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Address all correspondence, including enquiries about subscription, to
The Editor, *Pachyderm*
PO Box 68200 – 00200
Nairobi, Kenya
tel: +254 20 890605–12
fax: +254 20 890615
email: afesg@iucn.org
website: www.iucn.org/afesg

Pachyderm

journal of the African Elephant, African Rhino and Asian Rhino Specialist Groups

July – December 2007 **No. 43**

Cover: A Yemeni man proudly wears his dagger with its priceless rhino horn handle. Photo: Lucy Vigne

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URGENT APPEAL

Dear *Pachyderm* readers,

Since 1983 *Pachyderm* has served as an excellent platform for disseminating information and sharing lessons learned from conservation of African elephants and African and Asian rhinos. However, it is perhaps a sign of the times that we are now finding it increasingly hard to raise the approximately USD 50,000 per year we need to produce and disseminate this journal in hard copy and free of charge to our readership. In fact, it is only because of the support of WWF International, the US Fish and Wildlife Service, the Santa Barbara Zoo and a private donation from an anonymous benefactor that we have been able to produce the present issue. Despite our greatest efforts, we have not yet managed to secure adequate funds for producing *Pachyderm* 44 or beyond. This means that we again must now seriously start considering all options to make production and dissemination of this journal more sustainable in the long term, including approaching a commercial publisher or shifting to a purely electronic format. However, the latter is clearly not a completely satisfactory solution, especially because many of our African readers still do not have reliable Internet access.

In light of this, we are turning to you, the readership, for suggestions as to any possible funding sources that we might be able to access to ensure the continued production of this journal in its present form. Any donation of USD 100 or more we will acknowledge in future issues. Any additional support, ideas, suggestions or other relevant information should be sent to Julian Fennessy, Programme Officer, IUCN SSC African Elephant Specialist Group, email`; Julian.Fennessy@iucn.org; tel: +254 (0)20 890605–12; fax: +254 (20) 890615.

Yours sincerely,

Dr Holly T. Dublin, Chair
IUCN/SSC African Elephant Specialist Group

Dr Martin Brooks, Chair
IUCN/SSC African Rhino Specialist Group

Dr Nico van Strien, Co-chair
Dr Bibhab Kumar Talukdar, Co-chair
IUCN/SSC Asian Rhino Specialist Group

CHAIR REPORTS
RAPPORTS DES PRESIDENTS

African Elephant Specialist Group report
Rapport du Groupe Spécialiste des Eléphants d'Afrique

Holly T. Dublin, Chair/Président

IUCN/SSC African Elephant Specialist Group, PO Box 68200 – 00200, Nairobi, Kenya
email: holly.dublin@iucn.org

Another six months and although many of the challenges continue, in particular the eternal search for funds, the African Elephant Specialist Group (AfESG) is slowly settling into its new Secretariat offices while the new programme officer has had to find his feet quickly to enable the work to continue.

However, as with the case of AfESG in recent times, where there are pros, sadly cons follow.… This is hard to pen but it is with great sadness that I inform you of another departure from the AfESG Secretariat. Our longest-serving staff member, close friend, colleague and secretary to AfESG since 1992, Monica Buyu, has left the Secretariat due to the significant budget constraints facing the Group. Monica and the AfESG are synonymous and without her dedicated work, support and exuberant persona, much of AfESG success would not have been achieved. I think anyone who has worked with her can attest to that! Monica has seen many of the programme and administrative officers come and go, from her initial office based within WWF in downtown Nairobi to its new location within IUCN EARO. She has been the backbone of *Pachyderm* and the African Elephant Library, and her institutional knowledge will be sadly missed. I want to thank Monica for her tireless effort and support over the past 15 years and wish her good luck in her new endeavours. It is safe to say that once part of AfESG, always part of AfESG. Asante sana!

Six mois se sont écoulés, et bien que la plupart des challenges se poursuivent, en particulier l'éternelle recherche de fonds, le Groupe spécialiste des éléphants d'Afrique (GSEAf) s'installe peu à peu dans les nouveaux bureaux de son Secrétariat, et le nouveau responsable des programmes a dû rapidement trouver le rythme pour que le programme continue.

Pourtant, comme au GSEAf ces derniers temps, quand il y a du pour, le contre vient aussi hélas.… C'est difficile à écrire, et c'est avec une immense tristesse que je dois vous informer d'un nouveau départ du Secrétariat du Groupe. Le membre le plus ancien du personnel, une amie proche, une collègue, qui est secrétaire du GSEAf depuis 1992, Monica Buyu a quitté le Secrétariat en raison des difficultés financières sérieuses que connaît le Groupe. Monica et le GSEAf étaient des synonymes, et sans son travail dévoué, son support et son exubérante personnalité, une grande partie des succès du GSEAf n'auraient pas pu être atteints. Je pense que tout qui a travaillé avec elle peut en attester ! Monica a vu arriver et repartir de nombreux responsables de programmes et de l'administration, depuis son premier bureau au sein du WWF au cœur de Nairobi jusqu'à sa nouvelle installation, dans l'EARO de l'UICN. Elle était l'épine dorsale de *Pachyderm* et de la Bibliothèque de l'éléphant africain, et ses connaissances institutionnelles nous manqueront beaucoup. Je veux remercier Monica pour les efforts et le soutien infatigables qu'elle a montrés au cours de ces quinze ans, et lui souhaiter bonne chance dans ses nouvelles activités. Il est tout à fait juste de dire que quand on fait partie du GSEAf un jour, on en fait partie pour toujours. Asante sana !

Fortunately not all is doom and gloom, and ongoing support from the US Fish and Wildlife Service (USFWS) and the UK Department for Environment, Food and Rural Affairs (DEFRA) has enabled the Secretariat to continue with current activities, and to search further afield for funding, project partnerships and mechanisms to better support the membership. The strong relationships forged with CITES-MIKE over the years will hopefully continue in 2008 as the two bodies look towards forging new synergies through some interesting joint initiatives. Stay tuned.

Pachyderm

Pachyderm is steadily inching its way into the digital age and professional, online publishing! In an effort to better serve our authors and readership, the Editorial Board has agreed to establish an online system to streamline the overall management of the journal. The system being adopted, known as Open Journal Systems (OJS), assists with every stage of the refereed publishing process—from manuscript submission and peer review through to online publication, indexing and subscription management. OJS is an open source software developed by the Public Knowledge Project of Simon Fraser University with the aim of making online, open-access publishing a viable option for small journals.

The benefits of OJS will be manifold. Individual articles will be made available on the website, rather than as part of a large pdf file containing the entire issue in which they are published as has been the case up to now. In addition, all content will be automatically indexed and will be searchable online, as well as through other bibliographic databases such as Current Contents, the Science Citation Index and Google Scholar. From the journal management perspective, and aside from the benefits already mentioned, OJS will allow us to distribute the editorial roles and the overall management of the journal, which will enhance the sense of ownership by the three Specialist Groups and lighten the burden on AfESG shoulders.

As a sophisticated journal management system, OJS runs on an enterprise-grade database management system. The database system chosen to implement *Pachyderm* on OJS is PostgreSQL—the world's most advanced open source database. It is

Heureusement, tout n'est pas aussi triste et déprimant, et le support continu du *US Fish and Wildlife Service* (USFWS) et du *UK Department for Environment, Food and Rural Affairs* (DEFRA) a permis au Secrétariat de poursuivre ses activités actuelles et de chercher ailleurs encore des financements, des partenariats et des mécanismes pour mieux supporter nos membres. Nous espérons que les relations solides établies au cours des années avec MIKE-CITES vont se prolonger en 2008. Les deux organismes se réjouissent de forger de nouvelles synergies dans le cadre de quelques initiatives conjointes très intéressantes. Restez branchés.

Pachyderm

Pachyderm fait son chemin avec détermination vers l'ère digitale et la publication professionnelle en ligne ! Pour mieux servir nos auteurs et nos lecteurs, notre conseil éditorial a accepté d'établir un système en ligne pour concentrer la gestion générale du journal. Le système adopté, connu sous le nom de *Open Journal Systems* (OJS), assiste à chaque étape du processus d'édition — depuis la soumission du manuscrit jusqu'à la publication en ligne en passant par la revue par les pairs, la classification et la gestion des souscriptions. OJS est un logiciel en code source libre mis au point par le *Public Knowledge Project* de l'Université Simon Fraser, dans le but de faire de la publication en ligne ouverte à tous une option viable pour les petites revues périodiques.

Les avantages d'OJS seront multiples. Des articles particuliers pourront être mis en ligne et ne devront plus faire partie d'un fichier pdf qui contient tout le numéro dans lequel ils sont publiés, comme c'était le cas jusqu'à présent. De plus, tout le contenu sera automatiquement indexé et pourra être atteint en ligne, comme par toutes les banques de données bibliographiques telles que *Current Contents*, le *Science Citation Index* et *Google Scholar*. Au point de vue de la gestion de la revue, en plus des avantages déjà mentionnés, OJS va nous permettre de répartir les rôles éditoriaux et la gestion générale de la revue, ce qui va stimuler le sens de la propriété chez les trois Groupes spécialistes et soulager d'autant le poids qui pèse sur les épaules du GSEAf.

Système sophistiqué de gestion d'un journal, OJS fait fonctionner en continu un système « entreprise-grade » de gestion de base de données. Le système choisi pour composer *Pachyderm* sur OJS est le PostgreSQL — le système de gestion de bases de données relationnelles libre le plus avancé du monde. C'est une coïncidence

a pleasant coincidence that the logo of PostgreSQL is a picture of an African elephant and, as reported in a previous issue of *Pachyderm*, AfESG has already initiated collaboration with the developers of PostgreSQL to use it for mutual benefit.

The IUCN web server, where *Pachyderm* has been hosted for the last six years, is unfortunately unable to offer the database-hosting capabilities required to run OJS. I'm happy to report, however, that the curators of ibliblio.org, a huge online repository of publicly available information maintained by the University of North Carolina at Chapel Hill, have kindly agreed to host *Pachyderm* online. To this end, we have recently registered the Internet domain www.pachydermjournal.org. Although a link to the new site will be maintained at the AfESG website (www.iucn.org/afesg), by the time you read this, *Pachyderm* will be moving to its new home. I therefore encourage all authors to embrace this transition and submit your manuscripts through www.pachydermjournal.org.

As with the evolving face of *Pachyderm* we have made changes in the Editorial Board. We say thank you and fond farewell to Leo Niskanen, who was a long-standing member (and manager) of the journal, and hello to new editorial members Julian Blanc, CITES-MIKE CCU data analyst, and Dr Julian Fennessy, AfESG programme officer. Additional members have been invited and we will notify you in the next issue. We hope that the fresh faces and enthusiasm will enable its success to continue; already the two new members have played a key role in the new-look *Pachyderm* described above.

The African Elephant Database

Following the publishing of the *African elephant status report 2007* (AESR 2007), an update from the African Elephant Database (AED), AfESG has managed to distribute copies and upload the document online for broader accessibility (http://www.iucn.org/afesg/aed/aesr2007.html). Traffic to the site, its referencing and requests for use of the data have been encouraging, highlighting the importance of AED as an invaluable tool in the conservation and management of the species.

As the database looks towards a new generation following its temporary mothballing, some

plaisante de constater que le logo de PostgreSQL est un dessin d'éléphant africain et, comme le rapportait un numéro antérieur de *Pachyderm,* le GSEAf a déjà entamé une collaboration avec les développeurs de PostgreSQL pour l'utiliser dans leur intérêt commun.

Le serveur du site de l'UICN où *Pachyderm* est accueilli depuis six mois n'est malheureusement pas capable d'offrir les capacités nécessaires pour faire fonctionner la banque de données avec OJS. Mais je suis heureuse de vous dire que les curateurs de ibliblio.org, une formidable mine, en ligne, de toutes les informations publiquement disponibles qui est gérée par l'Université de Caroline du Nord à Chapel Hill, ont accepté d'accueillir *Pachyderm* en ligne. C'est pourquoi nous avons récemment enregistré un nom de domaine www.pachydermjournal.org. Même si un lien vers ce nouveau site sera conservé sur le site du GSEAf (www.iucn.org/afesg), au moment où vous lirez ces lignes, *Pachyderm* sera en route vers sa nouvelle adresse. J'encourage donc tous les auteurs à adhérer à ce changement et à soumettre leurs manuscrits via www.pachydermjournal.org.

Tout comme avec la nouvelle présentation de *Pachyderm,* nous avons apporté des changements dans notre conseil de rédaction. Nous disons un grand merci et au revoir à Leo Niskanen, qui est un membre (et gestionnaire) de longue date de la revue, et nous accueillons les nouveaux membres de la rédaction, Julian Blanc, analyste des données de l'UCC de MIKE-CITES, et le Dr Julian Fennessy, responsable de programme du GSEAf. D'autres membres sont invités, et nous vous en parlerons dans le prochain numéro. Nous espérons que les nouveaux visages et leur enthousiasme tout neuf nous permettront de poursuivre nos succès : les deux nouveaux membres ont déjà joué un rôle clé dans le nouveau look de *Pachyderm* dont nous avons parlé plus haut.

La Base de Données de l'Eléphant africain

Après la publication du *Rapport 2007 sur le Statut de l'éléphant africain* (AESR 2007), une mise à jour tirée de la Base de données de l'éléphant africain (BDEA), le GSEAf a fait en sorte de distribuer des copies et de mettre le document en ligne pour qu'il soit plus accessible (http://www.iucn.org/afesg/aed/aesr2007.html). Les visites du site, son référencement et les demandes d'utilisation des données sont encourageants et soulignent l'importance de la BDEA comme outil de conservation et de gestion de l'espèce.

innovative and enlightening discussions with other Specialist Groups are helping to once again bring AED, or a new collaborative derivation of it, to life. Although in its infancy, we hope to bring you news in the next issue of some exciting new initiatives for AED and how it can benefit many other iconic species in the future.

Managing the ecological impact of elephants

Update from the Local Overpopulation Task Force

Finally, the long-awaited *Review of options for managing the impact of locally overabundant African elephants* has hit the shelves. The publication has been a long time in the making but hopefully the final product will be a valuable technical resource. The voluntary efforts of all Task Force members, especially Debbie Gibson and Dave Balfour, who picked up the momentum when it looked as if it was getting away from us, are greatly appreciated. The publication has been translated into French and Portuguese and will be disseminated widely. We must thank WWF International, DEFRA and USFWS for their invaluable financial contributions enabling this publication to be completed and made available to many users across Africa. Please order a copy though the AfESG website or download at www.iucn.org/afesg.

Human–elephant conflict

Two case studies have been adapted from our preliminary investigations into the development of vertically integrated HEC models at national level in Tanzania and Burkina Faso, and are now available online: www.iucn.org/afesg. These case studies highlight key HEC activities and actions in both countries, as described in my previous report in *Pachyderm* 42.

Comme la base de données se tourne vers une nouvelle génération après sa mise au placard temporaire, certaines discussions novatrices et révélatrices avec les autres Groupes spécialistes nous aident à rendre la vie à la BDEA, ou à une nouvelle formule collaborative qui en dérivera. Bien qu'elle en soit encore à ses débuts, nous espérons pouvoir vous donner dans le prochain numéro des informations sur quelques nouvelles initiatives excitantes concernant la BDEA et la façon dont elle pourrait bénéficier à de nombreuses autres espèces phares dans le futur.

Gérer les impacts écologiques des éléphants

Mise à jour par la Force spéciale chargée de la surpopulation locale

La *Revue technique des principales options pour gérer les impacts des éléphants africains qui sont localement en surnombre* est enfin parue. Sa publication a pris beaucoup de temps, mais nous espérons que le produit final sera une ressource technique de grande valeur. Les efforts bénévoles de tous les membres de la force spéciale, et spécialement de Debbie Gibson et Dave Balfour, qui ont récupéré le mouvement au moment où il semblait nous échapper, ont été très appréciés. Cette publication a été traduite en français et en portugais et sera largement diffusée. Nous remercions le WWF International, le DEFRA et le USFWS pour leurs inestimables contributions financières qui ont permis de terminer cette publication et de la rendre disponible pour de nombreux utilisateurs partout en Afrique. Vous pouvez en commander un exemplaire via le site du GSEAf ou le décharger sur www.iucn.org/afesg.

Conflits hommes–éléphants

Deux études de cas ont été adaptées à partir de nos investigations préalables pour le développement de modèles verticalement intégrés pour les CHE, au niveau national, en Tanzanie et au Burkina-Faso ; ils sont désormais disponibles en ligne sur : www.iucn.org/afesg. Ces études de cas soulignent les démarches et les activités CHE clés dans ces deux pays, qui ont été décrites dans mon rapport de *Pachyderm* 42.

2008 IUCN Red List assessment for the African elephant

AfESG is currently re-assessing the African elephant Red List status for publication in 2008. Currently, the African elephant is listed as *Vulnerable* (under criterion A2a). The submission for the 2008 Red List will build on the approach employed in 2004, using the updated data in AESR 2007, which covers the period ending December 2006. Numerous factors will be considered during the re-assessment, including the increase in population numbers in southern Africa as well as reported population declines in central Africa. The 2008 Red List is scheduled for release in mid-2008.

Illegal killing and ivory trade

Update on the CITES–MIKE programme

In the last few months, Phase II of the MIKE programme has been kicking into gear. Subregional Steering Committee meetings have now been held in central, eastern and West Africa, as well as in South Asia. These meetings proved very productive in setting the stage for work in the years to come, and each produced a set of recommendations to streamline and improve the effectiveness of the MIKE system. It is interesting to note that many of the challenges encountered in implementing MIKE appear to be similar across subregions. These recommendations were synthesized, distilled, and extensively discussed at a meeting of the MIKE subregional support officers for the Africa region, held in Nairobi in early October. Subsequently, an integrated plan to refine the MIKE system is rapidly taking shape.

The plan touches all aspects of MIKE including selecting sites, simplifying field forms and data entry procedures, enhancing analytical capacity at site and national level, streamlining data flow, prioritizing elephant population surveys in the face of limited funding, using innovative yet sustainable and cost-effective solutions for site hardware and software, developing training tools to reduce the effect of staff turnover at MIKE sites, and reviewing the suite of site and national influencing factors to replace them with objective quantitative variables. The technical aspects of

Evaluation 2008 de la Liste rouge de l'UICN pour l'éléphant africain

Le GSEAf est actuellement en train de réévaluer le statut de l'éléphant africain pour la Liste rouge de l'UICN qui sera publiée en 2008. Pour le moment, l'éléphant africain est classé comme *vulnérable* (critère A2a). La soumission à la Liste rouge de 2008 se basera sur l'approche employée en 2004, en utilisant les données actualisées de l'AESR 2007 qui couvrent la période allant jusqu'en décembre 2006. De nombreux facteurs seront pris en compte pendant la réévaluation, y compris l'augmentation des populations en Afrique australe ainsi que le déclin des populations d'Afrique centrale. La Liste rouge de 2008 devrait être prête à la mi-2008.

Massacres illégaux et commerce d'ivoire

Mise à jour du programme MIKE/CITES

Ces derniers mois, la phase II du programme MIKE est passée à la vitesse supérieure. Il y a eu des réunions des Comités de direction sous-régionaux en Afrique centrale, de l'Est et de l'Ouest ainsi qu'en Asie du Sud. Ces réunions se sont avérées très productives pour établir un cadre de travail pour les années à venir, et chacune a abouti à une série de recommandations pour rationaliser et améliorer l'efficacité du système MIKE. Il est intéressant de remarquer que nombre de défis rencontrés lors de la mise en œuvre de MIKE semblent être similaires dans toutes les sous-régions. Les recommandations émises par les comités de direction ont été longuement discutées au cours d'une réunion des responsables du support sous-régional de MIKE pour la région Afrique, qui s'est tenue à Nairobi début octobre. Ces recommandations ont été synthétisées et concentrées, et un plan intégré pour affiner le système MIKE prend forme rapidement.

Ce plan touche tous les aspects de MIKE, y compris le choix des sites, la simplification des formulaires employés sur le terrain et des procédures d'entrée des données, le renforcement des capacités analytiques sur site et au niveau national, la concentration du flux de données, le classement des priorités en matière d'études des populations d'éléphants en regard de la limite des fonds disponibles, l'utilisation de solutions novatrices et néanmoins durables et peu coûteuses pour le matériel informatique, le développement d'outils de formation pour réduire les effets du turn-over du personnel sur les sites MIKE, et l'examen de la série de facteurs influents

these plans will be reviewed by the MIKE Technical Advisory Group (TAG) at a meeting in Nairobi in mid-January 2008 and will be presented to the African range States at a meeting to be held in the course of 2008, also planned for Nairobi.

In the meantime, the MIKE team continues to expand and be strengthened. On 1 August, Ms Claire Morwabe joined the Eastern Africa Subregional Support Unit (SSU) as administrative assistant. Similarly, Mr Yaw Boafo and Ms Aline Barry have been recruited as deputy subregional support officer and administrative assistant at the West Africa SSU, and they are expected to start in January 2008. Progress has also been made in re-establishing the southern Africa SSU, which is likely to be based at the IUCN office in Pretoria.

Training activities have resumed with a course on aerial survey techniques, held in Arusha and Tarangire National Park (Tanzania) 4–9 October. The training course was facilitated and conducted by the Tanzania Wildlife Research Institute, and was attended by MIKE national and site officers from the Eastern Africa SSU. Training courses on MIKE methodologies are also being conducted in Côte d'Ivoire and Botswana.

MIKE is also strengthening its collaborative links with AfESG. Planned areas for close collaboration include AED, a study on the impact of the bushmeat trade on elephant populations, and support to *Pachyderm* itself. In this respect, the possibility that future issues of *Pachyderm* will carry a new section entirely devoted to the MIKE Programme is under discussion.

Updates on conservation and management strategies and action plans

One of the key elephant conservation issues mandated from CITES CoP14 was that African elephant range States through the African elephant dialogue process shall develop an overall African elephant action plan for improved elephant management aiming at:

- accessing and directing resources towards strengthening enforcement capacity in African elephant range States to combat poaching and illegal trade in ivory

sur site et au niveau national pour les remplacer par des variables quantitatives objectives. Les aspects techniques de ce plan seront revus par le Groupe de Conseil technique de MIKE au cours d'une réunion à Nairobi, à la mi-janvier 2008, et ils seront présentés aux états africains de l'aire de répartition au cours d'une réunion prévue, à Nairobi aussi, dans le courant de 2008.

Entre-temps, l'équipe de MIKE continue de s'agrandir et de se renforcer. Le 1er août, Mme. Claire Morwabe a rejoint l'Unité sous-régionale de support sur site (SSU) comme assistante de l'administration. De même, M. Yaw Boafo et Mme. Aline Barry ont été recrutés comme responsable adjoint du support sous-régional et assistante de l'administration de la SSU d'Afrique de l'Ouest respectivement, et ils devraient commencer en janvier 2008. On a aussi progressé dans le rétablissement de la SSU d'Afrique australe, qui sera probablement basée au bureau de l'UICN à Pretoria.

Les activités de formation ont repris avec un cours sur les techniques d'observations aériennes qui s'est donné à Arusha et au PN de Tarangire (Tanzanie) entre les 4 et 9 octobre. Le cours a été facilité et donné par le *Tanzania Wildlife Research Institute* et suivi par des responsables nationaux et sur site de MIKE, venus des SSU d'Afrique de l'Est. Il y a aussi des formations aux méthodologies de MIKE en Côte d'Ivoire et au Botswana.

Mike est aussi en train de renforcer ses liens de collaboration avec le GSEAf. Les domaines où l'on prévoit une étroite collaboration incluent la Base de données de l'éléphant africain, le développement du Plan d'action pour l'éléphant africain mandaté par la CoP 14 de la CITES, une étude de l'impact du commerce de viande de brousse sur les populations d'éléphants, et *Pachyderm* lui-même. A ce propos, il est prévu que chaque numéro de *Pachyderm* contienne une nouvelle section entièrement consacrée au programme MIKE.

Mises à jour des stratégies de conservation et de gestion et des plans d'action

Comme c'est écrit plus haut, un des points clés de la conservation des éléphants mandatés par la CoP 14 à la CITES était que les états de l'aire de répartition des éléphants développent, au moyen d'un processus de dialogue sur l'éléphant africain, un Plan d'action général pour l'éléphant africain pour une meilleure gestion de l'éléphant qui vise à :

- implementing the action plan for controlling trade in elephant ivory
- enhancing capacity building, managing translocations, reducing human–elephant conflict and enhancing community conservation programmes and development programmes within or adjacent to the elephant range

AfESG, working collaboratively with CITES-MIKE and other key partners, hopes to play an integral role in developing the African elephant action plan by bringing together our vast experience and technical knowledge to help guide the process. Many of the subregional plans and strategies developed for conserving and managing the species will serve as an excellent baseline for developing the action plan.

Central Africa

Once again reports out of central Africa indicate that elephant populations continue to be at risk. Most recently, in Sembé District, north of Odzala-Koukoua National Park, Republic of Congo (a CITES-MIKE site) and to the south of Nki National Park, Cameroon, increased carcass counts have been observed, which highlights how limited control measures are at present. Many signs point to increasing market demands in China and elsewhere, posing additional challenges to law-enforcement efforts in the range States of these largely forested countries. Discussions with other partners have initiated some elephant conservation and management activities although with the recent changes in AfESG, these efforts have been limited. It is planned that in the coming year, AfESG with the elephant range States and other partners will be able to actively play a larger role in implementing the Central African Elephant Conservation Strategy.

Southern Africa

Over the past year AfESG has contributed to the development of a Southern Africa Elephant Conservation Strategy (SAECS), which was formally adopted by the Southern Africa Development Community (SADC) at their ministerial session in April 2007. AfESG provided important and up-to-date information on the status and distribution of elephants, outlined key issues for effectively

- Accéder aux ressources et les allouer à une augmentation du renforcement des capacités dans les états de l'aire de répartition des éléphants d'Afrique pour lutter contre le braconnage et le commerce illégal d'ivoire ;
- Mettre en œuvre le plan d'action pour le contrôle du commerce d'ivoire ;
- Stimuler le renforcement des capacités, gérer les translocations, réduire les conflits hommes–éléphants et renforcer les programmes de conservation communautaire et les programmes de développement dans l'aire de répartition des éléphants ou autour d'elle.

Le GSEAf, qui travaille avec MIKE-CITES et d'autres partenaires clés, espère jouer un rôle majeur dans le développement du Plan d'action général pour l'éléphant africain, en apportant notre grande expérience et notre base de connaissances pour aider à bien orienter le processus. Bon nombre de plans et de stratégies sous-régionaux qui ont été développés pour conserver et gérer l'espèce constitueront une excellente base pour développer le plan d'action.

Afrique centrale

Une fois encore, les rapports qui nous parviennent d'Afrique centrale indiquent que les populations d'éléphants y sont toujours en danger. Très récemment, dans le District de Sembé, au nord du Parc National d'Odzala-Koukoua (un site MIKE-CITES), en République du Congo, et au sud de Parc National de Nki, au Cameroun, on a observé un nombre croissant de carcasses qui montre combien les mesures de contrôle sont aujourd'hui limitées. De nombreux signes indiquent que les demandes augmentent sur le marché chinois et ailleurs, ce qui aggrave le défi posé aux efforts de maintien des lois dans ces pays principalement forestiers de l'aire de répartition. Des discussions avec d'autres partenaires ont permis de lancer certaines activités de conservation et de gestion des éléphants mais, avec les récents changements survenus au sein du GSEAf, ces efforts sont restés limités. L'année prochaine, le GSEAf, avec les états de l'aire de répartition et d'autres partenaires, devrait être à même de jouer un rôle plus actif dans la mise en œuvre de la Stratégie de Conservation de l'éléphant en Afrique centrale.

Afrique du Sud

L'année dernière, le GSEAf a contribué au développement de la Stratégie de Conservation de l'éléphant en Afrique

mitigating human–elephant conflict and provided guidance on developing the strategy. Discussions regarding SAECS implementation are currently under way, and AfESG intends to work collaboratively with the southern African elephant range States to assist with this. A regional meeting in Mozambique was held in November 2007 to further plans for fundraising and implementation.

West Africa

Thanks to a joint effort of AfESG West Africa, the Bonn Convention on Migratory Species and the French Fund for the Environment, a grant is being finalized to assist the ongoing implementation of the West African Elephant Conservation Strategy. Specifically, this funding enables the ongoing delivery of existing national and transboundary strategies for elephant conservation in West Africa. Although additional support will be needed, the addition of a new donor is an encouraging step in the right direction.

Thanks to the generous support of USFWS, Lamine Sebogo, the AfESG West Africa programme officer, has been providing technical support to many of the elephant conservation strategies. He recently visited Togo and Benin to provide guidance and assess their progress. It is encouraging that considerable progress has been made despite the funding difficulties, particularly in Togo, where the country is under a donor embargo.

Assisting AfESG members and partners with fundraising and proposal development has also been key. Discussions with researchers at universities in both countries have set a strong grounding for developing elephant research in the subregion further and in particular for supporting an elephant research symposium in West Africa, bringing together all the concerned parties to discuss the best ways in which to enhance elephant research.

Additionally and importantly, the design of various agreements between neighbouring countries regarding managing elephants in transfrontier conservation areas collaboratively has been progressing well.

Although it was not possible to visit all elephant range States of the subregion in the past six months, it appears that the West African Elephant Conservation Strategy is having similar success in many countries throughout the subregion.

australe (SAECS) qui a été officiellement adoptée par la *Southern African Development Community* (SADC) lors de la session ministérielle d'avril 2007. Le GSEAf avait fourni des informations importantes et actualisées sur le statut et la distribution des éléphants, mis en lumière les points clés pour atténuer effectivement les conflits hommes-éléphants et fourni des orientations pour développer la stratégie. Les discussions sont en cours pour la mise en œuvre de la SAECS, et le GSEAf entend bien collaborer avec les états de l'aire de répartition de l'éléphant en Afrique australe pour les y aider. Il y a eu une réunion régionale au Mozambique en novembre 2007 pour faire avancer les programmes de récoltes de fonds et de mise en œuvre.

Afrique de l'Ouest

Grâce à un effort conjoint du GSEAf-Afrique de l'Ouest, de la Convention de Bonn sur les espèces migratrices et du Fonds français pour l'environnement mondial, on est en train de mettre au point les derniers détails d'une subvention pour la mise en application de la Stratégie de conservation de l'éléphant en Afrique de l'Ouest. Très spécifiquement, ce financement permet de mettre la dernière touche aux stratégies nationales et transfrontalières existantes pour la conservation de l'éléphant en Afrique de l'Ouest. Bien qu'il faille encore des supports supplémentaires, l'arrivée d'un nouveau donateur est un pas important dans la bonne direction.

Grâce au support généreux du USFWS, Lamine Sebogo, le responsable du programme de GSEAf en Afrique de l'Ouest a pu apporter son soutien technique à de nombreuses stratégies de conservation de l'éléphant. Il a récemment visité le Togo et le Bénin pour leur donner des orientations et évaluer les progrès réalisés. Il est encourageant de constater que des progrès considérables ont été observés malgré les difficultés financières, et particulièrement au Togo qui souffre d'un embargo des donateurs.

Il était aussi crucial d'aider les membres et les partenaires du GSEAf dans des récoltes de fonds et dans le développement de propositions. Des discussions avec des chercheurs des universités des deux pays ont établi des bases solides pour le développement de la recherche sur les éléphants dans la sous-région, et en particulier pour soutenir un symposium sur la recherche sur l'éléphant en Afrique de l'Ouest, rassemblant toutes les parties concernées pour discuter des meilleures façons de stimuler les recherches sur les éléphants.

De plus, et c'est très important, la conception de divers accords entre pays voisins, concernant la gestion en col-

East Africa

A draft of Kenya's national elephant management strategy is expected to be ready for comments by the time this issue of *Pachyderm* goes to press, with the final draft to be finalized in the new year. Unexpected delays have hampered its progress; however, efforts to date have ensured the best product possible.

A strong finish for 2007

Another year and the search for more regular support goes on. We are encouraged that although AfESG has faced a few trials and tribulations in 2007—moved offices and undergone major staff changes—new and exciting projects are planned for next year, which we look forward to sinking our teeth into. Although I have been the AfESG Chair for many years, I remain encouraged by the steady and continuous demand for support that AfESG and its members can provide to range State governments, international conventions, institutions and researchers alike, and most importantly, by the high level of technical guidance we continue to supply. So—bring on 2008!

laboration des éléphants dans des aires de conservation transfrontalières, a fait des progrès appréciables.

Bien qu'il n'ait pas été possible de visiter tous les états de l'aire de répartition des éléphants de la sous-région, il semble bien que la Stratégie de conservation des éléphants en Afrique de l'Ouest connaisse une réussite comparable dans de nombreux pays de la sous-région.

Afrique de l'Est

Le projet de stratégie nationale kényane pour la gestion des éléphants devrait être prêt pour commentaires au moment où ce numéro de *Pachyderm* sera sous presse, et la version finale devrait être finalisée pour la nouvelle année. Des délais inattendus ont freiné sa production mais les efforts réalisés garantissent que le produit sera le meilleur possible.

Un clôture fort pour 2007

Autre année, autre dollar (à trouver !). Nous sommes optimistes parce que, même si le GSEAf a connu de nouvelles épreuves et tribulations en 2007 — changements de bureaux, de personnel, la liste pourrait continuer—de nouveaux projets excitants sont prévus pour l'année prochaine, dans lesquels nous pourrons mordre à pleines dents. Bien que je sois Présidente depuis des années, je suis confortée par le support que le GSEAf et ses membres peuvent apporter aux gouvernements des états de l'aire de répartition, à leurs institutions et à leurs chercheurs et, ce qui est plus important encore, par les orientations techniques de grande qualité qu'ils peuvent fournir. A nous 2008 !

African Rhino Specialist Group report
Rapport du Groupe Spécialiste des Rhinos d'Afrique

Martin Brooks, Chair/Président

59 Silverdale Crescent, Chase Valley, Pietermaritzburg 3201, South Africa
email: rhinopmb@telkomsa.net

Strategic plan for the northern white rhino

The extremely critical status of the last northern white rhinos, *Ceratotherium simum cottoni,* prompted the Institut Congolais pour la Conservation de la Nature (ICCN) of the Democratic Republic of Congo to convene a meeting of partners in Kinshasa on 17–18 September 2007 to discuss and agree on the most appropriate strategy to ensure the survival of this *Critically Endangered* subspecies. The major partners present included the African Parks Foundation (APF is currently contracted to manage Garamba National Park), IUCN, UNESCO, Fauna and Flora International, and the Earth Organization. As their primary scientific advisers, AfRSG provided a comprehensive background document and addressed the meeting on a number of issues. Critical to the debate were the results of population viability analyses undertaken with Bob Lacy, which predicted the probability of the remnant population surviving over the next 50 years, assuming no poaching losses. This indicated that at least two males and two females were required to achieve a survival probability of 96% or more and to avoid significant effects from the loss of genetic diversity—which suggested that the currently known population of four rhinos in Garamba NP might just be sufficient, assuming an even sex ratio. However, augmentation by locating additional animals in Garamba (if present) or by adding one or more captive females from Dvur Kralove in the Czech Republic would be highly desirable. Four potential survival strategies were also presented and discussed, and it was agreed that the security of the population was of paramount importance as the loss of even one rhino in the short to medium term could prove catastrophic to their survival chances.

Plan stratégique pour le rhino blanc du Nord

Le statut extrêmement critique des derniers rhinos blancs du Nord, *Ceratotherium simum cottoni*, a poussé l'Institut Congolais pour la Conservation de la Nature (ICCN), en République Démocratique du Congo, à organiser une réunion de ses partenaires à Kinshasa les 17 et 18 septembre 2007 pour discuter et s'accorder sur les stratégies les plus appropriées pour garantir la survie de cette sous-espèce *en danger critique d'extinction*. Les principaux partenaires présents incluaient l'*African Parks Foundation* (APF est actuellement sous contrat pour gérer le Parc National de la Garamba), l'UICN, l'UNESCO, *Fauna and Flora International* et l'*Earth Organization*. Principaux conseillers scientifiques, les membres du GSRAf ont fourni un document récapitulatif complet et se sont chargés d'un grand nombre de questions au cours de la réunion. Les résultats de l'analyse de viabilité de la population entreprise avec Bob Lacy furent cruciaux pour le débat : ils prédisent la probabilité que la population survive au cours des 50 prochaines années, à la condition qu'il n'y ait aucun braconnage. L'analyse indiquait qu'il fallait au moins deux mâles et deux femelles pour atteindre une probabilité de survie de 96 % ou plus, et pour éviter les effets significatifs dus à la perte de diversité génétique — ce qui veut dire que la population connue aujourd'hui, de quatre rhinos dans le PN de la Garamba, serait juste suffisante si l'on suppose que le sex-ratio est de 1/1. Cependant, l'augmentation de ce nombre, soit que l'on parvienne à localiser d'autres animaux à la Garamba, s'il y en a, ou que l'on ajoute une ou plusieurs des femelles captives de Dvur Kralove, en République Tchèque, serait extrêmement souhaitable. Quatre stratégies de survie possibles furent aussi présentées et discutées, et tous ont reconnu que la sécurité de la population était d'une importance primordiale étant donné que la perte, ne fût-ce que d'un seul de ces rhinos, à court ou à moyen terme se révélerait catastrophique pour leurs chances de survie.

After extensive debate ICCN and APF, as the management authorities for Garamba NP, caucused to consider the various strategic management options; their recommendations were formally announced by the minister of Environment at the close of the meeting. These recommendations were, however, to remain strictly confidential until they had been considered and hopefully adopted at the highest political level. This political process was continuing at the time of drafting this report.

Local community ownership of black rhinos

An extremely exciting and historic event occurred in November 2007 with the release of 11 black rhinos, *Diceros bicornis minor,* on the Somkhanda Game Reserve in northern KwaZulu-Natal in South Africa. Somkhanda is owned by the Gumbi community following a successful claim under the land restitution process of five game farms, and as such it has become the first black community in Africa to restore a viable breeding population of black rhinos onto community land. The Gumbi community has zoned the land to include areas for conservation, commercial hunting, commercial cattle farming, development and settlement. The reintroduction was made possible through the WWF/Ezemvelo KZN Wildlife Black Rhino Range Expansion Project that provides black rhinos under custodianship, with the progeny being shared between the land owner and the provincial conservation authority. A further five black rhinos will be reintroduced in 2008 to bring the founder population up close to the recommended 20. It is hoped that this conservation model will be used to create further community-owned black rhino populations in the future. Rhino Notes on page 116 in this issue contains more details.

Threats to Zimbabwe's lowveld black rhinos

Zimbabwe is one of the four most important range States in Africa for black rhinos, with just over 500 rhinos representing about 30% of the southern-central subspecies *D.b. minor.* Following their numbers 'bottoming out' in 1995, they increased rapidly until 2001, but since 2003 the numbers

Après des débats extrêmement approfondis, l'ICCN et l'APF, ainsi que les autorités de gestion du PN de la Garamba, se sont réunis pour envisager les différentes stratégies de gestion possibles ; leurs recommandations furent annoncées officiellement par le Ministre de l'Environnement à la fin de la réunion. Ces recommandations doivent toutefois rester strictement confidentielles jusqu'à ce qu'elles aient été analysées et, nous l'espérons, adoptées en haut lieu. Ce processus politique se poursuit au moment de rédiger ce rapport.

Une communauté locale propriétaire de rhinos noirs

Un événement historique tout à fait excitant a eu lieu en novembre 2007, quand 11 rhinos noirs (*Diceros bicornis minor*) ont été relâchés dans la Réserve de Faune de Somkhanda, au nord du KwaZulu-Natal, en Afrique du Sud. Somkhanda appartient à la communauté gumbi depuis qu'elle a obtenu satisfaction à sa demande lors d'un processus de restitution des terres de cinq fermes à gibier. Elle est donc devenue la première communauté noire d'Afrique à restaurer une population reproductrice viable de rhinos noirs sur des terres communautaires. Au lieu de transformer toute cette surface en installations fermières, les chefs de la communauté ont décidé de délimiter les terres de façon à y répartir des zones pour la conservation, pour la chasse commerciale et l'élevage commercial de bétail, le développement et les installations. La réintroduction fut possible grâce au Projet d'extension de l'aire de répartition du rhino noir, qui est un partenariat entre le WWF et *Ezemvelo KZN Wildlife* et qui confie des rhinos noirs à la bonne garde de la communauté, sachant que leur progéniture sera partagée entre le propriétaire du sol et l'autorité de conservation de la province. Cinq autres rhinos seront réintroduits en 2008 pour porter la population fondatrice à un nombre plus proche des 20 animaux recommandés. Nous espérons que ce modèle de conservation sera utilisé dans le futur pour créer de nouvelles populations communautaires de rhinos noirs. Les notes sur les rhinos (page 116) de ce numéro fournissent plus de détails.

Menaces sur le rhino noir de plaine au Zimbabwe

Le Zimbabwe est un des quatre états les plus importants de l'aire de répartition du rhino noir en Afrique : il compte

have remained stable or slightly declined. The earlier increase was entirely due to good population growth in the conservancies, which more than compensated for the declining populations in the national parks and other areas. However, the escalation of poaching since 2000 in which over 100 black rhinos have been killed is now threatening the future of the entire population. Of particular and extreme concern is the deteriorating situation in lowveld conservancies since 2001 associated with the occupation of parts of the conservancies by subsistence farmers. No black rhinos had been poached in lowveld conservancies between 1993 and 2000, but armed poaching has accounted for the loss of at least 16 black rhinos since 2005 alone. The lack of effective action in apprehending and sentencing those involved will, we believe, soon result in poaching running completely out of control, with devastating and potentially irreversible effects on black rhinos in the lowveld and, indeed, on the overall wildlife industry in the region. Intervention by the relevant authorities in Zimbabwe to ensure the protection of these internationally recognized and *Critically Endangered* black rhinos is urgently required, and AfRSG is currently supporting initiatives aimed at bringing to the authorities' attention the gravity of the situation.

African and Asian Rhino Reintroduction Guidelines Workshop

An expert workshop to further develop 'IUCN African and Asian Rhino Reintroduction and Translocation Guidelines' was held in Tsavo West National Park, Kenya, 29–30 October 2007, with delegates attending from all over the world representing the five species of rhino. These guidelines are a joint effort of IUCN SSC African and Asian Rhino Groups as well as the Veterinary and the Reintroduction Specialist Groups. A straw-dog draft of the guidelines compiled by AfRSG's scientific officer, based on input he had received from a number of specialists, provided a good starting point for discussion at the workshop. The workshop reviewed the work done to date, identifying possible gaps in the draft and desirable changes to the document's text, structure and

un peu plus de 500 rhinos noirs qui représentent presque 30 % de la sous-espèce *D.b. minor* qui vit dans le centre-sud. Suite à l'effondrement de leur nombre en 1995, ils ont rapidement repris jusqu'en 2001, mais depuis 2003, les chiffres restaient stables ou ont diminuent de nouveau légèrement. La première augmentation était entièrement due à une bonne croissance de la population dans les aires de conservation qui avait plus que compensé les populations qui déclinaient dans les parcs nationaux et dans les autres aires. Mais l'escalade du braconnage, constatée depuis l'an 2000 et qui a éliminé plus de 100 rhinos noirs, menace maintenant l'avenir de toute la population. Très particulièrement, ce qui nous inquiète beaucoup, c'est la dégradation de la situation dans les aires de conservation de plaine depuis 2001, liée à l'occupation de certaines parties des aires de conservation par des agriculteurs. Aucun rhino noir n'avait été braconné dans les aires de conservation de plaine entre 1993 et 2000, mais le braconnage avec armes est déjà responsable de la mort d'au moins 16 rhinos noirs depuis 2005. Le manque d'actions efficaces pour arrêter et punir ceux qui sont impliqués va entraîner, nous le craignons, un braconnage complètement hors de contrôle, qui aura des effets dévastateurs et potentiellement irréversibles sur les rhinos des plaines et, en fin de compte, sur toute l'industrie faunique de la région. Il est urgent que les autorités zimbabwéennes responsables interviennent pour assurer la protection des rhinos noirs, cette espèce connue dans le monde entier et qui est aujourd'hui *en danger critique d'extinction*. Le GSRAf soutient actuellement des initiatives qui visent à porter la gravité de cette situation à l'attention des autorités.

Atelier pour préparer les lignes directrices pour la réintroduction des rhinos africains et asiatiques

Un atelier d'experts a eu lieu au Parc National de Tsavo-ouest, au Kenya, les 29 et 30 octobre 2007, pour préparer les lignes directrices de l'UICN pour la translocation et la réintroduction de rhinos asiatiques et africains. Il a réuni des délégués venus du monde entier et représentant les cinq espèces de rhinos. Ces lignes directrices sont le résultat de l'effort conjoint des Groupes CSE/UICN de spécialistes des rhinos africains et asiatiques et de spécialistes de médecine vétérinaire et de la réintroduction. Une ébauche de projet des lignes directrices, compilée par le responsable scientifique du GSRAf et basée sur l'input qu'il avait reçu d'un certain nombre de spécialistes, a fourni un bon point de départ pour les discussions de

scope. The workshop provided a good opportunity for specialists in Africa and Asia to share information, lessons and experience, and many delegates who attended commented that they found the workshop and the chance to interact with colleagues from another continent very worthwhile. Much progress was made with revising the draft document and in particular, incorporating more input from Asian rhino conservationists. AfRSG is grateful to the US Fish and Wildlife's Rhino and Tiger Conservation Fund, and the Conservation Division, Forestry Bureau, Council of Agriculture, Taiwan, for sponsoring the experts workshop, as well as the Zoological Society of London and the Kenya Wildlife Service for logistical assistance and support in organizing it. Some of the delegates from Asia made use of the opportunity to take part in a study tour of some of the Kenyan rhino areas after the workshop.

Kenyan conservation plan

The third edition of the *Kenya conservation and management strategy* was officially launched in Nairobi on 31 October 2007 together with new management guidelines for the white rhino in Kenya. Both cover the period 2007–2011. AfRSG members Dr Raj Amin and Benson Okita-Ouma with Dr Richard Kock facilitated the workshop to revise the strategy. The *Black rhino strategy and white rhino management guidelines* document includes a detailed 79-page illustrated background and review of the strategic plan and actions 2001–2006 entitled 'A positive turning point in black rhino conservation in Kenya'. Four of the six authors of this review document were AfRSG members. This annexincludes many of the main findings and outputs of the successful Darwin Initiative Kenyan Black Rhino Conservation Enhancement and Capacity-Building Project, a joint activity of AfRSG, the Zoological Society of London and the Kenya Wildlife Service, funded by the UK.

IUCN SSC's strategic conservation planning

AfRSG's scientific officer has also been a participating member of the IUCN SSC's Strategic

l'atelier. L'atelier a passé en revue le travail fait à cette date, identifiant les lacunes éventuelles dans l'ébauche du projet et les changements souhaitables pour améliorer le texte, la structure et la portée du document. L'atelier a donné aux spécialistes d'Afrique et d'Asie, une bonne occasion de partager des informations, des leçons et des expériences, et de nombreux délégués présents ont dit qu'ils avaient trouvé l'atelier, et la chance d'interagir avec des collègues d'un autre continent, très utiles.

Nous avons beaucoup progressé lors de la révision du projet de document, et en particulier en incorporant plus de données en provenance de tous ceux qui protègent des rhinos en Asie. Le GSRAf remercie le Fonds de conservation des Rhinos et des Tigres du *US Fish and Wildlife Service*, la Division de la Conservation, le Bureau des Forêts et le Conseil de l'Agriculture de Taiwan, qui ont sponsorisé l'atelier des experts, ainsi que la Société Zoologique de Londres et le *Kenya Wildlife Service*, pour l'assistance logistique et le support qu'ils ont fournis à toute l'organisation de l'atelier. Certains délégués d'Asie ont profité de cette opportunité pour prendre part à une excursion d'étude dans certaines des aires à rhinos du Kenya après l'atelier.

Plan de conservation kényan

La troisième édition de la *Kenya conservation and management strategy* (Stratégie kényane de conservation et de gestion) a été officiellement lancée à Nairobi le 31 octobre 2007, en même temps que les nouvelles lignes directrices en matière de gestion du rhino blanc au Kenya (page 117). Les deux couvrent la période de 2007 à 2011. Le Dr Raj Amin et Benson Okita-Ouma, membres du GSRAf ont facilité l'atelier avec le Dr Richard Kock pour réexaminer la stratégie. Le document *Black rhino strategy and white rhino management guidelines* (Stratégie du rhino noir et Lignes directrices pour la gestion du rhino blanc) comprend, en 79 pages, un récapitulatif détaillé et illustré et l'examen du plan et des actions stratégiques 2001–2006 intitulé *A positive turning point in black rhino conservation in Kenya* (Un tournant décisif de la conservation du rhino noir au Kenya). Quatre des six auteurs de ce document étaient des membres du GSRAf. Cette annexe a inclut beaucoup d'observations et des outputs de l'excellent projet de la *Darwin Initiative* pour l'amélioration de la conservation du rhino noir et le renforcement des capacités au Kenya, une activité conjointe avec le GSRAf, la Société Zoologique de Londres et le *Kenya Wildlife Service*, financée par le Royaume-Uni.

Species Conservation Planning Task Force, which to date has met twice. Lessons AfRSG learned in assisting conservation agencies develop plans, strategies and policies helped inform discussion. It is likely that recommendations to emerge from the task force will be much along the lines of those AfRSG has promoted over the years.

Biological management

AfRSG members participated in an Ezemvelo KZN Wildlife workshop to review the performance and biological management of the Hluhluwe-iMfolozi Park's black rhino population, one of the most important in Africa. Comparative reviews of underlying performance of a number of harvested populations presented at the workshop provided empirical evidence of the success of harvesting in other areas in maintaining or increasing underlying productivity. The workshop came up with a number of recommendations, including a plan to assess the extent of suitable black rhino habitat in the park using the standardized black rhino habitat assessment method (developed by AfRSG's Keryn Adcock) to shed light on whether declines in underlying performance in this *Key 1* population could be caused by declines in black rhino carrying capacity, possibly exacerbated by increases in alien plants and densities of potentially competing browsers.

Training courses

AfRSG's scientific officer has recently given two short courses. The first was in use of the latest version of Wildlife Investigator software at the November 2007 meeting of the SADC Rhino and Elephant Security Group and the Interpol Regional Wildlife Crime Task Force, held in Pilanesberg National Park. The second was a course in population estimation using RHINO 2.1 mark-recapture software; this course was given on request to staff from the North West Parks and Tourism Board, South Africa.

2008 AfRSG meeting

The next AfRSG meeting will be held 24–29 May 2008 at the Lake Manyara Serena Safari Lodge in Tanzania. Emphasis will be placed on assessing

Plan stratégique de conservation de la CSE/UICN

Le Responsable scientifique du GSRAf fait aussi partie du Groupe de travail de la CSE/UICN sur le Plan stratégique de conservation des espèces qui s'est réuni deux fois jusqu'à présent. Les leçons que le GSRAf a apprises en aidant les administrations de la conservation à développer leurs plans, leurs stratégies et leur politique ont été très utiles dans les discussions. Il est probable que les recommandations qui émergeront du groupe de travail seront dans la ligne de celles que le GSRAf promeut depuis des années.

Gestion biologique

Des membres du GSRAf ont participé à un atelier organisé par *Ezemvelo KZN Wildlife* pour examiner les performances et la gestion biologique de la population de rhinos noirs du Parc de Hluhluwe-iMfolozi, une des plus importantes d'Afrique. L'examen comparatif des performances sous-jacentes d'un certain nombre de populations où l'on prélève des animaux qui étaient présentées à l'atelier a fourni des preuves empiriques du fait que les prélèvements effectués dans d'autres aires ont réussi à préserver, voire à augmenter la productivité sous-jacente. L'atelier a produit un certain nombre de recommandations, y compris un plan pour évaluer l'étendue de l'habitat souhaitable pour les rhinos noirs du parc, en utilisant la méthode standardisée d'évaluation de l'habitat du rhino noir (développée par Keryn Adcock, du GSRAf), afin de déterminer si le déclin des performances sous-jacentes de cette population pourrait être causé par une diminution de la capacité de charge, peut-être accentuée par l'augmentation des plantes invasives et de la densité d'éventuelles espèces compétitrices.

Cours de formation

Le responsable scientifique du GSRAf a récemment dispensé deux courtes formations. La première concernait l'utilisation de la dernière version du logiciel *Wildlife Investigator* et fut donnée au cours de la réunion du Groupe responsable de la sécurité de la SADC et de la Force spéciale régionale d'Interpol chargée des crimes contre la faune sauvage, qui s'est tenue au Parc National de Pilanesberg. La seconde était un cours sur l'estimation des populations en utilisant le logiciel RHINO 2.1, avec marquage et recapture ; ce cours fut donné à la demande du personnel du Conseil des Parcs et du Tourisme du Nord-ouest, Afrique du Sud.

the status of all Africa's rhino populations and the extent of poaching and illegal trade, as required by CITES; capacity building through sharing information on management techniques and approaches and recent initiatives; and direction for rhino strategies and important uses. Sponsorship to support the attendance of key members, especially those representing certain rhino range States, is urgently required. This is one of the most important strategic planning and capacity building activities of the AfRSG, so please contact the AfRSG Chair if you are able to assist.

Appreciation

The AfRSG Secretariat is extremely grateful to WWF South Africa, the WWF African Rhino Programme, Save the Rhino International, the International Rhino Fund, the EAZA Campaign, and the US Fish and Wildlife Service for their active support of the Secretariat during 2007.

Réunion 2008 du GSRAf

La prochaine réunion du GSRAf se tiendra du 24 au 29 mai 2008 au Safari Lodge du lac Manyara, en Tanzanie. On y insistera particulièrement sur l'évaluation du statut des populations de rhinos d'Afrique et de l'importance du braconnage et du commerce illégal, comme le demande la CITES ; sur le renforcement des capacités par le partage d'informations concernant les techniques et les approches de gestion et les initiatives récentes ; et sur des orientations pour des stratégies pour les rhinos et les utilisations importantes. Nous avons besoin d'urgence de sponsors pour soutenir la participation des membres clés, et particulièrement de ceux qui représentent certains états de l'aire de répartition. C'est une des activités du GSRAf les plus importantes pour la planification stratégique et le renforcement des capacités ; c'est pourquoi nous vous demandons de contacter le Président du GSRAf si vous pouvez nous aider.

Remerciements

Le Secrétariat du GSRAf est très reconnaissant envers le WWF-Afrique du Sud, le Programme du WWF pour le Rhino africain, *Save the Rhino International*, la Campagne EAZA et le *US Fish and Wildlife Service* qui ont activement soutenu le Secrétariat en 2007.

Asian Rhino Specialist Group report
Rapport du Groupe Spécialiste des Rhinos d'Asie

Nico van Strien,[1] Co-chair for South-East Asia, and Bibhab Kumar Talukdar,[2] Co-chair for South Asia

[1] Kondominium Taman Anggrek 3-23B, Jin. Parman, Slipi, Jakarta 11470, Indonesia
email: strien@compuserve.com
[2] Aaranyak, 50 Samanwoy Path (Survey), PO Beltola, Guwahati – 781 028, Assam, India
email: bibhab@aaranyak.org

Workshop to draft guidelines on translocating and reintroducing African and Asian rhinos

A workshop to prepare the IUCN/SSC draft guidelines on translocating and reintroducing African and Asian rhinos was held at Tsavo National Park, Kenya, on 29–30 October 2007. It was organized by the IUCN/SSC Veterinary Specialist Group and the Zoological Society of London in collaboration with the Kenya Wildlife Service. The workshop was attended by Dr Bibhab Kumar Talukdar, Co-chair of AsRSG (South Asia), and Mr Sectinov, assistant to the Co-chair of AsRSG (South-East Asia), together with four participants from Nepal, five from India, two from Malaysia and three from Indonesia, all of whom contributed species information on the three species of rhino found in South and South-East Asia. Dr Richard Kock, Chair of the IUCN/SSC Veterinary Specialist Group, and Dr Richard Emslie, programme officer of the African Rhino Specialist Group, coordinated the workshop. Also attending were rhino specialists working in Africa, who contributed information on the two species of African rhinos. It is anticipated that by early 2008, the draft guidelines will be available for further comments and inputs.

Update on Indian Rhino Vision 2020 update

A meeting of the Rhino Task Force constituted by the government of Assam was held at the Assam State Zoo, Guwahati, on 23 November 2007, where the current status of progress on Indian

Atelier pour préparer les lignes directrices pour la translocation et la réintroduction de rhinos africains et asiatiques

Les 29 et 30 octobre 2007, s'est tenu au Parc National de Tsavo un atelier pour préparer le projet de lignes directrices de la CSE/UICN pour la translocation et la réintroduction de rhinos africains et asiatiques. Il était organisé par le Groupe CSE/UICN de spécialistes de médecine vétérinaire et par la Société zoologique de Londres avec la collaboration du *Kenya Wildlife Service*. Le Dr Bibhab Kumar Talukdar, co-président du GSRAs (Asie du Sud) y assistait, ainsi que M. Sectinov, assistant du co-président du GSRAs (Asie du Sud-est), quatre participants venus du Népal, cinq d'Inde et trois d'Indonésie, qui tous ont apporté des informations sur les trois espèces de rhinos que l'on trouve en Asie du Sud et du Sud-est. Le Dr Richard Kock, président du Groupe CSE/UICN de spécialistes de médecine vétérinaire, et le Dr Richard Emslie, Responsable de programme du Groupe spécialiste des rhinos d'Afrique, coordonnaient cet atelier. Il y avait aussi des spécialistes des rhinos qui travaillent en Afrique, qui ont contribué à l'apport d'informations sur les deux espèces de rhinos africains. L'on s'attend à ce que, début 2008, le projet de lignes directrices soit prêt à recevoir tous les commentaires et les inputs.

Mise à jour de *Indian Rhino Vision 2020*

Une réunion du groupe de travail sur les rhinos constitué par le gouvernement d'Assam s'est tenue dans le Zoo d'état d'Assam, à Guwahati, le 23 novembre 2007, et on y a évalué le statut actuel de l'avancement de *Indian Rhino Vision 2020*. La construction de campements

Rhino Vision 2020 was assessed. The construction of anti-poaching camps in Manas National Park is in full swing. The field director of Manas Tiger Project in this meeting shared the progress made on infrastructure development and strengthening of anti-poaching patrols. The Security Assessment Group of the Rhino Task Force is now revisiting Manas in mid-December 2007 to assess the security component; it is expected to submit its recommendation at the next meeting of the Rhino Task Force scheduled for 28 December 2007. It is hoped that with improved security, the first batch of about four wild rhinos will be translocated from Pabitora Wildlife Sanctuary of Assam to Manas National Park by early February 2008. The Rhino Task Force formed a subcommittee, the Translocation Core Committee (TCC), with Mr B.S. Bonal, chief conservator of forests (Wildlife), Assam, as the chief operations officer, Mr Amit Kumar Sarmah from WWF-India, North East Office, as deputy, and Dr Bibhab Kumar Talukdar as a member of TCC. This team will look into all the aspects to ensure smooth translocation and post-release monitoring of rhinos in Manas National Park involving concerned officials. The Rhino Task Force has entrusted TCC to make subcommittees whenever needed.

Launching the Indonesian Rhino Conservation Strategy

The Strategy and Action Plan for the Conservation of Rhino in Indonesia (Rhino Century Programme) is the government of the Republic of Indonesia's official policy for the conservation of the country's rhino populations. The programme was formulated in a consultative process including all protected areas holding rhinos, responsible authorities of the government of Indonesia and non-governmental organizations involved in rhino conservation work.

This strategy was initiated by Dr Nico J. van Strien (International Rhino Foundation), who Co-chairs for South-East Asia, Mr Gert Polet (WWF-International), and the late Dr Thomas J. Foose (former programme director of the International Rhino Foundation). They coordinated and contributed to preparing and developing this document. We posthumously thank Tom Foose.

anti-braconnage bat son plein dans le Parc National de Manas. Le directeur, sur le terrain, du *Manas Tiger Project*, a fait part au cours de cet atelier des progrès réalisés dans le développement des infrastructures et le renforcement des patrouilles anti-braconnage. Le Groupe d'évalua-tion de la sécurité du Groupe de travail sur le rhino doit revisiter Manas à la mi-décembre 2007 pour en évaluer la composante sécurité : il devrait présenter ses recommandations à la prochaine réunion du Groupe de travail sur le rhino, prévue pour le 28 décembre 2007. On espère qu'avec une sécurité renforcée, le premier groupe d'environ quatre rhinos sauvages pourra être déplacé du Sanctuaire de la faune de Pabitora, en Assam, vers le Parc National de Manas au début de février 2008. Le Groupe de travail sur les rhinos a formé un sous-comité, le Comité centrale pour le translocation (*Translocation Core Committee*—TCC) dont Mr B.S. Bonal, conservateur en chef des forêts (Faune sauvage), Assam, est le responsable en chef des opérations, avec M. Amit Kumar Sarmah du WWF-Inde, Bureau du Nord-est, comme adjoint, et le Dr Bibhab Kumar Talukdar, comme membre de la TCC. Cette équipe examinera tous les aspects pour garantir des translocations en douceur et le suivi des rhinos après leur lâcher dans le Parc National de Manas, en y impliquant tous les officiels concernés. Le Groupe de travail sur les rhinos a confié à la TCC la charge de constituer des sous-comités en cas de besoin.

Lancement de la Stratégie indonésienne de Conservation du Rhino

La Stratégie et le plan d'action pour la conservation du rhino en Indonésie (*Rhino Century Program*) est la politique officielle du gouvernement de la République d'Indonésie en matière de conservation des populations de rhinos du pays. Le programme a été formulé par un processus consultatif qui a réuni toutes les aires protégées qui accueillent des rhinos, les autorités responsables du gouvernement d'Indo-nésie et les organisations non gouvernementales impliquées dans le travail de conservation des rhinos.

Cette stratégie a été lancée par le Dr Nico J. van Strien (*International Rhino Foundation*), co-président pour l'Asie du Sud-est, M. Gert Polet (WWF-International) et feu le Dr Thomas J. Foose (ancien directeur de programme de l'*International Rhino Foundation*). Ils ont coordonné et contribué à la préparation et à la mise au

The government of Indonesia announced the strategy and also the Elephant and Tiger Action Plan on the occasion of the president's speech on 5 November 2007 during Hari Cinta Puspa dan Satwa (National Plant and Animal Day).

point de ce document. Nous en remercions Tom Foose à titre posthume.

Le gouvernement d'Indonésie a annoncé la Stratégie et aussi le Plan d'action pour l'éléphant et le tigre à l'occasion du discours présidentiel du 5 novembre 2007 à l'occasion du *Hari Cinta Puspa dan Satwa* (Journée nationale des plantes et des animaux).

RESEARCH

Probable extinction of the western black rhino, *Diceros bicornis longipes*: 2006 survey in northern Cameroon

Isabelle Lagrot, Jean-François Lagrot, Paul Bour

605 chemin Tour d'Olivier, F-83210 Belgentier, France; e-mail: ijflagrot@wanadoo.fr

Abstract

From 25 January to 8 June 2006, the NGO Symbiose and veterinarians Isabelle and Jean-François Lagrot with their local teams patrolled the distribution area of *Diceros bicornis longipes* in northern Cameroon to assess the status of the last population of the western black rhino subspecies. Over 46 field patrols were organized in the area situated roughly between Faro National Park on the western border and Bouba Ndjida National Park on the eastern border, totalling over 2500 km of patrol effort. Using historical data, results of previous surveys, information from a network of villagers and cooperation with trophy-hunting guides, the fieldwork carried out during the dry season concluded that no reliable sign of rhino presence was found to attest to the survival of the western black rhino. The estimation of around 30 individuals produced by Symbiose in August 2004 was based on fake rhino tracks, which some of the trackers had made to preserve their jobs. Following this survey, the African Rhino Specialist Group of the International Union for the Conservation of Nature, Species Survival Commission, modified the official status for *D.b. longipes*. Thus far classified as *Critically Endangered* with 5 confirmed individuals in 2001, it has now been declared *Probably Extinct*. Symbiose continued the survey through the rainy season until the end of 2006. Despite 23 additional field patrols, no reliable sign of rhino presence was found.

Résumé

Du 25 janvier au 8 juin 2006, l'association Symbiose, les vétérinaires Isabelle et Jean-François Lagrot et leurs équipes ont parcouru l'aire de répartition de *Diceros bicornis longipes* au Nord Cameroun afin d'évaluer le statut de la dernière population de cette sous-espèce de rhinocéros noir. Plus de 46 missions de terrain ont été effectuées sur l'ensemble du territoire qui s'étend du Parc National de Faro, à l'Ouest au Parc National de Bouba N'Djida, à l'Est, totalisant plus de 2.500 km de marche. Basées sur les données historiques, sur les résultats des missions passées, sur les informations recueillies auprès d'un réseau de villageois et sur une coopération avec les guides de chasse, les recherches entamées tout au long de la saison sèche ont donné les résultats suivants. Aucun indice fiable ne permet de croire à la survie du Rhinocéros noir de l'Ouest. L'effectif d'une trentaine d'individus avancé au mois d'août 2004 par l'association Symbiose reposait sur de faux indices. Il résultait d'une falsification des traces par certains pisteurs recrutés, dans le but de conserver leur emploi. A la suite de cette étude, le Groupe Spécialiste des Rhinos d'Afrique de l'Union Internationale pour la Conservation de la Nature, Commission de Survie des Espèces a modifié le statut officiel du Rhinocéros noir de l'Ouest. Anciennement classé « en danger critique d'extinction », avec un effectif de 5 individus confirmés en 2001, il a été déclaré « probablement éteint ». L'association Symbiose a mis en place un dispositif de veille jusqu'à la fin de l'année 2006. Malgré 23 missions de terrain supplémentaires aucun indice de présence n'a été mis en évidence.

Introduction

During the last century, the population of *Diceros bicornis longipes* sharply decreased. This rhino was already on the verge of extinction in central Africa around 1930 (Blancou 1958) because it had been heavily hunted for its horns. It rapidly but only partly recovered during the following decades, because the French colonial administration implemented protection measures (Malbrant 1952; Bourgoin 1958). By 1980 in northern Cameroon, there were at least 100 animals left (Pfeffer 1980). Nowadays, it is most probably extinct in the other countries of its former distribution area; there has been no reliable sighting or report of *D.b. longipes* presence from Central African Republic since the mid-1980s or from Chad since the late 1980s or early 1990s (Pfeffer 2005).

Cameroon's Northern Province was thus the last home for the subspecies. The historical distribution area lies roughly between the cities of Garoua in the north and N'Gaoundere in the south, the borders of Nigeria to the west and Chad and the Central African Republic to the east (roughly between 7°30′N and 9°N and 12°E to 15°E). Most of that range area is a protected territory, shared between trophy hunting concessions and national parks (Faro, Benoué, Bouba Ndjida). In 1997, out of these 25,000 km^2, the surviving rhinos still occupied around 3200 km^2 (roughly 13%). At that time, 10 to 18 rhinos, divided into at least seven breeding groups of one to four rhinos each, were still roaming in the area (Walter 1996, 1997; Planton and Walter 1997; Brett 1998).

Conservation of the remaining western black rhinos has been a high priority for the last 15 years in Cameroon. In 2001, the last location and identification WWF survey concluded that five animals had survived plus three unconfirmed (Kock 2001). Because of this low number and the difficulty of implementing a recovery plan, official plans were abandoned.

Following the 2001 survey by M. Kock, the NGO Symbiose (created by Paul Bour and Michaël Walter) started fieldwork to locate rhinos based on track observations. In August 2004, Symbiose produced an estimate of 31 rhinos. But a number of AfRSG members expressed their doubts over the claim that rhinos had survived in such numbers. Early in 2005,

Jean Thal

Female and calf photographed in Bamingui Bangoran National Park, Central African Republic, in 1974.

Jean-François Lagrot

Cameroon's Ministry of Wildlife and Forest official holding horns from Sopen, a female poached in 1996 after a transmitter had been implanted.

we did a field trip in northern Cameroon to assess the Symbiose methods and results and to bring back photographic evidence of rhino survival. We obtained no photos and the field trip revealed a need for scientific backup of Symbiose's activities.

We travelled to southern Africa in June and July 2005 on a fact-finding trip to meet rhino specialists in South Africa and Zimbabwe, to gain some field training with trackers, and to obtain advice from field scientists in various national parks and game reserves.

Supported by the IUCN French committee and financed by the French Foreign Office and private sponsors, we planned a survey over most of the historical distribution area of *D.b. longipes* in Cameroon's Northern Province during the dry season from 25 January to 8 June 2006. We had essential technical and scientific support from AfRSG members and we brought in an experienced tracker from Zimbabwe.

The project's objectives were

- to assess the previous results produced by Symbiose
- to locate and identify any remaining rhinos
- to quantify and optimize the Symbiose fieldwork
- to determine the viability of the population by determining whether a minimum population of 5 unrelated rhinos with at least 3 females and 1 male still survives (Brooks 2005)
- to draw up and apply a recovery plan for the population

We based ourselves in Garoua, about 80 km north of the *D.b. longipes* distribution area, and collaborated closely with Symbiose staff members, benefiting from their logistical means and intimate knowledge of the area.

From June to December 2006, Bour and the local team continued fieldwork through the rainy season in areas where they had not completed their survey during the first phase, gathering and verifying any new information.

Methods

To assess the Symbiose results, Jackson Kamwi, a senior tracker from Save Valley Conservancy in Zimbabwe, joined the survey early on, from 23 February to 22 March 2006. He was expected to confirm or reject the tracks recorded by Symbiose, help locate

M. Brunel

Photographed in 1977 in Bouba Ndjida National Park, Cameroon.

the surviving rhinos, and train local trackers. Before his arrival, the first four weeks were dedicated to creating teams, organizing logistics and fieldwork, and testing the survey method. Teams were sent to several favourable sites to collect fresh information and signs of rhino presence in preparation for Kamwi's visit.

After Kamwi concluded he had not witnessed any reliable sign of rhino presence during 11 field trips through the range area and demonstrated that some trackers had been faking spoor for an undefined number of years, the team leaders had to adapt the survey strategy. The third stage of the survey (from 22 March to early June 2006) then consisted of checking as many suitable sites as possible during the remaining time to complete the work started under Kamwi's control.

Organization and materials

[illegible]

In January 2006, Symbiose employed nine trackers and staff, some of whom could not read and one who could not speak French. Two could use a GPS or a satellite phone. Tracking skills were basic; locals had lost rhino-tracking skills and knowledge of rhino behaviour.

Teams of two to three members were given a GPS, satellite phone, digital camera, customized data-collecting forms, a small kit for collecting dung, and walking and camping equipment. They hired a local tracker at each site.

All supposed signs of rhino presence as well as poaching signs were to be photographed and recorded on standardized forms. Satellite phones allowed communication with headquarters three times a day at a fixed time. Teams were asked to save GPS routes as well as all GPS points, downloaded afterwards on aeronautical Fugawi software (fig. 1).

[illegible]

Access to the rhino range area is difficult because of the poor road network, mud during the rainy season, security problems because of increasing armed road attacks, and long distances from base (most field trips took teams over 150 km from Garoua). Only expensive motorcycle taxis are available in remote areas. We had two 4x4 Toyota Land Cruisers available for the field missions. When travelling by themselves, teams used

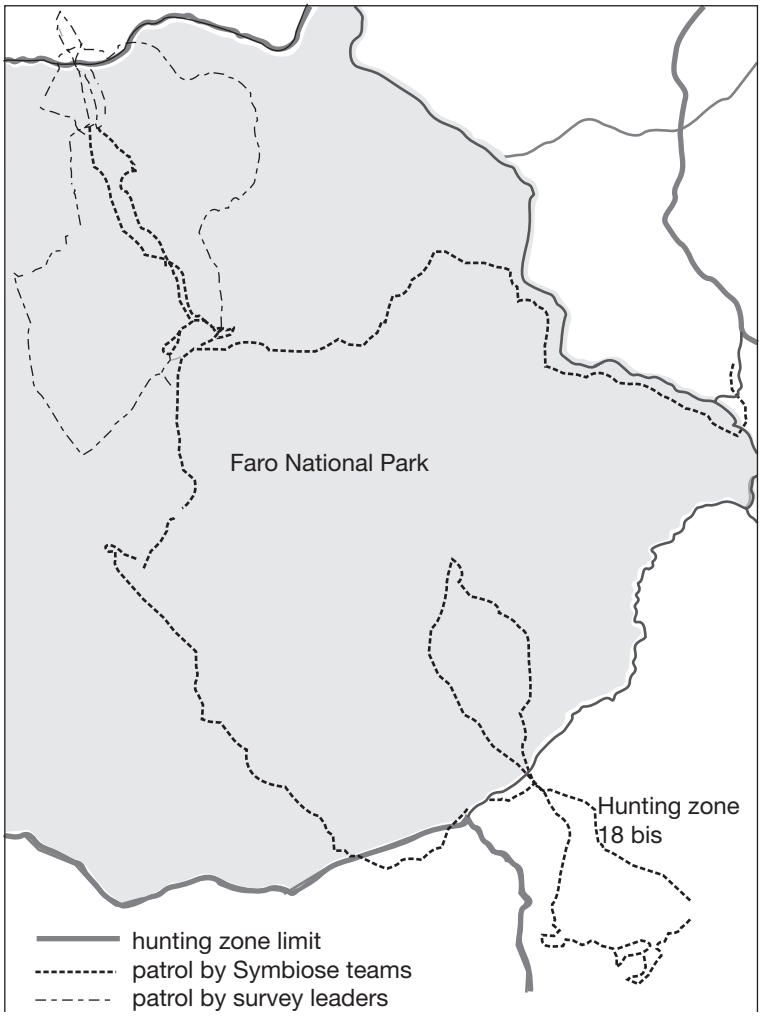

Figure 1. Routes followed during patrols in Faro National Park and hunting zone 18bis during the dry season (other patrols were done during the rainy season). Total: 469 km.

public transport, which turned out to be irregular, highly time and cost consuming, and hard to control. However, previous attempts to buy motorcycles for the teams had not been successful.

VHF radios allowed easy communication between teams. Thuraya satellite phones were used for communication between the base and teams in the field. Photo trapping was quickly abandoned because its reliability at high temperatures (40–45 °C) is low, and there was no evidence of rhino presence.

Bour's microlight plane (Joker 300-Sauper) was used for aerial surveys of selected areas to assess poaching pressure.

Fieldwork

We decided to implement a method suggested by Raoul du Toit (pers. comm. 2006) in a range of sites considered as most favourable throughout the distribution area. Systematic survey of the total suitable area was not possible because the area contained over 25,000 km^2 of rough and mountainous terrain, climatic conditions were harsh (40 to 45 °C in April) and the road network was poor. The global strategy was adapted according to the results. Three stages can be defined.

[illegible]

The sites to be checked were selected according to historical data, previous survey results, recent information and findings. The initial method provided by du Toit (pers. comm. 2006) was adapted to local conditions after experimentation in the field.

To search for sign of rhino presence, blocks of 3 x 3 km (instead of 4 x 4 or 5 x 5) were defined. Blocks were patrolled on foot at a minimum of 0.6 km walked per square kilometre. Within the block, favourable rhino habitats or waterholes were patrolled as a priority. At least 9 to 12 blocks would be patrolled in a few days, progressively outwards in a spiral pattern starting from a central block around the initial sign of rhino. The objective was to find and track any existing fresh spoor (fig. 2).

The method was tried at two different sites during the first month and was to be used extensively after Kamwi confirmed any possibility of rhino presence.

[illegible]

During tracker Kamwi's field trip, as many suitable sites as possible were visited to assess rhino presence and suitability of habitat within the distribution area of

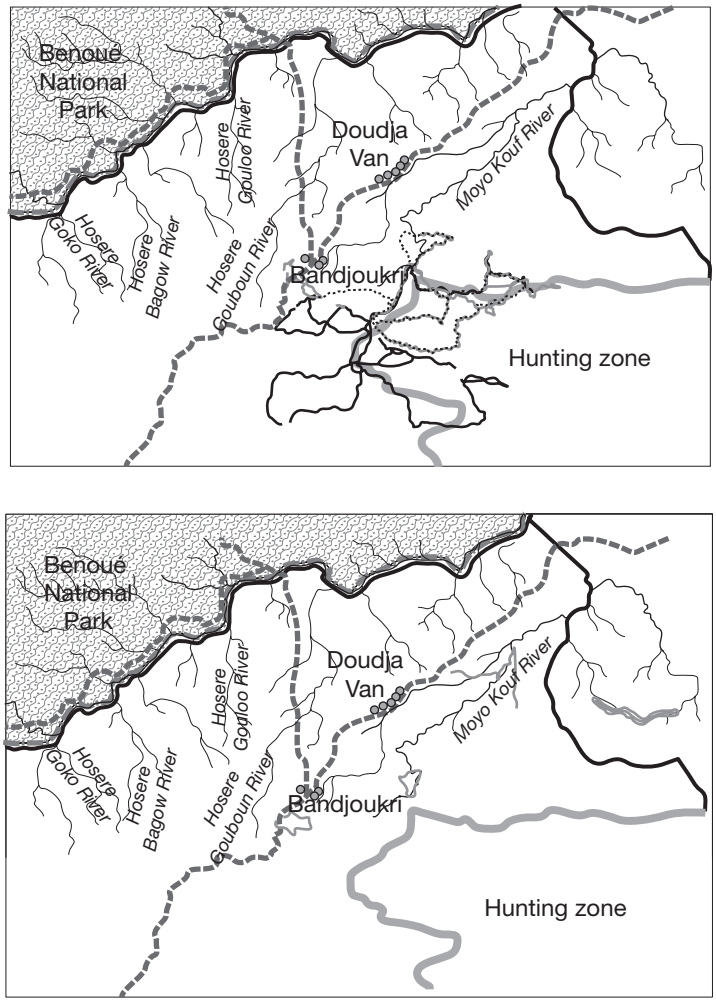

Figure 2. The favourable area of Hosere Makat was chosen to try Raoul du Toit's survey method and was visited again several times with tracker Kamwi. Above, routes of first survey; below, routes of subsequent visits.

D.b. longipes. Teams were sent in the field in advance to patrol several favourable areas; they kept in contact with headquarters to report any fresh spoor found and to allow immediate control by Kamwi. The tracker was also asked to train local staff in the field in two classroom sessions with educational material he had brought with him.

[illegible]

After discovery during Kamwi's mission that Symbiose staff had made fake tracks, the complete approach of the survey had to be reassessed. Du Toit's method was found inappropriate when no sign of rhino presence was found. Five trackers were fired and a new one hired.

Kamwi observed no evidence of rhino presence in 11 spots including most of the main historical sites. We decided to complete the survey in the remaining distribution area, searching for any authentic rhino signs.

New teams were asked to produce standardized quantification:

- patrol effort (kilometres walked, GPS routes, team members, date, time, reports to Garoua headquarter by satellite phone, etc.)
- rhino presence and poaching pressure (signs noted, position, date, photographs, poaching material, camps destroyed)

Sites to be patrolled were chosen according to the following criteria:

- historical rhino presence information, data from previous surveys (all available GPS points checked)
- information gathered during the current season and previous years by Symbiose's informer network, new information from local villagers, poachers, and Cameroon's Ministry of Wildlife and Forest staff. In some places, after study of a detailed map an aerial survey was undertaken in search of suitable rhino biotope
- information from trophy hunting guides operating in the 27 trophy hunting zones. Most of them were aware of the ongoing survey and were willing to cooperate.

In case of any alleged evidence, a team was sent to the site to check the information. If no reliable evidence was found, the team was sent on to the next site. If rhino presence was suspected, survey leaders joined the team to check signs. Criteria to confirm

rhino tracks had been discussed with Kamwi: shape, overlapping tracks, size of front and rear foot, number of tracks and possibility to follow the tracks for a certain distance, stepping pattern, deepness of the spoor in the mud, browsing signs, dung, etc.

Questionnaire for hunting guides and national park wardens

One or more hunting guides spend several months in the field in each of the 27 trophy hunting zones from November to May each year. To benefit from their observations in the field, we prepared a questionnaire asking for any information on past or recent rhino presence as well as an estimation of poaching pressure and status of other endangered species (wild dogs and cheetah were mainly targeted). When possible, survey leaders met directly with hunting guides or national park conservators to fill in the form.

Results

Kamwi's mission

On his first field trip to Hosere Makat, a historical stronghold of the subspecies, Kamwi expressed his doubts about the tracks shown by trackers from the nearby village. No dung or browsing signs were ever observed on subsequent field trips, track shape looked unusual, tracks didn't overlap, running pattern was not logical, rear and front footprints looked similar, dust was thrown in front of the footprint instead of behind it.

Moreover, after Kamwi's training course for our staff, the tracks found became almost perfect, and started overlapping.

On the 11th and last fieldtrip with the tracker, one of the teams was tricked and admitted faking the spoor with pieces of wood or stones. As real tracks had become scarce in the last few years, trackers feared they would lose their jobs and started creating rhino tracks.

Kamwi never observed any real sign of rhino presence in all the areas patrolled, despite suitable habitat in most areas. He pointed out that rhino survival was unlikely in these areas, considering the poaching pressure observed.

General rhino survey

During the first part of the survey (25 January–8 June 2006), survey leaders went on 12 field trips totalling 526 km on patrol (fig. 3). Symbiose's teams went on 35 field missions, totalling over 2000 km on patrol. According to the criteria fixed with Kamwi, no reliable signs of rhino presence were found to attest to the survival of *D.b. longipes* in any of the areas patrolled. All available GPS points for rhino presence signs from previous surveys by M. Kock and M. Walter (GPS points from H. Planton's work are not available) were checked as well as areas surrounding them, but no signs were found. Teams were also sent to investigate any information of rhino presence out of the historical distribution area south of Garoua Boulaï, around Banyo and Tchabal Mbabo. Contradictory information regarding rhino presence was collected, but later checking led to nothing of interest.

Collaboration with hunting guides and questionnaire

Paul Bour's long-term good relationship with trophy hunting guides and park conservators was invaluable. We were able to rely on their help for logistics and information at all times. On several occasions, teams were sent to check tracks reported by trackers from the hunting zones. Some hunting guides sent their own teams and best trackers to check on the information they had of possible rhino presence. However, no signs of presence were confirmed. Cooperation was efficient and several times Symbiose teams were able to report to the guides the presence of poaching camps located in their zones.

There were 27 trophy hunting guides; 22 answered the questionnaire. The last rhino sighting was reported as occurring at the end of 1998 in Hosere Makat. All hunting guides answered that they did not believe any rhinos survived in their zones, confirming the survey's results in these areas. Only park conservators from Bouba Ndjida and Benoué National Parks answered they probably still hosted rhinos in their parks. This answer goes against the survey's results, with the poaching pressures measured in Bouba Ndjida National Park being more than twice as high as in the hunting zones. The results of a WWF and Ministry of Wildlife and Forest transect survey in Benoué National Park in May 2006 also found no sign of rhino presence (Gilles Atoga, WWF, pers. comm. 2006).

Poaching

Hunting guides estimate that the hunting pressure is high and increasing. Poaching was observed on every

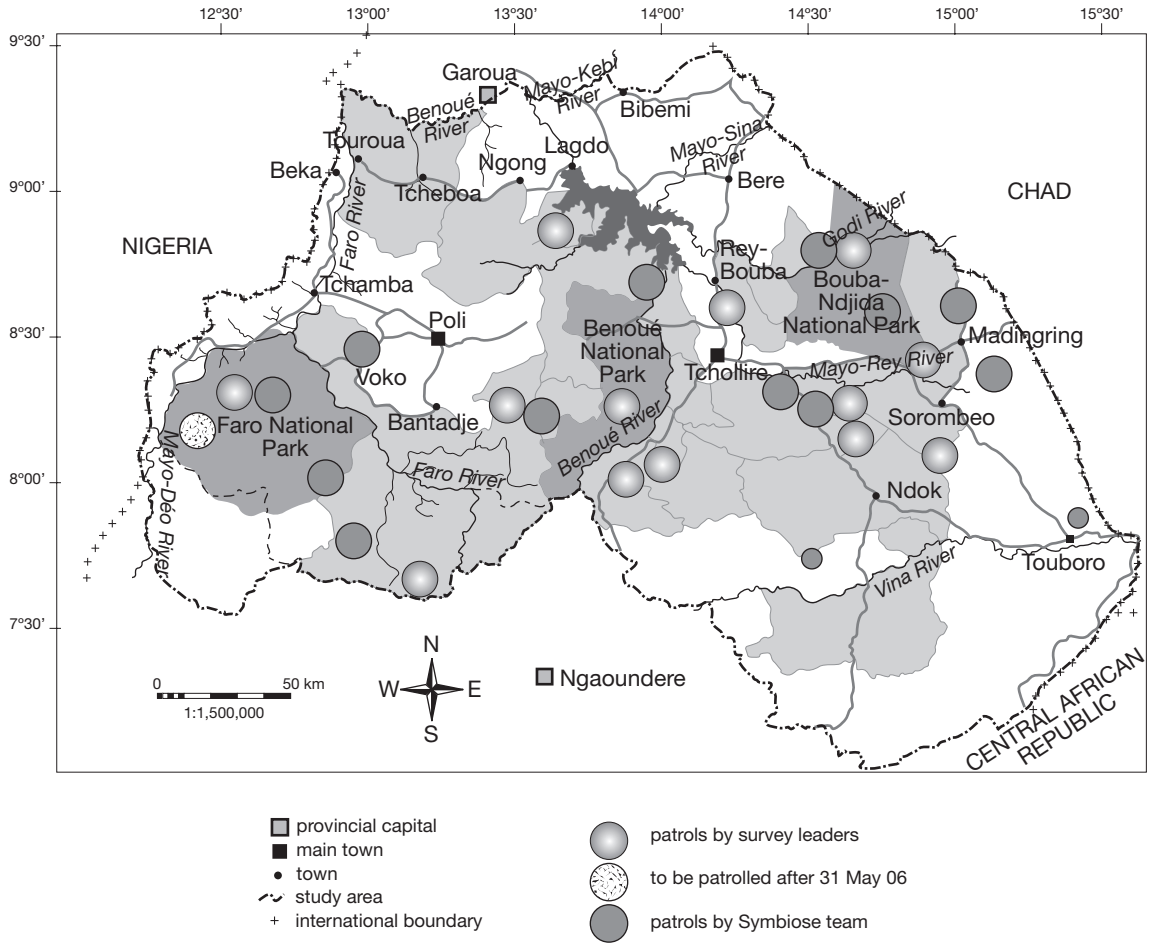

Figure 3. Areas patrolled at the end of May 2006. Dark grey: national parks; light grey: trophy hunting zones. Spots indicate areas patrolled.

field mission during the survey. Quantification was difficult to standardize among the teams. It was decided to consider any event or finding in relation to poaching as one poaching sign, whether it was a snare (or several snares belonging to the same poacher), a poacher, a poaching camp, a wounded or trapped animal, a gunshot, a poisoned waterhole, a fishermen's camp, a lost poached carcass. Between 1 February and 31 May 2006, 18 field patrols out of 46 produced reliable data that were used to calculate a poaching index out of a total of 1621 km of patrol effort:

PI (poaching index) = poaching signs / km patrolled

General PI =	0.094
Bouba Ndjida National Park PI =	0.140
Faro National Park PI =	0.140
Trophy hunting zones PI =	0.063

Poaching pressure is 2.22 times higher in these national parks than in trophy hunting zones.

Discussion

A steady decline in rhino numbers over the past 15 years and the lack of protection measures or law enforcement were already strong elements to anticipate pessimistic results.

The 2006 rhino survey does not claim to have patrolled the total possible distribution area. However, all of the most favourable areas have been largely patrolled, from Bouba Ndjida National Park to the east (which historically was the main stronghold) as well as Hosere Makat area to Faro National Park to the west, with the same results. The WWF and Ministry of Wildlife and Forest survey over Benoué National

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Rhino nails and snares collected during patrols.

Park in May 2006 confirmed that no signs of presence were found in that area either. The enquiry with trophy hunting guides confirmed the survey's results.

One of the main difficulties during this survey was to judge how reliable a piece of information was, especially with regard to the date given for one particular event or finding. Much information on sightings was true but had actually happened several years previously and had become part of local stories. Villager mistrust, information passing through several intermediate persons before reaching headquarters, and difficulty for team members to evaluate the reliability of any information often made it difficult to have a clear idea of how true it was. The skills and reliability of the survey teams were obviously a major problem. Climate and terrain conditions, as well as insecurity were added difficulties.

A few facts raised unanswered questions during the survey.

Although we had information about supposed rhino carcasses, it was never possible to find one. Informers always changed their mind before taking us to the carcass, apparently frightened or threatened by other villagers.

An apparently reliable report of tracks from a trophy hunting guide familiar with rhino hunting in southern Africa in the favourable area of Hosere Kotape remained unconfirmed when checked. The main tracker on that zone said he had not seen rhino spoor for seven years. It was therefore impossible to conclude that a rhino survived in that area, which had been patrolled several times already, including with Kamwi.

The survey teams reported some single, isolated sightings of spoor, described as dating from the last rainy season. In accord with the required criteria, we did not classify these as signs of rhino presence. Further patrols were organized later in those locations during the year's rainy season without results.

According to all personal communications gathered during this survey, it is likely that a very small breeding population existed before an irreversible decline in 2003. The results of this survey suggest that the last western black rhinos were poached during the following years.

Though the habitat of areas patrolled was always favourable to very favourable, the totally uncontrolled poaching problem and the lack of government will do not allow for planning a reintroduction programme.

The question of what subspecies to reintroduce would also be an issue.

Conclusion

This survey tried to assess a situation that has been unclear for the last few years. The recent estimations produced by Symbiose turned out to be based on fake tracks. In search of surviving rhinos, this survey patrolled over 2500 km, including all former strongholds for rhino population, and checked information from a wide range of sources.

No reliable sign of rhino presence was found. On the most favourable sites, an experienced and respected tracker confirmed these results. Systematic survey of the total range area was not possible. But the increasing poaching pressure leaves little prospect of survival of any remaining rhino.

The western black rhino is in all likelihood extinct.

Acknowledgements

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Application of ArcView Animal Movement Analysis Extension as a tool for monitoring elephant movement: preliminary results from northern Cameroon

Désiré Foguekem[1,2], Martin Ngankam Tchamba[1], Mark Macallister[2], Pierre Ngassam[2], Mike Loomis[3]*

[1] WWF Cameroon Country Program Office, PO Box 6776, Yaoundé, Cameroon;
email: mtchamba@wwfcarpo.org
[2] University of Yaounde 1, Faculty of Science, Department of Animal Biology, PO Box 812, Yaoundé, Cameroon; email: d_fogke@yahoo.fr
[3] North Carolina Zoological Park, 4401 Zoo Parkway, Asheboro, North Carolina, USA;
email: michael_loomis@ncsu.edu
* corresponding author

Abstract

ArcView Animal Movement Analysis Extension was used to survey the movement of two female elephants, Eka from Benoué National Park and Habsatu from Bouba Ndjida National Park in northern Cameroon. The results show that Eka is seldom in the park if 5% of the outliers are not considered, while Habsatu is in the park more often, especially in its northern and western parts, and she moves over the border into Chad. Home ranges were calculated as 1750 km^2 for Eka and 2058 km^2 for Habsatu. Recommendations are made for improving the study in the future.

Résumé

L'Extension ArcView Analyse du Mouvement Animal a été utilisé pour étudier le mouvement de deux éléphants femelles, Eka et Habsatu respectivement des parcs nationaux de la Bénoué et de Bouba Ndjida au nord Cameroun. Les résultats montrent que, Eka est difficilement dans le parc lorsque 5 % des points externes sont retirés alors que Habsatu est très souvent dans le parc et plus précisément dans les portions nord et ouest du parc, et se déplace vers la frontière à l'intérieur du Tchad. Les domaines vitaux étaient calculés comme étant de 1750 km^2 pour Eka et de 2058 km^2 pour Habsatu. La discussion est donnée suivi des recommandations pour améliorer l'étude dans le future.

Introduction

Investigating patterns of movement in wildlife species touches upon migration and habitat seletion and informs the design of protected areas. The Elephants of Cameroon is a joint project ot the North Carolina Zoological Park and WWF Cameroon that is studying elephant movement. Its purpose is to monitor the movements of individual African elephants (*Loxodonta africana*) to help determine the areas that they frequent, their migration patterns and habitat requirements. This work is particularly important because of the increasing conflict in Cameroon, as elsewhere in Africa, between elephants and human settlements. The aim of the project is to help develop management plans, such as sustainable land-use policies, and highlight areas requiring protection. This will help to eliminate or at least minimize the destructive interactions that are taking place between elephants and people. In the long term this will help develop sustainable uses of Cameroon's remaining elephant habitats while also providing economic security for local people.

Data used for this project were from two of the elephants being satellite tracked. These data were ana-

lysed using ArcView's Animal Movement Analysis Extension (AMAE) version v2.04 beta. As we had not previously used this extension, it was decided to keep the analysis of the data simple, applying the functions available and seeing how useful the outputs would be for environmental management of this nature.

The two elephants chosen for analysis are both adult cows with young calves. Habsatu is part of a herd of 25 elephants whose home range is in Bouba Ndjida National Park; Eka belongs to a herd that congregates around Benoué National Park of northern Cameroon. Both parks are in the Mayo-Rey region of Cameroon and suffer from agricultural encroachment and poaching. Both of these elephants were fitted with Argos satellite collars and radio transmitters.

As AMAE is a recent development there has to date been little in the literature about its usefulness and application. There are, however, projects where some of the functions available within AMAE are being used to analyse information on animal movements from satellite recordings. One such project is based in Malaysia (www.si.eduJelephantl) where conflicts are arising between Asian elephants (*Elephas maximus*) and humans. The problem here is that elephants that have developed a preference for plantation crops rather than natural forest vegetation are destroying plantations (Stüwe et al. 1998).

In this project elephants are being tracked by satellite and the resulting data analysed using GIS. The purpose is to determine the effects of translocating elephants, whether they establish a new home range, the consequences of moving individual female elephants separated from their matriarchal herd, and whether translocated elephants remain within the boundaries of nature reserves or choose to seek out plantations (Stüwe et al. 1998).

GIS is also being used to track animal movements in the aquatic environment. The people responsible for the Malaysian elephant-tracking project are also running a project named Ocean Ambassadors. One aspect is tracking green turtles (*Chelonia mydas*) using satellite telemetry. GIS is being used to monitor turtle movements, migration paths and the impact that anthropogenic activities such as trawling and the use of long lines are having on them.

In northern Cameroon, Tchamba et al. (1995) used satellite telemetry to track elephant cows in Waza National Park. The study found that one elephant mainly used the central and north-western parts of the park and migrated 80 km north in the dry season; the other elephant used the south-eastern parts of the park and migrated 100 km south in the wet season (Tchamba et al. 1995). The study also used the minimum convex polygon (MCP) method to determine home ranges. Another study by Verlinden and Gavor (1998) satellite-tracked elephants in northern Botswana. GIS was used to relate positions to spatial factors such as water distribution and vegetation types. They found that home range size increased with an increased distance to dry-season surface water. Migratory herds were also observed to move between fixed wet- and dry-season ranges (Verlinden and Gavor 1998).

Methods

Data required

1) Maps of Cameroon, Chad and the national parks that the elephants use. 2) Field data—the date, time, latitude and longitude of elephant positions. 3) Field data—vegetation cover for the area under study.

Sources of data

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Digitized maps of Cameroon and Chad were obtained from the US Geological Survey West Africa Spatial Analyst Project, http://edcintl.cr.usgs.gov/adds/adds.html. Metadata for these maps were available at the following site: http://edcintl.cr.usgs.gov/adds/c1In/cmldoc/wasa!cmwasa.html. The maps of Benoué and Bouba Ndjida National Parks were obtained from the Elephants of Cameroon website (2000). These maps were not digitized and metadata were not available.

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Elephants were collared as described by Tchamba et al. (1995). The date, time, longitude and latitude of the elephant's positions were obtained from the Elephants of Cameroon website (2000). There was concern about the accuracy of the data available on the Internet, the positions provided by the satellite and also why each data set was not complete. To clarify these issues the project was contacted via email (fran.nolanncmail.net). We were informed that the satellite data were correct and that data sets for individual elephants were not complete up to the present because the satellite collars had failed. Vegetation data were omitted from the project as there were problems

opening the files in ArcView. Inclusion of these data and a digital elevation model of the area would have made the project more realistic. It would have enabled the true attributes of the area and the diversity of habitats to be portrayed. This would allow analysis of preferred habitats to be undertaken and areas of potential conflict to be determined.

Input and processing methods

[illegible]

Data sets for Eka and Habsatu consisting of date, time, latitude and longitude were copied from the Elephants of Cameroon website (2000) and pasted into the computer package Excel. Data were separated into four columns and formatted to be meaningful when imported into ArcView. Once these individual tables were completed, each was saved as a dBase 4 file, which allowed the ArcView project to open them.

[illegible]

Files containing data on Cameroon and Chad were downloaded from the West African Spatial Analysis Project website (2000). The files consisted of projects, rather than simply maps. Consequently, before they could be imported into ArcView they first had to be imported into ERDAS Imagine version 8.1. Here they were converted to Arc/Info files using the Arc Interchange to Arc Coverage option. This conversion made it possible to import them into ArcView.

[illegible]

Maps of the parks were saved onto disk from the Elephants of Cameroon website (2000) as jpeg files. They were then imported into ERDAS and converted so that they could be exported to ArcView as a grid data source.

Each map then had to be georeferenced so that the national parks, road and rivers could be digitized and placed onto the map of Cameroon. To do this, 25 ground control points were chosen and listed in an Excel spreadsheet, which was then saved as a dBase 4 file. These were points of uncertainty retained on the map during satellite image analyis. The points were manually introduced into a GPS Gamin 12 XL and divided into reference zones from which data were verified in the field wih the help of local guides.

The map of the national park area was created as an event theme to which this table was added. The projection of the view was changed to UTM 1983, Zone 33, and the selected ground control points were then added to the view using the add event theme. The add x, y, coordinates function under the Movement menu was then used to add the latitude and longitude coordinates to the attribute table. This table was then exported as a dBase 4 file to Excel where it was printed out and the image geocorrected in ERDAS following the method of Winterbottom (2000).

The geocorrected map could then be imported into ArcView and overlaid on the digitized Cameroon map. This made it possible to digitize the rivers, roads and national park areas and add them to the view as a new theme.

Once the national parks were entered into the view, the map showing the area under study was complete. The positions of the elephants were then added to the project.

[illegible]

The MCP method of calculating home range is greatly affected by outliers. Removing 5% of the outliers can mitigate this effect. Therefore, to analyse the positions of the elephants, obvious outliers first had to be removed. This was carried out on both Eka's and Habsatu's positions. The outlier removal function under the Movement menu was used to remove 5% of the data points. The outlier removal function works by the harmonic mean method, which is quite a slow procedure, particularly when the data set is large, as for Habsatu. ArcView displays these points in two colours—one showing the points that have been excluded and another showing the points retained, which can then be used for further analysis. These points were converted to a shape file from which the 5% of outliers were excluded to allow further analysis to be conducted.

Results

Habsatu's positions provided 386 data sets covering a 522-day period from 27 May 1998 to 31 October 1999. Eka's positions consisted of 84 data sets covering 111 days between 27 February and 18 June 1999 inclusive.

Use of national parks

A display of Eka's positions shows that she is hardly ever in the park. When 5% of the outliers have been

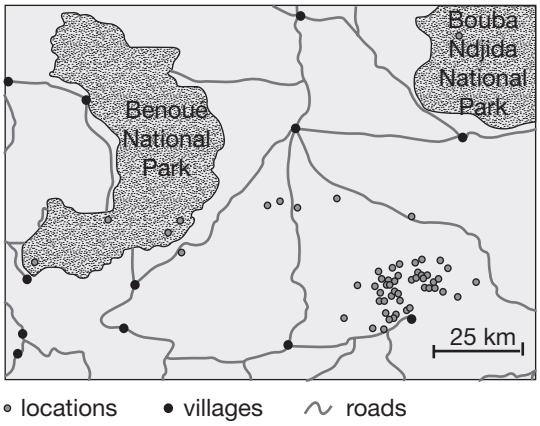

Figure 1. Eka's locations in Benoué National Park.

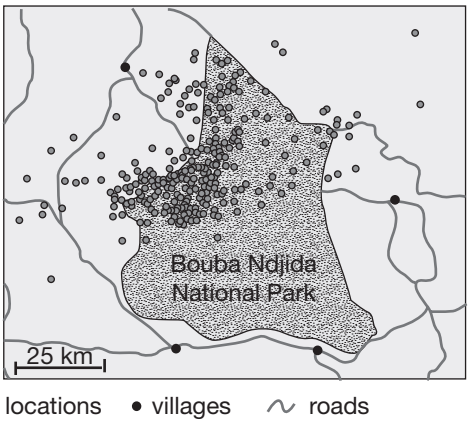

Figure 2. Habsatu's locations in Bouba Ndjida National Park.

removed, she is not in the park at all (fig. 1). Figure 2 shows that Habsatu is in the park more often, especially in its northern and western parts. She also moves over the border into Chad, where elephants are at risk from poachers. If vegetation had been mapped it would be possible to propose hypotheses about habitat preferences in relation to the elephant's positions.

Home range analysis

Many studies concerned with animal movement are interested in determining the home range. Four different methods of home range calculation are available within AMAE: Kernel, MCP, Jennrich-Turner and Harmonic Mean. The latter two methods of calculation were not used in this study. The Jennrich-Turner home range, while having the advantages of speed and simplicity, assumes the data follow a bivariate normal distribution, a requirement that animals in the wild often do not meet. This method is principally useful for generating the principal axis of the data. The Harmonic Mean home range is especially useful in determining animal activity centres. AMAE does not calculate area values for the Harmonic Mean home range. We have chosen to implement the first two models, based on their robustness and common usage.Results of using the other methods are as follows.

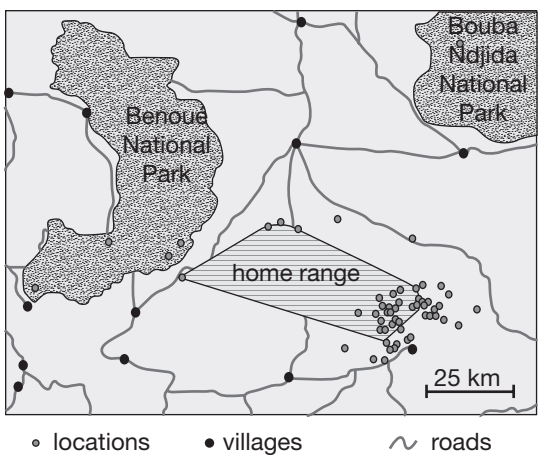

Figure 3. Eka's home range calculated using MCP.

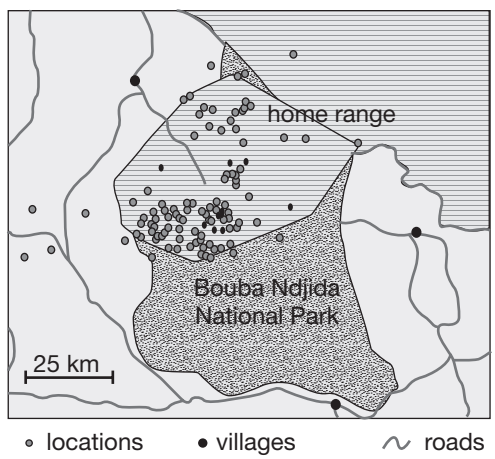

Figure 4. Habsatu's home range calculated using MCP.

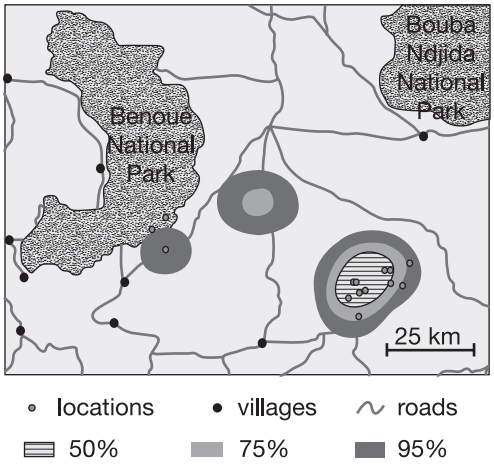

Figure 5. Eka's Kernel home range.

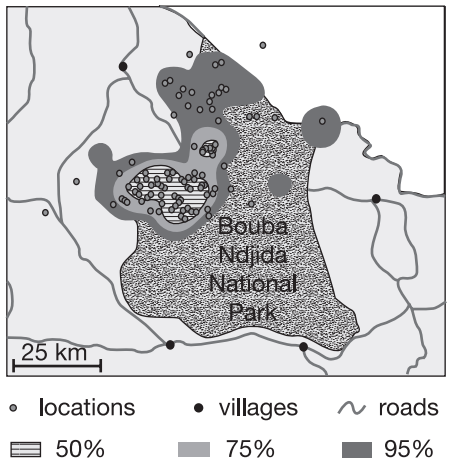

Figure 6. Habsatu's Kernel home range.

Eka's home range calculated using MCP was 1749.698 km^2 and Habsatu's 2057.72 km^2 (figs. 3, 4). With the probabilistic Kernel method, Eka's home range was calculated using a 95% probability polygon and Habsatu's using a 50% one (figs. 5, 6).

Wet- and dry-season positions for Habsatu

The query function was used to determine Habsatu's position in wet and dry seasons (figs. 7, 8). The different methods of calculating home range can then be run with this reduction of data and the results compared with the home range for the data set as a whole.

The ability to do this is extremely useful as it enables managers to identify seasonal patterns of movement and therefore seasonal migration routes and seasonal home ranges. This information can be used to develop management plans. If vegetation and human populion data or information on distance to water could also be used, reasons for the range covered in respective seasons would become clearer by drawing up correlation analysis.

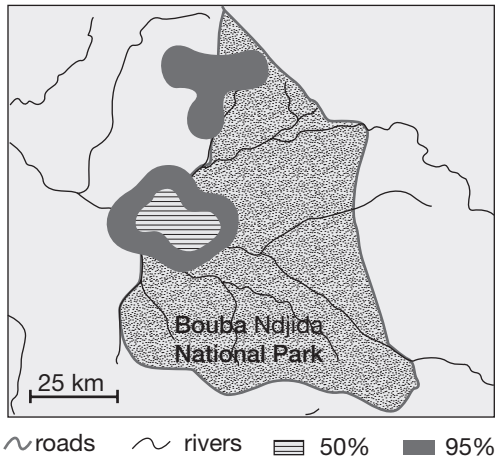

Figure 7. Habsatu's dry-season Kernel home range position.

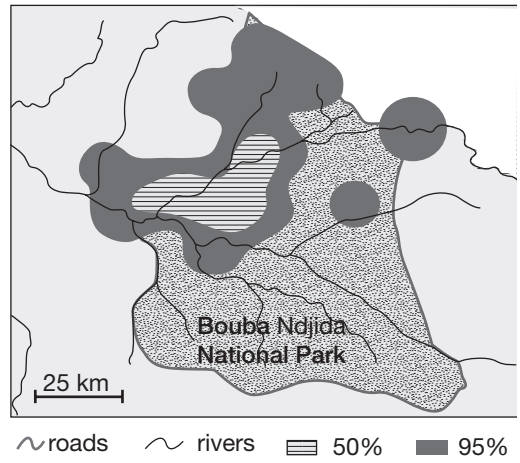

Figure 8. Habsatu's wet-season Kernel home range position.

Table 1. Statistics on Eka's and Habsatu's positions

Item	Eka[a]	Habsatu[b]
Sample size	80	25
Minimum distance	247 m	247 m
Maximum distance	38,990 m	22,587 m
Total distance	625,010 m	140,172 m
Mean distance	7,912 m	5,841 m
Minimum date	27 Feb 99	—
Maximum date	18 June 99	—
Duration of study	111 days	24 days
Minimum speed (units/day)	—	663 m
Maximum speed (units/day)	57,521 m	22,587 m
Mean daily speed	5,633 m	6,094 m
MCP area	1,750 km^2	2,058 km^2

[a] 5% of outliers removed
[b] positions 2–25 July 1999

Statistics on elephant positions

AMAE has the facility to calculate location statistics on the active point theme using either all the data sets or a selection. A selection of the descriptive statistics generated is illustrated in table 1.

The statistics function is especially useful when used in conjunction with a query. Queries can be run on an active point theme to determine, for example, how far an elephant has moved within a certain amount of time. The results of such an analysis are shown in table 1.

The statistical capabilities within AMAE are currently limited although there is an option to export data to stand-alone statistical applications such as SPSS for further analysis.

Discussion

The MCP method of calculating home range is one of the most widely used (White and Garrot 1990; Kenward 1992; Hooge et al. 1999). The method shows the area the animal uses and traverses. Its major fault is that it is sensitive to sample size. As the total area is being calculated the size of the home range can increase indefinitely as new locations arise outside of MCP (White and Garrot 1990). It is therefore affected by outliers and the animal may never use much of the area contained within the polygon (Hooge et al. 1999). To reduce this effect MCP was calculated for both Eka and Habsatu once 5% outliers had been removed. The area of home range calculated using the Kernel method is a more realistic interpretation of what an animal is likely to use than the area calculated under the MCP method.

In this study accuracy concerns were based on whether the satellite recordings were correct. One of Habsatu's positions was so far away from her other positions (fig. 2) that it would appear that 13 degrees longitude were recorded instead of 14 degrees longitude. This could be data entry error or an incorrect spatial reference from Argos. Duplicate entries were also found on a couple of occasions. These factors make the quality of the data questionable.

One problem of using Argos satellite telemetry is the low accuracy of individual locations and the low resolution. These factors prevent detailed analysis of animal locations (Stüwe et al. 1998). Low accuracy ratings may occur if the satellite does not receive sufficient signals from the collar (Stüwe et al. 1998). This is a particular problem near the equator, where opportunities are short for a location to be taken as the satellite passes. It is therefore questionable how accurate the data used in this study were on elephant positions. However, accuracy of the GPS devices could be tested both before and after they are deployed.

From what has been determined in the findings it can be seen that AMAE, despite a few shortcomings such as slow processing of large data sets, is a useful package for analysing animal movements. More could have been obtained from this study if vegetation data and elevation data had been incorporated. Increased knowledge and experience of using the extension would also have improved the analysis.

In light of the findings the following recommendations are put forward to improve this study for use in the future.

- Although there are a lot of data points for each elephant, the sample size is only two. Consequently, for valid scientific conclusions to be drawn, more individual elephants in the herds to which Eka and Habsatu belong need to be collared and tracked by satellite.
- Adult bull elephants are known to cause considerable damage to crops and villages in other parts

of Africa (Hoare 1999). Collars should therefore also be fitted to adult bull elephants, to establish the level of damage and disturbance to human settlements that they cause.

- To make this study more realistic and to enable further analysis of, for example, home ranges in relation to preferred vegetation and migration routes in correspondence with food supply, vegetation and elevation data need to be incorporated.
- GPS collars should be fitted. This would enable real-time collection of data from a GPS using ESRI's Tracking Analyst Extension and AMAE. This would increase the accuracy and therefore improve the analysis.
- The distance function should be used to determine the areas moved from the national parks and the rivers.
- The error of the satellite positions could be checked by using radio-tracking methods to locate the elephants and compare positions on the ground with those provided by the satellite.
- The use of a statistical package such as SPSS version 10.01 for Windows should be used to test whether hypotheses are relevant.

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Elephant movement in W Regional Park, western Africa

Audrey Ipavec[1], Daniel Maillard[2], Philippe Chardonnet[3], Camille Danes[1], Mamoudou Wally[4], Moussa Lompo[4], Dominique Dulieu[1]

[1] Cirad-EMVT, UR 22 Gestion Intégrée de la Faune Sauvage, Campus International de Baillarguet, 34 398 Montpellier, France; email: ipavec@yahoo.com
[2] ONCFS, 95, rue Pierre Flourens, 34 098 Montpellier Cedex, France
[3] IGF, 15, rue de Téhéran, 75 008 Paris, France
[4] Association des Guides Touristiques de La Tapoa, BP 10, Say, Niger

Abstract

Few studies have focused on the elephant population of W Regional Park in western Africa (Benin, Burkina Faso and Niger) with an essentially national perspective rather than a transfrontier one. During a four-month period from April to July 2004, two elephant females were radio-tracked to establish their transfrontier movements. A total of 556 locations were recorded. Home range sizes calculated using the 95% Kernel method were estimated at 2572 km^2 for one female and 1970 km^2 for the other. Home ranges for the two females largely overlapped with close associations recorded during the tracking period. Movements from Niger to the central part of the park (Burkina Faso) through northern Benin were observed at the beginning of the rainy season along the Mekrou River. Regional survey and management practices should be encouraged to allow this remaining large elephant population to maintain itself.

Additional key words: Argos, home range, radio telemetry

Résumé

Peu d'études se sont portées sur la population d'éléphants du Parc Régional du W, en Afrique de l'Ouest (Bénin, Burkina Faso et Niger), et c'était dans une perspective essentiellement nationale plutôt que transfrontalière. Pendant quatre mois, d'avril à juillet 2004, deux femelles éléphants ont été équipées de colliers radio pour connaître leurs déplacements transfrontaliers. Cela a permis de rapporter 556 localisations. La taille des domaines vitaux calculée par la méthode de Kernel 95 % a été estimée à 2.572 km^2 pour l'une et 1.970 km^2 pour l'autre. Les espaces vitaux des deux femelles se recouvraient fortement et elles étaient étroitement associées pendant la période concernée. Les déplacements des animaux du Niger vers la partie centrale du parc (au Burkina Faso) en passant par le nord du Bénin ont été observés au début de la saison des pluies, le long de la rivière Mekrou. Il faudrait encourager des études régionales et l'adoption de pratiques de gestion transfrontalière pour permettre à cette grande population restante d'éléphants de se maintenir.

Mots clés supplémentaires : Argos, domaine vital, radio télémétrie

Introduction

During the 20th century, human population grew exponentially and led to large habitat conversion and fragmentation, which still are the main threats to elephant survival. In West Africa, elephant range currently covers approximately 221,000 km^2 (Blanc et al. 2002), representing less than 7% of the area they had occupied in 1900 (Roth and Douglas-Hamilton 1991). Barnes (1999) highlighted the relationship between human densities and elephant distribution in West Africa, illustrating the vulnerability of elephants in arid areas to increasing human disturbance. The main savanna elephant population currently occupies a fairly continuous range of protected areas (extending over 30,800 km^2). These areas comprise Arly National Park and its several contiguous hunting zones and reserves in Burkina Faso, Pendjari Biosphere Reserve, Atakora and Djona Hunting Zones in Benin; Tamou Total Reserve in Niger; and finally, W Regional Park

(WRP), shared by these three countries. In 2002 this park became the first transfrontier biosphere reserve in Africa.

Funded by the European Union since 2001, the W Regional Park Ecopas Project has two global objectives—to reverse the degradation of natural resources and to preserve biodiversity in this regional ecocomplex. The programme comprises research and scientific support including describing megaherbivore populations, especially elephant distribution and dynamics relating to resources and habitat distribution. Information on elephant movement is crucial to harmonizing management over the three countries, and to understanding the role of human activity surrounding the park in conditioning elephant home ranges. Radio telemetry techniques were used to explore movements of female elephants within this transfrontier protected area as part of a study initialized in 2003, focusing on the savanna elephant population of W Regional Park.

This paper summarizes data on range size and movement pattern comprising the seasonal shift in home range between dry and rainy seasons of two collared female elephants collected during four months from April to July 2004.

Study area

W Regional Park covers 10,339 km^2 (fig. 1); it is located in the upper Niger basin between 1°59′E and 3°05′E latitude and 12°35′N and 11°22′N longitude. The area experiences Sudanian climatic conditions; mean temperature ranges from a minimum of 21.6 °C to a maximum of 36.1 °C. Annual rainfall, although averaging between 640 mm in the north and 1000 mm in the south, is erratic and limited to the well-marked rainy season (May–September/October). Despite low rainfall, WRP has a dense hydrographical network with the Niger River and its tributaries, the Tapoa and Mekrou Rivers, and other rare perennial water

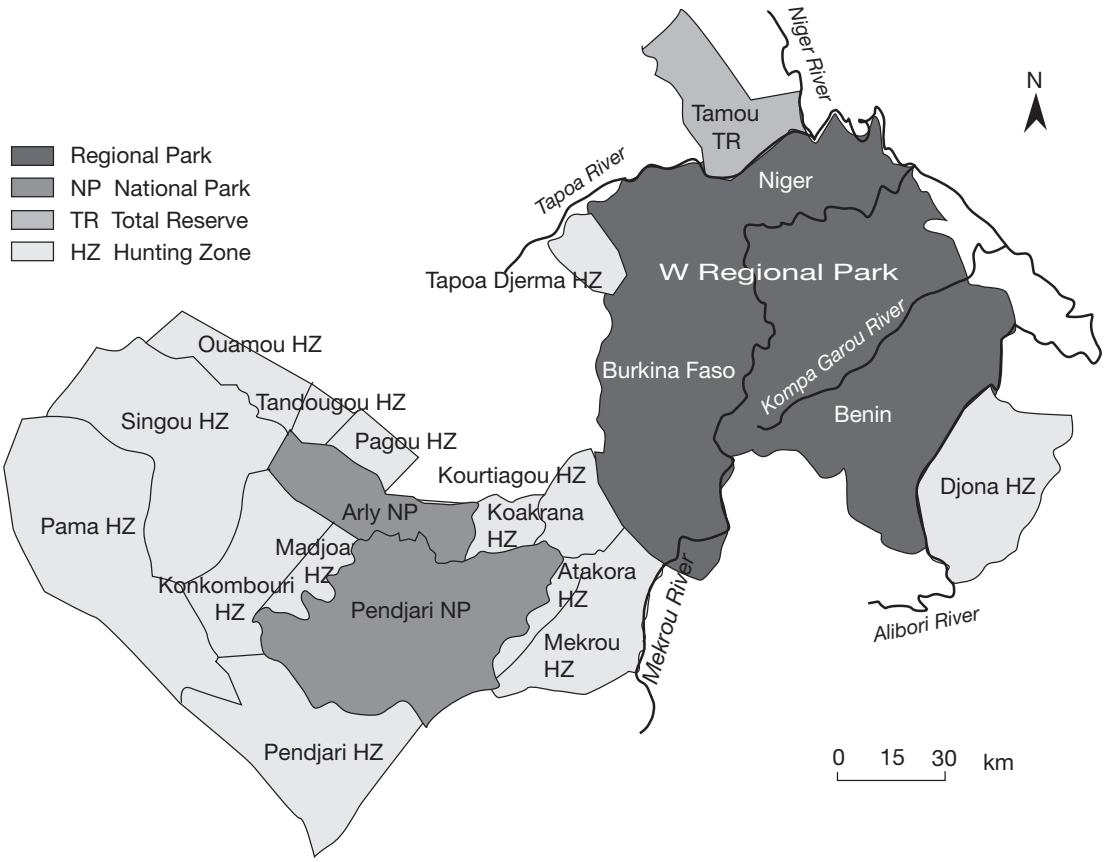


Figure 1. W Regional Park with its contiguous protected areas (modified from the Ecopas Project).

points representing the last source of naturally occurring water with remaining waterholes at the end of the dry season.

Plant species composition and structure change along the north–south gradient between sudano-sahelian and sudano-guinean savannas, with shrubland of Combretaceae dominating in the northern part leading to woodland dominated by legumes (Fabaceae, Caesalpiniaceae and Mimosaceae) in the south.

Methods

Immobilizing and radio telemetry tracking

The basic unit of elephant social organization is the family group or herd. By marking adult female elephants, we can follow movements of the entire family group (Thouless 1996b; Galanti et al. 2000; Galanti et al. 2006). In January 2004, two females were captured and radio tagged in the Niger part of W Regional Park. Their age, estimated by dentition (Laws 1966), was between 15 and 19 years. The elephants were immobilized using gun-propelled syringes containing etorphine. While they were anaesthetized, their vital signs were continuously monitored according to Thouless (1996a). They were fitted with VHF/Argos collars (Sirtrack Ltd) then were given diprenorphine as a reversal drug. The capture and collaring techniques have been detailed elsewhere (Chardonnet et al. 2004). The collar of female 1 (F1) did not start to correctly emit until two months after initial capture. The collar of female 2 (F2) gave reasonable radio locations. Unfortunately, these two collars fell off in mid-July 2004.

Data processing

Argos radio collars were scheduled to function 24 h on and 48 h off. The two females were irregularly tracked during 6 months of the dry–wet season transition, which does not enable any segregation between valuable dry- and wet-season data. To allow comparison, data obtained during a similar transmission period (April to July) were used to calculate 1) total home range size (100% of fixes) using the minimum polygon convex method (MCP), 2) Kernel home range estimators using 95% and 50% (core area) of all locations, and 3) home range overlap (using MCP and 95% Kernel values) between the two females. To describe global movements of each female, one location with the highest precision class attributed by Argos (less than 150 m) was selected for each 'On' period. Females were considered to be associated when they were located within 1 km of each other. Daily movements were described and expressed for each elephant by accumulating successive distances between all obtained fixes (10 fixes per day on average) over the 24-hour 'On' period from 0830 to 0830 the next day. Speed was calculated by considering the distance travelled between two successive locations. However, this virtual speed measure, called mean daily translocation, is underestimated when the distance between the two locations was considered as a straight line (Owen-Smith 1988). All data on home range and movement were analysed using the Animal Movement SA 2.0 extension, ArcView GIS 3.2 (ESRI 1997). Statistical analyses were performed with R Project for statistical computing (2006).

Results

Between April and July, there were 297 fixes for F1 and 259 for F2 (fig. 2). Total home range sizes calculated using the 95% Kernel method were smaller than those calculated using the MCP method for both females (table 1). The two methods are presented to

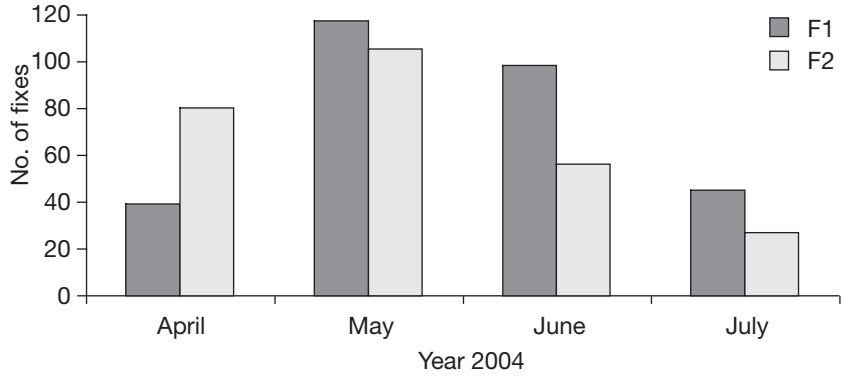
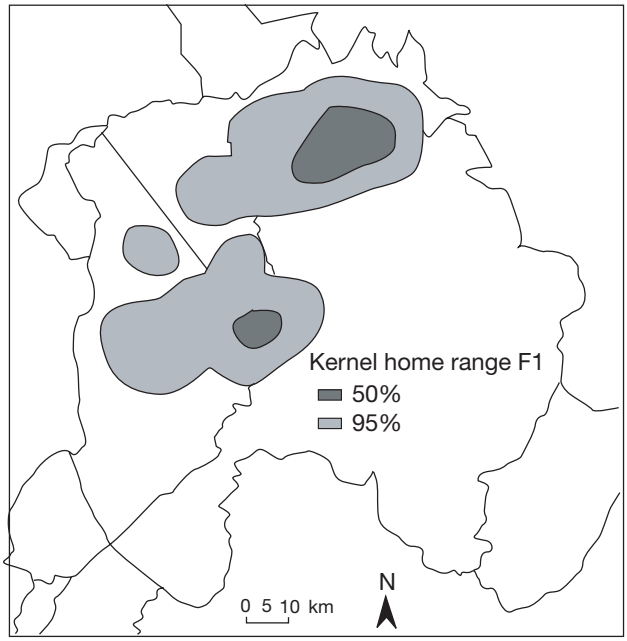
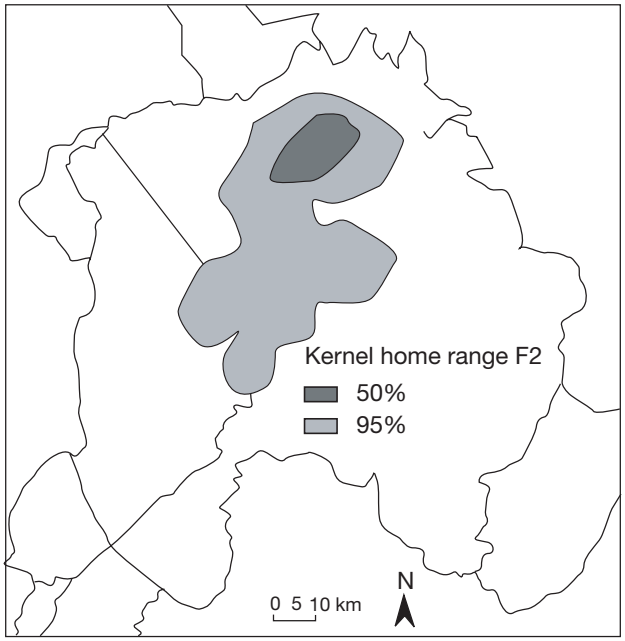


Figure 2. Distribution of fixes for the two females during the radio-tracking period.

Table 1. Total home range size (MCP, 95% and 50% Kernel) and home range overlap (%) between elephants

Elephant	MCP (km^2)	95% Kernel (km^2)	50% Kernel (km^2)	Overlap (%)	
				MCP	Kernel (95%)
Female 1	2756	2572	360	75	65.2
Female 2	2722	1970	209	76	85.1





allow comparison with other studied elephant populations. Figure 3 shows the Kernel home range (including 95% and 50% of locations) drawn for the two fitted females.

During the same collar-transmission period, the two females remained inside the park. Their ranges largely overlapped (65–85% based on Kernel estimation and 75–76% based on MCP contour), which included most of the Niger side and more specifically a large buffer area along the Mekrou River. This river partly dried as the dry season progressed but offered several pools. Movement patterns of the two females were also similar. Both females were captured on the Niger side of the park and stayed in that zone until the end of the dry season. As soon as the first rains appeared in the central part of the park in April, F1 and F2 similarly moved towards that sector. F1 stayed in this area during April and the first half of May. F2 spent only two weeks. Then they returned to their original home range in the north. Finally, at the beginning of June for F2 and July for F1, both animals moved southward, returning to the central part. Close associations occurred between the females on 10 June and 12 July (fig. 4).

Daily movements were expressed for each elephant by accumulating successive distances between fixes over the 24-hour On period from 0830 to 0830 the next day. Figure 5 presents daily movements calculated for each On session. No significant difference (Kruskal-Wallis chi-squared = 285.6, $P = 0.51$) was found in the average distance travelled per session by female F1 (4.03 ± 2.81 km) and female F2 (6.31 ± 5.59 km).

Figure 3. Total home range of females F1 and F2 (from April to July 2004) using Kernel's method.

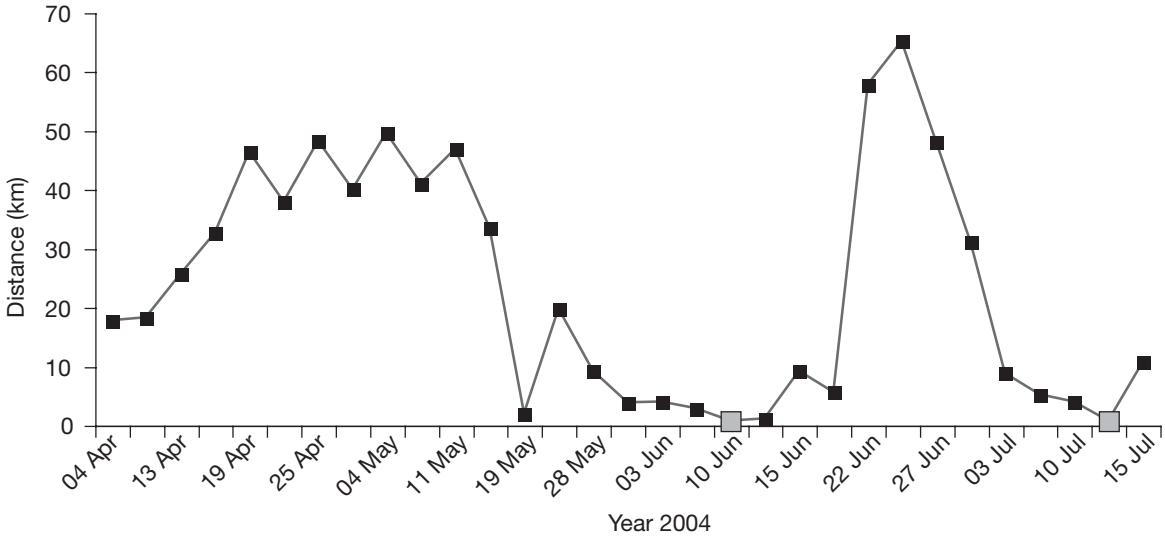


Figure 4. Daily distances between females. Grey squares indicate when distance between the two females was less than 1 km.

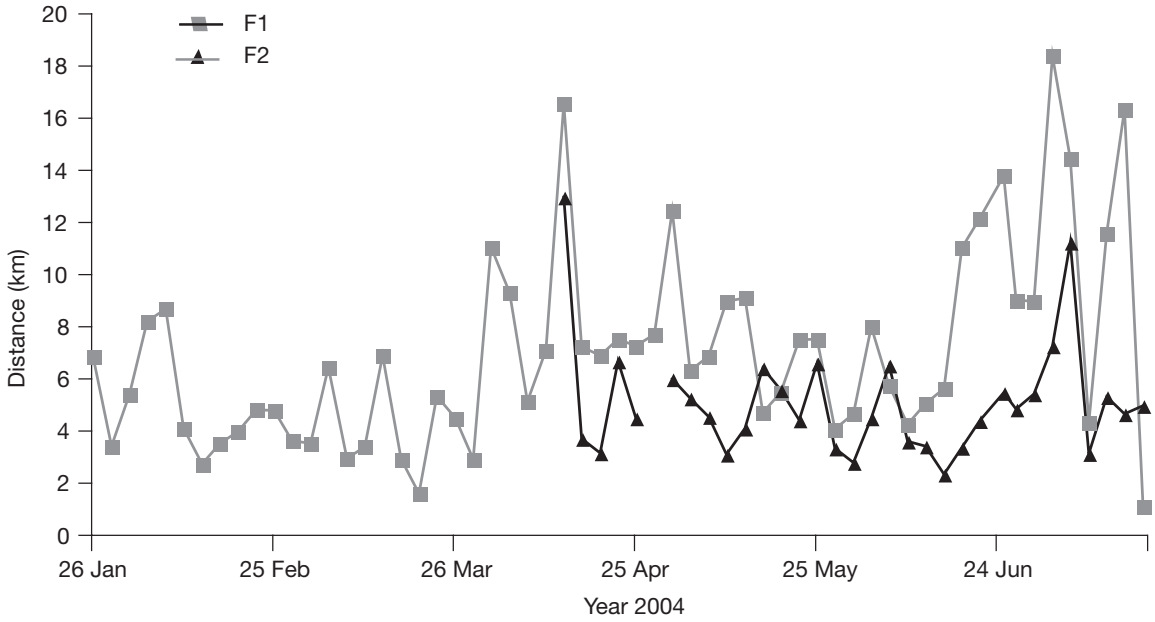


Figure 5. Daily distances travelled by the two females.

Speed was measured to detect the impact of threat (wildfires, poaching and human disturbance) on elephants. F1 moved on average at 1.9 ± 2.1 km/h while F2 walked at 2.4 ± 2.9 km/h, with no significant difference (Kruskal-Wallis chi-squared = 2.36, $P = 0.12$).

Discussion

Radio-tracking data gave precious information on movement patterns of two females from WRP's elephant population. The total home ranges of the two distinctly comprised a large buffer zone along

the Mekrou River, main core areas (covering 50% of relocations) being located in the northern part of the WRP. They could regularly fulfil their water needs in large pools remaining in the riverbed. Elephant migration routes are likely to partially depend on permanent river and pool systems, as observed in various sites such as in southern Tanzania (Mpanduji et al. 2002). On 13 April, both females simultaneously travelled long distances while heading southward, 10 days after the first rains fell in the central part of WRP, crossing the extreme northern part of Benin. This movement could probably be ascribed to differences in forage quality as new rapidly growing grasses and fresh water availability were probably attractive to elephants (Western and Lindsay 1984; Viljoen and Bothma 1990). Wide movement was also observed on 3 July for female F1 and 24 hours later for female F2, as they both were in the neighbourhood of the Mekrou River. The key factor responsible for this event was thought to be disturbance from humans as several field observations showed that the Mekrou River was frequented by poachers and illegal fishermen. But no firm evidence for this relationship was found.

Both females were captured in the northern part of WRP. Home ranges, which can be considered large, covered 2572 km^2 and 1970 km^2, according to the 95% Kernel estimator. In more intensively studied populations, female elephant home ranges varied between 102 and 5527 km^2 in northern Kenya (Thouless 1996b), 115 and 465 km^2 in South African nature reserves (De Villiers and Kok 1997) and 126 and 2716 km^2 in Tanzania (Galanti et al. 2006). Results also suggest they are quite sedentary, occupying the core area of WRP within its limits. In 1974, Poché reported that elephant herds were also occupying the main part of the Tamou Total Reserve in Niger. They exhibited yearly migrations from the Torodi area (extreme north of the reserve) to the Niger, Tapoa and Mekrou Rivers during the latter part of the dry season. This extended phenomenon is not observed any more because of increasing human pressure in this area (poaching, illegal domestic livestock grazing). No segregation between dry- and wet-season home ranges was made, considering the small number of locations.

From a management point of view, it should be pointed out that even if only two females were radio-tracked during four months, they both globally followed the same movement pattern and crossed borders within WRP; their total home ranges encompassed portions of all three countries. This result is important because it demonstrates the existence of transboundary elephant movements, confirming earlier suggestions by some WRP agents, local populations, Poché (1974), Bousquet (1984) and Green (1988). Therefore, this elephant regional population must be considered as one.

Although the movement patterns are consistent in this part of the park, a different situation occurs in the extreme south-eastern part. Each dry season, an elephant population inhabits the Djona hunting zone: in 2002, 59 different groups of 361 individuals were recorded (Alfa Gambari Imorou 2002). In that region, human–elephant conflicts occurred regularly, as elephants would cross communal lands to find available water outside the hunting zone (Kidjo 1992). They would reach Goungoun and Sota classified forests, damaging crops, especially maize (*Zea mais*) and cotton (*Gossypium* sp.) (Alfa Gambari Imorou et al. 2004). More collars are expected to be deployed to address these questions.

These preliminary results highlight the necessity to consider and to manage WRP as a single protected area, encouraging cooperative efforts already initiated by the three countries: Benin, Burkina Faso and Niger. Further analyses will concentrate on understanding ecological parameters that influence WRP elephant dispersal. Results could provide insight into which areas are important for that population.

Acknowledgements

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Forest elephant dung decay in Ndoki Forest, northern Congo

Thomas Breuer[1,2], Mireille Ndoundou Hockemba[1]

[1] Mbeli Bai Study / Nouabalé-Ndoki Project, Wildlife Conservation Society, BP 14537, Brazzaville, Republic of Congo; email: breuer@eva.mpg.de
[2] Max Planck Institute for Evolutionary Anthropology, Department of Primatology, Deutscher Platz 6, 04103 Germany

Abstract

The decay of elephant dung piles has been shown to be a complex process. Rainfall has been attributed as the main factor influencing dung pile survival in various central African forests. This study monitored elephant dung piles from deposition to disappearance to show that dung survival in Ndoki Forest in northern Congo is mainly influenced by the intensity of irradiance and minimum temperature in the days after deposition. This could lead to substantial differences of dung decay in pristine forest compared with logged forest with a disturbed canopy, and care should be taken when applying rainfall models to calculate dung decay rates. On-site surveying of elephant dung piles covering all habitat types should therefore be undertaken before any elephant dung survey is conducted.

Additional key words: density estimates, *Loxodonta africana cyclotis,* monitoring, rainfall, rainforest

Résumé

Il a été démontré que la dégradation des crottes d'éléphants est un processus complexe. On a montré que dans les forêts d'Afrique Centrale, la quantité de pluie tombée est le facteur principal qui influence la durée de visibilité des crottes d'éléphants. Dans cette étude nous avions suivi la dégradation des crottes du jour de leur déposition jusqu'à leur disparition afin de montrer que dans la forêt de Ndoki située au Nord Congo, la dégradation est principalement influencée par l'intensité de solaire et la température minimale dans les jours qui suivaient leur déposition. Ce qui pourrait conduire à des différences appréciables vis-à-vis la dégradation des crottes dans les forêts intactes et les forêts perturbées. Par conséquent, il faut faire attention en appliquant les modèles de la pluie (« rainfall models »). Avant chaque inventaire sur la densité des éléphants, il est recommandé d'étudier la dégradation des crottes dans le site d'étude.

Mots clés supplémentaires : estimations de densité, *Loxodonta africana cyclotis,* monitoring, pluie, forêt dense

Introduction

Despite intensive conservation efforts, the future of African forest elephants (*Loxodonta africana cyclotis*) is unsure. This is due to numerous threats such as ivory poaching and loss of habitat but also we lack reliable estimates of population size throughout their range (Blake et al. 2007).

The remote Ndoki Forest of the Sangha Trinational Conservation Landscape is one of the last intact forest blocks in central Africa. It harbours one of the largest remaining populations of forest elephants (Blake et al. 2007). Several hundreds up to thousands of elephants have been identified in forest clearings in the region (Vanleeuwe et al. 1998; Turkalo and Fay 2001; Inkamba Nkulu 2005; Mbeli Bai Study, long-term data). However, logging around the protected areas is increasing at a dramatic rate and pressure on the elephant population is continuous because of illegal poaching for ivory (Blake et al. 2007; Carpe

2007). Population estimates are therefore essential to monitor the status of elephants in the region.

Forest elephants are difficult to observe in the dense rainforests of western and central Africa. Therefore indirect survey methods such as dung counts along line transects are used to calculate elephant dung density (Merz 1986; Barnes and Jensen 1987; Plumptre 2000; Eggert et al. 2003 for a genetic survey). To convert dung-pile density to elephant density it is important to calculate dung decay rate (assuming defecation rates are known) (Barnes and Jensen 1987). Decay of elephant dung is a complex process and the use of dung decay rates from other sites or even different seasons can lead to false estimates of elephant densities. Seasonal variation in dung decay is caused by different environmental variables, particularly rainfall (Barnes et al. 1997; Nchanji and Plumptre 2001), and rainfall models have been proposed that can be used to estimate elephant numbers (Barnes and Dunn 2002). Also, the amount of fruit in the diet, the type of habitat, the microclimate where the dung is deposited, and the abundance and diversity of decomposers (particularly fungi and dung beetles) are important factors that regulate dung decomposition (White 1995; Barnes et al. 1997; Nchanji and Plumptre 2001; Mubalama and Sikubwabo 2002; Barnes et al. 2006; Masunga et al. 2006). In addition to this within-site variation, dung decay estimates vary substantially between sites (Nchanji and Plumptre 2001). Using decay rates from other sites can therefore be problematic and on-the-site studies are recommended for each dung survey (Hedges and Lawson 2006).

By knowing the factors affecting dung survival one can better plan the timing and duration of an elephant survey to avoid sampling in seasons with different environmental conditions affecting dung survival. In this study, we monitored the exact duration of elephant dung piles to describe factors affecting dung survival around Mbeli Bai in the south-west of Nouabalé-Ndoki National Park. We investigated how some of the factors mentioned above affect dung survival. Additionally we included an alternative factor, solar radiation, as a covariable that has rarely been included in modelling dung decay.

Methods

Study site and field methods

Dung piles were monitored around Mbeli Bai, a large swampy forest clearing ('bai' in the local language) in the south-west of Nouabalé-Ndoki National Park, Republic of Congo (fig. 1). Fresh dung piles (maximum 24 hours old) were surveyed from shortly after deposition up to the day when we could not detect the dung from a distance of 2 m in the undergrowth (Barnes and Jensen (1987) stage E or Hedges and Lawson (2006) stage S4). Instead of monitoring a dung pile every 7 or 14 days until it decays (Barnes et al. 1997; Nchanji and Plumptre 2001), both authors monitored dung piles that were deposited 1) on the 2.6-km forest path from the research camp to the bai each day (bai path sample) and 2) on phenology trails (around 15 km) in the middle of each month (phenology path sample).

To calculate the lifespan of each dung pile, we calculated the number of days from date of first observation to date last seen in stage D, following morphological categories of Barnes and Jensen (1987).

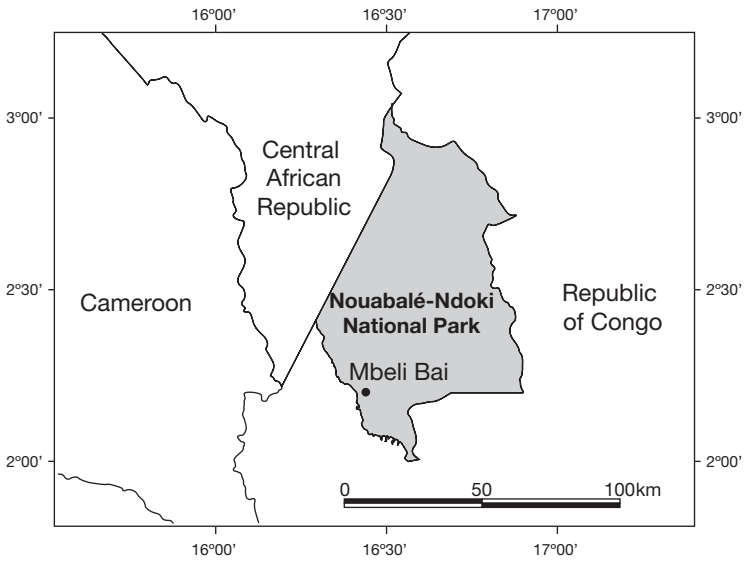

Figure 1. Location of Mbeli Bai in Nouabalé-Ndoki National Park. Map courtesy of Emma J. Stokes.

For dung piles encountered on the phenology path we added a random number between 0 and 30 to the time of deposition to last observation. To reduce the degree of subjectivity in deciding when a dung pile disappeared (see also Nchanji and Plumptre 2001) we monitored various dung piles before we started data collection to arrive at a certain consistency in deciding when a dung pile is no longer visible (Barnes 1996). Whenever we assigned different dates of disappearance of dung piles we used the midpoint of the dates we had assigned. We excluded dung piles that were deposited right on the path because other researchers, porters and trackers used the path and the dung decay there might not be as representative as from elsewhere in the forest (White 1995).

Environmental covariables

We analysed habitat type and climatic factors such as rainfall, temperature and sunshine hours, which might influence the lifespan of elephant dung piles at our site. We did not systematically collect information on other factors such as canopy coverage, activity of other animals or leaf litter, which could potentially influence dung decay.

Three main habitat types can be distinguished in the study area: 1) monodominant *Gilbertiodendron dewrevreii* (hereafter called *Gilbertiodendron* forest) forest—34% of study area with 66% closed canopy coverage; 2) mixed-species forest (mixed forest) on terra firma soil—62% of study area with 49% closed canopy coverage; and 3) seasonally inundated or swamp forest (inundated forest), often found along river courses—4% of study area with 41% closed canopy coverage. We recorded rainfall and temperature (daily maximum and minimum) at our research camp. We estimated solar radiation by monitoring sunshine hours during daily monitoring at the forest clearing. Rainfall variables used included rainfall of the date of deposition and the following 3 (R + 3), 10 (R + 10), and 30 (R + 30) days as well as rainfall of the 3 (R – 3), 10 (R – 10) and 30 (R – 30) days before deposition (Nchanji and Plumptre 2001). We followed the same process with sunshine hours after first detection of dung piles (S + 3; S + 10; S + 30); mean minimum daily temperature (MinTemp + 3; MinTemp + 10; MinTemp + 30); and mean maximum daily temperature (MaxTemp + 3; MaxTemp + 10; MaxTemp + 30) in the days after deposition. We did not aim to investigate how covariables associate with mean monthly dung duration (pooled dung piles monitored in the same month) because of the small monthly sample size (5.94 ± 5.48 piles/month, range 1–23).

Statistical analysis

Previously multiple regressions have been employed to investigate the influence of various covariables on dung survival (Nchanji and Plumptre 2001). More recently Barnes et al. (2006) used a survival model (e.g. Cox hazard model) to evaluate the effect of covariables that had the greatest influence on dung survival. We adopted this approach; details of the method are given elsewhere (Cox 1972; Barnes et al. 2006). Given the large number of covariables, we first condensed variables by applying a principal component analysis (PCA) on each set of variables (rainfall, sunshine, maximum temperature, minimum temperature). Each PCA resulted in condensing three variables into one value with high correlation of the variables (mean 0.89, minimum 0.782). Following Barnes et al. (2006), we first fitted each independent variable by itself. We then added variables to the null model and retained the variables that produced the greatest reduction in $-2\log L$; we continued this until no further significant reduction of $-2\log L$ resulted. Models with AIC (Akaike Information Criterion = $-2\log L$ * 2df) of less than 2 are similar (Burnham and Anderson 2002).

Results

We monitored 171 dung piles deposited from December 2002 to February 2006 on the forest path and 37 from November 2002 to August 2004 on the phenology trail (table 1). Sixty-two per cent of phenology trail dung piles ($n = 23$) were encountered in mixed forest (11% in *Gilbertiodendron* forest, 27% in inundated forest); in the bai path sample only a minor portion of dung piles was encountered in mixed forest because most of the bai path covered monodominant *Gilbertiodendron* forest (54% in *Gilbertiodendron* forest, 15% in mixed forest, 31% in inundated forest). The survival of dung piles showed high variation with some piles disappearing within a couple of days and a few lasting several months. However, most dung piles quickly passed stage A, B and C within one or two days and then remained visible for a much longer period in stage D. The mean survival of dung piles in the bai path sample was 51.3 ± 36.8 days (mean ± SD; range 5–236) and in the phenology trail sample

Table 1. Summary of elephant dung decay duration revealed by the two different sampling methods and habitat types

Method / Habitat type	Sample size (*n*)	Minimum decay rate (days)	Maximum decay rate (days)	Mean decay rate (days)	Standard deviation
Bai path sample					
All	171	5	236	51.298	36.766
Gilbertiodendron forest	93	5	236	53.065	4.496
Mixed forest	25	10	112	57.600	5.895
Inundated forest	53	7	125	45.226	3.448
Phenology path sample					
All	37	3	168	65.243	40.321
Gilbertiodendron forest	4	53	93	78.500	8.770
Mixed forest	23	13	168	81.261	7.334
Inundated forest	10	3	74	23.100	8.182

65.2 ± 40.3 days (range 3–168). Although there was no significant difference in dung survival between the two sampling methods ($t = -1.514$, $P = 0.137$; data square root transformed), survival curves differed between methods (figs. 2a, 2c) and we therefore decided not to pool the data sets.

Dung decay of piles in the phenology path sample showed a slower rate of disappearance in the first 70 days with 57% of dung piles surviving to this age compared with only 22% of piles surveyed daily on the bai path. For both methods dung encountered in mixed forest survived longest (bai path sample: 57.6 days ± 29.5; phenology path sample: 81.3 ± 35.2) and dung in inundated forest disappeared quickest (bai path sample: 45.2 ± 25.1; phenology path sample: 23.1 ± 25.9) with dung found in monodominant *Gilbertiodendron* forest being intermediate (bai path sample: 53.1 ± 43.4; phenology path sample: 78.5 ± 17.5). Figures 2b and 2d show habitat-related differences in dung survival.

Covariables

Given the small sample size of dung piles surveyed along the phenology trail and the different sampling period, we decided to limit all further analysis to the bai path sample of 171 dung piles. Survival of dung deposited in the dry-season months (less than 100 mm rainfall) ($n = 95$) was 63.2 ± 37.5 days (range 13–236) and significantly longer compared with dung deposited in rainy-season months 41.6 ± 33.3 days (range 5–181) ($t = 3.939$, $P < 0.001$).

When we included each of the explanatory variables independently to the null model only the models with 'PC_rain before', 'PC_sun', and 'PC_min_temp' remained significant, but not 'PC_rain after' or habitat type; 'PC_max_temp' showed a trend (table 2). The 'PC_sun' variable was retained because it was the best predictor of hazard (AIC = 1410.77).

The next model included 'PC_min_temp' (AIC = 1396.31). Including 'PC_rain before' did not significantly improve the model (AIC = 1398.26).

The overall model, including all five principal components (PC) and habitat type as a categorical covariable, explained significantly the dung duration (AIC 1395.84, table 2). In this overall model only 'PC_sun', 'PC_min_temp' and 'PC_max_temp' remained significant but not 'PC_rain before', 'PC_rain after', or habitat type.

Therefore, more sunshine and warmer daily minimum temperature appeared to cause longer dung survival whereas rainfall before deposition had no influence on dung duration in combination with sunshine and temperature.

When pooling monthly samples it appeared that mean monthly decay varied substantially between months up to a factor of 2.8 (fastest decay in September, 28 days; slowest decay in February, 79 days). Dung decay was fastest in August to October and slowest in February and March; it remained relatively constant between May and July (fig. 3).

Discussion

Our preliminary data suggest that elephant dung-pile duration at Mbeli Bai is similar to that in data obtained in Lopé National Park (White 1995) and Makokou

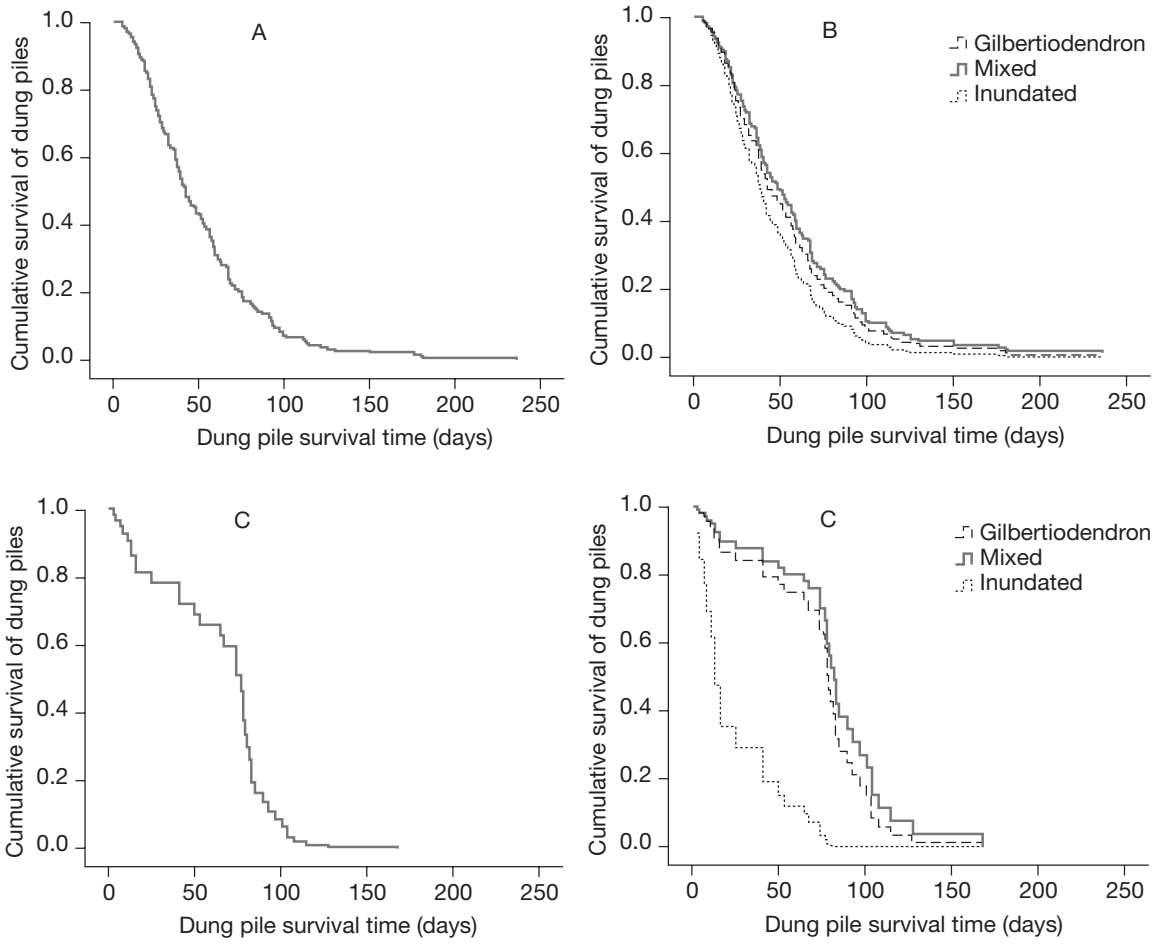

Figure 2. Cumulative survival plots of elephant dung piles showing A) all dung piles monitored on the bai path sample, B) habitat-specific curves of the bai path sample, C) all dung piles monitored on the phenology path sample, and D) habitat-specific curves of the phenology path sample.

in Gabon (Barnes and Barnes 1992) and in Virunga National Park, Democratic Republic of Congo (Mubalama and Sikubwabo 2002) but much shorter than dung decay rates obtained in Cameroon (Nchanji and Plumptre 2001). However, any dung survey ideally has to include a retrospective method prior to the survey (Hedges and Lawson 2006).

Our results confirm that there is substantial variation in dung survival even when dung piles are deposited under apparently similar subjective conditions (same habitat type, same day). Dung decay is a complex process that includes interaction of various environmental variables and hence it is not surprising to find that different studies have found different interactions with dung survival. In comparison with results from other sites (Barnes and Barnes 1992; Barnes et al. 1997) the rate of disappearance after deposition (at least for the bai path sample) was very fast. Fresh dung piles quickly decayed and dung boli broke apart after a few days only (class D). Contrasting modes of disappearance can be caused by different decay of some dung components (fibre, leaf fragments, fruits, other faecal matter). Further studies monitoring different dung-pile classes and dung components through time could provide important insights on why the patterns of disappearance at our site differ. One possible explanation to this quick disappearance might be the increased activity of dung beetles and the absence of dung-pile baking under exposed sunlight. Dung beetles quickly remove the faecal matter of the dung pile and we could observe them causing the complete decay

Table 2. Results from a model using each of the five predictor variables separately and the overall hazard model

Variable in models	Unstandardized regression coefficient (B)	Standard error of B (SE)	Wald test significance value	Degrees of freedom (df)	Significance (p-values)	Expected beta (upper-lower 95% confidence interval)	Akaike Information Criteria (AIC)
Using each of the five predictor variables separately							
PC_rain_before	0.201	0.071	7.938	1	**0.005**	1.222 (1.063–1.405)	1422.25
PC_rain_after	0.021	0.068	0.092	1	0.762	1.021 (0.893–1.167)	1429.49
PC_sun	–0.369	0.086	18.394	1	**< 0.001**	0.691 (0.584–0.814)	1410.77
PC_min_temp	–0.224	0.068	10.763	1	**0.001**	0.799 (0.699–0.914)	1419.64
PC_max_temp	–0.127	0.076	2.789	1	*0.095*	0.880 (0.758–1.022)	1426.70
Habitatcode			2.877	2	0.237		1428.76
Habitatcode(1)	–0.248	0.177	1.967	1	0.161	0.780 (0.552–1.104)	
Habitatcode(2)	–0.362	0.244	2.199	1	0.138	0.696 (0.431–1.124)	
Overall hazard model (AIC = 1395.84, χ^2 = 45.358, P < 0.001, df = 7)							
Habitat_code			4.119	2	0.128		
Habitat_code(1)	–0.343	0.186	3.400	1	*0.065*	0.709 (0.493–1.022)	
Habitat_code(2)	–0.446	0.269	2.740	1	*0.098*	0.640 (0.378–1.085)	
PC_rain_before	–0.035	0.090	0.153	1	0.696	0.966 (0.810–1.151)	
PC_rain_after	–0.055	0.087	0.401	1	0.527	0.947 (0.799–1.122)	
PC_sun	–0.581	0.120	23.396	1	≤ **0.001**	0.559 (0.442–0.708)	
PC_min_temp	–0.483	0.105	21.304	1	≤ **0.001**	0.617 (0.502–0.757)	
PC_max_temp	0.268	0.112	5.731	1	**0.017**	1.307 (1.050–1.627)	

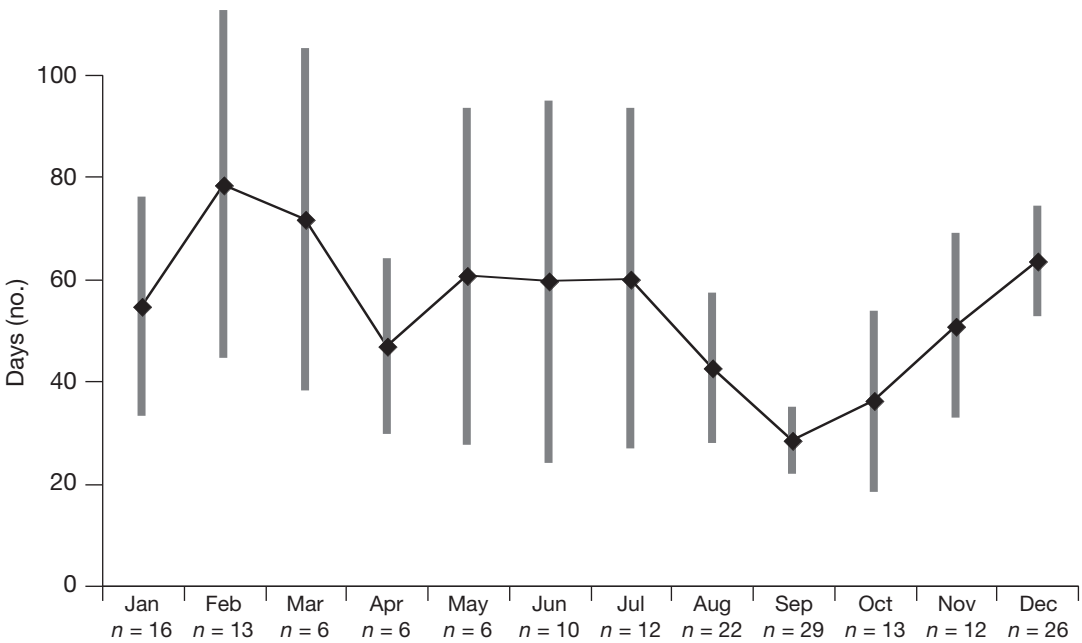

Figure 3. Mean monthly dung decay rates with ± 95% confidence limits (*n* – no. of samples).

of dung piles of western gorillas (*Gorilla gorilla*) and duikers (*Cephalophus* spp.) within a few hours. Other studies have shown that age is an important covariable that has to be included in any decay model (Laing et al. 2003; Kuehl et al. in press).

To our surprise, our findings do not confirm rainfall after deposition as being the most important factor influencing elephant dung decay as previously suggested (White 1995; Barnes et al. 1997; Nchanji and Plumptre 2001), although rainfall before deposition correlated with dung duration in the 0-model, showing that wet conditions on the date of deposition appear to have a positive effect on dung duration.

We found that increased sunshine slowed down the decay process. Sunshine has rarely been considered as a necessary covariable to include, possibly due to the effort needed in collecting data. However, many studies have clearly shown that sunshine can have a pronounced effect on dung survival by baking dung piles, which become 'fossilized' and remain visible for a long period (White 1995; Nchanji and Plumptre 2001). This effect is further supported by the fact that dung piles in more open forest and lower canopy coverage last longer (Nchanji and Plumptre 2001; Barnes et al. 2006). Our results appear to support this finding because dung piles lasted slightly longer in the mixed forest (with less canopy coverage) than in the *Gilbertiodendron* forest.

Further, sunshine might indirectly influence the activity of dung beetles, the main decomposers, through its negative effect on humidity, because sunshine is responsible for the decrease in humidity in Ndoki Forest (H.S. Kuehl, pers. comm.). Humidity triggers the emergence and onset of activity in dung beetles (Doube 1991) and possibly fungi (Masunga et al. 2006). Accordingly, termite and dung beetle activity appears to be less common in the dry season (White 1995) and in open habitats (Horgan 2005; Vernes et al. 2005).

Although we did not note other potential influential variables, it is plausible to assume that canopy coverage, elephant diet and activity of other seed consumers all influence dung duration. Given that fruit consumption of forest elephants is strongly seasonal (White et al. 1993; Blake 2002) it is plausible to assume that large mammals such as red river hogs (*Potamochoerus porcus*) adjust their seed consumption accordingly (White 1995). Observations from Mbeli Bai indicate that seed consumption from dung is more frequent during frugivorous months (T. Breuer pers. obs.). This activity combined with the less fibrous diet during frugivorous months can further accelerate dung decay (White 1995, but see Nchanji and Plumptre 2001).

Additionally, in the semi-deciduous Ndoki Forest, leaf litter in the dry season appears to be higher than in the wet season. It was not uncommon to find elephant dung completely covered by old leaves. We also found that warmer daily minimum temperature resulted in longer dung survival, demonstrating that temperature is an important covariable that needs to be included in dung survival models. In contrast to White's (1995) finding that wet substrate slows down the decay process we found that dung deposited in swamp habitat decayed faster than on terra firma forest, possibly because many piles were washed away and the positive effect of sun baking was missing in these habitat types.

Conclusion

Our study suggests that sunshine plays an important role in the complex process of elephant dung decay, and data on irradiance should therefore be included in modelling dung decay. Calculating cloud cover from satellite images can alternatively be used to estimate solar radiation. Given that many different factors influence dung survival we do not suggest extrapolating dung decay and instead support conducting site-specific dung decay experiments, which should take place before and during the dung survey. However, given the numerous factors that influence the decay process, monitoring an adequate number of dung piles can be time consuming and costly, particularly at sites of low density (Kuehl et al. in press). Our study also shows that adequate sampling in different habitat types including different canopy coverage is important. That might be particularly important given the longer survival of dung deposited in more open forest, potentially leading to an overestimation of elephant numbers in logged forests with disturbed canopy coverage. Further studies are needed to better understand the complex interaction of various climatic factors on dung decay, for example using the retrospective dung decay method (Laing et al. 2003). Using objective criteria of dung decay, such as dung height and volume, should be tested to reduce the degree of subjectivity in deciding when a dung pile disappears (Kuehl et al. in press). Alternative methods such as genetic capture-mark recaptures estimates (Eggert et al. 2003) or acoustic monitoring (Payne et

al. 2003) should be combined with dung estimates to improve our ability and precision to detect population changes.

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Preliminary survey of forest elephant crossings in Sangha Trinational Park, central Africa

Karen Weinbaum[1], Zacharie Nzooh[2], Leonard Usongo[2], Melinda Laituri[1]*

[1] Colorado State University, Department of Forestry, Rangeland Watershed Stewardship, Fort Collins, CO 80521, USA
[2] World Wide Fund for Nature, Cameroon Programme Office, PO Box 6776, Yaounde, Cameroon
* address for correspondence: Department of Environmental Science, Policy and Management, 140 Mulford Hall, University of California, Berkeley, 94720-3110, USA; email: kzw@nature.berkeley.edu

Abstract

Wildlife corridors between protected areas play a critical role in maintaining genetic flow between increasingly isolated populations of many species. The importance of wildlife corridors for African savanna elephants (*Loxodonta africana*) has been well investigated. However, African forest elephants (*Loxodonta africana cyclotis*) are difficult to observe in dense tropical vegetation and much less is known about their ecology than about their savanna counterparts. The Sangha River forms an international border between Cameroon, Central African Republic and Republic of Congo and bisects the biologically rich transboundary Sangha River Trinational Conservation Area. The river serves as a primary route for human transportation and trade in the region, and therefore acts as a partial barrier to elephant movement between protected areas. We used a reconnaissance survey technique and dung counts combined with a GIS analysis to survey elephant crossings on the Sangha River. At present, radio-collaring elephants in dense forest is both logistically difficult and expensive, and therefore ground surveys provide a cheaper alternative method for identifying major elephant movement corridors. Results will contribute to a more targeted approach to anti-poaching patrol efforts in the transboundary area.

Additional key words: dung counts, reconnaissance survey, spatial autoregressive model, corridor

Résumé

Les corridors pour la faune sauvage entre les aires protégées jouent un rôle critique dans le maintien d'un brassage génétique entre les populations de plus en plus isolées de nombreuses espèces. L'importance des corridors pour les éléphants de savane africains (*Loxodonta africana*) a déjà été bien étudiée. Cependant, les éléphants africains de forêt (*Loxodonta africana cyclotis*) sont difficiles à observer dans la végétation tropicale dense, et l'on en sait beaucoup moins sur leur écologie que sur celle de leurs homologues de savane. La rivière Sangha constitue la frontière internationale entre le Cameroun, la République centrafricaine et la République du Congo et donc coupe l'aire de conservation du Trinational de la Sangha qui est biologiquement très riche. La rivière est la principale voie de transport et de commerce dans la région et elle agit partiellement comme une barrière qui freine les déplacements des éléphants entre les aires protégées. Nous avons utilisé une technique d'étude par reconnaissance et le comptage des crottes combinés avec une analyse SIG pour étudier les traversées de la Sangha par les éléphants. Pour le moment, la pose de colliers radio à des éléphants dans la forêt dense est à la fois logistiquement difficile et coûteuse, et les investigations au sol sont une méthode alternative moins chère pour identifier les principaux corridors par où passent les éléphants. Les résultats vont contribuer à une approche plus ciblée des efforts de patrouilles anti-braconnage dans la zone transfrontalière.

Mots clés supplémentaires : Comptages de crottes, reconnaissance, modèle autorégressif spatial, corridor

Introduction

Wildlife ranges of many species are becoming increasingly fragmented and constricted into isolated protected areas as anthropogenic land use expands. This is particularly problematic for species that range widely outside protected area boundaries or are migratory. Corridors between viable populations are regarded as one of the best solutions to mitigating problems posed by fragmentation (Beier and Noss 1998; Tewksbury et al. 2002). Corridors are believed to facilitate wildlife dispersal and migration between safe population havens, thereby enhancing genetic flow and thus the potential for species persistence (Taylor et al. 1993; Beier and Noss 1998; Chetkiewicz et al. 2006). In regions where wildlife habitat is fragmented by roads and railway lines, wildlife corridors are increasingly being used to reconnect otherwise blocked passages (Trombulak and Frissell 2000; Clevenger 2005).

The African savanna elephant (*Loxodonta africana* [Blum., 1797]) is a long-distance and seasonal migrant. Savanna elephant population movements have been well studied, either through aerial surveying, radio- and satellite-collar monitoring (Thouless 1995; Osborn and Parker 2003), indirect indices (de Boer et al. 2000), or a combination of interviews with local people and field observation (Mpanduji et al. 2002). Savanna elephants are known to travel up to 450 km (Douglas-Hamilton et al. 2005) and their home ranges vary from 200 to 10,700 km^2 (Blake et al. 2001). Range corresponds with size of protected area and therefore it is not surprising that whole populations of elephants will travel beyond park borders to sustain themselves. Habitat corridors allow elephants to move between protected areas (Johnsingh and Williams 1999; Osborn and Parker 2003; Douglas-Hamilton et al. 2005).

Much less is known about forest elephant *(L. africana cyclotis* [Matschie, 1900]) movements, however. Genetic evidence has recently confirmed the separation of the African elephant (formerly recognized as *L. africana* with two subspecies) into at least two distinct species: savanna elephants *(L. africana*) and forest elephants *(L. cyclotis*) (Roca et al. 2001), and even a third, West African species, has been proposed (Eggert et al. 2002). Forest elephants play a keystone role in equatorial Africa's tropical forests, structuring tree species composition and physiognomy through seed dispersal (Western 1989), opening up clearings around salt licks and forest gaps, and engineering major paths within the forests subsequently used by other animals and humans (Blake and Inkamba-Nkulu 2004). Forest elephants make up most of mammalian biomass (52–89%) in the African tropical forest ecosystem, underscoring their importance in ecosystem function (White 1994a). They are often one of the first mammalian species to be hunted to local extinction, making them an important indicator species of hunting pressure (White and Edwards 2000).

Unlike savanna elephant populations that can be censused and monitored by aerial surveying, forest elephant ecology is often extrapolated from indirect methods, most commonly using dung counts as a proxy for elephant abundance (White 1994b; White and Edwards 2000), but also through identification of individual elephants at a small number of forest clearings (Turkalo 1996). That the understanding of forest elephant ecology remains low relative to that of the savanna elephant is largely due to logistical difficulty in sampling large, remote swaths of rainforest, the dense canopy cover that precludes aerial surveillance, and habitat that is located in countries often beleaguered by corruption and political strife (Blanc et al. 2003). Seasonal and cross-border movements are additional confounding factors when trying to understand the ecology of a species from static dung counts. VHF and GPS collaring of forest elephants has begun to shed light on home range size, seasonal migration and ranging behaviour. However, collaring in tropical humid forest conditions is still logistically difficult, expensive and subject to relatively high rates of equipment failure (Blake et al. 2001).

Past forest elephant survey efforts have focused on estimating elephant population numbers (Fay 1991; Fay and Agnagna 1991; Barnes et al. 1995b; Hall et al. 1997), and how elephant distribution correlates with human abundance (Barnes et al. 1991; Fay and Agnagna 1991; Hall et al. 1997). White (1994b) noted that elephant movements and densities were strongly correlated with the seasonal fruiting phenology of *Sacoglottis gabonensis*, a fruit elephants greatly favour. Preliminary data from radio-collaring is showing that elephants spend significant time outside protected areas (Usongo 2003; Douglas-Hamilton et al. 2005), traverse national park territories and may have minimum home ranges of 800–1000 km^2 (Blake et al. 2001). Despite emerging reports of elephants crossing country borders and major rivers (Ekobo 1995; Usongo 2003), little is still known about sea-

sonal migratory behaviour or major corridors (Barnes 1999).

The objectives of this study are to identify major forest elephant crossings on the Sangha River between Cameroon, Republic of Congo (Brazzaville), and Central African Republic using dung count methodology and to predict environmental and anthropogenic determinants of elephant corridors in the study region. This study complements existing research work on trans-boundary monitoring of radio-collared forest elephants and will contribute to more targeted anti-poaching patrols in the study area.

Materials and methods

To identify major elephant crossing points and model ecological and anthropogenic determinants of elephant distribution in the study region, we used the directed reconnaissance survey method to collect dung encounter rates as an index of relative elephant abundance. This method was developed to survey elusive mammals in dense humid African rainforests (White and Edwards 2000), and dung encounter rates were quantified as the number of dung piles per kilometer surveyed. We also collected georeferenced data on active and abandoned human settlements and obtained vegetation class data from Landsat Thematic Mapper (TM) satellite imagery. Our models used dung encounter rates as the dependent variable, and both active and abandoned human settlements and percentage of vegetation classes as independent variables. Because of possible autocorrelation in the data, we compared ordinary least squares and a spatial autoregressive model to examine significant predictors of elephant abundance indices.

Study area

The Sangha Trinational Park Conservation Area is formed where the borders of three protected areas in three central African countries meet—the Dzanga-Sangha Dense Forest Special Reserve and Dzanga-Ndoki National Park in south-western Central African Republic, Nouabalé-Ndoki National Park in northern Republic of Congo (Brazzaville), and Lobeke National Park in south-eastern Cameroon, contributing to a contiguous protected forest of over 10,000 km^2 (fig. 1).

The vegetation is representative of the northern fringes of the Guinea–Congolean forest block with

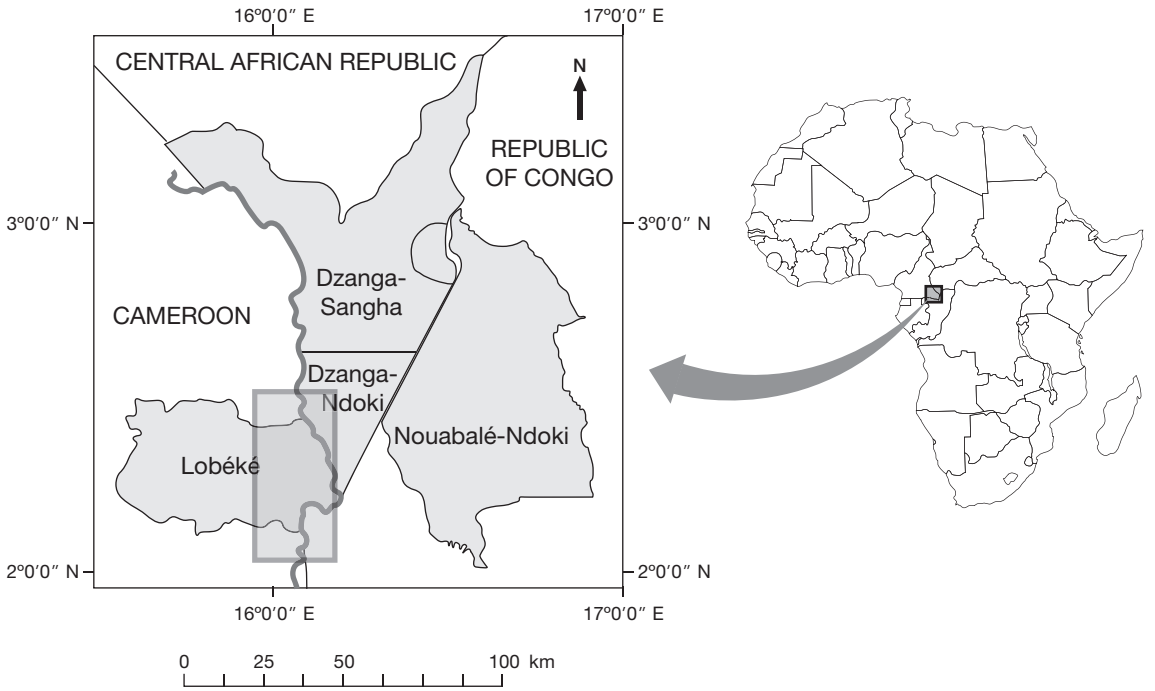

Figure 1. Sangha Trinational Park region, Central Africa. Box indicates study area.

semi-deciduous forest on sandy clay soils, evergreen forest on red clay soils, and transitional evergreen and semideciduous forest (Letouzey 1985; Ekobo 1995). The climate is transitional between the Congo-equatorial and subequatorial zones with a mean annual rainfall of 1400–1500 mm (Ekobo 1995; Blake 2002a). Rainfall is bimodal with peaks in June and October and a main dry season from December to March, with 100–120 rainy days per year. The average daily temperature is 24 ºC with little seasonal variation (Blake 2002a).

Field methods

Mammal surveys in the African rainforest are traditionally carried out using the line transect method, considered the most efficient way of sampling large areas (White and Edwards 2000; Buckland et al. 2001). Line transects in rain forest are cut through vegetation following a compass bearing, and either live sightings or indirect indices (e.g. nest or dung counts) are recorded. There are several drawbacks to this method; it is time-consuming, expensive (considering logistics of labour and transportation), and detrimental to the forest by directly damaging the vegetation and by facilitating hunter access into formerly unpenetrated forest (White and Edwards 2000).

The reconnaissance modification of line transect sampling (hereafter 'recce') for humid tropical forest surveying has recently been developed (Walsh and White 1999; White and Edwards 2000; Walsh et al. 2001). In a recce survey, the observer follows pre-existing paths or the path of least resistance through the brush whenever possible, with less than 45º deviance in either direction from a compass bearing. Advantages of this method are faster travel (allowing more distance to be covered) and less physical damage to vegetation. The main disadvantage is that this method may produce biased results because the survey technique is not random and may not be representative of all vegetation or habitat types. However, Walsh and White (1999) compared paired 1-km recce and line transects of elephant dung in several central African forest sites and found the slope of the relationship between pairs to be 0.98, indicating a nearly one-to-one relationship, for a much higher sampling efficiency. In this study we use mean dung encounters per kilometre of recce survey as an index of relative abundance. However, if true animal density estimates are desired, the directed reconnaissance survey can be combined with traditional transects (using a correction factor for inherent site-dependent bias) and distance methods used to calculate density estimates (Walsh and White 1999; Buckland et al. 2001; Walsh et al. 2001). Dung counts are the standard proxy for estimating relative elephant abundances, density estimates, and distribution in forests (Barnes et al. 1991; White and Edwards 2000). They are undertaken along line and/or recce transects. For each dung pile, the age of dung, vegetation type and other animal and human signs are recorded.

In this study we used two 60-km long parallel recce surveys (hereafter 'transects') along both banks of the Sangha River (fig. 2a): on the Cameroonian border (western bank of the Sangha River, hereafter 'west bank'), and the Central African Republic and Congolese border (eastern bank of the Sangha River, hereafter 'east bank'). Surveys were conducted at a distance of 50–100 m from the Sangha River on both its east and west banks, within and adjacent to Lobeke National Park (south-east Cameroon), Nouabalé-Ndoki National Park (northern Congo) and Dzanga-Ndoki National Park (southern Central African Republic), between March and May 2003. Surveying forays were 3–10 days in the forest, with three local assistants, covering a total of 120 km. Each datum was georeferenced and entered directly into a Palm Pilot with CyberTracker Software 2.72 and a GPS Navigator attachment, which allowed continuous GPS coverage and data storage.

Data analysis

We buffered each transect line at 200 m in ArcGIS v9.1, and divided these into kilometre-long segments. The unit of analysis was the number of dung counts per kilometre (log transformed). These were used to calculate the correlation between mean dung encounter rates on each side of the river, as the dependent variable in modelling determinants of elephant abundance (by indirect dung encounter rates).

We also used ArcGIS to count the number of abandoned and active villages in each segment, and tabulate percentage of types of vegetation for each kilometre segment, based on 15 classes of a supervised 30 x 30-m resolution Landsat TM image. These types were consolidated into nine vegetation classes based on ecological similarity, to integrate land classes with low representation. The final class types were monodominant evergreen *Gilbertiodendron dewevrei* forest (> 90% canopy cover), mixed

semi-evergreen closed forest (> 90% canopy cover), mixed semi-evergreen semi-open forest (60–90% canopy cover), mixed semi-evergreen forest with understorey dominated by *Megaphrynium* spp. (very open), semi-evergreen mixed species tall swamp, monodominant *Raphia* swamp, savanna, agriculture, and bare soil and roads.

We evaluated the relative influence of ecological and anthropogenic determinants on the spatial distribution of elephants (according to dung distribution) in the study area using multiple regression. Most natural ecological phenomena display spatial structuring and typically ecological phenomena are positively autocorrelated in space, so that nearby points have more similar values than would be expected at random (Legendre 1993; Carroll and Pearson 2000; Lichstein et al. 2002). If autocorrelation is present, the value at one location can be partly predicted by values at nearby locations, violating the basic assumption of independence in most common statistical tests and predictive models used in ecology (Carroll and Pearson 2000). Violation in the assumption of independence can lead to false conclusions in interpreting statistical results, including failure to discover existing relationships, false identification of non-existing relationships and inaccurate predictions (Carroll and Pearson 2000). The continuous nature of line-transect sampling and recce surveys, designed to maximize data collection with logistical efficiency, also increases the chances of sampling autocorrelated data. Therefore, we tested for the presence of spatial autocorrelation in the data using Moran's I and Geary's C statistics. Once detected, spatial autocorrelation can best be dealt with using spatial autoregressive models (Legendre 1993; Carroll and Pearson 2000; Lichstein et al. 2002).

We used the log transformed number of dung counts per kilometre segment as the response variable, and a dummy variable for the east–west transect, latitudinal and longitudinal coordinates, presence of abandoned and active villages, and nine vegetation types. We compared the ordinary least squares (OLS) method with three spatially autoregressive models—spatial lag, spatial error, and exponential autoregressive (Carroll and Pearson 2000; Lichstein et al. 2002)—which make slightly different assumptions about how to model spatial effects.

An exponential covariance structure was chosen from available PROC MIXED spatial correlation models based on lowest Akaike's Information Criterion. For all models, non-significant vegetation variables were removed with stepwise selection and we

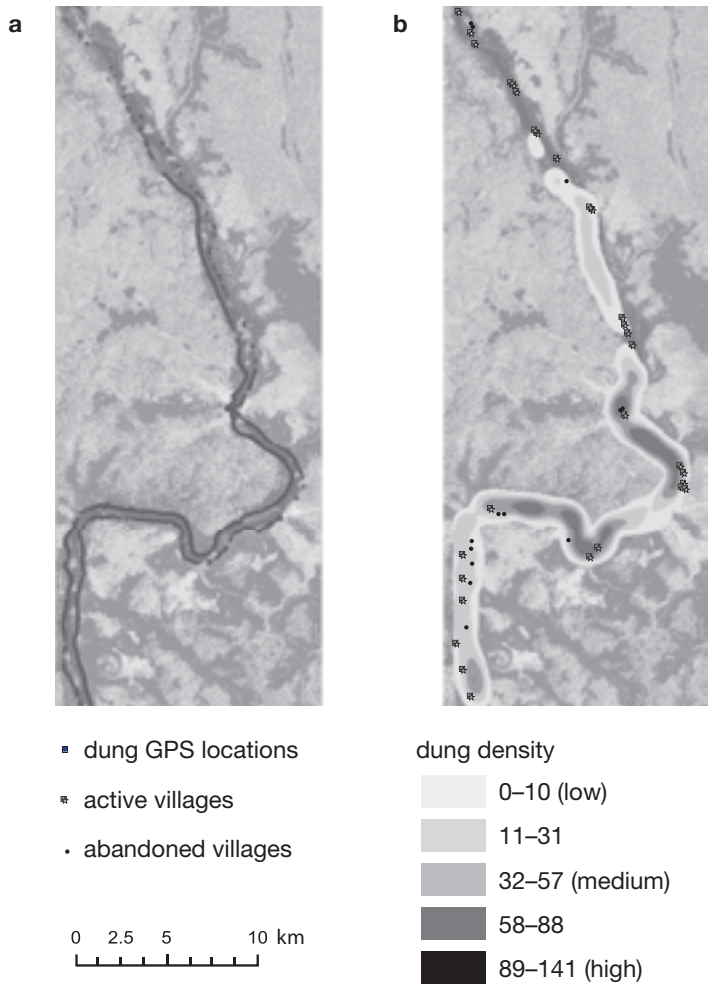

Figure 2. a) GPS locations of dung counts recorded on east and west transects of Sangha River; b) final density map of elephant crossing locations (dung counts per km^2).

checked for and removed collinear variables based on a multicollinearity index and cross-correlation between independent variables (SAS v9.1, Geoda 0.95i). We used minimum AIC's to select the most parsimonious model.

Results

A total of 120 km of transect segments were conducted, 60 km on the west bank of the Sangha River (Cameroon), and 60 km on its east bank (Central African Republic and Congo). In all, 3545 dung piles were encountered (2572 on the west bank and 973 on the east bank). After harmonizing start and finish points on both transects, 59 adjacent transect segments on each side of the river were used for this analysis, with 2570 dung piles on the western transect and 960 on the eastern transect. Figure 2b shows the final map of elephant corridors based on dung counts.

Although separated by no more than 0.5 km in most places, the mean dung count was significantly higher on the west bank (43.56 ± 4.25 SE per km) than on the east bank (16.27 ± 2.12 SE per km, $t = 5.75$, $P < 0.0001$, fig. 3). The correlation coefficient (Pearson product moment) of the relationship between dung counts on the east and west bank before adjustments for spatial autocorrelation in the residuals was positive and significant ($r = 0.6385$, $F = 39.23$, $P < 0.0001$) (fig. 4).

Dung counts per kilometre between each transect were significantly correlated with one another, and each transect alone also exhibited internal trends. The west bank was described by a negative second-order polynomial equation ($R^2 = 0.8374$). This showed first an increasing and then a decreasing trend in dung density along the transect in a north-to-south direction. The east bank was also described by a negative second-order polynomial equation ($R^2 = 0.6395$), with a general increasing trend from north to south along the transect (fig. 5).

The Moran's I and Geary's C tests for autocorrelation in continuous data revealed the presence of significant autocorrelation in the residuals of the data: Moran's $I = 0.8632$, $P < 0.0001$, Geary's $C = 0.2056$, $P < 0.0001$, for the west bank; and Moran's $I = 0.7932$, $P < 0.0001$, Geary's $C =$

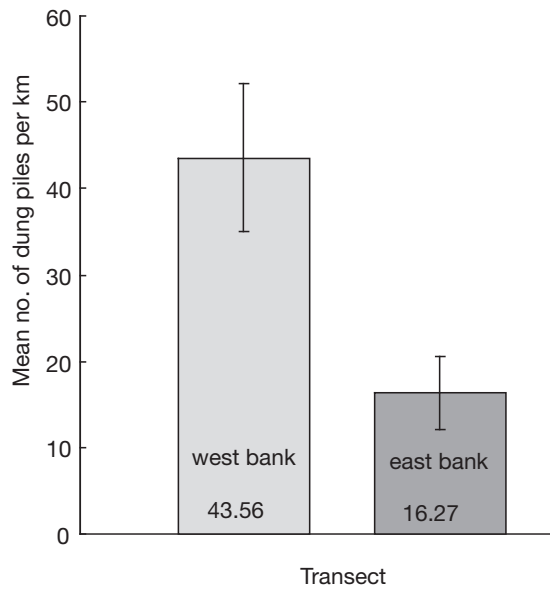

Figure 3. Mean dung pile density per kilometre of transect, west and east banks (error bars indicate 95% confidence).

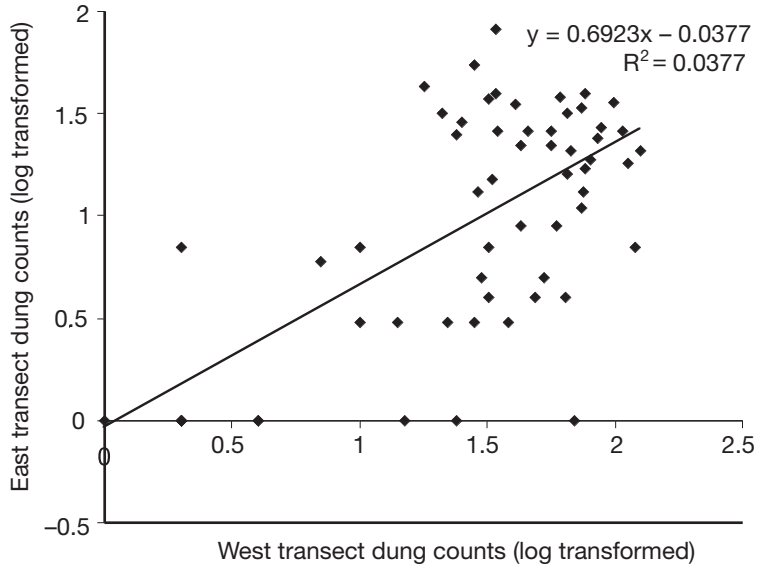

Figure 4. Correlation between east bank and west bank, $r = 0.6385$.

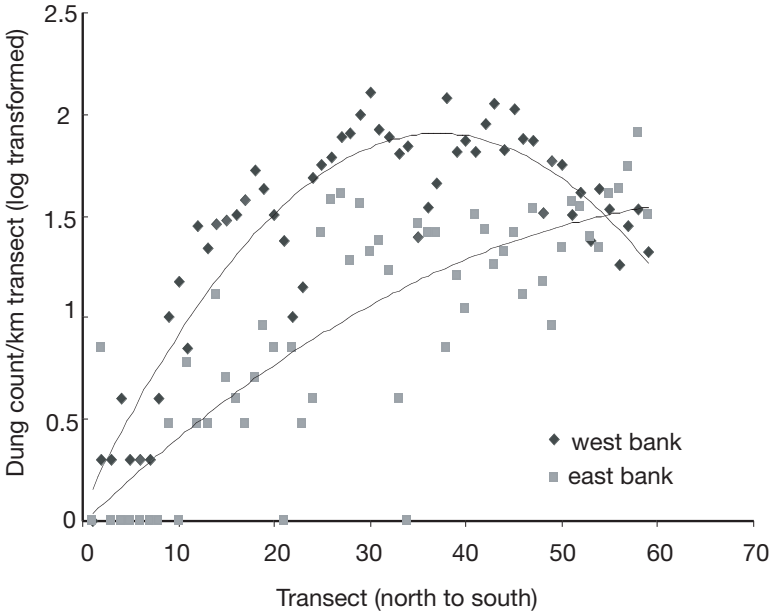

Figure 5. Dung pile counts per kilometre transect from northern to southern end of each transect. Fit trend lines for the west bank are described by the equation $y = –0.0013 \times 2 + 0.0995x + 0.0588$ ($R^2 = 0.8374$), and for the east bank $y = –0.0003 \times 2 + 0.0455 – 0.0123$ ($R^2 = 0.6395$).

0.3246, $P < 0.0001$, for the east bank; thus violating the assumption of most common statistical methods of independent errors (Legendre 1993; Lichstein et al. 2002). Therefore, a spatial *t*-test (Reich and Davis 2003) was used to compare means, which also showed significant differences in mean counts ($t = 14.31$, $P < 0.0001$). Autocorrelation function plots, which reflect how much correlation is present between lagged observations for each transect, also demonstrate significant positive correlation in successive counts, up to a distance (lag) of about 8 km in both cases.

Comparison among models

Parameter estimates among the OLS model and three autoregressive models were similar, so we discuss here only the OLS and best fit (lowest AIC) auto-regressive model. According to the overall lowest AIC ranking, the spatial error autoregressive model provided the best fit to the data and accounted for 85.6% of the observed variability (AIC = 28.42, $R^2 = 0.8561$, table 1). All models showed highly significant 1) difference in mean dung density between transects, 2) increase in dung density when moving southward along the transects, and 3) positive correlation with mixed species tall swamp and monodominant evergreen *Gilbertiodendron dewevrei*. Most models predicted a significant positive correlation with abandoned villages, negative correlation with active (currently inhabited) villages, and positive correlations with monodominant *Raphia* swamp, mixed semi-evergreen closed forest and mixed semi-evergreen, semi-open forest.

Discussion

Though separated by not more than 500 m in most places, there was a significantly higher number of dung piles per kilometre on the west bank than on the east bank, indicating significantly higher elephant densities. These results may be partly explained by previous logging regimes in the area, or different current park management strategies. Large areas of the Cameroonian side have previously been logged, including up to 60% of the national park's territory (L. Usongo, unpublished data). Elephant preference for secondary vegetation has been well documented (Barnes et al. 1991, 1995a) and is seen in other species as well such as forest buffalo (Blake 2002b) and gorillas (Matthews and Matthews 2004). Additionally, each park is managed by different government wildlife institutions and supported by a different non-governmental organization (NGO). This may have more direct impact locally if management styles and strictness of anti-poaching efforts vary.

In addition to the generally higher dung-encounter rates on the west bank, it was interesting to note another difference between trends in each transect: the significant negative polynomial trend on the west bank (first increasing and then decreasing at the southernmost end of the transect), and the increasing trend on the east bank (fig. 5). We suspect two reasons for these trends: first, the presence of a relatively large logging town (pop. ~8000) about 15 km north of the transect lines may negatively affect the distribution of forest elephants in the northern portion of both transects (and as noted by Barnes et al. (1995), 'man

Table 1. Parameter estimates and significant level of OLS and spatial autoregressive models with inverse-distance weight matrix (spatial lag and spatial error), and exponential covariance structure (exponential autocorrelation model)

Variable	OLS model	Simultaneous autoregressive (spatial lag model)	Simultaneous autoregressive (spatial error model)	Exponential autocorrelation model
Constant	–0.0400 ± 0.4648	–0.4709 ± 0.4201	–0.1394 ± 0.3773	0.0958 ± 0.3983
East–west	–0.4110 ± 0.0796***	–0.4451 ± 0.0702***	–0.5087 ± 0.0660***	–0.5320 ± 0.0676***
UTM northing	–1.2482 ± 0.1981***	–1.0068 ± 0.1884***	–1.2351 ± 0.2159***	–1.2346 ± 0.2642***
UTM easting	0.4553 ± 0.0927***	0.3754 ± 0.0852***	0.4904 ± 0.1248**	0.4799 ± 0.1842*
Abandoned villages	0.0681 ± 0.0269*	0.0640 ± 0.0238**	0.0640 ± 0.0199**	0.0589 ± 0.0212**
Active villages	–0.0626 ± 0.0249*	–0.0546 ± 0.0220*	–0.0309 ± 0.0183	–0.0251 ± 0.0192
Mixed species tall swamp with closed canopy	1.9743 ± 0.4515***	2.0183 ± 0.3985***	2.0866 ± 0.3641***	1.8636 ± 0.3726***
Raphia swamp	1.4938 ± 0.4702**	1.6068 ± 0.4147***	1.6306 ± 0.3800***	1.4442 ± 0.3930**
Gilbertiodendron dewevrei forest	2.3856 ± 0.5240***	2.4460 ± 0.4627***	2.5646 ± 0.4274***	2.2504 ± 0.4422***
Savanna	1.4894 ± 2.3030	2.3084 ± 2.0344	1.9537 ± 1.8609	1.4136 ± 1.8901
Agriculture	0.3948 ± 1.4973	1.1194 ± 1.3213	2.3708 ± 1.1771*	1.8977 ± 1.2129
Bare soil; roads	1.1723 ± 0.7701	1.1414 ± 0.6799	1.2476 ± 0.5944*	1.0414 ± 0.6116
Mixed species semi-evergreen, understorey *Megaphrynium* spp.	4.1669 ± 1.5112**	3.8130 ± 1.3330**	2.1455 ± 1.2133	1.9405 ± 1.2257
Mixed species semi-evergreen forest (closed)	2.4440 ± 0.8184**	2.5254 ± 0.7229***	1.7143 ± 0.7242*	0.6391 ± 0.7484
Mixed species semi-evergreen forest (semi-open)	2.4528 ± 0.7775**	2.6237 ± 0.6857***	2.9603 ± 0.6374***	2.8951 ± 0.6304***
Lambda			0.4575 ± 0.0667***	
R^2	0.7999	0.8217	0.8561	
AIC	52.2414	44.1345	28.4241	29.80

Geoda 0.9.5-i5, SAS v9.1, S-PLUS 2000, Reich and Davis 2003
*$P \leq 0.05$, **$P \leq 0.01$, *** $P \leq 0.001$, AIC based on maximum likelihood

determines the distribution of elephants'). These trends may also be partly explained by NGO presence (Wildlife Conservation Society) on the southern end of the east bank transect (Congo) near the logging town of Kabo. Locals claim that anti-poaching laws there have been strictly enforced on the Congo side of the river. The act of strictly enforcing anti-poaching laws on one side of an international border may chase a number of poachers to the other side of the border where there is less on-the-ground enforcement.

The regression models in this study linked observed dung counts per kilometre to explanatory human and environmental variables, to identify potential determinants of elephant crossings. All models showed highly significant 1) difference in mean dung density between transects, 2) increase in dung density when moving southward along transects, and 3) positive correlation with mixed species tall swamp and monodominant evergreen *G. dewevrei*. Most models predicted a significant positive correlation

with abandoned villages, negative correlation with active (currently inhabited) villages, and positive correlations with monodominant *Raphia* swamp, mixed semi-evergreen closed forest and mixed semi-evergreen, semi-open forest (table 1).

The regression models revealed patterns similar to those in other published accounts. All the models predicted significant positive trends of elephant dung with abandoned camp sites (secondary vegetation), and two of the models predicted significant negative trends with sites presently occupied by humans (generally small clusters of housing). Previous research has also found preference of forest elephants for secondary or disturbed vegetation (Barnes et al. 1991; Barnes et al. 1995a), and elephant avoidance of active human settlement (Barnes et al. 1991; Fay and Agnagna 1991; Hall et al. 1997). All models showed strong positive correlation with monodominant evergreen *G. dewevrei*. Of the Caesalpiniaceae family, *G. dewevrei* forms extensive single-species stands in the Congo Basin, commonly in riparian areas (Blake and Fay 1997). It is a supra-annually mast-fruiting tree and elephants likely receive high payback from foraging on seeds of *G. dewevrei* in mast-fruiting years. Mast-fruiting refers to the intermittent and synchronous production of large quantities of fruits by a community of plants over long intervals (Numata et al. 1999). Both swamp vegetation types (mixed species tall swamp and monodominant *Raphia* swamp) were also consistently significant predictors across models. Swampy vegetation types may offer large quantities of herbaceous browse that are unavailable in more closed forest habitat types (Barnes et al. 1991). Finally, mixed semi-evergreen closed forest and mixed semi-evergreen forest with understorey dominated by *Megaphrynium* spp. were significantly correlated with elephant dung counts in half of the models. These semi-evergreen forests ranked highest in a list of 23 evaluated for fruit trees favoured by elephants and exhibiting high elephant densities. Additionally, at least one author describes that the highest consistent density of forest elephants yet recorded (ca. three individuals ha^{-1}) was in the Marantaceae (*Megaphrynium* spp.*)* forest of Lopé Reserve, Gabon (White 1994a), a vegetation type for which half the models predicted positive correlation.

As suspected, the transect data exhibited strong autocorrelation. The recognition that most natural ecological phenomena have spatial structure (e.g., patchiness and gradients) (Legendre 1993; Lichstein et al. 2002) continues to be relatively ignored in ecological research in general and in transect studies in particular, and can potentially have serious ramifications in parameter and trend estimations. The OLS model was compared with various spatial models that in addition to modelling independent variables model the correlated residuals. Differences between models proved to be relatively minor in our study, with strong overlap in parameter estimates and significance levels. While parameter estimates were similar among the models, AIC model selection favoured a spatial model, which accounted for over 85% of the variability observed in dung density effects. The autocorrelation function plot revealed that the transect data are autocorrelated up to a distance of 8 km. This suggests that future transect work in this region for forest elephants should either be spaced out at distances larger than 8 km apart for independent sampling units or analysed using autoregressive models. Any data from similar survey work should be examined for autocorrelation.

The Sangha Trinational Park conservation area provides habitat for some of the largest intact populations of large mammals, notably forest elephants and western lowland gorillas (*Gorilla gorilla gorilla*). Initial results from radio-collared forest elephants show that home ranges of elephants in Sangha Trinational Park go far beyond protected area boundaries, with some individuals travelling more than 150 km outside the national park boundary and spending at least 40–60% of their time in surrounding land-use zones, primarily logging concessions (Blake et al. 2001; Blake 2002a; Usongo 2003). Any protection effort by park authorities to save elephant populations must include participation of all stakeholders in the surrounding use zones including logging companies. Effective transboundary protected areas will also require full coordination between participating country national park staff and conservation NGOs in monitoring and surveillance of wide-ranging species to adequately ensure their survival.

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Determining minimum population size and demographics of black rhinos in the Salient of Aberdare National Park, Kenya

Felix Patton, Martin Jones

School of Biology, Chemistry and Health Science, Manchester Metropolitan University, Manchester M1 5GD, UK; email: felixp@africaonline.co.ke

Abstract

Photographic identification techniques were applied in the Salient of Aberdare National Park, an area known to be one of the most difficult in Kenya for sighting and identifying black rhinos (*Diceros bicornis*). A method of assessing photographs visually was used to identify individuals. Individual identification features were recorded and an identification description written for each rhino. Descriptions were reduced to 'descriptors' and combined with appropriate photographs in a searchable Access database; a simple sighting recording system that could be used in conjunction with the database was developed. The database and a standard method of describing the identification features of each of the rhinos enabled details of individuals to be disseminated, patrol rangers trained to identify individuals accurately, minimum population demography to be described and changes in minimum population size, from potentially 23 in 2003 down to possibly only 7 individuals in 2005, to be observed. Resighting some of the rhinos was a problem, and there was concern that the significant reduction in the number of previously identified individuals may have been due to poaching.

Résumé

On a appliqué des techniques d'identification photographique dans le *Salient* du Parc National des Aberdares, une zone connue pour être une des plus difficiles du Kenya pour l'observation et l'identification des rhinos noirs (*Diceros bicornis*). On a utilisé une méthode d'évaluation visuelle sur photos pour identifier les individus. Les caractéristiques de chaque individu et une description permettant de l'identifier ont été rapportées pour tous les rhinos. Les descriptions ont été réduites à des « descripteurs » et combinées aux photographies appropriées dans une base de données Access ; on a mis au point un système simple de compte-rendu des observations qui peut être utilisé en conjonction avec la base de données. La base de données et une méthode standardisée pour décrire les caractéristiques d'identification de chacun des rhinos ont permis de faire connaÓtre les détails concernant les individus, de former les gardes en patrouille à l'identification précise des animaux, de décrire la démographie minimale de la population et d'observer les changements de la taille minimale de la population qui est passée de 23 animaux potentiels en 2003 à seulement sept en 2005. Il a été problématique de revoir certains des rhinos, et la réduction significative du nombre des individus identifiés auparavant pourrait être due au braconnage.

Introduction

The Aberdare Mountains support the largest indigenous forest in Kenya. They run along the edge of the Rift Valley for some 60 km in the central part of the country. In 2004 the ecosystem, which covers 2185 km^2, received international recognition as a 'tropical wilderness hotspot' (an area of crucial importance to climate regulation and watershed protection) by the Global Conservation Fund in partnership with Conservation International. Aberdare National Park covers some 767 km^2. The area in the east known as the Salient extends from Treetops Lodge to the 2600-m contour and covers 100 km^2. It receives up to 1000 mm of rainfall per year with peaks in March–May and October–November.

The altitude exceeds 3000 m with Dongo Lesatimma in the north reaching 3999 m and Kinangop

in the south 3905 m. There are five main habitat zones: 1) salient shrub characterized by *Ocimum suave*, *Hypoestes verticillaris* and *Toddelia asiatica*, with swampy glades rich in mineral salts; 2) bamboo forest with closed canopy and little undergrowth; 3) moorlands of tussocky grassland; 4) north and south montane forests on the lower slopes; and 5) north and south hagenia forests on the upper slopes.

In the 1940s and 1950s, the Aberdares forest was known to hold one of the highest densities of black rhinos in Kenya with estimated densities of at least one rhino per square kilometre (Sillero-Zubiri and Gotelli 1991). There were thought to be 450 black rhinos in the park in the early 1970s but a census in 1982 recorded only 132, and by 1987, the population was estimated at 50, 30 of which were in the Salient (Sillero-Zubiri and Gotelli 1991). The Salient was identified by the Kenya Wildlife Conservation Department (now known as the Kenya Wildlife Service, KWS) as a priority area for developing a rhino sanctuary. It was upgraded from a priority area to rhinos sanctuary status in 1988. An electric fence was constructed along the part of its boundary that abutted land settlement and this was completed in 1990 (Brett 1993). During June–July 1991, 31 different rhinos were identified at the Ark and Treetops lodges (Brett 1993), the two tourist lodges located in the Salient. A photography-based monitoring programme in July 2000, based mainly at night at these two lodges, resulted in photographs of 17 individual rhinos being placed on record.

The population of rhinos in Aberdare National Park is particularly valuable as it is indigenous with only one rhino introduced from outside from the neighbouring Solio Ranch. The Aberdares population was believed to be genetically pure and represents the only large, indigenous population of the 'highland' ecotype in Kenya (Brett 1993).

At the start of 2003, KWS had no accurate census of the rhinos in Aberdare National Park and therefore could not evaluate whether the management plan for the rhinos was the most effective to ensure their safety and successful breeding performance. Changes in the KWS Aberdare rhino unit personnel meant that a largely new team of rangers was given the task of estimating the number, recording individual identity by photographs or drawings, and regularly monitoring the rhinos in the Salient. Daytime rhino sightings were rare, often of only a few minutes duration and from a distance that made identification photography or drawing impossible. Also many sightings were either early in the morning or late in the evening when light levels were too low for the equipment to work. Preliminary discussions with and observations by KWS staff at Aberdares suggested there was much confusion over the rhino population size and structure. Between 50 and 60 rhinos were thought to be ranging mostly in the Salient, but most sightings were recorded as 'unidentified' because new staff did not know how to distinguish individuals and often could not get close enough to recognize identification features. The shrub habitat of the Salient is very dense and offers a special challenge first to finding and then to observing rhinos for a time sufficient to make reliable identification.

The aims of the study were to photograph and positively identify individual rhinos in the Salient, use the photographs to make a 'best estimate' of the minimum current rhino population, and use the photographs to assist in training local staff to identify individual rhinos as part of the KWS rhino-monitoring programme.

Materials and methods

The work was carried out by vehicle-based monitoring throughout the Salient during the day and at the Ark and Treetops lodges, where rhinos visit the waterholes and salt licks, mostly at night. Daytime patrols were between one and five and a half hours long. Daylight techniques for obtaining, enhancing and analysing appropriate identification photographs (left and right body profile, left and right head profile, a front view of the head, left and right ear, nose wrinkles and rear view) were known from previous research (Patton 2007). A pilot research study was carried out in February 2002 to consider, from the equipment available, what was best suited to taking photographs at night under lodge floodlighting systems. Identification research was undertaken during March, June and September of 2003 and 2004 and March and June 2005. Monitoring was carried out on 112 days, which included 209 daytime patrols throughout the Salient, 66 nights at the Ark and 42 nights at Treetops.

Equipment and processing

Daytime photographs were taken from a vehicle during patrols in the Salient. Those made in good light were taken with a Minolta Dynax 5 single-lens reflex camera with Tokina 80–400 mm zoom lens. This

lens allowed good flexibility and versatility in open-ground conditions. Low-cost ASA 400 colour film was used. Rhinos were found in the open at certain locations early in the morning and late in the afternoon when only a Sony TRV240 digital camcorder (video camera) could successfully capture images in the low light levels.

For night photography at the artificially lit waterholes, it was found that a 400 mm K lens attached to a Minolta Dynax 5 camera body gave adequate results. It required placing the camera on a bean bag and using an external shutter switch to avoid any camera shake. The film used was ASA 1600, or ASA 800 with the camera stopped to ISO 1600, which was cheaper than using ASA 1600 film and gave acceptable results. With these materials, it was necessary to leave the shutter open for several seconds to bring in sufficient light. It was important to capture the rhino when it was completely still to avoid blurring. Several attempts were often needed to do this.

To overcome the problem of animal movement, we also used a Sony TRV240 digital camcorder and Digital8/High8 tape. With a x25 zoom it was possible to get close-up images of identification features.

The layout of the Ark waterhole meant that rhinos came as close as 10 m to the building where a ground-level concrete photohide allowed direct photography rather than through the glass windows of other observation points, which reflected light and gave poor results. The area was brightly lit and both still and video cameras gave good results.

At Treetops, the lighting was less bright. The layout of the waterhole was such that rhinos that took only water remained more than 50 m from the vantage point on the terrace of the lodge. This was outside the capability of the camcorder. While it was nearly impossible to see the rhinos through the viewfinder of the still camera at such a distance, it was found that acceptable identification pictures could be obtained by watching one through binoculars until it was still and then opening the camera shutter. Because of the poor light quality, a photograph required up to 10 seconds. Rhinos using the salt lick had to come right up to the building. Those that did could be photographed with both cameras. A ground-level photohide also allowed direct photography with the video camera, the slits in the walls being too narrow to balance the still camera.

Film was processed in the nearby town of Nyeri through a standard Kodak C41 processor onto 4″ x 6″ Kodak paper with gloss finish.

Image enhancement

Individual rhino features were obtained by scanning the prints with an Epson Perfection 1240U scanner using a Toshiba Satellite Pro 4600 laptop computer. After much trial and error, scanning was carried out at 600 dpi when features such as a head profile were readily discernible, at 900 dpi when features were more difficult to discern, and at 1200 dpi for small features such as eye wrinkles where detail was difficult to capture. In 2003, the Epson scanner was replaced with a Mustek 1200 UB Plus scanner, an inexpensive model, but no effect on scan quality was observed.

The scans were saved using JASC Paint Shop Pro 7 software as jpeg files in greyscale as this gave the most observable contrast. Features were cropped out and resized to a height standard of 2.25 inches (572 mm). When the file size was large (over 500 kb) this was done by reducing the dpi, but when it was small, less than 500 kb, this was done by adjusting the print size to the required height. Scans were adjusted for brightness and contrast using Paint Shop Pro software as and when necessary.

From photographs taken with the Sony TRV240 digital camcorder, still pictures were extracted from a video stream using PIXELA ImageMixer Version 1.0 for Sony™ software.

The most important identification features used to distinguish the Aberdares rhinos were sex, ear markings, horn size and shape, body markings and tail size. Three evaluators—the rhino warden, an experienced ranger who had been formally trained in rhino identification and had been with the rhino-monitoring team in the Aberdares for five years, and the first author—visually studied the photographs to identify individual rhinos. While all three of us exhibited strong aptitude, visual assessment cannot be considered completely reliable (Patton 2007).

Based on the photographs, a standard identification description was made for each rhino identified. Descriptions were given to the key features of sex, age, horn size and shape, and ear markings and any additional ‘special’ feature such as prominent scars. The full description was then reduced into a number of key descriptors as shown in table 1.

The description of each rhino, in the form of the appropriate descriptors, name and code number plus identification photographs, was entered in a Microsoft Access™ database. For Aberdares rhinos,

Table 1. Key descriptors used for identifying individuals

Category	Descriptor	Description
Sex	M	male
	F	female
Age	A	adult
	SA	subadult
	calf	calf
Horn size	>	front longer than rear
Front : rear	><	front and rear equal length
	<	rear longer than front
Rear horn shape	triangular	as descriptor
	conical	
Rear horn length	shorter	as descriptor
	medium	
	longer	
Notches right	0	no notch
	1	one notch
	2	two notches
	3	three notches
Notches left	0	no notch
	1	one notch
	2	two notches
	3	three notches
Calf sex	M	male
	F	female
	UID	unidentified
Calf age	250605	date of birth if known
	> 3 yr	as descriptor
	2–3 yr	
	1–2 yr	
	3 m–1 yr	
	< 3 m	
	none	

many rarely seen, the photographs were of the most recent face, left and right profile views and, where appropriate, former pictures. The database could be interrogated and a query form was included in its setup to enable this.

As new photographs were obtained, the descriptions were tested against the database. Where a match was found, the new pictures were compared with previous photographs of the individual to visually confirm the match. Where no match was found the new pictures were compared with all previous photographs to confirm there was no match by visual assessment and therefore a new rhino had been identified. In this way the database was built from the bottom up and a minimum population demography for Aberdares rhinos was determined.

Results

Despite the difficult 'closed bush' conditions throughout the Salient, identification photographs were obtained both in the bush during the day (from over 600 hours of monitoring time) and at the lodges at night (from 108 nights monitored), which could be used to visually assess individuals and enable a minimum population estimate to be made. During the study periods in the Aberdares, 170 rhino sightings were made, of which 31 (18.2%) were in the open bush during vehicle-based patrols, 84 (53.5%) were at the Ark waterhole and 55 (28.3%) at the Treetops waterhole. Based on the noted features of each rhino, a standard identification description was made. An example is given in figure 1 for the rhino Ann, one of the regularly seen individuals visiting the Ark waterhole at night.

Visual assessment of the identification features of the rhinos photographed suggested there were at least 23 individuals. Seven of these had been individually identified from previous records and already had names—Ark, Ruinu, Ann and calf Lucy, Siankikki and calf Daniel, and Nyalou. The remaining 16 rhinos for which good identification photographs had been obtained were assessed as new individuals and named during the research period. The identities of another 9 rhinos were considered uncertain as, while they appeared to be different from the 23 named rhinos, their identification photographs were of insufficient quality to ascertain identification reliably. These rhinos were ascribed the title Tofauti plus a letter A to J (see table 2). In some cases a rhino was photographed on only one occasion and it was not possible to verify the consistency of its identification features, especially horn size and shape.

With the importance of the Ark and Treetops waterholes as sources of sightings (81.8%), some further analysis was undertaken using data collected daily by staff at the two lodges at each of the waterholes. It may contain some bias because the consistency of recorder effort is not known. The results, shown in table 3 and figures 2 and 3, clearly demonstrate a major decline in the number of sightings at both sites over the period. In both cases, the monthly pattern of sightings is

Horn anterior: medium long, gently curved, narrow rounded tip
Posterior: short, narrow and triangular, rounded tip, back face indented in top third with front face straight, $^1/_2$ of anterior
Ears: clean, hairy fringed
Other: ring marking on stomach

Figure 1. Example rhino identification description and photographs produced for Aberdare rhinos.

Table 2. Aberdare National Park, black rhino demography 2004 (estimate by first author)

Male	Female	Calf	Subadult	Unknown
Ark	Ann	Lucy f	Daniel – male	Tofauti A ?
Ezekiel	Kilema	—	Hurricane – male	Tofauti B f
Ndirangu	Malaika	Hadija f	male like Nyalou	Tofauti C f
Ngiriini D	Nyaruii	?		Tofauti D f
Ngiriini W	Pembemoja	Kelele m		Tofauti E ?
Nyalou	Siankikki	Aberdare m		Tofauti F ?
Nywele	Treetops	? m		Tofauti G sam
Ruinu	Wanjiko			Tofauti H f + calf
	Warimu	Mwangi m		Tofauti J ?
	?	?V small ?		
8	10	8	3	9

Any rhino given a name including Tofauti has been photographed. Any rhino marked ? has not been photographed but has been recorded by a ranger. It is possible that Tofauti rhinos are actually ones named but the photographs are not conclusive.

f – female; m – male; sam – subadult male

generally the same for all years, suggesting the drop is real and not a seasonal effect. Figure 4 illustrates the reduction in total visits per year.

After the rangers had been trained in identifying the named individuals, more recent daily sighting records of the rhino-monitoring patrols were reviewed to determine when the rhinos identified in table 2 had been last seen.

At the Ark waterhole, the male Ark was last reported on 10 March 2003, the male Ruinu on 14 May 2003. The male Nyalou was seen regularly from September 2003 until the end of July 2004. The subadult male Hurricane visited the waterhole between September 2004 and the end of November 2004. The adult female Ann was seen with her calf Lucy until the end of April or early May 2004, when Lucy started to appear alone. Ann had a male calf in June 2004 but it was killed. Lucy reunited with Ann from August 2004 and they were always seen together from then on. The male Ngiriini W was seen in its normal area

Table 3. Rhino sightings made at the Ark and Treetops waterholes, 1999, 2002 and 2004

	ARK			TREETOPS		
Month	1999	2002	2004	1999	2002	2004
January	81	88	41	51	31	46
February	46	74	36	38	18	29
March	67	53	26	52	33	31
April	70	44	24	26	45	48
May	79	56	37	66	31	55
June	96	61	31	47	37	15
July	67	42	40	36	23	14
August	76	29	39	85	34	16
September	81	36	62	27	17	14
October	63	45	46	42	16	15
November	42	23	26	69	26	26
December	60	18	16	69	43	24
Annual	828	569	424	608	354	333

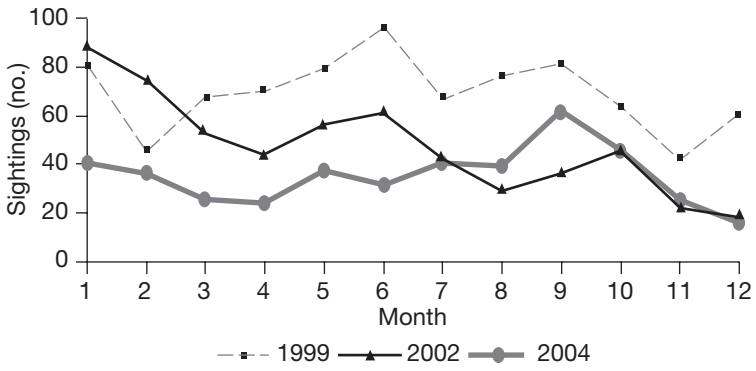

Figure 2. Monthly rhino sightings made at the Ark waterhole, 1999, 2002 and 2004.

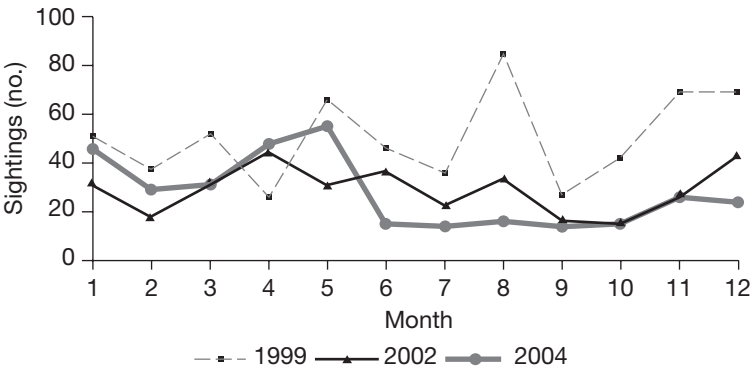

Figure 3. Monthly rhino sightings made at the Treetops waterhole, 1999, 2002 and 2004.

around the Treetops waterhole on 16 November 2004 then was later seen for the first time at the Ark waterhole on 22 January 2005. It was fighting with the female Siankikki, who would have been a candidate for mating as her calf Aberdare had beens poached on 21 November 2004. Since February 2005, Ngiriini and Siankikki have been seen together.

The female Malaika and her calf Hadija were last observed at the Treetops waterhole on 8 October 2004; the female Kilema, a regular visitor, was last observed there on 3 November 2004. The female Pembemoja and her calf Kelele were last observed at the waterhole on 18 February 2005 but were positively identified nine days later at Ngiriini Dam, on 27 February. These were the only rhinos visiting Treetops regularly at the end of 2004 and the beginning of 2005.

The number of newly identified rhinos found during each of the study periods in Aberdares is shown in figure 5. New sightings tailed off from June 2004 and no new sightings were made during 18 days of monitoring in 2005.

A reconsideration of the demographics of the rhino population was made based on the date of the last sightings and resightings in the first half of 2005 (table 4). The names shown in bold are of the only seven individuals that could be found and photographed in June 2005 over 10 days and nights; patrols sighted no others. Only four adult rhinos were seen regularly during the study periods and these were all easily distinguished—the only male was notched in the left ear, one female had no rear horn, another female had long horns of equal length and a small ear notch, the third female had a prominent body scar.

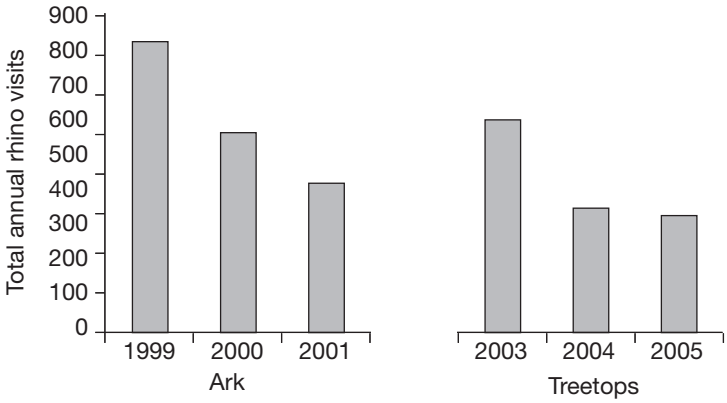

Figure 4. Total number of rhino sightings at the Ark and at Treetops waterholes.

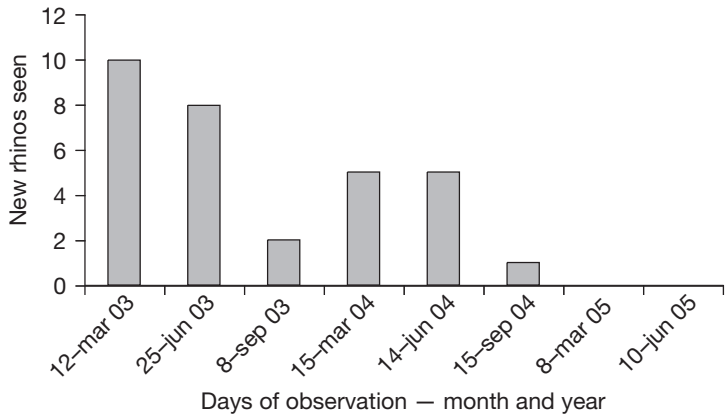

Figure 5. Number of newly identified rhinos at each study period in Aberdare National Park.

Discussion

Identification of individuals

Photographs from both still and video cameras were essential to obtain the identification description as some of the sightings were very brief. With the photographs available for extended analysis, identification features that were missed at the time of the sighting were seen and described.

Development of the photographic identification database for the Salient and a standard method of describing the identification features of each of the rhinos enabled details of individuals to be disseminated, patrol rangers trained to identify individuals accurately, the population demography described, and changes in minimum population size observed.

Photo identification enabled the sightings at the Ark, where names were being assigned to each individual seen, to be verified and, where inaccuracies were found, rangers trained to correct the inaccuracies. At Treetops, where all sightings were being recorded as unidentified, names and descriptions enabled all sightings to be assigned to particular rhinos. It had been decided to station one ranger at Treetops full time, whhich enabled him to acquire, with the help of the photographs, experience in recognizing rhinos visiting the waterhole and thus ensure accurate identification.

It also meant that even when individual sighting frequency was low, a combination of identification features could still be used to describe an individual rather than relying on a single feature, however distinct. For example, the rhino Pembemoja had no rear horn and was therefore distinct. However, another rhino could, at some time in the future, lose its rear horn and be mistaken for Pembemoja. Pembemoja was therefore fully described as a female, with a class D female calf, with clean but clearly tufted ears and no rear horn.

Table 4. Aberdare National Park, black rhino demography as at June 2005

Rhino	Last seen	Rhino	Last seen
MALE		SUBADULT	
Ark	March 03	Daniel	February 04
Ezekiel	March 03	Hurricane	November 04
Ndirangu	June 04	**? female**	**June 05**
Ngiriini D	June 04		
Ngiriini W	**June 05**	UNKNOWN	
Nyalou	July 04	Tofauti A ?	June 04
Nywele	October 03	Tofauti B f	March 04
Ruinu	May 03	Tofauti C f	March 03
FEMALE		Tofauti D f	March 03
Ann and Lucy	**June 05**	Tofauti E ?	June 04
Kilema	November 04	Tofauti F ?	March 03
Malaika and Hadija	October 04	Tofauti G sam	March 03
Nyaruii	June 03	Tofauti H f + calf	May 03
Pembemoja and Kelele	**June 05**	Tofauti J ?	March 04
Siankikki	**June 05**		
Treetops	June 03		
Wanjiko	June 04		
Warimu and Mwangi	January 04		

Names in bold are of rhinos photographed in June 2005; f – female, sam – subadult male, ? – sex unknown

The KWS standardized monitoring system requires rangers, at the time of sighting, to make drawings of a rhino's identification features on a special form (Adcock and Emslie 2004). For drawings to be accurate, the observer needs time to see the features carefully and record them correctly—which many rangers find difficult. Drawings are less appropriate where sightings last for a relatively short period, as is the case in Aberdares. An alternative was developed—a sighting record form (fig. 6)—to act as a prompt for rangers to look quickly for key features. Even after a brief sighting and on immediate prompting, rangers can remember a lot of detail, which can be recorded. In dense habitats, like the Aberdares, where sightings are infrequent and where often nothing is currently being recorded from a brief sighting, the gathering of such additional information could be especially helpful in deciding if there were more rhinos to find. While rangers may not be able to state which rhino they saw, they may recognize it if they saw its picture. By interrogating the database with the details collected at the sighting, photographs of individuals that potentially match their description can be selected from those available for review with the possibility that a rhino that has not been seen before is identified. However, visual assessment of photographs is not without error (Patton 2007) and any selection a ranger makes would have to be treated with caution.

An additional problem is that the system would provide a 'result' even if the ranger may have wrongly described the rhino seen. For example, if an Aberdares adult male rhino was said to have one notch in its right ear instead of two, it would have been identified as Ezekiel and not Ngiriini D or Ngiriini W.

Or if it were described as having one notch in the left ear instead of the right, it would be identified as 'new'.

The 'simple to construct and interrogate' database approach is appropriate for use with any rhino population. The 'sighting record form' approach offers an easier alternative to that of drawing but the level of error arising from each would have to be determined and compared before deciding which one (or both together) might be appropriate for individual populations.

Sighting record

1	Rhino sex		male	female	DK		
2	Rhino age		adult	SA	calf	DK	
3	Calf	calf sex	male	female	DK	none	
4		calf age	< 3 m	3–12 m	1–2 yr	2–3 yr	> 3 yr
5	Ears	right notches	0	1	2	3	DK
6		left notches	0	1	2	3	DK
7	Horns	front : rear	longer	equal	shorter	DK	
8		rear shape	triangular	conical	DK		
9		rear length	longer	shorter	equal	DK	
notes			any other feature				

Date ..... Observer .....

Figure 6. Field sighting record form. DK – don't know

Previous to this study, most rhino sightings including those at the lodge waterholes (some of which were first class sightings) had to be classified by most rangers as 'unidentified' because there was no description or name or code for each rhino on which to base an identification. During the study, most daytime bush-based sightings that were photographed were found to be of known, subsequently named, rhinos. With most individuals now identifiable and most sightings and resightings recorded by name rather than as''unidentified', it should be possible to make an overall estimate of the rhino population using mark-recapture analysis.

Reasons for the apparent decline

Two possible reasons have been put forward for the decline in sightings (and consequently the population from potentially 30 to possibly just 7)—drought or poaching. It was reported in the press that February 2005 was the hottest in Kenya for 20 years. In the Aberdares this followed poor short rains with dried-up dams and shrivelled vegetation. It was thought likely that the rhinos no longer seen regularly in the Salient had moved to higher ground where habitat would have been 'fresher'. It was believed that they would return to visit their normal waterholes following rains. There was a normal rainy season recorded in March and April but no rhinos had returned by the end of June 2005 (table 3). It is possible that they found new home ranges but there was only one confirmed sighting of a rhino outside of the Salient during the study period and no spoor reported.

A far more plausible hypothesis is that the rhinos were being poached. It has been suggested that a professional poaching unit was operating in the area with some 30 rhinos killed in a five-year period on nearby Solio Ranch (E. Parfet, director and general manager of Solio Ranch, pers. comm. 2006). A poacher caught in Solio made a statement to the effect that elephants and rhinos were being poached in Aberdares (E. Parfet, pers comm. 2006). This is supported by the known loss to poaching of the rhino calf Aberdare in 2004, snare marks around the body of Kilema, snare marks on other large animals such as buffalo, and the many snares found in the park. Because the vegetation is dense and there is a high density of hyenas, finding a carcass is difficult, so the lack of such finding is understandable. Therefore, poaching offers a credible reason that so many rhinos were not resighted. However, more research is necessary before any firm conclusions can be made.

Whatever the cause of the decline in numbers is found to be, it is only since the rhinos have been individually identified and named, the result of this study, that this analysis has been possible.

Acknowledgements

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Increased demand for rhino horn in Yemen threatens eastern Africa's rhinos

Lucy Vigne[1], Esmond Martin[1], Benson Okita-Ouma[2]

[1] PO Box 15510 – 00503, Nairobi, Kenya; email: rhino@wananchi.com
[2] Kenya Wildlife Service, PO Box 40241 – 00100, Nairobi, Kenya; email: bokita@kws.org

Abstract

Conservation organizations have neglected Yemen's role in the rhino horn trade since early 2003, with no attention given to the problem, although most horns from eastern Africa's poached rhinos are known to go there. Therefore, in early 2007 we collated data on rhino poaching in eastern Africa, and the first two authors carried out a survey in Yemen to update information on rhino horn smuggling. We learned that demand has risen substantially with the price of rhino horn up by 40% in four years, despite an increase in quantity of horns entering the country. We had meetings with decisionmakers to try to curtail the trade and improve public awareness to reduce demand for rhino horn.

Résumé

Les organisations de conservation ont négligé le rôle que le Yémen tient dans le commerce de corne de rhino depuis le début de 2003 et elles n'accordent pas d'attention à ce problème alors qu'on sait que la plupart des cornes des rhinos braconnés en Afrique de l'Est vont là-bas. C'est pourquoi, début 2007, nous avons rassemblé toutes les données sur le braconnage de rhinos en Afrique de l'Est, et les deux premiers auteurs ont mené une enquête au Yémen pour actualiser les informations sur la contrebande de cornes de rhinos. Nous avons appris que la demande s'était considérablement accrue et que le prix de la corne avait augmenté de 40 % en quatre ans, malgré une augmentation de la quantité de cornes arrivant dans le pays. Nous avons rencontré des décideurs pour tenter de réduire le commerce et de sensibiliser le public afin de diminuer la demande de corne de rhino.

Rhino poaching in eastern Africa, 2003–2006

For centuries rhinos have been killed in eastern Africa to meet the demand for rhino horn in Yemen. The horns are cut up and made into handles for curved daggers called jambiyas, still worn daily by most Yemeni men. Most jambiyas with rhino horn handles are old, but new ones are still being made.

Democratic Republic of Congo

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By early 2003 there were 30 of the rare northern white rhino subspecies in Garamba National Park (Hillman Smith and Ndey 2005), the only viable population left. In 2003 and 2004 there was an upsurge in poaching with the ceasefire in southern Sudan. Northern Arab horsemen as well as southern Sudanese poachers penetrated the Intensive Protection Zone in the southern sector of the park, wiping out nearly all the rhinos and over 3000 elephants. Nine rhino carcasses were found from January 2004 to February 2005, all poached (Hillman Smith 2006), but between two and three times that number are missing. In a survey in November 2004 only four were seen in the park (Hillman Smith and Ndey 2005). An intensive aerial count in March 2006 saw two and with further groundwork two more were accounted for, maintaining the current minimum of four (Emslie 2006).

Kenya

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The official black rhino population in late 2005 was 540 (Emslie 2006). Poachers killed at least 11 black rhinos in Kenya from 2003 to 2006, mostly in Tsavo East National Park (5) and Solio Game Reserve in

Laikipia (3), according to the Kenya Wildlife Service (KWS) (table 1). In Tsavo East, most of the poachers were Somalis who succeeded in taking all the horns. In May 2006, however, KWS staff followed a gang of five Somali poachers responsible for killing the last two rhinos killed in this period. They reached Lamu District and shot dead three of the poachers, recovering all four horns (KWS Rhino Programme, pers. comm. 2006). On Solio, three black rhinos were snared in 2004.

T TTTTTTTTT

The official white rhino population in late 2005 was 235 (Emslie 2006). Kenya's white rhinos originate from southern Africa. Nine were poached, all on Solio, from 2003 to 2006 according to KWS. One was snared in 2003, and seven snared and one shot in 2004. The horns were left on the last shot rhino, as the poachers were scared away. No rhinos were poached or snared in 2005 and 2006.

Besides these 20 poached black and white rhinos that KWS recorded, others were known to have been poached in Kenya over this four-year period. In the huge expanse of Tsavo East, KWS estimates a black rhino population of 56, but not all these have been seen so the actual figure could be lower. In Aberdare National Park, KWS estimated 22 black rhinos in 2004, but in 2006 reduced this estimate to 10 pending an intensive rhino survey in a wider region of the park (KWS Rhino Programme unpublished data). So it is probable that most of these Aberdare rhinos were poached, although the official figure is only two poached from 2003 to 2006. On Solio, the security forces agree that at least another four or five black and white rhinos were poached within this time that KWS has not yet recorded.

Tanzania

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The official black rhino population in late 2005 was 101 (Emslie 2006).Tanzania has an estimated minimum population of 101 black rhinos (Emslie 2006). There are no white rhinos. From 2003 to early 2006 the Tanzanian authorities reported not a single rhino-poaching incident. Two horns were seized in Dar es Salaam in 2003, however, which may or may not have originated from Tanzania (Tanzania officials, pers. comm. 2006). The massive Selous Game Reserve, an area of 45,000 km^2, is home to several scattered groups of rhinos and some could easily have been poached without the authorities being able to find out. Most of the other rhinos are in the protected areas of Serengeti, Ngorongoro Crater and Mkomazi, which field staff are able to monitor well.

Uganda

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Although poachers killed all of Uganda's indigenous northern white rhinos and its black rhinos over two decades ago, partly to meet the Yemeni demand for horns, the country now has four white rhinos (from Solio in Kenya). Two came to the Uganda Wildlife

Table 1. Official number of poached black rhinos in Kenya, 2003–2006

Date poached	Location	Age	How killed	Horns
5 August 03	Tsavo East National Park	adult	gun	removed
16 April 04	Solio Game Reserve	?	snare	removed
May 04	Tsavo East National Park	adult	gun	removed
May 04	Tsavo East National Park	?	gun	removed
June 04	Solio Game Reserve	?	snare	removed
June 04	Solio Game Reserve	?	snare	removed
27 October 04	Ol Pejeta Game Reserve	adult	snare	removed
21 November 04	Aberdare National Park	1 yr 6 mo	snare	present
1 December 04	Aberdare National Park	adult	snare	present
20 May 06	Tsavo East National Park	? (male)	gun	removed*
20 May 06	Tsavo East National Park	?	gun	removed*

Source: KWS Rhino Programme, Benson Okita-Ouma, unpublished
Total number of black rhinos poached – 11
* recovered in Lamu District by Kenya Wildlife Service

Foundation Centre in 2001 and two more to the Ziwa Rhino Sanctuary in July 2005 (Yvonne Verkaik, manager of the Ziwa Rhino Sanctuary, pers. comm. 2006).

Trade routes and prices for rhino horn, 2003–2006

The best way to collect information on trade routes and prices for rhino horns is at the time they are intercepted, usually by officials, and sometimes with the help of informers as well. It is important for African governments to put a lot of effort into confiscating the illegal horns and arresting the illegal traders. It is also important to obtain updated information on smuggling routes, allowing officials to know where greater vigilance is necessary. Accurate prices in turn help us understand trends in demand.

Smuggling through eastern Africa

In Kenya an important middleman based in the town of Nyeri, near Solio Game Reserve, was paying poachers in 2006 KES 20,000 (USD 285) for a small horn weighing 1 kg and KES 30,000 (USD 428) for a large one of about 3 kg. Such horns are transported by road to Nairobi. These Nairobi traders may export directly or via someone else. The exporter pays USD 550–600/kg for the horns. From Tsavo East, horns probably go mostly overland to Mombasa or Somalia for export. Some of the evidence for the importance of Mombasa as an entrepot is that from 2000 to 2006 officials there made 13 seizures totalling 27 rhino horns. Kenya officials have also intercepted rhino horns in Marsabit and Lamu in northern Kenya, suggesting these horns were on their way to Somalia (KWS Rhino Programme, unpublished data). Prices for these horns were not obtained.

No prices for rhino horn from the Democratic Republic of Congo (DRC) have been recorded, either. Trade routes from Garamba have been affected by civil conflicts, particularly in neighbouring Sudan. In 1999 North and South Sudan forces essentially split with the SPLM (Sudan People's Liberation Movement), allying itself with Uganda. Uganda troops in turn occupied north-eastern DRC from 1999. Thus trade routes turned

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This entrance to the old town of Sanaa leads to the jambiya souk.

east through Uganda with several reports of horns being offered for sale in the Uganda–DRC border town of Aru and in Kampala (Hillman Smith, pers. comm. 2007). Three horns, at least one from a white rhino, were confiscated by Kenya officials in Busia on the Uganda–Kenya border in 2000 (KWS Rhino Programme, unpublished data). Furthermore, around the time of the southern Sudan peace talks in 2003, when Garamba was being flooded by poachers, the northern Arab horsemen took their horns to Omdurman and Khartoum reinforcing this old trade route.

Smuggling from Africa to Yemen

In early 2003 most of the rhino horn from eastern Africa went to Djibouti (Martin and Vigne 2003). Yemeni smugglers would arrive in Djibouti by dhow or small motorboat to sell heavily subsidized petrol, stolen Yemeni antiquities, and subsidized foods. With the money obtained they bought illicit drugs, alcohol, medicines, firearms, cigarettes, and sometimes rhino horn. Rhino horn in 2003 sold in Djibouti for USD 750/kg. The smugglers took their purchases back with them to the Yemen coast around Aden, Mocha, al-Khokha and Dhubab. These items were then moved clandestinely to different parts of Yemen, especially to Sanaa, and some, including a little rhino horn, went even as far as Saudi Arabia.

There was also considerable illegal movement of goods across the Red Sea from Somalia, Ethiopia and Eritrea to Yemen, and also people, livestock, and occasionally rhino horn, to Yemen. This trade continues, according to Yemeni officials and informers. Many illegal immigrants pass through Yemen on their way to the Gulf States and Europe, sometimes selling rhino horn to help pay their expenses. Customs agents are often bribed to get items through. According to a study carried out by the United States Agency for International Development, 'Yemen Customs remains one of the most corrupt government agencies' (Robinson et al. 2006). The Economist Intelligence Unit (2006) concurs, 'Smuggling forms a large and unrecorded part of trade, and collusion by officials occurs at all levels. Alcohol and firearms land on the Red Sea coast....' In fact, the Yemen government's official figures estimate that the country's losses through Customs evasion are USD 150 million annually (Economist Intelligence Unit 2007).

From 2003 to 2006 the Red Sea trade routes have become less popular for rhino horn due to the greater

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A Sanaa craftsman prepares a water buffalo horn handle for a jambiya.

presence of foreign military forces, which regularly patrol to intercept pirates, smugglers and terrorists (Vigne and Martin 2006). Yemen's officials have also been putting more effort and equipment into fighting this smuggling route. Yemeni authorities have established a Coast Guard Authority, and in 2004 the Italian government signed an agreement with the Yemenis to finance the first phase of a coastline surveillance (World Bank 2006). European governments have provided technical, financial and material assistance to improve Yemen's security on its coastline (Economist Intelligence Unit 2007). Americans have also helped obtain 15 boats, 7 metres long, called RIBs (rigid-hull inflatable boats). These run on 200 horsepower engines, strong enough to catch any dhow attempting to trade in illicit merchandise, including rhino horn. As a result of this assistance, in February 2007 the Yemen authorities seized a dhow carrying illicit cigarettes and alcohol from Djibouti to Yemen (Col. Ali al-Sufi, deputy head of Yemeni Coast Guard, pers. comm. March 2007).

As a result of increased sea patrols, perhaps only 10 kg a year are now coming across the Red Sea to Mocha or other coastal areas, according to informers. Horns are sometimes taken by air from Djibouti airport to Hodeidah, Taiz and Sanaa. Other air routes are now preferred for smuggling rhino horn as well, such as from Khartoum and perhaps other Sudan airports to Sanaa. Or they go on to Ethiopia to leave by air from Addis Ababa to Yemen, according to Sanaa traders.

More rhino horn is imported into Yemen in the summer when Sudanese students and teachers go back and forth for their holidays. Prices are lower for horn at that time. Diplomats, other officials, sheikhs and businessmen travelling to and from Africa carry it in their luggage or send it by air cargo, sometimes as full horns, but more usually cut into pieces to make it harder to identify. It is often hidden in food items such as recently in 20-litre cans of peanut butter. Traders in Sanaa verified the origin of some of their horn, saying they obtained it from South Sudan, DRC and a little from Tanzania.

Results of surveys and investigations in Yemen

We had informers collect information on the amounts and prices of rhino horn coming into Yemen. We also carried out investigations in Sanaa's old souk regarding both jambiya production and retail sales to compare with past surveys and trends.

Amounts of rhino horn smuggled into Yemen, 2003–2006

As this trade is illegal, Yemeni rhino horn traders will not divulge any information on the amount of rhino horn coming into the country. Nevertheless, through an intelligence-gathering network sporadically operating in recent years, we estimate perhaps 60–70 kg of rhino horn entered Yemen each year in 2004, 2005 and 2006.

There have been no successful confiscations recently. In late 2006 a small box of horn pieces came into Sanaa airport via Oman that Customs suspected

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Buyers in the Sanaa souk examine a selection of old jambiyas with rhino horn handles.

was rhino horn. Officials called in a prominent jambiya trader for his expertise, who said it was from ox (buffalo). This is unlikely, as water buffalo horns from the domestic animal are imported very cheaply in large consignments direct from India. The horn pieces were returned to the Yemeni importer.

Our informers have seen full new horns, old horns and small pieces from 2003 to 2006 in various houses in Sanaa. For example, in early 2006, a Sudanese man had a bucket full of pieces of various sizes, which he stored on the roof of his house in Hadda, a prosperous suburb of Sanaa. Two months later he sold it to a Yemeni trader 'from the north', but he said that he could obtain more horns in 2–3 weeks if needed. Also in early 2006 an old Yemeni man offered for sale to our informer 10–12 handles of old rhino horn. He said he had new horns in his house for sale, but he would not display them until he was shown the large amount of money he required in payment.

There are two ways to estimate the quantity of rhino horn imported into Yemen each year. One is by collecting information from those involved in the trade in Yemen: importers, wholesalers, jambiya makers and officials. As already mentioned, this figure was perhaps 60–70 kg a year from 2003 to 2006. The other is by calculating the potential amount of horn reaching Yemen from rhinos poached in eastern Africa, found or not by the authorities. This calculation excludes the few rhinos that die of natural causes in the thick bush and are never seen by either officials or poachers. Poachers have taken horns from nearly all the recorded carcasses in eastern Africa, and probably from the poached rhino carcasses that officials do not recover. There is no evidence from either official or private sources of any old rhino horns having been stolen and put on the market during this four-year period. We have to assume also that, excluding those horns officially seized from traders, nearly all the horns went to Yemen and not elsewhere — as has been the case over the last 20 years.

From official figures, DRC between 2003 and 2006 lost through poaching at least 26 northern white rhinos. In Kenya during this time, KWS can confirm that a minimum of 11 black rhinos and 9 whites were poached, plus our estimate of 17 poached black rhinos in the Aberdares and Tsavo East, and about 4–5, mostly whites, that were poached in Solio. (In Uganda no rhinos were poached and in Tanzania officials say none were poached during this time either.) This totals at least 29 black rhinos and 38 white rhinos illegally killed in eastern Africa. If the average black rhino carries 2.88 kg of horn (Martin 1983) and the average white rhino carries 5.5 kg (Anon. 1986), this gives a minimum total of 292.5 kg of horn over this period minus 22 kg that were seized. Therefore, a maximum of 270 kg of horn from eastern Africa's poached rhinos could have reached Yemen, or 67.5 kg on average per year from 2003 to 2006. This is coincidently close to the estimate our informers gave us earlier in Sanaa. There is still no evidence of horns from eastern Africa going directly to eastern Asia; horns from southern African rhinos go to the Far East and almost never to Yemen.

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Yemeni women shop at a jambiya stall.

Jambiya-making in Sanaa

We carried out a survey in late February 2007 on the number of workshops and craftsmen making jambiyas in the souk al-Janabi, which is within the walled city of old Sanaa. This is where nearly all the jambiyas are made in Yemen. We counted only the open workshops

with craftsmen making and repairing dagger handles. There were also craftsmen making blades, scabbards and belts in the souk, but we did not include them in our survey, concentrating on handles, as in the past. We conducted our counts, as before, in the afternoon as workers chew qat (a stimulant), making this the most active working time. We counted 124 craftsmen working in 74 workshops; 66 of these workshops were making new handles and 8 repairing old handles. These are all record numbers (table 2); the numbers have been increasing steadily from 1983 when there were 41 workshops and 61 craftsmen.

In the 1970s, when many thousands of jambiyas were made out of rhino horn, craftsmen spent much more time on each handle (1–2 days), producing higher profits on the finished product. By the mid-1980s when the amount of rhino horn imported dropped to less than 500 kg a year, the same number of craftsmen were using cheap alternatives and having to produce many more handles to make a reasonable profit. In 2006 only about 200 jambiyas were made with rhino horn handles, according to estimates on rhino horn imports from informers. From 1 kg of horn, usually about 3 handles can be made of about 130 g each; the rest—about 60% (Martin et al. 1997)—is waste, which used to be sent in huge quantities to China. Over 300,000 handles were

Table 2. Number of jambiya workshops and craftsmen in the souk al-Janabi, 1971–2007

Year	Workshops (no.)	Craftsmen (no.)
1971	47	?
1983	41	61
1986	51	84
1989	57	87
1993	56	91
1994	65	92
1999	59	100
2001	69	101
2003	70	102
2007	74	124

Source: surveys taken by Lucy Vigne and Esmond Martin, except for 1971 (Dostal 1983)

Lucy Vigne

Tourist shops selling jambiyas with water buffalo horn handles have become increasingly popular in Sanaa souk with the growth in tourism.

made of water buffalo horn in 2006, according to the biggest jambiya maker and trader. An average craftsman thus produces a far greater number of jambiyas nowadays than in the 1980s because they take a shorter time to make using buffalo horn. While there has been a doubling of craftsmen there has also been an even greater increase in jambiya production.

Over 90% of Yemen's total production of jambiyas is made from water buffalo horn. A cut piece is bought for 100–150 rials (USD 0.5–0.75) to produce a handle, and a craftsman may produce 10 a day, with another craftsman fitting the handle to the blade. Blades are all made in Yemen, almost entirely in Sanaa and Dhamar, costing 200 to 10,000 rials (USD 1 to 50). Only occasionally are handles made of other materials nowadays as they are less popular. Such materials include camel nails (obtained free from the butcheries), wood, bone and plastic. Rhino horn accounts for well under 1%. We saw no new horn being made into jambiya handles despite several visits into the souk al-Janabi, whereas in the past we would have seen it on at least one occasion. This could just mean that craftsmen were more careful and were working at home. But there again, they are very infrequently made.

The rent for a small workshop in early 2007 was about 7000 rials (USD 35) a month; for the larger ones 20,000 rials (USD 100). Many of the craftsmen receive a salary according to their skill, from 30,000 rials (USD 150) to 70,000 rials (USD 350) per month. Many are paid daily.

Jambiya retail sales

Within the workshop area is the main jambiya-making and trading family's relatively big shop, which is a workshop and retail shop combined. Here, men will come from all over the country for advice on buying a top-quality rhino horn jambiya. A selection of such jambiyas is displayed in two glass cabinets. Nearby is the retail souk with more old and expensive rhino horn jambiyas for sale. Here, stalls display tiers of jambiyas, with old rhino horn ones usually at the top and others (old and new) beneath. Only one of these stalls had several jambiyas with new-looking rhino horn handles, which are also recognizable, being paler than the older ones. Unlike the other sellers, the owner refused to let us photograph them. Individuals will also bring their own rhino horn jambiyas to this area of the market to sell, holding them out to passersby. (See table 3 for prices.)

Some older jambiyas with amber handles were for sale in the jewellery section of the souk. Those with medium-size handles were 40,000–60,000 rials (USD 200–300). Some jambiyas with amber handles and old silver sheaths cost 120,000–170,000 rials (USD 600–850).

New jambiyas, by far the majority, are made with cheap materials. These jambiyas sell for different prices depending on the size of the handle (table 4). They are sold in some of the workshops, in the area selling scabbards and belts, and in tourist sections of the souk. Many are sold in an area opposite the main entrance to the old city. Other jambiya shops are sprinkled elsewhere in Sanaa.

Effects of the population, economy and culture in Yemen on rhino horn demand

The amount of rhino horn reaching Yemen per year in the 2003–2006 period has doubled since the 1995–2002 period (table 5). The import price in Sanaa

Table 3. Retail prices for jambiyas with rhino horn handles in Sanaa, March 2007

Age	Size	Price range in Yemeni rials	Price range in USD	Av. price in USD
New	small	50,000 – 150,000	250 – 750	450
New	medium	150,000 – 200,000	750 – 1000	875
New	large	250,000 – 400,000	1250 – 2000	1670
50 years	small	70,000	350	350
50 years	medium	150,000 – 450,000	750 – 2250	1500
50 years	large	600,000 – 700,000	3000 – 3500	3250
Antique	medium	400,000 – 40,000,000	2000 – 200,000	—

Source: survey taken by Lucy Vigne and Esmond Martin
These are prices that Yemenis would pay, not tourists.

Table 4. Retail prices for new jambiyas with various cheaper handles in Sanaa, March 2007

Handle material	Size	Price range (Yemeni rials)	Price range (USD)	Av. price (USD)
Water buffalo	small	2000 – 4500	10 – 22.50	15
horn	medium	3000 – 15000	15 – 75	25
	large	8000 – 12000	40 – 60	50
Camel nail	medium	4500 – 7000	22.50 – 35	29
	large	7000 – 8500	35 – 42.50	39
Plastic	small	500 – 800	2.50 – 4	3.25
	medium	1500 – 5000	7.50 – 25	17.75
	large	2500 – 3500	12.50 – 17.50	15
Bone	small	500	2.50	2.50
	medium	800 – 1500	4 – 7.50	5.75
	large	3000 – 3500	15 – 17.50	6.25
Wood	small	200 – 300	1 – 1.50	1.25
	medium	800 – 1200	4 – 6	5
	large	1500 – 3000	7.50 – 15	11.50

Source: survey taken by Lucy Vigne and Esmond Martin
These are prices that Yemenis would pay, not tourists.

Table 5. Minimum imports of rhino horn into Yemen, 1990–2006

Year	Amount (kg)	Origin of horn
1990	333	Kenya, Sudan, Tanzania
1992	150	East Africa
1993	80	?
1995	30	?
1998	< 30	DRC, Kenya
2000	< 20	Kenya
2002	30	Eastern Africa
2003	60–70	Eastern Africa
2004	60–70	Eastern Africa
2005	60–70	DRC, Kenya
2006	60–70	DRC, Kenya

Estimates calculated by Lucy Vigne and Esmond Martin
Eastern Africa includes Kenya, Tanzania, Uganda and DRC – Democratic Republic of Congo

Table 6. Import price for raw rhino horn in Sanaa, 1980–2007

Year	Av. price per kg (Yemeni rials)	Av. price per kg (USD)
1980	3,500	766
1984	4,300	782
1988	12,400	1035
1991	30,000	1220
1995	135,000	1200
1999	182,000	1400
2001	214,500	1300
2002	218,400	1200
2003 early	218,400	1200
2005	263,300	1375
2006	285,940	1450
2007 early	340,000	1700

Source: surveys taken by Lucy Vigne and Esmond Martin

for raw rhino horn has also gone up from USD 1200/kg in early 2003 to 1700 in early 2007 (table 6). The wholesale price in Sanaa is today USD 2000–3000/kg depending on quality—this is, as expected, higher than the import price.

Jambiyas with new rhino horn handles have also risen in retail price from 2003 to early 2007: a small one from USD 255 to USD 450 and a large one from USD 824 to USD 1670 (see table 4), despite a devaluation of the Yemeni rial. The production of all jambiyas has grown markedly over this time.

As both the quantity and the price of rhino horn have risen in Yemen since 2003, demand is up. This rising demand has been mostly the result of a large population growth. The population has increased from 9.7 million in 1983 for North and South Yemen to 21 million in 2007 for Yemen (with North and South having reunited in 1990). The number of people and the number of craftsmen have doubled in the last 24 years (see table 2). With the population increasing at 3% annually, the demand for jambiyas will probably continue to rise.

Lucy Vigne

A retailer offers for sale a jambiya with sheath and belt.

The increased demand for rhino horn has not been due to a rising per capita income. Yemen is still a poor country with a per capita income of only USD 649 in 2004 (Yemen 2006) and there has been little per capita income growth from 2003 to 2006 (Economist Intelligence Unit 2007). The Economist Intelligence Unit (2006) even goes further by stating that since the late 1960s real living standards have continued to deteriorate. If there is a reversal and the per capita income rose briskly, as has occurred in most of the Gulf, it could be disastrous for rhinos.

Until the economy grows, international NGOs should support the government in building first class museums to improve the education of its people to make them culturally aware that in today's world it is no longer morally acceptable to support trade in a product from a rare and endangered animal. Yemenis have remained in a time warp compared with the rest of the Gulf and desperately need better education. Since 1970 when thousands of Yemenis were able to afford rhino horn jambiyas, they did so to emulate the elite in the country. Most of all, they follow the example of their leaders, like the president, in culture and dress. Yemeni elite have a responsibility to discourage such use of new rhino horn and to make these handles unfashionable. It would be a good idea if the president were photographed for posters wearing western dress (as is often the case) or with a jambiya made with a handle alternative to rhino horn, such as silver, gold or even water buffalo horn decorated with gems.

Efforts to curtail the trade in rhino horn in Yemen

Our three weeks in Yemen were spent with jambiya traders and influential people to bring their attention to the continuing rhino horn problem. We also worked at the two government zoos to increase public awareness on the plight of the rhino, and with the media to cover the problem for a wider audience.

The main jambiya dealers

We held discussions with the family that employs the largest number of craftsmen working on jambiyas in the country to find a suitable high-quality substitute.

The senior member said that he was continually looking for such a material but has not yet found one: 'I am not asleep on this issue,' he said. For example, he has experimented with adding gold to a buffalo horn handle of a jambiya but lamented that nobody bought it at 50,000–70,000 rials (USD 250–350). He has been hoping that scientists abroad would make an acceptable expensive alternative to rhino horn, which he would eagerly buy. He claims that his business is not as profitable as in the past when he could legally use rhino horn. When asked his present-day demand for raw rhino horn, he replied that he would like to receive a one-off legal sale of 1000 kg or preferably 300 kg a year indefinitely. He was evasive about the price he would pay. He said he had about 1750 kg of rhino horn shavings and 250 kg of large chips. Since 1987 the government has not allowed its export. He still regrets not having received any compensation from the United Nations for this, which he claims is legal old stock.

Meetings with senior government officials and ambassadors

The American ambassador, Thomas Krajeski, helped us to meet some of the most influential people in Yemen regarding rhino horn and agreed to be alert to the problem himself. The British ambassador, Mike Gifford, and the Dutch ambassador, Johan Blankenberg, and his colleagues also greatly assisted us in this regard.

We met the chairman of the Environment Protection Authority (EPA) under the Ministry of Water and Environment, Mahmoud Shidiwah. He said that he would check the 775.5 kg of rhino horn stocks that the jambiya traders had recorded with the government in 1993 and find out which traders were still in the jambiya business. Regarding penalties, Mr Shidiwah told us that the judges in Yemen are responsible for setting fines when people break any environmental law (in-

Esmond Martin

A jambiya trader sits in his retail shop beneath pictures of the president of Yemen in both western and traditional dress.

cluding rhino horn matters—although this has never happened). We were told that the Yemen government is aware that their judges need training to improve their knowledge on environmental law. Mr Shidiwah also supported the need for a workshop funded by the United Nations Environment Programme (UNEP) regarding the implementation of CITES in Yemen, including training on rhino horn recognition. Mohammed al-Haddad from the Department of Animal Health (Ministry of Agriculture and Irrigation) is in charge of CITES on checking confiscated rhino horn for authenticity. He was extremely keen to have further training to recognize rhino horn. It is important that the government also introduces a better system to prevent bribing, such as offering rewards, changing job positions more often, and having officials of different tribal backgrounds working together on confiscation so they do not collude. A workshop on these matters would help improve CITES implementation and law enforcement in Yemen, which are crucial to cut back on smuggling. We helped the EPA and UNEP negotiate for such a workshop to take place.

We also saw the minister of Water and Environment, Abdul Rahman Fadl al-Iryani, who also thought it would be worthwhile to have a workshop on CITES and to encourage greater commitment to law enforcement. He was highly aware and concerned about conservation issues in Yemen.

At a several-day security meeting in Sanaa we met senior members of Yemen's Border Forces, Customs Authority and Navy as well as advisers from Britain on smuggling. We asked these Yemeni officials to be vigilant about rhino horn to prevent it from coming into the country. The officers said they were presently increasing all security measures on their borders, ports and airports.

We established contact with the minister of Tourism, Nabil Hassan al-Fakih, who agreed to support us. He said he could help by printing posters on Yemen's wildlife and conservation, including the rhino horn problem. From 2003 to 2006 the number of foreign visitors to Yemen expanded from 154,667 to 382,332 (unpublished statistics from the Ministry of Tourism 2007). The minister said that tourists should be encouraged to support the crafting of water buffalo horn handles for jambiyas and of course be discouraged from buying rhino horn ones. When posters are produced, his ministry will distribute them to schools and also travel agents, he said. Because of shortage of funds and time on this visit, we had to put this work on hold.

We also met the minister of State, Yahia al-Shaibi, who is also the mayor of Sanaa, to inform him that rhino horn smuggling was continuing into Yemen. He agreed to spread awareness, which he said could be especially effective on radio and television. He said he could assist us, if we gave him the materials, by putting up a sign about rhinos in the old souk and by distributing leaflets in the old city. When we have more funds we hope to do this.

Minister al-Shaibi suggested we see the minister of Planning and International Cooperation, Abdul Karim Ismail al-Arhabi, which we were able to do. He was surprised to learn that rhino horn was still being imported and also agreed to spread awareness. He suggested we see the minister of Information for media involvement, especially a radio programme to cover the subject. Unfortunately, we ran out of time for this.

Public awareness

On this visit, we produced banners on the plight of the rhino, specifically for the zoos of Sanaa and Taiz. We also talked to professors and teachers for their support, and gave interviews to the two main English-speaking newspapers.

Banners and billboards

We designed and printed in Arabic 12 banners (1 x 2 m) in durable heavy-weight plastic so they could be displayed in the open air in the Sanaa and Taiz zoos for many people to see. We had three basic designs showing wild animals on the left and African rhinos on the right with pictures of jambiyas and the fatwa (religious edict) written at our request by the grand mufti (Yemen's religious leader) in 1992 stating that it was against the will of God to kill rhinos for their horns. The messages on the banners stated 'Rhinos are threatened with extinction', 'Take care of our animals in today's world' and 'Protect Yemen's animals, which are rare and threatened with extinction'. We kept the wording simple and to a minimum.

Although four years ago we had hoped to produce posters for an education centre at Sanaa zoo, such a centre still had not been built by early 2007. With the new management we were able to get permission to display the banners in prominent positions around the zoo, putting two up as billboards on metal posts, one at the zoo entry and one in the middle of the zoo. Before this, the zoo had no banners, only signs on

Esmond Martin

Banners and billboards were put up in Sanaa and Taiz zoos to promote rhino conservation and popularize the religious edict against killing rhinos for their horns.

some of the animal cages. From the day they were erected they attracted much attention. Similarly, we got permission to put the banners up at Taiz zoo, which until then had no pictures of animals at all. Both zoos are visited by thousands of people every month and are excellent places to increase wildlife conservation awareness.

Professors and teachers

With the help of Laurens Jacobs and Linda Olyhoeck from the Dutch Embassy, we met Dr Abdul Nasher, professor of Zoology at Sanaa University, who is a member of the IUCN Leopard Specialist Group. We gave him updated information on the rhino horn problem in Yemen, asking him to include more information in his lectures. We also met the biology teacher at the Sanaa International School and he also agreed to include this information in the curriculum. Many Yemeni children from wealthy families attend this school. It is important to target the young and prosperous males of Yemen, who are the ones who will next buy jambiyas.

The press

We gave interviews to the two English language newspapers in Yemen, which are read by the Yemeni elite. The *Yemen Observer* (Estrada 2007) ran a page-long story on rhinos and a poached rhino picture on the back page was entitled ‘Shame of day’. The political adviser of the president and retired prime minister, Abdul Karim al-Iryani, told us that he liked the article, adding positively that it will be available everywhere on the Internet. The *Yemen Times* took a lot of information and illustrations for future stories and will carry out investigations in the souk. It is important to keep the rhino horn trade issue alive in the press to help keep up pressure on the government to reduce it.

Conclusion

The import price of rhino horn in Yemen since early 2003 has gone up by 40% from USD 1200 to USD 1700 a kilogram. This alarming statistic will stimulate poachers and traders to put more effort into killing

rhinos for their horns in eastern Africa. The governments and conservationists involved in eastern Africa will need to be aware of this increase in price. They will need to increase their anti-poaching efforts and in turn the Yemen government must implement a strategy to combat this illegal trade. Therefore, international conservation organizations urgently need to work more closely with the Yemen government to reduce demand for rhino horn and improve law enforcement.

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MANAGEMENT

Establishing a monitoring system for black rhinos in the Solio Game Reserve, central Kenya

Felix Patton, Petra Campbell, Edward Parfet

c/o Solio Ranch, PO Box 2, Naro Moru, Kenya; email: felixp@africaonline.co.ke

Abstract

Solio Game Reserve in central Kenya was the first black rhino (*Diceros bicornis*) sanctuary in the country. In 1970 five remnant individuals were moved into it for safekeeping against poachers. Eighteen further introductions and subsequent births in good habitat with no human interference led to rapid population increase, and the reserve has since become the source of 67 rhinos to assist in stocking new sanctuaries. In 2000, when the reserve had the highest density of rhinos in Kenya, poachers attacked Solio and nine black rhinos were killed in a five-year period. A security and monitoring system needed to be established. All previous records had been destroyed in a fire and there were no accurate population estimates of the number of rhinos. Patrol camps, patrol staff and associated equipment were acquired and training was undertaken. The reserve was GPS mapped and divided into seven security sectors, each with four or five monitoring areas. Photo identification was used to determine the number, identity and demography of the rhinos. A simple computerized record-keeping system was designed and installed and is outlined. In December 2005 field monitoring began. At the end of the first year, using identification photographs and with nearly 6000 sightings, 87 rhinos were identified but with the likelihood that there were some duplication errors and some rhinos not yet found and photographed. From this, a sex and age profile was produced and breeding performance estimated and benchmarked. With a population greatly in excess of estimated carrying capacity, reduction in numbers by translocation to other areas is essential but with an imbalance in the sex and age profile, choosing suitable candidates will be a problem.

Additional key words: photo identification, demography, carrying capacity, benchmark, performance indicators, GPS

Résumé

La Réserve de Faune de Solio, au centre du Kenya, fut le premier sanctuaire du pays qui a accueilli des rhinos noirs (*Diceros bicornis*). En 1970, cinq des individus restants furent déplacés là pour être protégés contre les braconniers. Dix-huit introductions supplémentaires et des naissances dans un habitat favorable qui ne connaissait aucune interférence humaine ont conduit à une augmentation rapide de la population, et la réserve est devenue la source de 67 rhinos qui ont aidé à peupler de nouveaux sanctuaires. En 2000, alors que la Réserve connaissait la plus forte densité de rhinos au Kenya, des braconniers ont attaqué Solio, et neuf rhinos noirs ont été tués en cinq ans. Il fallait installer un système de sécurité et de suivi. Tous les rapports antérieurs avaient été perdus dans un incendie, et il n'existait aucune estimation correcte du nombre de rhinos dans cette population. On fit l'acquisition de campements pour les patrouilles, de personnel et de tout

l'équipement nécessaire, et les formations commencèrent. La réserve fut cartographiée au GPS et divisée en sept secteurs de sécurité, avec chacun quatre ou cinq domaines de suivi. L'identification par photo servit à déterminer le nombre, l'identité et la démographie des rhinos. Un système informatique simple pour conserver les rapports fut conçu et installé et il est décrit ici. En décembre 2005, le suivi sur le terrain a commencé. A la fin de la première année, grâce aux photos d'identification et à près de 6000 observations, 87 rhinos avaient été identifiés mais il est possible qu'il y ait eu quelques doublons ou que quelques rhinos n'aient encore été ni vus, ni photographiés. A partir de là, on a produit un profil par âge et sexe de la population et on a estimé ses performances en matière de reproduction, qui serviront de références de base. Avec une population qui dépasse largement la capacité de charge estimée, il est essentiel de réduire le nombre de rhinos par des translocations vers d'autres endroits, mais avec le profil d'âge et de sexe déséquilibré qui a été observé, le choix des meilleurs candidats sera un problème.

Mots clés supplémentaires : identification par photos, démographie, capacité de charge, référence, indicateurs de performances, GPS

Introduction

Over the period 1970 to 2003, the world population of the African black rhinoceros (*Diceros bicornis* L.) declined from ca. 65,000 to ca. 3725 (Emslie 2006). Kenya, with 18,000, held approximately 28% of the population in 1970 but this reduced to 1500 in 1980 and only 400 in 1990—some 12% of the remaining world population (Brett 1993). The reason for the decline was that throughout the 1970s and early 1980s, Kenya's black rhinos were poached in all areas, both inside and outside of national parks and reserves, with few controls and little law enforcement.

One outcome of the intensive killing was to leave small remnant populations, sometimes just a single individual, scattered across the country with no hope of long-term survival and often endangering nearby human settlements while still under threat from poaching.

For this reason, Kenya's Wildlife and Conservation Management Department approached Mr Courtland Parfet, owner of the Solio cattle ranch located on the Laikipia plateau in central Kenya, for assistance. With a commitment to conservation, a 55-km^2 area of the ranch had been fenced off to protect indigenous wildlife and allow them to live their natural life without interference or threat from humans. The Solio Game Reserve was home to many buffalos, zebras, gazelles and leopards but there were no rhinos.

The Wildlife and Conservation Management Department, the forerunner of today's Kenya Wildlife Service, requested Solio to take in some remnant black rhinos while a permanent home was found for them. The first five individuals were moved in from Kiboko in the south-east of Kenya in 1970 and the country's first sanctuary for rhinos was established. With no other secure areas available, over the next 10 years the department continued to move in more rhinos. By 1980, 23 founders from nine different areas had been introduced into Solio Game Reserve.

With excellent habitat and securely hidden from view, this new group of rhinos bred and prospered, and the reserve had to be extended to 68 km^2 in 1991. In the meantime other areas in Kenya in national parks and private ranches were made sufficiently secure to take in rhinos, and Solio became the prime founder source for many populations.

By 1992 there were 66 black rhinos (Brett 1993) in the reserve, and this after some 30 individuals had been moved out to help form nucleus populations in other new reserves including Nakuru National Park, Sweetwaters Game Reserve, Lewa Downs Conservancy and Ol Jogi. The rhinos continued to thrive, and by the end of 2005 there had been 67 translocations to other areas. However, at the start of 2000 the reserve became a major target for professional poachers and in a five-year period nine black rhinos were either shot or caught in snares.

During this period, in March 2003, the Kenya Wildlife Service adopted a new management plan for black rhino conservation in Kenya (KWS 2003). Surplus rhinos from both private land and national parks and reserves were to continue being used to complete the stocking of new sanctuaries in both sectors. Kenya Wildlife Service reported that there was an urgent need to maintain a sustainable and high annual growth rate in population to develop and conserve a genetically viable population of black rhinos of the East African race or subspecies (*Diceros bicornis michaeli*) in their

natural habitats in Kenya. This was to be accomplished through increased attention to biological management and law enforcement, which is particularly important in small enclosed reserves where intensive protection to support rhino conservation also benefits the other species present, leading to rapid increases in their population density (KWS 2003).

The specific goal of the KWS strategy was to increase the black rhino numbers by at least 5% per annum and reach a confirmed total of 500 rhinos by 2005, 650 rhinos by 2010 and 1000 by 2020. The strategy also stated that without reliable monitoring data, informed biological management decisions could not be made and progress towards meeting the overall goal could not be assessed (KWS 2003). Basic information on population performance such as birth rate, mortality, sex ratio and calving index would be provided by regular monitoring (Walpole 2002) and, importantly, the monitoring of populations should be undertaken using recognized techniques for identifying individuals.

Individual rhinos can be identified from a number of features including the size and shape of the anterior and posterior horns, peculiarities of the ears, the pattern of wrinkles on the snout, prominent scars and sores on the body, the state of the tail, body size including the size of a calf in relation to the mother, and skin folds (Goddard 1966, 1967; Hamilton and King 1969; Hitchins 1969; Schenkel and Schenkel-Hulliger 1969; Hitchins and Keep 1970; Klingel and Klingel 1996). In Javan rhinos (*Rhinoceros sondaicus* L.) eye wrinkle patterns have been used to separate individuals (Polet et al. 1999).

For Solio, a key problem was that in the 1990s a fire had destroyed all the records and there was not an accurate census of the rhino population; management was estimating the herd size to be around 55. To combat poaching and support biological management of the rhino herd, a security and monitoring system had to be established. To monitor the rhinos it was important to know how many there were and how to recognize each individual. To manage the rhinos for maximum breeding performance and ensure their health, ideally the age, sex and condition of every rhino would be known.

Management area

Solio Game Reserve covers 68.3 km^2. The seven sectors vary in size between 4.5 and 13.2 km^2 (average 9.8 km^2) with the 31 areas varying between 0.8 and 4.3 km^2 (average 2.2 km^2). The size difference reflects the amount of open bush habitat and plain, where monitoring is easier and patrols can cover a greater area than in the dense thicket found especially in the west of the reserve. The area of plains in Solio Game Reserve is 7.82 km^2, representing 11.4% of the total area and varying among sectors by 0.9% to 29.0%.

Materials and methods

The 68-km^2 reserve was mapped using a Garmin 12 hand-held GPS set with freely available TrackMaker software enabling the transfer of data to computer. Features included the reserve fence, all main roads and usable side roads, bridges, rivers, dry riverbeds, water points such as dams and water troughs, and all entrance gates. The map was partitioned into smaller sections and areas (fig. 1) based on established roadways or natural features such as riverbeds. For security purposes, there were seven sectors with the objective of staffing each with a resident basic three-man patrol. For monitoring purposes, each sector was divided into four or five areas, and further by habitat type into bush or plain. All the data were loaded into ArcView GIS and used to draw sector maps and determine their size, the size of each area, and the proportion of bush and plain in each sector and area.

Figure 1. Solio Game Reserve showing partitioning into sectors and areas.

Photographs of the rhinos were taken over 21 days in September–October 2005, 14 days in February–March 2006 and 22 days in August–October 2006.

Identification photographs were taken where possible of the left and right body profile, rear view, left and right head profile, front view of the head, left and right ear, nose wrinkles, and left and right eye wrinkles, using a Minolta Dynax 7D single-lens reflex digital camera with a Tokina 80 mm to 400 mm zoom lens. The single lens with variable zoom allowed for greater flexibility and versatility in open ground conditions. Creating noise by changing lenses in the presence of a dangerous animal is not recommended and such disturbance could lead to an abrupt end to the photographic opportunity (F. Patton, pers. obs.). Manual focus was selected, with ISO settings of 400, 800 or 1600 depending on light levels. The highest-quality 'fine' setting was chosen to enable later editing. Photographs were edited in PaintShop Pro 9.01 software and were saved as jpeg files in greyscale to eliminate colour change effects as this gave the most observable contrast. Features were cropped out and resized to a height standard of 2.25 inches (572 mm). Where the file size was large, more than 500 kb, this was done by reducing the dpi but where it was small, less than 500 kb, this was done by adjusting the print size to the required height. Scans were adjusted for brightness and contrast using PaintShop Pro software as and where necessary.

Individuals were identified by the visual assessment of only those photographs of sufficiently good quality to show clear identification features. The assessment was carried out by the main author and the head of security working together, and each newly identified rhino was given an identity number. Over the three periods of photography, duplications were expected and the photo database was regularly reviewed to sift out as many as possible. At the time the photograph was taken, a record was made of the sector, sex of the animal, age class (calf, subadult, adult), size of the group it was with, and identity number of any of the individuals that had previously been found that were in the group.

A rhino photographic master ID file was created for the reserve. Three of the identification photographs—face view, right profile and left profile—were copied into an identification folder, printed on inkjet paper, the identity number written alongside the photographs, the paper laminated and plastic-comb bound into a pocket-sized (A5) booklet, which allowed two rhinos per page (fig. 2).

Monitoring began in mid-November 2005 after training newly recruited patrol rangers in the identification features of each rhino and equipping each

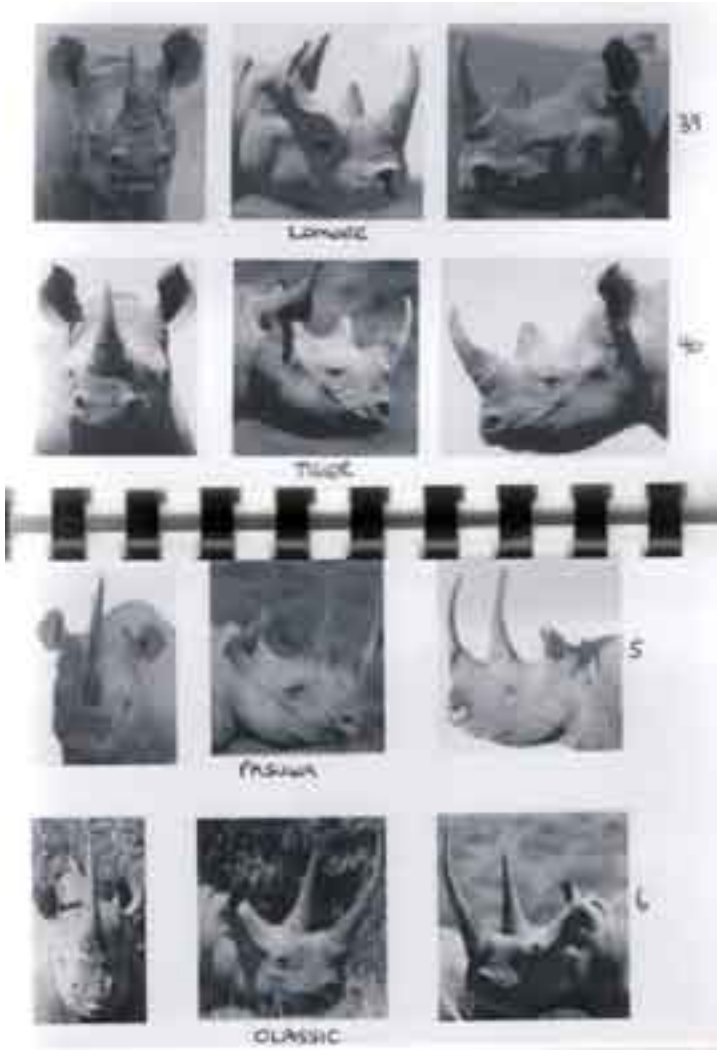

Figure 2. Typical pages from the rhino ID booklet.

patrol team with an identification booklet, binoculars and hand-held radio. To record rhino sightings made by each patrol, a simple-to-use computer-based database was created using linked Excel spreadsheets. At a sighting, the patrol radioed in to the rhino monitoring control centre the identity number, sector, area, bush or plain habitat, identity of other rhinos present, activity of the rhino (walking, sitting or sleeping, browsing, mating, fighting), name of the reporting ranger, and whether morning or afternoon. The data were loaded directly into the daily control report sheet using drop-down menus to minimize mistakes. At the end of each day a series of other Excel spreadsheets was automatically updated: 1) sighting data for individuals, separately recording sightings of each rhino, 2) monthly sighting sheet, showing which rhinos were seen on each day of a month, 3) quarterly report and annual summary, recording the number of sightings per month, quarter and year, 4) quarterly records of the number of sightings per sector for each rhino, and 5) monthly records of the number of sightings per sector per area for each rhino.

The computerized daily sighting data entries were regularly checked against a daily rhino patrol report sheet, a handwritten record patrols made of their sighting information. Any discrepancies were discussed with the patrol and then amended. Field checks of patrol sightings were made at random by the head of security and the main author.

Results

For security, data are summarized and not presented in detail.

In most cases it was possible to obtain high-quality identification photographs with features as intricate as nose and eye wrinkles. The mostly open habitat and the rhinos' lack of fear of humans, rarely found in other reserves, enabled photographs to be taken at close proximity, sometimes as close as 5 m. Where individuals were found on plain areas, all three identification views could often be captured; when in bush habitats it was usual to obtain only either a left or a right profile, but not both, along with a face view.

Visual assessment of the photographs to determine new individuals was generally straightforward, using clear differences in horn shape and size and by comparing the length of the rear horn with that of the front. In addition, some rhinos had distinct ear markings, from tears, artificial notches or hair tuft configuration. Most confusion as to whether particular rhinos were different individuals or the same one could be confirmed by reviewing photographs taken at different times and comparing them visually. In some cases, analysis of sighting data or the suspicions of the patrols led to identifying duplications, especially as more data were recorded and therefore more experience was obtained.

By the end of the first year of monitoring, 5947 sightings had been made with an average probability of sighting each individual rhino per day of 16% (range 2–46%) or a mean of 4.8 sightings per individual per 30 days. The critical sighting period—the maximum number of days acceptable in between sightings of any individual rhino—was set at 10 days for Solio, which required a sighting probability average of 10% per day. During the first year only13 rhinos were seen at a frequency of less than once every 10 days.

With only two rhinos not resighted or rephotographed, and with six births and three natural deaths (that is, not caused by poaching), the free-ranging population was estimated for December 2006 from photographic and sighting records at a definite minimum of 82 but possibly up to 10 more and most likely 87 in total. Using the lower estimate of 82 gave a density of 1.2 per km^2. Also, assuming a population of 82 with a net increase of 3 individuals, the growth rate over the year was 3.8%; only 6 of the 29 females (21%) calved that year—the growth rate and calving rate of females are both indicators of suboptimal breeding performance.

Separating the population by sex gave 46 males, 38 females and 3 unsexed calves. The three age classes were insufficient to fully describe the age profile of the population so three experienced evaluators—the main author, the Solio head of security and the rhino warden at Nairobi National Park—reviewed the photo database and further separated the age classes into seven: calves, 3.5–7 years, 7–10 years, 10–15 years, < 20 years, > 20 years, > 30 years. The evaluators' individual results were then averaged for the profile, which gave the number per class: 17 calves; 1 of 3.5–7 years; 6 of 7–10 years; 10 of 10–15 years; 16 < 20 years; 23 > 20 years; and 9 > 30 years.

The 17 calves were further subdivided into age classes according to Hitchins (1970) by comparing their size with that of their mother. From this an estimate was made for when their mothers should calve again; when the current calf would be 3 years old, a

new calf would hopefully have been born. While not a precise analysis, this enabled an estimate to be made of a further breeding performance indicator—inter-calving interval. Eight females were considered to have the potential to calve within 2006 but only two did so with the calving interval for both estimated at 34 months. The other six females did not calve within 36 months.

Sighting data showed that 59% of the rhinos were found normally in one sector (over 90% of sightings), 22% were found normally in one of two adjacent sectors and only 19% were found in three or more sectors.

Discussion

While with experience patrols became confident in being able to discriminate between individuals, they placed much reliance on horn size and shape. Although no signs of horn rubbing were found, some photographs showed rhinos with broken horns and several individuals had long, slender horns that potentially could break. It will thus be important for the photographic database to be regularly updated and for patrols to report any change in horn size and shape or other identification features.

The photo identification booklet ensured there were only a few 'confusions' between individuals reported by patrols. This, coupled with field verification of rhino identification, resulted in a high level of accuracy in reporting sightings. There was therefore no general need for artificially marking the rhinos with ear notches.

This paper reports on the first year of rhino monitoring at Solio Game Reserve, before which there was no formal system in place. Full staffing was not achieved until August 2006. It can be expected that sighting numbers will increase in the second year as patrols become experienced in where to find rhinos in their sector. The critical sighting period requirement of 10 days and a sighting frequency minimum of 10% will therefore most likely be achieved for all rhinos, although a few of particularly nervous disposition may remain more difficult to locate. The density of rhinos in Solio Game Reserve at 1.2 per km^2 is high compared with other similar enclosed Kenyan reserves, which is typically around 0.5 rhinos per km^2. A habitat evaluation study showed that there had been severe degradation of important rhino browse species and suggested that the population was well in excess of the reserve's carrying capacity (Adcock 2006). Evidence of this was found in the analysis of breeding performance. The 3.8% growth rate is below the Kenya Wildlife Service target of 5% per annum although single-year rates in small populations must be treated with caution.

Benchmarks of breeding performance for black rhinos (du Toit 2001) class the annual (December 2005–November 2006) Solio growth rate of 3.8% as poor to moderate, the calving interval of 36+ months as poor to moderate, and percentage of cows with calves of that year of 21% as very poor to poor although again single-year rates in small populations must be treated with caution. This poor performance may be due to foetal deaths caused by poor nutritional conditions as a result of habitat degradation, or just that poorer nutrition means it may take longer for females to build up sufficient condition to be able to successfully conceive and raise calves. However, with six females estimated to calve in 2007 and six that did not calve as estimated in 2006, there could be 12 new calves by the end of 2007. If there are no deaths, this increase would give a population size of 99 at a growth rate of 14.6% and percentage of cows with calves of that year of 41%—both performance indicators rated as good to excellent. This would also mean that 12 current calves would move to independent status either as calves (≤ 3.5 years old) or as subadults (3.5–7 years), giving 29 individuals younger than 7 years (30% of the increased population compared with the current 21%), improving the age balance between young and old.

Of the nine rhinos judged to be over 30 years old and with the knowledge that there had been little ear notching undertaken except for the founder individuals, it was considered probable that some of the nine were from the original stock, which meant that they were likely to be over 40 years old and therefore some of the oldest wild black rhinos in the world. These included the magnificently horned female Pasuka (fig. 3), and the 'three-horned' male, Karanja (fig. 4).

While the sex ratio of the population is considered acceptable at 1.2 males per 1 female, the ratio of rhinos less than 10 years old is imbalanced at 2 males per 1 female. This may be the result of a number of factors. For example, it is known that females in poor body condition because of inadequate feed may produce sons as they will disperse and not compete locally for resources (S. Reece 2005 pers. comm.). However, it may also be simply chance that has led to

a run of male births, which could be countered over time by a run of female births.

Sex ratios have been shown to have a significant effect on population increase, and to promote population growth it would be beneficial to distort adult sex ratios in favour of females (Knight 2001). If the current situation of too many males does not change with new births being predominantly female, the effect on future population growth rates could be detrimental.

With data collection, many rhino sightings in Kenyan reserves are recorded by specific GPS location points. This information is later analysed to estimate each rhino's home range. The Garmin 12 units usually used for this are not cheap at about USD 200 per set, and the financial resources available to Solio, as with any other reserve, were limited. This was especially true in the setup year, when establishment costs were high for building and equipping patrol camps, purchasing ranger uniforms, paying salaries and buying mobile communication equipment. There was a need to assess the value of collecting data on GPS locations in Solio.

Figure 3. Pasuka, probably one of the oldest female rhinos in the world.

Figure 4. Karanja, probably one of the oldest male rhinos in the world.

Rhino patrols are normally carried out at specific times, and sightings were most frequent either very early when rhinos were browsing or moving to a day bedsite or mid-morning where a rhino was on a day bedsite. Where a rhino was moving, the GPS reading taken depended on the precise time of the observation. Had it been 15 minutes earlier or later, the location could have been different by 1 km or more. Also to find a rhino, a patrol may have followed its footprints for several kilometres. For monitoring purposes, once a rhino has been found, it need not be seen again that day and there may be other duties for patrols such as detecting snares or other signs of poaching. This resulted in afternoon sightings being much less frequent than morning ones. It was found that rhinos often moved, especially around midday, from their initial morning location to a new location, which could be several kilometres away. There were instances where a rhino was sighted at night or in the early morning several kilometres from its normal daytime location. All these factors suggest that single precise GPS location fixes are heavily biased to time-related sightings and do not represent the full range the rhino uses. According to Tatman et al. (2000), the range should be estimated using additional data from

middens, scrapes, browse, footprints and so on where an individual can be correctly identified. In the Solio situation, it was considered sufficient for management purposes to obtain representative use of space and ranging areas from the sector or area blocks either by using the whole block or by using a point at the centre of the block to demonstrate which rhinos were using the same areas and any changes in area use.

Another use of GPS location data could be to find a 'missing' rhino by reviewing the sightings to determine where the rhino was most often seen. The simplified Solio record-keeping system made it possible to present the sighting data for an individual rhino in an automatically produced table that showed where it would most often be found—although the rangers knew this anyway without using technology. In any case, it would be unlikely that the rhino would be in precisely the same location but rather in a rough area that could be determined by the block system.

GPS data may be collected on the patrol routes undertaken so that in any time period it can be seen which areas of a reserve have been covered and which areas need to be covered. Block data with an average size of 2.2 km^2 could be used as effectively to record areas covered on patrol.

There are practical considerations. GPS units fail: they fail eventually due to hardware degradation; they fail in the field due to lack of battery power; they fail when they are dropped; they fail when the wrong buttons are pressed; they fail when they are forgotten; they fail when the data are incorrectly entered into the computer. Gaps in GPS data collection and errors in entering data into the computer are known to occur (Okita 2004). GPS data are significantly more difficult and time consuming to enter into the computer than block data where simple drop-down menus can be used to minimize entry errors.

The general conclusion was that GPS location information was unnecessary in a small reserve such as Solio and its use for scientific analysis was potentially flawed. The data required for management purposes could be produced from the block system employed with the additional benefit that as records were entered into the computer at the time of the sighting, the database could be updated immediately thereafter. It was considered more important to acquire a digital camera with minimum x10 optical zoom to maintain an up-to-date photo identification database and to be able to update the field identification booklets. However, Solio is a small sanctuary, intensively patrolled. GPS data can be useful in bigger, less intensively monitored parks of say 350–1000 km^2 in size where the data can be used, for example, to confirm that guards actually patrolled where they said they did and to allow for plotting search effort.

The carrying capacity for Solio was provisionally modelled at 42 individuals (Adcock 2006) giving a maximum sustainable yield (75% of carrying capacity) of 32, although it was thought it could be somewhat higher due to the permanent wetland area providing a nutrition 'bank' and low densities of other potentially competing browsers compared with other black rhino areas. This suggested a need to reduce population by between 45 and 55 individuals. Data obtained from the first year of monitoring was used to inform management on the selection of candidates for translocation of 30 individuals from Solio to two other rhino reserves in Kenya in early 2007. After this a further 15 to 25 individuals would have to be moved to meet the targets. However, with currently 20 calves and 19 breeding females, both of which belong to classes less favoured for translocation (Brett 1998), there are insufficient candidates to enable such a movement to be completed in the near future.

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Illegal killing of African rhinos and horn trade, 2000–2005: the era of resurgent markets and emerging organized crime

Simon A.H. Milledge

TRAFFIC East/Southern Africa, PO Box 106060, Dar es Salaam, Tanzania; email: traffictz@bol.co.tz

Abstract

This paper summarizes rhino poaching, rhino horn seizure and stockpile data in Africa for 2000–2005. It is derived from a document prepared by TRAFFIC, the wildlife trade monitoring network, for the 14th meeting of the Conference of the Parties to CITES in June 2007. The volume of horn entering illegal trade from Africa has increased significantly since 2000, indicating ongoing market demand and organized trade routes to the Middle and Far East. Through law enforcement, range States collectively recovered 42% of the potential number of rhino horns moving into illicit trade, but a minimum of 386 horns are believed to have evaded detection and were lost to illegal trade. Poached rhinos continue to supply most horns, with at least 252 rhinos detected as illegally killed during 2000–2005. However, prominence has been rising of horns acquired and laundered from private stockpiles and from legally hunted white rhinos in South Africa. With effective metapopulation management strategies, most range States in Africa have minimized poaching to levels at which their overall rhino populations continue to increase in numbers. Two notable exceptions are the Democratic Republic of Congo and Zimbabwe, where respectively 59% and 12% of their 2003 rhino populations were illegally killed during 2003–2005. Where illegal activities have escalated in key rhino range States, two important factors limiting management effectiveness are the increased levels of criminal organization and a breakdown of socio-economic stability and governance. TRAFFIC recommends renewed international attention following recent CITES decisions, with a focus on problems in DRC, South Africa and Zimbabwe.

Résumé

Cet article résume les données sur le braconnage des rhinos, les saisies de cornes et les stocks en Afrique pour la période 2000–2005. Il est tiré d'un document préparé par TRAFFIC, le réseau de suivi du commerce des espèces sauvages, pour la Conférence des Parties à la CITES de juin 2007. Le volume de corne qui entre dans le commerce illégal en provenance d'Afrique a augmenté significativement depuis 2000, ce qui indique une demande soutenue et des routes de trafic bien organisées vers le Moyen- et l'Extrême-Orient. Les états de l'aire de répartition ont réussi à récupérer collectivement, grâce à des activités de maintien des lois qui ont eu lieu entre 2000 et 2005, 42 % du nombre potentiel de cornes qui étaient absorbées par le commerce illégal, mais on estime qu'au moins 386 cornes ont échappé à toute détection et se sont fondues dans le commerce illégal. Les rhinos braconnés continuent à alimenter la plus grande partie de ce commerce, avec au moins 252 rhinos tués illégalement pendant cette même période. Pourtant, on constate l'importance croissante des cornes acquises et blanchies auprès de stocks privés et venant de rhinos blancs tués légalement en Afrique du Sud. En raison des stratégies efficaces de gestion en métapopulations, la plupart des pays africains de l'aire de répartition ont pu réduire le braconnage jusqu'à un niveau qui permet à leur population totale de rhinos de continuer à croître. Les deux exceptions notables sont la République Démocratique du Congo et le Zimbabwe qui ont respectivement perdu 59 % et 12 % de leur population de rhinos à cause de massacres illégaux entre 2003 et 2005. Là où les activités illégales ont augmenté dans les états de l'aire de répartition des rhinos, les deux facteurs importants qui ont limité l'efficacité de la gestion sont le niveau plus élevé de criminalité organisée et un effondrement de la stabilité socio-économique et de la bonne gouvernance. Les recommandations données s'inscrivent dans le contexte d'un intérêt international renouvelé suite aux récentes décisions de la CITES, avec une attention particulière pour les problèmes que connaissent la RDC, l'Afrique du Sud et le Zimbabwe.

Introduction

The illegal killing of rhinos for horn trade to the Middle and Far East markets has long posed a serious threat to both African rhino species. Less than 15 years after numbers of African rhinos had reached their lowest level in history, both species have shown a steady recovery. White rhinos, *Ceratotherium simum,* more than doubled from 7095 in 1995 to 14,550 in 2005, while black rhinos, *Diceros bicornis,* increased from 2410 to 3725 during the same period (Emslie and Brooks 1999; Emslie et al. 2007). Indeed, the ongoing recovery of African rhino populations could be one of the most heralded conservation success stories in the making.

A two-pronged approach helped halt the decline of African rhino numbers. First, the severity of illegal activities experienced during the 1970s and 1980s was reduced through a combination of measures along the trade chain, ranging from intensive in situ protection in range States to promoting substitutes in consumer nations. Second, metapopulation management and innovative partnerships have been instrumental in improving rhino population performance and range expansion. CITES decisions have played their part in addressing illegal activities (e.g. national and international trade restrictions) and in helping to provide economic incentives for further investment in rhino conservation (e.g. down-listing of white rhinos to Appendix II in two southern African countries).

Since the early 2000s, however, several wildlife management authorities have voiced concerns over a resurgence of rhino-related criminal activities and their negative effects. Other contemporary challenges include the need to properly manage the legal trade options under Appendix II listings, and to ensure security of rapidly accumulating horn stockpiles across the continent. For these reasons, rhinos will surely continue to have strong relevance on the CITES agenda.

Following decisions made at the 13th meeting of the Conference of the Parties to CITES, in 2004, and subsequent meetings of the Standing Committee, IUCN/SSC and TRAFFIC were mandated to report on the status of rhinos and related trade issues at the 14th meeting of the Conference of the Parties (CoP14), held in June 2007. This article is derived from the report 'Rhino-related crimes in Africa: an overview of poaching, seizure and stockpile data for the period 2000–2005' (CoP14 Info. 41; Milledge 2007). It was submitted by the CITES Secretariat at the request of TRAFFIC as an addendum to CoP14 Doc. 54 *Rhinoceroses* Annex 1 (Emslie et al. 2007).

This study used standardized indicators for monitoring the extent, severity and response to rhino-related crimes across the continent. By providing a contemporary assessment of rhino horn trade in Africa, this study served to assist CITES Parties in their deliberations at CoP14 and subsequent intersessional work. The reports IUCN/SSC and TRAFFIC submitted at CoP14 prompted several decisions to refocus international attention on rhinos.

Materials and methods

This study was based on an analysis of all known rhino-related crimes in Africa during the period 2000–2005, and on discussions with relevant national and regional bodies. Crimes included incidents of illegal killing, horn seizures, thefts and unauthorized sales. Most data were provided by government wildlife and law enforcement authorities and stored in the TRAFFIC African Rhino Crime (ARC) database. ARC has three major components:

- *Component 1—Populations:* annual population numbers, detected mortalities and translocations are provided for every rhino population and species
- *Component 2—Poaching:* detailed information is provided for each incident, including the date, location, species, method of killing, details on horn losses and recovery, origin of poachers, destination of horns, arrests and convictions
- *Component 3—Seizures:* detailed information is provided for each incident, including the date, location, species, number, weight, origin and destination of seized horn, arrests and convictions

Due to the sensitive nature of most information on illegal rhino activities, the confidentiality of some crime data, and the understanding between TRAFFIC and range States regarding data analysis and use, this study does not attribute findings and opinions directly to individual sources. Data were collected with the willing participation of government conservation authorities, and almost every range State offered comments during peer review.

Analysis of ARC data focused on calculating various indicators (table 1). The use of standardized indicators allowed more accurate comparisons between different countries, and the measure of changes over time (TRAFFIC 1999).

Table 1. Overview of rhino crime indicators analysed for Africa, 2000–2005

Category	Indicator	Mode of calculating indicator
Severity of rhino crimes	Occurrence of rhino crime	Relative spatial distribution of rhino poaching and seizure incidents
	Relative poaching intensity	Proportion of all detected mortalities attributed to illegal killing
Effectiveness of management response	Poaching impact on populations	Proportion of living rhinos killed illegally
	Horn recovery	Proportion of lost horns recovered through enforcement
	Arrests and convictions	Proportion of cases resulting in arrests, and the proportion of suspects convicted
Useful explanatory indicators	Rhino population performance	Population growth rate
	Patrol efficiency	Comparison of actual and expected rhino mortality detection rates

Results

Markets for rhino horn from Africa

Almost all rhino horn sourced from Africa continues to be sold to countries in East and South-East Asia for use in traditional Asian medicine,[1] and to Yemen for making *jambiya* (traditional dagger) handles. China, Hong Kong, the Philippines, Singapore, Thailand, South Korea and Vietnam have all been implicated as having a role in the illicit trade in horn coming from Africa, with particular concern over the increasing and highly organized role of Vietnamese nationals since 2004.

Sources of rhino horn in Africa

During the six-year period between 2000 and 2005, confirmed cases of illegal killing accounted for 252 rhino carcasses detected in seven African rhino range States (table 2). Over 90% of the reported poaching incidents were recorded in three countries: Zimbabwe, South Africa and Kenya (fig. 1).

The majority of illegally killed rhinos in Africa were shot (70%), with a further quarter snared. Trade in bushmeat from other target species is believed to be the motivation behind some of the snaring cases, most of which occurred in Kenya, South Africa and Zimbabwe. Black rhinos constituted just over half (54%) of the poaching incidents recorded for rhinos in Africa during 2000–2005.

On occasion, horns are stolen from natural mortalities. Such theft of rhino horn can be significant, even in areas where rhinos are relatively intensively monitored and protected. For example, 16% of the horns entering illegal trade from one South African province between 2000 and 2005 were stolen from natural mortalities (40% of these horns were subsequently recovered). For all range States, ARC records show that at least 25 horns stolen from natural mortalities were not recovered between 2000 and 2005.

The annotations for the Appendix II listing of white rhinos in South Africa and Swaziland allow the export of hunting trophies and live animals to appropriate destinations. In addition, South Africa and Namibia

Table 2. Number of rhinos known to have been killed illegally in Africa by species and poaching method, 2000–2005

Mode of poaching	White rhinos	Black rhinos	Total
Shot	74	77	151
Snared	20	32	52
Speared, stabbed, poisoned	10	2	12
Unknown	12	25	37
Total	116	136	252

are each permitted an annual export quota of five male black rhino hunting trophies.

It is acknowledged that the majority of legally hunted rhino trophies exported from South Africa and Namibia have remained as bona fide personal hunting trophies. Indeed, until recently there has not been any particular reason to question the purpose of rhino horn exports obtained from legitimate hunting operations as anything but 'hunting trophies'. According to the UNEP–World Conservation Monitoring Centre database on CITES trade, such trophies have been imported into 41 countries since 2000. In a relatively new development, it appears that the existing legal measures to regulate white rhino trophy hunting in South Africa are being abused by persons intent on trading the horn commercially. For example, once horns are legally acquired as hunting trophies, some individuals have subsequently mixed them with horns that were acquired illegally, or used the trophy ownership documentation in a fraudulent manner.

It should be recognized, however, that to date these practices have *not* affected the sustainability of the white rhino trophy hunting industry in South Africa, nor affected the ongoing growth in rhino populations of both species in the country. However, the scale of this problem has grown significantly in the past two years—with uncertainty over the ultimate destination of trophies from over 50 rhinos in 2006—and is an entirely new dimension to the illicit trade in rhino horn.

[illegible]

Stockpiles of rhino horn may accumulate in government stores from a number of different origins, including discovered mortalities, dehorning or tipping exercises, confiscations and accidental knock-offs. In some countries, rhino horns are also held in private hands (e.g. pre-Convention personal items, hunting trophies and horns from privately owned rhinos). By early 2007, TRAFFIC had documented just over 20,000 kg of rhino horn under government and private ownership in Africa. South Africa, Zimbabwe and Namibia held over 90% of this stockpile by weight.

To minimize the risk of horn flowing into illegal markets, ensuring that horn stockpile are adequately managed is as important as traditional field protection. Prevention of theft is an important consideration for *State-owned* stockpiles, some of which have accumulated into large amounts. Fortunately, large-scale theft of rhino horns from centralized strongrooms is not known to have occurred in Africa since 2000.

In South Africa, ongoing challenges concern the existence and registration of horns under private ownership. First, the actual existence of officially registered horns had not been verified for many years, although a nationwide audit was initiated during 2006. While the results have not been finalized, it is already apparent that some registered horns are no longer in the possession of the registered owners in several provinces.

Second, there remains a mismatch between the quantity of *expected* (i.e. according to rhino population sizes and expected accumulation rates) and *officially registered* horn under private ownership. In 2001, a survey of the status of white rhinos on 242 private properties in South Africa highlighted the scale of this discrepancy (Castley and Hall-Martin 2003). Owners reported just 291 horns (estimated weight, 578 kg)—less than 5% of the total horn stockpile in South Africa, although the private sector held up to a quarter of the live white and black rhino population in the country. With a population totalling more than 3700 animals, the accumulation of horns from natural and management-related causes should result in significantly higher numbers of horn in private hands than has been reported.

Of related concern is the reluctance of some private rhino owners to comply with the legal registration requirements for rhino horn. Castley and Hall-Martin (2003) found that only 30% of the privately owned horns were reportedly registered with the respective provincial nature conservation authorities. During 2006, provincial wildlife investigations discovered that some private rhino owners in South Africa have indeed sold unregistered horn to suspects linked to illegal traders.

To complicate matters further in South Africa, it has become evident that illegal horn-trading networks have been legally acquiring horns, but with the intention of onward commercial sale outside South Africa. South African legislation permits the sale of rhino horn but prohibits the horn leaving the country for commercial purposes.

Estimating the total volume of horn traded onto the illegal market

The quantity of rhino horn destined for illegal markets was calculated using known poaching incidents, thefts

and other irregular acquisitions, as outlined above. During 2000–2005, a minimum of 664 horns was acquired with the intention of illicit trading (table 3). Most of these horns were derived from poached rhinos.

Law enforcement ranging from rapid response in protected areas to investigations and confiscations in urban centres, resulted in 42% of these horns being recovered. Nine countries successfully recovered 278 horns during 2000–2005 (table 3).

As a result of these recoveries, the minimum amount of horn from Africa calculated to have entered illegal trade during this period was 386 horns, or an annual average of 64. The majority (86%, equivalent to 49 horns annually) came from southern Africa, and the remaining 15 horns annually from eastern Africa (fig. 1). The actual quantity of lost horn is almost certainly higher due to a combination of undetected poaching or thefts (especially from large rhino areas) and as yet undetected, further illegal sale of private stock.

Using average horn weights for black and white rhinos, these 64 horns were equivalent to an annual average of 102.4 kg entering illegal trade during 2000–2005. This amount can be compared with the devastating poaching era during 1970–1986 when an estimated 2648 kg of horn left Africa annually (Martin and Ryan 1990). Despite volumes in the current trade being far lower than in the 1970s and 1980s, available information raises concern by suggesting a steadily upward trend in the volume of horn entering illegal trade since 2000, while showing no fundamental change in the number of horns recovered through law enforcement (fig. 2).

Table 3. Known rhino horn flowing to illegal markets in Africa, 2000–2005

Source or recovery of horns	No. of horns
Source of horns to illegal markets	
Horns taken from poached rhinos	(535)
Horns stolen from natural mortalities	(25)
Horns suspected sold from legal trophy hunts or private stocks	(>100)
Thefts from government stockpiles	(4)
Subtotal of horns lost	(> 664)
Recovery of horns by government enforcement agencies	
Recoveries in the field	105
Confiscations and seizures	173
Subtotal of horns recovered	278
Total balance of horns lost to illegal trade chains	(386)

( ) indicates horns lost

Impact of illegal trade on rhino population status

While the trend in rhino population numbers is ultimately the main gauge of population growth and recovery rates, two other indicators provide an accurate picture of where poaching pressure is most serious in terms of *intensity* or *impact* on the rhino populations:

- *Proportion of carcasses killed illegally:* range States where a higher proportion of detected carcasses were poached indicates high poaching intensity
- *Percentage of population killed illegally:* a high proportion of living rhinos killed illegally is more likely to be unsustainable

Poaching intensity varied greatly among range States during 2002–2005 (fig. 3). For example, not a single mortality was attributed to illegal causes in Swaziland, whereas all carcasses found in DRC over this period were poached. The highest levels of poaching intensity were witnessed in DRC, Zimbabwe and Kenya (depicted as a time series in figure 4). Poaching has caused greater damage to rhino populations in DRC and Zimbabwe than in any other range States in recent years (fig. 3). During 2003–2005, the DRC rhino population declined by over 40% per annum, while the total black and white rhino population in Zimbabwe grew at just 3% per annum.

For other range States, the net annual increase in national populations (black and white rhinos combined) exceeded 6%, accounting for count variance in annual estimates from the larger populations. Kenya was a notable range State in this regard, with good population growth between 2003 and 2005 despite the fact that illegal killing caused more than 40% of the documented mortalities.

Effectiveness of law-enforcement responses to rhino crimes

Effective law-enforcement responses to rhino-related crimes are important for two main reasons. First, they help to reduce to a minimum the quantity of rhino horn flowing onto the illegal market.

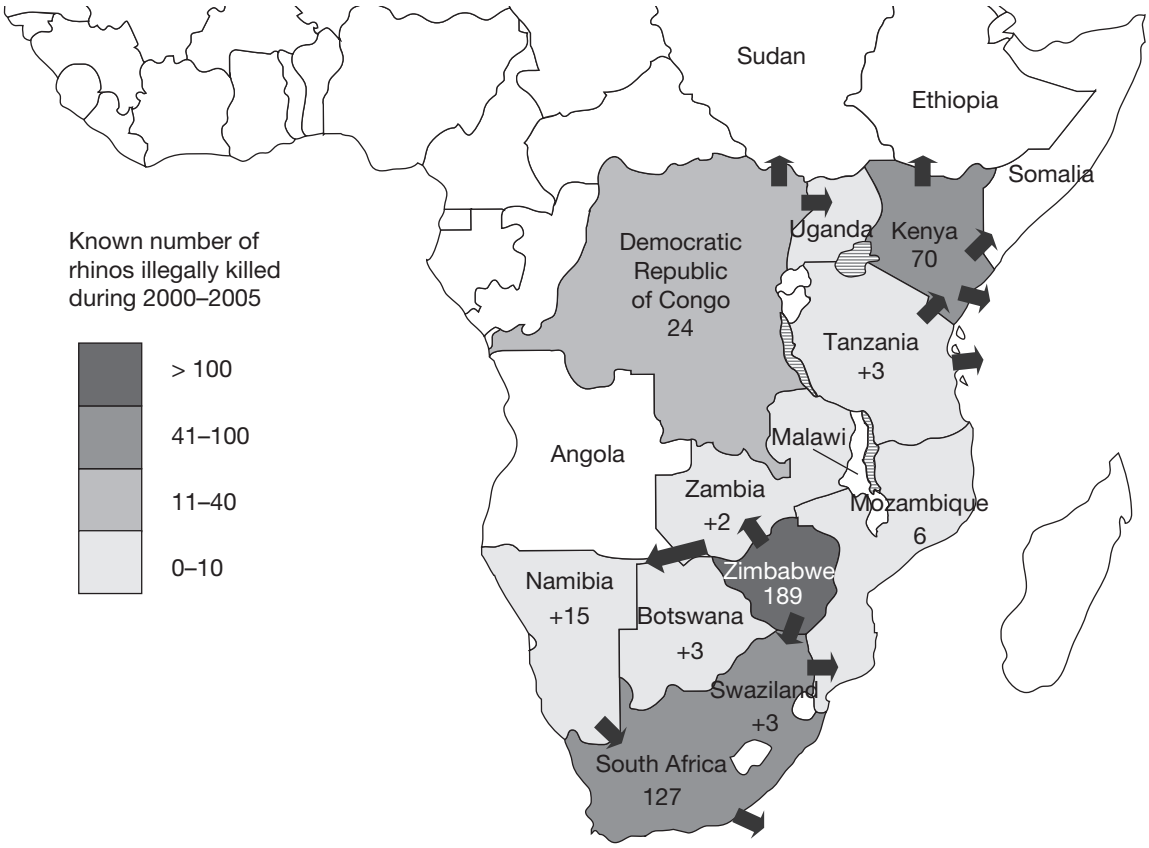

Figure 1. Distribution of rhino poaching incidents (shaded), primary trade routes (arrows) and numbers of horns lost to illegal trade (numeric values), 2000–2005. Values written as + or – are the *net* minimum flow of horns in or out of each country during 2000–2005. For example, accounting for recoveries, at least 70 horns were lost to illegal trade from Kenya during 2000–2005. In Namibia, more horns were recovered than could have been lost from illegal killing, resulting in a net recovery of 15 horns that probably came from another country. Relatively little knowledge exists on trade routes in Ethiopia, Mozambique, Tanzania and Zambia.

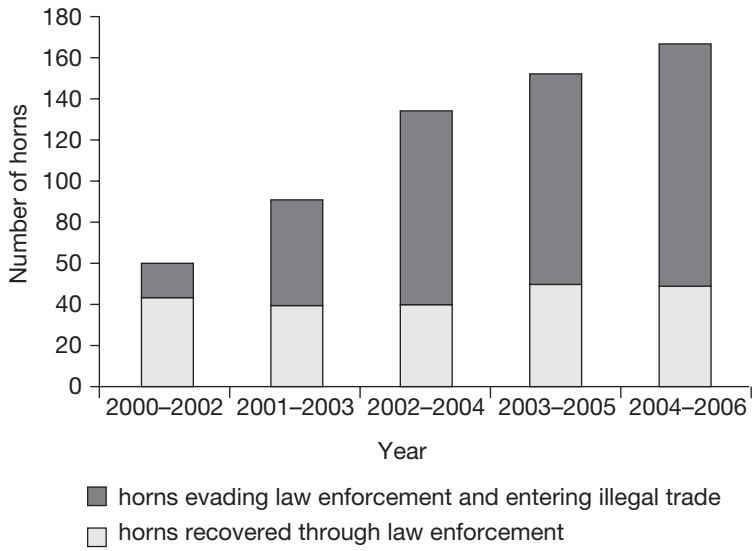

Figure 2. Annual average number of horns recovered and lost to illegal trade in Africa, 2000–2006, plotted as moving three-year windows to reduce the inaccuracy of some data, especially the imprecise periods during which some private horn stocks were sold to the illegal market.

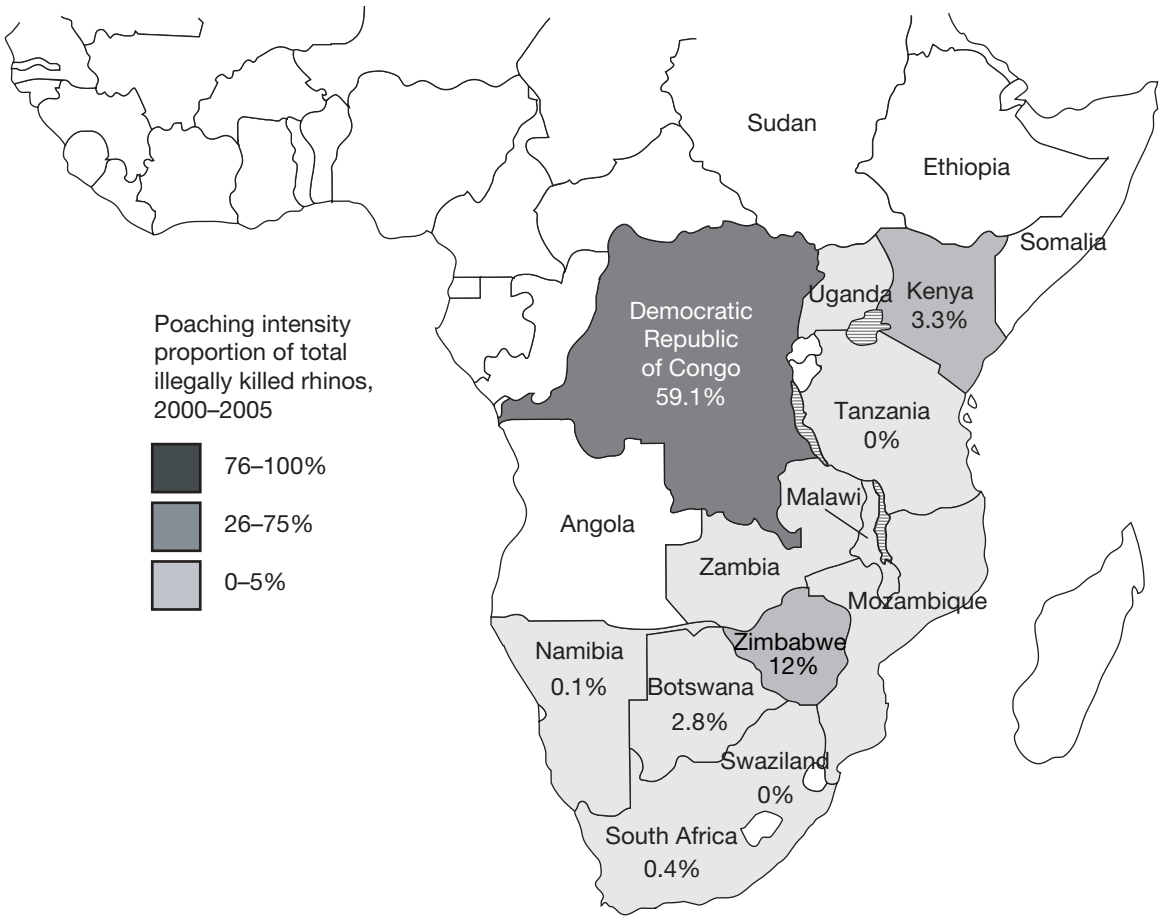

Figure 3. Relative poaching intensity (shaded) and impact on populations (numeric values) in African rhino range states, 2000–2005. Values written as a percentage are the proportion of the total end-2003 rhino population illegally killed, 2003–2005.

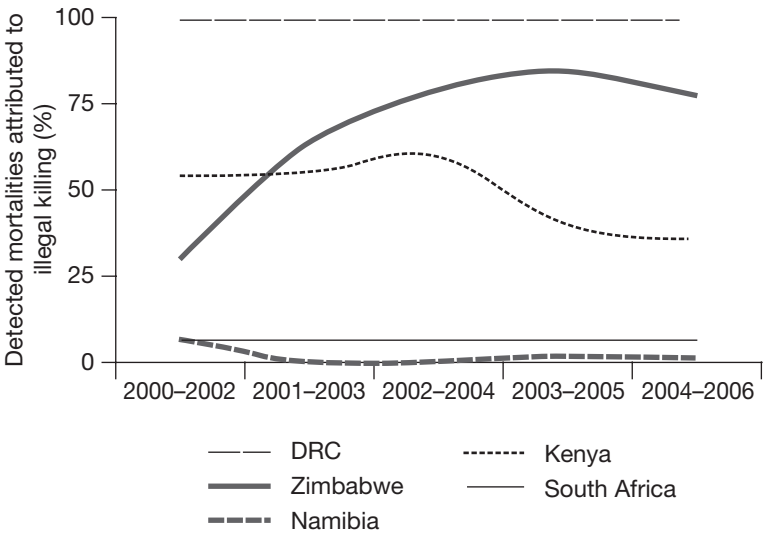

Figure 4. Smoothed poaching intensity trends in five range States expressed as the percentage of detected mortalities attributed to illegal killing. Since some detected carcasses in a given year may have been more than one year old, data points are expressed as moving three-year windows, thus helping to reduce the degree of inaccuracy.

Second, effective enforcement is important in reducing the impact of illegal activity on rhino populations. This applies to rhino populations both in the country in which enforcement action is being taken, and in neighbouring countries since illegal trading networks operating with relative impunity may soon set up cross-border operations.

A combination of adequate legislation, capacity and implementing appropriate enforcement strategies is needed to successfully prevent and respond to rhino crimes. The following are useful indicators of law-enforcement response to rhino-related crimes:

- *Arrest and conviction rates:* the proportion of rhino crimes (e.g. poaching and seizure incidents) where suspects were arrested, and the proportion of cases where arrests were made resulting in successful convictions. Data from all range States at the time of this analysis were insufficient to present these indicators.
- *Horn recovery rate:* the proportion of horn potentially lost from poached rhinos and other sources (e.g. stockpile thefts or illegal sales) later recovered through field recoveries and seizures.

Overall, 42% of all horns potentially lost to illegal trade during 2000–2005 were recovered—about one-third were recovered in the field as part of rapid responses to poaching incidents and two-thirds from subsequent seizures at other locations (table 3). Horn recovery rates varied among different range States, with five countries actually recovering more horns than could be accounted for from detected poached rhinos or other sources (Botswana, Namibia, Swaziland, Tanzania, Zambia; fig. 1). Of the remaining countries, South Africa had the highest horn recovery rate (54%), followed by Kenya (47%), Zimbabwe (13%) and DRC (8%).

One concern is the increasing proportion of horn lost to illegal markets since 2000 (fig. 2). Available data from Kenya and South Africa indicate that the declining proportion of horns recovered is largely attributed to increased organization of illegal poaching and horn-trading networks. As a result, horns are acquired and moved using far more efficient and clandestine modus operandi. A drop in wildlife-enforcement budgets and capacity may also have had an effect. South Africa has taken commendable steps to investigate organized rhino-related crimes that link different parts of the country, as well as neighbouring countries. One obstacle to overcome in completing these outstanding investigations is the limited jurisdiction of the various provincial authorities and law-enforcement institutions involved.

Discussion

Summary of spatial and temporal patterns in rhino crimes

Three main patterns are evident from rhino-related crime data analysed during 2000–2005. First, the overall volume of horn entering illegal trade has increased since 2000. This matches a switch to commercial rhino poaching targeting horn in Kenya, Zimbabwe and DRC during the period 2001–2003 (du Toit 2002; Mulama 2002; Hillman Smith et al. 2003; Matipano 2004). Also key to this development has been the rising prominence of horn entering trade from sources other than poaching, including horns acquired and laundered from private stockpiles and legally hunted white rhinos. This laundering does not appear to have negatively affected rhino population performance, but it has contributed to the quantities of horns entering illegal trade for commercial purposes.

Second, the intensity of poaching—measured using the proportion of total mortalities that were killed illegally—rose to levels of serious concern in Zimbabwe up to 2005 (fig. 4). In Kenya, poaching intensity peaked during 2001–2003 but has actually fallen in recent years. Rhino populations in Zimbabwe and DRC have experienced the greatest impact from poaching. Poaching does not appear to have prevented positive growth in total rhino populations in other range States.

A third pattern in rhino-related crimes was the overall decline in the proportion of enforcement-related horn recoveries. This appears to be most linked to the increased organization of criminal horn-trading networks operating in Africa. Several wildlife enforcement officials have expressed concern over the increased levels of sophistication by which some South-East Asian horn-trading networks operate, which may pose a more serious threat to rhino populations if left unaddressed.

Table 4 presents a summary of the main rhino crime indicators for the eight largest rhino range States. These countries can be placed into four groups according to their similarities.

Table 4. Selected indicators for rhino crimes in African range States

Country	Sample size: rhino crimes[a], 2000–05 (no.)	Poaching pressure: detected mortalities from poaching, 2000–06 (%)	Poaching impact: percentage of 2003 population poached during 2003–05	Management response: horns lost[b] to illegal markets but recovered by enforcement, 2000–05 (no.)
DR Congo	14	100.0	59.1	8
Kenya	64	41.1	3.3	47
Namibia	20	2.7	0.1	288
South Africa	86	6.6	0.4	54
Swaziland	2	0.0	0.0	n/a
Tanzania	3	14.3	0.0	200
Zimbabwe	105	69.2	12.0	13

Zambia and Mozambique are not included in the table because of the lack of data, but they are implicated as transit countries for a portion of horn leaving both Zimbabwe and South Africa. Both countries have relatively small rhino populations and are negligible sources of horn.

[a] Rhino crimes here include poaching and seizure incidents.

[b] Estimated calculation of horns supplied to illegal markets included horn from poached rhinos, thefts from natural mortalities and stockpiles, and acquisition of hunting trophies or private stock.

[illegible]

These two countries are characterized by having not only the highest severity of poaching (i.e. poaching pressure and impact) but also of low ratings for effectiveness of management response. More than 60% of the rhino population in DRC was illegally killed during the three-year period 2003–2005. This coincided with a switch from meat to ivory poaching in Garamba National Park witnessed in the second half of 2003 (Hillman Smith et al. 2003). Strengthened park management since 2005 has led to reduced wildlife poaching pressure in general, but the situation remains grave.

In Zimbabwe, a high number of rhino crimes took place, and poaching accounted for two-thirds of all rhino mortalities. Translocation of populations under threat has helped reduce the impact of poaching, but poaching intensity has increased. Illegal killing during 2003–2005 affected 12% of the 2003 rhino population, and recent data shows a downturn in some key populations. Further, effectiveness of enforcement follow-up has been limited, with low levels of arrests and prosecutions.

[illegible]

Kenya and South Africa have both experienced a general rise in the proportion of horn entering illegal trade (not recovered through enforcement), indicative of the enforcement challenges following increased organization of illegal horn-trading networks and, possibly, capacity shortages within some conservation authorities. For example, the proportion of recovered horn decreased from 72% during 2000–2002 to 23% during 2003–2005 in Kenya, and from 64% to 49% in South Africa. In the case of Kenya, 40% of all detected mortalities during 2000–2006 were caused illegally although poaching intensity appears to have declined. Some rhino populations have suffered from illegal killing but the national totals continue to rise.

While one-third of all poaching incidents recorded in Africa took place in South Africa, the country conserved 82% of the continent's rhinos in 2005 and the overall poaching intensity remained relatively low and constant. Illegal killing, amounting to just 5% of all mortalities during 2002–2005, had a minimal impact on rhino population growth. Greater concern lies in South Africa's role as a source of relatively large quantities of horn for illegal markets, including horns acquired through legal means on private property but subsequently laundered into illegal trade. It should be noted, however, that the total rhino population in the private sector nevertheless continues to grow, and imminent promulgation of new national regulations covering trophy hunting of rhinos should eliminate recent abuses in the hunting industry).

[illegible]

Swaziland and Namibia are two range States that have managed to reduce poaching to minimal levels (or zero in the case of Swaziland). In addition, Namibia

has played a major role in intercepting horn in transit from neighbouring countries, while enforcement deterrents appear to have greatly reduced the transit of horns through Swaziland. As a result of low poaching threat and effective metapopulation management, rhino populations in these countries are growing at some of the highest rates in Africa.

[illegible]

The sample size of rhino crimes is low for this group and illegal killing of rhinos does not currently appear to pose a serious threat to the rhino populations. Data deficiency is a concern in Tanzania, with low detection rates of natural mortalities within heavily wooded parts of the rhino range. Poaching threat needs to be monitored closely in Botswana. Both countries have seized horns in transit, albeit at much lower levels than countries in group C.

Important factors influencing illicit rhino horn trade in Africa

Wildlife and law-enforcement experts consulted in most range States concurred over the importance of a few key factors influencing patterns of illegal killing of rhinos and rhino horn trade in Africa. First, *sustained demand* for rhino horn is being felt in most range States. Most horns coming from Africa are destined for Asian markets, and intelligence officials indicate that this demand is most closely linked to the increasing number of East and South-East Asian nationals resident in Africa, as well as positive economic growth, particularly in China.

Second, conditions within the two countries experiencing the highest poaching pressures and impact illustrate the importance of *socio-economic stability and good governance*. In DRC, the devastating poaching of the last remaining northern white rhino population was influenced by proximity to an international border, military conflict and political instability, with poachers having easy access to weapons (Hillman Smith 2006). Declining government operational budgets, changes in land use and socio-economic hardships in Zimbabwe were reported to be major factors weakening governance structures, thus reducing management effectiveness. Many rhino losses in Zimbabwe involved animals caught in snares targeting animals for bush meat rather than rhinos for their horns, but targeted rhino poaching for horn has emerged as a worrying development.

A third influencing factor is the increased levels of *criminal organization* within rhino-poaching and horn-trading networks. This matches findings from the most recent global analysis of illegal elephant ivory trade presented at CITES CoP14 (Milliken et al. 2007). Rhino-poaching gangs in two countries, South Africa and Kenya, were reported to operate more efficiently than previously experienced, indicating the presence of clear conduits and better organized networks that also operate across national borders. Confidential sources also indicated that some illegal trading networks have links with other highly lucrative natural resource trades, including abalone, ivory, live game and diamond smuggling.

Recommendations based on outcomes of CoP14

[illegible]

The disturbingly high extent and impact of rhino-related crimes in DRC and Zimbabwe, combined with the apparently low effectiveness of management response, provides clear justification for greater international scrutiny under the auspice of CITES. Decision 14.90, adopted at CoP14, calls for the CITES Secretariat to 'examine the implementation of Resolution Conf. 9.14 (Rev. CoP14) in the range States where illegal poaching of rhinoceroses appears to have increased and to pose a significant threat to populations of rhinoceroses, particularly in the Democratic Republic of Congo, Nepal and Zimbabwe'.

It is envisaged that such an examination will help identify and forge stronger interventions. As a first step, however, it is important that these three countries first review existing measures and demonstrate improved management results (e.g. reduced number of poaching incidents, improved conviction rates and horn recoveries). The establishment of stronger partnerships, both multiagency consortia at the national level and cross-border partnerships with key neighbouring countries, is recommended as a means to mobilize combined resources. At present, stronger political commitment is required in both DRC and Zimbabwe to reverse current trends.

[illegible]

As a result of the apparent increasing trend in volume of horn leaving Africa and the existence of sophisticated criminal operations involving several countries, Decision 14.89 was adopted to more closely examine cross-border collaboration, the accumulation of horn stocks (including trophies) and illegal trade flows. As part of this decision, TRAFFIC will be reviewing information on priority countries. With regard to cross-border collaboration, it is apparent that bilateral wildlife-enforcement relationships between the following countries need to be strengthened to ensure successful investigation outcomes: Zimbabwe–South Africa, South Africa–Mozambique, Zimbabwe–Zambia, Namibia–Zambia, DRC–Sudan and Kenya–Somalia. Wildlife crime investigators and prosecutors in many range States need capacity building.

[illegible]

A critical issue requiring attention is the emergence of more sophisticated criminal operations in South Africa, including the laundering of horns acquired legally (e.g., white rhino hunting trophies and horns registered on private property). The new NEMA Biodiversity Act regulations, coming into effect on 1 February 2008, should improve controls in hunting and horn possession, and in the interim some provinces have initiated stricter measures to more closely scrutinize and monitor trophy hunters. We recommend a number of measures to fully address a situation that has the potential to seriously undermine legal, sustainable use permitted under CITES. These issues are likely to be reviewed in the context of Decision 14.89.

First, a national task force should be commissioned to finalize outstanding investigations into rhino poaching and illegal horn trade. Existing enforcement bodies (e.g., at provincial level) do not have the mandate or resources to effectively act on horn-trading networks that have elements of organized crime, involve foreign diplomats, and operate nationwide and with links to neighbouring countries.

Second, we recommend that the South African CITES management authority request that certain importing countries confirm the presence, location and ownership of all horn trophies that have been exported with valid CITES permits, but under suspicious circumstances. Third, to reduce sales of privately held horns to illegal traders, a national audit of horns in private possession should be completed expediently to guide compliance measures. We further recommend introducing a compulsory, nationwide moratorium on domestic horn sales (i.e., intra- and interprovincial). While positive white rhino population growth has continued in South Africa, conservation agencies should seriously consider establishing a national white rhino hunting (and trophy export) quota, as a precautionary measure.

[illegible]

Yemen, East and South-East Asia remain important destinations for African rhino horn, with an apparent increasing trend in volume of horn leaving the continent. The precise nature of markets in East and South-East Asia is not fully understood. For example, the degree of speculative buying of rhino horn compared with purchases to meet current market demand, has not been ascertained. It has been suggested that trade in wildlife medicinals is increasing in Vietnam as a result of increasing affluence (Venkataraman 2007). It is therefore necessary to conduct and update end-market research, including a detailed assessment of trade dynamics, enforcement and status of horn stocks in key consuming nations.

[illegible]

We recommend that South Africa and Namibia develop legal provisions to ensure that black rhino quota allocations are biologically sustainable, maximize incentives across sectors, reward good management, and ensure appropriate controls—as recommended by the IUCN/SSC African Rhino Specialist Group and by Leader-Williams et al. (2005) and further developed by the SADC Rhino Management Group.

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Note

[1] Other rhino products are also in demand for traditional Asian medicine, with two incidents recorded in South Africa during 2004 involving the attempted export (by Vietnamese nationals) of rhino genitals and dried intestines.

FIELD NOTE

Dhikala grasslands in Corbett Tiger Reserve, a potential site for reintroduction of the one-horned rhinoceros in India

A.J.T. Johnsingh[1,2], K. Ramesh[1], Qamar Qureshi[1]

[1] Wildlife Institute of India, Post Box 18, Chandrabani, Dehradun 248001, India; email: ramesh@wii.gov.in
[2] Nature Conservation Foundation, Mysore, and World Wide Fund for Nature–India, New Delhi
email: ajt.johnsingh@gmail.com

The greater one-horned rhinoceros (*Rhinoceros unicornis*), an obligate species of tall grasslands and forest mosaic in the flood plains, was found abundantly across the Brahmaputra, Ganga and Indus river valleys including in Sind Province in Pakistan (Dinerstein 2003). With the beginning of early settlements, most of its original habitats were lost to human habitation and arable lands, and currently only a few isolated patches remain in the Ganga and the Brahmaputra floodplains. Relentless poaching for rhino horn continues to cause serious population decline (Martin 1983) and still presents grave threats for the surviving populations (Foose and van Strien 1997). The latest estimate suggests that only about 2000 individuals are left in the wild, with Kaziranga National Park in India and Chitwan National Park in Nepal together harbouring about 83% of them (Dinerstein 2003). The remaining populations are very small and highly isolated; they include the reintroduced populations in Dudhwa National Park in India and Bardia National Park and Suklaphanta Reserve in Nepal. Extinction risk of large populations confined to few areas and scattered small populations was clearly articulated in the IUCN/SSC Asian Rhino Specialist Group meeting at Bangkok (Schenkel and Schenkel 1979), which essentially signalled the beginning of a past rhino reintroduction programme in India and Nepal (Sale and Singh 1987).

The new state of Uttarakhand in north-west India contains grassland habitats that are potentially suitable for establishing new populations of the one-horned rhinoceros. Sighting of a male rhino near Kotdwara in this state in 1789 confirms that this rhino occurred here in the past (Rookmaaker 1999). Dhikala and Paterpani grasslands in Corbett Tiger Reserve and Surai grasslands in the Terai East Forest Division provide the last opportunity for the reintroduction programme in this state (fig. 1). However, among these three sites, Dhikala grasslands could be considered the priority because of its size, location and protection status.

Dhikala grasslands

Dhikala grasslands (or *chaur* as they are locally known) cover about 10 km^2 in the core area of Corbett Tiger Reserve and include Phulai chaur on the Ramganga riverbed, Dhikala chaur largely to the west of the tourism complex, and Kinanauli chaur to its east. These grasslands together with the adjoining forests form 20 km^2. Given that it is possible to stock one rhino per square kilometre (Sale and Singh 1987), Dhikala grasslands can potentially support a maximum of 15 rhinos. This potential relocation site has the outer Himalayan range to the north, dense extensive Sal forests to the east, Sal forests and Shivalik Hills to the south and the Ramganga reservoir to the west. Hence, the new population would be unlikely to stray out and come into conflict with villagers, and it could be well protected. Plentiful water in the Ramganga River and the reservoir and wallows in the marshy Phulai chaur provide ideal conditions for the rhinos. Also, plenty of food plants for this species grow in the area. The list provided by Laurie (1978) of rhino food plants is exhaustive, with about 180

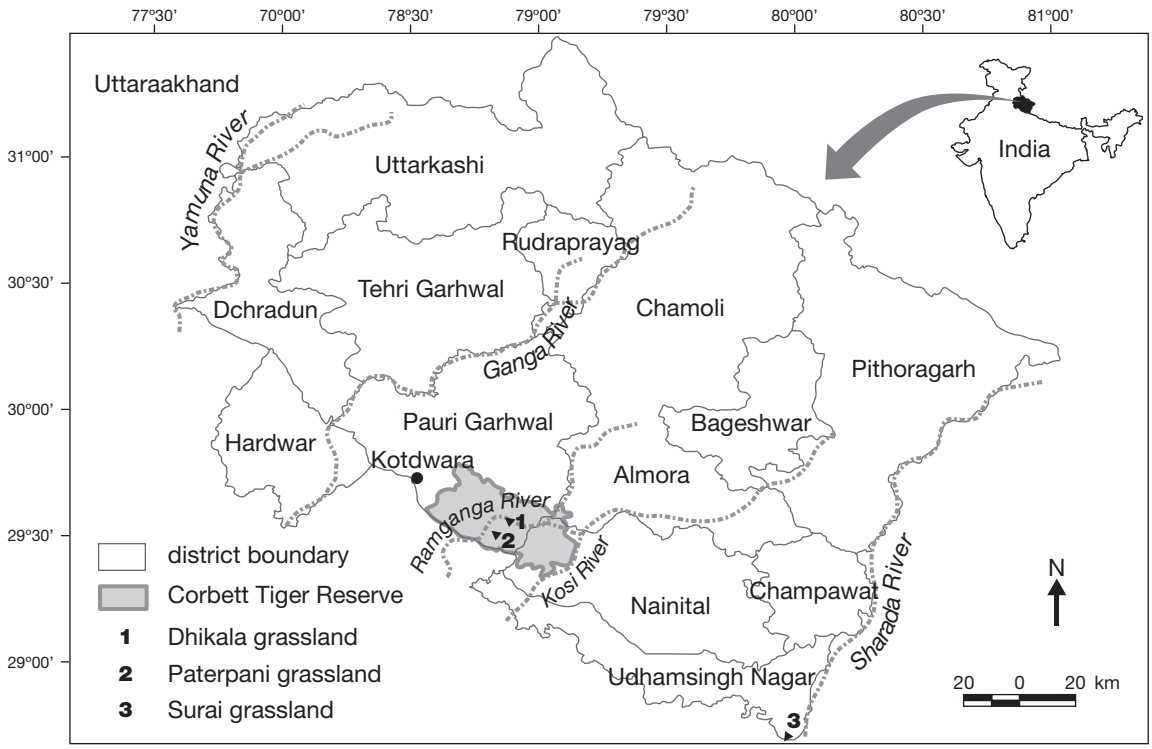

Figure 1. Potential sites for reintroduction of the greater one-horned rhinoceros in Uttarakhand State, India.

species representing 54 families. In these grasslands are found 97 species belonging to 33 families; notably, the graminoids are well represented with 36 (78%) of the 46 species. Dinerstein (2003) lists 10 grass species and 14 browse species as the most commonly eaten food plants in Royal Bardia and Royal Chitwan National Parks. All of these grasses and nine of the browse species are found in Dhikala. Therefore, as mentioned earlier, Dhikala grasslands appear to have all the essential requirements (protection, water, wallows and food) to sustain a small population of rhinos. As was done with the reintroduction programme in Dudhwa National Park, to establish a vigorous breeding nucleus, rhinos could be brought in both from Assam and Nepal. As Sale and Singh (1987) suggest, these rhinos should be young so that they will withstand the rigors of translocation. Of the eight animals translocated into Dudhwa in 1984 and 1985, seven had survived by December 1986 (1 adult male, 5 females, 1 subadult female). With care and planning, the number of animals increased over 20 in 2006. It is possible to establish such a population in Dhikala grasslands.

Paterpani grasslands

Paterpani chaur, with a grassland–forest area of 5 km^2, is located south of Dhikala grasslands along the Paterpani stream. It can support a minimum of five rhinos. Active management of excess animals that the Dhikala and Paterpani chaurs cannot sustain will become vital thereafter. Although the number projected here falls well short of the minimum population size of 50 suggested for a large mammal reintroduction programme (Franklin 1980), the chance of reducing the extinction risk or at the least, prolonging the extinction process, is possible by creating more populations within whatever potential area is available for the species (Caughley and Gunn 1996).

Surai grasslands

The Surai grasslands are small, less than 2 km^2, located in the Surai Range of Terai East Forest Division on the south-eastern end of Uttarakhand, bordering the state of Uttar Pradesh. Rhino conservation can be planned here only if the Mala-Mohaf grasslands in the adjacent Pilibhit Forest Division of Uttar Pradesh

State are included with them as one complex. This is an extremely challenging task, since it involves two governments with distinct political and socio-economic backgrounds. Further, rhinos reintroduced here, if not protected by an electric fence, would stray into the agricultural fields that border the Mala Range, thus coming into conflict with farmers. The problem of poaching is another threat in this area.

Discussion

Establishing new populations obviously requires careful planning and needs to follow existing legal and ecological frameworks. The guidelines provided by the IUCN Asian Rhino Specialist Group and the Reintroduction Specialist Group, along with the experience gained while reintroducing rhinos in Dudhwa National Park (Singh and Rao 1984) can be used to guide the initiatives. Similar to the Dudhwa rhino reintroduction programme, the entire activity should begin by coordinating and collaborating with appropriate agencies and individuals. A technical committee consisting of forest officers, field biologists, an advocacy officer, experts having prior experience in translocating rhinos, and conservation agencies such as IUCN Specialist Groups and WWF should be constituted. This committee would be expected to accomplish the finer assessment of habitat conditions, and should evolve a microlevel plan before investing much human and fiscal resource towards this programme. If established, the rhino population in Corbett Tiger Reserve is certain to enjoy a secure future. The presence of this large herbivore here, which will make the tall grass habitat more productive by breaking the stands and promoting sprouting, will only be beneficial to other ungulates and will enthral visitors.

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HISTORY

Black rhino, white rhino: what's in a name?

Jim Feely

PO Box 237, Maclear 5480, South Africa; e-mail: jimfeely@xsinet.co.za

> *All this (and much more) forms a consistent, logical, and widely accepted story—which, however, cannot be sustained from the records of actual woods or forests. It is a* ***pseudo-history*** *which has no connexion with the real world, and is made up of* ***factoids****. A factoid looks like a fact, is respected as a fact, and has all the properties of a fact except that it is not true. (Rackham 1990, p. 23)*

It has been fascinating to witness in my lifetime the birth, growth and acceptance of a piece of pseudo-history and the factoids that comprise it. This is the widely accepted explanation of how the white rhino *(Ceratotherium simum)* got its name, which is such an inaccurate description of its outward appearance. Its skin colour is largely determined by the soil of its surroundings overlaid on a medium grey by its wallowing in mud and rolling in dust, as it is too for the black rhino *(Diceros bicornis)* (Skinner and Chimimba 2005, p. 527).

The factoids can be summarized: 1) in the 18th and 19th centuries Afrikaner hunters called it the *wijd [mond] renoster* (wide [mouth] rhinoceros) in colloquial Dutch and Afrikaans; and 2) early English-speaking travellers and hunters when they heard this mistook the sound of *wijd (weid, weit, wyd)* for 'white', hence the English name.

The first written mention in English of the name white rhino was made by John Barrow (1801, p. 395, map) in describing his travels in Namakwaland in the present Northern Cape Province during 1798. There he met a Griqua Afrikaner who told him that in his youth he had killed 'seven camelopardales [giraffes] and three white rhinoceroses in one day' (in Skead 1980, pp. 290, 298) but did not say where. This conversation must have been conducted in Dutch or Afrikaans, the informant using *kameelperde* and *wit(te)renosters*, not their English translations.

The earliest written use in Dutch of both the names white and black rhino was made by Petrus Borcherds in a letter to his father in 1802 (English translation Bradlow and Bradlow 1979b, unpublished original in Dutch). Borcherds, then in his teens, acted as assistant secretary and scribe to the commissioners of the Truter-Somerville expedition to the Tswana people at Dithakong (earlier known as Lattakoe), north-east of Kuruman, in 1801–1802. Their report to the Cape governor was submitted in English (Theal 1899), but Borcherds had probably prepared the original draft in Dutch. (Where some minor discrepancies occur between these accounts, such as in dates, spelling, I follow the official report.) His first observation referred to a male of the 'black variety' of rhino killed by Jacobus Kruger[1] near Kuruman on 27 December 1801 (Bradlow and Bradlow 1979b, p. 219), and the second described a female 'white' rhino killed south of Kuruman by Kruger and Meintjes van den Bergh on 30 December 1801 (Bradlow and Bradlow 1979b, p. 220). In a separate account written in English by William Somerville, the first animal killed was called a 'black two-horned Rhinoceros'(Bradlow and Bradlow 1979a, pp. 162–165), no mention being made there of the second animal.

Of the first rhino killed, it was noted that the 'upper lip was more pointed and hung over the lower lip' (as Somerville also recorded, Bradlow and Bradlow 1979a, p. 162), and the Setswana name was *seikloa* (Theal 1899), a name *(keitloa)* for the black rhino used during the 19th century (Shortridge 1934, p. 412). It was recorded that the upper lip of the second animal killed was 'more flat', and that its Setswana

name was *magooe* (Theal 1899), which is clearly a phonetic rendering of the name *mogohu* still recently in use for the white rhino (Roberts 1951, p. 241; Setswana name provided by N.J. van Warmelo). These accounts confirm conclusively to me that the animal killed on 27 December 1801 was *D. bicornis,* and that killed on 30 December was *C. simum,* although Kees Rookmaaker thought them inconclusive (Rookmaaker 2003). The second animal was described as being smaller than the first, thereby indicating that it must have been immature, since an adult white rhino of either sex is larger than an adult black.

Concerning the female rhino killed, Borcherds stated (in translation, original in Dutch): 'She was of the type known to us as the *White Rhinoceros*. . . . I expected this animal to be entirely *white according to its name,* but found that she was a paler ash-grey than *the black*. I suppose that when the rain falls this animal is cleansed of mud and other impurities and will appear lighter at a distance, and put the derivation of the name down to that …" (italics mine; Bradlow and Bradlow 1979b, p. 220; also quoted in Rookmaaker 2003). Thus the oldest written record in Dutch is unequivocally of both 'black' and 'white' species under those names and not any other. Furthermore, the recorder himself saw and described the carcases of both animals and gave their Setswana names, in a way that identifies them beyond doubt in my opinion. Clearly, the factoids are not true. Unfortunately, neither Borcherds, Truter nor Somerville asked Kruger how the names were derived.

There is no indication that any Setswana name referring to a colour or other characteristic of either rhino has been mentioned in any of the works referred to here. This also applies to the Khoe and Bushman names recorded by Guy Shortridge (1934, pp. 412, 413, 425). Nevertheless, the possibility needs further study (Rookmaaker 2003), particularly since in my experience it may be true of the isiZulu name for each species.[2]

Later, in 1841, Cornwallis Harris (1986, p. 86) gave the names 'The Square-nosed or White Rhinoceros' on his plate XIX illustrating the species; in the caption he gave *witte rhinoster* as the Cape colonists' name, and *mohoohoo* as the Setswana name. The latter is clearly another phonetic spelling of the modern name *mogohu* for the white rhino. In the caption to plate XVI depicting the 'African Rhinoceros' (black rhino, *D. bicornis)* he gave the colonists' name as *rhinoster* and the Setswana as *borili* (Harris 1986, p. 74). There is no recent version of this term (Shortridge 1934, p. 412; Roberts 1951, p. 241). He had hunted in both the present North West and Limpopo Provinces in 1836. A. Steedman (1835, p. 232, in Skead 1980, p. 293) recorded each species under the names black and white near Mafikeng in 1826. Andrew Geddes Bain also noted 'white' rhino in the Mafikeng area in 1826 (Skead 1987, p. 552*),* and both rhinos under these names on a tributary of the Molopo River in 1834 (Skead 1980, p. 293; 1987, p. 552), while James Alexander (1838) likewise recorded both species with these names in central Namibia in 1836/37 (Skead 1980, p. 288).

Thereafter throughout the 19th century other hunters travelling in the white rhino's historical range and writing in English, such as Charles Andersson (1861), Thomas Baines (1864, not Bain), William Baldwin (1894), Gordon Cumming (1850) and Frederick Selous (1881, 1908), consistently used the names black rhino and white rhino. Selous was fluent in Afrikaans, as no doubt were at least some of the others. He often accompanied Afrikaner hunters and would not have misunderstood them. However, one writer who did not use a common name was William Burchell, either in the original scientific description of *Rhinoceros simus* or in the account of his travels (Skead 1980, p 297; Rookmaaker 2003).

From this brief history, I believe it is clear that 1) the Dutch and Afrikaans name for *C. simum* has been *wit(te)renoster* since at least the end of the 18th century, as recorded by Barrow, Borcherds and Harris, and this is correctly translated as white rhino; 2) the Dutch and Afrikaans name for *D. bicornis* gained the qualifier of *'swart'* (black) at the same time as the other was named *wit*; and 3) these names originated in the country inhabited by Bushman, Griqua and Tswana north of the Orange River where both rhinos occurred together. By late in the 18th century many Griqua were of mixed descent, as Barrow noted, and were bilingual speakers of Afrikaans and Khoe-khoen. Consequently, it was probably they who were the first to use these names in Afrikaans and Dutch, as is suggested by Barrow's report.

Rookmaaker (2003) in his detailed study of the name 'white rhino' concluded, on the evidence quoted above, that the English adjective 'cannot have evolved from a Dutch or Afrikaans word. This derivation should no longer be used in popular texts to explain the name of the rhinoceros called "white".' By this he meant any Dutch or Afrikaans word except *wit(te),*

from which it was translated (Rookmaaker in litt. 2007). But he did think that the accounts of Barrow or Borcherds might 'hold the key to the truth', having also quoted the same passage in the Borcherds letter as above, although omitting that it is translated from Dutch.

Southward of the Orange River the black rhino continued to be known as just the *renoster* or *rhinoster* at least until 1841 (Harris 1986, caption to plate XVI). Not long afterward in 1853, or possibly 1858, the last of its kind in that region was killed near Port Elizabeth (Shortridge 1934, p. 416). This had been its name from the time when it was first encountered by the early Dutch settlers near Cape Town in the 17th century. They knew no other African rhino for more than a century thereafter that would have warranted distinguishing it specifically (Skead 1980, p. 277).

The names of the two species are a contrasting pair whether in Dutch and Afrikaans or in translation. As Teddy Roosevelt and E. Heller remarked in 1915: 'The Black Rhinoceros has not received its common English name because its coloration is actually blacker than that of the other species, but rather to contrast it with the other African Rhinoceros which has been so unfortunate as to have the designation "white" bestowed upon it' (Shortridge 1934, p. 423–424). Rookmaaker (2003) also suggested this as a possible explanation for 'white'.

Since the names do not describe the skin colour of either species, they could allude metaphorically to their differing reactions to humans: *swart* referring to that species' well-known aggressiveness, with *wit* as its opposite for the inoffensive animal. *Swart* in Afrikaans and 'black' in English have similar metaphorical allusions to anger, danger or threat, as for instance in *die swart kuns, swart kyk* (Eksteen 1997), 'the black art', 'things looked black', 'a black look' (Tulloch 1993). However, *wit* in Afrikaans does not have the allusions that 'white' has in English; in both languages they are just the opposites of *swart* or black (Tulloch 1993; Eksteen 1997). Thus, I would argue, the derivation of the name *swart* should be the issue with *wit* as its opposite, and not vice versa, as Roosevelt and Heller and most other writers have supposed. Nevertheless, there is neither etymological nor historical support for this idea.

This difference must have been as significant to hunters of both rhinos as those in their outward appearance. It is to such behaviour that Ian Player (1972, p. 30) refers in his suggestion that 'the old Boer hunters likened the white rhino to the white man because of its timid disposition as opposed to the black rhino which was wild and fierce, like the tribes of the interior'. (His choice of analogy was perhaps unfortunate.) In 1802 Somerville (Bradlow and Bradlow 1979a, p. 164) said of the black rhino: 'This animal is the most ferocious that Africa produces . . . for when wounded he seldom fails to fly to the place from which the shot came.' Conversely, in mitigation Borcherds at the same time wrote: 'One must surmise that much more is told of the ferociousness of this animal than is actually in his nature (Bradlow and Bradlow 1979b, p. 221). A famous early report of black rhino bellicosity described Simon van der Stel's close encounter with one near Piketberg, in the present Western Cape Province, in 1685 (Skead 1980, p. 284). Alexander (1838) described this behavioural difference between the species: 'The white rhinoceros . . . is a timid animal compared with the savage black which commonly charges whether wounded or not, whereas the white variety tries to effect an escape' (Skead 1980, p. 302).

However, nine of the ten etymological theories identified in the literature and discussed by Rookmaaker (2003) consider only the white rhino and its physical appearance, ignoring both the black and the behaviour of either. Borcherds's response to the name *wit* or white rhino in 1802 (quoted above) was echoed by nearly every writer after him. The exception is Player's suggestion that the names refer to a behavioural difference. Without saying so, Alexander's description in 1838 of these differences (quoted above) also points to this explanation.

The earliest suggestion that the original Dutch and Afrikaans name for *C. simum* was not *wit(te)renoster,* and that another adjective had been misunderstood by English-speakers, was a speculative proposal made in 1931 by Charles Pitman, first game warden of Uganda. At that time the northern white rhino *(C.s. cottoni)* still occurred in western Uganda although it later became extinct there. He thought that a Dutch word meaning 'bright', 'shining' or 'great' might have been used instead of *wit* but did not give an example of such use (Pitman 1931a). He then dismissed the first two possibilities on advice he received (Pitman 1931b, p. 1 footnote), and soon after Shortridge (1934, p. 435 footnote) showed that Pitman's third possibility, *widg*, is not a Dutch word.

Thereafter the idea seems to have lain dormant in South Africa until revived by Charles Astley-Ma-

berley (1963, p. 11) who wrote: 'There have been a variety of suggestions as to why the species became known as "white", the best I think being that offered by T.R.H. Owen [probably Owen 1956, quoted in Rookmaaker 2003]—that it is a corruption of the term "wyd mond" or "broad-mouthed" originally applied by the old Boer hunters.' Owen was in the British colonial service in Sudan and had encountered the white rhino in the south-west of that country, where it is also now extinct. He was repeating a suggestion made in 1952 by W. van den Bergh in relation to white rhinos acquired by the Antwerp Zoo in Holland (Rookmaaker 2003).

The originally speculative suggestions of Pitman, van den Bergh and Owen—clearly made in ignorance of the early 19th century reports (Borcherds was not published until 1979)—evolved into factoids in publications after 1963. These ignored the fact that no historical example of such a use had ever been produced in their support. And they went on being repeated, although not by Reay Smithers. He accepted my comments on his draft manuscript on the white rhino, omitted the speculation about the name, and relied on documented facts in *The mammals of the southern African sub-region* (Smithers 1983, p. 558), which became the standard work. They are repeated in its second edition (Skinner and Smithers 1990, p. 567). However, the current edition (Skinner and Chimimba 2005, p. 527) states further: 'The most popular explanation for the derivation of the colloquial name is that it probably derives from the uninformed interpretation of the Cape Dutch word *weit,* meaning wide, referring to the species' wide mouth'—once more resurrecting the factoids. But it does mention Rookmaaker's report that there is no etymological evidence in either Dutch or Afrikaans that *wyd* or its cognates have ever been used in the name of a rhino (Rookmaaker 2003). However, it concludes that there is insufficient evidence for a definite explanation.

Consequently, one should keep in mind Rackham's (1990, p. 23) further warning: 'Pseudo-history is not killed by publishing real history. In a rational world this might lead to a controversy in which either the new version was accepted or the old version shown to be right after all. In our world, the matter is not controversial: either the old version is re-told as if nothing had happened, or authors try to combine the two versions as if both could be true at once.'

Short and pithy, *swart* or black with its opposite *wit* or white have remained firmly in everyday use to distinguish the African rhinos for more than two centuries. As a pair they are an appropriate metaphor in Afrikaans and English for a well-known difference in the rhinos' reactions to humans—at least today, if not so used originally. Thus the names will no doubt continue in common usage, whatever their etymology or the alternatives preferred by zoologists. One thing is certain, no other African animal has attracted as much attention to its name as has the white rhino.

Acknowledgements

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Notes

[1] He had been charged with issuing bank notes forged by his younger brother Carel in 1783, for which the penalties were 15 years imprisonment and death, respectively. Thereupon together they fled the colony. Carel was killed by an elephant he was hunting in 1791. His body was carried to its burial place approximately 50 km north of Carnarvon from somewhere further north, perhaps beyond the Orange River. Jacobus was later pardoned (Mossop 1947).

[2] Black rhino, *ubhejane* = 'one that is enflamed with anger', from *bheja* 'to be red in anger', referring to its usual reaction to humans; white rhino, *umkhombe* = 'the pointer', from *khomba* 'to point at', referring to the carriage of the head when walking with its mouth close to the ground and horns pointing to where it is going (explanations given by Magqubu Ntombela to author c. 1978; see Doke and Vilakazi 1953). However, in isiXhosa *umkhombe* is the black rhino, and has the alternative meaning of 'a fierce, savage person; a person who is furious or in a towering rage' (Mini et al. 2003). Historically, the white rhino did not occur in the region inhabited by isiXhosa-speakers, whereas the black rhino was found in its westernmost part (Skead 1987).

RHINO NOTES

Update on the Black Rhino Range Expansion Project: local community receives black rhinos

Pamela Sherriffs

WWF/Ezemvelo KZN Wildlife Black Rhino Range Expansion Projectemail: psherriffs@wwf.org.za

History was made recently when 11 black rhinos were released onto the Somkhanda Game Reserve in northern KwaZulu-Natal, South Africa. Somkhanda is the first community-owned land to become a partner in the Black Rhino Range Expansion Project.

The project is a partnership between WWF and Ezemvelo KZN Wildlife and is supported by the Mazda Wildlife Fund.

Somkhanda Game Reserve is owned by the Gumbi community, which successfully claimed five commercial game farms under the land restitution process. Rather than turn the whole area into settlement and farming, the community leaders decided to zone their land for economic sustainability. The zones include areas for conservation, development and commercial cattle farming.

WWF's Dr Jacques Flamand, leader of the Black Rhino Range Expansion Project, said empowering black communities to become stakeholders is a priority in conservation, and Somkhanda is an example where it is really starting to happen.

iNkosi Zebelon Gumbi, head of the Gumbi royal family, explains: 'When the land was gone, there were no opportunities. Now there are opportunities. There is work in security protecting animals from poachers. And there is work at the lodges. We have set aside some land for farming and settlement, and some for development projects that will boost the Gumbi economy. We are asking our people to think like businesspeople. We are living in modern times. It is not just building a place and relying on cattle any more. Now we ask people to work and get money.'

But conservation always involves the heart as well as the head. Nathi Gumbi, director of Somkhanda Game Reserve, says: 'When the Gumbis were moved from their land, we had no choice. But thank God the white people who took our land also loved it. So our land is still beautiful. Now we have the land back and we shall also love it and look after it as our ancestors loved it.'

The founder population of black rhinos—the 11 that are being released now—belongs to Ezemvelo KZN Wildlife. When the population grows, ownership of the offspring will be shared 50/50 between the Gumbi community and Ezemvelo KZN Wildlife. 'But the reality is that these animals belong to all of us—to KwaZulu-Natal, to South Africa, to Africa, to our children and our children's children,' said Rejoice Mabudafhasi, deputy minister of the Department of Environmental Affairs and Tourism, who attended the release. 'They are our heritage, our responsibility, our privilege. The Gumbi leadership has shown the courage and foresight to accept that opportunity and that responsibility and we salute you for that. It may not always be easy. There will be challenges and setbacks. It will be hard work. But it will be worth it. As the first community to become partners in this important project, you are pioneering a way that we hope many others will follow.'

The black rhino is still critically endangered, although numbers have increased to about 3700 from a low point of around 2500 in the 1990s. The Black Rhino Range Expansion Project supports ongoing protection of existing populations but also aims to increase land available for black rhino conservation, thus reducing pressure on existing reserves and providing new territory in which the animals can rapidly increase in number. This is done by forming strategic

partnerships with landowners within the historic range of the black rhino. The first three partner sites were Mun-ya-wana Game Reserve, Zululand Rhino Reserve and Pongola Game Reserve.

There are now 70 black rhinos on project sites in KwaZulu-Natal, of which 6 are calves born on the sites. These rhinos comprise approximately 15% of the black rhino population of KwaZulu-Natal. Through the project, black rhinos have been reintroduced onto nearly 70,000 hectares of land so far.

Conservation strategy for black rhinos and management guidelines for white rhinos launched in Kenya

Benson Okita-Ouma[1], Patrick Omondi[2]

[1] Rhino Programme Coordinator, Kenya Wildlife Service, PO Box 40241 – 00100, Nairobi, Kenya; email: bokita@kws.org

[2] Head, Species Conservation and Management, Kenya Wildlife Service, PO Box 40241 – 00100, Nairobi, Kenya; email: pomondi@kws.org

The third edition of 'Management strategy for the black rhino in Kenya and management guidelines for the white rhino in Kenya, 2007–2011' was launched on 31 October 2007 at Kenya Wildlife Service (KWS) headquarters in Nairobi. The occasion was presided over by the chair of KWS Board of Trustees and attended by a multitude of rhino stakeholders including donors, conservation organizations, the private sector, local communities, the diplomatic corps, IUCN, and the African and Asian Rhino Reintroduction and Veterinary Specialist Groups.

This five-year rhino conservation and management strategy was developed at a rhino stakeholders' workshop in February 2007. A draft document was circulated to other stakeholders including the African Rhino Specialist Group for comments and input before its ratification by the KWS Board of Trustees. The process aimed at ensuring that KWS continues to make the most appropriate strategic approaches in managing, making decisions and using its resources, in line with its 2005–2010 strategic plan. Figure 1 presents facets of the strategy graphically.

During the next few years, Kenya will move into a new phase of black rhino conservation. This third edition of its management strategy and guidelines retains the vision of conserving in situ at least 2000 black rhinos in Kenya. It includes revised goals and strategic objectives, and it emphasizes the 2007–2011 strategy period as the turning point in significantly increasing black rhino numbers. The current goal for the eastern black rhino in Kenya is to maintain a minimum growth rate of 6% per annum in established sanctuaries, achieve a minimum population of 150 black rhinos in free-ranging areas, and realize population growth of a minimum of 20 rhinos in montane forest areas—all aimed at achieving 700 black rhinos by 2011.

The long-range vision of 2000 black rhinos cannot be achieved within fenced areas alone and therefore the remaining still-extensive range and intact habitats in Tsavo, Meru and northern Kenya will need to be secured and made available over the next five years to enable the planned translocation of black rhinos from sanctuaries that have attained ecological or social carrying capacity. With sound science, effective protection, and monitoring and community engagement, this should be possible. Aiming towards this goal, the KWS Board of Trustees approved implementing an intensive protection zone (IPZ) in Tsavo West National Park, where black rhinos will be translocated in 2008. Land held by individuals, local communities and authorities will continue to play an important role as breeding reservoirs to complement the official black rhino conservation areas, particularly the IPZ.

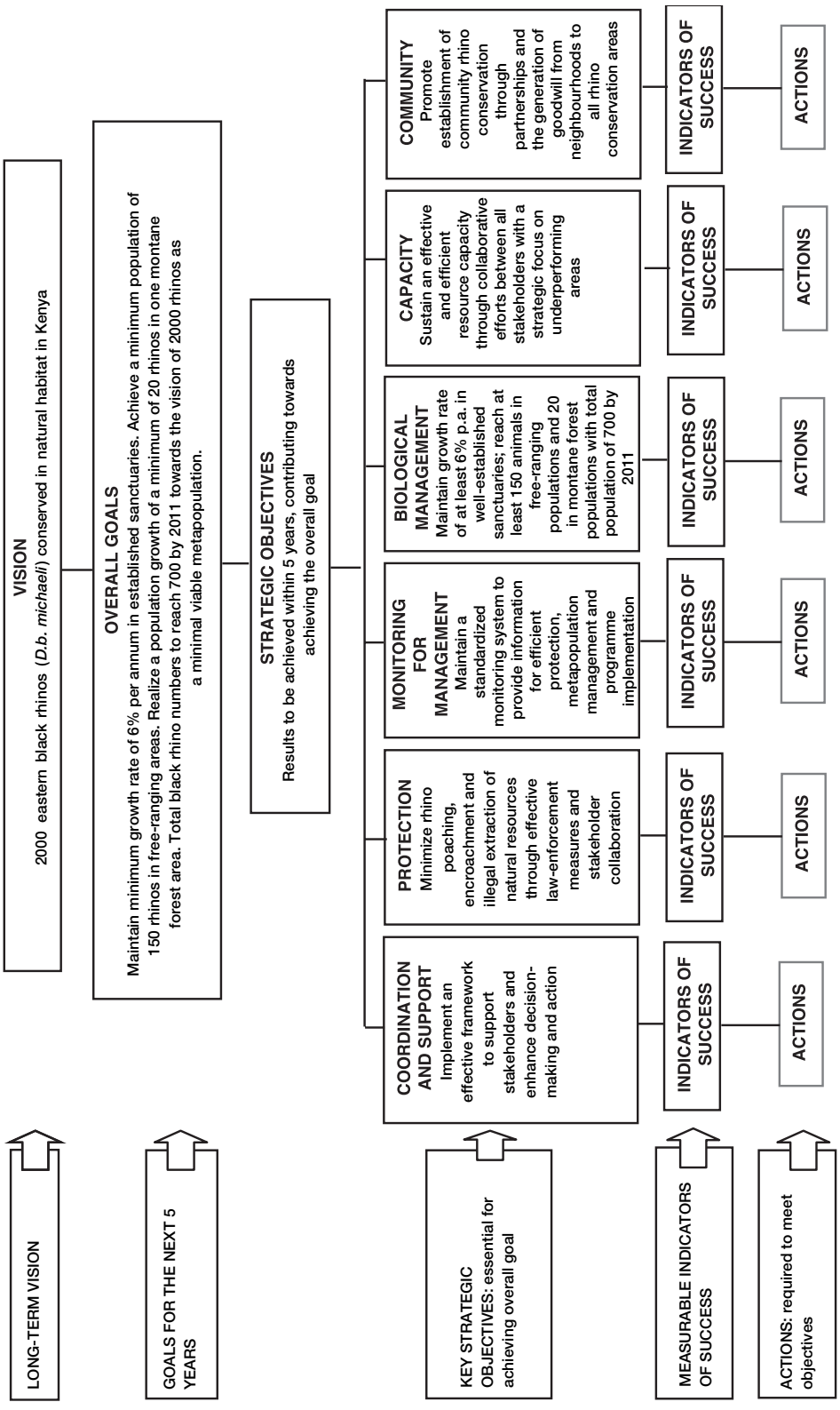

Figure 1. Kenya black rhino conservation and management strategy for the eastern black rhino in Kenya, 2007–2011.

Successful implementation of the strategy will require training staff at all levels, from rangers through middle-level managers and scientists to senior staff involved in policymaking. KWS and other stakeholders are committed to greater capacity building in all aspects of rhino conservation.

Rhino management and conservation will not only consider the entire rhino population but will also focus on different habitats; the strategy therefore emphasizes directing extra effort towards overcoming the problems of monitoring populations in montane forest areas.

Regional cooperation in conserving the eastern black rhino will also be considered. In addition to working closely with Kenyan stakeholders, KWS is initiating regional cooperation to increase rhino numbers. This initiative is being explored through a proposal seeking to establish an East African Rhino Management Group to set protocols for managing and exchanging eastern black rhinos within East Africa.

Rhino stakeholders in Kenya have also recognized that guidelines are needed to manage the southern white rhino, particularly in relation to what commitment of local resources is appropriate for conserving this strictly exotic species, how to handle trophy rhinos and horns, and matters of white rhino movements and ownership. White rhinos in Kenya will be managed as a species for community conservation, education and tourism and as a conservation resource for restocking white rhino ranges outside of Kenya.

BOOK REVIEW

Historical mammal incidence in the Cape Province vol. 2: *The eastern half of the Cape Province, including the Ciskei, Transkei and East Griqualand,* by C.J. Skead

Second edition edited by André Boshoff, Graham Kerley and Peter Lloyd

Centre for African Conservation Ecology, Nelson Mandela Metropolitan University, Port Elizabeth, South Africa, 2007, xiii + 570 pages, ISBN 1-920176-08-X

review by Kees Rookmaaker

Rhino Resource Center, c/o IUCN Species Survival Programme, 219c Huntingdon Road, Cambridge CB3 0DL, UK; email: rhino@rookmaaker.freeserve.co.uk

There is a growing realization among ecologists and conservationists that an understanding of the past is essential for wise planning for the future. Ecology, animal diversity and landscapes show significant changes over time, which are often inconspicuous in the short term but nonetheless far-reaching in their effects. Historical zoogeography is a tough subject to research because of the wide variety of sources and the need to analyse each statement in detail to pinpoint localities and identify species, often from meagre information. Mammal incidence combined with an ecological perspective was the subject of Skead's research, which was published in two volumes in 1980 and 1987. Like 'Roberts Birds' or 'Fitzsimmons Snakes', 'Skead' deserves a place among the classics of South African biology, but the use of his books has remained limited to a relatively small number of specialists. Probably this was partly due to the bulk of the two volumes, 902 and 1121 pages respectively, reproduced from typewritten pages.

Cuthbert John (Jack) Skead (1912–2006) had a successful career as the director of the Kaffrarian (now Amathole) Museum in Grahamstown. After his retirement in 1972, he started to gather data from historical books and records to document the ecology and distribution of mammals, birds and plants in the Cape region. This was a mammoth task, which he pursued with an increasing love for the subject and a remarkable tenacity. Skead persevered where others in retirement might have given up, showing emotion only when typing the final sentence of volume 2, having reached the 'end of this bloody index'. But the results of his labour will continue to bear fruit, guiding and stimulating young scientists in their understanding of contemporary wildlife and environment.

The second volume of Skead's magnum opus has now been edited and reissued by a team of ecologists and mammalogists. They have removed a few sections that are no longer relevant, but added new maps and topical photographs, and of course have given the book a more modern appearance. While there is no need to read the volume from cover to cover, it provides many opportunities to browse and to learn about particular regions or individual species. Skead started with the geographical and ecological background of nine sectors located in the Eastern Cape region, analysing all mammals, both large and small, that would have been found in each of them. In the third chapter each species is discussed extensively; it is followed by chapters on the abundance and movement of game animals, early human influence, interesting gaps, and patterns in the status of larger mammals. A final

chapter discusses the controversial black leopard and Cape lion. An extensive 15-page bibliography and an index provide many opportunities to reconstruct his sources and gain additional insights.

Skead would certainly have been the first to accept that there was still much to be learned and new documents to be discovered. He overlooked the article on the animals of the Eastern Cape published in 1857 by Henry Hall, who worked in the Royal Engineers Department and visited many parts of the Eastern Cape in the 1840s and 1850s. For a species like the black rhinoceros, Hall was able to record many occurrences that otherwise would have been lost. It would be advisable one day also to reprint Hall's zoological summaries with the addition of a historical commentary. Conversely, Skead was able to include a large amount of information from local newspapers and magazines, which otherwise would have been forgotten.

In conservation, in an age in which animals are easily transported from one region to another, it is a generally accepted fundamental rule that species should remain within their historical ranges. For instance, in recent guidelines on conservation strategies for the rhinoceros in southern Africa, it is clearly stated that 'the founder animals should of course be of a "subspecies" that occurred within the area prior to extinction or is the same as any surviving rhinos in that area' (du Toit 2006:51). Unfortunately, in reality this tenet is followed only when pragmatically or economically viable, with the borders of the ranges of subspecies adjusted according to particular needs. It is certainly true that the historical range or classification of a particular species is rarely studied or documented in any detail before wide-ranging conservation actions are taken. I would argue that investigations on the historical distribution of mammals should be extended to the entirety of the African continent. Skead has done the work for the Cape region, it is for us to follow his example—to learn about the environment as it used to be and to understand how best to allow species to evolve naturally even if it must be in a managed environment.

The editors of this second volume of Skead's book must be congratulated on their undertaking. The book is priced at a very reasonable R490 (+VAT & PP); all proceeds will be added to a fund to produce the first volume of the original work. Enquiries should be directed to Dr André Boshoff, email: andre.boshoff@nmmu.ac.za.

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LETTER

Dear Samuel,

I have just been reading your interesting paper on in- and outbreeding of African rhinos published in Pachyderm no. 42 [Krummenacher and Zschokke, Inbreeding and outbreeding in African rhinoccerous species: p. 108–115].

The lack of data or size of datasets is always a problem with animals like rhinos, which don't breed very quickly.

I was somewhat surprised that you, on the basis of Rookmaaker (1998) [author name misspelled], considered that I thought that there were 6 subspecies of the black rhino. In fact, I believe that the species needs a proper revision and until such time the latest revision by Groves should be followed. See also my paper in IZN 2005: http://www.rhinoresourcecenter.com/index.php?s=1&act=refs&CODE=ref_detail&id=1165245183.

The recognition of conservation units, at present 4, is a valid exercise, but does not necessarily coincide with the actual subspecies, hence the use of scientific names for these units should be discouraged—but it doesn't seem that anybody heeds that message. Also, there seems to be no money for a proper taxonomic revision, and while this is pending, conservation decisions are taken on the basis of convenience rather than science.

Otherwise an enjoyable paper. Are you planning any further on the subject. There is an 'in press' in the text, but not mentioned in the references.

All the best, Kees [Rookmaaker]

GUIDELINES FOR CONTRIBUTORS

Aim and scope

Pachyderm publishes papers and notes concerning all aspects of the African elephant, the African rhino and the Asian rhino 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.

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Use common names of animals and plants, giving scientific names in italics on first mention.

Generally refer to animals in the plural form: rhinos, elephants.

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Use British spelling, following the latest edition of the *Concise Oxford dictionary* or the *Oxford dictionary of English*, using 'z' instead of 's' in words like 'recognize', 'organization', 'immobilized'; but 'analyse', 'paralyse'.

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Use SI units for measurement (m, km, g, 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.

In the text, write four-digit numbers without a comma; use a comma as the separator for figures five digits or more: 1750, 11,750. The separator will be a full stop in French papers.

References

Use the author-year method of citing and listing references.

In the text, cite two authors: '(X and Y 1999)' or 'X and Y (1999)'; cite more than two authors '(X et al. 1996)' or 'X et al. (1996)'. Note that there is no comma between the author(s) and the year.

In the reference list, cite publications as in the following examples. List in alphabetical order. Write out journal titles in full.

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