swimming on one occasion, while there were no observations of walking behaviour (Table 4, Fig. 3).

Sub-adults in KNP displayed patterns of activity very different from those of adults. Sub-adults spent much less time resting (18% of samples) and more than half of the time feeding (51%), again preferring to browse rather than graze. Sub-adults also spent much more time than adults moving around without feeding, either wallowing (11%) , walking (11%) or swimming (10%) (Table 5, Fig. 4).

Calves in KNP divided their time evenly between resting (33% of samples), feeding (37%, again mostly browsing) and moving around by swimming or walking (36% in total). Calves were observed wallowing on just two occasions, both in June (Table 6, Fig. 5).

Figure 6 compares the patterns of behaviour of adults, sub-adults and calves in KNP in 2017 alongside the behaviour pattern of the sub-adult in BWS in 2016. Notable features include the very large amount of time that adults spent resting, the time that sub-adults in KNP dedicated to feeding, and the fact that the sub-adult in BWS spent more time swimming, and less time feeding, than any of the age groups in KNP.

Discussion

Even though the annual floods are welcome, since they rejuvenate the rhino habitats in protected areas along the river Brahmaputra, they can cause huge challenges under certain circumstances. Factors such as the level and velocity of the floodwaters, duration of waterlogging, quality of deposit material, and erosion all have impacts on wildlife, including rhinos, and require appropriate management responses.

The behaviour of rhinos has been observed to be affected by the fluctuating water levels during the floods. In the past, as the water level rose in KNP, the rhinos attempted to move to nearby Karbi Anglong hills to find shelter and food (Patar 2005). However, with the increase of traffic on the highway and expansion of development activities in the surrounding areas of KNP it is becoming increasingly difficult for animals to move to nearby hilly areas and some rhinos prefer to remain in the artificially constructed highlands inside the Park.

In normal conditions, rhinos' daytime activities consist mainly of feeding, followed by wallowing, walking, and resting in that order (Laurie 1982; Owen-Smith 1988; Dinerstein 2003; Patar 2005; Dutta 2018). However, patterns of behaviour are altered during peak flooding, as shown by the results of this study (Figs. 3–5).

Table 2. Behaviour of lone sub-adult individual in Burhachapori Wildlife Sanctuary in 2016

Behaviour category	June	July	September	Total	Percentage
Grazing	1	1	0	2	1
Browsing	9	13	10	32	17
Wallowing	0	0	0	0	0
Resting	25	34	26	85	45
Walking	2	6	4	12	6
Swimming	20	30	10	60	31
Total observations	57	84	50	191	100

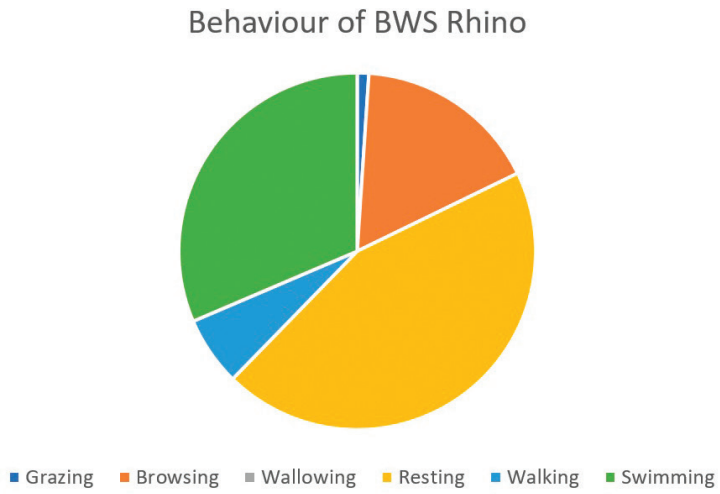

Figure 2. Behaviour of lone sub-adult individual in Burhachapori Wildlife Sanctuary in 2016.

Table 3. Age group and month of observation of rhinos observed in Kaziranga National Park in 2017

Age group	June	July	September
Adult	13	15	10
Sub-adult	14	9	7
Calves	3	5	6

Table 4. Behaviour of adults in Kaziranga National Park in 2017

Behaviour category	June	July	September	Total	Percentage
Grazing	1	2	0	3	4
Browsing	4	6	4	14	19
Wallowing	0	2	0	2	3
Resting	14	22	18	54	73
Walking	0	0	0	0	0
Swimming	1	0	0	1	1
Total observations	20	32	22	74	100

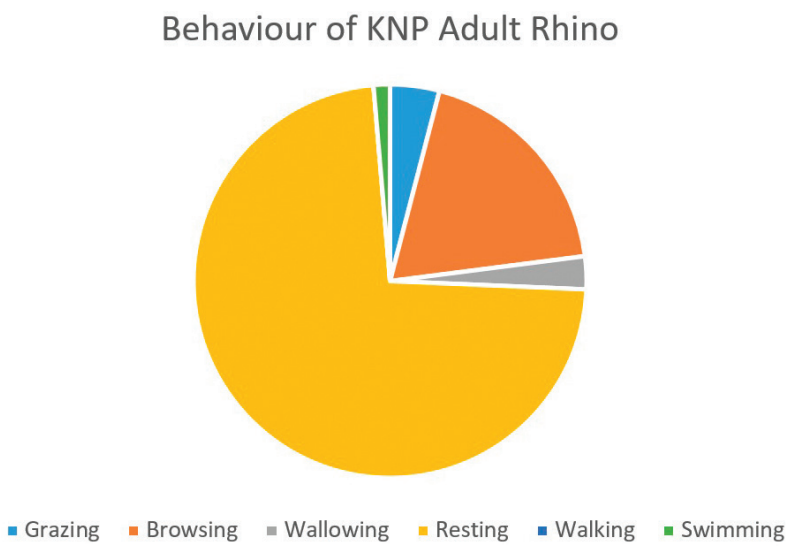

Figure 3. Behaviour of adults in Kaziranga National Park in 2017.

Table 5. Behaviour of sub-adults in Kaziranga National Park in 2017

Behaviour category	June	July	September	Total	Percentage
Grazing	3	4	2	9	11
Browsing	12	8	14	34	40
Wallowing	2	4	3	9	11
Resting	4	8	3	15	18
Walking	2	2	5	9	11
Swimming	2	3	3	8	10
Total observations	25	29	30	84	100

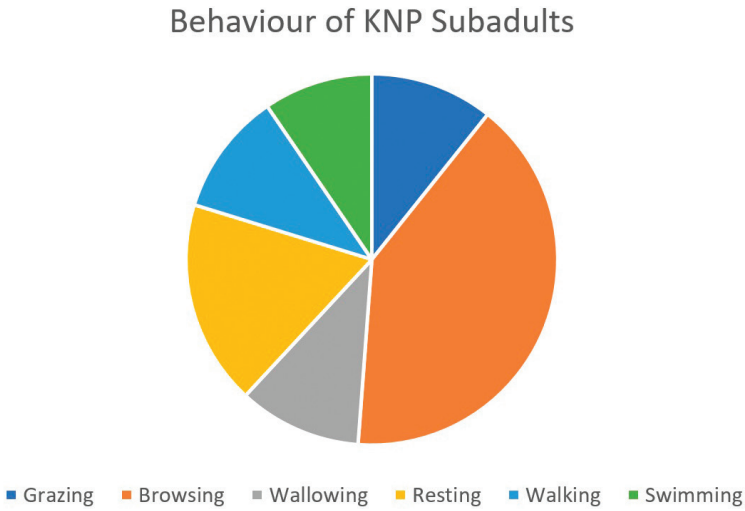

Figure 4. Behaviour of sub-adults in Kaziranga National Park in 2017.

Table 6. Behaviour of calves in Kaziranga National Park in 2017

Behaviour category	June	July	September	Total	Percentage
Grazing	1	1	1	3	6
Browsing	4	1	5	10	21
Wallowing	2	0	0	2	4
Resting	7	4	5	16	33
Walking	6	2	2	10	21
Swimming	2	3	2	7	15
Total observations	22	11	15	48	100

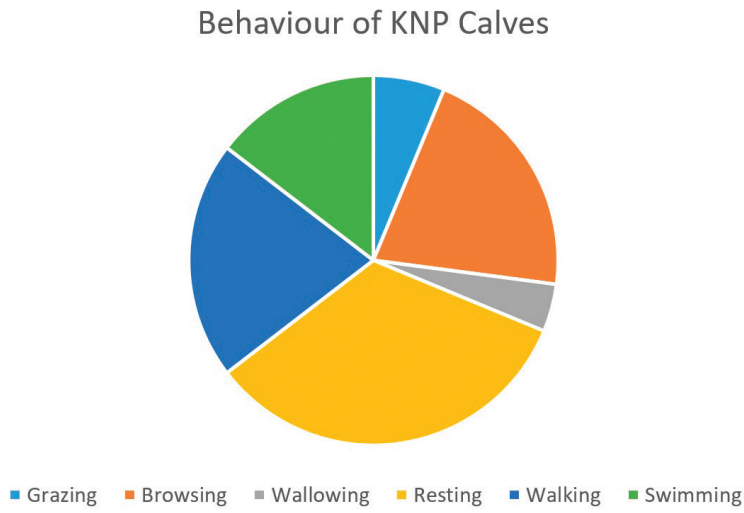

Figure 5. Behaviour of calves in Kaziranga National Park in 2017.

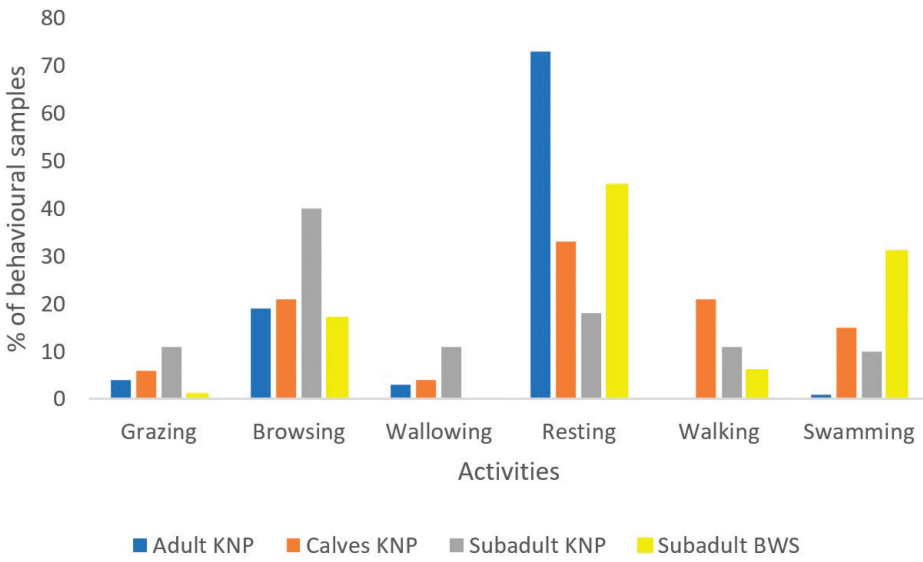

Figure 6. Comparison of behaviour of lone BWS sub-adult female rhino in 2016 with those of adults, sub-adults and juveniles in Kaziranga National Park in 2017.

In our study, during the high flood period, adult rhinos of KNP spent most time resting. This may be a behavioural response to overcome stress during high flood periods. Zheng and Zheng (2014) report that animals alter their behaviour under stressful situations as a means of coping. Specifically, animals in vulnerable situations may change their behaviour from positive states (struggle to escape/flee) to negative states (stay rested and limit movement). Zheng and Zheng (2014) suggest that this response to stress is an adaptive behaviour that may benefit survival. Thus, the behaviour inhibition exhibited by rhinos during periods of flood stress may be adaptive behaviour to survive in such a situation.

In this study we observed a new behavioural category, not reported in previous studies, i.e. swimming. Both calves and sub-adult rhinos in KNP and especially the lone BWS sub-adult female rhino were observed to swim frequently from one highland to another, despite the heavy floodwater current. The motive for these movements may have been to eat the aquatic plants or (in the case of KNP individuals) to avoid other animals (Fig. 6). In contrast, adult rhinos were almost never observed swimming. They remained on the highland refuges, appeared sluggish and hardly moved. We surmise that the minimal movement of adult rhinos was not only a tactic to overcome stress, but also behaviour learned from previous experience of high floods that it is safer to remain on the raised areas and not to attempt to escape by swimming against the strong current.

With less experience of floods, the sub-adults and calves might have been tempted to explore the situation. We observed that calves sometimes fell accidently into the rapid floodwater currents while wandering about and became separated from their mothers, and a number of deaths by drowning among these age groups (calf and sub-adult) during high floods were reported by Barman et al. (2014). All these observations concur with the conclusions of Nishimura et al. (1988), that an experienced animal can cope with adverse circumstances and stress more adequately than a novice one.

We observed some other differences in behaviour patterns among the groups of rhinos studied during the high flood days. All animals were observed browsing tree twigs, and shrubs, as observed in previous flood events in KNP (Patar 2005), but this activity was observed much more frequently among sub-adult rhinos in KNP, compared to all other groups. By contrast, the lone BWS sub-adult spent less time feeding than all animals in KNP, and notably less than sub-adults in KNP. The lone sub-adult in BWS also spent more time resting than sub-adults in KNP.

This suggests that the stress experienced by the lone and inexperienced sub-adult rhino may have led to starvation. If the food intake was less than the nutritional requirement of the calf, this could have contributed to her death after the flood receded.

Recommendations

Climate extremes, such as increased temperatures, heavier than average rainfall, flood, and drought, may directly impact on behaviour and welfare of wild animals and their habitats. Our observations highlight the need for further research on how food availability, food intake and rhinos' nutritional requirements are affected by periods of flooding, and the implications for the health conditions of rhinos. The rhinos' anomalous behaviour during flooding also suggests that it would be useful to study how other species are affected by flooding and, more generally, the effects on species' behaviour caused by other evolving natural phenomena affecting the area.

The present study highlights the importance of improving fodder diversity and availability for rhinos during all weather conditions, including periodic floods. Specifically, measures should be taken to diversify vegetation on the highlands by establishing trees and shrubs to meet the nutrient requirements of rhinos (and other herbivores) during the high flood days. Since the flood plain grassland areas are changing rapidly due to seasonal flood and silt deposition, there is also a need for periodic surveys of the flora, particularly of enclosures where it is planned to hold translocated rhinos.

Additional measures recommended to better protect rhinos in the Brahmaputra valley from seasonal flooding include identification and delineation of the corridor complexes within KNP, preparation of a flood susceptibility map and identification of flood prone areas (Areendran et al. 2020), construction of more *highlands* or raised platforms as refuges during high floods in LBWS, and contructions of underpasses at strategic locations across the highways beside KNP to facilitate

free movement of animals (Areendran et al. 2020).

The results of this study also suggest that the ideal time for rhino translocation would be early December. This would allow areas to recover from the effects of floods in June–September, while allowing newly released rhinos sufficient time to settle in their new habitat before the next monsoon starts.

Finally, our results suggest that adult animals may be the better choice for future rhino translocations from KNP to LBWS or other flood plain habitats than sub-adult rhinos or a mother with calf. As flood events in the LBWS area and other flood plain rhino habitats are similar to those in KNP, survival capabilities of adult animals are expected to be greater than those of immature individuals (sub-adult and calf) when released into a new environment. Lastly, we recommend further studies on how soon behaviour patterns revert to normal after the flood waters recede.

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The authors dedicate this research to the late J.C. Mondal, Range Officer who died recently of Covid-19.

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MANAGEMENT

Elephant movements in different human land-uses in Chobe District, Botswana

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Abstract

We have a limited understanding of the effects that an increasing human population and urban and agricultural development are having on elephant movements in Botswana. Elephant movements are complex because they are influenced by a wide range of location-specific variables. This study aimed to investigate how elephants move through different human-dominated landscapes in the Chobe District, Botswana. The movements of four female elephants from the Chobe District were studied over a period of 13 months using GPS collars to follow them. Annual home ranges of the elephants were calculated using both the 100% minimum convex polygon (MCP) and 95% fixed kernel (FK) methods. Additionally, general estimating equation models were used to investigate which factors influenced the elephants' *distance* moved, both hourly and daily. We found the elephants' movement behaviour was dependent on the time of day and type of land use: whether agricultural areas, protected areas or wildlife management areas, trophy hunting blocks, and multi-use zones (e.g. game management areas). Overall, all of the elephants had smaller annual home ranges (~450-1,750 km^2) than seen in other studies within southern Africa, and there was a difference in seasonal movements, between individuals. Additionally, contrary to previously published studies, the elephants made larger diurnal movements than nocturnal movements. Movements were significantly different between different land-use areas, suggesting that elephants could be developing different strategies to move through differing levels of human disturbance.

It is vital for any wildlife management plan that the spatial movements of key conservation species are thoroughly understood, in order to formulate informed management decisions and create an integrated land-use management plan that enables both development and elephant coexistence.

Additional Keywords: Conservation, human-dominated landscapes, land-use, spatial behaviour.

Résumé

Nous avons une compréhension limitée des effets qu'une population humaine croissante et un développement urbain et agricole ont sur les mouvements d'éléphants au Botswana. Les mouvements des éléphants sont complexes car ils sont influencés par un large éventail de variables spécifiques à leur emplacement. Cette étude-ci visait à étudier comment les éléphants se déplacent à travers différents paysages dominés par l'homme

dans le district de Chobe, au Botswana. Les déplacements de quatre éléphants femelles du district de Chobe ont été étudiés sur une période de 13 mois, en utilisant des colliers GPS pour les suivre. Les domaines vitaux annuels des éléphants ont été calculés en utilisant à la fois les méthodes du polygone convexe minimum (MCP) à 100 % et du noyau fixe (FK) à 95 %. De plus, des modèles d'équation d'estimation généraux ont été utilisés pour étudier quels facteurs ont influencé les déplacements des éléphants, à la fois horaires et quotidiens. Nous avons constaté que le comportement de déplacement des éléphants dépendait de l'heure dans la journée et du type d'utilisation des terres, y compris les zones agricoles, les zones protégées ou les Zones de gestion de la faune, les blocs de chasse aux trophées et les zones à usages multiples (par exemple, les Zones de gestion du gibier). Dans l'ensemble, tous les éléphants avaient des domaines vitaux annuels plus réduits (~ 450–1,750 km2) que ceux observés dans d'autres études en Afrique australe, et il y avait une différence dans les mouvements saisonniers entre les individus. De plus, contrairement aux études publiées précédemment, les éléphants effectuaient des mouvements diurnes plus importants que des mouvements nocturnes. Les déplacements étaient significativement différents entre les différentes zones d'utilisation des terres, ce qui suggère que les éléphants pourraient développer différentes stratégies pour se déplacer à travers différents niveaux de perturbation humaine.

Il est essentiel pour tout plan de gestion de la faune que les mouvements spatiaux des espèces clés de conservation soient parfaitement compris, afin de formuler des décisions de gestion éclairées et de créer un plan de gestion intégrée de l'utilisation des terres qui permet à la fois le développement et la coexistence des éléphants.

Mots clés: Conservation, paysages dominés par l'homme, utilisation des terres, comportement spatial.

Introduction

Within the last 50 years, areas of conservation value have tended to overlap with areas of expanding human population (Carter et al. 2012), placing humans and wildlife in direct competition with one another. Growing human population and increasing development have resulted in fragmentation of the natural habitat, impacting ecosystems and wildlife populations. This can trigger a range of negative ecological consequences for wildlife including displaced movement behaviour, increased stress levels, reduction of reproduction rates and in the worst case scenario, local extinction (Blake et al. 2008), particularly where large mammals are concerned (Tucker et al. 2018).

The size of the area within which an animal moves correlates positively with its body size: larger animals use more space (Tucker et al. 2014). Consequently, large ranges many outside protected wildlife areas (PAs) facilitate survival for large wild mammals (Tucker et al. 2014), especially when there is high temporal variability in food resources (Gadde, 2005; van Aarde et al. 2006; Boettiger et al. 2011). However, recent advances in animal global positioning systems (GPS) and the creation of improved software have allowed us to further question the concept that individual wild animals restrict their movements to finite areas (Powell and Mitchell 2012). The locomotion strategy, foraging dimensions, trophic guild, and prey size make up 80% of the variation in home range size for vertebrate species (Tamburello et al. 2015). Elephant-movement behaviour is influenced by environmental factors such as water and foraging availability (Boettiger et al. 2011), and rainfall patterns (Thouless 1996). Additionally, elephants are increasingly affected by humans and their development into previous wilderness areas (Blake et al. 2008).

In order to create and implement effective land-use and wildlife management plans for an area, we need to increase our understanding of how rising human disturbance, different human activities and development can influence elephant movement behaviour (Graham et al. 2009; Roever et al. 2013; Adams et al. 2017a; Tucker et al. 2018). Gaynor et al. (2018) investigated the effect that human settlement and roads are having on the daily activities of elephants moving to and from Mozambique Gorongosa National Park (NP), a study focusing on a small population of elephants living within an area heavily populated by humans. Elephants restricted their activity to the

night when moving through areas of high human disturbance remaining in PAs during daytime hours. Similarly Buchholtz et al. (2021) found elephants visiting water points located close to higher human development accessed them at night. Both of these studies clearly show that elephant movements were directly impacted by human presence (Gaynor et al. 2018; Buchholtz et al. 2021). Additionally, another study by Blake et al. (2008) found that the movements of elephants were impacted by the construction of roads that acted as a barrier to elephants (Blake et al. 2008). Each of these studies showed that elephants avoid human development by altering their temporal movement patterns. However, we still have limited knowledge of how elephants in a stable unfenced population with an expanding range (Chase et al. 2019) use space and resources in areas with different levels of human disturbance.

In addition to temporally adjusting movements to avoid different human disturbance, wildlife can also change their pace (Tucker et al. 2018). Results from previous studies (Douglas-Hamilton et al. 2005; Blake et al. 2008; Graham et al. 2009) indicate that elephants exhibit a risk-avoidance behaviour while passing through community areas, by speeding up their movements to limit time spent in those areas. Therefore, it would be expected that there is reduced elephant competition for desirable resources (water, vegetation) found in human-dominated landscapes versus PAs and less dominated human areas. It is proposed that where competition for resources is high, some members of large elephant groups will enter human-dominated areas due to the need for resources overriding a preference to avoid the risk posed by humans.

Botswana has the largest elephant population in Africa with approximately 130,000 individuals (Chase et al. 2019), together with one of the lowest human populations of all African countries (~2.3 million) and it is considered an upper middle-income nation (World Bank Database 2019). The economy is largely reliant on diamonds, and in the 1960s, the government shifted from an agricultural based economy to mining (Malema 2012; Worldbank 2019). However, tourism is the second largest contributor to the economy which will only increase with importance as diamonds are predicted to be exhausted in the next 20-30 years (Malema 2012; Worldbank 2019). Given that Botswana is home to approximately one-third of the continent's population of elephants, it holds global conservation significance and tourism value, but unsurprisingly faces increasing challenges in managing and maintaining such a population in a growing human population (Chase et al. 2019). Many of the rural households living within the elephant range are also some of the poorest and are heavily reliant on the Botswana Government poverty alleviation programmes that aim to assist elderly and vulnerable farming households with "Ipelegeng" a drought relief food aid and labour based public works (Gupta 2013), rather than the tourism sector. There are many complex issues at play, the main one largely being the lack of connection of between those working in the tourism industry and the elephant and wildlife population (Adams et al. 2017b). Apprehension exists over the reported increases in human elephant conflict (HEC) over space and resources in the area (Adams et al. 2017b), especially where the elephant home-range overlaps hugely with the increasing human habitation (Adams et al. 2017a). Mitigating the impact of anthropogenic change on species and the conservation of those species is debatably the biggest conservation dilemma (Tulloch et al. 2018).

By deploying GPS collars, we followed the movements of four individual elephants from different family units through different human landscape land-uses in the Chobe District of Botswana. We hypothesized that the behaviour of elephants occupying areas of different human land-uses would differ according to different human activities within those areas. It was predicted that elephants would speed up their movements when passing through human-occupied areas to access required resources, in an effort to avoid humans. This study aimed to determine how female elephant movement behaviour differed between land uses. This study examined the hourly and daily movement patterns and home ranges of different elephants in PAs (national parks, forest reserves, and tourist and wildlife management areas), mixed-use areas (agricultural, trophy hunting wildlife management areas, and undesignated areas), and community areas (human settlements), within the Chobe District of Botswana.

Materials and methods

Study area

The study area is located in the north-east corner of Botswana, in the Chobe District (Fig. 1). The area is made up of Chobe National Park (10,740 km^2), community settlements, six different forestry reserves, and both trophy hunting and safari/photographic wildlife management areas (WMAs). There are approximately 32,000 elephants in Chobe District, with an estimated 17,000 of them in Chobe National Park (Chase et al. 2019). Chobe District is an unfenced area, where wildlife can move freely throughout the different land designations. The elephants in the Chobe District can and do move east into Zimbabwe and north into Namibia.

For the purpose of this study, conducted over 13 consecutive months in both wet and dry seasons, the seasons in northern Botswana are as follows: the cold dry season (May-July), hot dry season (August-October), wet season (November-March), and post-wet season (April) (Adams et al. 2017a).

The two largest human settlements within this region are the Chobe Enclave and the townships of Kasane and Kazungula, with a combined population of approximately 13,000 people (Census office 2014). Both locations are surrounded by PAs and are adjacent to the Kwando-Linyanti and Chobe Rivers (Fig. 1). Both the Enclave and the Kasane/Kazungula areas contain designated and undesignated wildlife corridors of varying sizes that elephants and other animals use to travel from the NPs and forestry reserves through to the riverfront for water and browsing (Adams et al. 2017a). The Chobe Enclave is a seasonal floodplain dominated by small-scale farming (mixed livestock and crops), with subsistence cultivation undertaken in the wet season, followed by harvest in the post-wet season (Jackson et al. 2008; Adams et al. 2017a). The area is made up of five low-density villages located next to the floodplain. Given the level of cultivation, close proximity to the floodplain, and its location alongside "PAs", the Enclave is an area of high HEC. Livestock are also prioritized in the area with a series of cattle posts located throughout the Enclave. It is also a trophy hunting concession where quota-based hunting occurs between April-October. Comparatively, the two towns Kasane and Kazungula (K/K) are the largest urban centres of the Chobe District, located just 2.5 km apart (Adams et al. 2017a). The human population in the Chobe District has increased by 27.9% during 2001–2011, and is set to continue increasing (Census 2014) due to a variety of factors, tourism, large civil service (Kazungula Bridge and border crossing is at the quadripoint of four countries: Botswana/Namibia/Zambia and Zimbabwe), and access to water resources. The urban centre is made up of residential housing, commercial and industrial businesses and government offices. K/K have only two horticulture farms. The towns are the base for the tourism industry in north-eastern Botswana (Adams et al. 2017a), and also have a number of lodges, hotels and guest houses located throughout both towns.

GPS / Satellite collars

Four elephants (Table 1) were fitted with GPS collars manufactured by African Wildlife Tracking (South Africa): one in the K/K side of the north-east corner of Botswana (CH 67) and three in the central and western side of the Chobe riverfront/Enclave (CH 62, 65, 69) (Enclave elephants). Data were collected from 1 October 2012 to 30 October 2013. Hourly location data were collected and collated into diurnal (06:00–18:00) and nocturnal (18:00–06:00) periods. The collaring was opportunistic, based on which individuals were in or near target areas at that time, however the objective was to collar females in family units, representing movements in different types of human-uses in the Chobe District. Individual elephants were selected based on either proximity to humans or their tendency to be sighted in human-dominated areas. All of the collared elephants were mature adult females, that were a part of family units (Table 1). All of the selected females had the potential to move into each of the defined land use designations.

Land use designation

We divided the study area into different categories based on land use designations made by the GPS programme "Tracks for Africa" (T4A, version 14.0):

1. Protected areas represent national parks, forest reserves and wildlife viewing management areas where humans are present, but to a very

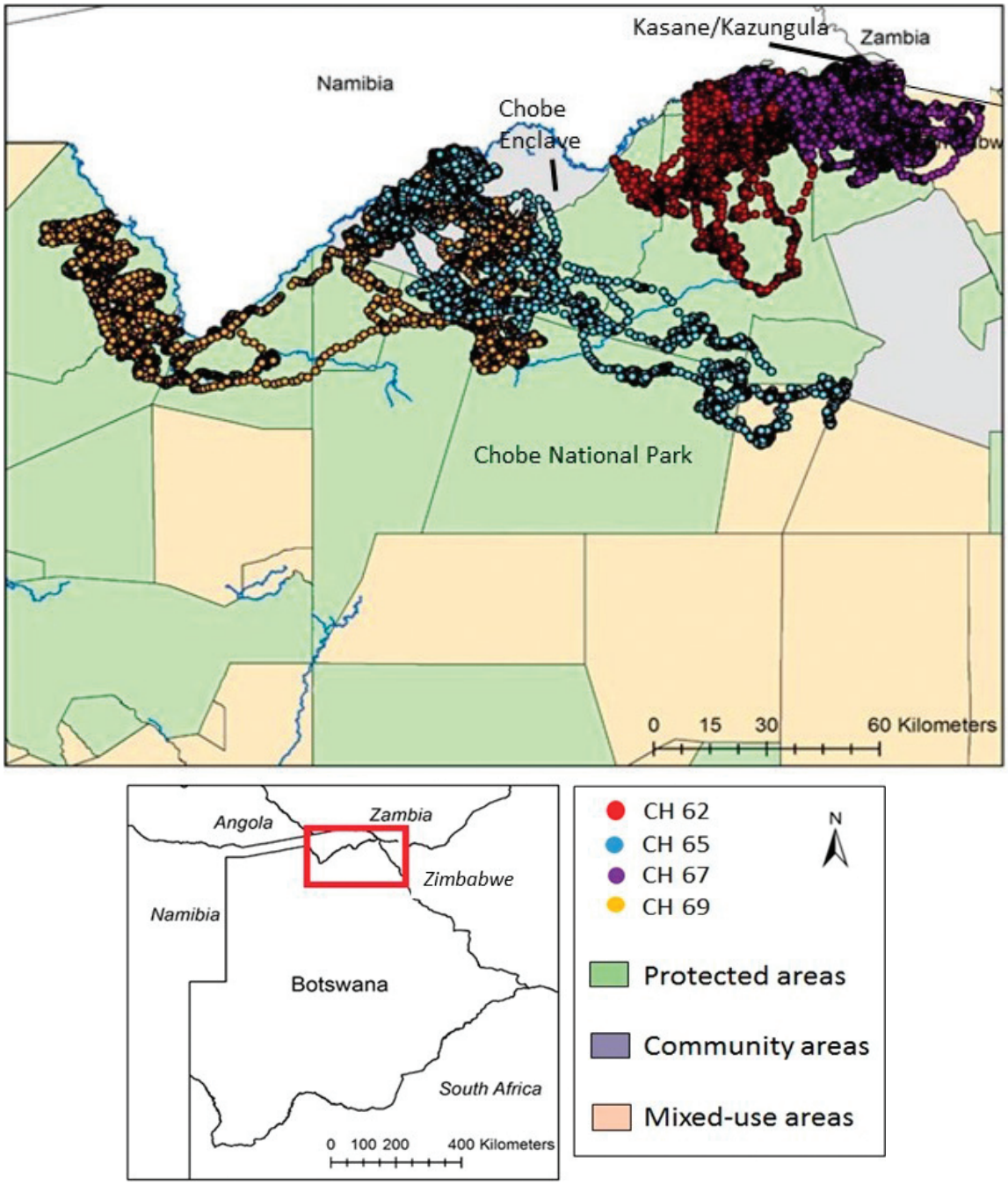

Figure 1. The study area within Botswana is outlined by the red rectangle. The magnified map displays relevant locations such as Chobe Enclave and Chobe National Park with the four individual GPS collared elephants' movements throughout each of the three different land use classification including protected, mixed-use and community.

limited extent and in a geographically and temporally constrained manner based on national legislation, e.g. tourists on game drives.

2. Mixed-use areas represent agricultural land, recreational human areas, trophy hunting wildlife management areas and unallocated land, which is land that has not been assigned a land use.
3. Community areas are where villages and towns (and any form of human settlements in close proximity to one another) are the dominant land use.

Home range and movement estimation

Home range size was calculated using both 100% minimum convex polygon (MCP) and 95 % fixed kernel (FK) methods (Seamen and Powell 1996) using 95% Gaussian kernel home ranges fitted in the R package 'LSCV' least-squares cross validation and in the R package 'adehabitatHR'. Both methods were chosen because MCP results are comparable with other elephant home-range studies within southern Africa (Jackson and Erasmus 2005; Chase 2007; Chase 2009; Roever et al. 2013). Home range was estimated using all data points rather than randomly selected daily points. To investigate whether movement rate and distance varied in relation to land designation, we calculated movement rate and distance in the R package 'adehabtitatHR'. Movement distance is represented between consecutive data points as a straight-line distance; providing the minimum distance that the collared elephants would have traversed during the time interval lapse between the reporting of consecutive data points. Speed of elephant movement was calculated as the distance between consecutive locations divided by time (km h^{-1}) (Graham et al. 2009).

Overall percentage occupancy was calculated on a daily basis by mapping the collared individual elephants' movements in the different land uses and calculating on a daily basis (24–hour) the time spent in each designated area (Table 1). The collared elephants would often move between different land uses through the course of one day, so a combined category was made for those movements, e.g. PAs/community areas.

Statistical analysis

The movement data was analysed using a Generalised Estimating Equation (GEE). GEE Models are used to analyse correlated data with continuous outcomes (Zeger et al. 1988). A GEE was used to investigate which factors influenced the elephants hourly and daily distance moved in metres. The hourly GEE model tested hourly distance moved for each elephant (metres) as a function of location (Kasane/Kazumgula or Enclave), season and time of day (diurnal or nocturnal) and daily GEE model tested daily distance moved for each elephants (metres) was tested as a function of location, season and land use designation using R statistical software and the package 'geepack' (R Studio version 3.0.2, http://www.rstudio.com). Residuals were plotted to test for autocorrelation in the dataset, as it is common for time series data. In order to minimize the impact of temporal autocorrelation in the dataset' a correlation structure 'CorAr1'was incorporated in the GEE, whereby the individual elephant was the ID variable, which defines the groups within which the data are correlated (Zuur et al. 2009). The response (hourly/daily-metres movement) variable was log-transformed to achieve a Gaussian distribution, with a log link function (Zeger et al. 1988).

Results

Annual home ranges

Using the 95% kernel and MCP method to represent an individual's movement range (Leggett 2009), the annual home ranges recorded are shown in Table 1, and schematically in Figure 1, ranging from 450km^2 for CH 67 to 1,764km^2 for CH 69.

The K/K female (CH 67) was the only elephant that moved into Zimbabwe for a portion of each season, making movements east to west, adjacent to the Chobe/Zambezi River. She moved into and around the towns in the area, then moved back into the forestry reserve and National Park. The K/K female's widest-ranging movements were into a hunting concession in Zimbabwe that runs alongside the Botswanan border. CH 67 spent a greater percentage of time (~50%) in PAs (Chobe National Park, contiguous forestry reserves) (Table 1) compared to that of the Enclave elephants with their larger home ranges (Table 1), south into the Chobe National Park. In comparison, the Enclave elephants that made wide movements remained in Botswana throughout the 13 months of

Table 1. The identity, age, location of collaring, tracking time, home range and proportion of elephants' overall daily time spent in land use designated areas for 13 months of the study

Elephant ID	Location of collaring	Age (approx.)	Family unit (approx.)	Tracking time (h)	Time in mixed-use areas %	Time in protected and community areas %	Time in community %	Time in protected areas %	Time in mixed-use and community %	Total home range (km^2) MCP 100%	Total home range (km^2) (95% kernel)
Enclave CH 62	Chobe, National Park	30+	5	8,834	0	97.23	0	2.77	0	2268.9	925.6
CH 65	Enclave, Chobe District	30+	A part of a clan 200+	7,261	4.22	3.92	58.43	33.43	0	4396.1	1453.2
CH 69	Kwando, Linyanti River	30+	12	8,799	0	5.63	31.97	62.40	0	6339.0	1764.5
KK CH 67	Kasane, Chobe District	25+	5	7,586	17.41	18.73	0.79	62.27	0.72	1443.2	453.0

Table 2. The coefficients of the GEE model of the variables that impact elephant hourly movements, with estimate, ±SE, Wald statistic and probability value. Significance level is <0.05

Coefficients	Estimate ± SE	Wald	P-value
(Intercept)	5.83±0.02	4391.02	<0.05
Kasane/Kazungula	-0.23±0.06	15.38	<0.05
Time of day	-0.35±0.08	18.52	<0.05
Hot dry	-0.15±0.09	3.07	0.08
Post wet	0.08±0.06	1.54	0.21
Wet	0.10±0.07	1.82	0.18

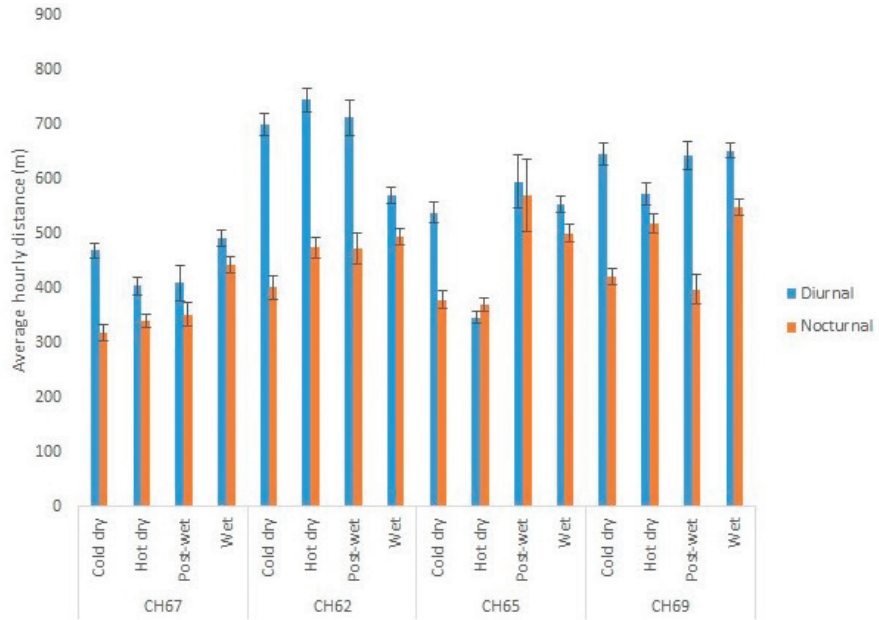

Figure 2. The mean and standard error distance of the seasonal hourly diurnal and nocturnal movements of the four GPS-collared elephants in both the Enclave and Kasane/Kazungula.

Table 3. The coefficients of the GEE model of the variables that impact elephants' daily movements, with estimate, ±SE, Wald statistic and probability value. Significance level is p<0.05

Coefficients	Estimate ± SE	Wald	P-value
(Intercept)	9.4-±0.07	16099.79	<0.05
Kasane/Kazungula	-0.36±0.04	96.97	<0.05
Hot dry	-0.13±0.09	1.92	0.17
Post-wet	-0.01±0,11	0.01	0.94
Wet	-0.03±0.08	0.12	0.73
Protected	-0.07±0.06	1.25	0.26
Protected areas / Community areas	-0.04±0.08	0.34	0.56
Mixed-use	0.04±0.08	0.26	0.64
Mixed-use / Community areas	-0.16±0.08	3.50	0.06
Mixed-use / Protected areas	-0.29±0.10	7.60	0.01

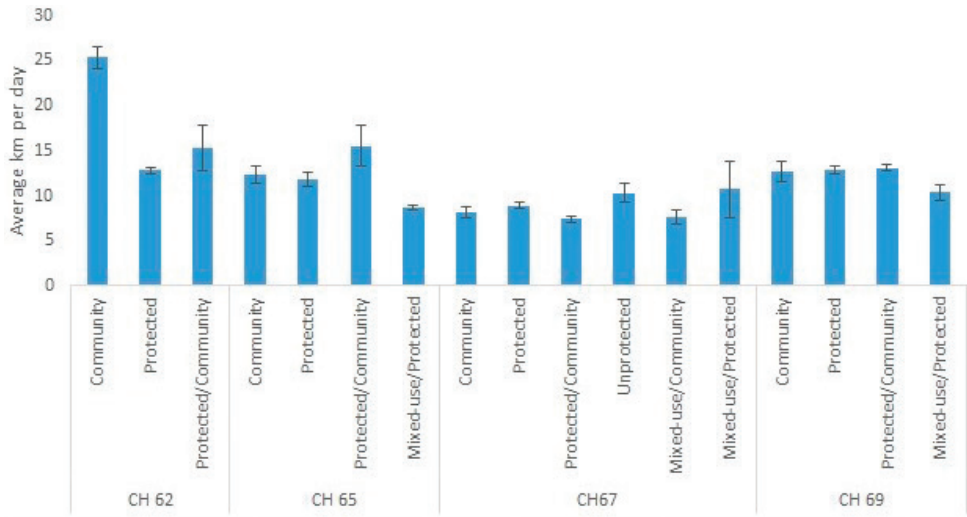

Figure 3. The average daily distance (SE±) in each land zone per area, for the four collared elephants.

the study period. The Enclave elephants spent the greatest proportion of their time moving between the community areas and PAs. CH 69 and CH 65 spent a large percentage (>30%, Table 1) of their time in the Enclave community area, more so than CH 62 who spent a greater proportion of time in PAs.

Elephants' hourly and daily movements

Location and time of day each contributed to the hourly movement of the elephants (Table 2). The average hourly diurnal and nocturnal movements of the three Enclave elephants were significantly larger than those of CH 67 (Table 2).

In all seasons except hot and dry, the diurnal hourly movements were greater than the nocturnal hourly movements for all four of the collared elephants (Fig. 2). Overall, the hourly diurnal movements of the elephants were significantly greater than their nocturnal movements (Fig. 2). This was consistent across all seasons, except for CH 65 during the hot dry season (Fig. 2).

Overall, the K/K elephants made smaller daily movements than those of the Enclave elephants (Table 3, Fig. 3). All elephants moved differently in each of the different land zones (Fig. 3). Specifically, the daily

distance that the elephants moved in mixed-use zones was significantly different from when in the PAs (Table 3). All of the elephants' (except CH 62) smallest daily movements were in mixed-use/communal land zones (Fig. 3). The Enclave elephants moved greater distances and at a faster rate through community areas (0.96–1.24 km/hr) than CH 67 (0.55km/hr).

There appeared to be no apparent seasonal pattern to when elephants moved through the community areas. CH 67 occupied the towns at different times of year, primarily during the wet season and post-wet season. The Enclave elephants entered the community areas at varying times of the year from one another. CH 62 came to community areas only in October and November (the end of the hot dry season and the beginning of the wet season); CH 69 during December, February (both months in the wet season) and June (the cold/dry season); and CH 65 between December and February (wet season), returning in May (cold/dry season) and remaining until October (the end of the hot/dry season). CH 65 spent the longest period in community areas of all the collared elephants.

Discussion

Understanding how elephants move through different human land uses, whether protected or unprotected areas, provides critical information to improve wildlife management plans to facilitate coexistence. In the Chobe District, elephants in the wet and post-wet season are found throughout the District, far from the permanent water sources such as the Chobe River, water is widely available as the natural pans are full. As is expected, as those water sources dry up the elephants move closer to the Chobe River and the series of artificial waterholes found throughout the District (Chase et al. 2019), that shared reliance of water for both humans and elephants is where a great deal of conflict exists. We aimed to determine how elephants move through different land use designations in the Chobe District an open system throughout each season. We found that the four collared elephants made larger diurnal hourly movements than nocturnal movements, overall we found that their movements were impacted by the time of day and the land use that they were moving through.

The home ranges of the Enclave elephants are consistent with previous studies where elephants avoided human-dominated areas (Osborn 2003; Douglas-Hamilton et al. 2005; Graham et al. 2009; Roever et al. 2013). The K/K elephant CH 67, by contrast, slowed down her movements and spent extended periods in community areas.

The annual home ranges of elephants collared for this study were smaller when compared to those calculated in other studies of elephant home ranges in Botswana. For example, Verlinden and Gavor (1998): 447–3,309 km^2, Jackson and Erasmus (2005): 2,500–3,019 km^2, Chase (2007): 910–24,828 km^2, and Buchholtz et al. (2019): 1,220–3,446 km^2. This study's smaller home ranges could be a result of the abundant quality resources available to elephants in this area of the Chobe District as elephants' movements are largely based on resource availability and quality (van Aarde et al. 2006; Boettiger et al. 2011). This could be plausible given that 70% of the District is designated NP and forest reserve (Chase 2007): consequently elephants do not often have to move out of the area to access the required resources.

The largest hourly movements recorded in this study were during diurnal hours, rather than nocturnal hours, in contrast to previous literature (Douglas-Hamilton et al. 2005; Leggett 2009; Loarie et al. 2009). We do not know the reason for this observed difference however it could be linked to the size of the Botswana elephant population. The size of the elephant population creates higher resource competition closer to water sources among the elephants as the vegetation there is the most heavily browsed due to its proximity to permanent water (Ben-Shahar 1996). As the season becomes drier, elephants must travel greater distances to and from water points to find enough graze or browse to survive (Loarie et al. 2009; Buchholtz et al. 2019). Also, they feel less threatened than in Kenya where they move fast at night in dangerous areas (Douglas-Hamilton et al. 2005).

Overall, the largest proportion of time that the collared elephants spent anywhere during the study was in PAs. The least amount of time was spent in mixed-use areas. This is consistent with a study conducted in Samburu, Kenya that showed dominant family units disproportionally preferred habitats that limited their time in unprotected areas (Wittermyer et al. 2007). This result is also similar to other elephant movement studies and is unsurprising as one would

predict elephants to spend more time in PAs than in or near human settlements due to the HEC risks and the stress experienced when near those settlements (Douglas-Hamilton et al. 2005; Wittermyer et al. 2007; Blake et al. 2008; Graham et al. 2009).

Additional risks include poaching for ivory, which has been shown to be increasing on the scale of hundreds of elephants per year (across Africa) and has also been occurring throughout northern Botswana (Schlossberg et al. 2019), as well as the re-introduction of trophy hunting. Both human activities are highly risky and stressful to elephants and will impact where and when elephants move through different land uses in the areas. The Enclave elephants made larger, faster movements through mixed-use and community areas. This movement from the Chobe National Park down to the river in the Enclave is similar to the "streaking" behaviour published by Jachowski et al. (2013). According to Jachowski et al.'s study, elephants that are stressed will increase their speed through corridors by "streaking" in order to reduce their time near the mixed-use areas while heading toward core protected areas. Streaking is in reference to elephants' increasing their movement speed through an area that they associate with risk (Jachowski et al. 2013). The K/K elephants did the opposite and made smaller, slower movements in the mixed-use and community areas. This could reflect the difference in land use between the K/K urban environment, more high density tourism-based development compared to the Enclave area which is comprised of small-scale agriculture.

The types of human activities in the area, for example rural villages predominately made up of dryland agricultural fields compared with the urban townships might foster differences in community tolerance to elephants. Gupta's (2013) study revealed the frustration Chobe Enclave farmers suffer from, vis à vis high rates of HEC compared to the rest of the District (Gupta 2013; Chase et al. 2019). Hence the increased speeds used by the Enclave elephants when in the community areas could be a result of more risk factors and persecution because of the farming in the areas compared to the K/K herd. For the residents of K/K, income is more focused on tourism employment than on crop and livestock production, and livelihoods are not as threatened by the presence of elephants. There is a perception that the financial benefit to the Enclave community from the local elephant population is very low, as the presence of elephants frequently threatens the locals' livelihoods through crop raiding (Gupta 2013).

This preliminary study highlights the importance of understanding the anthropogenic factors that potentially impact the movements of elephants through different human land uses. This data can assist in implementing informed management strategies that focus specifically on the integrated land-use management planning approach to mitigate human-elephant interaction (Adams et al. 2017a). The aim of the landscape management approach is to make holistic management decisions that take into consideration how different land uses impact the wildlife living in and moving through an area to mitigate that impact. In particular, the location of wildlife corridors and pathways is key as maintaining pachyderm access can serve as a mitigation in reducing HEC (Douglas-Hamilton et al. 2005; Graham et al. 2009; Adams et al. 2017a). Mitigation and conflict resolution success is highly dependent on a clear understanding of the drivers and temporal patterns of the conflict itself. Future studies could aim to measure and understand the different anthropogenic factors, specifically the socio-economic factors that are driving the movement behaviours of elephants and potentially the risk avoidance strategies (Jachowski et al. 2013; Gaynor et al. 2018). In addition, it would be useful to incorporate a larger sample size with representatives from both sexes, in order to determine if there is a difference in movements between the females/family herds and bulls. By measuring the anthropogenic factors and increasing the sample size, more resounding conclusions can be made, representing the population as a whole.

Elephant movements are complex because they are influenced by a wide range of variables, which are location specific. The hourly and daily movements of the four elephants we collared in the Chobe District were dependent on time of day, and the different land-use zones they passed through. Home ranges of these elephants were at the lower end of the recorded range compared with elephants who were tracked as part of other studies in Botswana, and interestingly, each individual in our study moved differently according to season. This study was the first focused investigation

of how elephants move through the different designated land uses in the Chobe District, one of the largest conflict hotspots in southern Africa (Gupta 2013), in addition to being one of the most significant conservation areas for megafauna left in Africa as it is one of the last interconnected transboundary elephant populations on the continent (Schlossberg et al. 2019).

Despite this being a preliminary study, the results suggest that elephants can adjust their movement behaviour based on different types of human activity in an open unfenced ecosystem. This is important as it shows that elephants are adapting to different human activities occurring in different human land uses, in an open and unfenced system. It is vital for any wildlife management plan that the movement of key species is thoroughly understood, in order to formulate informed boundaries and understand the impact of different human development. Furthermore, we recommend an integrated landscape planning approach in any future management plan, which accommodates both people's needs and those of elephant and other wildlife. With tourism making up 12% of Botswana's GDP, and Botswana being the last stronghold of a significant number of elephants, a better balance between livelihoods and elephants' free movement needs to be determined.

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HISTORY

Eponyms associated with the nomenclature of the recent species of rhinoceros

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Abstract

Since 1758, a total of 16 eponyms have been described to honour explorers and taxonomists for the recent species of rhinoceros. This paper presents short biographies and the circumstances of the description of these names used in zoological nomenclature. The name *blythii* was named after Edward Blyth (1810–1873), *brucii* after James Bruce (1730–1794), *burchellii* after William John Burchell (1781–1863), Campbell's rhinoceros after John Campbell (1766–1840), *camperis, camperii, camperi* after Petrus Camper (1722–1789), *cottoni* after Percy Horace Gordon Powell-Cotton (1866–1940), *crossii* after Edward Cross (1774–1854), *floweri* after William Henry Flower (1831–1899), *gordoni* after Robert Jacob Gordon (1743–1795), *harrissoni* after Tom Harrisson (1911–1976), *holmwoodi* after Frederick Holmwood (d.1896), *jamrachi* after William Jamrach (1842–1923), *michaeli* after Michael Grzimek (1934–1959), and *oswelli* after William Cotton Oswell (1818–1893).

Résumé

Depuis 1758, un total de 16 éponymes ont étés décrits pour honorer les explorateurs et les taxonomistes des espèces récentes de rhinocéros. Cet article présente de brèves biographies et les circonstances liées à la description de ces noms utilisés dans la nomenclature zoologique. Le nom *blythii* a été nommé d'après Edward Blyth (1810–1873), *brucii* d'après James Bruce (1730–1794), *burchellii* d'après William John Burchell (1781–1863), le rhinocéros de Campbell d'après John Campbell (1766–1840), *camperis, camperii, camperi* d'après Petrus Camper (1722–1789), *cottoni* d'après Percy Horace Gordon Powell-Cotton (1866–1940), *crossii* d'après Edward Cross (1774–1854), *floweri* d'après William Henry Flower (1831–1899), *gordoni* d'après Robert Jacob Gordon (1743–1795), *harrissoni* d'après Tom Harrisson (1911–1976), *holmwoodi* d'après Frederick Holmwood (décédé en 1896), *jamrachi* après William Jamrach (1842–1923), *michaeli* d'après Michael Grzimek (1934–1959) et *oswelli* d'après William Cotton Oswell (1818–1893).

Introduction

Taxonomists who decide that a specimen belongs to a new species are free to choose any names as long as these adhere to a few rules of spelling and format. Zoological nomenclature starts with the 10th edition of the *Systema Naturae* by Linnaeus of 1758, by

a convention introduced by Hugh Strickland in the first set of rules (Rookmaaker 2011). For the recent species of rhinoceros, 65 specific or subspecific names have been proposed (Rookmaaker 1983). Among these, 16 were originally proposed to honour the people who had discovered the animal or who otherwise were deemed worthy of this distinction. These names are called eponyms (Beolens et al. 2009, Gürtler 2017–2020). The names are usually just a surname with a suffix (-i or -ae) as required for the Latin format (ICZN 1999). As we work with these names in our daily practice, it is interesting to establish which people are actually acknowledged in this way. At the same time, this draws attention to the significance of zoological nomenclature, which is governed by a set of essentially simple rules which are one of the pillars of exact communication between zoologists discussing animals seen during their studies in museums and in the field.

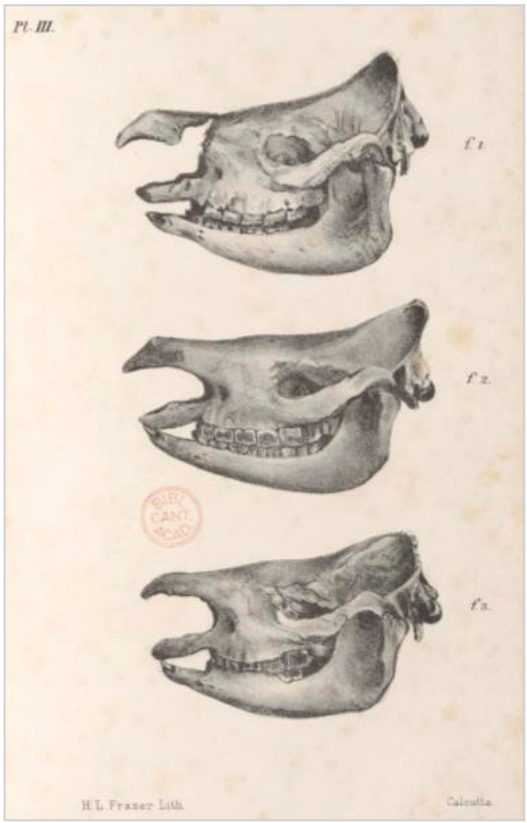

Figure 1. The syntypes of *Rhinoceros blythii*, two skulls of young animals figured by Edward Blyth (1862, pl. 3 Figs. 2, 3).

Ceratorhinus blythii Gray, 1873
Edward Blyth (1810–1873)

Blyth (1862) wrote a pivotal paper on the rhinoceros in Asia on the basis of the collection of the Asiatic Society of Bengal, which would later be incorporated in the Indian Museum, Kolkata. He discussed and figured two skulls of a double-horned rhinoceros from Tenasserim, Thailand (Fig. 1), which John Edward Gray (1800–1875) provisionally suggested to be different from other specimens (Gray 1873). The syntypes are still in the collection of the Zoological Survey of India (Fig. 2). The name is a junior subjective synonym of *Dicerorhinus sumatrensis* (G. Fischer 1814).

Figure 2. One of the syntypes of *Rhinoceros blythii* in Kolkata, ZSI 17687 (Photo. Tanoy Mukherjee, 2018).

Rhinoceros brucii Lesson, 1842
James Bruce (1730–1794)

The Scottish explorer James Bruce travelled in Ethiopia from June 1768 to November 1772. While staying at Tcherkin (Cherkin), about 10 km NW of Gondar, on 7 January 1772 his party killed an adult rhinoceros with two horns on the nose. The animal was 396 cm long, 213 cm high, with horns of near-equal lengths of 35.5 and 33 cm (Rookmaaker and Kraft 2011). Bruce wrote about the specimen to the French naturalist Georges-Louis Leclerc, Comte de Buffon (1707–1788), who kept track of new discoveries for his famous *Histoire Naturelle*, saying that all rhinos known in Ethiopia had two horns (Buffon 1778:134). In the extensive natural history section of his travels, Bruce (1790) included a plate of this African rhinoceros (Fig. 3). Inexplicably, the depiction was in fact a copy of the single-horned rhinoceros previously published by Buffon (1764) with

the addition of a second horn (Fig. 4). Therefore, Bruce's rhinoceros was a rhinoceros from Africa, double-horned and supposedly heavily armoured. The name was resurrected in the trinomen *Diceros bicornis brucii* by Zukowsky (1965).

Figure 3. "Rhinoceros of Africa" as perceived by James Bruce (1790).

Figure 4. "Le Rhinocéros", the single-horned rhinoceros illustrated in Buffon's *Histoire Naturelle* of 1764, pl.11.

Rhinoceros burchellii Lesson, 1827
William John Burchell (1781–1863)

During his expedition to the Bechuanas in the Northern Cape, Burchell reached Chué Springs or Heuningvlei in October 1812 (Rookmaaker 2008:67, Nowak-Kemp 2018). At this northernmost point of his journey, he shot a few black rhinoceroses as well as two white rhinoceroses, which showed him that these were two separate species (Fig. 5). The species was soon described as *Rhinoceros simus* in Burchell (1817). However, the French naturalist René Primevère Lesson (1794–1849) used a different name in his list of mammals in 1827.

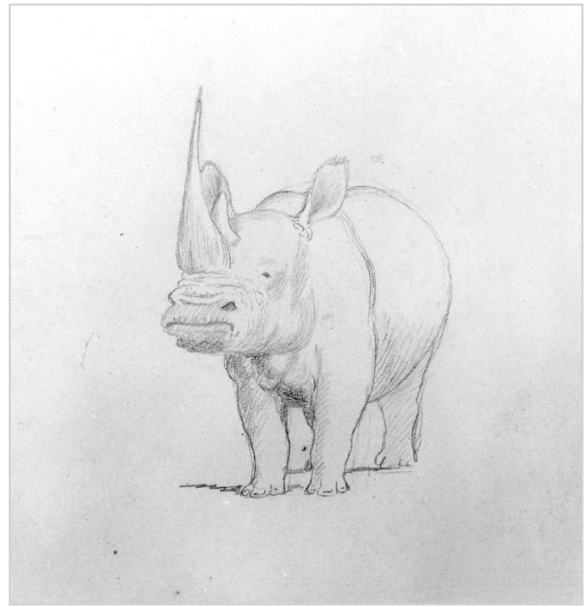

Figure 5. Sketch of a white rhinoceros made during the expedition by William John Burchell in 1812 (Museum Africa, Johannesburg 68/1844).

Campbell's Rhinoceros
John Campbell (1766–1840)

As Director of the London Missionary Society, Campbell travelled widely in South Africa 1819–1821. On 18 May 1820 two rhinoceroses were shot near Mashow, one of which had a very long anterior horn and a short posterior horn (Rookmaaker 2008). Campbell (1822:294) thought that this must be the unicorn, which was widely reported in the press at the time (Fig. 6). The horn was later added to the collection of the American Museum of Natural History, New York (Osborn 1905). The specimen in fact belongs to *Ceratotherium simum* (Burchell 1817).

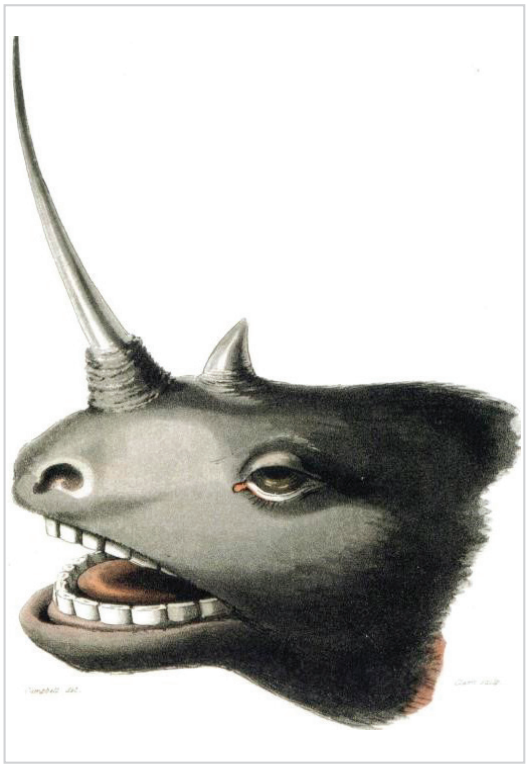

Figure 6. The unicorn found by John Campbell in South Africa in 1820 (Travels in South Africa, 1822).

Rhinoceros camperis Griffith, 1827
Rhinoceros camperii Jardine, 1836
Rhinoceros camperi Schinz, 1845
Petrus Camper (1722–1789)

The Dutch physician and naturalist Camper (1782) presented a lengthy monograph on the rhinoceros, mainly reporting on his examination of a skull brought from the Cape of Good Hope. Subsequently he received information and specimens from his pupil Jacob van der Steege (1746–1811) from Java (Rookmaaker and Visser 1982). This led him to recognize the Javan rhinoceros as a separate species, as seen on a broadsheet engraved by the Amsterdam engraver Reinier Vinkeles (1741–1816) in 1787 (Fig. 7). Camper's death two years later prevented him from pursuing this further in a publication. The names commemorating him by Jardine and Griffith are synonyms of *Rhinoceros sondaicus* Desmarest, 1822, the name by Schinz is a synonym of *Diceros bicornis* (Linnaeus 1758).

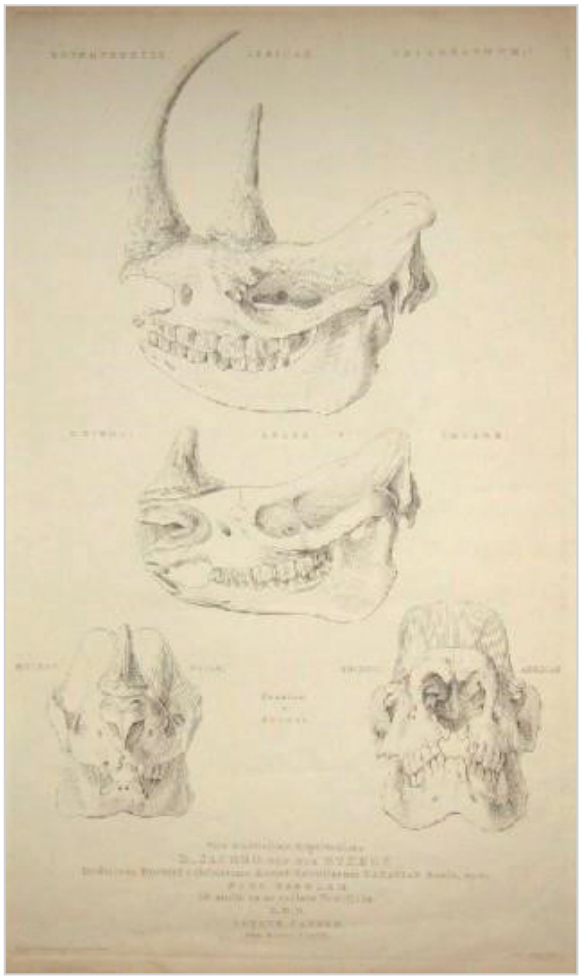

Figure 7. Broadsheet engraved by Reinier Vinkeles following the design of Petrus Camper, showing the distinction between rhinoceros skulls from Africa and from Java (British Library, London).

Rhinoceros simum cottoni Lydekker, 1908
Percy Horace Gordon Powell-Cotton (1866–1940)

Powell-Cotton's fourth African expedition of 1904–1907 started out in the Lado Enclave on the west bank of the Nile, now in South Sudan and north-western Uganda (Joynes 2016). He shot several white rhinoceroses here, probably early in 1905 as newspaper reports started to appear in the British press in April of that year. On his return home he donated a skull with horns to the British Museum (Natural History), where they were rather tentatively described by Richard Lydekker (1849–1915) as a new subspecies (Lydekker 1908). When Lydekker was writing, the use of subspecies had

evidently become more fashionable in mammalian taxonomy, whereas this was almost unheard of just a few years earlier. The *Illustrated London News* was able to print a photograph taken in Africa as well as an artist's impression of the hunt (Powell-Cotton 1907a, b) (Figs. 8, 9). Most of the specimens were added to his private museum, now the Powell-Cotton Museum in Quex Park, Birchington-on-Sea. Besides a short paragraph (Powell Cotton 1932), the details of the expedition have not been included in any of his own books.

Figure 8. "The chance of a life time". Impression by the London artist Frank Dadd (1851–1929) of Major Powell-Cotton shooting a white rhinoceros in the Lado Enclave (*Graphic*, Supplement of 9 March 1907).

Rhinoceros crossii Gray, 1855
Edward Cross (1774–1854)

Cross was the proprietor of the Surrey Zoological Gardens in Newington near London from 1831. A long rhinoceros's horn (Fig. 10) measuring 3 feet 5 inch (104 cm) along the curve length from his collection was described as a new species by John Edward Gray (1854). Its origin is not known but it is generally regarded to be a horn of a Sumatran rhinoceros (*Dicerorhinus*

Figure 9. "The famous white rhinoceros shot by Major Powell-Cotton". The only published photograph of the white rhino killed in the Lado Enclave (*Illustrated London News*, 13 April 1907, p. 561).

sumatrensis). Gray's description was read in the meeting of the Zoological Society of London on 28 November 1854, and published in the Proceedings which, according to the receipt of printed sheets, was 11 April 1855 (Sclater 1893a, Duncan 1937).

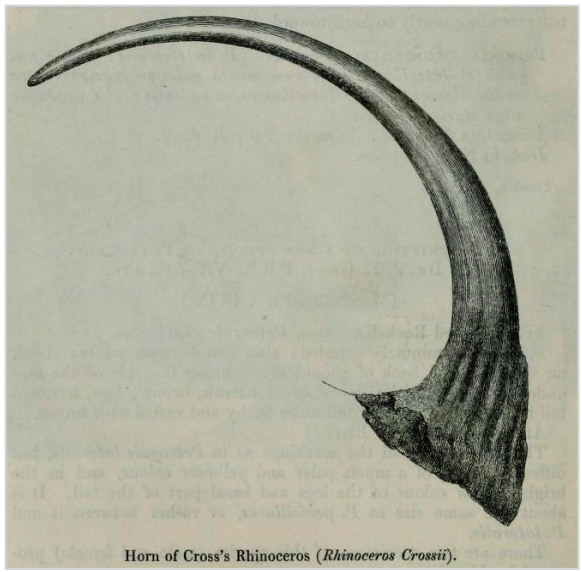

Figure 10. Horn of Cross's Rhinoceros (*Proceedings of the Zoological Society of London* 28 November 1854, p. 251).

Rhinoceros floweri Gray, 1868
William Henry Flower (1831–1899)

John Edward Gray (1868) here honoured Flower, who was Conservator of the Hunterian Museum of the Royal College of Surgeons of England 1862–1884. The skull had been obtained from Sumatra

(Flower 1876) (Fig. 11). Gray introduced a multitude of new species, many of which, like this one, did not stand the test of time through changes in taxonomic theories (Rookmaaker 2015). Gray read his paper in the meeting of the Zoological Society of London on 12 December 1867, which then became part of the third part of the *Proceedings* actually published in April 1868 (Duncan 1937). *Rhinoceros floweri* is a subjective junior synonym of *Rhinoceros sondaicus*.

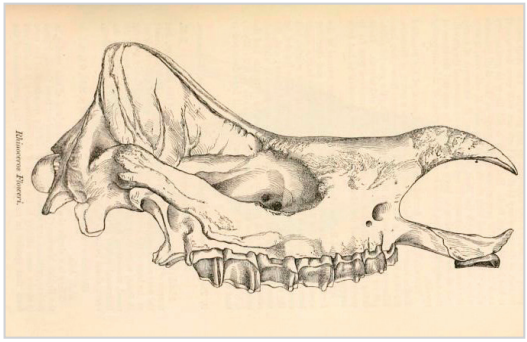

Figure 11. Type-specimen of *Rhinoceros floweri* in the Royal College of Surgeons of England, London, no. 2934 (Gray 1868).

Rhinoceros gordoni Lesson, 1842
Robert Jacob Gordon (1743–1795)

On 2 November 1778 Gordon shot a black rhinoceros near the source of the Gamka (Leeuwen) River in the Eastern Cape of South Africa (Fig. 12). He proceeded to dissect the animal, of which the results were preserved in a set of five detailed drawings of the anatomical details (Cave and Rookmaaker 1977, Rookmaaker 1989). He also sent details to Holland where they were summarized by Jean Nicolas Sebastien Allamand (1713–1787) in Leiden to be inserted in a supplement to the popular *Histoire Naturelle* by the Count de Buffon in 1782 (Rookmaaker 1982). While Gordon never claimed a new species, the one named after him is an example of the black rhinoceros of the Cape region which belongs to the nominal subspecies *Diceros bicornis bicornis*, which was the first subspecies we know of to go extinct (Rookmaaker and Groves 1978).

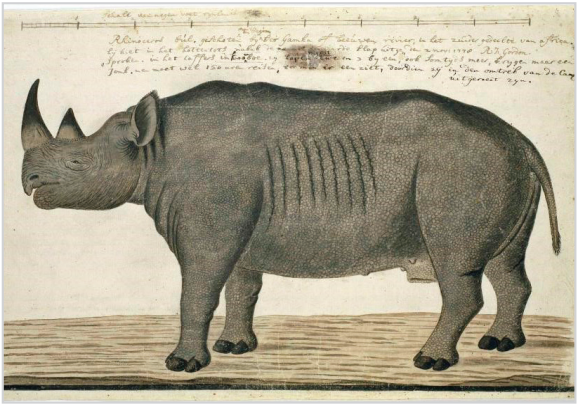

Figure 12. Black rhinoceros sketched by Robert Jacob Gordon in South Africa in 1778. (Gordon Atlas no. 205, Rijksmuseum, Amsterdam).

Didermocerus sumatrensis harrissoni Groves, 1965
Tom Harnett Harrisson (1911–1976)

Harrisson was well-known for his explorations and anthropological enquiries on the island of Borneo (Heimann 2000). The rhinoceros was just one of his passions, which he discussed with the present author in Brussels not long before he died in Bangkok in a car crash (Harrisson 1956; Harrisson 1975). The Bornean subspecies of the Sumatran rhinoceros, smaller than others, was one of the first taxonomic advances proposed by Colin Peter Groves (1942–2017), who became well-known as an anthropologist and taxonomist with enduring interest in the rhinoceros (Rookmaaker and Robovsky 2019).

Rhinoceros bicornis holmwoodi Sclater, 1893
Frederick Holmwood (d.1896)

Holmwood was the British Consul at Zanzibar from 1873–1887, and later at Smyrna. He received two long horns of a black rhinoceros obtained by a friend in the north-east of Tanzania, just south of Mwanza (Jackson 1969:73) (Fig. 13). They were provisionally described by Philip Lutley Sclater (1829–1913) and this name was revived as a valid subspecies *Diceros bicornis holmwoodi* by Zukowsky (1965:95). This is now a subjective junior synonym of the East African black rhinoceros *Diceros bicornis minor* (Drummond 1876), or rather *D. b. keitloa* (A.Smith 1836) as discussed by Rookmaaker (2016).

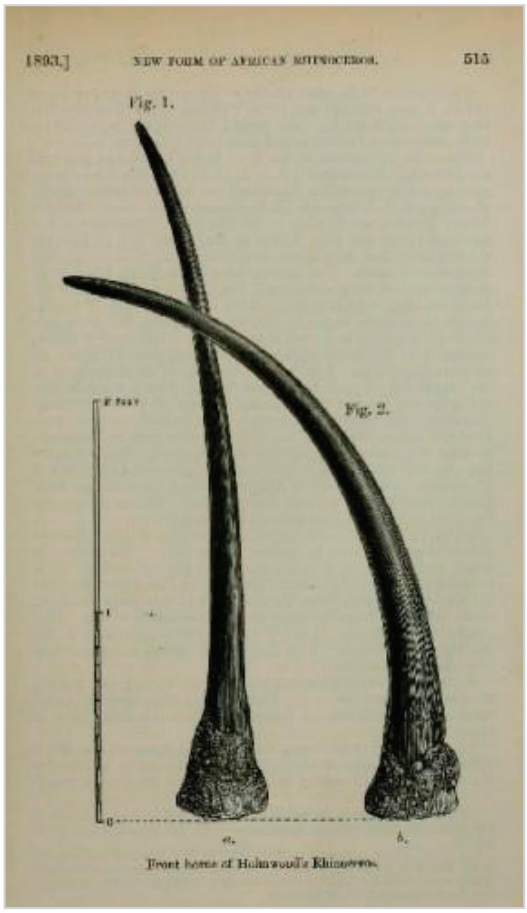

Figure 13. The long horns of *Rhinoceros holmwoodi* from Tanzania (Sclater, *Proceedings of the Zoological Society of London*, 6 June 1893, p.514).

Rhinoceros jamrachi Jamrach, 1875
William Jamrach (1842–1923)

The London based animal dealer William Jamrach described a female rhinoceros imported from India in 1874 as a new species in a green leaflet of three pages dated 8 October 1875, reprinted in January 1876 in the *Oriental Sporting Magazine* (Jamrach 1875; Jamrach 1876). Jamrach was part of a family concern started by his father Charles Jamrach (1815–1891), which often collaborated with similar firms run by Charles Rice (1841–1879) in London and Carl Hagenbeck (1844–1913) in Hamburg, Germany (Rookmaaker 2014:231). The rhinoceros which reached the Berlin Zoo on 30 June 1874 has been subject of much discussion because her actual specific identity is obscure in the absence of any good drawings or photographs, or even a clear description (Rookmaaker 1977; Rookmaaker 1998). Jamrach was convinced that it was a separate species and described it himself as he could not find a working taxonomist to do this for him, unconventionally naming it after himself. Only one depiction of the animal is known, next to a black rhinoceros 'Molly', as part of scenes in the Elephant House by the Berlin artist Gustav Mützel (1839–1893) illustrating the description by Woldt (1882) in the *Gartenlaube* (Fig. 14). The specific identity, *R. unicornis* or *R. sondaicus*, remains under review.

Diceros bicornis michaëli Zukowsky, 1965
Michael Grzimek (1934–1959)

Grzimek was at the start of a promising career in animal ecology, conservation and film production when he died in a plane crash in Tanzania. Together with his father Bernhard Grzimek (1909–1987) he was famous for research in the Serengeti National Park. The subspecies of black rhino named after him by Ludwig Zukowsky (1888–1965) was found in the border area of southern Kenya and northern Tanzania (Zukowsky 1965:115). The monograph on the genus *Diceros* was a major achievement by Zukowsky which includes many valuable data, often forgotten, despite the excessively elaborate taxonomy. Although dated 1964 on the title-page, it actually appeared in 1965, which date should be used in nomenclatorial citations (Mertens 1966).

Rhinoceros oswelli Elliot in Oswell and Vardon, 1847
Rhinoceros oswellii Gray, 1853
William Cotton Oswell (1818–1893)

Oswell journeyed to the Limpopo River in 1844–1846 together with Mungo Murray (1802–1890) and Frank Vardon (1815–1860) on leave from his position in the Indian Civil Service (Rookmaaker 2008:70). He shot a white rhinoceros with a long forward-sloping horn in June or July 1846 on the Makolwe (Mokolo) River (Oswell and Vardon 1847). The account is illustrated with a sketch of the animal labelled "Rhinoceros Oswelli" and this new name also appears in the text (p. 183) (Fig. 15). The name is generally attributed to the Editor of the *Madras Journal of Literature and Science* in which this notice appeared, then Walter Elliot (1803–1887). The name was again used by John Edward Gray (1854) describing a pair of horns

Figure 14. Some scenes in the Berlin Zoo drawn by Gustav Mützel (*Gartenlaube*, December 1882).

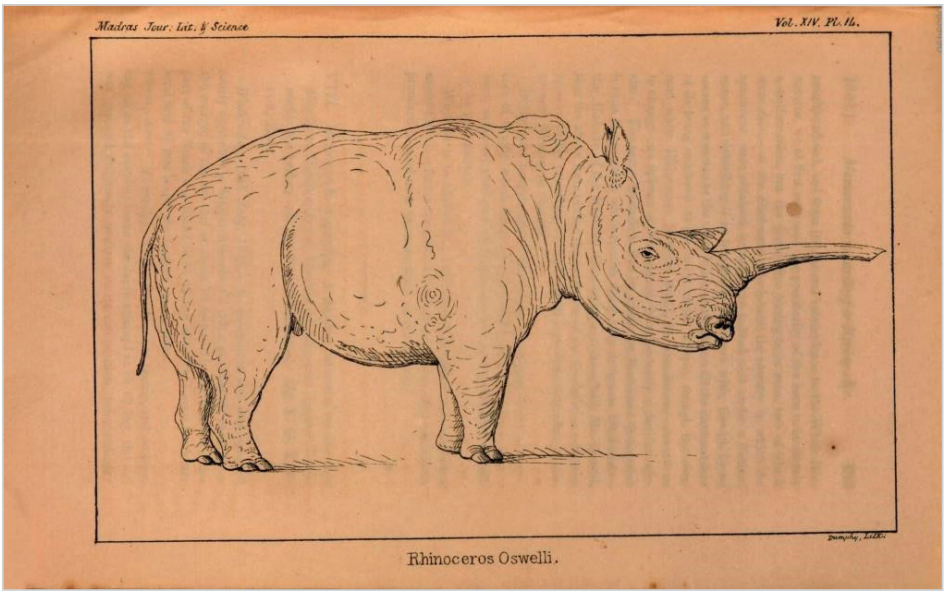

Figure 15. Sketch of *Rhinoceros oswelli* described in the *Madras Journal of Literature and Science* (July-December 1847, p. 169).

measuring 84 cm and 28 cm, obtained by Oswell and then donated by Thomas Montague Steele (1820–1890) to the Natural History Museum in London (Rookmaaker 2008:74). Gray's name is a junior primary homonym of Elliot's one, and both names are subjective junior synonyms of *Ceratotherium simum*.

Acknowledgements

The Rhino Resource Center www.rhinoresourcecenter.com includes the references mentioned in this paper on its website. The RRC is sponsored by SOS Rhino, International Rhino Foundation and Save the Rhino International. This paper benefits from pertinent and useful suggestions by a reviewer. Thanks to the Editor of *Pachyderm* to allow a longer than usual list of references to accommodate this historical subject.

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Early photographs of the greater one-horned rhinoceros (*Rhinoceros unicornis*) in the wild

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Abstract

Despite recurrent obstacles in photographing animals in the wild, there are a few early examples. A dead rhinoceros shot in Assam by Wilfred Dakin Speer was photographed in 1862. An image of a living rhinoceros in Nepal was published in the *Illustrated London News* of 1906. This was followed by black and white photographs taken in 1909 by Victor Brooke of a rhinoceros attacking his elephant in 1911 during the tour of King George V in Nepal, and in 1923 by George Miller Dyott for the Vernay-Faunthorpe expedition of the American Museum of Natural History in New York. Those taken in 1932 by the Swedish photographer Bengt Berg in Jaldapara, West Bengal, are among the best of early attempts in the wild.

Résumé

Malgré les obstacles récurrents liés à la photographie des animaux dans la nature, il existe quelques exemples antérieurs. Un rhinocéros mort abattu en Assam par Wilfred Dakin Speer a été photographié en 1862. Une image d'un rhinocéros en vie, prise au Népal a été publiée dans l'*Illustrated London News* de 1906. Ensuite suivirent des photographies en noir et blanc prises en 1909 par Victor Brooke, d'un rhinocéros s'attaquant à son éléphant, puis en 1911 lors de la tournée du roi George V au Népal, et en 1923 par George Miller Dyott pour l'expédition Vernay-Faunthorpe de l'American Museum of Natural History à New York. Celles prises en 1932 par le photographe suédois Bengt Berg à Jaldapara, au Bengale occidental, sont parmi les meilleures premières tentatives prises dans la nature.

Introduction

Nowadays it is relatively easy to take a photograph of a rhinoceros in the wild. Depending on the species, once the animal is traced, all it takes is a basic camera and these days even mobile (smart) phones. To take a photograph of professional quality more skill is involved, and the best results are achieved using a telephoto or zoom lens, just because it may be hazardous to get close enough. However, it isn't a major achievement, and tourists like myself are able to get decent snaps using simple equipment.

This is due to technical advances. In the days when photographic equipment and film were in more experimental stages, the cameras were large and cumbersome often requiring tripods, the subject was best "captured" if it remained stationary because a film had to be exposed for several seconds if not minutes, and also had to be at close range to be visible. Even then circumstances might produce an indifferent image while climate and transport could affect the images captured on plates or films.

A rhinoceros in the wild was therefore not an easy subject even if somebody had the rare chance to reach their habitats. It is not going to stand still on command, and it is not going to be happy to be approached within a few meters. To write about a "first ever" photograph in any combination is almost as hazardous as walking up to a wild rhinoceros. In my experience, as soon as the words are written, somebody will try, often successfully,

to find an earlier example. That is not as bad as it sounds, at least we will have learned something new about the early days of photography.

Earlier I discovered what must be the first photographs taken of a rhinoceros in the African bush. The explorer James Chapman (1831–1872) took these of a dead black rhinoceros (*Diceros bicornis*) on 13 May 1862 on the Botletlie River (now Boteti River) in central Botswana and on 12 June 1862 near the Victoria Falls in Zimbabwe (Rookmaaker 2006). Early photographs of the Indian rhinoceros (*Rhinoceros unicornis*) were taken in the Zoological Gardens in Regent's Park, London, first in 1856 by an unknown photographer, followed in 1864 by Frank Haes (1832–1916) of London and soon after this by Frederick York (1823–1903) of London (Edwards 2012).

In this paper I will highlight an early example of a dead rhinoceros in the Indian jungle, and proceed to rare images of living rhinos photographed in both India and Nepal.

Captain Speer in Assam in 1862

Captain Wilfred Dakin Speer (1835–1867) of Thames Ditton, was an officer in the First Middlesex Regiment in the United Kingdom. He had joined Charles Darwin (1809–1882) in 1858 on a petition regarding the administration of the natural history collection of the British Museum (Darwin 1858). Speer went on an adventurous sporting exhibition from September 1859 to May 1862 to India, crossing the Himalayas into Tibet, returning "with a number of most interesting photographic views of the places he had visited" (Anonymous 1870). He went on a second journey from November 1864 to June 1865.

A photograph "Rhinoceros shot by late Captain Speer in Assam, 1862" (Fig. 1) was published in part 5 of the *Sports of the World* edited by Frederick George Aflalo (1870–1918) in January 1903 illustrating a chapter by Kinloch (1903:164). As there is no reference to the event in the text, it is likely that Aflalo sourced the photograph from the Speer family. The rhino is shown lying on its side with the head facing the camera, surrounded by over 30 "native" assistants. As Captain Speer is absent from the picture, he is likely the one operating the camera. If the dates are correct, meaning that the photograph was taken in the first months of 1862, this photograph of a dead rhino in the wild is earlier than that attributed to Chapman in Botswana.

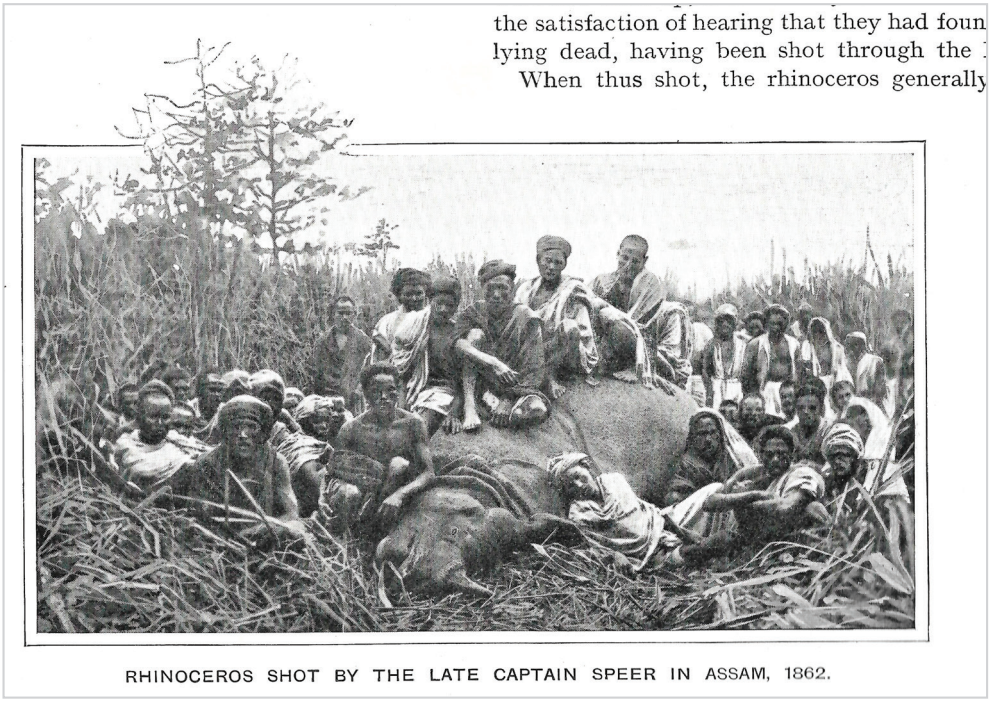


Figure 1. "Rhinoceros shot by late Captain Speer in Assam, 1862" (*The Sports of the World*, 1903, p. 164).

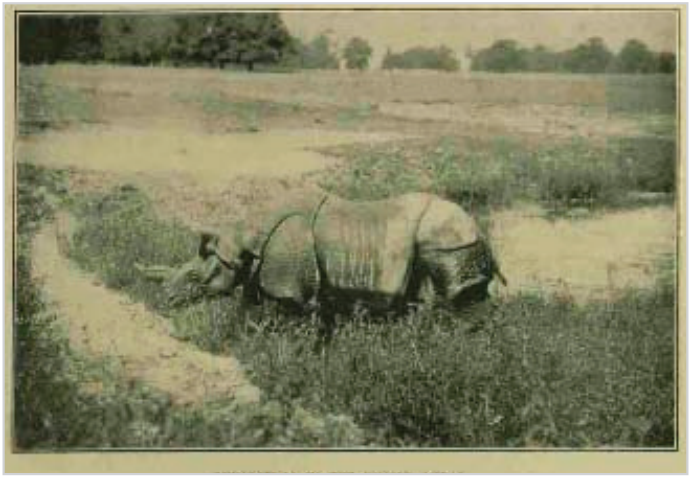


Figure 2. "Rhinoceros in the jungle, Nepal" from the *Illustrated London News* (10 February 1906).

The Illustrated London News of 1906

The popular *Illustrated London News* of 1906 included a page with four photographs of curiosities of big game hunting (Anonymous 1906). They supplied no additional information, and the images were credited to "the Illustrations Bureau" of 12 Whitefriars Street, London. This agency probably maintained a large series of photographs, and the provenance of the rhinoceros in the jungle is not recorded in the magazine. One of the photographs shows a rhinoceros in Nepal, standing on the edge of a pond, exhibiting a large forward-sloping horn (Fig. 2).

Probably unconnected, there is another reference to a photographer in Nepal around that time. The British consul to Nepal from 1905 to 1916, John Manners-Smith (1864–1920) mentioned that rhinos were reportedly quite common on the Rapti River (Manners-Smith 1909). Francis William Gordon-Canning (1854–1920) of the Pursa Indigo Factory in Champaran, Bihar had been there with the express goal to take photographs of the rhinoceros.

Victor Brooke in Cooch Behar in 1909

From 11 to 17 February 1909 the Viceroy Gilbert, 4th Earl of Minto (1845–1914) was hunting in the North Kamrup Reserve (now Manas National Park). Among his retinue was his military secretary Victor Reginald Brooke (1873–1914). While out riding on elephants on Sunday 12 February 1909 Brooke was injured by a rhinoceros, as told by Minto (1934:274): "The same day Victor Brooke had a different and very dangerous adventure. He was always casual as to personal safety, and when he saw a female rhino and her calf emerge from the jungle he did not shoot but hurriedly grasped his kodak, being excited about obtaining a photo. On sighting the elephant the rhino charged, and these huge beasts met with a tremendous concussion, like two battleships ramming each other; the shock was terrific." The photograph which Brooke took before the rhino reached the elephant was published a few years later (Brooke 1911). It may not be the clearest image, but definitely one showing unusual action (Fig. 3).

King George V in Nepal in 1911

King George V (1865–1936) visited Nepal by the invitation of Maharaja Chandra Shamsher (1863–1929) from 18 to 28 December 1911 (Fortescue 1912; Rookmaaker et al. 2005). There were several photographers in the camp, including Ernest Brooks (1875–1957), George Percy Jacomb-Hood (1857–1929) and professionals of the firm of Herzog and Higgins. There are two albums from the collection of Queen Mary in the Royal Commonwealth Society (preserved in the Library of the University of Cambridge) containing many photographs, without annotations of dates or photographers. One of the albums "Indian Tour 1911–1912" has a picture of a rhinoceros walking in the grass, with some elephants in the background (QM21, no.219) (Fig. 4).

The Vernay-Faunthorpe Expedition of 1923

The Vernay-Faunthorpe Expedition was organized to collect a series of mammals for the new exhibition spaces of the American Museum of Natural History in New York. Led by John Champion Faunthorpe (1871–1929) and Arthur Stannard Vernay (1877–1960), the group spent a week on the Gandak River on the western side of Chitwan, from 10–14 March 1923. The party also included the photographer George Miller Dyott (1877–1960), who was responsible for capturing the events on film (Dyott 1923). He took several photos of a female rhinoceros which had been named 'Lizzie' together with her half-grown calf (Figs. 5, 6). One was published in the museum's magazine (Faunthorpe 1924) and another appeared in The Times newspaper of London (Faunthorpe 1923).

Dyott, probably as a first, also took moving pictures, (and one of the first documentary films of rhinos). These were compiled on his return as a silent 16 mm film "Jungle Life in India" lasting 20 minutes, containing a few scenes showing the rhinoceros in the field. The first private view of the film was on 1 November 1923 at the St. James's Picture Theatre in London, with a lecture by Dyott, and then shown to the public in the Philharmonic Hall for four weeks, beginning 5 November (Vernay 1923a, b). The first showing of the film in the USA was on 21 December 1923, when Faunthorpe presented a lecture in the American Museum of Natural History (Osborn 1923).

Figure 3. Female rhinoceros and calf charging towards the elephant carrying Victor Reginald Brooke on 12 February 1909 (*Illustrated London News*, 30 December 1911).

Figure 4. A rare depiction of a living rhinoceros in the jungles of Nepal, running away from the elephants and hunters. Unsigned photograph in RCS Album (University of Cambridge, QM 21, no. 219).

Bengt Berg in Bengal in 1932

The Swedish zoologist, photographer and cinematographer Bengt Magnus Kristoffer Berg (1885–1967) had obtained permission to take photographs on the banks of the Torsa River in today's Jaldapara National Park, West Bengal, India. He spent about a month in the jungle in February 1932, taking pictures of rhinos and tigers with his heavy professional cameras. His black and white photographs taken in the jungle in Bengal are stunning, including a male rhino chasing a female, and a mother rhino followed by her young calf (Figs. 7, 8). In total 22 different photos of rhinos were published as a result his expedition. A selection of the images was first included, with explanatory text, in a book published in Swedish in 1932, translated into German and Danish, but never into English (Berg 1932, 1933).

Conclusion

Taking a good photograph of a rhinoceros in the wild is a thrilling experience. It always involves a challenge,

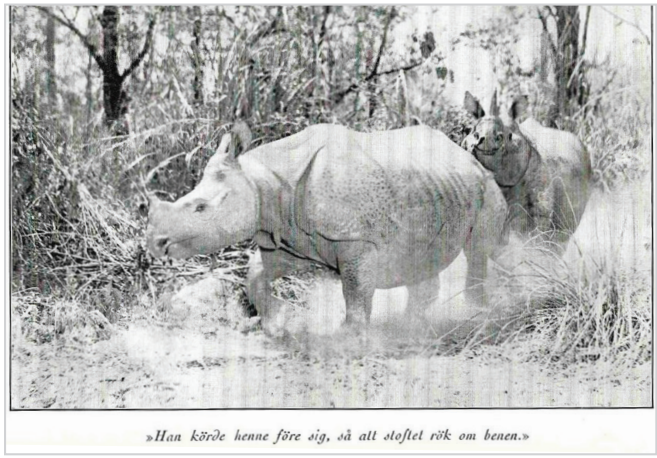
A RHINO AND HER CALF

It is believed that this is the only photograph ever secured of the one-horned Indian rhinoceros (*Rhinoceros unicornis*) in a wild state. These two animals lived in a patch of thorn and bush cover near the camp established by the Fauntheorpe-Vernay Expedition. They might easily have been shot, but only good specimens were desired and the horn of this female was poorly developed and her calf too small. Because the members of the expedition saw her again and again during their sojourn, they came to feel for her a familiarity that was untainted by contempt. They named her Lizzie

Figure 5. The female *R. unicornis* named 'Lizzie' in the Gandak Valley of Nepal followed by her half-grown calf. Photo by Dyott (*Natural History*, New York, 1924).

THE RHINOCEROS AT HOME.—One of the remarkable photographs obtained by Mr. G. H. Dyott, F.R.G.S., with the Vernay-Faunthorpe expedition. It is of Lizzie, the Indian one-horned rhinoceros, the subject of part of Lieut.-Col. J. G. Faunthorpe's article, and her baby in the thornbush of the Gandak Valley.

Figure 6. A second view of the mother rhino Lizzie with her calf (*The Times*, London, 7 September 1923).



»Han körde henne före sig, så att stoftet rök om benen.»

Figure 7. Male rhino chasing a female in Jaldapara, India, photographed in 1932 by Bengt Berg (1932, p. 176).

not only finding elusive animals but also to get exactly the right exposure. Many great pictures have been taken over the years. The public taste changed from sport hunting trips to photographic safaris. Marius Maxwell (1888–1936) explained that photography of wild animals, including the iconic pachyderms, could become a new way to experience adventure and wonder for wildlife. Maxwell working in Kenya was ahead of his time when he wrote: "Rather it has been my desire to secure photographic records…incidents such as are found in the writings of well-known hunters, and to illustrate these experiences by actual photographs…giv[ing] me opportunities to obtain an accurate shot with the camera instead of the rifle" (Maxwell 1924).

Acknowledgements

The Rhino Resource Center includes the references mentioned in this paper on its website, www.rhinoresourcecenter.com. The RRC is sponsored by SOS Rhino, International Rhino Foundation and Save the Rhino International.

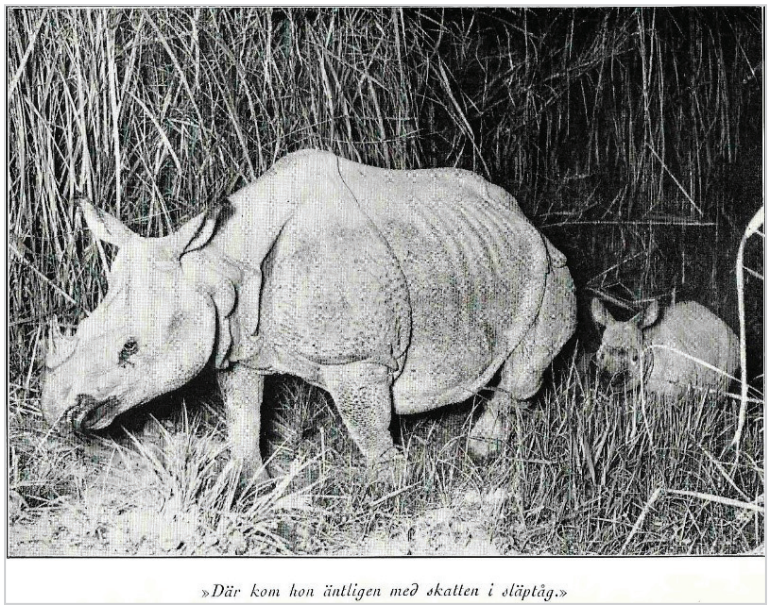


Figure 8. Mother and young one in Jaldapara in 1932 photographed by Bengt Berg (1932, p.137).

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FIELD NOTES

The Elephant Ethogram: a library of African elephant behaviour

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Introduction

This short paper is intended to alert our colleagues to the existence of The Elephant Ethogram: A Library of African Elephant Behaviour. It describes its purpose, form and scope, and appeals for contributions of undocumented, rare, novel or cultural *Loxodonta africana* behaviour. We do not present descriptions of behaviours, methodologies, results or discussion; these may be found online within *The Elephant Ethogram*.

The Elephant Ethogram is an ElephantVoices initiative to document the complex, diverse and nuanced repertoire of behaviour and communication of African savannah elephants (*L. africana*). In a unique, user-friendly, fully searchable and publicly accessible database, *The Elephant Ethogram* chronicles the rich postural, gestural, tactile, chemical and acoustic communication and behaviour of Africa's savannah elephants. It includes commonly displayed, unusual, novel and culturally learned behaviours, as well as those expressed in response to people. *The Elephant Ethogram* is based on published descriptions of behaviour and the decades of behavioural studies and photographic, acoustic and video-graphic collections from Amboseli National Park (NP), the Maasai Mara ecosystem (Mara), Kenya, and Gorongosa National Park, Mozambique conducted by ElephantVoices. It is also built from behaviour captured for documentaries filmed in the Mara and Gorongosa and video clips of unusual behaviour collected by colleagues and members of the general public.

The Elephant Ethogram replaces ElephantVoices' online Elephant Gestures and Elephant Calls Databases originally developed in 2003 and revamped in 2011 (Poole 2011; Poole and Granli 2011), that were based on our elephant studies in Amboseli National Park, Kenya between 1975 and 2009 (Poole 1987; Poole et al. 1988; Poole 1989a; Poole 1989b; Poole et al. 2005) and the work of other scientists (Douglas-Hamilton 1972; Berg 1983; Moss 1983; Kahl and Armstrong 2000; Kahl and Armstrong 2002).

Between 2011 and 2019 we carried out elephant behaviour studies and conservation projects in the Mara, and Gorongosa NP, during which we completed elephant, field notes, images and videos of the behaviour of known individuals. Furthermore, in a ground-breaking collaboration with copyright owners Off the Fence, Gorongosa Media Project and Bob Poole Films, hundreds of hours of raw footage of elephants, originally shot for documentaries in Gorongosa and the Mara, were granted to ElephantVoices for use in science and education. Since we collaborated with the filmmakers on site, the footage primarily depicts known individuals. In 2020 we collected additional footage of behaviour in Amboseli National Park. *The Elephant Ethogram* combines and significantly improves the structure and functionality of the original databases, includes hundreds of additional behaviours, 2,400 annotated video clip examples from three populations, higher-resolution images, additional audio files.

Elephant behaviour has been documented by

hunters, naturalists and scientists for hundreds of years starting with the earliest scholarly notes of Aristotle (1862 translation) to those of Darwin (1872) to Kühme's (1962; 1963) research on captive African elephants. The study of free-ranging elephants by Douglas-Hamilton (1972) stimulated the work of many who followed, including the five decades-long work of Moss and her colleagues, and our own.

From hundreds of published studies, we know that savannah elephants show great richness, variation and flexibility in their behaviour. Some of these publications have described elephant behaviours relevant to the aims of their particular study (Moss 1983 (oestrus); Poole 1987 (musth); O'Connell-Rodwell et al. 2011 (male-male relationships); Goldenberg and Wittemyer 2020 (death)), but only Kahl and Armstrong's work in Hwange National Park, Zimbabwe (2000; 2002) and our own in Amboseli National Park (Poole 2011; Poole and Granli 2011) aimed to document the full repertoire of behaviour of the species. We worked closely with Kahl to share data and to agree on terminology and definitions. Until his untimely death in 2012 Kahl's plan was to publish a detailed elephant ethogram.

The construction of "exclusive ethograms" to describe a species' behaviour or activity patterns is commonly used in behavioural studies, where the ethogram focuses on the behaviours of interest. It is more unusual to find catalogues that attempt to produce an "exhaustive" ethogram of all known behaviours of a given species. One example is the work of Nishida et al. (1999) on chimpanzees, *Pan troglodytes*, which aims to provide an exhaustive list of behaviours. This body of work defines 515 behaviours, recording whether they were idiosyncratic, limited to a small group, to one population or were, to a greater or lesser extent, cross-cultural. Another example is the work of Bolgan et al. (2014) on the Arctic charr, *Salvelinus alpinus*, a fish species.

A draw-back of these studies is that they are non-searchable, written documents without video-graphic documentation. Nishida et al. (2010) solved this problem for their study of chimpanzees by publishing a book with an accompanying CD. Very few studies; however, have attempted to produce an exhaustive, searchable web-based ethogram of a species with video examples of behaviour. One example is Mouse Ethogram: An Ethogram for the Laboratory Mouse developed in the Stanford Medical School in the Laboratory of Joseph Garner. Since this study was carried out in a captive environment it is unlikely to be exhaustive for the species.

African elephants (Savannah and Forest) are among the most socially complex non-human species (Moss and Poole 1983; McComb et al. 2000; Archie et al. 2005; Wittemyer et al. 2005), as well as one of the more heavily exploited (Meredith 2001; Wittemyer et al. 2014). As scientists continue to document their extraordinary behaviour, elephants are increasingly impacted by humans to the point where their behaviour is notably affected (Douglas-Hamilton et al. 2005; Gaynor et al. 2018; Wall et al. 2021) and their future survival endangered (Wittemyer et al. 2014; Hart et al. 2021).

Purpose

Supported by annotated video examples, *The Elephant Ethogram* is an attempt to provide an exhaustive, searchable, publicly available, catalogue of the behaviour of the endangered savannah elephant. Our aim is for *The Elephant Ethogram* to be a repository of the full range of *L. africana* behaviour for scientific study, reference and comparison and for posterity. We hope that it inspires broader interest in elephants—a deeper understanding of their behaviour, cognition and communication, improved protection of their lives and their landscapes and increased concern for their well-being and for Africa's Forest elephants and Asian elephants.

Form, function and scope

The Elephant Ethogram describes the form and, where possible, the function and/or contextual nuances in meaning of the rich behaviour and communication recorded. Entries include common, rare, novel and idiosyncratic behaviours, as well as cultural differences in behaviour documented between groups or populations acquired through social learning. In some cases, these are in response to anthropogenic threats.

The structure of *The Elephant Ethogram* is built upon uniquely observable *Behaviours*. A *Behaviour* is a unique movement or action in response to a particular situation or stimulus (e.g. Chin-In, Ear-Wave, Trunk-Twisting). Each *Behaviour* is documented by a detailed written description, noting: its form, function, if apparent, the age and sex of those observed to engage

in the *Behaviour*, the *Context(s)*, in which it occurs and video examples. When the *Behaviour* occurs in more than one *Context*, we note the age and sex of participants by *Context*. We aim to include video examples of the *Behaviour* as it is expressed in different *Contexts*, wherein the *Behaviour* is highlighted by a moving circle (Fig. 1). Audio examples are included where relevant.

A *Behavioural Constellation, or Constellation*, is a suite of *Behaviours* that usually occur together (e.g. Musth-Walk typically includes the *Behaviours*: Ears-Stiff, Head-High, Chin-In, Purposeful-Walk, Musth-Temporal-Gland-Secretion, Urine-Dribbling). Each *Constellation* is documented by a detailed written description (including its form, function, the age and sex of those engaging in the *Constellation*), the *Context(s)* in which it occurs, the *Behaviours* that are likely to be observed, and video examples. Again, when a *Constellation* occurs across more than one *Context*, we note the age and sex of participants by *Context*. Each video highlights the component *Behaviours* as they occur. Where it is relevant, we include audio examples.

A *Context* refers to the particular setting, situation or circumstances in which a *Behaviour* or *Constellation* occurs. We define 23 *Contexts*. Most *Behaviours* and many *Constellations* occur in more than one *Context*, and many have different functions or signal different meanings in different *Contexts*. For example, Trunk-to-Genitals may be a form of assessing sexual or physical state, a way to solicit suckling, a gesture of reassurance or of conciliation, depending upon the *Context* in which it is performed. Likewise, Periscope-Trunk may be used to detect scents carried on the wind, to signal to others to pay attention in a particular direction, a sign that a calf wants to suckle, or a signal that an individual is awaiting a partner's next move during social play, sparring or fighting. Ear-Folding may be a threat or be part of a suite of affiliative *Behaviours* associated with high social arousal.

The Elephant Ethogram includes an Introduction, a User Guide, the Ethogram Table, a Search Portal, The Science, References that have been cited throughout *The Elephant Ethogram* and Acknowledgements. Its contents may be accessed via the Ethogram Table or the Search Portal. The Ethogram Table (Fig. 2) provides an overview of all *Behaviours*, *Constellations* and *Contexts* contained in *The Elephant Ethogram*.

The Search Portal (Fig. 3) offers four search alternatives that return *Behaviours* and *Constellations*: Two Free–Text Searches, an Alphabetical Search and a Combined Dropdown Search, which allows the user to select more than one search criteria (e.g. to find behaviours typical of musth males that involve the ears, or how the feet are used for signalling in a leadership context, or vocalizations made by infants). Clicking on a returned linked *Behaviour/Constellation* takes the user to a page where it is described and where annotated video and audio examples may be accessed. The Search Portal also offers a slideshow of linked images of a limited selection of *Behaviours/Constellations* (Fig. 4).

The Science page includes an abstract, introduction, methods, a basic set of results and discussion. The methods describe the elephant populations represented in *The Elephant Ethogram*, the terminology and naming conventions that we use. We also describe the procedures used to: collect the data (e.g. elephant identification, group sightings records and field notes, audio, video and images and the separate apps and databases used to collect and house them); mine the collections of audio, video and images; extract, edit and annotate clips; upload material to SoundCloud and Vimeo; and code and populate the database. Once *The Elephant Ethogram* has been fully populated with our remaining material, we will expand the results and discussion with conclusions that can be drawn from the data.

The first version of *The Elephant Ethogram* was made available on www.elephantvoices.org in April 2021. As of its launch *The Elephant Ethogram* defined 322 *Behaviours*, 103 *Constellations* and 23 *Contexts* and contained over 3,000 media files, of which over 2,400 were annotated video clips (813 from Amboseli National Park, 940 from the Mara ecosystem, 658 from Gorongosa National Park and 3 from Kruger National Park).

Living database

The Elephant Ethogram is a living database. We will continue to supplement it with representative clips of behaviours from our own Gorongosa National Park footage as well as with submissions of currently undocumented behaviour or unusual video clips or photographs.

Creating and populating *The Elephant Ethogram* has been a multi-year endeavour and we acknowledge

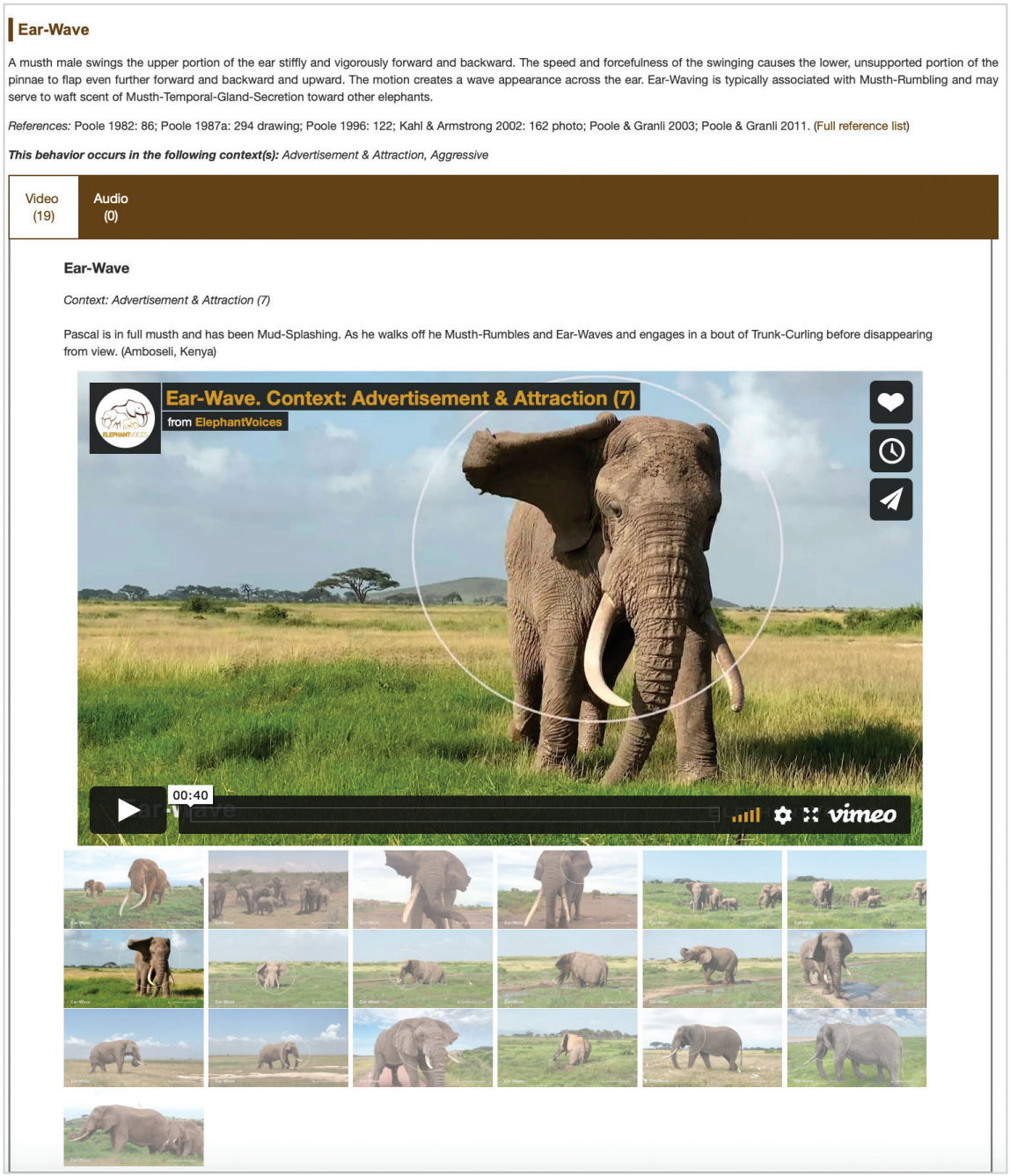

Figure 1. An example of a page describing a *Behaviour*. The *Behaviour*, Ear-Wave, is described followed by 19 annotated video examples. Clicking on a video, highlights it so that you may read the caption and play it.

Context	Behaviors	Behavioral Constellations
Advertisement & Attraction *Behaviors employed by adult males and adult females in the advertisement of sexual state and the attraction of, and search for, mates.*	Bonding-Rumble (0), Casual-Stance (5), Chin-In (1), Ear-Brush (1), Ear-Folding (3), Ear-Slap (1), Ear-Wave (18), Ears-Stiff (2), Estrous-Roar (5), Estrous-Rumble (4), Estrous-Running-Rumble (1), Exaggerated-Splash-with-Foot (2), Female-Chorus-Rumble (6), Flehmen (11), Foot-Scuffing (3), Grasp-Tail (2), Head-High (1), Head-Raising (0), Head-Toss (2), J-Trunk (2), Musth-Rumble (21), Musth-Temporal-Gland-Secretion (5), Musth-Temporal-Gland-Swelling (8), Musth-Trunk-Wrinkle (4), Nasal-Throb (6), Open-Mouth (0), Open-Mouth-to-Open-Mouth (0), Penis-Erection (3), Periscope-Trunk (2), Place (2), Purposeful-Walk (0), Rapid-Ear-Flapping (0), Rubbing (2), Rumble (0), Rump-Present (1), Run-Toward (0), Sniff-Dung (4), Sniff-Ground (1), Sniff-Urine (4), Social-Trumpet (2), Tail-Swatting (2), Temporin (0), Trumpet (0), Trunk-Bounce-Drag (0), Trunk-Curl (5), Trunk-Dragging (10), Trunk-Flick-Down (2), Trunk-Suction (3), Trunk-to-Genitals (9), Trunk-to-Genitals-Suck (1), Trunk-to-Mouth (1), Trunk-Toward (2), Tusk-Ground (4), Urinating (1), Urine-Dribbling (11), Walk-Away (0), Walk-Toward (0),	Estrous-Running-Rumble-Roar (0), Estrous-Walk (7), Female-Chorus (3), Listening (8), Mating-Pandemonium (7), Musth-Display (1), Musth-Walk (13), Roar-Rumble (1), Rumble-Roar (0), Rumble-Roar-Rumble (1), Simulate-Estrus (1), Tracking (9), Wariness (2),

Figure 2. An example of one of 23 rows from the Ethogram Table defines a context and lists the *Behaviours* and *Constellations* that have been observed to occur within it.

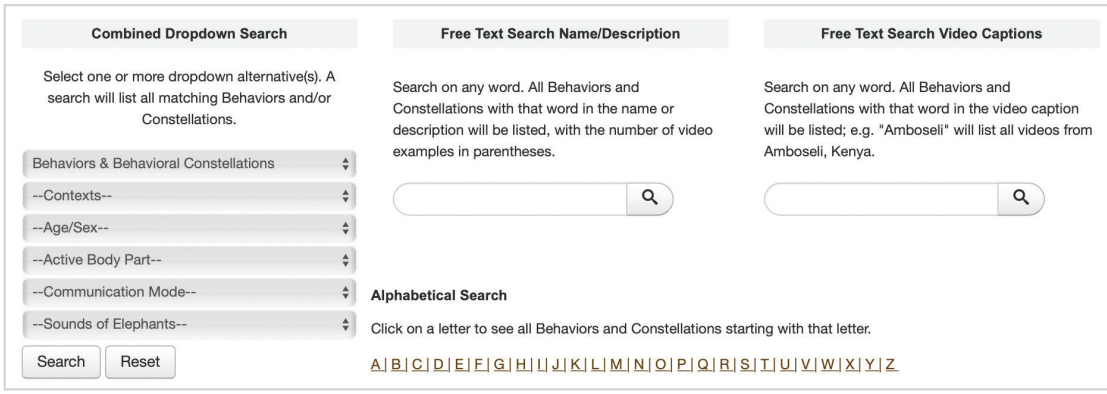

Figure 3. The Search Portal offers a Combined Dropdown Search, two Free Text Searches and an Alphabetical Search.

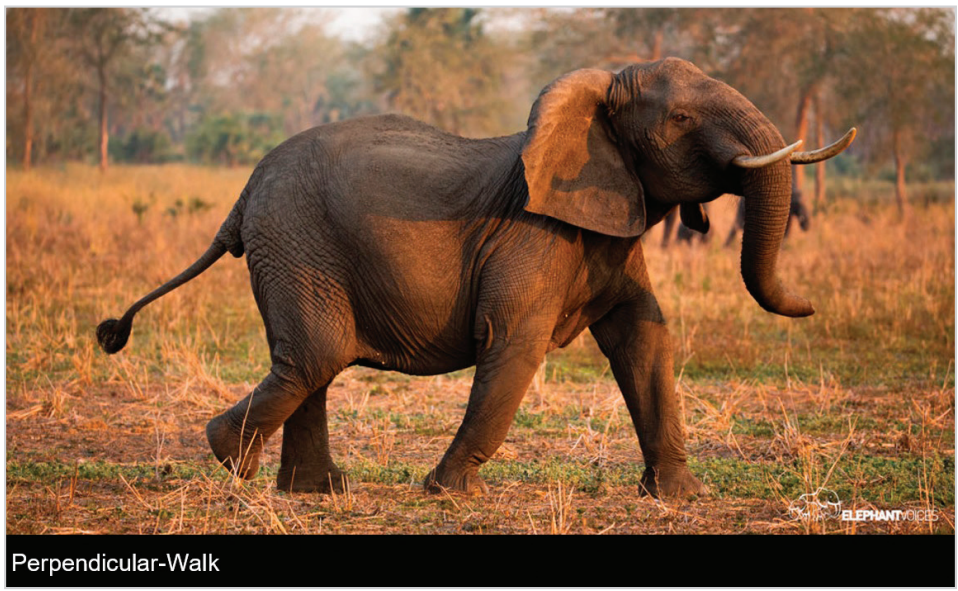

Figure 4. An example from the slideshow: Iphigenia engages in a Perpendicular–Walk, Gorongosa National Park.

its inevitable shortcomings and potential mistakes. We invite our colleagues to inform us of any amendments to be made, references to be included or terminology previously used to refer to a particular behaviour.

In conclusion, we hope to expand *The Elephant Ethogram* with selected files from additional populations as well as to note the occurrence of behaviours in African forest elephants (*Loxodonta cyclotis*). We appeal to our colleagues or members of the public to share with us interesting, unusual or cultural behaviour for inclusion in *The Elephant Ethogram*. We invite you to contact us via ethogram@elephantvoices.org to submit descriptions, photographs, audio or video recordings. All contributions will be credited.

The concept and structural design of *The Elephant Ethogram* was developed by Joyce Poole and Petter Granli of ElephantVoices. Programming and database coding and maintenance is handled by Derrick Joel, Nairobi, Kenya, in collaboration with Petter Granli. *The Elephant Ethogram* is coded in open-source software PhP and MySQL in Joomla! CMS, and is currently hosted on Cisco servers as a section of elephantvoices.org. Video and audio files are hosted on Vimeo and SoundCloud, respectively.

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Kenya's first White Rhino Conservation and Management Action Plan

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Introduction

Kenya conserves both subspecies of the white rhino (*Ceratotherium simum*). There are currently circa 750 southern white rhinos (*C. simum simum*) (SWR), on private, community and State lands (Table 1). The species was introduced into Kenya from South Africa to support conservation efforts, in total 51 animals (six animals in 1965, 20 in the 1970s, 5 in 1992, and 20 in 1994; six of the latter individuals died due to disease) (Rookmaaker 1998). The population has grown rapidly over the last 20 years at an average rate of 6.76% (95% CI: 6.19%–7.33%) per annum (Fig. 1). It has so far been managed with guidelines largely under the umbrella of the Black Rhino Conservation and Management Action Plan (Okita-Ouma et al. 2007). However, due to their rapid growth, there was an urgent need to develop a separate action plan to inform best practice management of the subspecies.

Despite continuing grave threats, including poaching and habitat loss, the SWR is currently the most abundant rhinoceros in the world, with about 18,000 individuals living primarily in South Africa

Table 1. Status of the southern white rhino in Kenya, information based on aerial census conducted in December 2020). (Note: rhino population numbers on request from authors)

Conservation area	Land ownership	Available habitat
Il Ngwesi Community Conservancy	Community	81 km²
Lake Nakuru National Park	State	124 km²
Lewa–Borana Landscape	Private	376 km²
Meru National Park	State	83 km²
Nairobi National Park	State	117 km²
Nairobi Safari Walk	State	
Ol Choro Oiroua Community Conservancy	Community	10 km²
Ol Jogi Conservancy/Pyramid	Private	50 km²
Ol Pejeta Conservancy	Private	300 km²
Ruma National Park	State	120 km²
Solio Game Reserve	Private	70 km²
National Total	~750	1,331 km²

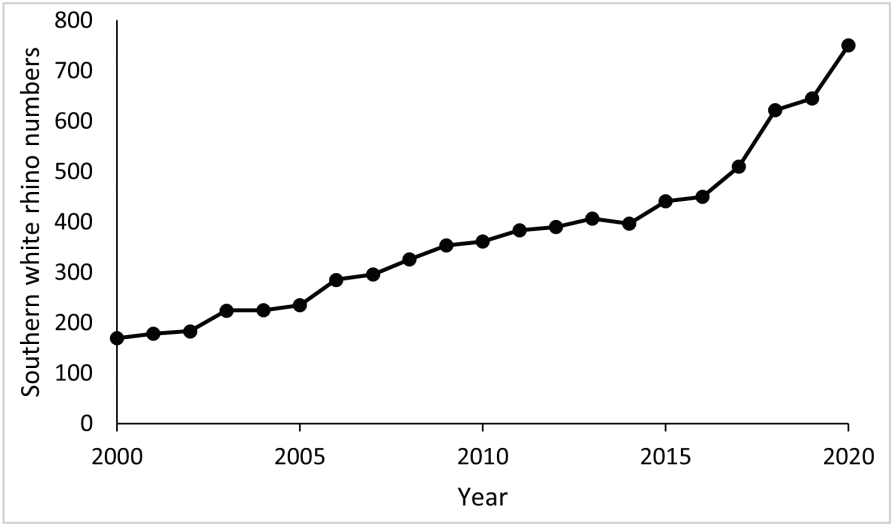

Figure 1. Population trend of southern white rhino in Kenya, 2000–2020.

(Emslie 2020). Nearly extinct at the beginning of the 20th century after being reduced to a single population of *circa* 200 individuals in South Africa (Rookmaaker 2002), subsequent conservation efforts have led to a dramatic recovery of this subspecies. However, poaching remains a serious threat (Emslie 2020), and the subspecies is listed as Near Threatened on the IUCN Red List of Threatened Species and is on Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

The northern subspecies or NWR (*C. simum cottoni*), listed as Critically Endangered is believed to be extinct in the wild. Only two remaining individuals, both females are held in captivity in Kenya (Emslie 2020). The NWR once ranged in large numbers throughout north-central Africa south of the Sahara (Central African Republic, Chad, the Democratic Republic of Congo, South Sudan, Sudan and Uganda). In 1960 there were approximately 2,250 animals remaining (Rookmaaker and Antoine 2012) but in the 1970s and early 1980s, poachers reduced the number of NWR to 15 surviving in Garamba National Park, DRC. However, by 1995, under protection, the population had recovered to 31 and for many years overall numbers remained stable. In mid-2003 there was a major upsurge in poaching in Garamba National Park and by May 2006 numbers had been reduced to *circa* three individuals. In May 2004 ten NWR were maintained in two zoological institutions; ZOO Dvůr Králové, Czech Republic (seven animals), and San Diego Wild Animal Park, USA (three animals) but breeding had been poor (Hermes et al. 2006). As a last effort to save the sub-species the four remaining NWR (from ZOO Dvůr Králové) were moved to Ol Pejeta Conservancy, Kenya in December 2009. The recovery of the NWR faces significant challenges, and steps have been identified for a long-term programme to "rewind" the extinction process and secure a viable population with sustainable levels of genetic diversity (Saragusty et al. 2016).

The development of the first Kenya White Rhino Conservation and Management Action Plan (WRAP) (2021–2025) involved a six-stage process: 1) review of existing Kenya white rhino management guidelines and laws, and a national-level population SWOT analysis (Strengths, Weaknesses, Opportunities, Threats); 2) site-level population assessments with SWOT analysis; 3) preparation of a zero-draft action plan for feedback from the IUCN AfRSG, stakeholders and technical experts; 4) virtual stakeholder meeting to review feedback; 5) presentation of the updated action plan to the National Rhino Steering Committee for further comments; and 6) endorsement of the Action Plan by the Rhino Executive Committee and the KWS Board of Trustees (KWS BoT).

Southern White Rhino Conservation and Management Plan

The long-term vision of the WRAP for the SWR is to have viable populations living in healthy ecosystems, valued as both a national resource and a global heritage. It aligns with national and regional conservation efforts through introduction/reintroduction programmes, and promotes local conservation education, tourism and community conservation initiatives. The overall goal is to maintain demographically and genetically healthy populations. With an average annual growth rate of 6.76%, realized over the period 2000–2020, there is every indication that the national population could reach 2,500 SWRs in the next 20 years (Fig. 2). The white rhino plays an important role in grassland ecological dynamics in a number of sanctuaries. However, their numbers need to be managed to maintain the health of the ecosystems they inhabit.

The WRAP is guided by five key components with strategic objectives: (1) *Rhino Protection and Law Enforcement*: to keep rhino poaching below 1% of the total population per annum by maintaining protection and law enforcement at required levels in all SWR areas; (2) *Biological Monitoring and Management*: to biologically manage SWR, and their habitats, for demographically and genetically healthy populations over the longer term; (3) *Communication and Engagement*: to use targeted communication and engagement of relevant stakeholders to increase the understanding and support for white as well as black rhino conservation; (4) *Sustained financing*: to sustain financing of key components of white rhino conservation, alongside Kenya's black rhino conservation requirements, for successful delivery of the plan; (5) *Overall Programme Management, Coordination and Collaboration*: to ensure effective programme management, coordination and collaboration nationally and regionally so as to achieve the strategic objectives of the Plan (Fig. 3).

Key activities of the WRAP include the following: (1) incorporating SWR meta-population management as a component in the East Africa Community–Rhino Management Group (EAC-RMG), (2) conducting grassland management through the control of invasive alien plant species, implementing a fire management plan, and maintaining sustainable grazing levels in SWR areas, (3) securing more space for SWR through the assessment of new areas and the expansion of existing areas, (4) developing and implementing a white rhino metapopulation translocation plan, (5) developing and implementing a white rhino database monitoring system based on the *Kifaru* model, (6) promoting white rhino via various platforms to bolster national and international tourism, and to support their conservation, and lastly, (7) coordinating white rhino management across all rhino areas and landscapes.

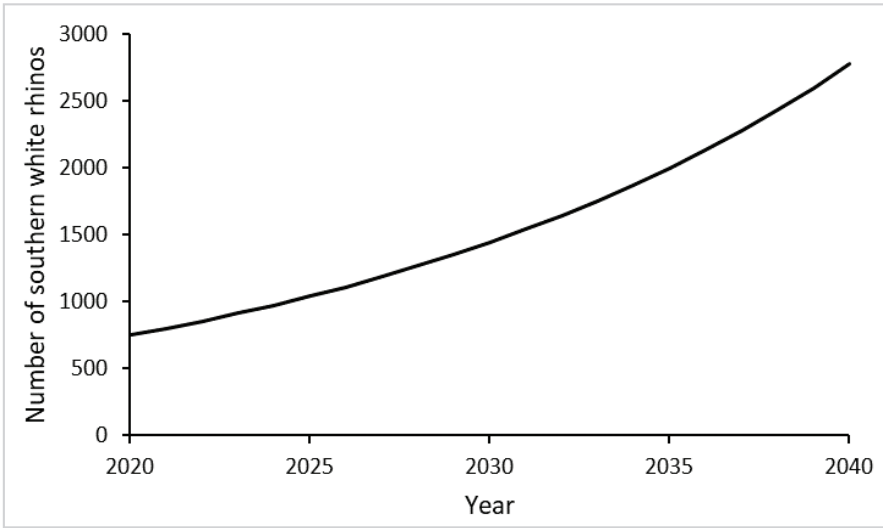

Figure 2. Projected increase in the population of southern white rhino in Kenya, 2020–2040.

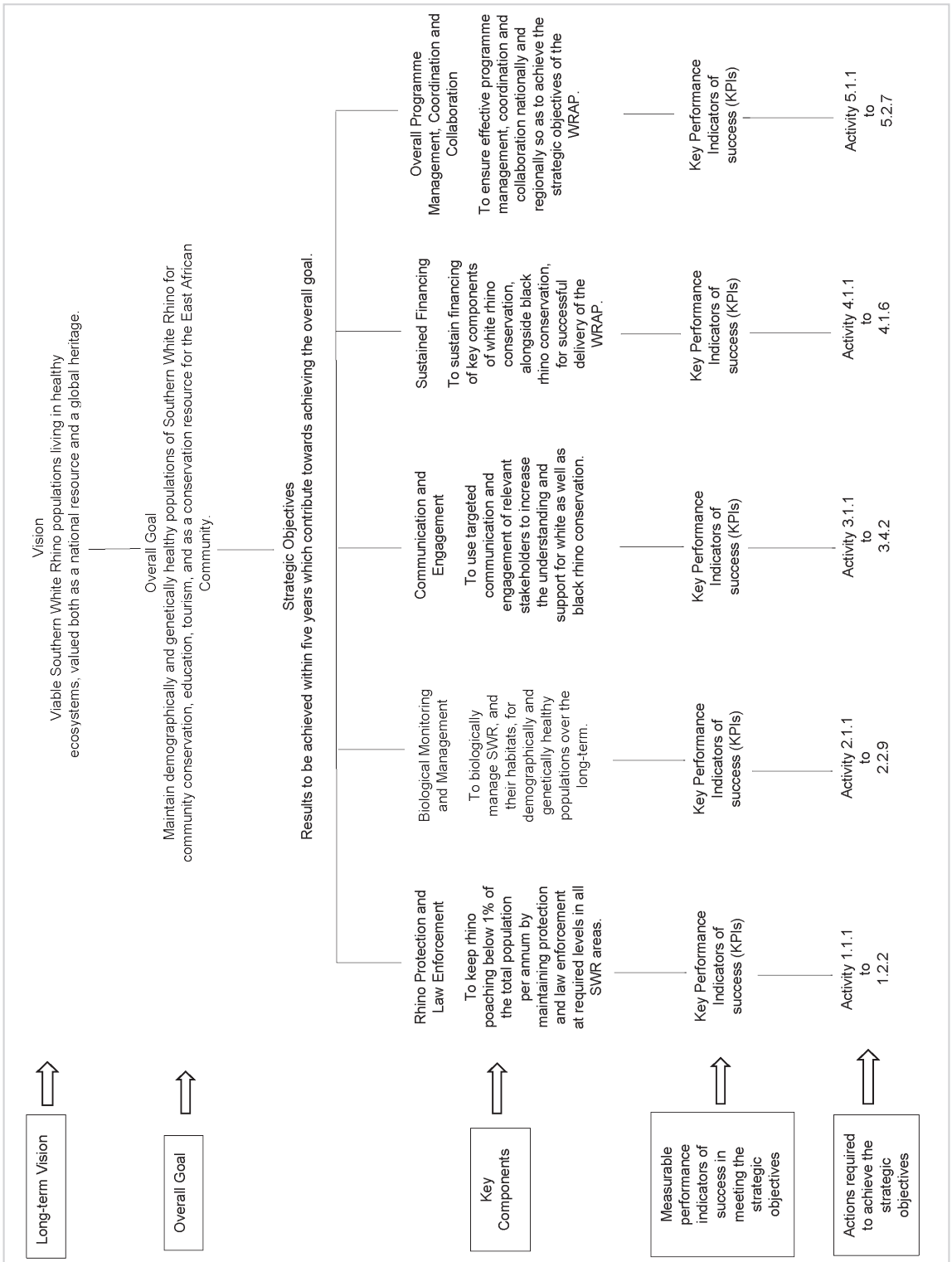

Figure 3. Framework of the southern white rhino component of the WRAP 2021–2025 (Anon 2021), showing the connection of actions or activities to the overall goal to maintain demographically and genetically healthy populations.

Northern White Rhino Recovery Plan

Background

On the 11 May 2009, senior representatives of the African rhino range states, wildlife agencies and stakeholders working under the umbrella of the East African Community held the first meeting of the EAC–RMG and produced the Nairobi Declaration (Okita-Ouma et al. 2009). Among its main goals, the participants agreed to "support all efforts to re-establish and recover the NWR within its former eastern African range states". Kenya is not a range state but is supporting the recovery efforts of the NWR.

In December 2009, four NWR were transported to Kenya (Ol Pejeta Conservancy) from the Czech Republic where they had been housed in the Dvůr Králové Zoological Gardens since 1975. A custodian agreement was made in the hope that bringing the rhinos into a natural environment close to their original habitat and conditions might encourage their natural, social and territorial behaviour and thus prompt successful breeding. These included two females (Najin and Fatu, the latter being Najin's daughter) and two males (Suni and Sudan, Sudan being the only animal that was born in the wild). The two males died of natural causes: Suni died on 16/17 October 2014 and Sudan 19 March 2018.

After no successful natural breeding was observed during the first five years after their translocation, health checks in late 2014 showed that none of the remaining animals were capable of natural reproduction. Consequently, a decision was made in January 2015 to ask a team of experts from ZOO Dvůr Králové, IZW Berlin and Avantea Cremona to develop an Assisted Reproduction Technique protocol and contingency plan. It was identified as necessary to produce an embryo *in vitro*, either through fertilization of oocytes (immature egg cells) harvested from live NWR donors (with NWR semen that is currently cryopreserved) or through fertilization of artificial gametes that would be produced from induced pluripotent stem cells. Such an embryo would be inserted into a SWR female and carried to term by this surrogate mother. Crucial for the large-scale generation of transferrable embryos produced *in vitro* was the optimization of the oocyte harvesting technique, so called ovum pick-up (OPU). In the following years, the OPU technique was developed on captive SWR in European zoos, which involved the ovarian stimulation of females as well as the collection of their eggs. *In vitro* procedures needed to generate a viable embryo from these eggs were also developed.

In August 2019, five oocytes were collected from Najin and five from Fatu. Two of Fatu's eggs developed into embryos that were cryo-preserved for future transfer. The procedure was repeated in December 2019 when three oocytes were collected from Najin and six from Fatu, and one of Fatu's eggs developed into an embryo. The procedure thus proved to be safe and reproducible and could be performed on a regular basis before the animals become too old.

In December 2019, semen of Sudan, and tissue and blood samples of Sudan, Najin and Fatu were transported to IZW Berlin. The aim is to use the samples in future for production of more embryos. Due to the restrictions related to Covid-19, only minor operations could be conducted in 2020. None of the 10 oocytes collected in August 2020 developed into a viable embryo. Another procedure was undertaken in December 2020 and 10 oocytes were harvested from Fatu out of which two eggs developed into embryos bringing the total number of NWR viable embryos to five at the end of 2020. In March 2021, 19 oocytes were collected from Fatu and four of them made it to viable embryos. Another 17 oocytes were collected from Fatu during an exercise conducted in July 2021 and three developed into viable embryos, so at the time of writing this paper (July 2021) the total number of NWR embryos stood at twelve. Eleven of the embryos were created with semen from the NWR rhino male Suni while one of the last three embryos was developed with semen from Angalifu, a NWR from San Diego that died in 2014. Using semen from completely unrelated rhino, raises hopes in genetic pool diversification of the cryo-preserved embryo population.

The Recovery Plan

The long-term vision of the Recovery Plan (under WRAP) hoped for is to have a stable population of the NWR in Kenya that provides individuals f or reintroduction of the NWR to former range states. The overall goal of the Plan is to have a number of NWR calves born in Kenya through IVF techniques. Given the situation as of July 2021 with 12 embryos produced

so far, but not a fully successful embryo transfer conducted yet, and given the long terms of rhino gestation, it is clear that having a few calves in the coming decade would be a significant achievement and very good foundation for accomplishing the long-term objective of the Recovery Plan that is aligned with the objectives of EAC-RMG (Okita-Ouma et al. 2009). The Recovery Plan is again guided by the five key components of Protection, Biological Management, Communication and Engagement, Sustained Financing, and Programme Management, Coordination and Collaboration.

The main activity in the Recovery Plan is to conduct OPU three to four times a year, depending on the health condition of the animals. The aim is to produce as many viable NWR embryos as possible before the health of the two females eventually deteriorates to a level at which it would be too risky to anesthetize them for the procedure. At the same time, work on perfecting the embryo transfer method would continue, with eventual transfer of the embryos into surrogate SWR in Kenya. Embryo transfer has to coincide with approximately a nine-day period after ovulation. Four SWR females have been identified as surrogates based in the Ol Pejeta Conservancy. To determine the time of ovulation in these females, the use of a SWR teaser bull, to live with the would-be surrogate mothers has been identified as the best option. The teaser bull was translocated to Ol Pejeta Conservancy from Lewa Conservancy in November 2020 and in December 2020 he was successfully sterilized.

To give the NWR the best chances to circumvent extinction, it is also necessary to work—apart from harvesting oocytes from live donors—with cellular technologies. At present, cell cultures from 12 specimens are available in Europe and the US. The current proposal being considered is to produce in vitro primordial germ cells from iPS cells (induced pluripotent stem cells) obtained from the NWR somatic cells cryo-preserved on previous occasions in the past, and through a second step these germ cells will then be transformed into eggs and sperm. This would substantially enlarge the founding genetic diversity of the future NWR population.

In summary, the Kenya WRAP provides a framework for the conservation and management of the SWR rhino by adopting best practice for population and habitat management through a consultative process involving all relevant stakeholders. This WRAP identifies key activities to conserve the species and to enhance its management by building synergy among the various stakeholders. The novel intervention for NWR, while not without challenges, is the only hope for saving valuable genetic material to perpetuate the NWR. Other opportunities remain to hybridize the northern and southern subspecies also, in order to preserve valuable genetic lineage if the attempts to produce pure NWR progeny are not successful.

A progress report of the White Rhino Conservation and Management Action Plan will be considered in 2023.

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Time series forecasting of greater one-horned rhinoceros poaching levels at Kaziranga National Park, Assam, India

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Introduction

This paper deals with the forecasting of poaching of the greater one-horned rhinoceros (*Rhinoceros unicornis*) (GOH) at Kaziranga National Park (KNP or the Park), Assam, India. Instances of poaching adversely affect efforts to conserve and increase the rhino population of the Park. The time series of total instances of poaching of GOH at KNP from the year 1965–2019 was considered in the study. The information about the period ending 2015 was used as training and testing data, and poaching levels for the period 2016–2019 were predicted using three different forecasting methods and compared with the available actual data. Three methods of time series forecasting are compared, namely Holt's method (HM), Holt–Winters' multiplicative method (HWMM) and Holt–Winters' additive method (HWAM).

KNP was the first area in Assam gazetted for rhino protection in 1908, and the Park achieved UNESCO World Heritage status in 1985 for being the world's major stronghold of GOH and for providing habitat for a number of other globally threatened species including tigers and Asian elephants. (UNESCO website; https://whc.unesco.org/en/list/337/). GOH numbers in the Park rose from 366 in 1966 (Vigne and Martin 1994) to 2,413 in 2018 (Talukdar 2018), and KNP now holds two-thirds of the world's GOH population. The 430 km^2 Park is ideal rhino habitat, with nutrient-rich grassland growing on fertile soils created by alluvial silt deposition from seasonal flows in the Brahmaputra Valley floodplain. Although KNP has been granted maximum protection under the Indian law for wildlife conservation with enactment of Assam Forest Regulation 1891 and Biodiversity Conservation Act 2002 (UNESCO website) poaching of the GOH has been a major concern for authorities. The perimeter of KNP is contiguous on three sides with urban development and this makes it difficult to protect the Park from illegal incursions of poachers and herdsmen. Only the northern side is better protected, as the 2 km wide Brahmaputra River acts as a natural boundary.

Until 1980 GOH were poached using the pit fall technique; however, with the increase in the availability of arms due to political disturbances in the state, cases of poaching escalated rapidly, reaching a peak during 1992 (Vigne and Martin 1994). In 1989 the first case of poaching by electrocution was observed. Conservation efforts initiated in 1997, including improved fencing and increased patrolling, strengthened security in the Park and led to a reduction in poaching incidents. In 2003, poaching was brought under control and reduced to just three incidents in 2003 (Talukdar 2006, Lopez 2014). Poaching incidents increased again thereafter, to 16 incidents per year in 2007 and 27 incidents in 2013 (Soud and Talukdar 2013). From 2013 onwards poaching levels have been brought down, according to the official statistics. Thus, numbers of poaching incidents have fluctuated over time, producing a time series with abrupt highs and lows. Such short-term fluctuations in data sets are often difficult to interpret and research to define the limitations of the various methods is incomplete. Despite these difficulties, it is useful to study the properties of the time series of incidents of rhino poaching. Results can be relevant for ongoing management and conservation initiatives, as they can help predict poaching spikes and thereby prepare the Park management to respond to future threats.

Previous research drawing on methods of fractal

analysis[1] established that the prediction of poaching levels using time series forecasting methods is feasible. The dispersion method is a powerful method that can be used for analysis of fractal properties of time-series data (Bassingthwaighte and Raymond 1995). The Hurst exponent (*H*) is one measure of these properties (Resta 2012). The Hurst exponent is a measure of long-term memory that calculates auto-correlations of time series over time and the rate of their decrease with increase in the lag between pairs of data values. It basically measures the amount of randomness in the given time series. A value of *H* of less than 0.5 indicates that the given time series is unpredictable, and of above 0.5 that the time series is persistent or predictable.

In previous research, the authors of this paper applied the dispersion method to study the statistical and fractal properties of the time series of incidents of rhino poaching in KNP (Bhardwaj and Das 2018). The time series of poaching showed a persistent behaviour, with the value of *H* above 0.5 indicating that present values are in sync with the trend of past observed values. The persistent pattern of the time series indicates that the prediction of poaching levels using time series forecasting methods is feasible.

In 1957, Holt developed the first forecasting method, known as the Holt method (HM), which was linear regression based and accounted only for the trend of the data. In 1960, Winter proposed the HWM (Holt–Winters' Method), which besides indicating trends accounted for the seasonality of data. The HWM is further divided into HWMM and HWAM depending upon the nature of seasonal component in data. If the seasonal variations are roughly constant over the time series, then HWAM is used for forecasting, while if the seasonal variation changes progressively over the course of the time series, then HWMM is used.

The HWAM model was applied by Szmit and Szmit (2012) to detect anomalies in network traffic and by Valakevicius and Brazenas (2015) to study exchange rate volatility. However, these forecasting techniques have not so far been used for ecological or biological time series data. This study applies these methods to predict poaching values for the years 2016–2018, using poaching data from 1965–2015 as training data. It compares values for 2016–2018 predicted using HM, HWMM and HWAM with actual data for these years. The methods are compared, and the best method is proposed on the basis of observed results.

Data and methodology

The annual data of the number of rhinos poached in KNP in the period 1965–2019 were mainly obtained from (a) Lopez (2014), covering the period 1972–2012; (b) Wikipedia (WP; 1965–2016); and KNP official data (KNPO) data, published on the websites of (c) KNP (2006–2019) and (d) the Wildlife Protection Society of India (WPSI) 2010–2017.

Furthermore, there are differences between KNPO and WPSI data for the period 2010–2016 and also among all three primary sources (Lopez 2014, KNPO and WPSI) for the period 2014–2016. Some data points are missing in the Wikipedia data (1965–2016), which were obtained from the other three sources. To address these inconsistencies, for this study we compiled different combinations of the available partial data from these four sources to create three different complete data time series (TS) for the period 1965–2019 (Table 1). For the years 2018 and 2019 the data are the same for TS-1, TS-2 and TS-3 as data for these years are only available from KNPO.

The combined plot of time series of different data sources is plotted in Figure 1a while the individual plots of time series of TS-1, TS-2 and TS-3 data are shown Figure 1b–d. The net oscillations of data (i.e. longer-term oscillations after smoothing of short-term fluctuations) show a repeating pattern, with a 32-year cycle over the period 1965–1996, followed by the onset of a second cycle. As mentioned above, the calculation by Bhardwaj and Das (2018) of the Hurst exponent (*H*) for the period 1965–2015 indicates that the rhino poaching time series is persistent in nature.

For this study we repeated this analysis for the three time series TS-1, TS-2 and TS-3. As all three time

[1]**Fractal analysis** is a contemporary method of applying non-traditional mathematics to patterns that defy understanding using traditional Euclidean concepts. In essence, it measures complexity using the **fractal** dimension: see https://en.wikipedia.org/wiki/Fractal_analysis

Table 1. Composition of TS-1, TS-2 and TS-3 time-series data. Keys to abbreviations are given in the text

Time series	Composition
TS-1	WP (1965–1971) + Lopez (1972–2012) + KNPO (2013–2019)
TS-2	WP (1965–1971) + Lopez (1972–2009) + WPSI (2010–2017) + KNPO (2018–2019)
TS-3	WP (1965–1993) + Lopez (1994–1997) + WP (1998–2006) + Lopez (2007–2012) + KNPO (2013) + WP (2014–2016) + WPSI (2017) + KNPO (2018–2019)

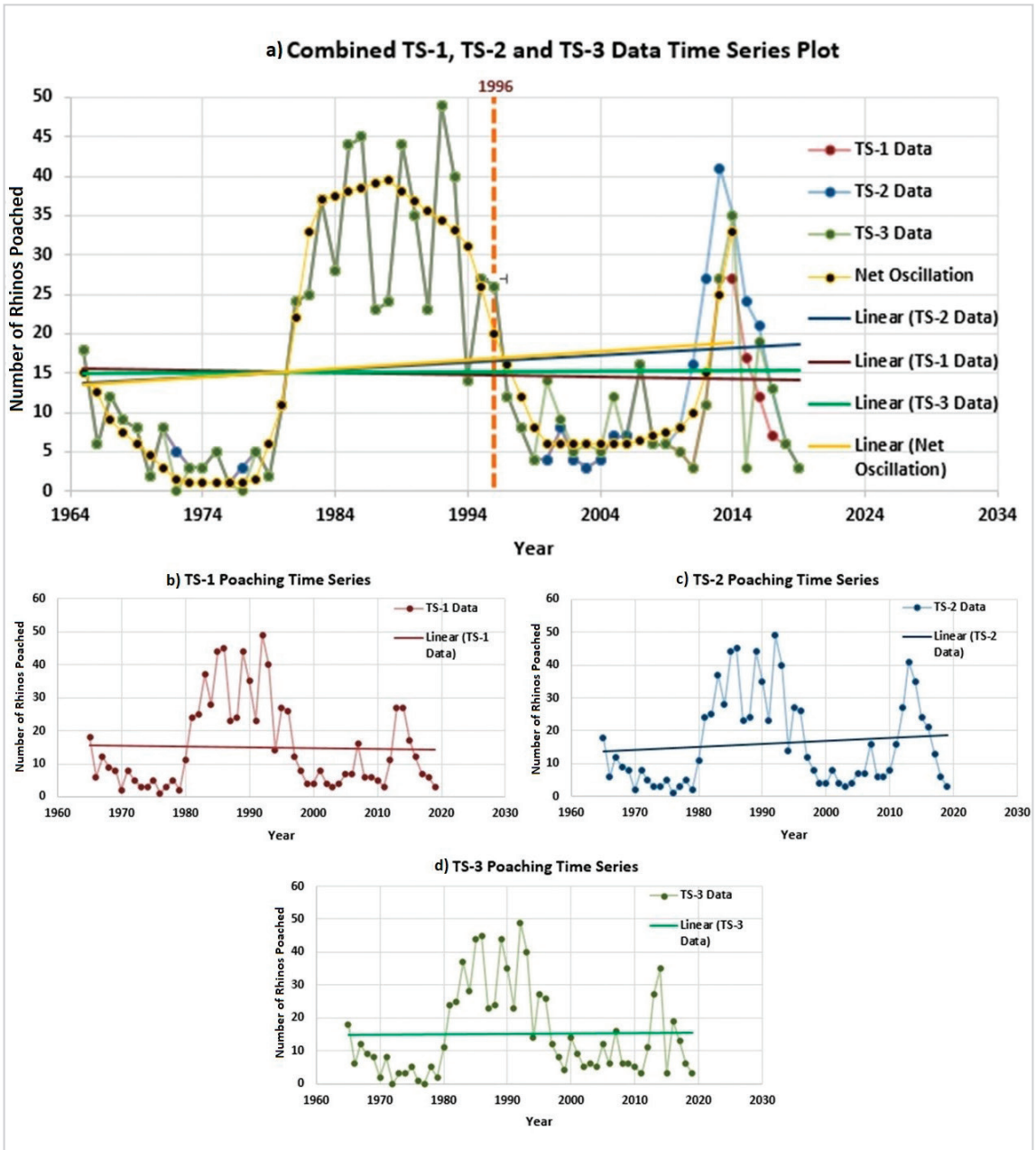

Figure 1. Time series plot of rhinoceros poaching levels in Kaziranga National Park from 1965–2019.

series show persistent behaviour with values of *H* between 0.5 and 1.0 (Table 2), indicating that the poaching levels can be predicted in future using forecasting tools, we proceeded with the application of the forecasting methods HM, HWMM and HWAM. These forecasting techniques are used as we observe cyclical behaviour alongside the long-term trend in the poaching data. While we acknowledge that one-and-a-half oscillations of a presumed 32-year cycle are insufficient to prove that there is a repeating pattern in the data, we assume it to be following a cycle because of the observed persistent nature in fractal analysis. As the data show only one-and-a-half oscillations of the net oscillation cycle, it is hard to assess the nature of a seasonal component and therefore we applied both HWMM and HWAM. For the three data series predictions, all were made for the years 2016–2019, using the data from 1965–1996 as training data and data from 1997–2015 as testing data.

Predicted data for 2016–2019 was compared to actual data, with deviations calculated as mean square error (MSE), mean absolute error (MAE) and mean absolute percentage error (MAPE) in order to determine the best method for prediction. We also compared predictions for the year 2020 with available data on poaching incidents for this year. The methodology used in the study is summarized in the schematic flowchart in Figure 2.

The average magnitude of error produced by the forecasting method is given by MAE, while MAPE provides information about the extent of deviation of forecasts from corresponding actual values. MSE is similar to MAE but when computing MSE the squares of difference between actual and forecast value are calculated before summing them up, instead of using absolute error values as in MAE. As a result of squaring the error values, outliers in the data contribute to a much higher total error in MSE compared to MAE. MSE is used to tune the smoothing parameters for improving the forecasting efficiency of the method.

Results

TS-1, TS-2 and TS-3 cover the time period 1965–2019, where 1965 is the first year and 2019 is the fifty-fifth year of the dataset $X = \{Xt\ ,\ t=1,\ 2,\ldots,\ \tau_2,\ \ldots n\}$ where $n = 55$ and τ_2 is the final year of the testing data set. Since data from period 1965–2015 is used for training and testing purposes and 2015 is the fifty-first year, $\tau_2 = 51$. Figure 1 shows a net oscillation which appears to enter a new cycle in

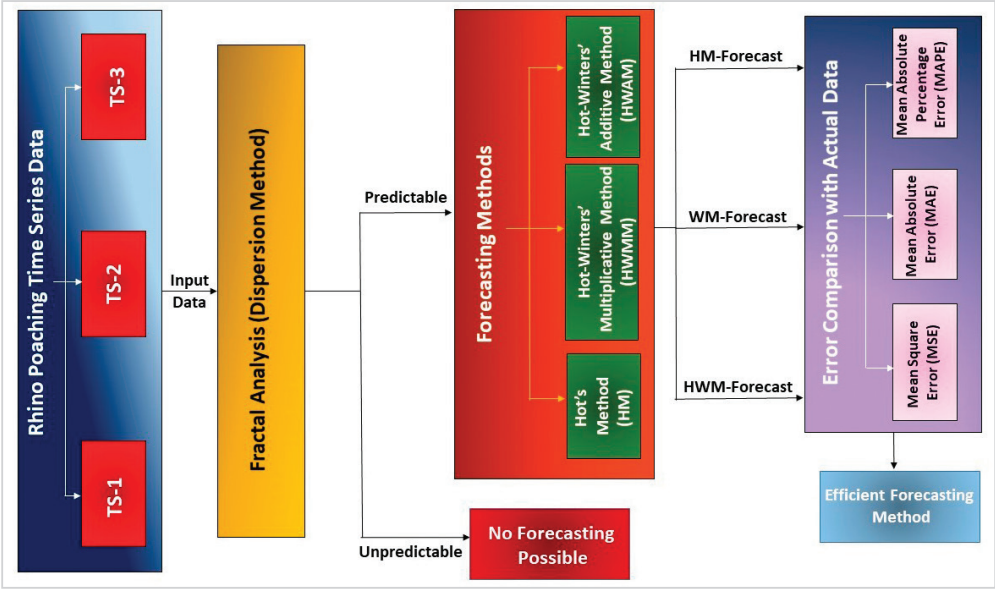

Figure 2. Schematic flowchart of the analysis.

Table 2. Hurst exponent values, the times series data of rhino poaching in Kaziranga National Park, 1965–2019

Time series	Hurst exponent (*H*)	Predictability
TS-1	0.9935	Predictable as 0.5 < H < 1.0
TS-2	0.9802	Predictable as 0.5 < H < 1.0
TS-3	0.9650	Predictable as 0.5 < H < 1.0

1996. Based on this visual analysis, the cycle duration or season period (p) is considered to be 32 years. The initial values of smoothing parameters used for forecasting are $\alpha = 0.4$, $\beta = 0.2$ and $\gamma = 0.3$. These parameters are optimized in subsequent calculations in such a way that reduces MSE to a minimum value and brings the forecasted data time series optimally in phase with the actual data[2].

Figure 3 shows the comparison plots between forecasted and actual data for the second cycle, post 1996, i.e. 1997–2019. The comparison plots for TS-1 data using the three forecasting methods are shown in panels (a)–(c), those for TS-2 in panels (d)–(f) and those for TS-3 in panels (g)–(i). Errors of all three methods calculated as MSE, MAE and MAPE are shown in panels (j), (k) and (l), respectively. For comparison, Table 3 shows values of forecasted data using the three methods against the actual values in TS-1, TS-2 and TS-3.

For the year 2020 (n + 1) no poaching data has been released yet by any of the sources considered in this study. Media outlets reported the death of two rhinos from poaching in May and August 2020[3]. Since we can find no further reports of poaching incidents in 2020, we therefore assume the actual number of poaching incidents for 2020 to be two in all the three time series. The forecasted values obtained for 2020 are compared in Table 4 and the error values are shown in Table 5.

Discussion

The results clearly show that the predictions made using the HWAM are the most accurate, compared to the other two forecasting methods. According to Tables 3 and 4, both HWMM and HWAM provide a more accurate forecast than HM. Unlike these two methods, HM does not take into account the seasonality of data (i.e. the regular oscillation frequency) and is purely regression based. This probably explains why predictions using this method were less accurate, as evidenced by higher MSE, MAE and MAPE values in comparison to HWMM and HWAM, as shown in Table 5. Furthermore, in Figure 3 (panels j–l) it can be seen that the trajectory of forecast data is much closer to actual data and there are less errors in the case of HWAM in comparison to the HWMM method. Thus the HWAM is observed to provide the most reliable forecasts, indicating the additive nature of the seasonal component in data, i.e. the seasonal variation is roughly constant throughout the considered series.

Bhardwaj and Das (2018) demonstrate that the data time series is persistent. This justifies our attempt to predict future rhino poaching trends using quality forecasting methods that account for seasonality in data time series over a net 32 year cycle. The forecast data follows the trend of actual data, showing a decline in rhino poaching in the period 2016–2019. In the case of TS-1 the forecast data for 2020 using HWMM and HWAM shows zero poaching (Table 4), which is close to the actual poaching level of just two rhino deaths as reported in the media. For both TS-2 and TS-3, year 2020 forecasts show a reduction post-2019 but they are much further from the actual value as observed in predictions for years 2016–2019 in Table 3 due to the time series composition. The forecast for TS-1 is better than TS-2 and the forecast for TS-2 is better than TS-3. Both TS-2 and TS-3 are composed of mixes of shorter data series from different sources, compared to TS-1 that is composed of three longer time series; The HWAM predictions are more accurate with higher predictability. In all cases, the HM continues to give the most erroneous forecasts.

[2]For more information on methodology see: https://otexts.com/fpp2/holt.html, https://otexts.com/fpp2/holt-winters.html and https://www.stat.ipb.ac.id/en/uploads/RA/Time%20series/Kuliah%206%20%20Metode%20Pemulusan%20Winter%20(Multiplikatif).pdf

[3]See https://www.indiatoday.in/cities/guwahati/story/assam-poachers-kill-one-horned-rhino-kaziranga-1793491-2021-04-21

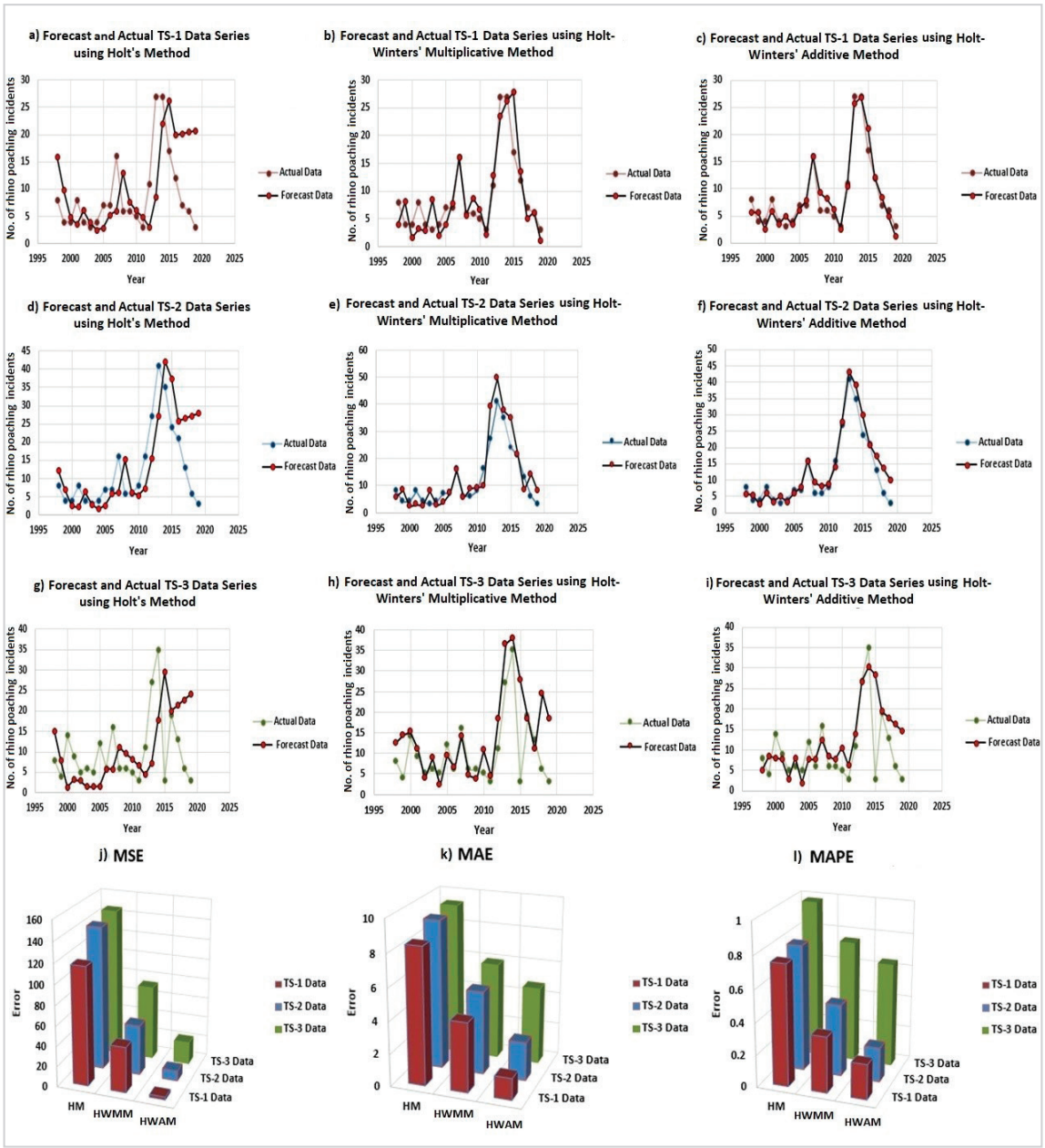

Figure 3. Comparison plot for rhinoceros poaching level forecast for the period 1997–2019.

Table 3. Comparison of forecasted and actual data for 2016–2019 period

TS	Year	Actual data	HM- forecast	HWMM-forecast	HWAM-forecast
TS-1	2016	12	19	13	12
	2017	7	20	5	8
	2018	6	20	6	5
	2019	3	21	1	1
TS-2	2016	21	26	21	21
	2017	13	26	8	17
	2018	6	27	14	13
	2019	3	28	8	10
TS-3	2016	19	20	18	19
	2017	13	21	12	17
	2018	6	23	24	16
	2019	3	24	18	14

Table 4. Comparison of forecasted data for year 2020

Year	TS	Actual data	Method		
			HM- forecast	HWMM-forecast	HWAM-forecast
2020	TS-1	2	21	0	0
	TS-2	2	29	3	6
	TS-3	2	25	11	13

Table 5. Error comparison for different forecasting methods

Method	Errors								
	MSE			MAE			MAPE		
	TS-1	TS-2	TS-3	TS-1	TS-2	TS-3	TS-1	TS-2	TS-3
HM	116.78	141.64	146.29	8.41	9.17	9.37	0.7	0.8	0.98
HWMM	44.95	49.76	73.58	4.29	5.17	5.96	0.35	0.45	0.75
HWAM	2.84	10.17	22.13	1.34	2.39	4.77	0.22	0.21	0.65

The incidence of poaching using arms intensified post-1980 and peaked in 1992 (Vigne and Martin 1994). But poaching subsided after 1996 with the introduction of improved security measures. Beyond 2020 the poaching level is predicted to remain low, with only a few incidents predicted as long as the current status quo prevails. However, it is not possible to predict the effects of external pressures in the surrounding region, such as civil unrest, political instability or Covid-19 induced poverty (i.e. loss of employment and income from tourism motivating a return to poaching). Lopez (2014) models the relationship between rhino poaching in KNP and civil unrest and obtains a good match between estimated and real data. As long as the current situation prevails the incidence of poaching may be expected to remain low; but if any change in the status quo occurs then poaching may rise once again, similar to the increase post-1980 when the poachers changed their tactics from using pits to using arms, taking advantage of the availability of guns due to political disturbance in the

State (Vigne and Martin 1994).

Assuming that poaching levels remain low until the end of the present 32-year period—which started in 1997 and ends in 2028—it is worth noting that the decline in the poaching level began earlier in the second cycle, compared with the previous 32-year period. This highlights the effectiveness of strengthened conservation measures. We recommend the use of drones for monitoring purposes and to target rhino poachers in bringing down poaching levels. Moreover, if the poaching level declines earlier in the second cycle than in the first cycle as predicted, then the decline in the third cycle can be expected to be even faster (should the status quo prevail). All these predictions are only reliable and the forecasting methods effective while the time series data continues to display the same properties of persistence and a constant frequency of oscillation. If these conditions are not met, then the forecasting methods considered in this study will not be able to predict future patterns accurately.

Conclusion

This study applies three forecasting methods, namely HM, HWMM and HWAM, to predict poaching levels of GOH in KNP. The data for the GOH poaching levels in the period 1965–2019 were obtained from KNPO, WPSI, WP and Lopez (2014). As there are discrepancies in the data from different sources, and no source contains a complete dataset, for the purposes of this study we complied three data series, TS-1, TS-2 and TS-3, composed of different combinations of data from the four sources. We applied the forecasting methods to obtain predictions for poaching levels in 2016–2019 and compared the predictions with actual reported values. For all three time series, the HWAM gave the most accurate predictions. The HWAM is superior to HM since its predictions incorporate the effects of seasonality. The predictions of the HWAM also follow the actual data trajectory more closely than the HWMM method, indicating that the seasonal variation in data is roughly constant over the time series. It is also observed that the predictions are more accurate for TS-1 which has fewer component partial data sets compared to the other two data series. It is important to further note that the fluctuations in data are a result of changes in the status quo and the one-and-a-half cycles of the net oscillation in the data are not sufficient to be absolutely certain about the pattern repetition observed in the available data. It should be emphasized that if in the future, rhino poaching trends at KNP change, all forecasting methods will provide erroneous predictions. Forecasting will also be impossible if the data loses its periodicity. For data time series of events which display seasonality and persistence, like rhino poaching incidents at KNP to date, the paper highlights the potential of forecasting methods to predict future poaching trends and thereby aid in the design and implementation of appropriate conservation measures. The limitations of a study comparing forecast methods is that predictions of future events are not entirely possible, due to unforeseeable circumstances.

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Pathology in elephant dentition—two addenda

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Additional Keywords: abscesses, molars, lower jaw.

Mots clés supplémentaires: abcès, molaires, mâchoire inférieure.

Parker (2017)* described a pathological condition of molar/alveola abscesses in elephants (*Loxodonta africana*). Instances cited were 84 in Uganda—all in Murchison Falls National Park (NP)—four single cases from different elephant groups in Kenya and one from Zimbabwe. This note extends those observations to a further six cases from central Mkomasi[1] National Park (then Game Reserve), Tanzania, that were overlooked at the time. The material was obtained during animals culled in 1969 and as described in Parker (2017). They are presented in Table 1.

No cases were seen in a similar cull of 300 elephants in Mkomasi East in 1968, and only one in 300 taken in Tsavo East National Park in 1966. The three groups—Mkomasi Central, Mkomasi East and Tsavo (Koito) were then considered to be three of the ten 'populations' occurring in the Tsavo ecosystem (Laws 2014).

The caries and associated alveola abscesses in Parker (2017) were only reported from lower jaws. Overlooked was a single left upper jaw instance of four cavities in M6 exposing the tooth pulp in a 45-year-old male (GMU1395).

Answering an editorial question of whether there were any signs of discomfort associated with the jaw abscesses, none were observed. All the evidence was post-mortem so behaviour in living elephants was not observed. The severity of the condition might reasonably be associated with pain, and in cases where they were mono-lateral this might favour the diseased ramus and produce greater wear in the opposing healthy jaw. Contrary to expectations, there appeared to be little imbalance in the normal wear between both rami and little interruption of the molars' forward progression. On this basis the condition did not seem to be causing discomfort.

A further expectation was that if the condition caused pain, it might reduce food intake and loss of weight. See Table 2, for cases of abscessed animals' live weights available for comparison. The seven animals live weights fell within the weight-at-age scatters of live weights given in Laws et al. (1975), but are too few to confirm or reject the possibility.

The records were searched for evidence that deficiencies of either phosphorus or calcium might be associated with jaw abscesses. A single case in which serum from an abscessed animal was available for comparison with a range of serum samples from elephants without the disease is given in Table 3. Again, the only conclusion is that both P and Ca levels fell within the ranges of animals without the disease.

The incidence of molar/alveola abscesses in Mkomasi Central extends what is known about the incidence of this condition. Subjectively evidence from all cases reported here and in Parker (2017) did not appear to disrupt normal molar replacement or create imbalance between its progression between the two rami. This suggests that they do not cause pain sufficient to induce imbalanced wear between rami. The aetiology of the molar/alveola abscesses as a 'relatively common and widespread' aspect

[1]Author's note: the etymology of Mkomas(z)i derives from *mkoma*—the doum palm, hence the preferred use of spelling Mkomasi

*See Parker. 2017. *Pachyderm*; Vol. 58: pp. 51-57 *https://pachydermjournal.org/index.php/pachyderm/article/view/417/419*

of elephant biology invites further research, especially the correlation of nutrition and pathological dental conditions among zoo elephants".

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Table 1. Six cases of jaw abscesses from Mkomasi Central

Serial number	Age in years	Sex M = male F = female
WLS 379	32	F
WLS 422	17	M
WLS 425	48	F
WLS 505	6	M
WLS 534	27	M
WLS 580	11	M

Table 2. Live weights from seven elephants with abscessed jaws compared to the average live weights of five elephants of the same sex and age without abscesses

Abscess cases Live weights kg		Average live weight of five samples live weight kg with range of weights	Weight of abscessed cases as a % of average of sample weights
male 6 y	1,089	1,004 (range = 800–1,268)	+ 8%
male 17 y	2,411	3,054 (range = 2,010–4,018)	-21%
male 24 y	3,400	3,442 (range = 3,080–3,740)	- 1%
male 27 y	5,750	4,488 (range = 4,010–5,179)	+ 28%
female 32 y	2,625	2,520 (range = 2,090–2,800)	+ 4%
female 41 y	2,020	2,613 (range = 2,430–2,690)	-23%
female 48 y	2,196	2,637 (range = 2,375–2,768)	-17%

Table 3. A comparison of p and Ca levels in the serum of an abscessed elephant with larger serum samples from those without the condition

	P in mm/100ml serum sample n = 50	Ca in mm/100 ml Serum sample n = 28
Range of samples mm/100 ml	3.00 –10.64	9.10 – 17.98
1 abscess case	4.74	12.38

Not so solitary? White rhinos seek company when relaxed

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Introduction

White rhinoceros (*Ceratotherium simum simum*) have been classified as "semi-social" as they often form groups or temporary aggregations of two to six individuals (Owen-Smith 1975; Patton et al. 2016; Pienaar 1994; Shrader and Owen-Smith 2002). Social behaviours such as grazing, and/or walking together and lying side by side, rubbing their head and body (sides) on another rhino and making panting contact calls, have been described in other studies (Owen-Smith 1975; Jenikejew et al. 2020). Playful behaviour such as horn wrestling has also been observed before in white rhinos (Owen-Smith 1975; Cinková and Bičík 2013).

Our field research in Botswana supports findings about the sociability of white rhinos and adds the observation of a calf suckling from a female that was not her biological mother, to the spectrum of social interactions between rhinos.

We observed one to three adult rhinos per day over a period of 60 days between March and May 2020. During the observation, we focused on one individual, hereafter called the "focal rhino", and videorecorded it for 30 minutes. We identified the rhinos through their individual ear notches and observed them in semi-randomized order at different times of the day. For each observation, we noted the number of individuals in a group at the same location. There was potential for more than eight adults to meet in the reserve (the total numbers of individuals are withheld for security reasons). Furthermore, the rhinos were dehorned after 30 days, and we were able to monitor whether dehorning had an effect on the group sizes.

Results

The focal rhinos often moved together with other rhinos, and we observed groups of two to four adults at the same place (Table 1). The number of individuals at the same location did not depend on the time of the day (Fig. 1).

All adult females had calves (younger than two years) and were often found grazing in the vicinity with other mothers while the calves played together (Fig. 2 and 3).

The adult bulls often joined females to socialize. Whether the females were in oestrus or not was not noted for this study. For example, there was a bull resting for several hours together with two mothers and their calves in the morning (Fig. 4). On other occasions, the bulls played with the calves or tried to mate with the females.

We observed a calf suckling from the mother of another calf after they had played together on at least one occasion. Due to the position of the rhinos to the research vehicle and related poor visibility, this cannot be confirmed for all observations, but it is clearly visible on one video recording (Fig. 5).

Over the last year of monitoring in the reserve, there had also been an observation of a six-month-old calf that had been separated from its mother. The reason for the separation was most likely caused by a bull chasing the calf away to mate with the female. The calf accompanied another female and her calf for about two days until its own mother found it again (Fig. 6).

To avert poaching, all rhinos were dehorned after one month of our field research in a two-day-operation. We surmise that the operation was stressful for the rhinos because they were chased with vehicles before being darted and anaesthetized. We observed only single rhinos or mother-calf pairs for six days after the operation concluded (Fig. 7). From the eighth day on,

Table 1. Number of observations of maximum group sizes of adult individuals (calves not counted) during a period of 60 days

Maximum group size (adult rhinos observed at the same location)	Number of observations
1	10
2	20
3	7
4	5

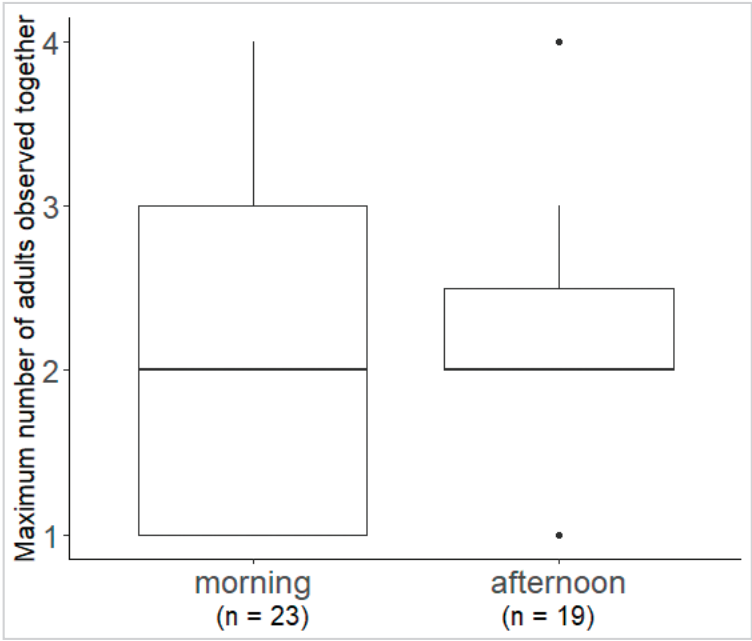

Figure 1. Boxplots of group sizes of adult rhinos comparing morning and afternoon observations. The thick middle line represents the median; thin lines of the boxes are upper and lower quartiles; points and whiskers show observations outside the quartiles, n indicates the number of observations.

Figure 2. Observation of two adult female white rhinos at the same location and their male and female calves playing. Photo: V. Pfannerstill.

Figure 3. Two adult females and their female calves at the same location playing together; the females had also shown playful horn wrestling without aggressive vocalizations. Photo: V. Pfannerstill.

Figure 4. One adult male, two adult females and their calves resting together at the same location in the morning. Photo: V. Pfannerstill.

Figure 5. From left to right: male calf, his mother, female calf, her mother. The female calf lying on the ground had been drinking from the female on the left, although her biological mother is the rhino on the right. The male calf had at this time been playing with the female on the right, but then came up to his mother and started to whine loudly to be able to suckle as well. Photo: V. Pfannerstill.

Figure 6. The calf on the right had been separated from its mother and stayed with the female on the left and her calf (middle) for about two days. Photo: OS. Maboga.

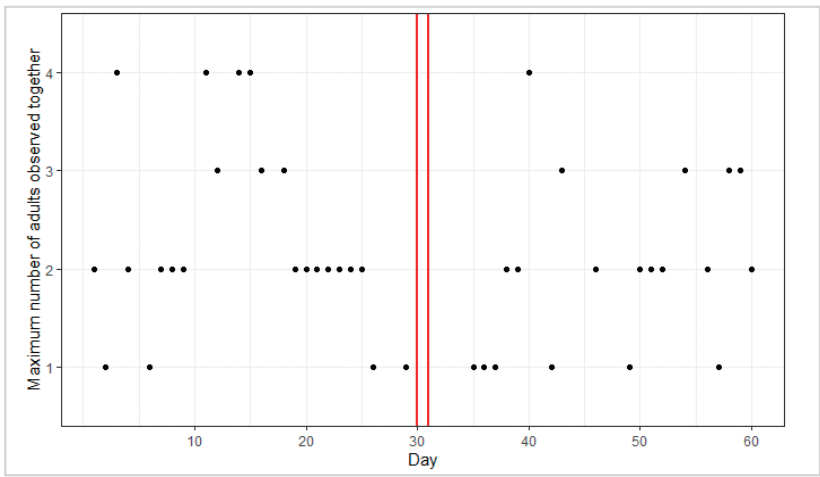

Figure 7. Maximum number of adult rhinos observed in a group at the same location per day over a period of 60 days. Red lines indicate the dehorning event on day 30 and 31.

Figure 8. Group of four adults and three calves observed together at the same location nine days after dehorning. Photo: V. Pfannerstill.

we observed pairing again and on the tenth day a group of four adults congregated at the same place (seven individuals altogether including the calves, Fig. 8).

These observations suggest that when rhinos are stressed, they flee on their own, perhaps even hiding and remaining solitary until the danger has passed; and they came together in groups when they feel safe and are relaxed. Groupings of different individuals every day seem to show that all rhinos in the reserve know each other well and enjoy the company of other rhinos. We encourage further study on social pattern changes caused by darting/dehorning operations and on dispersal triggers.

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A rudimentary assessment of rhinoceros horn regrowth in Africa based on photographs

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Introduction

Calves of all rhino species are born without horns. The anterior front horn starts to grow first followed by the posterior horn from about six months. The horn grows throughout the life of the rhino but is reshaped and influenced by use; namely from fighting, being rubbed on hard surfaces and by natural breakage.

Wallach (1969) described a female white rhino calf with a front horn of 2.54 cm at two months and 6.3 cm at five months old. Bigalke (1950) recorded a female white rhino with a horn of 5.6 cm long at 12 months and 8.2 cm at 18 months. Player (1967) recorded a 12-month old male with an anterior horn of 15.24 cm and an 18-month old female with a horn of 21 cm. A 30-month old female's horn grew 10.2 cm from 12 months old, and the front horn of a 34-month male rhino grew to 7.6 cm by 12 months.

The annual growth rate of the anterior horn seems to decrease with age from around 6 cm/year in young adults and around 4cm/year in old adult animals (Cunningham and Berger 1994). A captive female white rhino showed a growth rate of around 6 cm/year (front horn) and 1.5 cm/year (rear horn) between four and eight years of age while a male, from five to nine years of age, showed front horn growth of 5 cm/year and rear horn 2 cm/year (Klös 1969).

Horn regeneration after natural loss

Apart from fighting and wear and tear, occasionally, horns have been known to split down their length and eventually the thin weak parts break off (from personal observation in May 2009 and June 2010). The cause for the splitting is unknown but it is speculated that it could be a consequence of inadequate nutrition on which more research is needed.

The measurement of the regeneration of the anterior horn of a 14-year old captive female black rhino after natural loss was reported in Bigalke (1946). The horn which was shed was found to weigh 4.2 kg and its measurements taken with a tape measure were: measurement along the median line of the anterior surface, 57 cm; measurement along the median line of the posterior surface, 51 cm.

After nine years of growth the regenerated horn was still 4.4 cm short anteriorly and 1.3 cm posteriorly of the measurements of the shed horn. It was deduced that approximately ten years of growth were necessary for the new horn to attain the length of the original shed horn.

Pienaar et al. (1991) noted that the horns of both black (Bigalke, 1946) and white rhinos (Klös, 1969), appear to grow back faster in the first year than in subsequent years after horn loss—front 11cm and 10 cm.

Horn regeneration after invasive loss

Rhino "dehorning" involves the removal of most of the anterior and posterior horns of a rhino through artificial means. Dehorning is usually undertaken to make the rhino less of a target of potential poaching for the illegal wildlife trade or, for certain males to prevent serious injury during fighting for dominance. Removal is usually carried out using a chainsaw or a handsaw leaving just a small stump at the base of the horn to ensure the horn plate is not damaged and from which regrowth will occur. Dehorning is estimated to result in the removal of 90% and 93% of the mass of horns in male and female white rhinos respectively (Kock and Atkinson 1993). The rate of re-growth of

horns after dehorning is similar for both black and white rhinos (Lindsey and Taylor, 2011).

Pienaar et al. (1991) recorded an average of 5.5cm growth per year for the anterior horn, obtained by measuring the movement of a microchip from the horn base annually, in six wild adult white rhinos. Older adult rhinos showed slower horn growth rates than younger rhinos, while horn growth was found to be more rapid in the first year after loss, than subsequent years.

The horn growth of two young, dehorned black rhinos which were translocated in Namibia were approx. 7–8 cm/year for the front horn and about 5 cm/year for the back horn (Morkel and Geldenhuys 1993). Horn regrowth in old animals also appeared to be slower than in younger animals. Accelerated annual horn growth can result in having to repeat the procedure by trimming every two to four years for dehorning to be a deterrent.

According to Kock (1993; Kock 1994), approximately one year after seven females and seven male white rhinos were dehorned in Hwange, Zimbabwe 1991, the horns had grown on average 6.9 cm for the front horn (males 6.8 and females 7.0) and 2.9 cm for the rear horn (males 3.4 and females 2.5).

The re-growth of dehorned rhinos appeared to be slightly faster than horn growth in non-dehorned rhinos. Male white rhinos re-grew horn mass at a rate which is almost twice that of females. Female white rhinos reached a peak in horn regeneration at eight years, whereas the mass of horn regenerated by males approaches an asymptote slowly at >30 years of age (Rachlow and Berger 1997).

As can be seen, there is a paucity of information on how horns develop over a rhinoceros's lifespan. It is possible, with the human eye, to see changes in horn length of a rhino from photographs taken at different ages. The question is, can these changes be accurately quantified by measuring photographs using simple methodology?

Methodology

Head profile photographs of the Ziwa Rhino Sanctuary (ZRS) population were accessed from those taken for annual Master Identification (ID) files of two databases collated between 2005 and 2020. ID photographs require a clear profile view to be taken as close to right angles to the head as possible. The ID photographs are cropped so that only the head remained from the back of the ears to the front of the mouth and with both horns fully visible.

For the purposes of the analysis, the photographs were placed on the same horizontal plane by using the rotate facility in PaintShop Pro 9i software. A line between the eye and the front base of the anterior horn was used to create the horizontal aspect. The revised photographs were then cropped and saved so that only the head remained from the back of the ears to the front of the mouth and with both horns fully visible. These were further adjusted to a standard length of 3 cm between the eye and the front base of the anterior horn. This allowed for comparative measurements of two-dimensional hard copies to be made.

After trial and error, a measurement system using a ruler and the naked eye was chosen as being the simplest and most easily applied by anyone in the field. Individual measurements were taken for a mid-line of a horn from its base to its tip to represent the length.

Parallax affects measurements from photographs meaning detailed comparison of individual measurements are inappropriate. To overcome the inaccuracies caused by parallax, percentage growth rates were determined from individual measurements and placed in five classes:

A = 0 to10%; B = 11 to 30%; C = 31 to 59%; D = 60 to 89%; E = 90 to 100%

In order to illustrate the regrowth of horns, either removed naturally or by dehorning, the standardized photographs were printed out and re-growing horns traced onto tracing paper. The tracings were overlaid such that a single tracing could be made showing each growth stage.

The tracings were scanned in order to obtain each one as a jpg which was then imported into GIS using a Universal Transverse Mercator (UTM) reference system. This enabled shape files of each of the growth rings of the horn to be created. Outlines of each shape file could then be measured and presented as percentages of the final horn shape.

Two white rhinos—an adult female and a young male—were subject to veterinary intervention which enabled their horn lengths to be measured physically

Table 1. Percentage of horn growth for seven white rhinos from 1-14 years of age

Population 1			Population 2				
Age	%rear	%front	Age	%rear	% of final length	%front	% of final length
1			5		60		56
2	D	C	6	B	69	A	58
3	B	B	7	A	71	A	64
4	B	B	8	A	74	A	70
5	A	A	9	A	81	A	71
6	A	A	10	A	87	B	80
			11	A	93	A	86
			12	A	96	A	91
			13	A	96	A	93
			14	A	100	A	100

Note: Population 1 rhinos are 1-6 years, population 2 rhinos are 5-14 years.

Table 2. Percentage horn growth of three adult female white rhinos

Year	% increase rear	% increase front	Percentage of final length	
			%rear	%front
1	A	A	65	71
2	A	A	71	73
3	A	A	77	75
4	A	A	83	77
5	A	A	85	79
6	A	A	88	80
7	A	A	92	83
8	A	B	98	87
9	A	A	100	100

Note: the adult rhinos were believed to be around 15 years old in year 1.

and compared with photo records, on the same basis as used for the photographs (along a mid-line of the horn from the base to the tip). Up-to-date profile photographs were taken. By referring to previously taken annual photos it could be seen that the male had been dehorned in 2015 and the female had broken her front horn at the weak point where a transmitter had been fitted in 2010. It was, therefore, possible to estimate their horn re-growth rate over the relevant periods.

Results

How a rhino horn develops from birth to 15 years of age is illustrated in Figure 1. The photographs used to create the illustration were used to obtain comparative horn length measurements for the analysis (see Table 1).

Table 1 shows an estimate of the rate of growth of rhino horn from birth to age 15 years. The first six years are from one population at the ZRS and then from five years to 15 years old from another East African population. For the population starting at five years old there is a column (% increase in length) which compares the length at each year as a percentage of the length of the final year which, at 14 years is considered mature.

Percentage growth increases are greatest in the early years of the life of a rhino for both anterior and posterior horns but from around five years of age, the

annual growth rate is below 10%. Between year one and two, the growth rate was over 50%.

At five years old, both horns were over 50% of the length of the mature horn (14 years) (anterior 56%, posterior 60%) while the annual incremental increase was mostly less than 10%.

How horns develop in older rhinos, from 15 years old, is considered in Table 2 which shows the incremental increase in horn growth for three females believed to be around 15 years old at the start of the study. All nine annual increases for both horns were less than 10%, apart from one for the anterior horn at 15.2%. This demonstrates that the horns continue to grow through to an age of 24 years (± 20 years).

Only one study could be found which contained photographs and measurements of the development of rhino horns and to which the measurement system could be applied. Table 3 is the analysis of the actual measurements taken of the regeneration of an anterior horn of a captive black rhino in South Africa over a 10-year period. The average growth per year was 5.3 cm being annually slightly more in the early years, consistent in the mid years and growing less in the later years. This is also represented in the proportion of the final length reached with the first year's increase, around 20% of the final length and the remaining yearly increases of around 10%.

The regrowth of horns lost due to natural causes was analysed from photographs of two adult white rhinos (see Table 4). The percentage of anterior horn regeneration after natural horn loss for the two rhinos—an older male and a younger female (illustrated in figure 2, drawing 4) —shows a larger initial increase in growth followed by erratic incremental growth.

The percentage posterior horn regeneration after natural horn loss was analysed for three adult white rhinos. The results are illustrated in figure 2, drawings 1, 2 and 3, and presented in Table 5 as a percentage of the final length and the final area. Both follow a similar pattern to that found with the anterior horns in Table 4 of a large annual initial new growth which tapers down during the following years, although the time gaps are not uniform.

The rate at which horn grew back was estimated from photographs for three white rhino adult males (see Table 6 and illustration in figure 2: Taleo, Moja and Hassani).

The pattern of regeneration of both horns, although not uniform, again shows a general trend from higher incremental percentage growth after dehorning, tapering to smaller incremental percentage growth for both length and area measurements. The photograph data also show several months with little or no growth recorded after the initial spurt.

Discussion

There is little detailed research published on the rate of re-growth of rhino horns when removed either naturally or artificially. This paper attempted to gain some further insight by using measurements from photographs.

An attempt was made, using the methodology reported above and the details published in Bigalke (1946), to determine whether it was possible to calculate actual horn growth lengths from horn measurements taken from photographs. The five photographs published in Bigalke appear to be taken at right angles and the photographs could be standardised to the same size using the distance between the rear of the posterior horn and the front of the anterior horn. However, the length measurements obtained bore no resemblance or consistency with the actual lengths as published. Even a small amount of parallax and differences in focal distance clearly affects the measurements and cannot be corrected by simple photo manipulation.

The analysis of the photo measurements of the anesthetised, 20-year old, adult female white rhino in relation to the known actual final measurements showed its front horn length had grown at around 2.75 cm per year over a 10 year period. This single result differs markedly from the 5.5cm per year recorded in Pienaar et al. (1991) although it was reported that horn growth was found to slow as the rhinos aged.

The anesthetised dehorned young male white rhinos' rear horn had grown 2cm per year and front horn 7cm per year since dehorning over a 5-year period. This compares with the results of Kock (1993, 1994) of 3.4cm for the rear horn and 6.8cm for the front horn after one year of growth.

While published data on the amount of horn growth suggests consistency of growth in length/year, the data produced from the photographs suggest that growth is not at all consistent.

Table 3. Length of growth of a regenerating anterior horn of a captive adult black rhino (Bigalke 1946)

Date (month/year)	Length (cm)	Average growth per year (cm/yr)	% Increase in length
10/1928	0.00	7.9	0
04/1929	6.35		
08/1929	8.89		17
02/1930	12.95		
06/1930	14.10		
10/1930	15.87		30
10/1930	15.87	5.3	
07/1931	20.00		
04/1932	22.86		
02/1933	26.35		
10/1933	31.75		60
10/1933	31.75	5.1	
10/1934	36.83		70
10/1934	36.83	5.1	
04/1935	39.43		
10/1935	41.91		79
10/1935	41.91	5.7	
04/1936	45.10		
10/1936	47.62		90
10/1936	47.62	3.2	
10/1937	50.80		96
10/1937	50.80	2.2	
10/1938	53.00		100
		10 yrs = 5.3cm/yr	

Table 4. Percentage anterior horn regeneration after natural horn loss for two adult white rhinos

ADULT MALE			ADULT FEMALE		
Time gap	New growth	% Final length	Time gap	New growth	% Final length
4m	E+	25	12m	E+	18
12m	D	43	11m	B	38
12m	B	50	17m	C	46
12m	D	82	8m	A	63
11m	B	100	11m	C	65
			12m	A	90
			9m	A	100

Table 5. Percentage posterior horn regeneration after natural horn loss for three adult white rhinos

ADULT FEMALE 1				ADULT FEMALE 2				ADULT FEMALE 3			
Time gap	New growth	% Final length	% Final area	Time gap	New growth	% Final length	% Final area	Time gap	New growth	% Final length	% Final area
11m	C	37	21	13m	D	29	21	12m	B	18	
15m	B	43	26	12m	B	50	42	11m	B	38	
13m	B	49		11m	B	57		17m	C	46	46
12m	B	56		17m	B	71	54	8m	A	63	57
11m	B	62		8m	A	86		11m	C	65	
17m	A	68	57	11m	A	93		12m	A	90	90
8m	A	74		12m	A	100	100	9m	A	100	100
11m	A	77	61								
12m	A	80									
6m	A	86									
4m	A	100	100								

Table 6. Horn regeneration by three adult male white rhinos following dehorning

Approx age	Rear Moja	Time gap	% Final length	% Final area	Rear Taleo	Time gap	% Final length	% Final area	Rear Hassani	Time gap	% Final length	% Final area
15			32				37				40	
16	D	10m	55	40	D	8m	60	52	C	10m	57	55
17	B	13m	63	72	B	12m	67	79	B	17m	67	55
18	C	12m	71	72	C	15m	90	79	A	10m	70	80
19	A	11m	91	86	A	11m	97	100	A	11m	73	80
20	A	11m	100	100	A	11m	100	100	C	11m	100	100
approx age	**front Moja**	**time gap**	**% final length**	**% final area**	**front Taleo**	**time gap**	**% final length**	**% final area**	**front Hassani**	**time gap**	**% final length**	**% final area**
15			26				34				22	
16	D	10m	48	40	B	8m	44	58	D	10m	41	44
17	C	13m	68	73	C	12m	62	70	C	17m	59	69
18	A	12m	74	73	B	15m	78	85	B	10m	65	69
19	A	11m	81	87	A	11m	84	96	B	11m	76	95
20	B	11m	100	100	B	11m	100	100	C	11m	100	100

With small sample sizes, imprecise photography and rudimentary measuring techniques, the data was collected and analysed in order to determine if there were trends that could be elicited and what those trends were in order to guide managers. It is not meant to be and is not presented as a scientific, statistically analysed treatise, but is hoped might encourage more published research work.

Lastly, due to the paucity of information available on how horns develop over years for the different species and the effect of nutrition in particular on growth rates, further comparative studies in different countries are encouraged.

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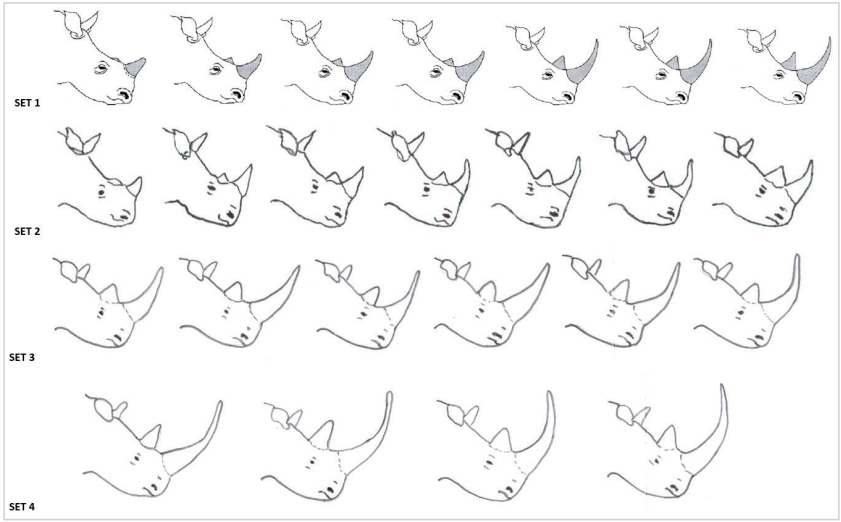

Figure 1. Natural horn growth as a rhino ages.
Set 1 is taken from the Monitoring African Rhino Trainee's Guide (Adcock and Emslie 2007).
Set 2 is taken from photographs of a wild population taken at 1 year, 2 years, 3 years, 3.5 years, 4 years, 5 years and 6 years old to compare with those of the advisory Set 1.
Set 3 is taken from photographs of a wild population taken at 5 years, 6 years, 7 years, 8 years, 9 years, and 10 years old.
Set 4 continues from Set 3 for 11 years, 12 years, 13 years and 14 years old.

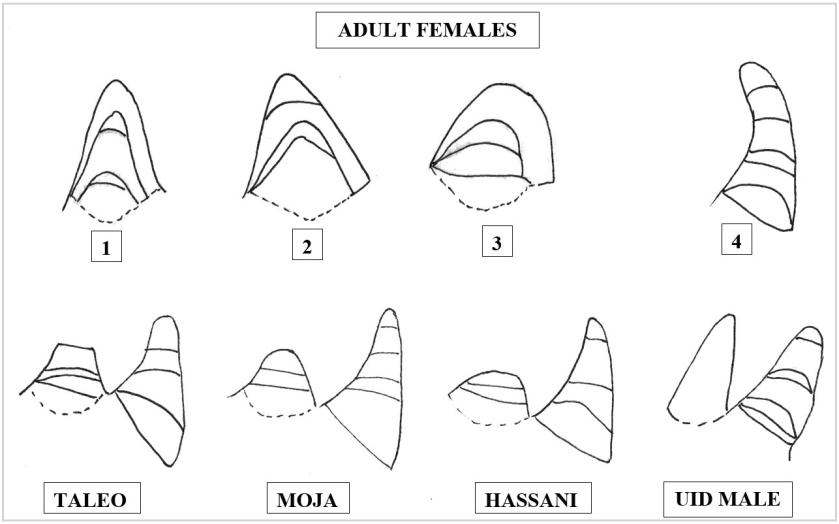

Figure 2. Horn regrowth from natural or artificial dehorning.
Drawings 1, 2 and 3 illustrate approximate annual horn regrowth for posterior horns from three adult females.
Drawing 4 is the anterior horn of one adult female who lost her horn naturally.
Drawings Taleo, Moja and Hassani illustrate approximate annual horn regrowth following dehorning for three adult males while the drawing UID male illustrates the approximate annual horn regrowth following natural loss.
The analysis of the photo measurements of the two anesthetized rhinos in relation to the known actual final measurements showed that the adult female front horn length had grown at around 2.75 cm per year between 2010 and 2021. The young male's rear horn had grown 2 cm per year and front horn 7 cm per year since dehorning in 2015.

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REVIEW

The World As It Once Was
Wildlife Has Never Been More Gloriously Shown Before

George Dian Balan

Reviewed by Kees Rookmaaker

Hon. Editor of the Rhino Section of Pachyderm
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White rhinoceros from *The World As It Once Was*; p.97. © George Dian Balan.

This is a large book about large animals. Perhaps an eclectic mix with lions, bison, mega-beetles all vying for space with elephants and rhinos. Dian Balan is a fine art wildlife photographer as well as a passionate conservationist. *The World As It Once Was* is a book full of photographs each occupying a full page, with explanatory text on the spread opposite. Definitely stunning examples of the animal world as some lucky travellers and artists could still see wildlife in my lifetime. These photographs were taken by an impressive series of dedicated men and women who must have spent many hours in remote corners of the earth to capture on camera a rare set of images of a world that once was. It is not necessarily a world that is entirely in the past. There remains hope that iconic individuals shown here might be born again later in this century. When it comes to the elephants (both Asian and African) and

the rhinos (all African), the text and pictures are definitely about size. Animals with 'plough the earth' long tusks and horns 'pointing to the skies' are put into special focus.

I was intrigued by the photograph of a black rhino with a 15–cm third horn on the forehead (p. 80). Balan has done his homework well and the text has some fascinating insights. Sometimes we like to know more, for instance when he says (p. 90) that he knows 20 horns over 90 cm from photographic evidence not yet recorded. Maybe some of this type of information will be shared elsewhere. There are pictures of the famous long-horned black rhinos of Amboseli in the 1970s, here called No.1 and No. 2 instead of *Gertie* and *Gladys*. They remind us of their special attraction to tourists and zoologists alike. In those days, these were the animals that we all wanted to see, and lucky were the privileged ones who made the journey and could obtain their simple snap. The record horn for a black rhino in the *Records of Big Game* of 136 cm, was one attributed to KV Paynter. I once tried to locate the specimen, somewhere in the USA, without success. Like the 159 cm long horn of Roualeyn Gordon Cumming, it has disappeared, possibly poached or pilvered in their immortal state. The front cover of volume 62 is also from *The World as it Once Was*, reproduced by kind favour of George Dian Balan.

There are many examples throughout this book of individual animals which were the pride of their species. Not only pachyderms, also some amazing individuals of black maned lions, wild pigs, deer, antelopes, and from all continents. This is a great visual treat to peruse and to marvel. The author is a conservationist and he explains his vision for sustained protection. He expands on the reasons why he feels that all trophy hunting, probably all hunting, should be banned forever. His is not a scientific treatise, but certainly a plea that is worth listening to. The text in this book might remain undervalued as there are so many beautiful, great, well-chosen photographs which will grab our attention first. This is a coffee-table book with a message, and one which we should discuss and take forward.

Published by George Dian Balan and printed by Graphius, 2020.

The book can be obtained directly from the author (dian.balan@gmail.com), who ships worldwide, or can be ordered on Amazon for readers based in the UK.

Hardback, pp. 1-286, size 30x24x4 cm
ISBN 978-2-8052-0590-3

Mega Mammals in Ancient India
Rhinos, Tigers & Elephants

Shibani Bose

Notice by Kees Rookmaaker

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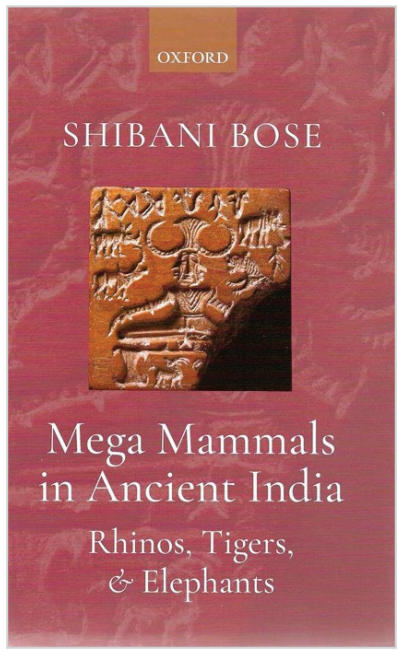
For those interested in the rhinoceros and elephant in an Indian environment, this book by Shibani Bose will open up the world of antiquity. She has assembled a large body of literature and provides an edited summary of what is known about faunal remains and visual depictions from archaeological sites. This is especially useful for western scholars who may not always have easy access to the growing literature published in South Asia. The book also discusses what has been written about rhinoceroses, elephants and tigers in the ancient Sanskrit, Pali and Pakrit accounts, which will appeal mainly to Indologists. These species were all once found much further to the west, in Gujarat, Rajasthan and Pakistan, indicating changes in habitat, increased human population pressure or climate change over the past two millennia. Bose makes a brave attempt to understand the complexities of past theories of archaeology about the dating of the various remains and provides a useful overview. The book is published as a nice hardback or is otherwise available as an e-book without loss of data.

Published by Oxford University Press, 2020.

Hardback, pp. i-xix, 1-361, 53 figures
£44.99
ISBN 978-0-19-012041-2 or 978-0-19-909987-0 (e-book)



CONSERVATION UPDATES FROM OUR DONORS

Fighting for their survival: The International Rhino Foundation ensures the survival of rhinos through strategic partnerships, targeted protection, and scientifically sound interventions

Christopher Whitlatch

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email: c.whitlatch@rhinos.org

The International Rhino Foundation (IRF), based in the United States operates on-the-ground programmes in Africa and Asia where rhinos live in the wild, supporting viable populations of the five remaining rhino species and the communities that coexist with them.

Through grants and field programmes, IRF has funded rhino conservation efforts in 10 countries, focusing on scientific research, anti-poaching, habitat conservation, captive breeding, environmental education, and demand reduction strategies. Over the last decade more than $20 million has been invested in rhino conservation.

The organization was founded by concerned individuals in response to intense poaching of Zimbabwe's black rhinos in the early 1990s. IRF with supporters and partners helped to virtually eliminate the threat and stabilize the population there. To this day, we support conservation programmes in Zimbabwe and IRF has expanded to support all five species of rhinos.

IRF prioritizes collaboration. Through a network of hundreds of conservation organizations, private foundations, corporations, government agencies and individuals all over the world, we achieve common goals for rhinos together. We are Team Rhino.

IRF listens to local communities living in close proximity to rhino populations. Working together, we participate in mutually beneficial partnerships through wildlife conservation. A key objective is to build a unified front to save rhinos by engaging and activating the many people around the world who are as concerned as we are about the rhino. Our global team of rhino conservationists is calling for an end to rhino poaching and sharing the plight of the rhino with others.

Rhinos in crisis

Rhinos are in crisis. At the beginning of the 20th century, there were 500,000 rhinos roaming the earth. By 1970, the worldwide population plummeted to 70,000. Today, the number of rhinos surviving in the world is just 28,000.

Furthermore, three of five species remaining are threatened with extinction. Black rhinos in Africa and Javan and Sumatran rhinos in Indonesia are critically endangered, the reality is that they could go extinct in our lifetime.

In the last decade, poachers have killed almost 10,000 rhinos across Africa to feed the demand for rhino horn in the illegal wildlife trade. If rhino deaths outpace births, their populations will continue to decline.

Burgeoning middle classes in China and Vietnam are increasingly able to afford rhino horn, which is illegally traded on the black market. (Rhinos are poached for their horn, which is primarily made of the protein keratin—the same substance as your hair and fingernails). This demand drives record poaching rates. Consumers in Vietnam use rhino horn as purported

cures for everything from hangovers to cancer and in showing-off their wealth. Consumers in China use rhino horn as a status symbol and in Traditional Chinese Medicine (TCM) to reduce fever and treat other ailments. There is no scientific evidence that rhino horn has any significant medicinal value, and other products have better efficacy than rhino horn at affordable prices.

Human development especially in Indonesia oil palm plantations and coal mining has fragmented landscapes where Sumatran rhinos live. Furthermore, Sumatran rhinos are mostly solitary or live in small, isolated units and this decreases the probability of breeding-age animals encountering one another across divided ecosystems.

We advocate that range countries and consumer countries alike crack down on corruption, enforce their laws, and uphold their commitments to international treaties. This is crucial if rhinos are to survive.

Taking action to reverse the decline

IRF has outlined the following four priorities for all five species of rhinos:

1. Bolster anti-poaching activities or "boots on the ground" to meet the challenge of increased poaching created by economic losses.
2. Maintain intensive monitoring and active management of wild populations in the face of revenue losses, employing conservation breeding where needed.
3. Work with local communities to ensure they are active participants in wildlife conservation and receive economic incentives that improve livelihoods.
4. Governments must commit to enforcing their wildlife crime laws with commitments to international treaties to foster more effective international collaboration on investigations to address the entire criminal supply chain, particularly in Asia.

Throughout its 30-year history, the International Rhino Foundation has supported and managed rhino conservation projects in Africa and Asia. Our core values—integrity, collaboration, adaptability, sound decision-making and commitment—are at the heart of everything we do.

IRF invites you to join Team Rhino as a partner, supporter or advocate. More information is available at rhinos.org.

Pumpkin, a black rhino orphaned in Zimbabwe when her mother was shot by poachers, was rehabilitated and successfully released back to the wild.

Rocky, a young black rhino in Zimbabwe
Photos: Lowveld Rhino Trust for the International Rhino Foundation.

OBITUARIES

Ian Lemaiyan—KWS bush pilot passionate about rhino conservation

Born: 19 April 1990
Died: 11 February 2021

Tribute by Paula Kahumbu

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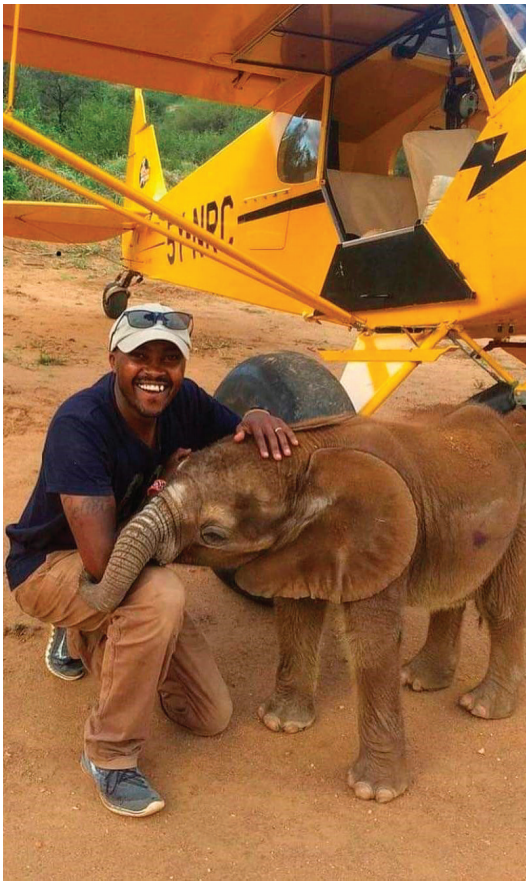

Everyone who met Ian was left moved by his passion. Those of us who knew him well would describe him as knowledgeable, positive, compassionate, forgiving, generous, and adventurous. Altogether an impressive person who was undeniably going places with his life.

He was also a dreamer—in his "about" section on Facebook he wrote "I believe in dreams coming true, in one way or the other, if you put enough strength, faith and smart work together, there is nothing one cannot achieve".

I got to know Ian really well during the 2014 Global March for Elephants and Rhinos in Nairobi, as we walked together for several hours. I learned that he was no longer a volunteer at the Kenya Wildlife Service (KWS) but had moved to Lewa Conservancy to start a job with the rhino team, and he loved rhinos more than anyone else I'd ever met. It was not until his first visit to the Nairobi National Park following his training at the KWS Training Institute, that he saw his first rhino. At KWS he assisted with notching rhinos and veterinarian work. He was intrigued by this giant animal and dedicated his life to saving them. I visited Lewa several times over the next few years, as a guest and as a board member, and every time I'd seek Ian out and spend time with him to hear about his work and support him in his aspirations. He always took me to meet the rhinos, especially the orphaned calves to give me a close up experience. He got along with the rangers, scientists and donors alike, Ian had a rare sense of self confidence, yet he was still hugely humble.

From the first day I met Ian, I knew that he wanted to be a pilot. He loved doing the field work by motorbike but spoke dreamily about saving rhinos from the skies. It might have seemed like a pipe dream for a boy raised by his grandparents in the dusty town of Kiserian on the outskirts of Nairobi. He didn't have much money, so he took his lessons secretly. He would take a bus to Nairobi every weekend to do just one hour of the course at a time. It was all he could afford. It took time, but in 2018 he finished the course and qualified as a pilot.

Newly qualified I filmed Ian for an episode

of *Wildlife Warriors*. He was a very good communicator, easy going, natural in front of the lens, quick to smile and at the same time, courageous enough to show his emotions. During the shoot I asked him if he had ever witnessed a dead rhino. His eyes immediately welled with tears, and he fell silent, turning from the camera, then spoke through the tears about a painful experience of witnessing the death of a five-year old rhino at Lewa. The whole crew were wiping their eyes as we shot that scene. During the shoot, I learned that he was building a house for his new wife and new-born baby Louis, who at the time were on their way back to Kenya. During the shoot he spoke about why he was so dedicated: he said it would be too sad if his son didn't grow up to see elephants and rhinos.

Ian's episode of *Wildlife Warriors* made him so proud because after the screening many people called him to inquire about volunteering—an offer he made on air. In July 2019 he wrote excitedly to me about a new job he had landed with the Northern Rangelands Trust (NRT) as assistant Security Administrator—a strange title he said, but he looked forward to the challenge. Soon after that he was offered his dream job at KWS which he took up. KWS had recently bought new aircraft and were recruiting new pilots. Best of all, his close friend Mike Nicholson was in charge. He was so happy at KWS where he had his own plane, 5Y KWL. Since then there have been numerous features across the media, where he regularly spoke about conservation issues.

He loved life and called it a "crazy wild unplanned adventure". At the time of his death, Meru National Park was his duty station, but the air was his playground. He generously shared his experiences, about the places he visited, and revelled in the diversity of the job of a bush pilot. He enjoyed it so much that he didn't refer to it as work. He said, "I love flying, I love rhinos, and possibly more than I love life". He had a beautiful wife Stephanie, a healthy son and his love for them shone through in the Facebook posts he shared every day.

In 2020 Ian lost a close friend during a training flight at KWS. I spoke to him at the time, he was gutted. I asked him to be careful and he assured me that he always was. Less than a year later, on 11 February 2021, Ian took off for the last time. Tragically his plane crashed shortly after take-off from the Nanyuki airstrip, with fellow passenger, and a warden of Meru National Park. Ian was beloved by so many of us, words cannot convey the sense of loss of such a great person, friend, and conservationist.

Ian will be remembered by so many for infecting all of us with his love of life. He never said a bad word about anyone, was hugely forgiving and an incredible ambassador for rhinos. His wife Stephanie has set up a scholarship in his name and I invite everyone to support it, to honor his legacy, by creating opportunities for others like him. To learn more about the scholarship fund, click on the link in the bio, or visit https://gofund.me/df552f17. If you're based in Kenya, you can donate directly via till number 5780089.

May Captain Ian Lemaiyan continue protecting our rhinos through all of us. Rest In Peace my friend.

Colin Church—Rhino Ark CEO, awarded an OBE for services to Kenya's conservation vision

Born: 28 January 1940
Died: 16 March 2021

Tribute by Julie Church

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Email: juleschurch@gmail.com

Colin Church was born in Kenya in 1940, the second son of Rev. Howard and Elisabeth Church, who came to Kenya in 1932 with the Church Missionary Society. Church attended Kenton College preparatory school and the Prince of Wales (now Nairobi School) and spent the school holidays with his elder brother Tony exploring the rivers of Mt Kenya and the Athi and Kapiti plains. Here his passion for fly-fishing developed in tandem with his passion for Kenya, its wild places and its people.

Church completed his education at King Edward's school in UK and began his career in journalism honing his skills with the Surrey Advertiser and latterly Reuters, reporting on the proceedings of the House of Commons in the 1960s. His first job on his return to Kenya was as an editor with the Nation Media Group. In the early 1970s, he set up Kenya's first Public Relations firm, Church Raitt and Associates. Following Ian Raitt's departure in 1975, Church founded Church Orr and Associates together with Patrick Orr. He also established the Public Relations Society of Kenya, and in 1996 was elected the President of the International Public Relations Association, the only Kenyan to hold this global position to date.

After 25 years in Public Relations, Church devoted the rest of his life to conservation. In 2005 he was appointed by President Kibaki to Chair the Board of the Kenya Wildlife Service (KWS). There he introduced new, innovative programmes developing inter-agency partnerships, and focusing on communication and marketing strategies, importantly propelling wildlife conservation into the national focus.

From 2002 to 2012, Church chaired the Management Committee of Rhino Ark and focused on bringing Kenya's unique fundraising mechanism—the Rhino Charge, a grueling orienteering rally—into the international limelight. Rhino Ark was initially established to raise funds for a 250 km perimeter fence around the Aberdare National Park (NP) to protect Kenya's black rhinos therein. Church changed the Mission of the institution, to "Humans in Harmony with Wildlife", protecting not just wildlife species including elephants, rhinos and bongos, but also and essentially, its mountain forest ecosystems and the welfare of farmers living in close proximity. The idea of the Rhino Charge as a fundraising event, has now been adopted by other countries in southern Africa.

In 2004 while inspecting illegal logging in the Aberdare National Park the helicopter in which he was travelling crashed as it approached the landing site. He later wrote: "I felt the chopper begin to gyrate anticlockwise as the controls to the tail steering appeared not to respond … It all happened in seconds. One skid hit the ground over a road indent. Lurching,

the hull tilted violently, and the rotor blades whacked into earth. "The blades shattered and were flung 100 metres away … The helicopter hit the ground with an ear-splitting crash, followed by silence except for a hissing from the engine." Fortunately, Church and the other members of his group had only minor injuries, and they continued their inspection by road.

After retiring from Rhino Ark in 2014 Church continued working in conservation, In 2018 he was elected the Chairman of the Mara Elephant Project working closely with its co-founding members and in 2019 he chaired Seas4Life Trust, a marine conservation organization established by his daughter Julie. He also co-founded Eburu Rafiki, became a key adviser to the Big Life Foundation, and the Bongo Surveillance Project. Church was a member of the Board of the Muthaiga Country Club for 17 years, chairing that institution for three years, where he was instrumental in leading the way for a younger generation of members. Church was awarded an OBE by the Queen in 2017 for his "outstanding contribution to conservation in Kenya".

In 2020 Church published Mel-el-Leks' Mountain, a fascinating book which portrays life as seen through the eyes of Mel-el-Lek–a member of the Wandorobo people. In the Maa tongue Mel-el-lek means: "It is not easy." Church must have relished researching and writing the book with his intimate knowledge of the Aberdare National Park and its people.

Church had the gift to listen, learn and gently find ways that supported conservation and sustainable development in Kenya. He has now handed the younger generation a torch, to create a pathway that involves living in harmony with wildlife and to make his contribution looking after the country he loved so dearly—Kenya. Known for his dry humour, and easy charm, Church will be remembered as an unassuming person, who quietly and most capably, got on with the tasks at hand.

While conservation became Church's professional career, he was a devoted family man, and most weekends and holidays were spent surrounded by his family and latterly seven grand-children. Church was married twice, in 1966 to Sally Hopcraft and then in 1984 to Nicole Heinmann. He is survived by three daughters Tanya, Julie, Antonia and a son, Marcus.

Church passed away in March 2021, after he developed septicemia during his last safari to Kora National Park, Tana River County, just after his 81st birthday. Kora has been home to the conservationists George Adamson and Tony Fitzjohn. It is a wild, rugged and remote landscape, a poignant location for Church's last big safari.

ACKNOWLEDGING OUR REVIEWERS

We thank our reviewers for their time and feedback, which improves the quality of the work that we publish.

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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 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 capitalize elephant, black rhino, white rhino and greater one-horned rhino. We do capitalize Javan and Sumatran rhino.

Spelling

Use British spelling, following the latest edition of the Oxford Advanced Learner's Dictionary or the Oxford English Dictionary, using 'z' instead of 's' in words like 'recognize', 'organization', 'immobilized'; but 'analyse', 'paralyse'.

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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.

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Journal names in full without leading article. Book titles are italicised. Journal titles are italicised.

Article in a journal or periodical

Buys D. 2000. The status of the southern white rhino (*Ceratotherium simum simum*) on private land in South Africa in 1999. *Pachyderm* 28: 60–64.

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Kindly, provide a website, location, or person from whom an unpublished report can be accessed when possible.

Website

Note that in the reference list, punctuation is minimized, remove final full stops at the end of online links.

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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