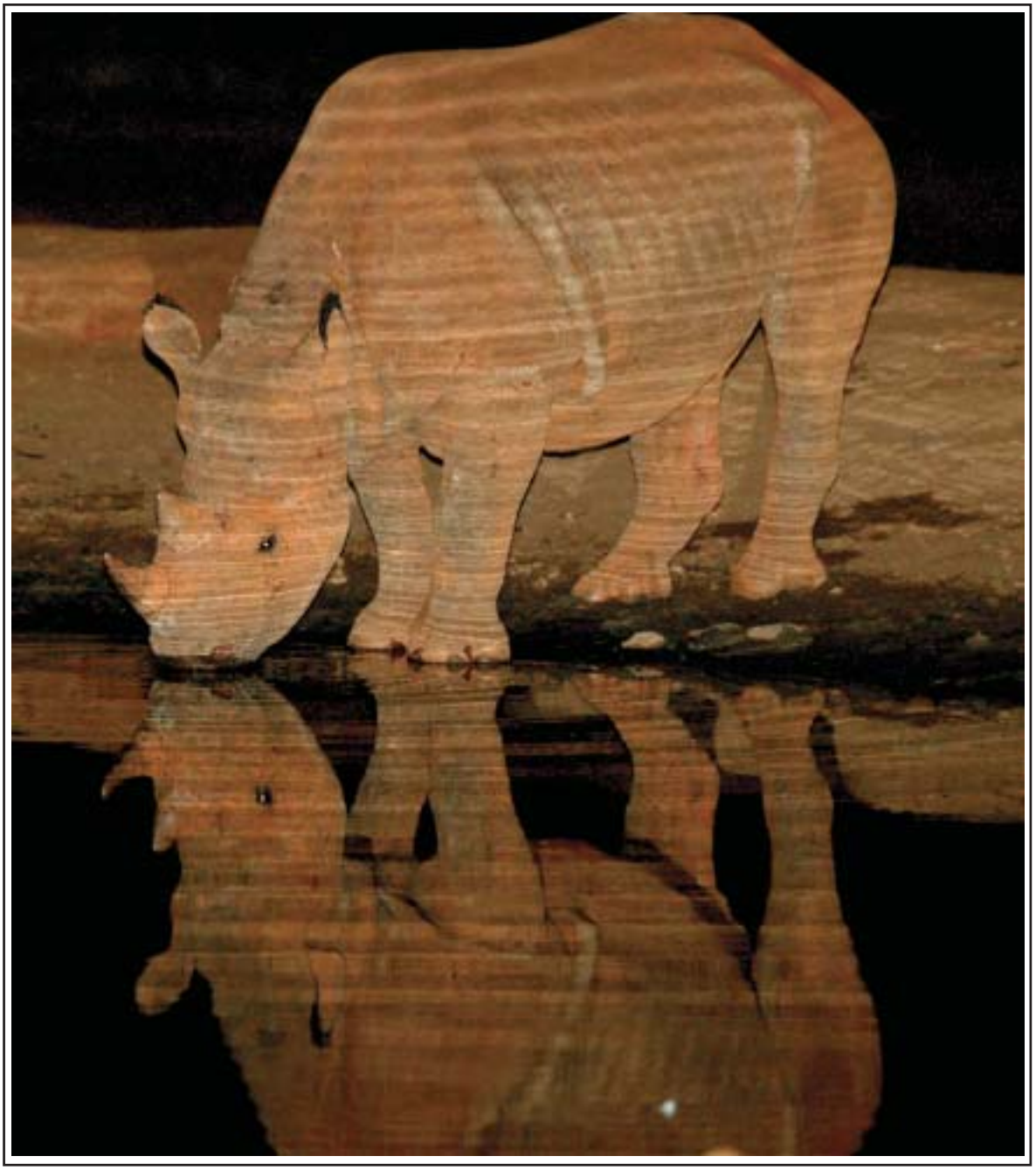
Pachyderm

July – December 2005 Number 39



ISSN 1026 2881

Pachyderm

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

July – December 2005 No. 39

Cover: An eastern black rhino, *Diceros bicornis michaeli,* in the Tsavo West rhino sanctuary, Kenya. Taking a drink at night, it creates ripples in the pool that are reflected on its hide. Photo taken with a flash at about 30 metres in full moon. Photo by Renaud Fulconis.

IUCN
The World Conservation Union

Species Survival Commission

Editor
Helen van Houten

Assistant Editor
Dali Pam Mwagore

Editorial Board
Holly Dublin
Esmond Martin
Leo Niskanen
Robert Olivier
Nico van Strien
Lucy Vigne

Design and layout
Damary Odanga

Graphics
Phillip Miyare

Address all correspondence, including enquiries about subscription, to
The Editor, *Pachyderm*
PO Box 68200 – 00200
Nairobi, Kenya
tel: +254 20 3876461
fax: +254 20 3870385
email: afesg@iucn.org
Web site: www.iucn.org/afesg

This document has been produced with the financial assistance of the US Fish and Wildlife Service, the International Elephant Foundation and the Messerli Foundation.

The views expressed herein are those of the authors and can therefore in no way be taken to reflect the official opinion of the donor agencies.

Pachyderm

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

July–December 2005 **No. 39**

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

Several important AfESG milestones have been reached in the last few months. The long-awaited Central Africa Elephant Conservation Strategy was finally completed and the West Africa Elephant Conservation Strategy received an important inter- governmental endorsement as the main framework to guide future elephant conservation action in the subregion. AfESG also provided technical input to a subregional elephant conservation and management strategy for southern Africa, a draft of which is at present undergoing final review. The deadline for submitting data on elephant distribution and numbers to be used in the next *African Elephant Status Report* was 31 December 2005. More details on these initiatives and on progress made with other AfESG activities follow.

The African Elephant Database

Part of the focus of the *African Elephant Database* (AED) during this period has been to raise funds to produce and publish the *African Elephant Status Report 2006* (AESR), which we hope to publish in 2006. Although at present there are sufficient funds to complete the AED update, we still need to raise money to pay for printing and distribution of the status report. In the meantime, while we hope that funds will materialize, important developmental changes have been implemented in the AED, including an overhaul of the bibliographical aspects of the database, systems for tracking changes, and implementation of a reliable data back-up strategy.

Le GSEAf a franchi plusieurs étapes importantes ces derniers mois. La Stratégie de Conservation des Eléphants de l'Afrique Centrale est enfin terminée, et la Stratégie de Conservation des Eléphants d'Afrique de l'Ouest a reçu un appui intergouvernemental important, qui la reconnaît comme étant le cadre principal pour guider les futures activités de conservation des éléphants dans la sous-région. Le GSEAf a aussi fourni un input technique à une stratégie sous-régionale de conservation et de gestion des éléphants pour l'Afrique australe, dont le projet est actuellement passé en revue une dernière fois. La date limite pour soumettre les données sur la distribution et le nombre d'éléphants à intégrer dans le prochain *Rapport du statut de l'éléphant africain* était le 31 décembre 2005. De plus amples détails sur ces initiatives et sur les progrès réalisés par les autres actions du GSEAf seront donnés plus loin.

La Base de Données sur l'Eléphant africain

Une partie des objectifs de la *Base de Données sur l'Eléphant africain* (BDEA) pendant cette période a été de réunir des fonds pour produire le *Rapport 2006 sur le Statut de l'Eléphant africain* (RSEA) que nous espérons publier en 2006. Bien que nous ayons maintenant suffisamment de fonds pour compléter la mise à jour de la BDEA, nous devons encore récolter de quoi payer l'impression et la distribution du rapport de statut. Entre-temps, tandis que nous espérons que des fonds vont arriver, d'importants changements

Work has moved forward on developing a web-based point data collection system to supplement the range data layer in the database. We are also forging collaboration with the Institute of Zoology, Zoological Society of London, to conduct a spatial analysis of elephant distribution in relation to a number of anthropogenic, geographic and biological variables, again with a view to improving AED's range data, as well as to help identify and map areas particularly susceptible to human–elephant conflict.

Although response to the AED data collection questionnaire initiative, reported in the last issue of *Pachyderm*, has been rather subdued, the pile of survey reports has continued to grow, and AED manager Julian Blanc has been busy digitizing them. The official closing date for new data to be included in AESR 2006 was officially the last day of 2005, but don't let that put you off sending any information you may have to aed@iucn.org.

Updates on conservation and management strategies

Central Africa

The Central Africa Elephant Conservation Strategy (CAECS) planning workshop took place in Limbe, Cameroon, from 29 August to 2 September 2005. The workshop was a great success with representation from senior-level wildlife management authorities of all seven central African elephant range states, together with key non-governmental, intergovernmental and regional organizations, including the Organization for the Conservation of Wild Fauna in Africa, the CITES Secretariat, the CITES MIKE programme, TRAFFIC representing the Elephant Trade Information System (ETIS), the Bushmeat Working Group, and of course, AfESG.

The workshop consisted of plenary and work group sessions, resulting in a draft framework for the strategy. As expected, the need to reduce the illegal killing of elephants in central Africa was identified as one of the main objectives of the strategy. Some of the actions recommended to address this issue include shutting down unregulated domestic ivory markets through full compliance with the CITES Action Plan for controlling trade in African elephant ivory, and better reporting to ETIS, run by TRAFFIC, of seizures of elephant products. Other key objectives discussed include raising awareness at all levels about

ont eu lieu dans le développement de la BDEA, y compris un remaniement des aspects bibliographiques de la base de données, des systèmes pour traquer les changements, et la mise en place d'une stratégie fiable pour la sauvegarde des données.

Il y a eu des progrès dans le développement d'un système internet de récolte des données des points, pour compléter les données sur la répartition dans la base de données. Nous sommes aussi en train d'établir une collaboration avec l'Institut de Zoologie de la Société Zoologique de Londres, pour réaliser une analyse spatiale de la distribution des éléphants, en relation avec un certain nombre de variables anthropogéniques, géographiques et biologiques, ici aussi dans le but d'améliorer les données sur la distribution de la BDEA et d'aider à identifier et à cartographier les régions particulièrement susceptibles de connaître des conflits hommes–éléphants.

Bien que la réponse au questionnaire sur la récolte des données de la BDEA, rapportée dans le dernier numéro de *Pachyderm*, ait été relativement modeste, la quantité de rapports d'études continue à croître, et le gestionnaire de la BDEA, Julian Blanc, est occupé à les digitaliser. La date de clôture officielle pour intégrer de nouvelles données dans le RSEA 2006 était officiellement le dernier jour de 2005, mais que cela ne vous empêche pas d'envoyer toute information que vous pourriez avoir à aed@iucn.org.

Mises à jour des stratégies de conservation et de gestion

Afrique centrale

L'atelier de planification de la Stratégie de Conservation des Eléphants de l'Afrique Centrale (CAECS) a eu lieu à Limbe, au Cameroun, du 29 août au 2 septembre 2005. Ce fut un grand succès, avec la représentation de cadres de haut niveau des autorités de gestion de la faune des sept pays de l'aire de répartition des éléphants en Afrique centrale, de même que des organisations non gouvernementales, intergouvernementales et régionales clés, y compris l'*Organization for the Conservation of Wild Fauna in Africa*, le Secrétariat CITES, le programme MIKE de la CITES, TRAFFIC représentant le Système d'Information sur le Commerce des eléphants (ETIS), le Groupe de Travail sur la viande de brousse (bushmeat) et bien entendu, le GSEAf.

L'atelier consistait en séances plénières et en

the importance of conserving elephants in central Africa, improving the understanding of the status of elephants in the subregion, and maintaining and improving the connectivity between individual elephant populations.

When discussing the way forward, range states expressed a strong desire to see the CAECS integrated into the Convergence Plan of the Yaoundé Heads-of-State Process and requested that AfESG bring this initiative to the attention of ministers at the next extraordinary meeting of COMIFAC (Commission des Fôrets d'Afrique Centrale), to facilitate the formal adoption of the strategy at the next official COMIFAC meeting, in June 2006.

It was also unanimously agreed that AfESG would be the lead agency in coordinating the implementation of the strategy. The best way to ensure this would, again, be to base a dedicated AfESG Programme Officer in the subregion. However, as AfESG is currently unable to play this critical role because it lacks the funds, it was made clear to the participants that the necessary funding would have to be raised before AfESG could resume this important coordinating role.

Finally, to achieve CAECS objectives, the task of developing and revising national elephant conservation strategies was highlighted as a priority action. The AfESG Secretariat signaled its readiness to provide assistance to such processes—again, within the human and financial resources available to it.

The workshop was skilfully facilitated by Bihini Won wa Musiti of the IUCN Regional Office for Central Africa (and former AfESG deputy chair), ably assisted by Sébastien Luhunu, the CITES MIKE Subregional Support Officer, who was also in charge of meeting logistics. Lamine Sebogo, the AfESG Programme Officer for West Africa, provided valuable input derived from many years of experience, during which he assisted West African range states implement their subregional strategy and develop many of their subsequent elephant strategies and management plans. The final strategy document was ready for dissemination at the end of November, after final touches were put on it by Dr Conrad Aveling, former director of ECOFAC (Conservation et utilisation rationale des Ecosystèmes Forestiers d'Afrique Centrale), whom AfESG contracted to carry out this important task.

groupes de travail qui ont produit un projet de cadre pour la stratégie. Comme prévu, la nécessité de réduire les massacres illégaux d'éléphants en Afrique centrale a été identifiée comme un des objectifs principaux de la stratégie. Parmi les actions recommandées pour affronter ce problème, il y a la fermeture des marchés intérieurs non réglementés par la stricte application du Plan d'action de la CITES pour le contrôle du commerce d'ivoire des éléphants africains, de meilleurs comptes-rendus vers ETIS, géré par TRAFFIC, des saisies de produits issus d'éléphants. Parmi les autres objectifs clés discutés, on note la sensibilisation à tous niveaux sur l'importance de la conservation des éléphants en Afrique centrale, l'amélioration de la perception du statut des éléphants dans la sous-région, le maintien et l'amélioration de la connectivité entre les diverses populations.

En discutant de la façon de procéder, les Etats de l'aire de répartition ont exprimé un désir très net de voir la CAECS intégrée dans le Plan de Convergence du Sommet des Chefs d'Etat de Yaoundé et ont demandé que le GSEAf soumette cette initiative à l'attention des ministres lors de la prochaine réunion extraordinaire de la COMIFAC (Commission des Forêts d'Afrique Centrale) qui devrait faciliter l'adoption formelle de la stratégie lors de la prochaine réunion officielle de la COMIFAC, en juin 2006.

Il fut aussi accepté de façon unanime que le GSEAf soit l'agence dirigeante dans la coordination de la mise en place de la stratégie. La meilleure façon de s'en assurer serait, de nouveau, de baser un chef de programme consciencieux du GSEAf dans la sous-région. Mais comme le GSEAf n'a actuellement pas les moyens de jouer ce rôle critique parce qu'il manque de fonds, on a bien fait comprendre aux participants qu'il faudrait rassembler le financement nécessaire avant que le GSEAf puisse reprendre ce rôle important.

Enfin, pour atteindre les objectifs de la CAECS, le développement et la révision de stratégies nationales de conservation des éléphants ont été mis en évidence comme activités prioritaires. Le Secrétariat du GSEAf a dit qu'il était prêt à fournir son aide pour ces processus—dans le cadre des moyens humains et financiers qui seraient disponibles.

L'atelier a été facilité de façon très compétente par Bihini Won wa Musiti, du Bureau régional de l'UICN pour l'Afrique centrale (et ancien vice-président du GSEAf), parfaitement assisté de Sébastien Luhunu, le Responsable du Support sous-

Southern Africa

In late May 2005 AfESG participated in a strategic planning meeting at Victoria Falls in Zimbabwe to discuss the development of a subregional elephant conservation and management strategy for southern Africa. This meeting was convened under the auspices of the African Wildlife Consultative Forum, a gathering of directors of wildlife management authorities from the subregion, and was attended by representatives of seven of the nine elephant range states. The primary purpose of the workshop was for the range states to agree on the form and function of a framework for a subregional elephant conservation and management strategy. It was organized by the IUCN Regional Office for Southern Africa with support from Africa Resources Trust, Safari Club International Foundation and WWF.

In light of concerns over the growing elephant populations of southern Africa and their effect on people, habitats and biodiversity, it was no surprise that how to manage local overpopulation of elephants dominated workshop discussions. Other issues discussed and debated in plenary and fleshed out in subsequent working group sessions included how to assess elephant populations more accurately, develop collaborative approaches in management and monitoring, and conduct more effective public relations and communications throughout the subregion. The AfESG Secretariat team, comprising Leo Niskanen, Julian Blanc and me, was privileged to contribute to these discussions by providing an overview of the status and numbers of elephants in southern Africa, outlining the key issues to be considered to effectively mitigate human–elephant conflict, and providing guidance on developing the strategy.

The proceedings of the meeting and the first draft of a subregional conservation strategy document have now been circulated to the relevant range states.

West Africa

On 22 November at the Eighth Meeting of the Conference of the Parties to the Convention on Migratory Species (CMS) in Nairobi, Kenya, 12 of the 13 West African elephant range states officially signed into effect an intergovernmental memorandum of understanding on conserving elephants in West Africa. The West African Elephant Conservation Strategy, first developed with assistance from AfESG in 1999 and revised in March 2005, forms the central operational component

Afrique australe

Fin mai 2005, le GSEAf a participé à une réunion de planification stratégique aux Chutes Victoria, au Zimbabwe, pour discuter du développement d'une stratégie sous-régionale de conservation et de gestion des éléphants pour l'Afrique australe. Cette réunion s'est tenue sous les auspices du *African Wildlife Consultative Forum*, un groupe de directeurs des autorités de gestion de la faune de la sous-région, et elle a réuni des représentants de sept des neuf Etats de l'aire de répartition des éléphants. Le but premier de cette réunion était de se mettre d'accord sur la forme et la fonction d'un cadre pour une stratégie sous-régionale de conservation et de gestion des éléphants. Elle était organisée par le Bureau régional de l'UICN en Afrique australe, avec le soutien du *Africa Resources Trust*, de la *Safari Club International Foundation* et du WWF.

Vu l'inquiétude suscitée par les populations d'éléphants croissantes en Afrique australe et par leurs effets sur les gens, les habitats et la biodiversité, il n'est pas étonnant que la façon de gérer la surpopulation locale d'éléphants ait dominé les débats. D'autres sujets de discussion et de débat en séances plénières, puis en groupes de travail, comprenaient les moyens d'évaluer plus précisément les populations d'éléphants, de développer des approches communes de gestion et de surveillance continue, et d'établir des relations publiques et des communications plus efficaces dans toute la sous-région. L'équipe du Secrétariat du GSEAf, composée de Leo Niskanen, de Julian Blanc et de moi-même, a eu le privilège de contribuer à ces discussions en donnant un aperçu du statut et du nombre d'éléphants en Afrique australe,

régional de MIKE/CITES, qui était aussi chargé de la logistique de la réunion. Lamine Sebogo, le Responsable du programme du GSEAf en Afrique de l'Ouest, a fourni un input appréciable grâce à ses nombreuses années d'expérience, quand il aidait les Etats de l'aire de répartition en Afrique de l'Ouest à appliquer leur stratégie sous-régionale et à développer les nombreuses stratégies et les plans de gestion pour les éléphants qui en découlaient. Le document de stratégie final était prêt pour la diffusion fin novembre, et le Dr. Conrad Aveling, ancien directeur d'ECOFAC (Conservation et utilisation rationale des Ecosystèmes Forestiers d'Afrique Centrale), engagé par le GSEAf pour remplir cette tâche importante, y a mis la touche finale.

of this memorandum. At the meeting, the CMS Secretariat announced USD 50,000 funding over the next four years to the AfESG to support the implementation of the strategy. It is with deep gratification and a great sense of accomplishment that I welcome this high-level endorsement, which we hope will help maintain elephant conservation as a priority issue in the subregion.

Two other important transfrontier elephant conservation initiatives are also under way in West Africa. Lamine Sebogo, the AfESG Programme Officer for West Africa, is busy preparing for a consultative workshop to discuss with local stakeholders the establishment of the Kabore Tambi–Red Volta–Doung elephant corridor that links important elephant populations in Burkina Faso and Ghana. Scheduled to take place before the end of 2005, this workshop follows from recommendations made in the 2003 action plan for conserving important transfrontier elephant ranges in West Africa and aims to secure the necessary local support on the Burkina Faso side of the border for safeguarding the connectivity between the transfrontier populations. Similar local consultations are being planned across the border in the Red Volta region of Ghana.

Another AfESG-organized workshop is being planned for early 2006 to develop a transfrontier action plan for the Ziama–Northeast Forest Reserve area, which straddles the borders of Guinea Conakry and Liberia, and according to the latest survey data from MIKE, hosts a population of over 200 forest elephants. The timing of this second action plan is most appropriate as it comes hot on the heels of a US Fish and Wildlife Service approval of funds to develop a national elephant conservation strategy for Liberia. The Liberian wildlife management authorities have already approached AfESG for technical assistance to develop a strategic framework at a workshop planned for next January. A key priority for Liberia's national strategy is likely to be to assess its elephant population, virtually uncounted during years of civil strife. Transfrontier cooperation with neighbouring states, including Guinea, will be important in these efforts.

Eastern Africa

Kenya has now secured funding to develop the long-awaited national elephant conservation strategy. Leo Niskanen, AfESG's Senior Programme Officer, has been invited to join the Kenya Wildlife Service's in-house technical advisory committee that will be providing input to this process.

en mettant en évidence les questions clés à aborder pour atténuer efficacement les conflits hommes-éléphants et en donnant des conseils pour le développement d'une stratégie. Les débats de la réunion et le premier projet de stratégie sous-régionale de conservation ont été communiqués aux Etats concernés.

Afrique de l'Ouest

Le 22 novembre, lors de la Huitième Réunion de la Conférence des Parties à la Convention sur les Espèces Migratrices à Nairobi, au Kenya, les Etats ouest-africains de l'aire de répartition des éléphants ont, par leur signature officielle, rendu effectif le protocole d'accord intergouvernemental sur la conservation des éléphants en Afrique de l'Ouest. La Stratégie de Conservation des Eléphants de l'Afrique de l'Ouest, développée au départ avec l'aide du GSEAf en 1999 et révisée en mars 2005, constitue la composante opérationnelle centrale de ce protocole. C'est avec un grand plaisir et un sentiment profond de devoir accompli que je salue cette approbation de haut niveau qui, nous l'espérons, aidera à maintenir la conservation des éléphants parmi les priorités de la sous-région.

Deux autres initiatives importantes en matière de conservation transfrontalière des éléphants sont en cours en Afrique de l'Ouest. Lamine Sebogo, le Responsable du Programme du GSEAf en Afrique de l'Ouest, est occupé à préparer un atelier consultatif pour discuter avec les parties prenantes locales de la création du corridor Kabore Tambi–Nazinon (Volta Rouge)–Doung qui relie d'importantes populations d'éléphants au Burkina Faso et au Ghana. Prévu avant la fin de 2005, cet atelier fait suite aux recommandations du plan d'action de 2003 pour la conservation d'importantes aires de répartition des éléphants en Afrique de l'Ouest et il vise à s'assurer l'appui local nécessaire du côté burkinabé pour sauvegarder la connectivité entre les populations transfrontalières. Des consultations locales similaires sont prévues de l'autre côté, dans la région du Nazinon (ancienne Volta rouge), au Ghana.

Le GSEAf prévoit d'organiser un autre atelier au début de 2006 pour développer un plan d'action transfrontalier pour la région de Ziama–Réserve Forestière du *Northeast*, qui chevauche la frontière entre la Guinée Conakry et le Liberia et qui, d'après les dernières données recueillies par MIKE, abrite une

Human–elephant conflict

Vertical integration of human–elephant conflict management actions

As I reported in the last *Pachyderm*, AfESG is currently seeking funds to carry out pilot studies to develop and test coordinated approaches to mitigate human–elephant conflict (HEC) at multiple scales with a broad spectrum of stakeholders. Starting with several countries, we are aiming to implement activities that simultaneously tackle the numerous technical, institutional, socio-political and economic issues that contribute to HEC. We envisage that through the synergy of carefully designed, vertically integrated action by diverse actors at all levels, from the conflict site right up to the national decision-making level, it will be possible to reduce HEC and increase thresholds of tolerance by both elephants and people in the long term. We are now working on an application to the Global Environment Facility to develop a proposal for a five-year pilot study to test the effectiveness of such vertically integrated systems.

Sharing lessons learned

AfESG is increasingly being called upon to share lessons learned from its long-standing work on HEC. In May, Leo Niskanen and I provided input to efforts to develop a human–wildlife conflict management strategy for Namibia by attending a two-day workshop in Windhoek, where we presented lessons learned from HEC work across the continent. The output from the workshop was a detailed action plan for managing human–wildlife conflict at the national level. Namibia is the first, if not the only, African country to develop such a technically sound and thorough approach to tackling these issues.

In August Leo gave a presentation in Nairobi at the request of the East African Wild Life Society as part of its monthly lecture series on the challenges of managing HEC, drawing on the lessons learned from the work of AfESG's Human–Elephant Conflict Working Group. This talk helped highlight a range of experiences throughout the continent and stimulated lively discussion on the need to broaden perspectives on conflict management beyond the quick-fix solutions, which merely act as temporary 'band-aids' when the deeper, underlying causes are not dealt with directly.

population de plus de 200 éléphants de forêt. Le timing de ce second plan d'action est tout à fait approprié dans la mesure ù il fait suite à l'approbation par le *Fish and Wildlife Service* américain d'un budget pour développer une stratégie de conservation des éléphants au Liberia. Les autorités libériennes de gestion de la faune ont déjà contacté le GSEAf pour recevoir une aide technique pour le développement d'un cadre stratégique lors d'un atelier prévu pour janvier prochain. Un élément clé de la stratégie nationale libérienne sera probablement l'évaluation de la population d'éléphants, qui n'a pratiquement pas été dénombrée pendant toutes les années d'instabilité civile. La coopération transfrontalière avec les Etats voisins, y compris la Guinée, sera très importante.

Afrique de l'Est

Le Kenya a désormais sécurisé un financement pour le développement de sa stratégie nationale si attendue pour la conservation des éléphants. Leo Niskanen, le Responsable du Programme du GSEAf, a été invité à rejoindre le comité consultatif technique interne du *Kenya Wildlife Service* qui fournira son input dans ce processus.

Conflit hommes–éléphants

Intégration verticale des activités de gestion des conflits hommes–éléphants

Comme je l'écrivais dans le dernier *Pachyderm*, le GSEAf est occupé à chercher des fonds pour effectuer des études pilotes afin de développer et de tester des approches coordonnées pour atténuer les conflits hommes–éléphants (CHE) à de multiples niveaux, avec une large gamme de parties prenantes. En commençant avec plusieurs pays, nous voulons réaliser des actions qui affrontent simultanément les nombreux problèmes techniques, institutionnels, sociopolitiques et économiques qui contribuent aux CHE. Nous prévoyons que, grâce à la synergie d'activités soigneusement conçues et intégrées verticalement par divers acteurs à tous les niveaux, depuis les sites de conflit jusqu'au niveau décisionnel national, il sera possible de réduire les CHE et d'augmenter à long terme les seuils de tolérance des éléphants et des hommes. Nous travaillons pour le moment sur une demande à adresser au Fonds

HEC discussion group

To facilitate technical exchange on matters related to mitigating HEC, the AfESG Secretariat also recently established an email discussion group for those mitigating HEC throughout Africa to share lessons learned. It is hoped that this forum will also contribute to our efforts to identify new HEC research priorities and foster future collaborative efforts among those working to mitigate HEC.

Update on the CITES MIKE programme

At the 53rd CITES Standing Committee meeting in June, it was agreed that the CITES Secretariat would underwrite a minimum-cost budget for MIKE that would allow the MIKE Secretariat to continue its operations until the end of March 2006, by which time new European Commission (EC) funding should become available. This bridging arrangement should ensure that MIKE implementation can build up momentum quickly as soon as the new EC funds have been received. In the meantime, however, restricted operational budgets have put a ceiling on the ability of the MIKE Secretariat to carry out the full range of support activities.

While the lack of funds has hampered progress in the field, some progress has nevertheless been made on further improving the MIKE database. The new version 1.06 of the MIKE database will allow waypoints created in the GPS to be downloaded directly. This should ease the laborious task of entering latitude and longitude readings via the keyboard.

Local Overpopulation Task Force

In addition to funding from WWF-Switzerland and the Toronto Zoo that I reported in the last issue, WWF International has now agreed to provide the balance of funds required to finalize the *Guidelines for Managing Local Overpopulation of Elephants*. In recent weeks AfESG's Local Overpopulation Task Force has been working on the draft document, and we hope that now that funds have been secured, we can complete this important project sometime in 2006.

Mondial pour l'Environnement pour développer une proposition d'étude pilote sur une durée de cinq ans pour tester l'efficacité de tels systèmes verticaux intégrés.

Partager les leçons apprises

On demande de plus en plus au GSEAf de partager les leçons apprises au cours des longues années de travail sur les CHE. En mai, Leo Niskanen et moi avons aidé à développer une stratégie de gestion des conflits hommes–faune sauvage pour la Namibie en participant à un atelier de deux jours à Windhoek, où nous avons présenté les leçons tirées du travail sur les CHE dans tout le continent. Le résultat de cet atelier fut un plan d'action détaillé pour la gestion des conflits hommes–faune sauvage au niveau national. La Namibie est le premier, mais pas le seul, pays africain à développer une telle approche techniquement raisonnée et directe pour affronter ces problèmes.

En août, Leo a fait une présentation à Nairobi à la demande de la *East African Wild Life Society* dans le cadre de ses exposés mensuels sur les challenges que représente la gestion des CHE, en s'inspirant des leçons apprises lors des activités du Groupe de Travail du GSEAf sur les Conflits Hommes–Eléphants. Ceci a permis de mettre en lumière une série d'expériences dans tout le continent et a suscité une discussion animée sur la nécessité d'élargir les perspectives de la gestion des conflits au-delà des solutions instantanées qui ne servent que d'« emplâtres » temporaires si les causes plus profondes ne sont pas traitées directement.

Groupe de discussion sur les CHE

Pour faciliter les échanges techniques sur les matières liées à la mitigation des CHE, le Secrétariat du GSEAf a créé récemment un groupe de discussion par email pour que tous ceux qui sont concernés par la mitigation des CHE partagent les leçons apprises. On espère que ce forum pourra nous aider à identifier les nouvelles priorités en matière de recherche sur les CHE et à rassembler les efforts de collaboration de tous ceux qui y travaillent.

AfESG website

The AfESG website, www.iucn.org/afesg, now contains a newly digitized version of Dr Michael Norton-Griffiths's *Counting Animals*—the classic how-to-do-it guide for wildlife surveys in Africa. Other recent additions include the national elephant conservation strategies for Burkina Faso and Côte d'Ivoire.

Prospects for the future

AfESG's fundraising efforts over the past six months have finally started to pay off. We have recently secured a 70,000 euro grant from the French Ministry of Agriculture and Environment to support our West Africa Programme Office over the next three years. In addition, our long-time supporters, the US Fish and Wildlife Service and the UK Department for Environment, Food and Rural Affairs, have once again delighted us by providing some badly needed funds to replenish our core operational budget. However, despite these positive developments, there is currently no long-term support. Major funding gaps remain, and these need to be plugged to ensure that our core operations continue.

One additional challenge is finding funds to continue producing *Pachyderm.* It is only because of a last-minute private donation from the Messerli Foundation and an anonymous benefactor that we have been able to complete the present issue. Such a funding situation is clearly unsustainable, and as *Pachyderm*'s production and mailing costs continue to rise and donor fatigue firmly sets in, pressure is also mounting on the AfESG Secretariat, which is still trying, on behalf of all three Specialist Groups, to find the resources to keep the journal going in its present format.

This means that we must consider all options for the long term including shifting to a purely electronic format for this journal. But even this is an option only if we can source the funds to continue paying a professional editor. It is therefore very possible that this is the last time, for the foreseeable future, that I will be able to communicate to you through the medium of a *Pachyderm* Chair report, at least in printed format.

Wish us luck and please send on any new and innovative fund-raising ideas you may have.

Mise à jour du Programme MIKE/ CITES

Lors du 53ème Comité permanent de la CITES en juin, il fut accepté que le Secrétariat de la CITES alloue un budget minimum à MIKE pour que son Secrétariat poursuive ses activités jusque fin mars 2006, date à laquelle un nouveau financement de la Commission Européenne (CE) sera disponible. Cet arrangement devrait permettre à la mise en route de MIKE de prendre un élan rapide dès que les fonds européens seront reçus. Entre-temps, le budget limité impose un plafond à la capacité qu'a le Secrétariat de MIKE de mener toutes ses activités de soutien.

Si le manque de fonds a ralenti les progrès sur le terrain, l'amélioration de la base de données de MIKE a néanmoins connu des progrès certains. La nouvelle version 1.6 de la base de données de MIKE permettra de décharger directement les *waypoints* notés dans le GPS. Ceci devrait faciliter la tâche laborieuse qui consistait à entrer latitude et longitude au clavier.

Force spéciale chargée des surpopulations locales

En plus des financements du WWF-Suisse et du Zoo de Toronto dont je parlais dans le dernier numéro, le WWF-International a accepté de compléter les fonds nécessaires pour terminer les *Lignes directrices pour la gestion de la surpopulation locale des éléphants*. La Force spéciale du GSEAf a travaillé ces dernières semaines sur le projet de document, et nous espérons que, maintenant que nous disposons des fonds nécessaires, nous pourrons mener à bien ce projet en 2006.

Site internet du GSEAf

Notre site internet http://iucn.org/afesg comprend maintenant une version digitalisée de *Counting Animals* du Dr. Michael Norton-Griffith, le guide pratique classique pour l'étude de la faune en Afrique. Parmi les autres additions récentes se trouvent les stratégies nationales de conservation des éléphants du Burkina Faso et de Côte d'Ivoire.

Perspectives de l'avenir

Les efforts de récolte de fonds des six derniers mois commencent enfin à porter des fruits. Nous avons reçu

l'assurance d'un financement de 70.000 euros du Ministère français de l'Agriculture et de l'Environnement pour le soutien de notre bureau en Afrique de l'Ouest pendant les trois prochaines années. De plus, nos plus anciens supporters, le *Fish and Wildlife Service* américain et le Département britannique de l'Environnement (*Food and Rural Affairs*), nous ont à nouveau fait le plaisir de nous fournir les fonds si nécessaires pour les frais de fonctionnement de base. Mais malgré ces éléments positifs, il n'y a actuellement aucun soutien à long terme. Il reste de sérieux manques et il faudra les combler pour garantir la poursuite de nos activités courantes.

Un des challenges sera aussi de pouvoir poursuivre le financement de la parution de *Pachyderm*. Ce n'est que grâce à une donation de dernière minute d'un bienfaiteur anonyme que nous avons pu assurer la parution de ce numéro. Une telle situation est insoutenable et comme la production et la distribution de *Pachyderm* coûtent de plus en plus cher et que la lassitude des donateurs est de plus en plus marquée, la pression augmente sur le Secrétariat du GSEAf qui essaie encore, au nom des trois Groupes de Spécialistes, de trouver les ressources qui permettront de maintenir la revue au format actuel.

Cela signifie que nous devons envisager toutes les options possibles, y compris le passage à un format uniquement électronique. Mais même ceci n'est une option que si nous pouvons continuer à payer un éditeur professionnel. Il est donc possible que ceci soit la dernière fois, dans un avenir proche, que je peux communiquer avec vous au moyen de ce *Rapport de la Présidente* dans *Pachyderm*, au moins sous cette forme.

Souhaitons-nous Bonne Chance et, s'il vous plaît, envoyez toutes les idées neuves que vous pourriez avoir pour récolter des fonds.

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

Conservation measures

A new chapter has been opened in efforts to save the northern white rhino, *Ceratotherium simum cottoni*, from extinction with the announcement by the Democratic Republic of Congo that it will outsource the management of Garamba National Park for the next five years. The African Parks Foundation will take over the management of the park, which currently conserves the last 5 to 10 northern white rhinos remaining in the wild. Emphasis will be placed on monitoring and protecting the rhinos from poachers, including Sudanese gunmen on horseback, especially during the dry season early each year when the rhinos are particularly vulnerable. This new initiative, which followed the Congo government's decision earlier in 2005 not to allow the temporary translocation of a small founder population to Kenya for safekeeping, is supported by AfRSG as it probably represents the best immediate option available to secure the survival of this critically endangered subspecies.

The West African black rhino, *Diceros bicornis longipes*, is similarly threatened with extinction as the few remaining individuals are scattered widely throughout northern Cameroon and currently are not adequately protected. In my last report I mentioned the need for a fresh initiative involving all parties to determine the viability of the remaining population, this being needed as a prerequisite to designing an appropriate survival strategy. To this end, the French IUCN committee convened a meeting in Paris in mid-October 2005 to discuss and agree on the way forward, but the recommendations had not been received by the end of October so could not be reported on here. The main thrust, however, has to be the clear identification, with scientific proof, of the existence of at least five apparently unrelated rhinos that could form the nucleus of a future population.

Mesures de conservation

On a ouvert un nouveau chapitre dans les efforts pour sauver de l'extinction le rhino blanc du Nord, *Ceratotherium simum cottoni*, lorsque la République Démocratique du Congo a annoncé qu'elle allait confier, pour les cinq prochaines années, la gestion du Parc National de la Garamba, qui abrite aujourd'hui les cinq à dix derniers rhinos restant à l'état sauvage, à la *African Parks Foundation.* On a mis l'accent sur la surveillance continue et sur la protection des rhinos contre les braconniers, y compris les tireurs soudanais à cheval, chaque année, surtout pendant la saison sèche, quand les rhinos sont particu-lièrement vulnérables. Cette nouvelle initiative, qui a suivi la décision du gouvernement congolais prise plus tôt en 2005 de ne pas autoriser la translocation temporaire d'une petite population fondatrice au Kenya pour sa sauvegarde, est soutenue par le GSRAf dans la mesure où elle représente probablement dans l'immédiat la meilleure option pour assurer la survie de cette sous-espèce en situation critique.

Le rhino noir ouest-africain *Diceros bicornis longipes* est lui aussi menacé d'extinction parce que les derniers individus sont éparpillés dans tout le nord du Cameroun et qu'ils ne sont pas correctement protégés pour le moment. Dans mon dernier rapport, je mentionnais la nécessité d'une nouvelle initiative impliquant toutes les parties pour déterminer la viabilité de la population restante, préalable indispensable à l'adoption d'une stratégie de sauvegarde appropriée. C'est pourquoi le Comité français de l'UICN a organisé une réunion à Paris, mi-octobre 2005, pour discuter et se mettre d'accord pour le futur, mais fin octobre, nous n'avions pas encore reçu ses recommandations et nous ne pouvons donc pas encore vous les livrer. L'idée maîtresse était cependant qu'il fallait identifier clairement, avec des preuves scientifiques, l'existence d'au moins cinq rhinos non apparentés qui pourraient former le noyau reproducteur d'une future population.

Sadly the first phase of the Italian-funded Southern African Development Community Regional Programme for Rhino Conservation (SADC RPRC) has just come to an end. AfRSG was one of five consortium members that helped coordinate the programme since it started in September 1999. Reports and software produced by the programme are being packaged together onto a CD and those interested in obtaining a copy are asked to contact Giuseppe Daconto at daconto@cesvi.co.zw. It is hoped that in time a second, different phase of the SADC regional rhino programme, which builds upon initial successes, will be funded by the Italian government. Towards the end of the programme the SADC RPRC helped facilitate increased political support at the SADC range state level for translocating rhinos cross-boundary and especially for trying to increase the black rhino founder numbers for the reintroductions in Zambia and Botswana.

Funding campaign

While one significant rhino conservation initiative has recently come to an end, EAZA (European Association of Zoos and Aquaria) has just launched a yearlong rhino conservation funding campaign at its annual conference in Bath, UK, on 7 September 2005. Nico van Strien (AsRSG Co-chair), Tom Foose (AsRSG Programme Officer) and Richard Emslie (AfRSG Scientific Officer) assisted the campaign by reviewing and commenting on the 53 proposals received by the campaign's core group, and Nico and Richard gave presentations at the launch of the rhino campaign at EAZA's annual conference. The campaign is targeted to raise 350,000 euros. Although the campaign is confident that zoos in other parts of the world, particularly in the USA, will run parallel fundraising, education and awareness campaigns, it was not possible for the campaign to support all the projects. Initially the core group with input from EAZA members has selected a group of 13 projects to benefit from the campaign, totalling a cost of 338,200 euros.

The seven selected African rhino projects will fund or co-fund 1) rhino monitoring equipment for Kenyan Wildlife Service rhino areas, 2) the Laikipia [Kenya] Wildlife Forum's Environmental Programme, 3) anti-poaching, monitoring and environmental education initiatives as part of the continued re-establishment of black rhinos in North Luangwa

La première phase du Programme Régional SADC pour la conservation des rhinos, financée par l'Italie, vient hélas de se terminer. Le GSRAf était un des cinq membres du consortium qui ont aidé à coordonner ce programme dès son lancement, en septembre 1999. Les rapports et les programmes informatiques produits par le Programme sont concentrés sur un CD et ceux qui seraient intéressés peuvent en obtenir une copie en demandant à Giuseppe Daconto à daconto@cesvi.co.zw. Nous espérons qu'à l'avenir, une seconde phase, différente, de ce programme basé sur des succès antérieurs sera financée par le gouvernement italien. Vers la fin du programme, le SADC RPRC (*Southern African Development Community Regional Programme for Rhino Conservation*) a aidé à faciliter un soutien politique accru au niveau des Etats de la SADC pour la translocation transfrontalière de rhinos et spécialement pour essayer d'augmenter le nombre de rhinos noirs fondateurs dans les réintroductions en Zambie et au Botswana.

Campagne de récolte de fonds

Alors qu'une initiative significative de conservation des rhinos vient de toucher à sa fin, l'AEZA (Association Européenne des Zoos et des Aquariums) vient de lancer une campagne de financement d'un an de la conservation des rhinos lors de sa conférence annuelle à Bath, le 7 septembre 2005. Nico van Strien (Co-président du GSRAf), Tom Foose (Responsable de programme du GSRAf) et Richard Emslie (Responsable scientifique du GSRAf) ont aidé à cette campagne en révisant et en commentant les 53 propositions reçues par le groupe chargé de la campagne, et Nico et Richard ont fait une présentation lors du lancement de la campagne rhino à la Conférence annuelle de l'AEZA. La campagne souhaite récolter 350.000 euros et bien qu'elle soit sûre que des zoos d'autres parties du monde, et particulièrement aux USA, mèneront parallèlement des campagnes de récolte de fonds, d'éducation et de sensibilisation, il ne lui était pas possible de soutenir tous les projets. Le groupe de base a sélectionné pour commencer, avec l'input de membres de l'AEZA, un groupe de 13 projets qui bénéficieront de la campagne, pour un total de 338.000 euros.

Les sept projets choisis en Afrique financeront, ou co-financeront 1) un équipement de surveillance continue des rhinos pour les zones concernées du *Kenya Wildlife Service*, 2) le Programme environnemental du *Laikipia Wildlife Forum* (Kenya), 3) des initiatives de surveillance antibraconnage continue et d'éducation à

National Parks in Zambia, 4) a lifting crane for a Zimbabwean rhino capture truck, 5) rhino translocation equipment for Namibia, 6) security equipment for Hluhluwe Game Reserve in South Africa, and 7) a small amount of funding to complete the final experimental phase of the AfRSG rhino horn fingerprinting project. In the event that the zoo community raises more than the target 350,000 euros, the additional funds will be used to support eight field-based African rhino conservation projects that are on a waiting list. Anyone interested in further details should see the Rhino Notes in this issue or contact the EAZA Rhino Campaign manager, Renaud Fulconis, at renaud@savetherhino.org.

Other events

In another positive initiative, the second new black rhino population has recently been set up as part of the joint WWF/Ezemvelo–KZN–Wildlife's Black Rhino Range Expansion project (see Rhino Notes in this issue for further details). Release of the 23 founders into Zululand Rhino Reserve went well (see Rhino Notes). The first birth has also been reported from the first range expansion project population established last year.

Since the start of 2005, AfRSG has experienced a funding shortfall; and it is therefore especially grateful to the International Rhino Foundation for its recent decision to partially fund the work of the AfRSG Secretariat over the coming year. This new IRF funding provides significant matching funds, which should facilitate raising from other donors the balance of operational funds AfRSG needs. While it is hoped to hold the next AfRSG meeting in mid-2006; at this stage no funding has been secured to enable this meeting to take place.

Loss of a member

It is with deep sadness that I report that past AfRSG member Steve Gartlan passed away in September this year. Steve was a member of AfRSG for much of the 1990s and made useful contributions to the efforts to conserve the last remaining western black rhinos in northern Cameroon, as well as actively participating in a number of workshops to develop rhino conservation strategies at our biennial AfRSG meetings.

l'environnement dans le cadre de la poursuite du rétablissement des rhinos noirs dans le Parc National de Luangwa nord, en Zambie, 4) de l'équipement pour la translocation des rhinos en Namibie, 6) du matériel de sécurité pour la Réserve de Faune du Hluhluwe, en Afrique du Sud et 7) un petit financement pour compléter la phase expérimentale finale du projet GSRAf d'empreinte génétique des cornes de rhinos. Au cas où la communauté des zoos récolterait une somme supérieure aux 350.000 euros prévus, les fonds supplémentaires soutiendraient huit projets de conservation sur le terrain de rhinos africains qui sont sur la liste d'attente. Celui qui voudrait plus de détails peut consulter les *Rhino Notes* dans ce numéro ou contacter le gestionnaire de la Campagne Rhino de l'AEZA, Renaud Fulconis, sur renaud@savetherhino.org.

Autres événements

Autre initiative positive, la deuxième population nouvelle de rhinos noirs fait désormais partie du projet conjoint WWF/Ezemvelo-KZN-*Wildlife's Black Rhino Range Expansion* (voir les Notes Rhinos pour plus de détails). Le lâcher des 23 fondateurs dans la Réserve des Rhinos au Zululand s'est bien passé (voir Rhino Notes). On a aussi relevé la première naissance dans la population du premier projet d'expansion établie l'année dernière.

Depuis le début de 2005, le GSRAf connaît un manque de fonds ; il est dès lors très reconnaissant envers l'*International Rhino Foundation* qui a décidé récemment de financer partiellement le travail du Secrétariat du GSRAf l'année prochaine. Ce nouveau financement de l'IRF est une subvention significative qui devrait faciliter la récolte, auprès des autres donateurs, du reste des fonds nécessaires pour les opérations courantes du GSRAf. Nous espérons tenir la prochaine réunion du Groupe vers la mi-2005 mais nous ne disposons pas encore des fonds qui le permettraient.

Disparition d'un membre

C'est avec beaucoup de tristesse que je dois vous faire part du décès, en septembre dernier, d'un de nos anciens membres, Steve Gartlan. Steve fut un membre du GSRAf pendant les années 90 et il fit de très utiles contributions aux efforts de conservation des derniers rhinos noirs de l'Ouest, dans le nord du Cameroun. Il a aussi participé activement à de nombreux ateliers pour développer des stratégies de conservation des rhinos lors des réunions semestrielles du GSRAf.

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

Nico van Strien, Interim Co-chair for South-East Asia

Kondominium Taman Anggrek 3-23B, Jln. Parman. Slipi, Jakarta 11470, Indonesia
email: strien@compuserve.com

At the IUCN World Conservation Congress in Bangkok (17–24 November 2004) all IUCN/SSC Specialist Groups were constitutionally dissolved, as happens after each quadrennial sitting period. The previous Chair, Mr Mohd Khan bin Momin Khan, who led and inspired the Asian Rhino Specialist Group (AsRSG) for almost two decades, retired and was awarded IUCN's oldest and most prestigious award, the Sir Peter Scott Award for Conservation Merit. Mr Mohd Khan received the award from the outgoing SSC Chair, Dr David Bracket, for a distinguished career, not only as AsRSG Chair but also in recognition of his many years of important and influential work championing species conservation in Asia.

As the new Interim Co-chair of AsRSG I wish to express my gratitude for the wise leadership provided by Mr Mohd Khan to the AsRSG for many years and for our friendship that has lasted for 30 years. I hope to be able to continue the work in his spirit and hope to benefit from his experience and wisdom for many more years.

After the World Conservation Congress, the Chair and the Steering Committee of IUCN/SSC decided, after lengthy deliberations, to change AsRSG structure and to initiate a subdivision of the group into SE Asia (Javan and Sumatran rhino, primarily occurring now in Indonesia, the Peninsula and Sabah in Malaysia, and Vietnam) and South Asia (Indian rhino, in India and Nepal), with a co-chair for each of the two areas. This division, now formalized, had already been initiated in the previous quadrennium.

I was appointed 'Interim' Co-chair for SE Asia, with the primary task of identifying suitable candidates for the South Asia Co-chair position and to reconstitute the group. In November consultation with key rhino conservationists and scientists will be concluded, and the next AsRSG Chair's report will be a joint effort between the new South Asia Co-chair and me and will include a comprehensive update on the

Au Congrès Mondial UICN de la Conservation à Bangkok (les 17 à 24 novembre 2004), tous les groupes de spécialistes de la CSE/UICN ont été constitutionnellement dissous, comme tous les quatre ans. Le président précédent, M. Mohd Khan Momin Khan, qui a dirigé et inspiré le Groupe des Spécialistes des Rhinos d'Asie (GSRAs) pendant presque deux décennies, s'est retiré et il a reçu le prix le plus ancien et le plus prestigieux de l'UICN, le Prix Sir Peter Scott pour services à la cause de la conservation de la nature. M. Mohd Khan a reçu ce prix des mains du Président sortant de la CSE, le Dr. David Bracket, pour sa carrière remarquable, non seulement comme président du GSRAs, mais aussi en reconnaissance des nombreuses années qu'il a consacrées à la défense de la conservation de l'espèce en Asie.

En tant que nouveau président *ad interim* du GSRAs, je veux exprimer ici toute ma gratitude à M. Mohd Khan pour sa direction avisée du GSRAs pendant de si longues années, et pour notre amitié qui dure depuis 30 ans. J'espère être capable de poursuivre ce travail dans le même esprit et pouvoir bénéficier de son expérience et de sa sagesse pendant de nombreuses années encore.

Après le Congrès Mondial de la Conservation, le Président et le Comité de direction de la CSE/UICN ont décidé, après de longues délibérations, de changer la structure du groupe et de le scinder en deux : pour l'Asie du Sud-Est (Rhinos de Java et de Sumatra, qui vivent surtout maintenant en Indonésie, sur la Péninsule de Sabah en Malaisie, et au Vietnam) et l'Asie du Sud (le Rhino d'Inde qui vit en Inde et au Népal), avec un co-président pour chacune des régions. Cette division qui est maintenant officielle avait déjà commencé au cours de la dernière période de quatre ans.

J'ai été nommé co-président *ad interim* pour l'Asie du SE, avec comme tâches premières d'identifier les candidats idéaux pour le poste de co-président pour

significant developments in India and Nepal. The present report is limited to SE Asian affairs.

Two Sumatran rhinos rescued and moved to Way Kambas National Park, Sumatra

In the second half of 2005 two young female Sumatran rhinos were rescued from unviable and threatening situations and moved to the Sumatran Rhino Sanctuary (SRS) in Way Kambas National Park, Sumatra, Indonesia.

The first rhino, Rosa, is a young female from Bukit Barisan Selatan National Park (BBS) that had become habituated to people and was venturing more and more out of the park into villages and fields. Sometimes she would make long treks through densely populated areas and once visited a village market about 30 km away from her usual home range in BBS. As of early 2004, two units of the Rhino Protection Units (RPUs) in BBS had already been permanently assigned to protect her intensively.

As Rosa became ever more attracted to people—and their crops and kitchens—the situation became untenable and too large a drain on RPU resources, which were also needed to protect the other 60–80 rhinos in BBS. Though people around BBS were well informed about Rosa and did not suffer major damage from her or hinder her from wandering through their fields and villages, the risk of Rosa being killed for her horn or out of fright was increasing, especially as she ventured farther and farther out of the forest.

In September it was decided to guide Rosa into a temporary enclosure in BBS to prevent her from wandering and to prepare her for the move to SRS, which will take place after she has been examined and is found to be free of communicable diseases or parasites.

Moving Rosa is a carefully planned operation. But moving Ratu, a second young female rhino, was the result of an unexpected search-and-rescue operation near Way Kambas National Park.

Before daybreak on 20 September 2005 a rhino was spotted wandering around a village in the vicinity of the southern boundary of the park. Fortunately a park guard lived nearby and immediately alerted the park headquarters and the police and formed a small team to protect the rhino.

The animal, a species unknown to most people, drew a lot of attention in this densely populated area,

l'Asie du S. et de reconstituer le groupe. En novembre, la consultation d'un responsable clé de la conservation et d'un scientifique sera terminée et le prochain rapport du Président du GSRAs sera un effort conjoint du nouveau co-président pour l'Asie du S. et de moi, et il comprendra une mise à jour complète des développements significatifs en Inde et au Népal. Ce rapport-ci se limite aux affaires du Sud-Est asiatique.

Deux rhinos de Sumatra rescapés et placés dans le Parc National de Way Kambas

Pendant la seconde moitié de 2005, deux jeunes rhinos de Sumatra femelles ont été extraites de conditions invivables et dangereuses et confiées au Sanctuaire des Rhinos de Sumatra (SRS), dans le Parc National de Way Kambas, à Sumatra, en Indonésie.

La première, Rosa, est une jeune femelle du Parc National de Bukit Barisan Selatan (BBS) qui s'était habituée aux gens et qui s'aventurait de plus en plus en dehors du parc, vers les villages et les champs. Elle faisait parfois de longs déplacements dans des zones densément peuplées et elle a même visité un marché à près de 30 kilomètres de son domaine habituel au BBS. Depuis le début de 2004 déjà, deux unités spéciales de protection des rhinos (UPR) avaient été chargées de sa protection continue.

Comme Rosa s'attachait de plus en plus aux gens – à leurs récoltes et à leurs cuisines – la situation était devenue intenable et mobilisait trop les ressources des UPR qui devaient aussi protéger les 60 à 80 autres rhinos de BBS. Même si les gens étaient tous informés des agissements de Rosa et qu'ils ne subissaient pas trop de dommages et pouvaient l'empêcher de divaguer dans les champs et les villages, Rosa courait néanmoins le risque d'être tuée pour sa corne ou parce qu'elle aurait effrayé quelqu'un, surtout qu'elle s'aventurait de plus en plus loin en dehors de la forêt.

En septembre, on a décidé de la diriger vers un enclos temporaire dans le BBS pour l'empêcher de divaguer encore et pour la préparer au déplacement vers le SRS qui aura lieu lorsqu'elle aura été examinée et reconnue indemne de toute maladie contagieuse ou de parasites.

Le déplacement de Rosa est une opération planifiée avec soin. Mais celui de Ratu, une autre jeune femelle, fut le résultat d'une opération de sauvetage soudaine près du Parc National de Way Kambas.

Nico van Strien, IRF

The two rescued female Sumatran rhinos.

and it was difficult for the protection team to keep up with the rhino, which was constantly being chased in different directions. Later in the morning more people from the park joined the protection team as they tried to guide the rhino back to the safety of Way Kambas.

By noon it became clear that it was impossible to accomplish the task because of the large crowds coming to see the rhino. Also she started to show signs of exhaustion. And some groups indicated that they wanted to kill her. Then the team, in consultation with the head of the park, decided to enclose her in a temporary, makeshift boma to protect her, and to move her to the SRS.

A crate was trucked in from SRS and in the afternoon, just 12 hours after the rhino was first spotted, she arrived safely in SRS. She showed signs of severe stress, dehydration and exhaustion, and she was markedly lame in her hind limbs, caused by capture myopathy. The first days in the temporary boma, she ate and drank little, but on about the third day her condition started to improve, and gradually she recovered from the effects of the capture. Now she is completely tame and can easily be handled by the keepers. She is almost fully recovered from the stress of 'getting lost' and her capture and transport. The International Rhino Foundation provided veterinarians to assist the team with the post-capture treatment.

Avant l'aube du 20 septembre 2005, on a repéré un rhino qui se promenait autour d'un village proche de la limite sud du parc. Heureusement, un garde du parc habitait près de là et put immédiatement alerter le quartier général et la police et former une petite équipe pour protéger le rhino.

L'animal, une espèce inconnue de la plupart des gens, a beaucoup attiré l'attention dans cette zone très peuplée et l'équipe de protection eut beaucoup de mal de garder le rhino qui était sans arrêt chassé dans toutes les directions. Plus tard dans la matinée, d'autres personnes du parc sont venues rejoindre l'équipe de protection pour essayer de guider le rhino vers la sécurité de Way Kambas.

A midi, il est devenu évident qu'il serait impossible de mener cette t,che à bien étant donné la foule de gens qui venaient voir le rhino qui, pour sa part, commençait à montrer des signes d'épuisement. Certains groupes disaient d'ailleurs qu'ils voulaient la tuer. Alors l'équipe, en accord avec le chef du parc, a décidé de l'enfermer dans un boma temporaire pour la protéger puis de la déplacer vers le SRS.

Une caisse fut apportée du SRS et l'après-midi, exactement douze heures après avoir été repérée, elle arrivait saine et sauve au SRS. Elle présentait des signes de stress, de déshydratation et d'épuisement sévères, et ses membres postérieurs étaient visiblement instables, à cause de la myopathie de la capture. Les premiers jours de captivité, elle mangea et but peu, mais vers le troisième jour, son état a commencé à s'améliorer et elle put peu à peu récupérer des effets de sa capture. Elle est maintenant tout à fait docile et les gardiens peuvent la manipuler aisément. Elle a presque récupéré du stress dû au fait de s'être perdue, d'avoir été poursuivie et transportée. L'*International Rhino Foundation* a fourni des vétérinaires pour aider l'équipe lors des traitements post-capture.

On ne sait pas pourquoi ce rhino a quitté la sécurité

It is not known why the rhino left the security of the park, but intensive disturbance by illegal loggers and encroachers in the fringe areas of the park may have contributed to her leaving the security of the national park. And if the rhino had not been first spotted near the home of a park guard the incident may very well have ended in tragedy.

Summary report on rhinos in Sabah

data provided by SOS Rhino–Borneo

Tabin Wildlife Reserve

SOS Rhino Borneo cooperates closely with the Sabah Wildlife and Forestry Departments to protect the Tabin Wildlife Reserve and to conserve rhinos in general. Other NGOs, villagers and oil palm plantations also intensively engage in rhino conservation activities in Sabah.

In the Tabin Wildlife Reserve three RPUs are operating and another two will have been established by the end of 2005. Each RPU consists of a team leader and three field assistants. A field coordinator for Tabin will be coming on board in November 2005. Four base camps have been established for the RPUs in the north, west and south-east of the Tabin reserve and additional base camps will be established for the new RPUs. The RPUs are involved with anti-poaching patrols. They are preparing transects for a rhino survey and are providing support to students and researchers. Some RPU members are recruited from the villagers around Tabin.

The Sabah Wildlife Department has trained some RPU members as honorary wildlife wardens. The Forestry Department has handed over one of its base camps at Dagat to support the programme.

Results of a two-year survey conducted in Tabin Wildlife Reserve from 2000 to 2002 indicate at least 6 *Known*, 10 *Probable* and 35 *Possible* rhinos. This does not show a significant increase in the population when compared with the results of earlier censuses. Now a more comprehensive survey to reassess the rhino population is being carried out. Six north–south transects have been prepared, and the surveys will continue to the end of 2006. Fresh rhino tracks will be located and measured. Statistical analysis on hoofprint measurements will be used to identify individuals. So far, this method has been able to iden-

du parc, mais des perturbations intenses causées par des coupeurs d'arbres illégaux et par des gens qui empiètent sur les limites du parc peuvent avoir contribué à la faire partir, ou en être même la seule cause. Si le rhino n'avait pas été d'abord aperçu près de la maison de ce garde, cet incident aurait très bien pu se terminer de façon tragique.

Résumé du rapport sur les Rhinos à Sabah

données fournies par SOS Rhino-Borneo

Tabin Wildlife Reserve

SOS Rhino-Bornéo coopère intimement avec les Départements de la Faune sauvage et des Forêts de Sabah pour la protection de la Réserve de Faune de Tabin, et des rhinos en général. D'autres ONG, des villageois et des plantations de palmiers à huile s'engagent aussi très activement dans les activités de conservation des rhinos de Sabah.

Dans la Réserve de Faune de Tabin, trois UPR travaillent déjà et deux autres doivent s'y ajouter fin 2005. Chaque UPR se compose d'un chef d'équipe et de trois assistants de terrain. Un coordinateur de terrain viendra prendre sa place pour Tabin en novembre 2005. On a installé quatre camps de base pour les UPR au nord, à l'ouest et au sud-est de la Réserve de Tabin et il y aura de nouveaux camps pour les unités qui arrivent. Ces unités sont impliquées dans des patrouilles anti-braconnage. Les hommes sont occupés à préparer des transects pour une étude des rhinos et fournissent un support à des étudiants et à des chercheurs. Certains membres des UPR ont été recrutés dans les villages proches de Tabin.

Le Département de la Faune de Sabah a formé certains membres des UPR comme conservateurs honoraires de la faune. Le Département des Forêts a mis un de ses camps à la disposition du programme, à Dagat.

Les résultats d'une étude menée pendant deux ans dans la Réserve de Faune de Tabin, entre 2000 et 2002, montrent qu'il existe au moins 6 rhinos *connus*, 10 *probables* et 35 *possibles*. Ceci ne montre aucun accroissement significatif par rapport aux recensements antérieurs. Maintenant, une étude plus complète est menée pour réévaluer la population de rhinos. Six transects nord-sud sont préparés, et l'étude va se poursuivre jusqu'à la fin de 2006. Les traces

tify three individuals out of nine tracks in the core area.

A student study on the nutrition of the wild rhinos in Tabin is nearing completion. So far, 69 plants that rhinos eat have been identified, and their nutritional composition has been analysed.

Captive Sumatran rhinos at Sepilok

SOS Rhino continues to help the Sabah Wildlife Department monitor the health and breeding condition of two captive Sumatran rhinos: a male named Tanjung approximately 17 years old, and a female named Gelugob approximately 27 years old.

The rhinos' breeding condition was examined with periodic ultrasonography and by regular hormone analysis using blood and fecal samples. Fecal analyses for progesterone and testosterone metabolite were established using a GnRH challenge. Hormonal patterns were compared alongside regular observation of behaviour and daily temperature measurements to analyse cycling activity in the female. Although the female does not have the extreme reproductive tract pathologies characteristic of other captive Sumatran rhinos her age, hormonally and anatomically she appears to be entering reproductive senescence. Hormone and behaviour activity demonstrate irregular patterns and anatomical responses are reduced.

The male has numerous periods of erection and masturbation, which appear to correlate with the female's hormonal levels. Although his testicles have been within normal parameters, little to no sperm has been collected from him using manual massage techniques. The recent loss of eyesight in the female and the poor sight in one eye of the male will further compromise breeding between this pair. Further research and consultation regarding reproductive issues will continue to be pursued.

fraîches seront localisées et mesurées. L'analyse statistique des mesures d'empreintes servira à identifier les individus. Jusqu'à présent, cette méthode a permis d'identifier trois individus à partir de neuf traces laissées dans l'aire centrale.

Un étudiant va bientôt terminer sa recherche sur la nutrition des rhinos sauvages à Tabin. Jusqu'à présent, 69 plantes consommées par les rhinos ont été identifiées, et leur composition nutritionnelle a été analysée.

Rhinos de Sumatra en captivité à Sepilok

SOS Rhino continue à aider le Département de la Faune de Sabah à surveiller la santé et l'état reproducteur de deux rhinos de Sumatra en captivité: un mâle nommé Tajung qui a environ 17 ans et une femelle nommée Gelugob d'environ 27 ans.

Leur état reproducteur est surveillé au moyen d'examens aux ultrasons périodiques et des d'analyses régulières des hormones dans le sang et les fèces. Les analyses des fèces pour tracer les métabolites de progestérone et de testostérone ont été conçues en utilisant un challenge de la GnRH. Les schémas hormonaux ont été mis en parallèle avec les observations régulières du comportement et avec la mesure quotidienne de la température pour analyser l'activité cyclique de la femelle. Bien que la femelle ne subisse pas les pathologies extrêmes du tractus génital des autres rhinos femelles de son âge en captivité, elle semble, au point de vue hormonal et anatomique, atteindre la sénescence reproductrice. Le taux d'hormones et le comportement présentent des schémas irréguliers et les réponses anatomiques sont réduites.

Le mâle présente de nombreuses périodes d'érection et de masturbation, qui semblent liées au niveau hormonal de la femelle. Bien que ses testicules aient des paramètres normaux, on n'a pu en tirer que peu ou pas de sperme au moyen des techniques de massage manuel habituelles. La récente perte de la vision chez la femelle et la mauvaise vue d'un úil du mâle vont encore compromettre la reproduction de ce couple. Nous allons poursuivre les recherches et les consultations au sujet des problèmes de reproduction.

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 needed to produce and disseminate this journal in hard copy and free of charge to our readership. In fact, it is only because of a last-minute donation from the Messerli Foundation and a private donation from an anonymous benefactor that we have been able to complete the present issue.

Despite our greatest efforts, we have not yet managed to secure any funds for producing *Pachyderm* in 2006 or beyond. This means that we must now seriously start considering all options to make production and dissemination of this journal more sustainable in the long term, including shifting to a purely electronic format or approaching a commercial publisher. However, neither of these is clearly a completely satisfactory solution, the former especially because many of our African readers still do not have reliable Internet access. In this light, we are turning to you, the readership, for suggestions on any possible funding sources that we might be able to approach to ensure the continued production of this journal in its present form. Any ideas, suggestions or other relevant information should be sent to Leo Niskanen, Senior Programme Officer, IUCN SSC African Elephant Specialist Group, at leo.niskanen@iucn.org; tel: +254 20 387 6461; fax: +254 20 387 0385.

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, *Interim Co-chair*
IUCN/SSC Asian Rhino Specialist Group

RESEARCH

Risk of crop raiding by elephants around the Kakum Conservation Area, Ghana

Richard F.W. Barnes,[1] Emmanuel M. Hema,[2] Awo Nandjui,[3] Mildred Manford,[4] Umaru-Farouk Dubiure,[5] Emmanuel K.A. Danquah,[6] Yaw Boafo[7]

[1] Ecology, Behavior and Evolution Section, Division of Biological Sciences 0116, University of California at San Diego, La Jolla, CA 92093-0116, USA, and Environmental Sciences Research Centre, Anglia Polytechnic University, East Road, Cambridge CB1 1PT, UK; email: rfbarnes@ucsd.edu
[2] Université de Ouagadougou, Unité de Formation et de Recherche en Sciences de la Vie et de la Terre, Laboratoire de Biologie et Ecologie Animales, 03 BP 7021, Ouagadougou 03, Burkina Faso
[3] 21 BP 721, Abidjan 21, Côte d'Ivoire
[4] 2720 Foster Ave, Apt #1A, Brooklyn, NY 11210, USA
[5] Mole National Park, PO Box 8, Damongo, Ghana
[6] Department of Wildlife Management, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana
[7] Wildlife Division Biological Monitoring Unit, PO Box 47, Goaso, Ghana

Abstract

Crop raiding by elephants is becoming a serious management problem around many protected areas in West Africa as forests shrink and human populations expand. We describe a case study of the Kakum Conservation Area in Ghana's forest zone. We monitored 203 farms to explain why some suffered huge crop losses from elephants while close neighbours remained unscathed. Less than a third of the farms in the most vulnerable farmland were raided by elephants. Elephants were attracted to larger farms and those with many types of crops. Isolated farms were more vulnerable than those in clusters. A farmer could dramatically reduce risk by moving away from the park boundary, joining other farmers in a cluster, limiting farm size and growing fewer kinds of crops.

Résumé

Les dégâts causés par les éléphants aux récoltes deviennent un problème de gestion grave autour de nombreuses aires protégées en Afrique de l'Ouest, étant donné que les forêts se réduisent et que la population humaine s'accroît. Nous décrivons une étude de cas de l'Aire de Conservation de Kakum, dans la région forestière du Ghana. Nous avons suivi 203 fermes pour tenter d'expliquer pourquoi certaines subissaient de lourdes pertes à cause des éléphants alors que de proches voisins restaient indemnes. Les éléphants ne s'attaquaient qu'à moins d'un tiers de fermes dans la partie la plus vulnérable. Ils étaient attirés par les plus grandes fermes, et par celles qui avaient de nombreuses sortes de cultures. Les fermes isolées étaient plus à risques que celles qui étaient groupées. Un fermier pouvait beaucoup réduire les risques en s'éloignant des limites du parc, en se regroupant avec d'autres, en réduisant la taille de son exploitation et en faisant pousser moins de plantes différentes.

Introduction

Wherever agriculturalists and elephants (*Loxodonta* spp. and *Elephas maximus*) share the same landscape there is conflict (e.g. Lahm 1994; Barnes 1996; Naughton-Treves 1998; Hoare 1999; Mubalama 2000; Seneviratne and Rossel 2001; Sitati et al. 2003; Sukumar 2003). Many elephant ranges in the West African forest zone are now surrounded by dense cultivation (Barnes 1999). An example is the Kakum Conservation Area (KCA) in the forest zone of southern Ghana. KCA is Ghana's most successful national park in terms of visitors and public education but the adjacent farmers receive few benefits and suffer grievous losses from marauding elephants (Azika 1992; Dudley et al. 1992; Nchanji 1994; Barnes et al. 1995; Barnes et al. 2003). Elephants are seen by farmers as a major pest species, but from the national point of view they are an asset. The government of Ghana has committed itself to conserving the country's remaining elephants and to resolving the issue of human–elephant conflict (Wildlife Division 2000). Here we present a case study of the human–elephant conflict around Kakum Conservation Area. The lessons from this study will enable managers elsewhere in the West African forest zone to reduce levels of crop damage by elephants.

Crop raiding is a question of risk: what is the probability that a particular farmer will lose crops to elephants during a given growing season? Proximity to the park was clearly an important predictor (Naughton-Treves 1998), but it did not explain why the risk varied so much between farms, with some farmers suffering catastrophic losses while their neighbours escaped completely. Elsewhere it had been shown that certain crops were preferred by elephants (Naughton-Treves 1998; Chiyo et al. 2005) while larger areas of cultivation were more likely to draw elephants (Sitati et al. 2003). Nchanji (1994) suspected that clusters of farms attracted elephants at Kakum. We speculated that a greater diversity of crop types would increase vulnerability because elephants select a varied diet. We collected data from a large sample of farms to identify the farming patterns and the combinations of variables that, after accounting for distance from the park boundary, determine the risk of crop loss for individual farms.

Methods

Study area

The Kakum Conservation Area lies in the moist evergreen zone defined by Hall and Swaine (1981). Kakum and Assin Attandanso Forest Reserves were demarcated in 1925/26 and 1935/36 respectively (Kpelle 1993). They cover 366 km^2 and now form the Kakum Conservation Area, which is managed as a national park. The mean annual rainfall during the 1990s was 1223 mm with peak rainfall in May–June and October–November.

The area is a fragment of the lowland forest that formerly covered south-western Ghana. Elephants once ranged throughout this area but were gradually restricted as the intensity of human disturbance increased during the 20th century (Barnes et al. 1995). Eggert et al. (2003) estimated their numbers at 225 (95% CI from 173 to 308).

KCA is completely surrounded by a human-dominated landscape consisting of a mixture of cultivation, farmbush, patches of secondary forest, and swampland. Farmbush consists of the regrowth that follows cultivation: forb regrowth, thicket and early secondary forest (Ahn 1961). Both commercial and subsistence farming are practised. Cash crops are cocoa, oil palm, coffee, citrus and coconut (Agyare 1995). The subsistence farming system is rain-fed mixed cropping on a shifting cultivation basis, or rotational agriculture (Agyare 1995). The main food crops are cassava (*Manihot utilissima)*, maize (*Zea mays*), plantain (*Musa paradisiaca*), cocoyam (*Xanthosoma* spp.), yam (*Dioscorea* spp.), and vegetables such as okra (also known as okro) (*Abelmoschus esculentus*), tomato (*Lycopersicon esculentum*), peppers (*Capsicum* spp.), beans, eggplant (garden egg, aubergine) (*Solanum melongena*) and watermelon (*Citrullus lanatus*). Rice (*Oryza sativa*) is grown only around the north-east.

A farmer might have several farms in different places or separated by patches of farmbush. Many farms are several kilometres from the farmer's house. The median farm size was 0.3 hectares in 2001 and 2002, and subsistence cultivation covered less than 10% of the land adjacent to the park.

Data collection and analysis

The time required to walk to each farm precluded a large random sample of farms. Instead, 10 study sites were randomly distributed around the KCA periphery

(fig. 1); each site was 1 km^2. Each farm on the site was identified, and a local villager was employed to work part-time as a monitor on each site. The monitors were trained to record all incursions by elephants into the site and record which farms were affected. Each incursion onto a farm, whether damage was caused by trampling as the elephant passed across the farm or by feeding, was recorded as one incident. The work of the farm monitors was checked at random intervals.

Data on crop-raiding incidents were collected from August 2000 to September 2002. Here we summarize the numbers of raided farms in both 2001 and 2002 and analyse in detail the data collected from the 2001 crop-growing season (April to August). We describe the number of crop damage incidents only; the damage caused per raid will be discussed in a separate paper.

Survey teams mapped each farm during the growing season. Most farms were mixed, that is, the different crop types were intermingled. The abundance of each crop staple (maize, cassava, cocoyam and rice) was estimated with random quadrats, and the percentage area of that crop was multiplied by the area of the farm to give the effective area (in square metres) covered by that crop. The data for field sizes and coverage of staple crops were normalized by square root transformations.

The number of raids recorded in each farm was typical count data: raids were not normally distributed and the data consisted of integers, positive numbers, and many zeroes. Therefore log-linear models with Poisson errors were fitted by maximum likelihood (McCullagh and Nelder 1989; Crawley 1994) to express the number of raids as a function of farming variables. The models had the form:

$Y = \exp[\, a + b.x \,]$

$Y = \exp[\, a + b_1.x_1 \ldots + b_n x_n \,]$

for one or n independent variables respectively, where Y was the number of raids during the growing season and x or x_i were independent variables. The significance of each variable was evaluated by comparing the change in deviance with χ^2 when that variable was added to the model (Crawley 1994). The exponent of the regression coefficient (i.e. e^b) measures the change in risk for an additional unit of the independent variable. Thus if the independent variable increases by z units, risk will change by $(e^b)^z$ (Selvin 2004).

For a few farms data were missing for some variables, thus reducing the sample size for analyses that included those variables.

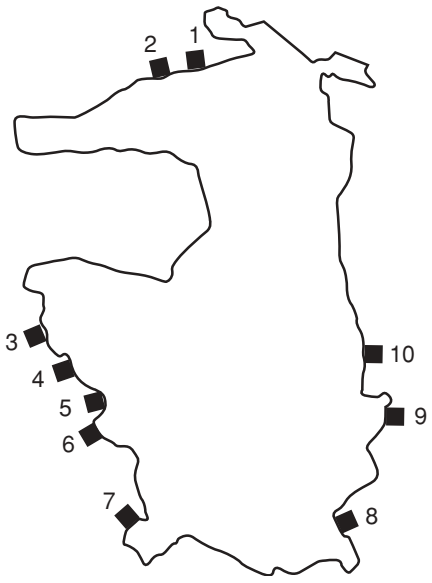


Figure 1. Outline map of the Kakum Conservation Area showing the location of the 10 study sites.

Results

Number of raided farms

In 2001 we monitored 213 farms in the 10 study sites for the whole year. Of these, 55 farms (26%) suffered one or more crop-raiding incidents by elephants, and 120 incidents were recorded. In the following year we monitored 179 farms in the same 10 study sites until the end of September. Again, 55 farms (31%) suffered one or more incidents, and 92 incidents were recorded. There was no difference between years in the frequency distribution of incidents (*G*-test comparing frequencies of 0,1,2,3 and > 3 raids, $G = 4.84$, $df = 4$, NS), and the combined data are shown in table 1. In both years most affected farms suffered only one or two incidents. One farm suffered 12 incidents during the course of 2001, 5 of which occurred during the growing season.

Incidents in the 2001 growing season

The most important single predictors of incidents in the 2001 growing season were farm size, distance to the park boundary, and number of food crops (table 2). Isolated farms—those far from the nearest neighbour—were at significantly greater risk of being raided (table 2). The number of incidents experienced by a neighbouring farm had no effect upon risk.

Table 1. Frequency distribution of crop-raiding incidents on farms, 2001 and 2002

No. of incidents	Frequency (no. farms) 2001	Frequency (no. farms) 2002	Combined frequency
0	158	122	280
1	31	34	65
2	11	16	27
3	4	3	7
4	1	3	4
5	4	0	4
6	2	0	2
7	1	1	2
8	0	0	0
9	0	0	0
10	0	0	0
11	0	0	0
12	1	0	1
13	0	0	0
14	0	0	0
Total	213	179	392

Table 2. The effect of farming variables on the number of raids in the 2001 growing season. The second column shows the reduction in deviance in number of raids when each variable was added alone to the null log-linear model (n = 203 farms). The residual deviance of the null model was 241.49. For plantain and the crops listed following it, the variables were entered as indicator variables (i.e. present/absent)

Variable added to null model	Change in deviance	Regression coefficient b	e^b	p
√Farm size	36.11	0.020	1.020	<0.001
Distance to park boundary*	35.51	–0.003	0.997	<0.001
Number of food crops	32.10	0.508	1.661	<0.001
Distance to nearest farm*	14.20	0.007	1.007	<0.001
Raids on nearest farm*	1.05	0.182	1.200	NS
√Maize	30.65	0.020	1.020	<0.001
√Cassava	20.83	0.022	1.022	<0.001
√Cocoyam	3.85	0.014	1.014	<0.05
√Rice	0.08	–0.004	0.996	NS
Plantain	9.28	0.811	2.250	<0.01
Watermelon	5.70	1.104	3.016	<0.05
Okra (okro)	4.22	0.870	2.387	<0.05
Tomato	3.90	0.687	1.988	<0.05
Pepper	3.52	0.677	1.968	<0.10
Beans	3.44	0.991	2.694	<0.10
Yam (all varieties)	2.01	0.580	1.786	NS
Eggplant (garden egg)	1.69	0.748	2.113	NS

* n = 198
NS – not significant

Maize was the crop that had the greatest attraction for elephants (table 2); next were cassava and plantain. Watermelon, okra, tomato and cocoyam were significant at $p < 0.05$. Pepper and beans exerted a weak effect ($p < 0.10$).

A multivariate model was built by adding variables one at a time and retaining those that gave a significant reduction in deviance at each stage. This gave a model where farm size, distance to the boundary, and number of crops were the major predictors of the number of incidents (table 3a). Each of the independent variables was significant at $p < 0.001$. Once one had accounted for the number of crops, each of the smaller crops (plantain, watermelon, okra, etc.) made no significant contribution to the model. In other words, it is the diversity of crops, not the particular small crop, that attracts elephants.

Risk could also be expressed in terms of proximity to the park and each of the major crops: maize, cassava or cocoyam (table 3b). In each case the independent variables were significant at $p < 0.001$, except for $\sqrt{CO}$ ($p < 0.05$). A similar model with rice returned a coefficient for $\sqrt{RI}$ that was not significant.

Models with greater predictive power for each crop included the number of crops (N) (table 3c). In each case the independent variables were significant at $p < 0.001$, except for $\sqrt{CA}$ ($p < 0.01$) and $\sqrt{CO}$ ($p < 0.20$).

The risk of crop raiding decreased with increasing distance from the park boundary. A farmer adjacent to the boundary could reduce risk by 75% simply by reducing the number of crops on the farm from six to two (fig. 2). The farmer could reduce risk even further by planting two crops and moving 1 km away.

Discussion

General

Farmers living around protected areas frequently suffer depredations from a variety of animals that may cause more damage than

Table 3. The models that best describe the relationship between the number of crop-raiding incidents and farming variables. In these equations, S is farm size (m²), x_b the distance to the boundary (m), N the number of crops, MA maize (m²), CA cassava (m²), and CO cocoyam (m²)

a) Number of incidents per month, Y, as a function of farming variables:
$Y = \exp[-2.32 + 0.015\sqrt{S} - 0.0025x_b + 0.32N]$
$(\chi^2 = 77.82, df = 3, p < 0.001)$

b) Number of incidents per month, Y, as a function of proximity to the park and each of the major crops:
$Y = \exp -0.66 - 0.0028x_b + 0.016\sqrt{MA}]$
$(\chi^2 = 58.17, df = 2, p < 0.001)$
$Y = \exp[-0.82 - 0.0030x_b + 0.019\sqrt{CA}]$
$(\chi^2 = 52.36, df = 2, p < 0.001)$
$Y = \exp[0.029 - 0.0033x_b + 0.016\sqrt{CO}]$
$(\chi^2 = 40.64, df = 2, p < 0.001)$

c) Number of incidents per month, Y, in 2001 as a function of the number of crops and each of the major crops:
$Y = \exp[-1.87 - 0.0025x_b + 0.015\sqrt{MA} + 0.34N]$
$(\chi^2 = 72.99, df = 3, p < 0.001)$
$Y = \exp[-1.95 - 0.0026x_b + 0.015\sqrt{CA} + 0.36N]$
$(\chi^2 = 67.15, df = 3, p < 0.001)$
$Y = \exp[-1.40 - 0.003x_b + 0.0097\sqrt{CO} + 0.41N]$
$(\chi^2 = 61.30, df = 3, p < 0.001)$

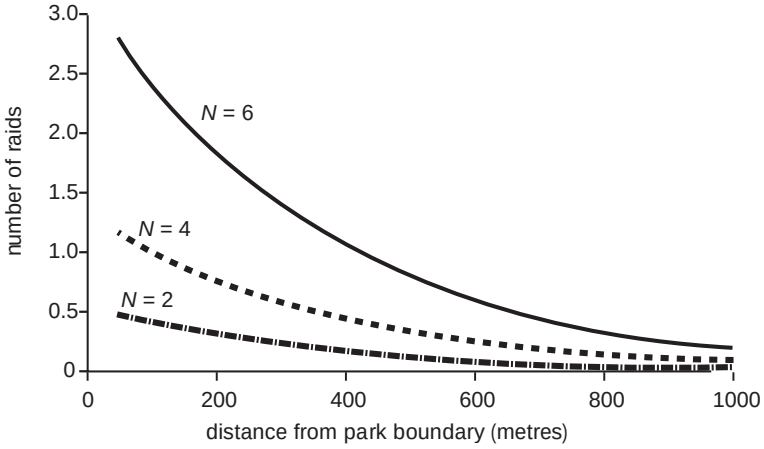


Figure 2. The risk of raiding in relation to proximity to the park and number of crops (N) during the 2001 growing season, estimated from $Y = \exp[-1.45 - 0.0028x_b + 0.44N]$, $(\chi^2 = 59.51, df = 2, p < 0.001)$

elephants (Dudley et al. 1992; Lahm 1994; Naughton-Treves 1998). But around KCA it was elephants that stirred passions, and their raiding became a sensitive political issue. Nevertheless, the situation may have been exacerbated by exaggerated reports of crop damage that gave local politicians the impression that the situation was much worse than it really was. Our data show that two-thirds of the farms in the most vulnerable farmland—within 1 km of the park boundary—were not damaged at all in the 2001 and 2002 growing seasons. Nevertheless, they were at risk, and one cannot quantify farmers' dread that they might awake one morning to find their fields devastated (Sam et al. 1997).

Raiding and the farming landscape

Four farming variables had a major influence upon a farm's risk of suffering raids by elephants: distance to boundary, area under cultivation, number of crops planted on the farm, and degree of the farm's isolation. Farms adjacent to the park boundary were obviously most at risk, reflecting the common problem of human–wildlife conflict on the boundaries of protected areas in Ghana and elsewhere (Naughton-Treves 1997, 1998; Seneviratne and Rossel 2001; Adjewodah et al. 2005; Sam et al. 2005). The important point is the rate of change in risk with distance from the boundary. In fact, a farmer could dramatically reduce losses by moving just a short distance from the boundary (fig. 2).

Sitati et al. (2003) and Sam et al. (2005) found that area under cultivation was a significant predictor of crop-raiding intensity, and our data showed that larger farms were indeed more attractive to elephants.

The third important variable influencing risk was the number of food crops grown on the farm (table 2 and fig. 2): six crops instead of two greatly increased the probability of a raid by elephants. Sam et al. (2005) showed that farms around Bia National Park, also in southern Ghana, suffered more raids

when they planted four or five crops instead of two or three. Elephants have evolved as catholic feeders (Sukumar 2003), and so they are more likely to be attracted to fields with a diversity of crops.

In contrast to Nchanji's (1994) prediction, isolated farms were more vulnerable than those in clusters. There is probably more human activity around clusters of farms where farmers can share the burden of guarding, while isolated ones are more likely to be left unwatched for long periods.

Maize was the crop bringing the greatest risk for farmers; next were cassava and plantain (table 2). This is similar to the pattern that Sam et al. (2005) recorded at Bia. Banana was elephants' preferred crop around Kibale National Park in Uganda (Naughton-Treves 1998) but maize suffered the greatest percentage of damage (Chiyo et al. 2005). Across Gabon banana was the most frequently damaged crop: elephants were attracted first to the bananas and afterwards they turned to other crops (Lahm 1994).

Most of the farmers around KCA believed that pepper was a deterrent because elephants did not eat it. However, pepper was associated with greater risk (table 2). This is probably because most of the farmers that grew pepper also cultivated a mixture of other vegetables such as tomatoes and okra, and it was the diversity of crops that attracted the elephants.

Each of the variables in table 2 influenced risk, but it is the combination that is important. This explains why farms in the same area can differ greatly in the losses they suffer. A small farm with two crops is less likely to attract elephants than a large one with six crops, especially if one of those is maize. At a given distance from the park boundary a farmer can cut risk significantly by growing fewer crops, limiting farm size, reducing the amount of maize, and joining with other farmers in a cluster. A modest farm will produce a smaller harvest, but that will be balanced by the reduced risk of loss.

Crop raiding by elephants is a growing problem across West Africa as forests shrink in the face of expanding human pressure. Between 2000 and 2005 the rural population of the West African countries between Guinea-Bissau and Benin (i.e. those with forest, excluding Nigeria) increased by 2.7 million, and they are predicted to grow by a further 2.3 million during the next five years (United Nations 2004). Crop raiding is a problem that will get worse across the region unless it is addressed now. In the long term, the problem must be addressed by land-use planning around protected areas (Barnes 2002; Boafo et al. 2004; Chiyo et al. 2005). But that will take time, and meanwhile something must be done to reduce immediately the suffering of farming communities. This case study emphasizes that there is much that wildlife managers can do outside protected areas to reduce the risk to farmers. The variables that influenced elephant behaviour at Kakum are unlikely to be site specific but will apply elsewhere in the forest zone. As a first step, park managers should persuade farmers to adopt the practices described above to reduce the risk of attracting elephants. Nevertheless there will always be some elephants that wander into the farmland, and then managers should repel them with the methods of Osborn and Parker (2002).

Acknowledgements

This study formed part of the training programme for the Elephant Biology and Management Project organized by Conservation International and the Ghana Wildlife Division. Funding came from Conservation International, the Center for Applied Biodiversity Science, the United States Fish and Wildlife Service (African Elephant Conservation Fund), the Smart Family Foundation and the Betlach Family Foundation. Brent Bailey inspired us throughout. We thank the staff in the Conservation International–Ghana office for administrative support. We thank the Wildlife Division staff at Kakum: Cletus Nateg, Moses Sam, Joseph Bilinla, Dan Ewur and Sylvester Azika. John Nyame, Michael Oppong, Isaac Owusu and the KCA park guards who accompanied us in the field. We thank the farm monitors: Emmanuel Abban, Christopher Appiah, John Arhin, Clifford Asare, Abdallah Abubakar Bentil, Alex Hammond, Paschal Hussah, Joseph Obeng, John Kojo Onoma, Samuel Quainoo. The assistant farm monitors were Bismark Amoah, Richard Larbi, Daniel Arthur and Frank Osei Attomoh. Our drivers were Johnson Kemeh and Baba Usman. Sally Lahm and three anonymous reviewers criticized the manuscript.

References

Adjewodah P, Beier P, Sam MK, Mason JJ. 2005. Elephant crop damage in the Red Volta Valley, north-eastern Ghana. *Pachyderm* 38:39–48.

Agyare A. 1995. The socio-economic perspective of Kakum National Park. Accra, Ghana: Forest Resource Management Programme, GWD/IUCN Project 9786, Wildlife Division. Unpublished report.

Ahn PM. 1961. Soils of the lower Tano basin, south-western Ghana. Soil and Land-Use Survey Branch Memoir No. 2, Ministry of Food and Agriculture, Kumasi, Ghana. Unpublished report.

Azika S. 1992. A study of the extent of crops destruction in farms surrounding the Kakum Nature Park and Assin Attandanso Game Production Reserve by forest elephants. Department of Game and Wildlife, Accra. Unpublished report.

Barnes RFW. 1996. The conflict between humans and elephants in the central African forests. *Mammal Review* 26:67–80.

Barnes RFW. 1999. Is there a future for elephants in West Africa? *Mammal Review* 29:175–199.

Barnes RFW. 2002. Treating crop-raiding elephants with aspirin. *Pachyderm* 33:96–99.

Barnes RFW, Azika S, Asamoah-Boateng B. 1995. Timber, cocoa, and crop-raiding elephants: a preliminary study from southern Ghana. *Pachyderm* 19:33–38.

Barnes RFW, Boafo Y, Nandjui A, Farouk UD, Hema EM, Danquah E, Manford M. 2003. An overview of crop raiding by elephants around the Kakum Conservation Area. Part 2: Technical report. Elephant Biology and Management Project, Africa Program, Conservation International, Washington, DC. Unpublished report.

Boafo Y, Dubiure U-F, Danquah EKA, Manford M, Nandjui A, Hema EM, Barnes RFW, Bailey B. 2004. Long-term management of crop raiding by elephants around Kakum Conservation Area in southern Ghana. *Pachyderm* 37:68–72.

Crawley MJ. 1994. *GLIM for ecologists*. Blackwell Scientific Publications, Oxford.

Chiyo PI, Cochrane EP, Naughton L, Basuta GI. 2005. Temporal patterns of crop raiding by elephants: a response to changes in forage quality or crop availability? *African Journal of Ecology* 43:48–55.

Dudley JP, Mensah-Ntiamoah AY, Kpelle DG. 1992. Forest elephants in a rainforest fragment: preliminary findings from a wildlife conservation project in southern Ghana. *African Journal of Ecology* 30:116–126.

Eggert LS, Eggert JA, Woodruff DS. 2003. Estimating population sizes for elusive animals: the forest elephants of Kakum National Park, Ghana. *Molecular Ecology* 12:1389–1402.

Hall JB, Swaine MD. 1981. *Distribution and ecology of vascular plants in a tropical rain forest: forest vegetation in Ghana*. Junk, The Hague, Netherlands.

Hoare RE. 1999. Determinants of human–elephant conflict in a land-use mosaic. *Journal of Applied Ecology* 36:689–700.

Kpelle DG. 1993. Evaluation of past management and resource use of Kakum and Assin Attandanso Forest Reserves. Tourism Development Scheme for the Central Region, CEDECOM, Cape Coast. Unpublished.

Lahm SA. 1994. *The impact of elephants on agriculture in Gabon*. African Elephant Conservation Programme, Final Report, vol. 4. Environment and Development Group, Oxford.

McCullagh P, Nelder JA. 1989. *Generalized linear models*, 2nd ed. Chapman and Hall, London.

Mubalama LK. 2000. An assessment of crop damage by large mammals in the Okapi Wildlife Reserve, with special emphasis on African forest elephant (*Loxodonta africana*), Ituri Forest, Democratic Republic of Congo. *Nature et Faune* 16(2):3–18.

Naughton-Treves L. 1997. Farming the forest edge: vulnerable places and people around Kibale National Park, Uganda. *Geographical Review* 87:27–46.

Naughton-Treves L. 1998. Predicting patterns of crop damage by wildlife around Kibale National Park, Uganda. *Conservation Biology* 12:156–168.

Nchanji AC. 1994. Preliminary survey of the forest elephant (*Loxodonta africana cyclotis*) crop damage situation around Kakum National Park. Conservation International, Cape Coast, Ghana.

Osborn FV, Parker GE. 2002. Community-based methods to reduce crop loss to elephants: experiments in the communal lands of Zimbabwe. *Pachyderm* 33:32–38.

Sam MK, Danquah E, Oppong SK, Ashie EA. 2005. Nature and extent of human–elephant conflict in Bia Conservation Area, Ghana. *Pachyderm* 38:49–58.

Sam MK, Haizel C, Barnes RFW. 1997. Crop-raiding by elephants during the 1997 harvest season in the Red Volta valley (Upper East Region, Ghana). Wildlife Department, Accra.

Selvin S. 2004. *Statistical analysis of epidemiological data*, 3rd ed. Oxford University Press, New York.

Seneviratne L, Rossel G. 2001. Living next door to a national park. *Sri Lanka Nature* 3(2):1–10.

Sitati NW, Walpole MJ, Smith RJ, Leader-Williams N. 2003. Predicting spatial aspects of human–elephant conflict. *Journal of Applied Ecology* 40:667–677.

Sukumar R. 2003. *Living elephants: evolutionary ecology, behaviour, and conservation*. Oxford University Press, Oxford.

United Nations. 2004. *World population prospects: the 2004 revision*. United Nations, New York.

Wildlife Division. 2000. *Strategy for the conservation of elephants in Ghana*. Wildlife Division, Forestry Commission, Accra, Ghana.

Can bees deter elephants from raiding crops? An experiment in the communal lands of Zimbabwe

Malvern Karidozo and Ferrel V. Osborn

Stand number 17907 Unit 'M', Seke South, Chitungwiza, Zimbabwe
email: mazdzambo@yahoo.co.uk

Abstract

Mitigating human–elephant conflict has arguably taken centre stage in elephant conservation concerns across the range states of Africa and Asia. Farmers in settlements that abut elephant range need sustainable ways of keeping elephants and other crop pests out of their fields. Here we examine the use of the African honeybee (*Apis mellifera scutellata*) as a possible means to deter the African elephant (*Loxodonta africana*) from raiding crops. We tested whether mounting beehives strategically around crop fields would deter elephants from crop raiding. No deterrent effect was detected, but the tests were small in scale, and further tests are needed to better assess the hypothesis that bees can be used to discourage elephants from raiding crops. Although not tested here, beehives might prove a useful livelihood addition if honey can be successfully harvested and marketed. We suggest that bees alone will not stop elephants from raiding crops, but if combined with a suite of 'low tech' methods and practically linked with the economic potential of honey production, bees can be another tool for rural farmers to use to improve their livelihoods and aid in conserving elephants.

Additional key words: human–elephant conflict, problem animal control, African honeybee

Résumé

On pourrait dire que la mitigation des conflits hommes-éléphants est au centre des préoccupations de la conservation dans tous les Etats de l'aire de répartition, tant en Afrique qu'en Asie. Les fermiers voisins de l'aire de répartition des éléphants ont besoin de moyens soutenables pour maintenir les éléphants et les autres animaux nuisibles pour les récoltes en dehors de leurs champs. Ici, nous examinons l'utilisation de l'abeille africaine (*Apis mellifera scutellata*) comme moyen éventuel de dissuasion contre les éléphants africains (*Loxodonta africana*). Nous avons testé le fait de placer des ruches à des endroits stratégiques autour des champs pour voir si cela dissuaderait les éléphants. Nous n'avons décelé aucun effet dissuasif, mais les tests se faisaient à petite échelle et il faudrait en faire d'autres pour mieux tester l'hypothèse selon laquelle on pourrait se servir d'abeilles pour décourager les éléphants de s'attaquer aux récoltes. Bien qu'on ne l'ait pas testé dans ce cas, les ruches pourraient s'avérer un moyen de subsistance très utile si le miel peut être récolté et vendu. Nous suggérons que les abeilles seules ne vont pas empêcher les éléphants de détruire les récoltes, mais que si on les combine à d'autres méthodes « *low tech* », et qu'on tient compte du potentiel économique de la production de miel, les abeilles peuvent être un autre moyen pour les fermiers d'améliorer leur quotidien et d'aider à la conservation des éléphants.

Mots clés supplémentaires : conflit homme–éléphant, control des animaux nuisibles, l'abeille africaine

Introduction

If human–elephant coexistence is to be a realistic long-term goal, then conflict must be addressed. Community-based crop protection programmes are becoming more widespread and recent research has suggested that the bee might be an answer to the persistent human–elephant conflicts as wildlife personnel seek non-lethal methods to mitigate this problem. In Kenya, Vollrath and Douglas-Hamilton (2002) observed that elephants did not feed on trees with hives, and trees prone to elephant damage experienced no

further damage when beehives were placed in them. They suggested that hives situated around fields might help keep elephants from raiding crops and that beekeeping could also be a source of income for people living in elephant range. We set out over the past two years to explore this hypothesis in the Zambezi Valley of Zimbabwe.

People and bees have a long and mutually beneficial history. In almost every community and country, bees are kept for the honey and wax that they produce, and for the crops that they pollinate. Human use of honeybees in fighting perceived or actual foes has a long history. Bérubé (2002) stated: 'It would probably be easier to enumerate the cultures which do not chronicle some kind of use of bees as weapons since this motif is so pervasive and most of these accounts are historical rather than mythical.' Some of the earliest battles were fought with honeybees being the chief agents of victory. In the 11th century, Irnmo, general of Emperor Henry I of England, threw beehives from cliffs onto the attacking troops of Geiselbert, Duke of Lorraine. The citizens of Gussing, Hungary, used the same technique in 1289 against the troops of Albert, Duke of Austria (Bromenshenk 2004). In several instances bees have been used in the more obvious way, as 'meat-seeking missiles'. The Romans, for instance, simply sent beehives catapulting into the ranks or fortifications of their enemies. Aouade (1979) described how the Tiv people of Nigeria kept bees in special horns that contained powdered poisons. Thus dusted to increase the efficacy of their own venom, the bees would be released in the heat of battle to attack Tiv enemies. This concept is also believed to have been used by the Sunde and the Varenje people of Lower Guruve in northern Zimbabwe in ancient times.

Beekeeping has had a more dubious history during the past few decades as a tool for rural people to develop economically. The honey business is competitive and the product is difficult to produce in quality and quantity high enough to be marketed sustainably. Much money, training and hives have been invested by well-intentioned donors, and the people in our study area had been part of two previously failed beekeeping projects.

Study area

Lower Guruve District encompasses an area of 2700 km^2 in the mid Zambezi Valley, northern Zimbabwe (Cumming and Lynam 1997) (fig. 1). The Zambezi Valley lies about 350–500 m above sea level and experiences low annual rainfall (650–850 mm per year), falling mainly between December and mid-March (Cumming and Lynam 1997). There are three seasons: a hot, dry season from August to October (mean daytime temperature > 35ºC); a rainy season from November to March; and a cool, dry season from April to July (mean daytime temperature 24–28ºC). The dominant vegetation consists of *Colophospermum mopane* and *Terminalia* woodland and mopane–combretum woodland, with dense riverine thickets of mixed species along the major rivers. Agriculture is practised mainly in bands of colluvial soil along the Zambezi escarpment and in alluvial soils bordering the major rivers (Cunliffe 1992). Most farming is

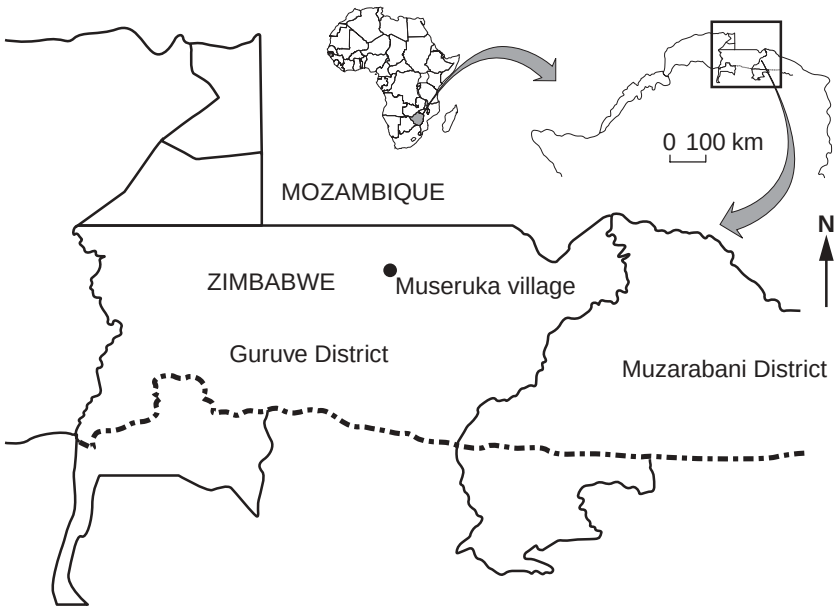


Figure 1. The study area, its location in northern Zimbabwe, and the approximate position of Museruka village in Guruve District.

small-scale dryland cultivation, and the main wet-season crops are maize (*Zea mays*), sorghum (*Sorghum vulgare*), and cotton (*Gossypium hirsutum*), all of which elephants and other wildlife predate (Cunliffe 1992).

Materials and methods

Measuring the effect of a potential deterrent on a wild elephant is difficult, and measuring the subtle deterrent properties of bees on elephants is not an exact science. Away from fields and also on paths that elephants were known to use, we set up control plots with different crops. We also situated hives at the edges of fields and in gardens at water points. This shotgun approach gave us coverage of different situations where people would tolerate the bees but the bees could deter the elephants.

We tested the effectiveness of beehives in deterring elephants from selected areas in three different ways, by mounting beehives, both empty and fully colonized by honeybees, 1) around test crop fields of cotton, sorghum and maize; 2) along selected paths in well-known elephant refuges, and 3) in trees surrounding entrances to natural water points that elephants were known to frequent in trials carried out in 2004 and 2005.

In the first test, trial plots were established at the onset of the wet season to coincide with the growing cycle of field crops. In virgin bushland away from human influence, we planted eight plots with maize, sorghum and cotton, the latter two being the most common crops in the area, to test whether placing beehives would deter elephants from visiting and raiding such crop types. Each plot was 10 m x 10 m and contained 35 seedlings of each crop. Four of the plots were left without beehives as controls. Both the test plots and their controls were sited at least 200 m from the edge of the community fields near Museruka village, Lower Guruve District. This distance was considered far enough for humans to have no observable influence over whether elephants would visit these fields.

Plots were arranged alternately in a randomized block design so that each plot had an equal probability of elephants visiting it. We mounted 12 hives (6

EPDT file photo

Fully colonized log-type beehive placed near a waterhole.

full and 6 empty) on poles 3 m long and 20 m equidistant from each other at an average height of 2 m—'a favourite elephant feeding height' (Vollrath and Douglas-Hamilton 2002)—around the test plots along elephant routes into the area identified as those most frequented. The hives used in this experiment were either the traditional log type, hollow *Colophospermum mopane* logs a half metre long and with a diameter of approximately 30–40 cm, or the manufactured Kenyan topbar hive, about a metre long. The hives were hung on the poles by two wires, baling twine or tree bark and were left swinging lightly in the breeze.

The plots were visited five times a week for six months, and crop raids by elephants were monitored over the same period. On every visit the number of intact plants was counted. If the count was different from the previous day, the dead plants were found and the reason for death determined from footprints and plant remains. If the death was not related to elephants, it was entered as 'other cause'. If the reason for death could not be ascertained, it was entered as 'unknown'.

Each enumerator was equipped with binoculars and a stopwatch to note movements and reactions of elephants (if any) upon encountering the hives. An 'incident' was defined as an occasion when elephants caused damage to the test crops, but we made a distinction between a 'raid' and a 'visit' by elephants to a field. A raid was an incident in which elephants destroyed crops by either consuming or trampling them. A visit was an incident in which elephants attempted to enter fields but moved away before causing damage. We collected crop damage reports in the control plots and compared it with the damage experienced in the test plots.

The severity of an incident was measured using two indicators: the area percentage of the field that was damaged, which was measured by pacing, and the type of damage to the crops, which was assessed visually. Crop damage was assessed in three general categories: low, medium and high. The seriousness of each damage incident was assessed by scoring the age and quality of the crop and the amount of damage reported on each incident. For example, damage to 10 seedlings would score medium where damage to 10 mature plants would be classed as high.

Occasionally it was necessary to provide supplementary watering and fertilizer to the plots, and each was weeded twice per month to remove any competing grasses and weeds. At the end of May the plots were discarded as this date coincided with the end of the wet-season peak of crop raiding and with the harvesting of most of the rain-fed crops.

We placed a further 12 hives around well-known elephant refuge areas, along selected paths crop-raiding elephants were known to use. Another 12 beehives were placed in trees of different species around three entrance points leading to waterholes that were identified as those the elephants of this area favoured. These hives were spaced at an average distance of 5 m ($\pm$ 2) apart and at a height of 2 m. In both tests we primed half of the hives with honey molasses, beeswax and propolis, leaving the remaining half unprimed, to test whether the mere presence of a beehive would deter elephants. By the end of the trial, honeybees had fully colonized all the primed hives but had left the unprimed ones unoccupied.

Results

We tested the effectiveness of bees in deterring elephants by comparing the mean severity of elephant crop damage in the test plots where we placed beehives with the control plots without beehives. At the end of the crop-raiding season, 58 incidents of crop damage had been recorded in both test and control plots. Of these incidents, 79% were identified to have been caused by individual bulls or in groups, with approximately 14% attributed to cows and 7% to mixed herds (fig. 2). Approximately 59% of the damage occurred when the crops were at their intermediate stage of growth and the remaining 41% when they had matured. No damage was recorded at the seedling stage. The maize crop proved to be highly susceptible to elephant damage as reflected by the number of damage incidents experienced by the crop: 19 in test plots and 23 in unprotected plots; next was sorghum with 18 incidents in test plots and 20 in unprotected; and finally cotton, which had damage incidents of 13 in test and 12 in unprotected (fig. 3).

In the test plots most of the damage (62%) was of medium severity, 10% low, and 28% high. Similarly, damage incidents in the control plots occurred more often in the medium severity category (59%), no incidents denoting low damage severity were noted, and 41% of the damage was classified as high (fig. 4).

This difference in damage between the two treatments was tested for significance using Student's two-tailed *t*-test and was found to be insignificant (t = 0.391; p = 0.05; df = 56), indicating that the presence

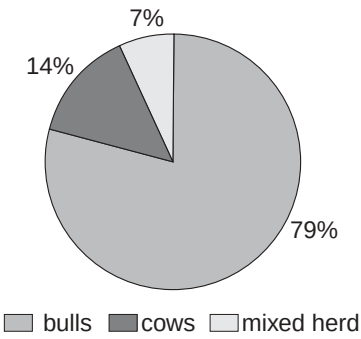


Figure 2. Sex of elephants visiting plots.

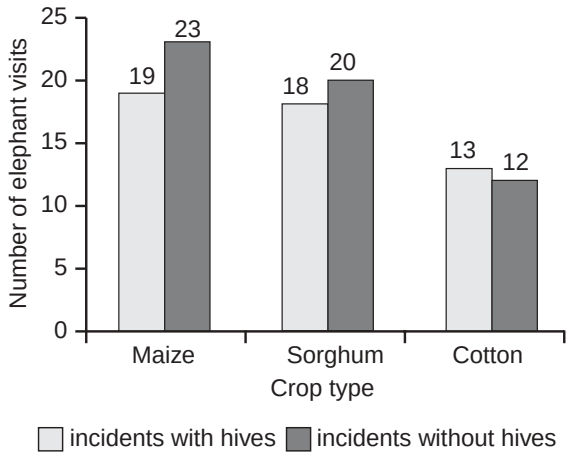


Figure 3. Frequency of elephant visits to test and control plots.

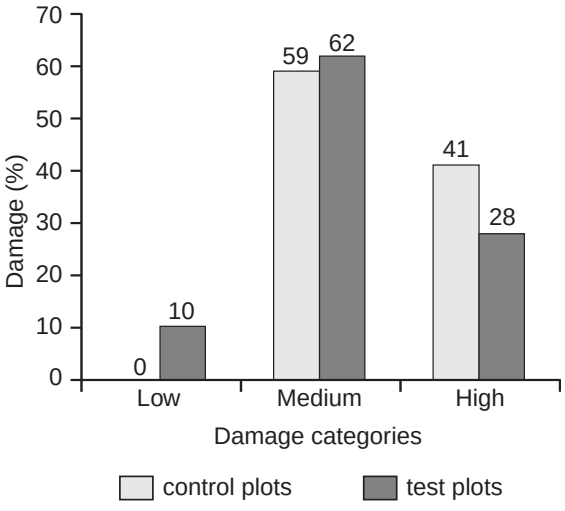


Figure 4. Level of crop damage in both test and control plots.

of beehives, with or without honeybees, did not provide the treatment plots with significant protection.

Elephants destroyed 2 uncolonized hives of the 12 hives mounted around the entire test plots; thus approximately 83% of the hives survived elephant harm. Elephants generally avoided entrance points into the plots with 'live' hives. This was clearly depicted by elephants not only continuously using the control points but also opening up three new points away from the hives that led into the hive-protected plots. They opened no new points of entry in the control plots and the regular routes showed signs of continuous and consistent use.

Interestingly, the same trends were noted in the other two tests, which involved placing hives on paths along elephant refuge areas and on paths around natural water points that elephants regularly visited and used. In the former, two days after mounting the hives the elephants started moving away from their refuge into deep and thick forests. By the time six of the hives had been fully occupied, the elephants had abandoned the area. They had not tampered with the trees with fully occupied hives, although a bull elephant had felled a tree that had a hive without bees. Beehives were then moved into the areas newly settled by the elephants with similar occurrences of the elephants retreating.

In the waterhole test, we noted that at the peak of the rainy season elephants preferred using the control watering hole. When the waters of the control waterhole began to recede rapidly, the elephants increased their use of the test water source. When honeybees fully occupied the primed hives, the elephants opened up two new entrance points around that water point, clearly showing that the elephants avoided the live hives. It is important to note, however, that we never actually observed an elephant avoiding beehives.

Discussion

In Lower Guruve District, rapidly expanding agricultural activities and an increasing and mobile population of elephants are the perfect conditions for human–elephant conflict to occur. From the crop damage data it appears bulls were responsible for nearly all of the recorded damage and that beehives, either colonized or uncolonized, did not provide much protection to the crops.

Villagers in the study village gave an account of how a common waterbuck cow (*Kobus ellipsiprymnus*)

and her calf were stung to death by a rare combination of enraged swarms of wasps and bees from the test hives around one watering hole, and they hoped that if their crop fields were filled with colonized beehives elephants with crop-raiding proclivities could meet the same fate, as 'honeybees can and will sting elephants with considerable effect' (Vollrath and Douglas-Hamilton 2002).

Using honeybees to deter elephants from raiding crops is fraught with many challenges. It is appreciated that guarding one's crop fields from marauding elephants at night is no mean task. But it is important to note that from either a technical or a practical perspective, being able to use bees on a large scale is questionable. It is not clear how many beehives would be required to protect lengthy crop boundaries spanning hundreds of hectares, and moving fully occupied beehives from one spot to another to follow elephants' movements is not only hard, tedious work but also dangerous, as one risks getting severely stung.

Crop raiding was nocturnal, the time when bee activity is at its lowest but wild elephants with crop-raiding proclivities are at their most alert state. Moreover, bees do not fly during heavy rain or wind, or when temperatures drop to near or below freezing (Bromenshenk 2004). Also the practicability of the idea from a social point of view in a human settlement, as compared with a protected area where few people are found, is also a major consideration because of the risk that the particularly aggressive African honeybee poses.

While every effort was made to position the test plots far from the villages, where human influence or disturbance was minimal, working in the fields proved difficult, particularly when the bees were disturbed. In one incident two goats were stung to death after knocking down a colonized hive, and people could not work in nearby fields as the enraged bees sought any exposed body on which to vent their anger. The issue of compensation on the affected families in such cases would also be raised, with questions as to who should be responsible for compensating the affected party in the event of an attack on humans, particularly if life were to be lost.

However, we noted that none of the trees in which hives were mounted and fully occupied experienced any form of damage or disturbance. We further noted that elephants frequenting the plots had opened up new entrance points, apparently to avoid the paths with hives. Here we believe that smell or sight might have been a contributing factor causing them to change their movement pattern, as 'smell is crucial for elephant social and foraging decisions'. (Marschner 1970 cited in Vollrath and Douglas-Hamilton 2002).

Elephants are known to follow well-defined paths consistently, and we believe the presence of the hives and bees likely contributed to the elephants changing their points of entry in the test plots. This assumption is supported by the fact that in the control plots no new entrance points were created. If we can assume that smell had an effect in causing the elephants to change their movement pattern, it is important to note that in this study we dealt with wild elephants with a history of being harassed by humans who defend their crops and who engage in isolated poaching activities. Thus, such elephants are wary of humans, and with their acute sense of smell they might have detected and associated the human scent on the hive test trees with the crop protection and poaching incidents they may have experienced in the past.

Unfortunately, at the time of publication we had yet to harvest the first crop of honey so we were unable to assess the practicalities of honey production and sales. This would be extremely important if beekeeping were to be integrated into the livelihood strategies of people living in elephant range.

We support the continued examination of the use of honeybees proposed by Vollrath and Douglas-Hamilton (2002) as a potential tool, if combined with other locally available mitigation methods, to improve the livelihood of farmers losing crops to elephants.

Acknowledgements

We would like to thank the Lower Guruve Rural District Council for permission to conduct the research, the villagers of Museruka, and other organizations for training and supervising the enumerators. This research was funded with a grant from the European Commission through the IUCN/SSC African Elephant Specialist Group and the Wildlife Conservation Society.

References

Aouade JAA. 1979. Traditional beekeeping in Nigeria. Editorial summary from *Beekeeping among the Tiv.* Beekeeping in rural development: unexploited beekeeping potential in the tropics with particular reference to

the Commonwealth. Commonwealth Secretariat and the International Bee Research Association, London. 23 p.

Bérubé C. 2002. *War and bees, military applications of apiculture.* Island Crop Management website: www.beekeeping.com; www3.telus.net/conrad. Accessed 6 May 2003.

Bromenshenk J. 2004. *Can honeybees assist in landmine detection?* Division of Biological Sciences, University of Montana, Missoula, MT 59812, USA.

Cunliffe RN. 1992. An ecological resource survey of the communal lands of Centenary District. WWF Maps Project Paper No. 26. World Wide Fund for Nature Programme Office, Harare, Zimbabwe.

Cumming DHM, Lynam T. 1997, Land use changes and utilization and the sustainability of agro-ecosystems in the Zambezi Valley. WWF Maps Project Paper. World Wide Fund for Nature Programme Office, Harare, Zimbabwe.

Marschner C. 1970. Qualitative und quantitative Untersuchungen am Bulbus olfactorius des Elefanten im Vergleihch mit dem des Menschen und des schweines. *Acta Anatomica* 75:578–595.

Vollrath F, Douglas-Hamilton I. 2002, African bees to control African elephants. Naturwissenschaften online publication. Website: www.savetheelephants.org/publications. Accessed 10 March 2003.

Elephant-poaching weapons and new experiences from the Banyang-Mbo Wildlife Sanctuary, Cameroon

Anthony Chifu Nchanji

Banyang-Mbo Wildlife Sanctuary Project, c/o Wildlife Conservation Society, Limbe Office behind Limbe Botanic Garden, PO 1308 Limbe, Cameroon; email: chifu62@yahoo.co.uk

Abstract

Although elephant poaching has been well studied there have been few reports of the equipment poachers use and the danger it poses to all forest users. Information about this equipment, especially the cheap, locally available inventions and innovations, would improve anti-poaching planning and the safety of all forest users including the elephants. This paper reports on confiscated firearms and cheap, locally made slugs, pin-board traps, cable snares; it explains the inventions, innovations and strategies poachers have used during the last 10 years of the anti-poaching campaign the Wildlife Conservation Society initiated in the Banyang-Mbo Wildlife Sanctuary in south-western Cameroon. Further, it identifies the origin of poachers and their driving forces and highlights the strategy the Wildlife Conservation Society uses to conserve forest elephants in the sanctuary.

Résumé

Bien que le braconnage des éléphants ait déjà été bien étudié, il existe peu de rapports sur l'équipement utilisé par les braconniers et sur les dangers qu'il représente pour tous les utilisateurs de la forêt. Des informations sur cet équipement, et particulièrement sur les inventions et innovations locales bon marché, amélioreraient le programme anti-braconnage et la sécurité de tous les utilisateurs de la forêt, y compris les éléphants. Nous faisons ici un rapport sur les armes à feu confisquées et les balles bon marché, fabriquées localement, les pièges, les lacets ; nous expliquons les inventions, les innovations et les stratégies que les braconniers ont utilisées au cours des dix dernières années et qu'a révélées la campagne anti-braconnage de la *Wildlife Conservation Society* dans le Sanctuaire de la Faune de Banyang-Mbo, au sud-ouest du Cameroun. De plus, nous identifions l'origine des braconniers et ce qui les pousse et nous mettons en lumière la stratégie de la WCS pour conserver les éléphants de forêt dans le sanctuaire.

Introduction

For the last two decades, poaching has been a well-known and well-studied conservation problem for both African and Asian elephants (Bell 1984; Cumming et al. 1984; Fay and Ruggiero 1986; Douglas-Hamilton 1987; Anon. 1989; Western and Cobb 1989; Ruggiero 1990; Dublin and Jachmann 1992; Bell et al. 1993; Fay and Agnagna 1993; Milner-Gullard and Beddington 1993; Dublin et al. 1995; Jachmann 1998; Mkanda 1993; Waithaka 1997, 1998; Mubalama 2000; Mubalama and Mapilanga 2001). These studies have examined poaching in terms of its magnitude, trends, serious negative effect on elephant populations (numbers and densities, structure and distribution) and elephant behaviour, or they have examined ivory trade and law enforcement.

However, only a few of these studies (such as Nishihara 2003) have addressed the equipment that is used for poaching. Knowledge of poaching weapons seems to be limited mainly to conservation agents—both non-governmental organizations (NGOs) and government departments—or the writers assume that the weapons are known. This could explain why most anti-poaching teams are ill equipped to face their enemy, the poachers. It is imperative that researchers and protected-area managers working in elephant conservation areas have good knowledge of this equipment, especially in forest ecosystems where visibility is poor. Otherwise, they risk being intimi-

dated, sustaining serious injuries, or even being killed if they are confronted by well-equipped poachers.

Poachers also use various camouflaged, familiar-looking traps and tools, often local inventions and innovations, making detection difficult. Acquiring good knowledge of this equipment and its application will improve the ability of forest users to reconnoitre the forest and detect traps—and hence improve their margin of safety. Therefore, it is important for researchers, protected-area managers and agencies funding anti-poaching efforts to know the different types of weapons and locally developed techniques that poachers use in various elephant conservation areas, so they can equip themselves or their anti-poaching teams against risk.

This article reports the different weapons and techniques used for capturing and killing elephants in the Banyang-Mbo Wildlife Sanctuary (BMWS) that poachers who have been arrested have used over the last 10 years, and local techniques recently developed for poaching. It does not, however, discuss anti-poaching operations and strategy or law enforcement and its effectiveness that lead to arrests; these are being reported in detail elsewhere (Anthony C. Nchanji and T.C.H. Sunderland, in prep.).

Study area

The Banyang-Mbo Wildlife Sanctuary is in south-western Cameroon in central Africa (fig. 1); it extends from 5º8' to 5º36' N and 9º29' to 9º47' E and covers an area of about 66,200 ha. The climate is hot and humid with distinct but unequal dry and rainy seasons. The rainy season runs from about mid-March to the end of October. However, seldom is a month completely devoid of significant precipitation. Nchanji and Plumptre (2003) with weather data in Nguti from 1993 to 2002 show that the heaviest rainfall occurs between June and October. August with mean rainfall of 782 ± 178 mm is the wettest month while February with mean rainfall of 4 ± 3.6 mm is the driest. However, the months of June to September each have more days of rainfall (almost daily) than others. Annual rainfall ranges from 3438 to 5429 mm with a mean of 4526 mm. Relative humidity and daily temperature are fairly constant throughout the year and respectively range from 84% to 90% and 27ºC to 29ºC with means of 87% and 27ºC. Altitude ranges from 120 m in the northern part to 1756 m in the south-eastern part of the sanctuary. The sanctuary is drained with numerous permanent and seasonal streams that rise from the highlands in the south and flow into the Rivers Mbei (Mbu) and Mfi. Vegetation is generally evergreen rainforest; it falls within the Guinea-Congolian forest region as described by White (1983). Plant species diversity in the sanctuary is among the highest in Africa (T. Duncan, pers. comm.). Presently BMWS is the only submontane protected habitat in Cameroon with a potentially viable elephant population. This population of 200 to 400 remains probably the largest in the Cross–Sanaga Rivers region.

Ethnologically, BMWS is inhabited to the north by the Banyangi people, to the east by the Mbo and Banyui, to the south by the Bakossi and to the west by the Mbo and Bassosi. There are about 60 villages (fig. 1) with a total human population of about 25,000 within 5 to 20 km of the sanctuary boundaries; another 300 to 400 villages plus 5 suburban and 2 urban sites are within 30 to 150 km of the boundaries. Therefore BMWS is in a landscape dominated by humans. The economy of the entire region is predominately agriculture—small-scale cash crops (cocoa and coffee) and subsistence crops (oil palm, banana, plantain, cassava, coco yam, various vegetables)—widely supplemented by hunting and collection of several non-timber forest products.

The Wildlife Conservation Society and anti-poaching initiatives in Banyang-Mbo Wildlife Sanctuary

Wildlife Conservation Society (WCS) field biologists carrying out research in Korup National Park on the ecology of forest elephants from 1988 to 1991 were unsuccessful at radio collaring due to the low elephant population in the park, perhaps because of previous excessive poaching before the park's status was upgraded in 1986 to increase protection. In 1992 WCS extended the study area 80 km east to include the Banyang-Mbo Council Forest Reserve (BMCFR) where elephant density was found to be about five times higher than in the park (B. Powell, pers comm.); BMCFR also had high biodiversity. Within two search days in BMCFR, an elephant was successfully darted and radio collared, and later two more elephants were collared. However, active elephant poaching was serious in this unprotected forest. WCS instituted an anti-poaching campaign to protect the tagged ele-

phants while lobbying the government of Cameroon to increase protection of this forest for general biodiversity conservation and elephant protection.

In 1996 BMCFR, plus an additional adjacent forest to its south, was upgraded to become the Banyang-Mbo Wildlife Sanctuary (BMWS) with an area of about 662 km^2. WCS continued to implement anti-poaching activities, using informants, intelligence and sporadic interventions of gendarmerie and police in the area as government did not immediately appoint a conservator and guards. Meanwhile it worked with the government of Cameroon and local communities

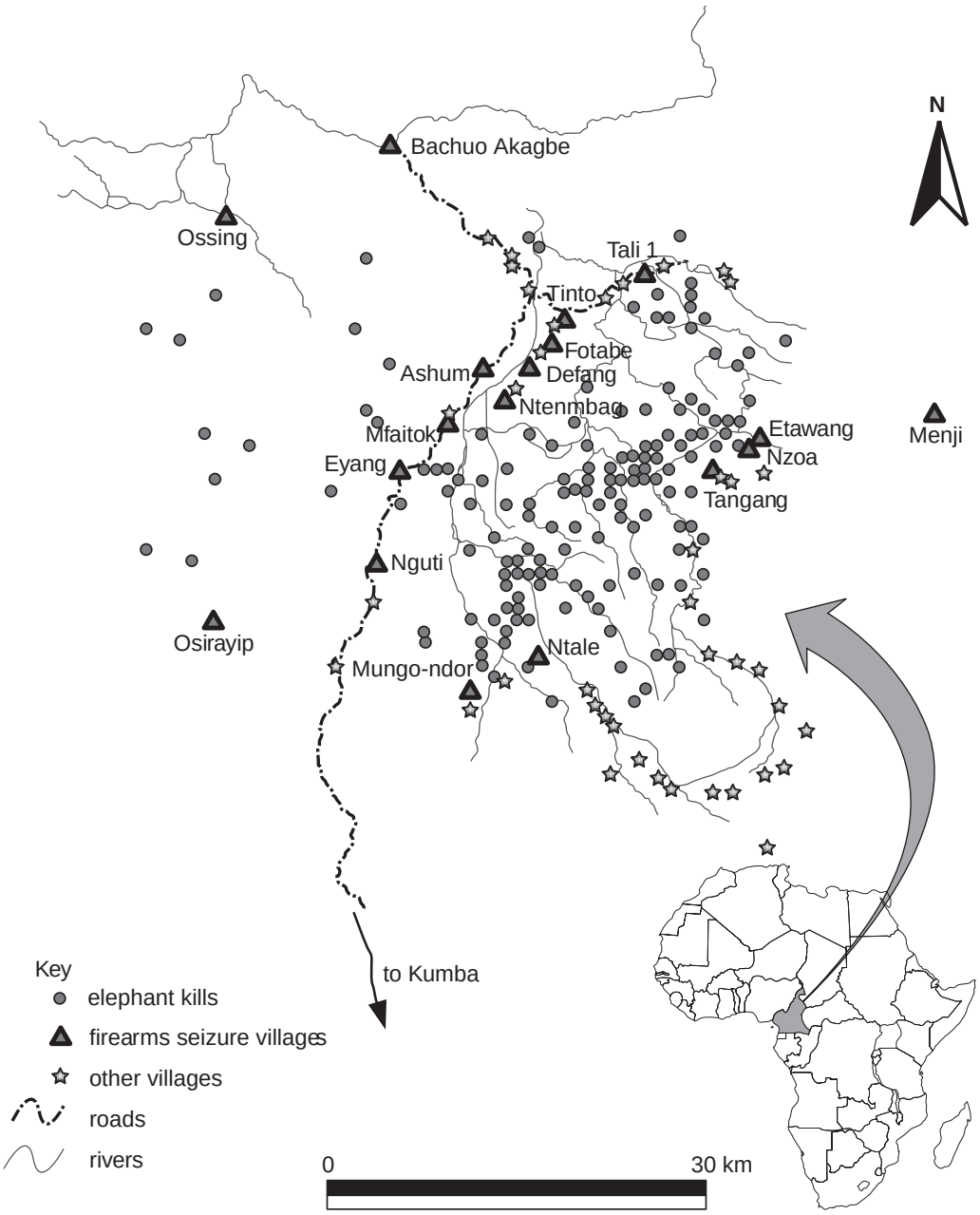


Figure 1. Location of elephants killed and villages where poaching weapons were seized, Banyang-Mbo Wildlife Sanctuary, 1993 to 2003.

to design a community-based conservation programme to protect the biodiversity and the elephants. Poaching, however, especially of elephants, continues to be a major threat to conservation in this sanctuary despite the serious commitment of the local communities and WCS. Nchanji (2004) reported 186 elephants killed in and around BMWS between January 1993 and June 2004 (fig. 1) and a remaining estimated population of 214 ± 159 elephants in the sanctuary. Despite the poaching, this sanctuary still holds the largest elephant population in south-western Cameroon. Poaching in this region is encouraged by the large domestic clandestine ivory market that flourishes in Douala, Cameroon, and the relative ease of smuggling ivory from this region into Nigeria.

Types of weapons seized from arrested elephant poachers, 1993–2003

The WCS anti-poaching campaign in the BMWS region from 1993 to 2003 confiscated 21 weapons (fig. 1, table 1) of 6 types used in killing elephants: .458 rifles (33.3%), .404 carbine rifles (23.8%), .375 Winchester rifles (19.0%), English automatic assault rifles (4.8%), imported single-barrel shotguns (9.5%), and locally made single-barrel shotguns (9.5%). Nine other weapons of these types are known to still be used for poaching within the zone but have not yet been confiscated (table 1), as the legal system in place requires substantial evidence before action. Therefore, weapons can be seized only during the actual poaching. Cameroonian firearms legislation permits individuals to own and use firearms under specified conditions for hunting and self-defense. Four (19%) of the weapons confiscated were legally owned but were used illegally. Six categories of people were identified as owners of the seized weapons: businessmen (nationals and non-nationals (33.3%), poachers (any person who illegally kills animal species protected by law (23.8%), civil servants (in this paper a non-native state employee working in the BMWS area, 19%), elites (in this paper a rich and influential person who may or may not be a state employee) of the region, currently either resident in the area or not (19%), and farmers (4.8%). Most of the owners of the seized weapons were Cameroonians (90.5%), and only two were foreigners, who were operating businesses in Douala. Natives of the region were 42.9%, Cameroonian immigrants into the region 28.6%, and civil servants 19.0%. The poachers arrested were all Cameroonians. Three (14.3%) were from out of the region, one (4.8%) was a permanent resident (an immigrant) and the rest (80.9%) were natives of the area.

Newly found methods and experiences of elephant poaching

HUNTING AND KILLING ELEPHANTS WITH SHOTGUNS

Two types of firearms—shotgun and rifle—of varying calibres are used for game hunting. The single- or double-barrelled shotgun of 15-mm diameter bore designed to use 12-mm cartridges containing 3–9 large pellets or 10–34 small pellets is meant for killing small game at close range (10–20 m). Shotguns imported from Europe or America into Cameroon cost between CFA 400,000–750,000 (~USD 725–1365) and the cartridges CFA 750–1200 (~USD 1.4–2.2) each. Rifles meant for hunting big game such as elephant, buffalo and bongo are even more expensive—CFA 750,000–1,200,000 (~USD 1365–2200), and bullets cost CFA 5000–12,000 each (~USD 9–22). These amounts of money are not easily affordable by poor rural people

Table 1. Elephant-poaching weapons confiscated in Banyang-Mbo Wildlife Sanctuary, 1993–2003

Weapon	No.	Remarks
.458 rifle	7	Includes Czech and Winchester makes; all illegally owned
.404 carbine rifle	5	One legally owned, the others illegally owned
.375 Winchester rifle	4	Two legally owned, two illegally owned
English automatic	1	Illegally imported for trade; seized in transit assault rifle
Shotgun	4	Two imported single barrel; two locally made, a single and a double barrel
	Known but not yet confiscated in Banyang-Mbo Wildlife Sanctuary	
.458	4	Two legally owned, two illegally, but all known to be used for poaching
.404 carbine rifle	4	One legally owned; all known to be used for poaching
.375 Winchester rifle	1	Legally owned, but leased to poachers

who live with the elephants and wish to hunt or own firearms to protect their property and for self-defence. Therefore, only rich civil servants or businessmen interested in bushmeat and ivory can afford to buy rifles and shotguns and hire hunters (legally or illegally) to hunt, or lease guns to hunters on specified conditions, usually 50% of the hunting proceeds of tusks or meat.

In the last three decades, local blacksmiths in both Cameroon and neighbouring countries have improved their ability to make shotguns—commonly from the steering arm of a Landrover, Peugeot or Hilux, and now produce good-quality guns that rival those imported. These are safe to use, cheap, costing CFA 50,000–80,000 (~USD 90–150), and are very effective for small game hunting. These amounts are affordable for average citizens. Many young people have such shotguns, especially farmers and people who have returned to rural areas from the city because of the existing economic recession and consider commercial hunting a fast remedy for scarce income. More than 98% of households in the eastern and northern parts of the sanctuary own a shotgun (Nzoaungo and Willcox 2000). Unfortunately these local blacksmiths operate their workshops and trade their products in secret. These guns are also used clandestinely.

Hunters in the BMWS region produce two types of forged bullets and use these in shotguns, both imported and locally made, to kill big game at close range, including even elephants and buffaloes. In the first type, the top of the plastic casing of a 12-mm cartridge is carefully opened and the bullets or missiles are emptied, melted and allowed to cool in an empty cartridge shell lined with plastic wrap structured to produce a clout with a sharply pointed end. The slug produced (fig. 2) is replaced in the case and loaded into the shotgun to kill elephants. In the second type, the plastic ends of the 12-mm cartridges are carefully opened and the pellets are replaced with metal construction rods 12 mm in diameter cut into pieces 3 cm long and well sharpened at one end (fig. 3). These are then sealed and loaded into a shotgun to kill elephants and other big game at close range, 15 to 20 m. Two elephants, aged about 23 and 34 years, were recorded killed with forged bullet type 1 and three of about 15, 21 and 28 years with type 2 during the reporting period. Carcass ages were determined from the skulls following the method of Laws (1966) with adjustments of Jachmann (1998).

Figure 2. Slug for a shotgun produced by melting bullets or missiles of 12-mm cartridges and solidifying them in a 12-mm plastic cup.

Figure 3. Forged bullets for a shotgun produced by cutting and sharpening 12-mm metal construction rods.

HUNTING ELEPHANTS WITH CABLE SNARES

Using vehicle tow ropes (fig. 4), poachers set up cable snares on regular elephant trails (around licks, drinking points, wallow points, fruiting trees) in BMWS in the way widely used in African forests to trap small game. One end of the tow rope is fastened to a large tree of diameter ≥ 50 cm and the other made into a knob and circle and attached to a trigger system. This is spread around a hole 35–40 cm diameter and 40–50 cm deep dug on an elephant trail and covered with leaves and forest litter. When the elephant steps on the tow rope, it is triggered and fastens on the ele-

Figure 4. Tow rope used as a cable snare for elephants.

phant's leg. The rope fastens further as the elephant agitates to free itself. The rope holds the elephant in place until the hunter returns several hours (or days) later and uses a shotgun as described above, or any other weapon, to kill the helpless victim. Two of these traps were observed in the sanctuary but their success or effectiveness was neither reported nor observed. Nevertheless, a poacher who developed this trap system explained that a friend with whom he hunted big game in the south-eastern forests of Cameroon has successfully killed buffaloes and bongos with the system in forests in Central African Republic. He is reproducing it in BMWS for elephants, but has yet to kill one.

HUNTING ELEPHANTS WITH PIN-BOARD TRAPS

The poachers rivet three thick, sharp triangular flat iron pins (sometimes poisoned) to a thick wooden board (fig. 5) and place the board covered with forest leaf litter on a regular elephant trail. The pin-board is attached to weak cables to hold it in position. Three or four of these pin-boards are placed on the trail in succession at intervals of about 30 to 50 cm (the probable length of an elephant footstep). The pins pierce the foot of the elephant and penetrate further as the elephant moves forward. The injured foot slows the victim and drains its strength, and the elephant leaves an easily tracked trail of blood, so that it can be shot later with relative ease. We have observed this type of trap on BMWS elephant trails on four different occasions and poachers explained its function. A farmer in Nguti on the west of the BMWS boundary confirmed that one female elephant was injured and then killed around his farm in March 2004 using this system.

SLAYING AND BURYING

Usually poachers kill elephants in and around BMWS, extract the tusks, and sell the carcass cheaply— CFA 40,000–60000 (~USD 73–109) to villagers who butcher it for food. The conservation law in Cameroon (Cameroon Govt 1994) maintains that a person caught in possession of a whole or partial carcass of a protected species is deemed to have killed the animal and is responsible for the act unless proven otherwise. It has always been difficult to track down poachers in the BMWS area, earlier due to the absence of game guards and recently because the number of patrol guards WCS recruits is insufficient to patrol the area effectively. Therefore, this provision of the law is often applied to villagers who are found butcher-

Figure 5. The pin-board trap used for trapping elephants.

ing any elephant killed or in possession of elephant meat. These villagers usually reveal the identity of the poacher and necessary interventions are undertaken to apprehend the poacher, with the villagers as prosecution witnesses.

Consequently, poachers have resorted recently to two new strategies: 1) killing elephants, extracting tusks and abandoning the carcass to rot—*slaying and burying* (fig. 6), or 2) selling the carcass cheaply to villagers on condition that they do not report the matter to officials until two or three days after the poachers have left, as an act committed within their forest by unknown poachers. The carcass, by then already decomposing (fig. 7), is inspected and the villagers are authorized to butcher it, if it still interests them. This slaying-and-burying strategy has made anti-poaching more complex and wastes an already destroyed resource, depriving villagers of cheap fresh elephant meat, and discouraging them from active participation in conserving elephants that also sometimes raid their crops.

Discussion

Arrested poachers from whom weapons were confiscated in BMWS during the reporting period have indicated a variety of people involved in the poaching chain and some newly found methods of poaching in the area. Trapping elephants with vehicle tow ropes and pin-board traps as observed in the BMWS area confirm the use of elephant snare traps using metallic logging cables and a similar version of the pin-board trap observed in Gabon (Sally A. Lahm, pers. comm.). These trapping techniques are new in the African rainforests. They can be very dangerous for other forest users, both animal and human, especially the pin-board traps. Therefore human forest users should be extremely vigilant, because such new, camouflaged trap types could threaten their safety. Although the effectiveness of these new trapping systems has not yet been observed, they are cheap, locally available and potentially effective but dangerous. It is therefore of urgent importance to locate and eliminate them.

Figure 6. Slay and bury: carcass of an elephant abandoned by poachers and left to rot in the forest after they had removed the tusks.

Figure 7. Slay and bury: villagers butcher the decomposing carcass of an elephant that poachers abandoned in the forest after removing the tusks.

Slaying and burying, though a new experience in this region and one that complicates anti-poaching efforts, has been observed in north-eastern Nigeria (Bita 1988), Central African Republic (Ruggiero 1990), north-eastern Democratic Republic of Congo (DRC) (Vanleeuwe et al. 1997), Ethiopia (Demeke and Bekele 2000), Mouadjé in north-western Republic of Congo (Nishihara 2003) and Gabon (Sally A. Lahm, pers. comm.). However, human population densities in these areas are low, poaching is far from human habitation, and local people have a low preference for elephant meat. Therefore slay and bury is a technique that is becoming prominent in forest ranges of elephants; it indicates active, intensive commercial poaching of elephant for tusks. Consequently, this could be addressed by increasing patrols in areas where elephants are concentrated, especially those under protection, and stationing well-equipped guards at blocks on strategic roads and pathways, so that poachers are arrested before they kill the elephants. Unfortunately, many protected areas in the central African region including BMWS are grossly under

staffed and poorly equipped for this task, consequently patrolling outside protected areas is a myth.

Melting small and large pellets into slugs and using them in a shotgun in the BMWS area is similar to observations of Fay and Agnagna (1993) in Central African Republic, where slugs were made by melting lead into 14-mm socket spanners and double charging them into shotguns to kill elephants. The use of assault weapons such as the AK 47 and Kalashnikov rifles observed in Congo (Nishihara 2003), DRC (Mubalama 2000; Mubalama and Mapilanga 2001), Malawi (Mkanda 1993) and Central African Republic (Ruggiero 1990), which could be attributed to war circumstances in these and neighbouring countries, was not observed in the BMWS area. However, one assault weapon was confiscated from a Nigerian trader operating illegally in complicity with a villager in the region. Other such weapons may also be in use in Cameroon, possibly originating from fugitives of the Chadian war.

Poaching in the BMWS region appears to be a complex activity sponsored by members of the elite group, civil servants and rich foreign businessmen who reside far from the region. This activity is most likely driven by the underground ivory market flourishing in Douala, where most of these sponsors live or have relations who understand the network. Subverting such a market might be a more rewarding anti-poaching strategy than merely targeting and arresting culprits at site. About 48% of the weapons confiscated in arrests belonged to natives of the BMWS area. Hence the very local people who are most likely to benefit from conservation in the area are promoting poaching more than anyone else.

It would appear that people of this region consider killing elephants as their customary right, despite long-time conservation efforts of the government in collaboration with conservation agencies. Given this fact, it may be necessary to strictly implement the conservation law so that culprits suffer maximum sentences, with the intent to deter others. However, continued poaching may also indicate that local people are yet to perceive benefits from conservation. Therefore anti- poaching efforts in BMWS and elsewhere must not only concentrate on arresting poachers on site but extend to sensitizing the indigenous elites and local population at all levels, so that they perceive conservation as beneficial to them locally. Combating poaching thus requires a more educational approach than merely pursuing and arresting poachers.

The WCS programme at BMWS has witnessed much anti-poaching success by confiscating 21 poaching firearms (average of 2 a year) from the region with the collaboration of the state counsels, gendarmerie and police, local administrators, some traditional leaders, informants and intelligence agents during the last 10 years. This ensued with minimal involvement of the competent Cameroon ministry in charge of conservation. This ministry has recently appointed a conservator who will organize, coordinate and supervise anti-poaching activities with direct financial support of WCS, which will provide a team of well-trained patrol guards and logistics. In addition WCS has so far established village forest management committees (VFMCs) in 29 of 60 villages around the sanctuary and registered them by the Cameroonian law of association as 'common initiative groups'. These VFMCs are already organizing their own patrols for surveillance of their territorial forests in the sanctuary and reporting poachers and other defaulters.

VFMCs are also being trained to write proposals and raise funds so they can handle microprojects that open opportunities for alternative livelihoods, with particular focus on poachers and hunters. Nature Cameroon, a local NGO created by WCS, identifies the microprojects through needs-assessment analyses. It coordinates the VFMCs and fundraises locally so that such projects may be carried out. Such activities make local people fully aware of the benefits conservation brings to their area.

Crop raiding by elephants from the sanctuary is still a problem, but poachers aggravate it in two ways. 1) Poachers kill deep in the forest, forcing elephants into farmland vicinities where they are left more peacefully—and where they sporadically raid crops. 2) Cameroonian conservation law allows for killing of protected animals to protect human life and property but emphasizes that the slaughter must be reported within three days. Hence poachers subtly herd elephants from the forest to kill them illegally near farmlands or villages in the pretence of applying this law, but they never report their kill. This has frustrated all attempts to mitigate elephant crop raiding in the region. Consequently poaching is the major cause of crop raiding at the moment around BMWS. Therefore anti-poaching in BMWS is a dual programme—to protect the elephants and to mitigate their crop raiding.

Acknowledgements

The cooperation and assistance of the various senior and subdivisional officers, the gendarmerie and police officers (especially bosses) and the state counsels that have served in Bangem, Kumba, Mamfe, Nguti and Tinto during the study period, some of the elites and chiefs, and several informants in the region made the anti-poaching activities successful. I thank them individually and collectively. Funds to organize and manage anti-poaching activities were small amounts from various donors that have funded activities in BMWS in the past 10 years; they include USAID, the Liz Claiborne/Art Ortenberg Foundation, the Walt Disney Company Foundation, the Environment and Development Department of the Netherlands, the MacArthur Foundation, and the WCS Trust Fund. Professor John Oates, Drs T.C.H. Sunderland and R. Fotso, and Messrs D.J. Hoyle and L. Mubalama read earlier versions of this manuscript and made useful comments. Finally, I express my profound gratitude to Dr Sally Lahm, the editors of *Pachyderm* (Ms Helen van Houten and Ms Dali Mwagore), and the anonymous reviewers of this article for their inputs.

References

Anon. 1989. The ivory trade and the future of the African elephant. Summary of the interim report of the Ivory Trade Review Group. IUCN/SSC/AfESG. *Pachyderm* 12:32–37.

Bell RHV, Jachmann H, Chimbali DM, Mulonda EY. 1993. Illegal activities and law enforcement in the Central Luangwa Valley, Zambia from 1979–1992. *Pachyderm* 16:81.

Bell RHV. 1984. Monitoring illegal activities and law enforcement in African conservation areas. In: Bell RHV and McShane-Calusi E, eds. *Conservation and wildlife management in Africa*. US Peace Corps, Washington, DC.

Bita BB. 1988. The rising spate of elephant poaching in the Lake Chad area. A situation report submitted to the Ministry of Agriculture and Natural Resources, Borono State, Nigeria.

Cameroon Government. 1994. Law No. 94-1 of January 1994 to Lay Down Forestry, Wildlife and Fisheries Regulations. Official Gazette Department, Presidency of the Republic of Cameroon.

Cumming DHM, Martin RB, Taylor RD. 1984. Questionnaire survey on the management and conservation of elephants and rhinos. In: Cumming DHM and Jackson P. *The status and conservation of Africa's elephants and rhinos.* IUCN Gland, Switzerland. p. 46–62.

Demeke Y, Bekele A. 2000. Study on the elephants of Mago National Park, Ethiopia. *Pachyderm* 28:32–48.

Douglas-Hamilton I. 1987. African elephant population trends and their causes. *Oryx* 21:1–24.

Dublin HT, Jachmann H. 1992. *The impact of the ivory ban on illegal hunting of elephants in six range states in Africa*. WWF International Research Report. WWF, Gland, Switzerland.

Fay MJ, Agnagna M. 1991. Forest elephant population in the Central African Republic and Congo. *Pachyderm* 14:3–19.

Fay MJ, Agnagna M. 1993. Elephants and ivory in Congo since the ban: the lull before the storm? *Pachyderm* 16:51–58.

Fay MJ, Ruggiero RG. 1986. Poaching and anti-poaching in Manovo-Gounda St Floris National Park. Unpublished report to WWF/IUCN and government of Central African Republic.

Jachmann H. 1988. Estimating age in the African elephant: a revision of Laws's molar evaluation technique. *African Journal of Ecology* 22:51–56.

Laws RM. 1966. Age criteria for the African elephant, *Loxodonta africana africana*. *East African Wildlife Journal* 4:1–37.

Millner-Gulland EJ, Beddingon JR. 1993. The relative effects of hunting and habitat destruction on the elephant population dynamics over time. *Pachyderm* 17:75–90.

Mkanda FX. 1993. Status of the elephants and poaching for ivory in Malawi: a case study in Liwonde and Kasungu National Parks. *Pachyderm* 6:36–41.

Mubalama L. 2000. Population and distribution of elephants (*Loxodonta africana africana*) in the central sector of the Virunga National Park, eastern DRC. *Pachyderm* 28:44–55.

Mubalama L, Mapilanga JJ. 2001. Less elephant slaughter in the Okapi Faunal Reserve, Democratic Republic of Congo, with Operation Tango. *Pachyderm* 31:36–41.

Nchanji AC. 2004. Threats, constraints and critical issues facing the conservation of Banyang-Mbo Wildlife Sanctuary. Unpublished report submitted to Ministry of Environment and Forestry, Yaounde, and the Banyang-Mbo Wildlife Sanctuary Steering Committee, March 2004.

Nchanji AC, Plumptre AJ. 2003. Seed germination and early seedling establishment of some elephant-dispersed species in Banyang-Mbo Wildlife Sanctuary, south-

western Cameroon. *Journal of Tropical Ecology* 19:229–237.
Nishihara T. 2003. Elephant poaching and ivory trafficking in African tropical forests with special reference to the Republic of Congo. *Pachyderm* 34:66–74.
Nzouango D, Willcox SA. 2000. Bushmeat extraction survey within the Banyangi and Mbo tribes in the Southwest Province of Cameroon. Unpublished report submitted to the Wildlife Conservation Society, Bronx, New York, and Cameroon Biodiversity Programme, Banyang-Mbo Wildlife Sanctuary Project, Yaounde.
Ruggiero R. 1990. The effects of poaching disturbance on elephant behaviour. *Pachyderm* 13:42–44.
Vanleeuwe H, Gautier-Hion A, Cajani S. 1997. Forest clearings and the conservation of elephants (*Loxodonta africana cyclotis*) in north-east Congo republic. *Pachyderm* 24:46–52.
Waithaka J. 1997. Elephant poaching in Kenya. *Pachyderm* 24:66.
Waithaka, J. 1998. Trends of elephant poaching in Kenya: the elephant mortality database. *Pachyderm* 25:40–41.
Western D, Cobb S. 1998. The ivory trade review. *Pachyderm* 11:1–12.
White F. 1983. The vegetation of Africa. UNSCO, Paris.

Can African elephants survive and thrive in monostands of *Colophospermum mopane* woodlands?

D.D. Georgina Lagendijk, W. Fred de Boer, S.E. van Wieren*

Resource Ecology Group, Wageningen University Bornsesteeg 69, 6708 PD Wageningen, The Netherlands
*corresponding author: email: Fred.deBoer@wur.nl

Abstract

Colophospermum mopane is an important food source for elephants during the dry season, being one of the few food plants still carrying leaves during this bottleneck period, and maintaining high feed value throughout the year. Several authors mention mopane as a bulk food for elephants, and one claims that elephants have been found feeding exclusively on mopane. Whether this is possible in terms of energy requirements is the focus of this literature review. Calculations have been made to see if elephants in different life stages can survive feeding on mopane during the different seasons, in terms of digestible energy requirements, intake and foraging time. The results indicate that elephants can indeed survive, in the scope of the criteria mentioned, on mopane solely, although time for ingestion and foraging has to be increased.

Additional key words: energy requirements, intake, foraging time, digestibility, food, modelling

Résumé

Les *Colophospermum mopane* sont une source de nourriture importante pour les éléphants en saison sèche, car c'est une des rares plantes qui portent encore des feuilles pendant cette période critique et elle garde une haute valeur nutritive toute l'année. Plusieurs auteurs mentionnent les *Mopane* comme étant la nourriture la plus consommée par les éléphants, et un dit même qu'on a vu des éléphants ne se nourrir que de *mopane.* L'objectif de cette revue de la littérature est de voir si ceci est possible en termes de besoins énergétiques. On a fait des calculs pour savoir si les éléphants à différentes étapes de leur vie peuvent survivre en se nourrissant de *mopane* au cours des différentes saisons, en termes de besoins énergétiques alimentaires, de temps d'absorption et de recherche de nourriture. Les résultats indiquent que les éléphants peuvent en effet survivre, pour ce qui est des critères mentionnés, avec uniquement des *mopane*, mais qu'il faut augmenter la durée d'ingestion et de quête de nourriture.

Mots clé supplémentaires : besoins énergétiques, temps d'absorption, recherche de nourriture, absorption, food, modelling

Introduction

Colophospermum mopane (Leguminosae: Caesalpinioideae) is a deciduous tree widely distributed across an area of 550,000 km^2 throughout southern Africa and occurring over a wide range of ecological conditions (Walker 1980; Timberlake 1995; Mapaure and Mhlanga 2000). Mopane is an important browse species for African elephants (*Loxodonta africana*), especially in the dry season as regrowth of leaves and the long leaf-carriage period continuing in the dry season are crucial to sustain elephants through this resource-deficient time of year (Walker 1980; Villier et al. 1991; Brophy et al. 1992; Dekker and Smit 1996; Rooke 1998; Smallie and O'Connor 2000; Ben-Shahar and Macdonald 2002). Mopane is known for its phenolic compounds, which have a negative effect on intake, protein and cell wall digestibility, and metabolism (Owen-Smith 1993; Rooke 1998; Aganga et al. 2000). In addition, in the northern Namib Desert mopane is one of the most important tree species elephants use as bulk forage (Viljoen 1989; Timberlake 1995). Ben-Shahar (1996) found that elephants in northern Botswana feed on mopane

exclusively, although according to Lewis (1986) they are not dependent on mopane solely. Nevertheless, elephant densities are higher within mopane areas than outside them (de Boer 2003). This implies that mopane is an important food source for elephants.

The aim of this research is to establish whether elephants can feed exclusively on mopane. Foraging time and amount of intake are constraining factors. Elephants tend to forage for 60% to 75% of the day (Owen-Smith 1988) to ingest their mean daily intake, which is around 4% (fresh weight) of the live body weight (Laws et al. 1970 in Williamson 1975). In addition, elephants have a short mean retention time, of 12–50 hours, and low digestive capacity (Owen-Smith 1988).

Literature collated focused on energy requirements of African elephants. Calculations on their energy requirements were made with regard to intake and foraging time. The data obtained in in vitro digestibility trials were used to assess the digestibility of mopane.

The study gives insight as to how the energy requirements of African elephants in *Colophospermum mopane* woodlands can be met, and it indicates how mopane woodlands may be managed to help conserve elephants in these areas.

Materials and methods

The study was carried out as a literature analysis with a modelling approach. The chemical composition of mopane leaves, as found in literature, as well as mopane leaves from Kruger National Park, South Africa, were analysed for nutrients.

Mature green and senescing mopane leaf samples were chemically analysed for digestibility. The samples were gathered during May 2002 (early dry season) in Kruger National Park, South Africa. The in vitro digestibility of the mopane leaves was determined following Tilly and Terry (1963).

The different seasons mentioned in this study are defined as follows:

- Late dry season: August, September, October; no rainfall, low temperatures
- Early wet season: November, December; medium rainfall, high temperatures
- Late wet season: January, February, March, April; main rainy season, high temperatures
- Early dry season: May, June, July; no rainfall, low temperatures

The energy requirements and foraging time for elephants of different sex and age categories feeding on three mopane sources including mature green leaves (MGL), senescing leaves (SL) and twig bark (TB) were calculated using the metabolizable energy (ME) requirements in table 1 provided by Meissner (1982). The energy contents for the three different mopane plant parts used were derived from Styles and Skinner (1997, 2000) and are listed in table 2. To calculate the daily intake (kg) the ME was converted to dry-matter intake incorporating digestibility, methane and urinary losses. Digestibility levels were obtained from Foose (1982) and from the in vitro digestibility analysis. Methane and urine losses were estimated at 14.13 kJ kg d^{-1} when the elephants were feeding on MGL, 12.24 kJ kg d^{-1} on SL, and 12.24 kJ kg d^{-1} on TB (Meissner et al. 1990). Foraging time was calculated using 2.4 trunkloads of 180 g of wet mass per minute as found by Guy (1975, in Owen-Smith 1988).

Table 1. Average metabolizable energy intake of African elephants for various age and sex classes

Elephant	Mass (kg)	Metabolizable energy (MJ/d)
Calf, 5 years	850	84.8
Cow, dry, 15 years	1850	285
Cow, dry, 50 years	3300	291
Cow, with calf, 15 years	1850	362
Cow, with calf, 50 years	3300	375
Bull, 15 years	2200	303
Bull, 50 years	3700	310

Source: Meissner 1982

Table 2. Gross energy contents (kJ/g plant material) in three *Colophospermum mopane* sources in Northern Tuli Game Reserve, Botswana, during four seasons

Season	Mature green leaves	Senescing leaves	Twig bark
Late dry	20.43 ± 2.31	17.65 ± 0.41	18.5 ± 1.0
Early wet	19.12 ± 0.40	18.48 ± 0.22	17.7 ± 0.1
Late wet	18.55 ± 0.33	16.75 ± 0.39	17.6 ± 0.2
Early dry	19.45 ± 0.32	16.97 ± 0.18	17.3 ± 0.3

Source: Styles and Skinner 1997, 2000

Results

Figure 1 shows the late dry season intake and foraging time for a bull elephant and a cow with a calf feeding on mature green mopane leaves. The energy content of mature green mopane leaves during the late dry season is 20.43 kJ g^{-1} plant material. The 50-year-old bull weighs 3700 kg and has a ME requirement of 310 MJ d^{-1}. Correcting for digestibility (29.2%), methane and urine losses, we determine that for the bull to fulfil its energy requirements, its late dry season intake needs to be 151.83 kg wet mass (WM) per day. The foraging time needed to ingest this amount of forage would be approximately 14 hours. The 50-year-old cow with a calf weighs 3300 kg and has an ME requirement of 375 MJ d^{-1}. Following the same procedure, we determine that its late dry season intake needs to be 176.70 kg WM d^{-1}, with a foraging time of approximately 16 hours.

The digestibility of senescing leaves for elephants is 24.1% and of twig bark 25%. Equation 1.1 expresses the diet necessary for a 50-year-old bull (3700 kg) to acquire the minimum energy requirements when feeding on three different mopane sources during the late dry season and equation 1.2 for a 50-year-old cow (3300 kg) with a calf.

$$\text{Eq. 1.1} \quad \frac{TB}{192}+\frac{MGL}{152}+\frac{SL}{209}=1,$$

$$\text{Eq. 1.2} \quad \frac{TB}{225}+\frac{MGL}{177}+\frac{SL}{244}=1,$$

where *TB* = twig bark, *MGL* = mature green leaves and *SL* = senescing leaves. If the sum is > 1 the diet is sufficient, if it is < 1 it is deficient.

For instance, if a bull elephant feeds on 134 kg of twig bark and 15 kg of green leaves, it must ingest another approximately 42 kg of senescing leaves to fulfil its daily energy requirements.

Intake and foraging time of elephants in different life stages and during all seasons feeding on the three sources of mopane are presented in figure 2 and table 3. Minimum intake as calculated in this study can vary between 40.57 and 257.27 kg/d, with foraging times varying between 3 h 45 min and 23 h 49 min per day, depending on the life stage, part of mopane ingested and season.

Figure 2 visualizes that the calculated intake from this study is always above the mean daily intake of 4% of the live bodyweight (see table 3). Table 3 presents the exact numbers and also how much the calculated intake is above the mean daily food in

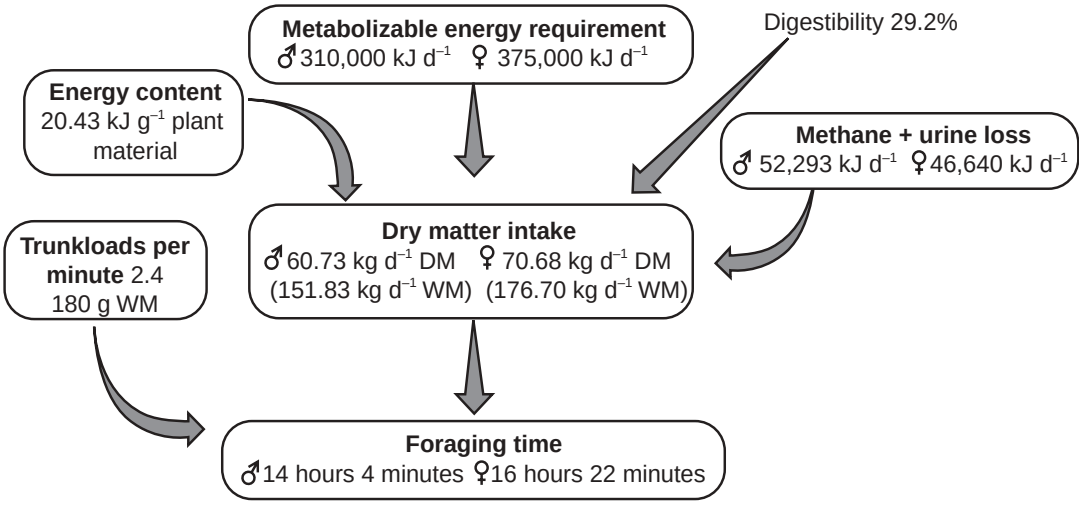


Figure 1. Late dry season intake and foraging time for a bull elephant (♂ : 50 yr; 3700 kg) and cow with a calf (♀ : 50 yr; 3300 kg), feeding on mature green *Colophospermum mopane* leaves (DM: dry mass, WM: wet mass).

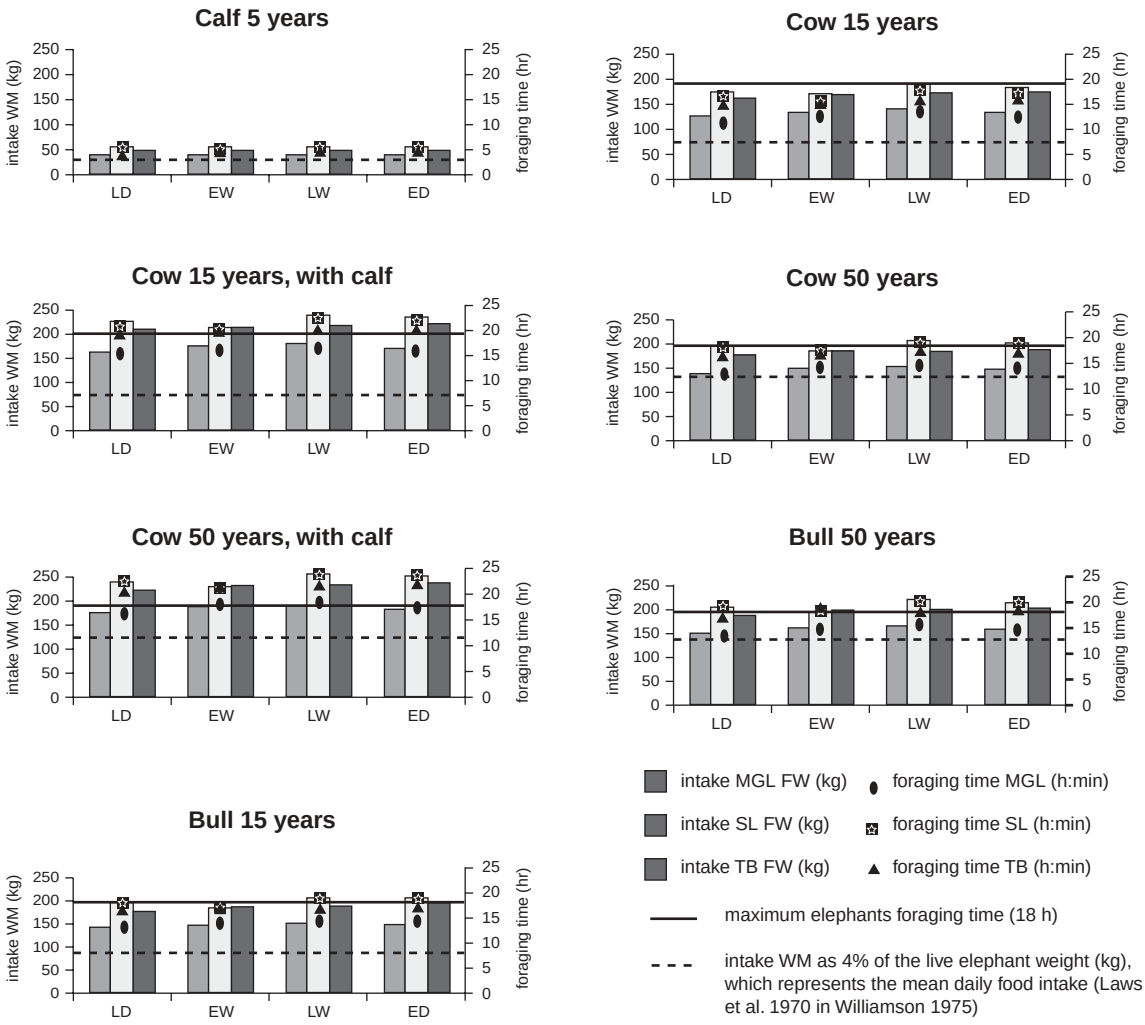


Figure 2. Simulated seasonal intake and foraging time for different sex and age categories when feeding on three mopane sources (excluding all other potential forage sources). Maximum foraging times for calves are unknown and therefore not included. FW – fresh weight, MGL – mature green leaves, SL – senescing leaves, TB – twig bark, WM – wet mass.

take, calculated from 4% live weight. This varies between 3% (bull 50 years old feeding on MGL during the late dry season) to 222% (cow 15 years old with calf, feeding on SL during summer) above the mean daily food intake, although the exact daily intake rates of lactating females and calves remain unknown.

Intake from mature green leaves always remains under the foraging time constraint for all life stages.

Foraging times when feeding on senescing leaves or twig bark are under the maximum foraging times for elephants, except for lactating cows (both 15 and 50 years of age feeding on SL and TB), 50-year-old cow (SL in the early and late dry and late wet seasons), 15-year-old bull (SL in late wet and early dry seasons) and 50-year-old bull (SL all seasons and TB in early and late wet and early dry seasons).

Discussion

The mean daily food intake (kg WM) was estimated at 4% of the live weight for all classes except lactating females, according to Laws et al. (1970 in Williamson 1975). In the case of the bull elephant, in figure 1, this would account for an intake of 148 kg WM, which is

Table 3. Simulated seasonal intake in wet mass (WM) kilograms and foraging time for different sex and age categories, when feeding on three mopane sources, including percentages of increase or decrease relative to mean daily intake and mean foraging time (FT) (max. 18 h)

				Mature green leaves				Senescing leaves				Twig bark			
Animal and weight (kg)	WM intake[a] (kg)	ME (kJ/d)	Season[b]	Intake (kg WM)	%[c]	FT (h:min)	%[d]	Intake (kg WM)	%[c]	FT (h:min)	%[d]	Intake (kg WM)	%[c]	FT (h:min)	%[d]
Calf 5 yr, 850	~ 34	84,800	LD	40.57	19	3:45	–79	55.96	65	5:11	–71	51.46	51	4:46	–74
			EW	43.35	28	4:01	–78	53.44	57	4:57	–73	53.79	58	4:59	–72
			LW	44.68	31	4:08	–77	58.96	73	5:28	–70	54.10	59	5:01	–72
			ED	42.62	25	3:57	–78	58.20	71	5:23	–70	55.03	62	5:06	–72
Cow 15 yr, 1850	74	285,000	LD	130.39	76	12:04	–33	180.82	144	16:45	–7	166.30	125	15:24	–14
			EW	139.33	88	12:54	–28	172.70	133	15:59	–11	173.81	135	16:06	–11
			LW	143.61	94	13:18	–26	190.53	157	17:38	–2	174.80	136	16:11	–10
			ED	136.96	85	12:41	–30	188.06	154	17:25	–3	177.84	140	16:28	–9
Cow 15 yr, w/calf 1850	~ 74	362,000	LD	162.66	120	15:04	–16	226.07	206	20:56	16	207.92	181	19:15	7
			EW	173.81	135	16:06	–11	215.92	192	20:00	11	217.32	194	20:07	12
			LW	179.15	142	16:35	–8	238.22	222	22:03	23	218.55	195	20:14	12
			ED	170.86	131	15:49	–12	235.13	218	21:46	21	222.34	200	20:35	14
Cow 50 yr, 3300	132	291,000	LD	141.50	7	13:06	–27	194.78	48	18:02	0	179.14	36	16:35	–8
			EW	151.32	15	14:01	–22	186.03	41	17:14	–4	187.24	42	17:20	–4
			LW	155.84	18	14:26	–20	205.24	55	19:00	6	188.30	43	17:26	–3
			ED	148.62	13	13:46	–24	202.58	53	18:45	4	191.56	45	17:44	–1
Cow 50 yr, w/calf 3300	~132	375,000	LD	176.70	34	16:22	–9	244.15	85	22:37	26	224.54	70	20:47	16
			EW	188.80	43	17:29	–3	233.19	77	21:35	20	234.69	78	21:44	21
			LW	194.61	47	18:01	0	257.27	95	23:49	32	236.03	79	21:51	21
			ED	185.60	41	17:11	–5	253.93	92	23:31	31	240.12	82	22:14	24
Bull 15 yr, 2200	88	303,000	LD	140.01	59	12:58	–28	193.91	120	17:57	0	178.35	103	16:31	–8
			EW	149.60	70	13:51	–23	185.21	110	17:09	–5	186.41	112	17:16	–4
			LW	154.20	75	14:17	–21	204.34	132	18:55	5	187.47	113	17:22	–4
			ED	147.06	67	13:37	–24	201.68	129	18:40	4	190.72	117	17:40	–2
Bull 50 yr, 3700	148	310,000	LD	151.83	3	14:04	–22	208.82	41	19:20	7	192.06	30	17:47	–1
			EW	162.23	10	15:01	–17	199.44	35	18:28	3	200.74	36	18:35	3
			LW	167.21	13	15:29	–14	220.04	49	20:22	13	201.88	36	18:42	4
			ED	159.48	8	14:46	–18	217.19	47	20:07	12	205.38	39	19:01	6

ME – metabolizable energy; [a] Mean daily intake, 4% of live weight; [b] LD – late dry, EW – early wet, LW – late wet, ED – early dry, [c] percentage relative to mean daily intake; [d] percentage relative to mean foraging time

3.8 kg less than the intake as calculated in this study, when feeding on mature green mopane leaves solely.

Elephants tend to forage 12–18 hours a day (Owen-Smith 1988). When feeding on mature green mopane leaves only, this bull elephant has to feed for at least 14 hours to achieve its digestible energy requirements, which is within the 12–18 hour range.

What is evident in figure 2 is that the total daily intake is not the highest during the late dry season, which would normally be expected because of the lower amount of energy in woody forage. However, the energy contents of mopane, as derived from Styles and Skinner (1997, 2000), give higher gross energy amounts in the late dry season for mature green leaves and twig bark than in the late wet season.

From our calculations it appears that an adult elephant bull can survive entirely on mature green mopane leaves during the late dry season only in terms of energy requirements, minimum daily intake and available foraging time.

The results in figure 2 and table 3 suggest that not all elephant age and sex classes can survive on mopane parts in terms of intake, as intake is usually more than the daily mean intake (4% of the live weight).

Some comments must be made:

- Metabolizable energy requirements are probably season dependent.
- The conversion rate used here to calculate forage dry matter to wet mass was 2.5 (40%). This value may fluctuate across seasons.
- The maximum intake rate calculated from the number of trunkloads per minute may vary across life stage and sex.
- In these calculations urinary and methane energy loss of 14.13 kJ kg^{-1} d^{-1} and 12.24 kJ kg^{-1} d^{-1} are used. These values are derived from Meissner et al. (1990), who calculated these amounts based on digestibility of 25% and 30%. However, the digestibility calculated in the article by Meissner et al. (1990) is calculated using the lignin index, meaning that digestibility might be overestimated. If this is true, the values for urinary and methane energy losses may be too high.
- Digestibility is probably not stable throughout the year.
- Intake might differ over the seasons.

The effect of secondary compounds on ingestion remains unknown. Mopane trees are known for their high amount of tannins, which could have a negative influence on intake, digestibility and metabolism. Therefore, tannins might influence the quality of mopane as a feed, because they may reduce the availability of nutrients. However, the negative effect of the mopane secondary compounds has not been included in this study, although it could affect the maximum admissible amount of mopane that an elephant can ingest, even when studies have shown that they can feed exclusively on mopane. Mopane makes up a considerable part of the diet for elephants in the northern Namib Desert (Viljoen 1989). In addition Ben-Shahar (1996) claimed that elephants in northern Botswana fed on mopane exclusively. The results of the minimum energy requirement calculations suggest that elephants can indeed survive by feeding on mopane only, although several assumptions incorporated in the calculations make it impossible to draw a hard conclusion as to whether this is so. However, we have shown that elephants seem to be able to survive on mopane entirely, as the energy contents are sufficient for elephants feeding solely on mopane parts during all seasons.

Conclusion

Colophospermum mopane is an important food source in the diet of elephants, especially during the dry season, as it makes up a considerable part of the diet. The nutritive quality of mopane throughout the year is high, and its energy content is sufficient for elephants feeding solely on mopane parts during all seasons to survive, although ingestion and daily foraging time need to be increased to obtain sufficient energy.

Acknowledgements

We would like to thank T. van der Laan for the results of the laboratory measurements, Jelle Ferweda for his mopane leaves, and Dr P. Lee of the University of Stirling for encouraging us to write this article. We are grateful to H.H. Meissner for his cooperation.

References

Aganga AA, Adogla-Bessa T, Omphile UJ, Tshirelets K. 2000. Significance of browses in the nutrition of Tswana goats. *Archivos de Zootecnia* 49:469–480.

Ben-Shahar R. 1996. Do elephants over-utilize mopane woodlands in northern Botswana? *Journal of Tropical Ecology* 12:505–515.

Ben-Shahar R, Macdonald DW. 2002. The role of soil fac-

tors and leaf protein in the utilization of mopane plants by elephants in northern Botswana. *BMC Ecology* 2:3.

Brophy JJ, Boland DJ, Lingen van de S. 1992. Essential oils in leaf, bark and seed of mopane (*Colophospermum mopane*). *South African Forestry Journal* 161:23–25.

De Boer Y. 2003. Elephant distribution in mopane woodlands: a literature analysis. MSc thesis, Animal Ecology, Wageningen University and Research Centre, Wageningen, The Netherlands.

Dekker B, Smit GN. 1996. Browse production and leaf phenology of some trees and shrubs in different *Colophospermum mopane* savanna communities. *African Journal of Range and Forage Science* 13:15–23.

Foose TJ. 1982. Trophic strategies of ruminant versus nonruminant ungulates. University of Chicago. Dissertation.

Lewis DM. 1986. Disturbance effects on elephant feeding: evidence for compression in Luangwa Valley, Zambia. *African Journal of Ecology* 24:227–241.

Mapaure I, Mhlanga L. 2000. Patterns of elephant damage to *Colophospermum mopane* on selected islands in Lake Kariba, Zimbabwe. *Kirkia* 17:189–198.

Meissner HH. 1982. Theory and application of a method to calculate forage intake of wild southern African ungulates for purposes of estimating carrying capacity. *South African Journal of Wildlife Research* 12:41–47.

Meissner HH, Spreeth EB, Villiers PA, Pietersen EW, Hugo TA, Terblanché BF. 1990. Quality of food and voluntary intake by elephant as measured by lignin index. *South African Journal of Wildlife Research* 20:104–110.

Owen-Smith N. 1988. *Megaherbivores: the influence of very large body size on ecology.* Cambridge University Press, Cambridge.

Owen-Smith N. 1993. Comparative foraging strategies of grazing ungulates in African savanna grasslands. In: Baker MJ, ed., *Grasslands for our world: 17th International Grassland Congress, February 1993, New Zealand and Queensland.* SIR Publishing, Wellington, New Zealand. p. 217–223.

Rooke T. 1998. Responses to simulated browsing in five savanna shrubs. Minor Field Studies No. 48. International Office, Swedish University of Agricultural Sciences, Uppsala, Sweden.

Smallie JJ, O'Connor TG. 2000. Elephant utilization of *Colophospermum mopane*: possible benefits of hedging. *African Journal of Ecology* 38:352–359.

Styles CV, Skinner JD. 1997. Seasonal variations in the quality of mopane leaves as a source of browse for mammalian herbivores. *African Journal of Ecology* 35:254–265.

Styles CV, Skinner JD. 2000. The influence of large mammalian herbivores on growth form and utilization of mopane trees, *Colophospermum* mopane, in Botswana's Northern Tuli Game Reserve. *African Journal of Ecology* 38:95–101.

Tilly JMA, Terry RA. 1963. A two-stage technique for the in vitro digestion of forage crops. *Journal of the British Grassland Society* 18:104–111.

Timberlake JR. 1995. Colophospermum mopane: *annotated bibliography and review.* Zimbabwe Bulletin of Forestry Research No. 11. Zimbabwe Forestry Commission, Harare. 49 p.

Viljoen PJ. 1989. Habitat selection and preferred food plants of a desert-dwelling elephant population in the northern Namib Desert, South West Africa/Namibia. *African Journal of Ecology* 27:227–240.

Villiers PA, Pietersen EW, Hugo TA, Meissner HH, Kok OB. 1991. Method of sampling food consumption by free-ranging elephant. *South African Journal of Wildlife Research* 21:23–27.

Walker BH. 1980. A review of browse and its role in livestock production in southern Africa. In: Le Houërou HN, ed., *Browse in Africa: the current state of knowledge*. International Livestock Centre for Africa (ILCA), Addis Ababa, Ethiopia. p. 7–24.

Williamson BR. 1975. The condition and nutrition of elephant in Wankie National Park. *Arnoldia (Rhodesia)* 7:1–20.

Elephant numbers in Kafue National Park, Zambia

*Robert A.R. Guldemond, Emily R. Lehman, Sam M. Ferreira, Rudi J. van Aarde**

Conservation Ecology Research Unit, Department of Zoology and Entomology
University of Pretoria, Hatfield 0028, South Africa
*corresponding author: rjvaarde@zoology.up.ac.za

Abstract

Aerial surveys of Kafue National Park in Zambia suggest that 3729 ± 1602 (SE) elephants were present in the park in 2001 and 1555 ± 447 in 2004. Elephant numbers may have declined between these surveys, but the wide confidence limits do not allow us to define a trend in population. A comparison of our estimates with the outcomes of earlier surveys suggests a decline over the past 14 years. However, both movements of elephants between the park and game management areas and differences in the extent of the areas surveyed confounded comparisons of the census results. To allow for comparisons, future survey designs should include both the park and the game management areas.

Additional keywords: aerial survey, estimate precision, game management areas, population growth

Résumé

Des études aériennes du Parc National de Kafue, en Zambie, suggèrent que 3729 ± 1602 éléphants vivaient dans le parc en 2001 et 1555 ±447, en 2004. Les chiffres pourraient avoir baissé entre ces deux études, mais les grandes marges de confiance ne nous permettent pas de définir un e tendance pour cette population. Une comparaison de nos estimations avec les résultats d'études antérieures suggère un déclin depuis 14 ans. Cependant, les déplacements des éléphants entre le parc et les aires de gestion de la faune, et des différences de superficie entre les aires étudiées rendent caduques les comparaisons entre les résultats des recensements. Pour permettre de telles comparaisons, les futures études devraient inclure le parc et les aires de gestion de la faune.

Mots clé supplémentaires : recensement aérien, precision d'estimation, aires de gestion de la faune, la croissance de population

Introduction

A worldwide ban on elephant products (Stiles 2004) assisted the anti-poaching programmes the Zambian Wildlife Authority launched or sanctioned to deal with their waning elephant populations (Lewis 1989; Jachmann and Kalyocha 1994). One of these regions was Kafue National Park and its surrounding game management areas. The number of elephants present in the region apparently declined. Since the mid-1980s, though, control of poaching has been high on the management agenda (Lewis 1989; Lewis and Alpert 1997). Such management may have led to an increase in Kafue's elephant numbers. Here we provide details of two recent estimates of population size to evaluate trends in elephant numbers in the park.

Study area

Kafue National Park is situated in south-central Zambia between 14°03'–16°43' S and 25°13'–26°46' E; it covers an area of 22,480 km^2 (Mwima 2001). There are no fences between the park and the adjacent game management areas (fig. 1). Yearly rainfall ranges from 600 mm in the south to 1200 mm in the north of the park (NPWS/JICA 1999), with the rainy season extending from October to April (Mwima 2001). Mixed woodlands (Kalahari sandveld, miombo and mopane), *Baikiaea* forests, termitaria vegetation and seasonally flooded grasslands are the key features of the landscape (NPWS/JICA 1999).

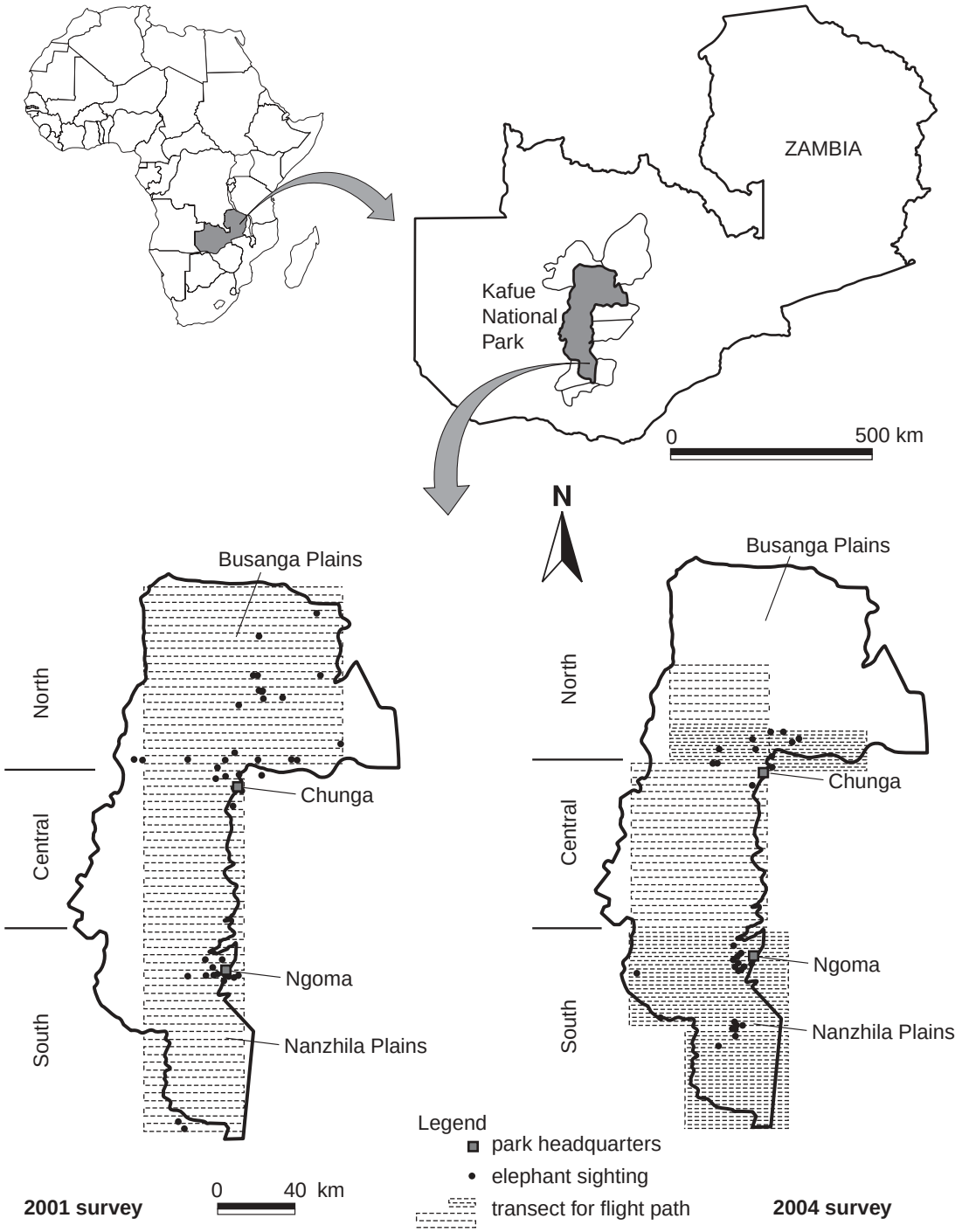


Figure 1. Kafue National Park and surrounding game management areas are situated in south-central Zambia. Transects overlying the park indicate the flight paths for the 2001 (left) and 2004 (right) elephant surveys. The south, central and northern strata used for each year are illustrated. Elephant sightings centred on the southern (Ngoma) and northern (Chunga) headquarters, the Nanzhila Plains in the south and the Busanga Plains in the north.

Materials and methods

We opted for aerial surveys that allow for rapid assessment of large numbers of animals spread over vast areas (Norton-Griffiths 1978). Fairall and Kampamba (2001) reported on our September 2001 survey, but we re-analysed the raw data in our present report. We surveyed the southern sector of the park in September 2004 and the central and northern sectors during the first week of the following November. The onset of the rainy season and aircraft failure did not allow us to complete the 2004 survey of the park's northernmost regions. Here, seasonal movements induced by the onset of the rainy season could violate survey assumptions and potentially bias a population estimate (Caughley 1974).

We used GIS techniques to place strip transects systematically across most of the park, some of which overlapped with the adjacent game management areas (see fig. 1). During 2001, coverage within the survey area was 21%. For this survey, we placed markers on the windows of a Cessna 210 to represent 420 m on the ground on each side of the aircraft. The aircraft flew at 160 km h^{-1} and maintained a height of 160 m above the ground. No radar altimeter was available. The landscape of the park is relatively flat and we thus assumed that the height measured using a conventional altimeter was relatively constant. Two observers, one positioned on each side of the aircraft, recorded elephant data and relayed information via intercom to a survey coordinator.

The 2001 survey consisted of 70 transects and the 2004 survey of 113. Following our correction of strip width, the 2001 survey covered 21% of the survey area (fig. 1).

During 2004, we sampled predetermined strata at various intensities based on the expected elephant distribution noted in the 2001 survey. We surveyed areas where we expected large numbers of elephants in 81 transects at 43.2% (transects spaced at 1 nautical mile) and those where we expected low numbers in 32 transects at 21.6% (transects spaced at 2 nautical miles) (fig. 1). For this survey, we placed markers on the Cessna 210 wing struts to represent 400 m on the ground on each side of the plane flying 100 m above the ground. We maintained a flying speed of 175 km h^{-1} during surveys, using an aircraft-fitted global positioning system to track our flying path. The pilot maintained height using a radar altimeter. For both surveys, we used standard techniques (see Norton-Griffiths 1978) to calibrate and verify strip width.

During the 2004 survey, each of the two observers used a Canon EOS 10D digital SLR camera to take multiple images of elephants found along transects. From these we counted the numbers of elephants that we saw in each transect.

Analyses

The clumped distribution of elephant sightings required us to use a stratified analysis to get a more precise population estimate (Caughley 1977). We therefore distinguished between the southern, central and northern sectors of the park. We based our population estimates for each of these sectors on method II of Jolly (1969) for transects of unequal sizes using a sample design without replacement of transects.

Fairall and Kampamba (2001) used all the elephant sightings they made up to 2000 m on each side of the flight path during September 2001. Their estimate of 2194 elephants had wide confidence limits (95% confidence interval: 768–3620, confidence limit = 65%) and was based on the assumption that they saw all the elephants within such a wide strip. Their effort to correct for this by analysing distance data in a distance-sampling design yielded an estimate of 2141 with an even wider confidence limit (95% confidence interval: 983–4662, confidence limit = 86%). In an effort to reduce confidence limits and minimize the influence of distance on estimates, we opted to recalculate this 2001 estimate. For this we used only the data collected between 80 and 500 m on either side of the aircraft and Jolly's method II (1969).

We used estimates to calculate densities for each of the three sections of the park and used these to extrapolate section-specific population sizes. The population sizes were the product of densities and area, while the variances in population sizes came from the products of variance in density and area squared (Glen et al. 2004). Our estimate of population size for the park is the sum of the values for each of the three sections for each survey year. Variances for these estimates were the sum of all the section-specific variances (Spiegel 1975). We calculated population growth rate (see Caughley 1977) using estimates extracted from the literature for the park's elephants over the last 14 years.

Results

During the 2001 survey, 1096 elephants were recorded at 42 locations while we recorded 582 elephants on

38 occasions during the 2004 surveys. Sightings were clumped and most elephants were seen in either the south or the north sections during 2001 and 2004 (fig. 1). Most were in the proximity of the park's southern and northern headquarters, as well as on the Nanzhila Plains.

Our estimate (± SE) of 3798 ± 1635 elephants for the 2001 survey area is higher than that estimated by Fairall and Kampamba (2001). Our approach did not reduce the 95% confidence interval (our estimate: 6408; Fairall and Kampamba's (2001) estimate: by Jolly's method 2852 and by distance estimate 3679), but had a confidence interval of 84.4%, which is similar to that of the distance estimate (86%) and higher than that of Jolly's estimate (65%). Our extrapolation yielded an estimate of 3729 ± 1602 elephants for the park in September 2001 (table 1).

The survey in 2004 yielded an estimate of 1337 ± 451 (95% confidence interval: 452–2221) elephants for the survey area (table 1). The percentage confidence interval was 66.2%. Our extrapolation yielded an estimate of 1555 ± 447 elephants for the park during the 2004 surveys (table 1).

Earlier estimates of the elephant population in the Kafue region were based on either surveys of the park alone or surveys that also included the game management areas (table 2). Estimates ranged widely, and though mostly imprecise, they suggest that elephant numbers in the park decreased by 9.3% per year over the past 14 years ($F_{1,6} = 6.66$, $p = 0.04$) (fig. 2). We noted no trend in the percentage confidence limits over time ($F_{1,2} = 0.23$, $p = 0.67$).

Discussion

Elephant numbers are increasing across most of southern Africa (see Blanc et al. 2005), but this may not hold for Zambia (see table 2 in Blanc et al. 2005). Given the anti-poaching campaigns across the Kafue region (see Lewis 1989), we expect that elephant numbers in Kafue National Park would show signs of recovery, especially when considering that elephants used to occur here in higher numbers (see table 2). The census estimates reported here do not support our expectation (fig. 2). This could be for several reasons, the most important being inconsistent survey designs.

The precision of repeated estimates affects the confidence in calculated population growth rates. For instance, the conditions that give rise to possible estimate biases should always be taken into account (Caughley 1974, 1977). To improve estimates we limited the effect of survey effort (Craig 1993) by using systematic aerial surveys that covered 21–43.2% of the area. It is not clear if this was the case in earlier surveys across the Kafue region. During the 2004 survey we maximized our ability to count the correct number of ele-phants in large herds by using aerial digital photography (Redfern et al. 2002) and kept our search rate per observer relatively low (1.16 km^2 min^{-1}). Even so, we realize that our surveys yielded estimates that do not necessarily represent true population sizes. We recognize that estimates also may be influenced by observer fault (see Watson et al. 1981) and by elephants that may not be available for the sample or if they are, are not detectable (see Beavers and Ramsey 1998).

Table 1. Elephant population and density estimates for the southern, central and northern sectors of Kafue National Park, Zambia, from the 2004 and recalculated 2001 surveys (only elephants seen within the first 500-m survey strip)

	South				Central				North				Total			
	2001[a]	2001[b]	2004[a]	2004[b]	2001[a]	2001[b]	2004[a]	2004[b]	2001[a]	2001[b]	2004[a]	2004[b]	2001[a]	2001[b]	2004[a]	2004[b]
Population estimate	2220	2063	1055	810	11	14	102	163	1566	1651	180	582	3798	3729	1337	1555
Standard	1274	1184	436	335	11	14	81	130	1024	1080	82	266	1635	1602	451	447
Upper 95% CL	4717	4388	1910	1467	34	42	261	417	3573	3768	341	1103	7002	6869	2221	2431
Lower 95% CL	–277	–257	199	153	–11	–14	–57	–91	–441	–465	19	61	594	588	452	679
Density	0.354		0.152		0.002		0.025		0.141		0.049					

We report estimates for the survey areas representing each stratum and, by extrapolation, for the corresponding areas of Kafue National Park.
[a] estimate for the survey area; [b] estimate after proportional linear extrapolation; CL – confidence limit

Table 2. Elephant population estimates for Kafue National Park and adjacent game management areas (GMAs), 1991–2004

Year	Total	Kafue National Park	Kasonso–Busanga GMAs	Lunga–Luswishi GMAs	Mumbwa GMA	Namwala GMA	Sichifula & Mulobezi GMAs	Reference
1991	10263	5927 (2919–8935)	–	125 (0–351)	2538 (0–6486)	–	1673 (0–3789)	Said et al. 1995
1994	3862	3862	–	–	–	–	–	Yoneda and Mwima 1994
1995	3840	3840	–	–	–	–	–	Yoneda and Mwima 1995
1996	4980	4482 (1260–7704)	0	0	124 (0–229)	–	374 (0–1060)	Zyambo 1997
1997	5250	5250	–	–	–	–	–	NPWS/JICA 1999
1999	4104	1453	–	–	2435 (0–3017)	216 (0–627)	–	Jachmann 2000
2001	3729	3729 (588–6869)	–	–	–	–	–	This study
2004	1555	1555 (679–2431)	–	–	–	–	–	This study

Values in brackets refer to the 95% confidence interval. All estimates are based on aerial surveys.

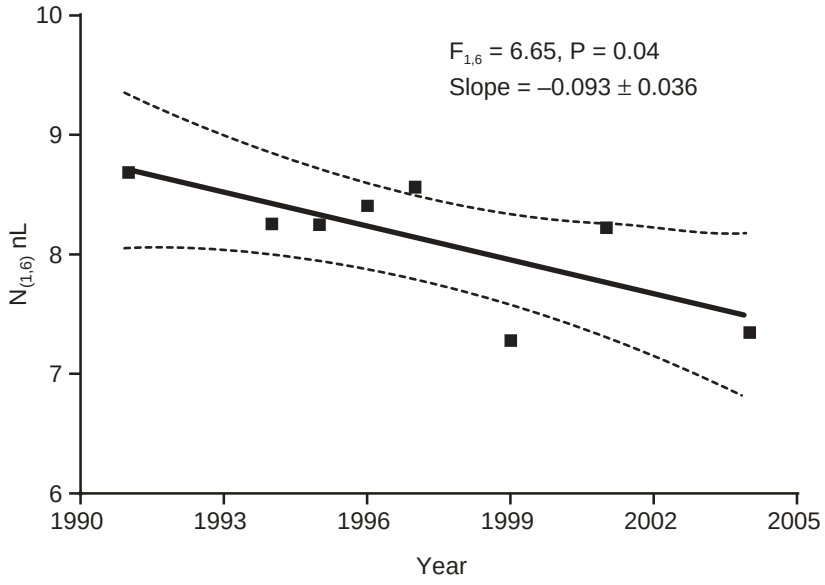


Figure 2. The natural logarithm of the number of elephants (N_t) recorded in Kafue National Park and the surrounding game management areas since 1990. The slopes of the linear regressions provide estimates of the exponential growth in population sizes. Elephant numbers appear to have decreased from 1991 to 2004.

We are concerned with factors underlying the continued decline of elephant numbers estimates (see fig. 2) in the park. Ignoring the confounding influences of survey design, factors such as poaching, changes in ranging behaviour, distributional ranges and vegetation cover may account for the declining estimates. The uneven distribution of elephants across the park, however, is probably one of the most important variables limiting estimates and their precision.

Our surveys suggest that at the end of the dry season elephants in the park occur in two discrete areas. These areas are associated with the two park headquarters, and the clumped distributions we observed may be related to apparent localized protection from poaching. Alternatively, landscape conditions may explain these localities—for instance, historical records suggest that Ngoma Forest adjacent to the present southern headquarters served as an elephant stronghold (J. Hanks, pers comm.).

Population growth of elephants varies (Jaarsveld et al. 1999; Slotow et al. 2005) but cannot exceed 7% per year for long periods (Calef 1988). Aerial counts of elephants at yearly intervals seldom provide data that are precise enough to estimate intrinsic population growth rates. In spite of this, repeated estimates often define growth rates in elephant populations (for example Blanc et al. 2005). Before calculating population growth, managers should carefully consider trends defined by repeated aerial surveys. They may improve the precision of calculated trends by increasing the number of survey efforts or, alternatively, using demographic variables to model potential changes in their elephant populations. Due to the imprecision of surveys in Kafue National Park during the past 14 years, we cannot evaluate whether the long-term decline in numbers continues. In the future, emphasis needs to be placed on survey intensities, with resources channelled to cover the expected distributional range of elephants as part of a national survey strategy, rather than site-specific yearly counts.

Acknowledgements

Conservation Foundation Zambia, the International Fund for Animal Welfare (IFAW) and CERU provided financial support. The Director of Research and Planning of the Zambian Wildlife Authority, Mr George Kampamba, sanctioned the census. We would like to extend a special word of thanks to Alan and Kim Parnass of Wings4Wildlife Inc. and Ed Smythe for the use of their aircraft during the surveys. Jeremy Pope of Conservation Foundation Zambia played an instrumental role in arranging the logistics to ensure the success of the 2004 survey. Ian Whyte, Anouska Kinahan, Tim Jackson and Johan Fourie helped in observing elephants and analysing the digital images.

References

Beavers SC, Ramsey FL. 1998. Detectability analysis in transect surveys. *Journal of Wildlife Management* 62:948–957.

Blanc JJ, Barnes RFW, Craig CG, Douglas-Hamilton I, Dublin HT, Hart JA, Thouless CR. 2005. Changes in elephant numbers in major savanna populations in eastern and southern Africa. *Pachyderm* 38:19–28.

Calef GW. 1988. Maximum rate of increase in the African elephant. *African Journal of Ecology* 26:323–327.

Caughley G. 1974. Bias in aerial survey. *Journal of Wildlife Management* 38:921–933.

Caughley G. 1977. *Analysis of vertebrate populations*. John Wiley & Sons Ltd., New York.

Craig GC. 1993. Plenary paper one: options for aerial surveys of elephants. *Pachyderm* 16:15–20.

Fairall N, Kampamba G. 2001. *Aerial census of Kafue National Park.* CERU Technical Report 10, CERU, University of Pretoria.

Glen AG, Leemis LM, Drew JH. 2004. Computing the distribution of the product of two continuous random variables. *Computational Statistics and Data Analysis* 44: 451–464.

Jaarsveld AS van, Nicholls AO, Knight MH. 1999. Modelling and assessment of South African elephant *Loxodonta africana* population persistence. *Environmental Modelling and Assessment* 4:155–163.

Jachmann H. 2000. Abundance of wildlife in Mumbwa GMA (west), Namwala GMA (west) and Kafue National Park (central), December 2000. Unpublished report to USAID/WRMU, Environmental Council of Zambia, Lusaka.

Jachmann H, Kalyocha G. 1994. *Surveys of large mammals in 9 conservation areas of the Central Luangwa Valley (1994).* LIRDP, Chilanga, Zambia.

Jolly GM. 1969. Sampling methods for aerial censuses of wildlife populations. *East African Agriculture and Forestry Journal* 34:46–49.

Lewis D. 1989. Zambia's pragmatic conservation programme. *Pachyderm* 12:25–27.

Lewis DM, Alpert P. 1997. Trophy hunting and wildlife conservation in Zambia. *Conservation Biology* 11:59–68.

Mwima HK. 2001. A brief history of the Kafue National Park, Zambia. *Koedoe* 44:57–72.

[NPWS/JICA] National Parks and Wildlife Services/Japan International Cooperation Agency. 1999. Kafue National Park General Management Plan. NPWS Departmental Report.

Norton-Griffiths M. 1978. *Counting animals*. 2nd edition. African Wildlife Foundation Technical Handbook No. 1. African Wildlife Leadership Foundation, Nairobi.

Redfern JV, Viljoen PC, Kruger JM, Getz WM. 2002. Biases in estimating population size from an aerial census: a case study in the Kruger National Park, South Africa. *South African Journal of Science* 98:455–461.

Said MY, Chunge RN, Craig GC, Thouless CR, Barnes RFW, Dublin HT. 1995. *African elephant database 1995*. IUCN, Gland, Switzerland.

Slotow R, Garai ME, Reilly B, Page B, Carr R. 2005. Popu

lation dynamics of elephants re-introduced to small fenced reserves in South Africa. *South African Journal of Wildlife Research* 35:23–32.

Spiegel MR. 1975. *Schaum's outline of theory and problems of probability and statistics.* Schaum's Outline Series. McGraw-Hill, New York.

Stiles D. 2004. The ivory trade and elephant conservation. *Environmental Conservation* 31:309–321.

Watson RM, Tippett CI, Jolly GM. 1981. The static model sampling strip for investigating observer bias in aerial surveys. In: Grimsdell JJR, Westley SB, eds., *Low-level aerial survey techniques.* ILCA/ILRI Monograph 4. International Livestock Centre for Africa, Addis Ababa.

Yoneda K, Mwima HK. 1994. Report on the aerial census of large mammals in the Kafue National Park, 1994. National Parks and Wildlife Services departmental report, Chipata, Zambia.

Yoneda K, Mwima HK. 1995. Report on the aerial census of large mammals in the Kafue National Park, 1995. National Parks and Wildlife Services departmental report, Chipata, Zambia.

Zyambo P. 1997. Aerial sample counts of large mammals in Kafue National Park and seven surrounding game management areas. National Parks and Wildlife Services, Chipata, Zambia.

Demography of a confined elephant population and the potential consequence of translocation: the case of Sweetwaters Game Reserve, Kenya

Patrick O. Ogola and Patrick O. Omondi

Elephant Programme, Kenya Wildlife Service, PO Box 40241, Nairobi, Kenya
email: ogolapatrick@yahoo.com

Abstract

The demography of elephants at Sweetwaters Game Reserve in Kenya was studied between February and July 2001 and the results were compared with a similar study done in 1992–1993. This study documented demographic changes in the population following 10 years of confinement. The 120 elephants encountered comprised 100 elephants in 12 cow–calf groups and 20 independent bulls aged 10 years and older. Groups involving cows accounted for 59% of elephant sightings. The structure of the population was represented by 9.6% calves aged 1 year and younger, and 49.6% females aged above 12 years. In line with models of an elephant population increasing at a high rate, an estimated 94% of the females in the population were observed to associate closely with calves thought to be their offspring. The number of groups had increased, but the average group size had decreased between 1993 and 2001, which indicates that the population was secure.

Additional key words: fencing, recruitment, age structure, sex ratio

Résumé

On a étudié la démographie des éléphants de la Réserve de Faune des Sweetwaters, au Kenya, entre février et juillet 2001, et on a comparé les résultats à ceux d'une étude similaire réalisée en 1992-1993. Cette étude documentait les changements démographiques de la population suite à 10 années de confinement. Les 120 éléphants rencontrés se partageaient entre 100 éléphants divisés en 12 groupes composés de femelles et de jeunes et 20 mâles indépendants âgés de 10 ans et plus. Les groupes de femelles comptaient pour 59% des observations d'éléphants. La structure de la population comptait 9,6% de jeunes d'un an ou moins et 49,6% de femelles âgées de plus de 12 ans. Correspondant au modèle d'une population croissant à un rythme élevé, on estime que 94% des femelles de la population étaient étroitement associées à des jeunes dont on pense qu'ils étaient les leurs. Le nombre de groupes avait augmenté, mais la taille moyenne du groupe avait diminué entre 1993 et 2001, ce qui indique que la population était en sécurité.

Mots clés supplémentaires : fencing, recrutment, structure d'âge, sexe ratio

Introduction

Populations of the African elephant, *Loxodonta africana* (Blumebach, 1797), in East Africa suffered seriously from poaching in the 1970s and 1980s (Douglas-Hamilton 1987; Poole et al. 1992). Poaching caused not only a decline in elephant numbers but also unprecedented distortion of the social organization of affected populations (Chanda and Tembo 1993; Njumbi 1993; Sherry and Tattersall 1996). In Laikipia District in Kenya, the elephant problem of crop raiding and loss of human life and property due to elephant attacks began when the elephants moved south from Isiolo and Samburu Districts in the 1950s in search of food and water (Thouless 1993), and it intensified in the 1970s due to intense poaching (Poole et al. 1992; Thouless 1993). Tight security in private ranches such as the Ol Pejeta Ranch in Laikipia Dis-

trict provided refuge to the fleeing elephants. However, with time the mostly fenced ranches could not support the growing numbers. As a result, elephants started breaking out of the ranches in search of resources such as food, resulting in high management costs. Outside the sanctuaries and ranches, human population continues to increase and with it greater demand for land. As the proximity of human settlement and activities to the conservation areas increases, human–wildlife conflicts, particularly with elephants, intensifies. Human–elephant conflict in Laikipia District is serious as the district has the country's largest elephant population outside protected areas, estimated at 3241 (Omondi et al. 2002a).

In Sweetwaters Game Reserve, crop raiding, destruction of property, and loss of human life have resulted in negative attitudes toward wildlife conservation and the high cost of maintaining fences. These factors led the Kenya Wildlife Service (KWS) to search for a feasible wildlife management solution. Under this backdrop KWS adopted elephant translocation as a management tool to address the problems while securing a future for the elephants.

Here we discuss the results of a demographic study of individually identified elephants and compare our findings with those of a similar study conducted eight years earlier (Omondi et al. 1993). We also estimate the size of the population in 1989 at the time of fencing, provide the age and sex structure of the population after the subsequent 2001 translocation of 56 elephants from Sweetwaters, and predict the likely consequences for the population that will result from these elephants having been removed.

Study area

Sweetwaters Game Reserve, located about 25 km west of Nanyuki, Kenya, covers an area of approximately 95 km^2; it is completely fenced electrically (fig. 1). The fence was constructed in 1989 when the reserve was opened as a rhino sanctuary and black rhinos were brought in from Lake Nakuru National Park. The fence was intended to provide tight security for the black rhinos to promote population recovery. The fencing also confined many other mammals including elephant, buffalo, giraffe, zebra and waterbuck. With time, the tight security provided a favourable environment for reproduction, and soon populations of most of the confined mammals increased significantly (Birkett et al. 2000). In the late 1990s, the reserve management expressed concern about the rising occurrence of human–wildlife conflict. Male elephants were largely identified by management as responsible for the escalation. Thouless and Sakwa (1995) reported that bull elephants exhibited a greater tendency than cow–calf groups to try to break through electric fences.

Confinement has also eventually led to habitat destruction. Vegetation in the reserve consists of *Euclea divinorum*, which dominates much of its southern half, while *Acacia drepanolobium* bush and expansive grasslands cover much of its north. Elephants were reported to exert great pressure on mixed stands of these species, which are the preferred breeding grounds of the endangered black rhino (Birkett et al. 2000). Dying *Balanites glabra* shoots, particularly in the central and northern parts of the reserve, are also an emerging sign of declining habitat quality and quantity (Ogola, pers. obs.).

Methods

We carried out a reconnaissance survey at the beginning of the study to locate places such as water points, salt licks and a central marshy area that park management and tour guides knew the elephants frequented.

Collection of demographic data

Elephant encounters were opportunistic, but searches were concentrated around water points, artificial salt licks and the marshy area in the central part of the reserve. We used basic individual elephant recognition techniques (Laws 1966; Douglas-Hamilton 1972; Moss 1988) to study the demographic status of the population. We developed an identikit of the population based on unique features on elephant ears such as nicks, notches, holes and in some cases general ear shape. Additionally, notes on any other conspicuous features such as patches of dry tissue on the body, nature of tusks or physical deformities were made in field notes to improve the accuracy of the identikit.

Physical features such as pronounced sexual dimorphism in body size (for adults), external genitals, side view of head shape, and nature of tusks were used to sex the elephants (Moss 1996). The shoulder-height index (Laws 1966), visually determined in combination with other features (Laws 1966; Douglas-Hamilton 1972; Moss 1996), was used to determine their age. The same method for registering individual elephants

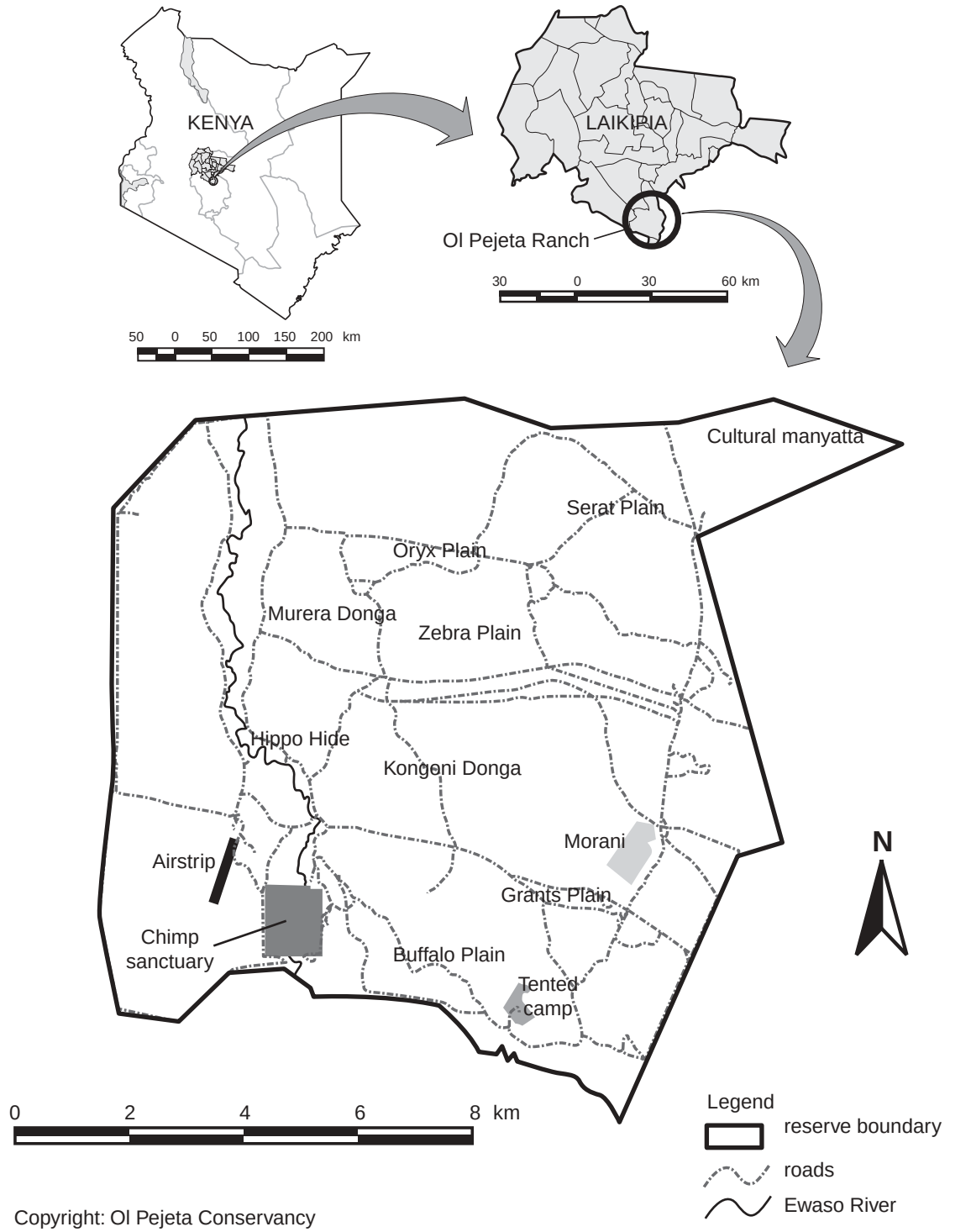


Figure 1. Sweetwaters Game Reserve in Laikipia District lies in the southern part of a contiguous complex comprising fenced ranches and free wildlife ranges.

was used by Omondi and colleagues in the early 1990s to study the demography of the population. The use of similar methodology in the two studies made it possible to compare the results.

Determination of maternity

Elephants live in a semi-closed matrilineal system in which females stay in their natal groups while males go out after attaining maturity (Douglas-Hamilton 1972; Moss 1988). Consequently, quantified data on association between cows and calves makes it possible to delimit family units and to predict maternity. At each encounter of a cow–calf group, considerable time was spent with the group to establish sibling relationship or maternity. Maternal relationship was confirmed when a cow was seen associating closely with a calf during all sightings of the pair and when that calf was not seen to associate closely with another cow. These relationship inferences may not always be accurate, as caregiving by non-mothers, known as allomothering or foster-mothering, in case of death has been reported for elephants (Lee 1987). However, we spent considerable time with each group during each sighting to determine mother–child relationship, and such associations were considered only when they were observed in every sighting of the group.

Results

During the 2001 study, 120 elephants in 12 cow–calf groups and individual bulls aged 10 years and above were catalogued (table 1). Groups with cows accounted for approximately 59% of all group sightings, and group sizes remained relatively stable throughout the study period. The average population group size was 7.02 (n = 136, range = 1 to 34); for bull groups the mean was 1.64 (n = 33) and for cow–calf groups mean was 8.43 (n = 103). Among the 12 cow–calf groups, 10 were discrete and exhibited localized habitat-use patterns, which made it further possible to distinguish between groups. However, the other two groups, which were larger in size and had the oldest matriarchs, were observed to aggregate consistently. We established 17 mother–child relationships by keenly monitoring cow–calf associations between 6 cows and 17 calves. Calving interval, obtained by averaging the number of years between any two calves thought to be of the same mother, was estimated at 3.82 ± 1.02 years (n = 11, range = 2 to 4 years).

Although available data were inadequate for determining age at first reproduction, one female of about 12 years gave birth during the study. Omondi et al. (1993) had found 61 elephants in 5 cow–calf groups in the following age structure: 16 elephants aged less than 5 years, 24 aged 5–10 years, and 21 older than 10 years. In addition, 22 bulls comprising 4 aged 10–15 years and 18 aged over 20 years were counted in the previous study. The age structure of the population obtained by the two studies was significantly different (χ^2 = 23.811, $p < 0.001$); there were more calves younger than 5 years of age but fewer calves aged 5–10 years in 2001 than in 1993. There were more elephants over 10 years of age in 2001 than in 1993: 43 in 1993 and 65 in 2001. In addition, the number of cow–calf groups had also increased while the average group size had decreased: 5 groups with 21.2 mean group size in 1993 and 12 groups with 8.43 mean size in 2001.

Using demographic data from 1993 and 2001, it was possible to estimate the number of elephants that were initially confined by the electric perimeter in 1989. All elephants aged over 10 years were probably initially confined when the fence was put up. Although there were some elephant break-ins immediately after the fence was erected, later fence-breakers were known and times of breakages predictable (J. Koskei, pers. comm.). The age structure obtained through individual identification in 2001 suggests an estimate of 62 elephants in 1989, including 27 females then aged at least 12 years. Consequently, the average annual recruitment in the 10-year period was estimated at about 6 calves, which represents an annual growth rate of approximately 10%.

Discussion

The elephant population in Sweetwaters Game Reserve remained largely confined from 1989 to the present study in 2001, except for initial elephant break-ins and the predictable movements in and out of the reserve by about nine known notorious fence-breaking males.

The increase in the number of cow–calf groups and their decreased average size besides their discrete or localized nature of habitat use indicated that the population was secure (Douglas-Hamilton 1972). The structure of the population was represented by 9.6% calves aged 1 year and less and 49.6% females aged above 11 years, which is taken as the age of first re-

production in most elephant populations (Poole 1996). Such an age structure is consistent with the criteria of a stable population that is increasing at maximum rate (Calef 1988). Nevertheless, the data also suggest that at the time of confinement, the population was not in line with some of Calef's (1988) assumptions of a maximum population growth model such as active reproduction by all adult females and a 50 : 50 sex ratio. In addition, the population may have experienced a reproduction hiatus following fencing, as depicted by the low number of elephants aged 5–10 years, which might have disrupted the social organization of the population.

Table 1. Age and sex structure of the Sweetwaters elephant population before and after the 2001 translocation

	Before translocation		After translocation	
	Female	Male	Female	Male
Age class (years)				
0–4.9	15	33	8	20
5–9.9	3	4	0	2
10–14.9	2	14	0	11
15–19.9	3	3	0	3
20–34.9	24	3	13	1
35–49.9	12	4	6	0
50+	0	0	0	0
Total	59	61	27	37
Sex				
Calves & subadults less than 20 years (no.)	23	54	8	36
Sex ratio	1	2	1	5
Adults 20 yr and older (no.)	36	7	19	1
Sex ratio	5	1	19	1

The disproportionate sex ratio and the possible negative lock-in lock-out effect of fencing on reproduction reinforce the view that the many free-ranging elephants outside the reserve continued to regulate the population, at least during the early 1990s before movements in and out of the reserve became predictable and involved known individuals. Kerr (1978) showed that in a population growing at maximum rate about 95% of the female elephants are either pregnant or lactating. In Sweetwaters Game Reserve, 94% of the cows of reproductive age were observed to associate closely with calves that were thought to be their offspring, a result that strongly suggests that the population was increasing at a high rate. The growth rate that we estimated to have occurred between 1989 and before the translocation in 2001 is very high, and our hypothesis is that part of that growth was due to immigration of elephants immediately following the completion of the fence.

Nevertheless, the high growth rate of the population, inferred from the associations between cows and calves, was thought to be a result of natural increase due to improved security from the fence and a daily network of ground patrols. It must, however, be pointed out that the minimum calving interval of 2 years could have arisen due to underestimation of age of some calves. A calving interval of 2.9 years, which is not largely different from our estimate, has been reported (Poole 1996).

The differences in age structure obtained from the results of the previous and present studies may be explained by natural recruitment, initial break-ins following the confinement, the translocation of 10 elephants in 2000, and the death of 3 elephants the same year (James Koskei, pers. comm.). The bulls that were identified in the previous study and not located in this one are thought to have either died or broken out of the reserve. It is also possible that some of those bulls were translocated to Meru National Park in 2000, although we could not verify this as individual translocated elephants were not identified.

After 57 elephants including 5 casualties were translocated to Meru National Park (Omondi et al. 2002b), leaving a biased adult sex ratio of 19 females to 1 male, the growth rate of the population is likely to be low. Despite the fact that the number of female individuals in a population plays a significant role in influencing population growth, it is possible that the Sweetwaters population may experience a reproduction hiatus due to the skewed adult sex ratio. The oldest male left in the population was aged 20–25 years, an age at which males do not take part in 'serious' copulation (Moss and Poole 1983).

It is possible, however, that this hiatus may not happen, given elephants' reproductive flexibility: in

disturbed populations, males 20–25 years old have been reported to enter musth and mate (McKnight 2000 for the African elephant and Sukumar 1989 for the Asian elephant).

Furthermore, identifying and subsequently translocating discrete family units, which is thought to be important for reducing any trauma associated with translocation in the donor population, is likely to decrease the chance of a break in reproduction. Also, given the high number of free-ranging elephants in the district, other mature bulls may break into the reserve to occupy 'mating space' left by the translocated bulls, albeit with high maintenance costs.

Acknowledgements

Funding for this study was provided by the Kenya Wildlife Service, Save the Elephants and the management of Sweetwaters Game Reserve. We are grateful to Messrs Richard Vigne, James Koskei and Nathan Gichohi of Sweetwaters and Elphas Bitok and Rose Mayienda of the Kenya Wildlife Service. We also extend our sincere thanks to Prof. Jeanne Altmann and Richard Odhiambo for their role in improving the manuscript.

References

Birkett A, Musyoki C, Bitok E. 2000. An ecological assessment of Sweetwaters Rhino Sanctuary. Unpublished report to Kenya Wildlife Service.

Calef WG. 1988. Maximum rate of increase in the African elephant. *African Journal of Ecology* 26:323–327.

Chanda G, Tembo A. 1993. Status of elephants on the Zambian bank of the middle Zambezi Valley. *Pachyderm* 16:48–58.

Douglas-Hamilton I.1972. On the ecology and behaviour of the African elephant. PhD thesis. University of Oxford.

Douglas-Hamilton I. 1987. African elephants: population trends and their causes. *Oryx* 21(1):11–24.

Kerr MA. 1978. The reproduction of elephants in the Mana Pools National Park, Rhodesia. *Arnoldia Rhodesia* 8(29):1–11.

Laws RM. 1966. Age criteria for the African elephant, *Loxodonta africana africana*. *East African Wildlife Journal* 4:1–37.

Lee PC. 1987. Allomothering among African elephants. *Animal Behaviour* 35:287–291.

McKnight B. 2000. Changes in elephant demography, reproduction and group structure in Tsavo East National Park (1966–1994). *Pachyderm* 29:19–24.

Moss CJ. 1988. *Elephant memories: thirteen years in the life of an elephant family.* William and Morrow, New York.

Moss CJ. 1996. Getting to know a population. In: Kangwana K, ed., *Studying elephants*. AWF Technical Handbook Series 7, African Wildlife Foundation, Nairobi.

Moss CJ, Poole J. 1983. Relationships and social structure in African elephants. In: Hinde RA, ed., *Primate social relationships: an integrated approach*. Blackwell Scientific Publications, Oxford.

Njumbi SJ. 1993. Effects of poaching on the population structure of elephants in Meru National Park. MPhil, Moi University.

Omondi P, Litoroh M, Njiraini N. 1993. Elephant Fertility Regulation Programme, Phase 1: Elephant Identification. Elephant Programme. Report to Kenya Wildlife Service, Nairobi.

Omondi P, Bitok E, Mayienda R. 2002a. Laikipia–Samburu total aerial count of elephants, buffaloes and rhinos. Report to Kenya Wildlife Service, Nairobi.

Omondi P, Wambwa E, Gakuya F, Bitok E, Ndeere D, Manyibe T, Ogola P, Kanyingi J. 2002b. Recent translocation of elephant family units from Sweetwaters Rhino Sanctuary to Meru National Park, Kenya. *Pachyderm* 32:39–48.

Poole J. 1996. Getting to know a population. In: Kangwana K, ed., *Studying elephants*. AWF Technical Handbook Series 7. African Wildlife Foundation, Nairobi.

Poole JH, Aggarwal N, Sinange R, Nganga S, Broten M, Douglas-Hamilton I. 1992. The status of Kenya's elephants. Kenya Wildlife Service and Kenya Department of Resource Surveys and Remote Sensing, Nairobi.

Sherry BY, Tattersall FH. 1996. The loss of a population of elephants in the middle Shire Valley, southern Malawi. *Pachyderm* 22:36–43.

Sukumar R. 1989. *The Asian elephant: ecology and management.* Cambridge University Press, Cambridge.

Thouless CR. 1993. Laikipia Elephant Project, final report. Unpublished report to Kenya Wildlife Service.

Thouless CR, Sakwa J. 1995. Elephant fences in northern Kenya. In: Daniel JC and Datye HS, eds. *A week with elephants.* Proceedings of the International Seminar on the Conservation of Asian Elephants, Mudumulai Wildlife Santuary, June 1993. Bombay Natural History Society and Oxford University Press, Bombay. p. 525–528.

Habitat selection by bull elephants in central Zimbabwe

Ferrel V. Osborn

24 Luisa Way, Hout Bay, Cape Town, South Africa; email: fvosborn@elephantpepper.org

Abstract

A sample of bull elephants was monitored over two years and the habitats in which they were found are presented. No seasonal preferences were identified but a significant selection was noted for three out of the eight woodland types used in the analysis. A method, somewhat dated already, of determining habitat preference for elephants is presented. This technique may prove useful for examining habitat preference with regard to making management decisions.

Résumé

Nous avons suivi pendant deux ans un échantillon d'éléphants m,les et nous présentons les habitats où nous les avons trouvés. Nous n'avons pas identifié de préférences saisonnières mais nous avons noté une sélection significative pour trois des huit sites forestiers utilisés pour cette analyse. Nous présentons une méthode, déjà ancienne, pour déterminer la préférence des éléphants en matière d'habitat. Cette technique peut se révéler utile pour examiner ces préférences au moment de prendre des décisions de gestion.

Introduction

Elephants (*Loxodonta africana africana*) rely on a wide range of seasonally varying vegetation to sustain themselves. If resources are exploited disproportionately to their availability, use is described as 'selective' (Johnson 1980). It is often assumed that an animal will select resources that are best able to satisfy its nutritional requirements (Manly et al. 1993). Since resources are usually not distributed evenly in the environment, it is reasonable to assume that elephants, for example, will prefer some habitats to others. Petrides (1975) defined a preferred habitat as the one in which an animal is found proportionally more frequently out of all available.

An animal's preference or avoidance of different habitats has been assessed using a variety of well-developed techniques. The simplest and most common method is the forage ratio that is attained by dividing the percentage of observations in a specific habitat by the percentage of that habitat in the study area. The forage ratio equation was modified by Ivlev (1961) to be 'bounded' or scaled. The limitations of this method were pointed out by Jacobs (1974) when he noted that the forage ratios depend on the relative abundance of food types in the environment. Unless the habitat areas are equal the potential will be to overestimate the preference shown for small habitats and underestimate for larger habitats. He suggested a modification of Ivlev's index based on relative habitat availability. While this modification gives relatively accurate indices of selection, they lose biological relevance at the extremes of their respective scales. The issue of overestimating selectivity of small habitats by small amounts of use and underestimating large-habitat selection unless the habitat is heavily used is not completely solved by the above methods. Also, this form of analysis is limited because it provides only a ratio of habitat use to the availability and does not test the results statistically (Alldredge and Ratti 1986). Many studies have used a chi-squared goodness-of-fit approach for testing if the observed habitat use is equal to the expected use (Neu et al. 1974). However, a danger with this approach is that with many habitat types and few observations, assumptions of chi-square may be violated. An additional problem is that if the observed values are high there is a greater likelihood of the second type of errors.

The selection index technique described by Manly et al. (1993) was used in this analysis because it is a technique based on the concept of a resource selection function. This is a function of characteristics measured on resource units such that the value for a unit is proportional to the probability of that unit being used. Manly et al. (1993) argue that this concept leads to a unified theory for analysing and interpreting data on resource selection and can replace many ad hoc statistical methods that have been used in the past. The major advantage of this method for determining habitat selection is that it uses confidence interval procedures that consider multiple resources to assess selectivity.

Study area

The study area is situated in the Sebungwe region of Zimbabwe, in the Sengwa Wildlife Research Area (SWRA). The vegetation is generally deciduous and dry deciduous savanna woodland. The main vegetation associations are *Brachystegia–Julbernardia* woodland, *Colophospermum mopane* woodland, *Acacia* spp. riparian woodland, riverine grasslands and *Combretum* spp. thickets. A single rainy season usually occurs from November to April but is highly variable in timing and quantity, and the mean annual rainfall is 668 mm.

Materials and methods

Locations of the 16 bull elephants used in the habitat preference analysis were determined through radio-telemetry over two years. The UTM grid reference was entered into a spreadsheet then imported into the software programme MapInfo (Troy, NY ver. 2.1). Grid fixes, which had been overlaid onto a vegetation map of the research area, were then queried. The results were re-imported into the spreadsheet, and the determination of habitat preference was calculated as described in box 1. For this analysis, eight vegetation types were used.

Box 1. Measuring habitat selection (adapted from Manly et al. 1993)

The selection ratio is O_u/E_u

where: O_u= observed use of a habitat by all elephants
E_u= expected use of a habitat by all elephants

This ratio is defined by the equation:

$$\hat{w}_i = u_{i+}/(h_i\, u_{++})$$

where:

- $\hat{w}_i$ = the selection ratio using totals for all elephants during season *x* for habitat type *i*
- u_{i+} = the count of type *i* habitat used by all elephants by season
- h_i = the proportion of availability of habitat *i*
- u_{++} = the total count of fixes for all elephants in all habitats during season *x*

The variance of $\hat{w}_i$ (var($\hat{w}_i$))can be calculated and used to find the Bonferroni confidence intervals for population selection ratios to establish resource selection.

$$\mathrm{var}(\hat{w}_i) = \left\{ \sum_{j=1}^{n} \left(u_{ij}/h_i - \hat{w}_i u_{+j}^2 \right) \Big/ (n-1) \right\} \{ n/u_{++}^2 \}$$

where:
n = the number of collared elephants
Confidence intervals with an overall confidence level of approximately 100(1 – α)% are calculated using:

$$\hat{w}_i \pm z_{\infty/(21)} \mathrm{se}(\hat{w}_i)$$

where:
$z_{\alpha/(2I)}$ = the percentage point of the standard normal distribution corresponding to an upper tail probability of $\alpha/(2I)$, and I is the number of habitat types. Using $z_{\alpha/(2I)}$ is taking into account the fact that multiple comparisons were made. α = 0.05 (95% confidence limits) in calculating *z* (critical *z* value table; Siegel & Castellan 1988, p.320). These confidence intervals are based on the assumption that $\hat{w}_i$ is normally distributed. Comparison of the data from this study with similar data tested for normality in Manly et al. (1993) suggest that this is a reasonable assumption, provided there are more than 6 observations within each habitat type. Significance was determined if the confidence interval (ci) around was below 1 for negative selection (e.g. $\hat{w}_i$ = 0.5: lower ci = 0.2, upper ci = 0.8) or above 1 for positive selection (e.g. $\hat{w}_i$ = 2: lower ci = 1.5, upper ci = 5).

If $O_u = E_u$ (no selection) then $\hat{w}_i = 1$
If $O_u > E_u$ (+ selection) then $1 < \hat{w}_i < \infty$
If $O_u < E_u$ (– selection) then $0 < \hat{w}_i < 1$

Results

Table 1 shows the eight different vegetation types on which the analysis was performed. The first column indicates the habitat; the second the total number of locations used in the calculation of preference. The third and fourth columns show the percentage of habitat and the percentage of the total number of fixes used in determining the selectivity index (column five). The sixth and seventh columns show the upper and lower confidence limits, and the eighth column indicates whether a habitat is selected for, against or neither selected nor avoided NS.

The habitat selection analysis indicated that bulls appear to use the research area relatively equally with availability (fig. 1). The selection for *Julbernardia–Vellozia* woodlands and grasslands, *Brachystegia-Combretum* bush and *Colo. mopane* mixed woodland may be due to the diverse nature of the vegetation available in these habitats. The negative selection for the thickets may be due in part to the lack of surface water available to elephants because of the sandy soils and the deciduous nature of the woody vegetation. Overall, there was no significant selection for the four major vegetation types in the research area. There was, however, selection for *Julbernardia–-Vellozia* woodlands and grasslands, *Brachystegia–Combretum* bush, and *Colo. mopane* mixed woodland.

Large variation among elephants in their occupation of different habitats resulted in wide confidence intervals. The habitat selection analysis indicated that bulls appear to use the research area relatively equally with availability.

Discussion

These results indicate that the accepted pattern of seasonal habitat use by elephants in miombo woodlands was supported by these findings. Soils impede access to *Colo. mopane* woodlands in the wet season when the thickets are preferred.

The overall pattern of an animal's diet is a product of the time it spends feeding in different vegetation communities and on the various food types within those communities (Lindsay 1994). The Manly et al. (1993) method of habitat selection is a relatively simple way to accurately estimate elephant preferences for

Table 1. Summary of results showing the selection ratio (w_i) and the direction of habitat selection for bull elephants between January 1994 and June 1996. If $O_u = E_u$ (no selection) then $\hat{w}_i = 1$. If $O_u > E_u$ (+ selection) then $1 < \hat{w}_i < \infty$. If $O_u < E_u$ (– selection) then $0 < \hat{w}_i < 1$

Habitat	Fixes (total no.)	Total habitat (%)	Total fixes (%)	Selectivity index (w_i)	Lower 95% confidence limit	Upper 95% confidence limit	Selection ($p < 0.05$)
Combretum–Terminalia woodland	319	6	6	1.03	0.48	1.57	NS
Colophospermum mopane woodland	1582	43	30	0.70	0.59	0.82	positive
Miombo	1207	23	23	1.02	0.59	1.45	NS
Riverine wood and grassland	706	12	14	1.15	0.57	1.73	NS
Julbernardia–Vellozia wood and grassland	552	5	11	2.29	1.56	3.03	positive
Brachystegia–Combretum bush	301	1	6	4.43	1.82	7.03	positive
Colo. mopane mixture	423	4	8	2.13	1.58	2.67	positive
Thicket	134	7	3	0.35	0.21	0.48	negative
Total	5225						

NS = not significant. For a full explanation of this technique see box 1.

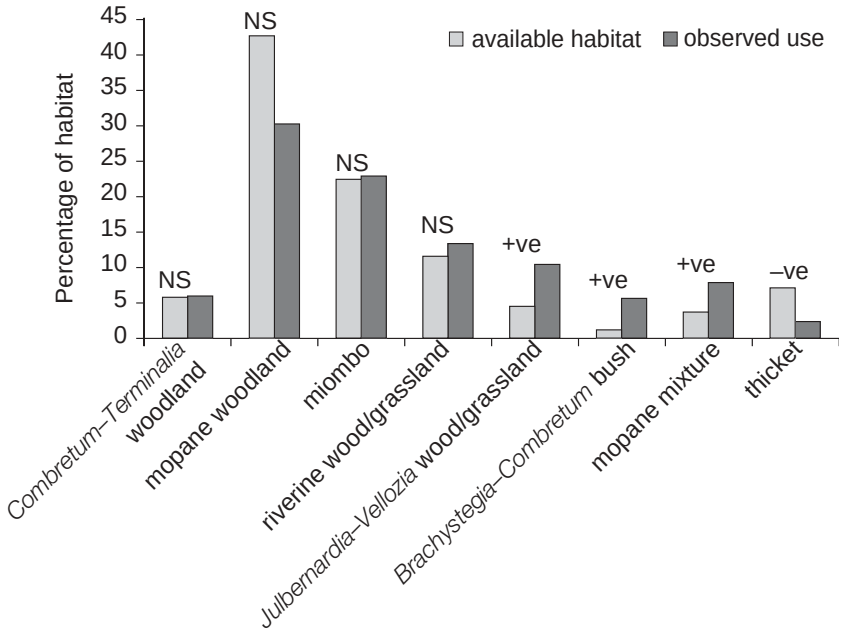


Figure 1. Differences in the availability and use of habitats by elephants. NS = not significant, +ve = positive selection, -ve = negative selection

different vegetation types. This method has been improved upon, and a more recent reference is Manly et al. (2002).

Acknowledgements

I wish to thank the Department of National Parks and Wildlife Management, Zimbabwe, and an anonymous reviewer. The Wildlife Conservation Society and the United States Fish and Wildlife Service funded this study.

References

Alldredge JR, Ratti JT. 1986. Comparison of some statistical techniques for analysis of resource selection. *Journal of Wildlife Management* 50:157–165.

Ivlev VS. 1961. *Experimental ecology of the feeding of fishes*. Yale University Press, New Haven, Connecticut.

Jacobs J. 1974. Quantitative measurements of food selection. *Oecologia* 14:413–417.

Johnson DH. 1980. The comparison of usage and availability measurements for evaluating resource preference. *Ecology* 61:65–71.

Lindsay WK. 1994. Feeding ecology and population demography of African elephants in Amboseli, Kenya. PhD thesis, University of Cambridge.

Manly B, McDonald L, Thomas D. 1993. *Resource selection by animals, statistical design and analysis for field studies.* Chapman & Hall, London.

Manly B, McDonald L, Thomas D, McDonald T. 2002. *Resource selection by animals.* Dordrecht, The Netherlands.

Neu CW, Byers CR, Peek JM. 1974. A technique for the analysis of utilization-availability data. *Journal of Wildlife Management* 38:541–545.

Petrides GA. 1975. Principal foods versus preferred foods and their relation to stocking rate and range condition. *Biological Conservation*, 7:161–169.

Siegel S, Castellan NJ. 1988. *Nonparametric statistics for the behavioral sciences*. McGraw-Hill International Press, London and New York.

Northern Sudan ivory market flourishes

Esmond Martin

PO Box 15510 – 00503. Nairobi, Kenya; email: rhino@wananchi.com

Abstract

The ivory market in the Khartoum–Omdurman area of northern Sudan is one of the few in the world that has expanded significantly since the mid-1990s. Today it has become one of the largest in Africa. Government officials and civilians transport the tusks to Khartoum–Omdurman where workshop owners and craftsmen pay USD 105/kg for a 2–5-kg tusk compared with USD 44/kg for a 5–10-kg tusk in 1997. There are 150 or so part-time ivory craftsmen who also carve in wood, compared with about 100 in 1997. They continue to produce mostly jewellery and figurines. In early 2005 there were 50 retail outlets displaying 11,329 ivory items (more than in 1997) made from tusks obtained from elephants poached after 1990. According to Sudanese law, this trade in new ivory is illegal. The items are cheap compared with prices in other countries. Nearly all the buyers are foreigners working in Sudan, especially Chinese, who purchase at least 75%, mostly for personal use, and smuggle them home to China. This growing and unregulated ivory market in northern Sudan is threatening central Africa's elephant populations.

Résumé

Le marché de l'ivoire dans la région de Khartoum–Omdurman au nord du Soudan est un des rares au monde qui s'est significativement étendu depuis le milieu des années 1990. Il est devenu aujourd'hui un des plus grands d'Afrique. Des employés du gouvernement et des civils transportent les défenses vers Karthoum–Omdurman ù les propriétaires d'ateliers et les artisans paient 105 dollars le kilo pour une défense de 2 à 5 kilos, comparé à 44 dollars le kilo pour une défense de 5 à 10 kilos en 1997. Il y a environ 150 artisans qui travaillent l'ivoire à temps partiel, mais aussi le bois, comparé à environ 100 en 1997. Ils continuent à produire principalement des bijoux et des figurines. Début 2005, il y avait 50 points de vente qui présentaient 11.329 objets en ivoire (plus qu'en 1997) réalisés à partir de défenses d'éléphants braconnés après 1990. D'après les lois soudanaises, ce commerce de nouvel ivoire est illégal. Les objets sont bon marché par rapport aux prix pratiqués dans d'autres pays. Presque tous les acheteurs sont des étrangers qui travaillent au Soudan, spécialement des Chinois qui en acquièrent près de 75%, surtout pour un usage personnel, et qui les passent clandestinement en Chine. Ce marché d'ivoire croissant et non réglementé du nord du Soudan menace les populations d'éléphants d'Afrique centrale.

Introduction

Since 1999 some of the major ivory markets in the world, such as those in Ethiopia, Egypt and Thailand, have declined in importance. Journalists, however, who visited northern Sudan in 2003/04 reported a very active trade in ivory in the Khartoum–Omdurman area, and conservationists feared that this commerce was actually on the increase. Therefore, I carried out a survey of the ivory markets in Omdurman and Khartoum in January and February 2005 to determine the status of the ivory trade in Sudan.

History

Ivory carving has been practised in southern Sudan for hundreds of years, but in the Khartoum–Omdurman area of northern Sudan, the profession may date from only the late 1890s. Both Khartoum and Omdurman were small villages in the early 19th century, but Khartoum by the 1830s had become a centre for the ivory trade in raw tusks.

Until 1840 there was a monopoly on the tusk trade out of Khartoum, confined to members of the Turkish–Egyptian ruling elite. In 1840 the monopoly ended

and new traders were attracted into the business because it was so profitable. At that time, two shillings of Venetian beads bought one tusk because local people, such as the Bongo and Bari from the White Nile Basin, were unaware of the international value of ivory.

From the 1840s until the time of the Madhi's uprising in the early 1880s, Egyptians, Turks, Europeans and other adventurers went to Khartoum to start expeditions to southern Sudan to obtain tusks. They organized their supplies through outfitters, many of whom were Copts (Christian Egyptians) in Khartoum, and put together parties of up to 200 men, mainly Danagola and Jwaaliyyin tribesmen from northern Sudan. They sailed up the White Nile to Fashoda and Gondokoro. From there, the expeditions usually marched westwards looking for local tribesmen to recruit as their allies. Having succeeded, the adventurers armed these recruited tribesmen and encouraged them to surround a neighbouring village.

Villagers in those days kept their own supply of tusks for carving and selling, and for fence posts. Rather than killing elephants, it was easier to obtain this ivory. The tribesmen tortured the elders to find out where their ivory was hidden, captured cattle and killed the older people, while the women, children and surviving men were immediately enslaved. The cattle were given to the tribesmen who initiated the raids, and the captured young men and women were forced to carry the tusks back to the boats waiting on the White Nile (Asher 2005; M. Asher, pers. comm. 2005).

On their return to Khartoum, the adventurers used the slaves to pay off members of the expedition and to make any final payments to the outfitters. The adventurers organized most of their tusks to be sent down the Nile to Berber by boat. Here regular caravans carried the tusks eastwards to Suakin on the Red Sea to be shipped to Europe and India. The journey from Khartoum to Suakin took about two weeks. About 10% of the tusks were carried across the Nubian desert by camel to Egypt for export, but as this was a longer route than the Suakin route, much less went out this way (Asher, pers. comm. 2005). By the mid-1850s Sudan was exporting on average 130 tonnes of tusks a year, one of the biggest exporting countries in the world (Parker 1979).

Ivory became the backbone of Khartoum's economy, and slavery was a by-product of the ivory trade. By the late 1870s Khartoum had grown to 50,000 inhabitants (about half were slaves), but there is no evidence that craftsmen worked ivory in any noticeable amount in Khartoum or Omdurman during that time.

This commerce in tusks, nearly all passing through Khartoum, continued until the early 1880s when the Madhi's aggressive expansions disrupted these traditional trade routes. In 1885 the Madhi finally took Khartoum from the Anglo-Egyptian forces under General Charles Gordon. The Madhi then ordered that most of the city's inhabitants be killed and the capital be moved across the Nile to Omdurman. Khartoum became abandoned for several years. In 1898 Anglo-Egyptian forces under the leadership of General Herbert Kitchener defeated the Madhists and re-established Khartoum in that year.

According to the reminiscences of a prominent ivory businessman in Khartoum, in 1898 or 1899 his grandfather moved from Asyut in Egypt, a town noted for the carving of ivory and camel bones, to Omdurman to establish an ivory-carving business and shop. This Egyptian family, called Iskander, were Copts. Other members of the family followed into the business (George Saber Iskander, pers. comm. 1997).

In the early 20th century four Copt families were crafting ivory, with the head of each family employing two or three young assistants. Three of the families lived in Omdurman and one in Khartoum, all having come originally from Asyut. They had trained in Asyut to carve and engrave wood, bone and ivory, but in Sudan specialized mostly in ivory. These craftsmen produced mostly ivory items that appealed to the British and other European residents of Khartoum: necklaces, walking sticks, animal figurines and candle holders. The British even drew samples of the items they wished the carvers to make (Murad Iskander, cousin of George Iskander, pers. comm. Khartoum 1997).

In the 1920s the number of ivory enterprises expanded to at least six with three in Omdurman and three in Khartoum. During the 1930s the ivory business prospered. By 1940 there were 10 such workshops with sales shops in Omdurman and three in Khartoum. Each workshop had from five to eight ivory craftsmen. Besides these approximately 85 craftsmen, about an equal number were working at home. Thus, at the beginning of World War II there may have been as many as 200 ivory craftsmen in Omdurman and Khartoum, many having been trained

by the Iskander family. Most craftsmen were Muslim Sudanese who lived and worked in Omdurman (M. Iskander, pers. comm. Khartoum 1997).

During World War II many foreign troops were stationed in Khartoum. The ivory craftsmen, using only hand tools in those days, produced animal figurines, badges for military uniforms and candle holders for the British and American armed forces, and handles for ostrich feather fans for the Egyptians. The quality of these items was quite high, as craftsmen specialized in individual objects.

To supplement their incomes at the time of World War II, some ivory craftsmen also carved rhino horn. One was the father of Murad Iskander. He made only cups which were used for detecting poisonous drinks. He sold them to Arab dignitaries and to some Europeans. The British officials in Omdurman at the time, however, asked Mr Iskander to stop making these cups as it was against the law—rhinos were already endangered. Other craftsmen in Omdurman made rhino horn rings, which still can be seen in Sudan today (M. Iskander, pers. comm. Khartoum 1997).

After the war, the ivory business slumped due to the exodus of the British and foreign troops. But from the 1950s to the early 1980s the ivory business revived and flourished with about 200 carvers catering mostly to British, French, German, Greek and Italian customers (M. Iskander, pers. comm. Khartoum 1997). In 1983 the Nimeiri government introduced *sharia* law, which closed all the bars and many restaurants in Khartoum. At the same time the economy in Sudan was in poor shape. Consequently, most of the 10,000-strong Greek community and other Europeans left Sudan. Sales of ivory items thus dwindled. The ivory traders tried to export ivory carvings wholesale during the 1980s (it was then still legal) to make up for their losses, but this generally failed. These Sudanese businessmen could not compete in price and quality with items made in India and Hong Kong.

With the CITES ban on the international trade in ivory that came into effect in 1990, the Sudan ivory business declined further. European and American visitors, the traditional buyers, stopped purchasing ivory. Politics worsened in northern Sudan with the military coup of June 1989, with Sudan government support of the Iraqi occupation of Kuwait in 1990, and with Sudan government aid towards terrorism (Economist Intelligence Unit 1998). Due to all these political problems, and with few visas being issued to Westerners, their numbers fell further.

Ivory trade survey of Khartoum and Omdurman, 1997

With growing concern among conservationists from the mid-1990s that the ivory trade in Sudan might be increasing once again, I carried out the first survey of the domestic ivory trade of Khartoum and Omdurman in November 1997 (Martin 1998a,b). According to the ivory traders there, tusks came mostly from southern Sudan, the Democratic Republic of Congo (DRC), and the Central African Republic (CAR) with smaller quantities from Kenya and Tanzania. Members of the Sudanese army and merchants moved tusks northwards by lorries. Craftsmen and workshop owners, mostly in Omdurman, bought these tusks. Small tusks of 1–2 kg sold for USD 15.50/kg while larger ones of 5–10 kg sold for USD 43.60/kg at the market rate of 1750 Sudanese pounds to the dollar (Martin 1998b).

Esmond Martin

An ivory craftsman uses a lathe to cut an elephant tusk in Omdurman.

The hundred or so ivory craftsmen at that time worked from home or in the Omdurman workshops. Some craftsmen made the distinction between tusks from the forest elephant, which are straight and more translucent and which they called Arab ivory, with those from the savanna elephant, which are more curved and creamy in colour and which they called African ivory. Most preferred the softer savanna tusks. The artisans were paid for what they produced. Skilled craftsmen earned about USD 100–200 a month.

One traditional Sudanese doctor bought some of the waste powder for USD 3.42/kg for some of his patients in order to reduce fluid in the legs or to help with childbirth, and one Greek paid USD 20 for some of the waste, but bought in very small quantities.

The most popular items made in 1997 were animal figurines, jewellery (especially beaded necklaces, rings and bangles), name seals, chopsticks and walking sticks. The supply of chopsticks and name seals was in response to a new demand for these items by the Chinese. Chinese expatriates started to come to Sudan in large numbers in the 1990s to work on construction sites, build an oil pipeline, work in the oil fields, and run two textile factories. The Chinese probably were buying at least half the ivory items, according to the shopkeepers, at this time.

Esmond Martin

Photographed in 1997, rhino horn and carved ivory tusks were still available in Khartoum in 2005.

Esmond Martin

In 1997 Chinese customers were buying about half the ivory items for sale in the souvenir shops of Khartoum and Omdurman.

Khartoum had little night life, so when these Chinese passed through the Khartoum area, they spent their evenings visiting the souvenir shops. Sometimes they made a list of items to buy and some had drawings of the actual size and shape of an item they were looking for. They often bought in bulk after extensive bargaining. The Chinese preferred beaded necklaces, chopsticks, animal figurines, name seals and cigarette holders. All these were cheaper in Khartoum than in China.

South Koreans may have been the next largest buyers of ivory objects. They chose name seals, beaded necklaces and animal figurines. I interviewed a South Korean in a hotel shop who had just bought four ivory seals for USD 5.71 each. He said he bought them as they were considerably cheaper than in South

Korea and he was going to give them as presents to friends on his return.

Gulf Arabs were next in importance as buyers of Sudanese ivory items. They preferred jewellery, walking sticks and prayer beads. The few Japanese who came to Sudan occasionally bought name seals and animal figurines. Europeans bought less—just the odd piece of jewellery or animal figurine. Sudanese bought extremely little and only jewellery, except for those who purchased a few objects as presents for foreign delegates or for friends in the Gulf.

My 1997 survey found new ivory items in 18 shops in Khartoum, 15 in Omdurman, and 1 in Khartoum North. There were several thousand items on display, mostly made in Omdurman. In the Omdurman open-air jewellery market where the traders displayed their tourist trinkets on the ground (not in stalls or shops), there were only a few new ivory items, but unlike the shops, many old ivory objects were for sale that had been made in the south and west of Sudan. A pair of bracelets from western Sudan was selling for USD 20, and there was jewellery from southern Sudan. A few other wildlife products were displayed for sale, both in the jewellery market and in the shops, such as men's leopard skin shoes for USD 80, cheetah skin shoes for USD 29, plain rhino horn finger rings for USD 17, monkey skins for USD 57, gazelle horns for USD 29–80 a pair, painted ostrich eggs for USD 29, and handbags or belts made from snake, crocodile and lizard skin.

Table 1. Retail prices for recently made ivory items seen in Khartoum, Omdurman and Khartoum North in November 1997

Item	Size (cm)	Average price (US dollars)
JEWELLERY		
Bangle	1	3
Earrings, pair	medium	9
Necklace, beaded	medium	17
Ring	1	2
FIGURINES		
Animal, thin	10	30
thick	12	86
thick	18	114
Human	25	100
Bust	16	34
TUSKS		
Carved bridge, 4 elephants	25	46
Carved bridge, 6 elephants	35	91
Polished	75	543
MISCELLANEOUS		
Candle holder	15	34
Cigarette holder	8	3
Chess set with wood board, wood black pieces, ivory white pieces	40 x 40	429
Name seal	7	6
Prayer beads for Muslims	medium	14
Walking stick (all ivory)	100	200

Exchange rate: 1 US dollar = 1750 Sudanese pounds

The prices for most ivory items offered for retail sale in 1997 were low (table 1) because the raw product was inexpensive and the cost of labour was low. Ivory craftsmen no longer specialize, and having become generalists in the last few decades, the quality of carvings is much lower, which also explains the cheap prices.

Results of an ivory trade survey in Khartoum and Omdurman in 2005

I carried out a second survey of the ivory markets of Khartoum and Omdurman in January and February 2005 (Martin 2005). According to the Omdurman craftsmen and traders, tusks were still mainly from elephants recently killed in DRC and southern Sudan. This dovetails well with reports of poaching in DRC (Mubalama 2005). As before, a few tusks came from CAR, Kenya and Chad. The hunters were, as in 1997, Baggara Arabs, policemen, Sudanese army personnel and local civilians. Some of the military personnel were still transporting the tusks northwards (England 2004) while a few officers were also implicated in carrying tusks to the traders' houses in Khartoum and Omdurman. Indeed, these soldiers and other government officials were the main suppliers of tusks, but Sudanese businessmen were also involved. This information came from extensive interviews with ivory traders.

The craftsmen and owners of the ivory workshops paid USD 26–105/kg or an average of USD 57/kg for tusks (at the market rate of 2530 Sudanese pounds to a dollar) for small, poor-quality tusks and scrap, and USD 44–148/kg or an average of USD 105/kg

for good-quality tusks of 2–5 kg. Most tusks sold wholesale were less than 6 kg.

Almost all the ivory workshops are still in Omdurman, and both Christians from various parts of Sudan and Muslims originating from northern Sudan still craft ivory. The number of ivory craftsmen has risen since 1997 and there may be as many as 150 today. They work in ivory and wood and occasionally silver or amber, but almost never camel bone. There are camel bone carvings in the shops, but these are almost all imported from Egypt. Ivory items are four or five times more expensive than camel bone (tables 2 and 3).

Table 2. Retail prices for camel bone objects seen in souvenir shops in Khartoum, Omdurman and Khartoum North in January–February 2005

Item	Size (cm)	Average price US dollars
Animal figurine	4	6
Animal figurine	8	15
Human figurine	5	4
Necklace, beaded	medium	5
Paperknife	13	3
Paperknife	15	4
Paperknife	18	4

Exchange rate: 1 US dollar = 2530 Sudanese pounds

The craftsmen said they used from 45 to 225 kg a year of tusks each, but the latter number is probably too high. The craftsmen and workshop owners sell their finished products to souvenir shops. Skilled craftsmen working six days a week from 1000 to 1800 hours earn the equivalent of USD 8–12 a day while polishers earn about USD 3 a day. The earnings of an ivory carver (about USD 10 a day or USD 260 a month) compare favourably with government salaries, while a polisher receives more than the minimum salary in Khartoum of about USD 50 a month.

My 2005 survey revealed 24 souvenir shops in Khartoum, 25 in Omdurman and 1 in Khartoum North that were offering ivory products for sale. Only two shops in two hotels displayed ivory. The owners of the souvenir shops are Muslims (56%) and Christians (44%). The Christians are mostly Copts while the Muslims were originally from Egypt, northern Sudan and Turkey.

The number of ivory objects displayed per shop varied from 2 to 1021. The total number seen in the 50 shops was 11,329 or an average of 227 per shop. The most numerous items were animal figurines (30%), pendants (19%), rings (15%) and bangles (8%) (table 4). No shop specialized in ivory only; all carried a mixture of items, such as wood, ivory, camel bone and leather. All the objects, including ivory, were

Table 3. Retail prices for recently made ivory items seen in Khartoum, Omdurman and Khartoum North in January–February 2005

Item	Size (cm)	Price range (US dollars)	Average price (US dollars)
Jewellery			
Bangle	1	12–29	20
Earrings, pair	3.5	3–4	3
Necklace, beaded	medium	14–45	30
Pendant	4–5	2–34	14
Ring	2.5	2–6	3
Figurines			
Animal, thin	10	12–63	23
thick	10	47–119	86
Human	15	59–99	72
Tusks			
Carved	21	100–140	120
	30	198–257	218
Polished	6.8 kg	—	800
	8.0 kg	—	2000
	15.4 kg	—	1200
Miscellaenous			
Box	8 x 8	59	59
Chopsticks, pair	20	10–14	13
Cigarette holder	12	5–8	6
Comb	15	18	18
Crucifix	15	59–90	75
Key ring	6	12	12
Letter of alphabet	4	2	2
Name seal	10	20–30	27
Napkin ring	1	6–20	13
Paperknife	19	6–20	14
Pen holder	10	5	5
Prayer beads for Muslims	medium	20–36	28
Vase	20	180–656	331
Walking stick (all ivory)	300	260–320	299

Exchange rate: 1 US dollar = 2530 Sudanese pounds
— not applicable

Esmond Martin

An artisan in Omdurman shows ivory items he has just carved.

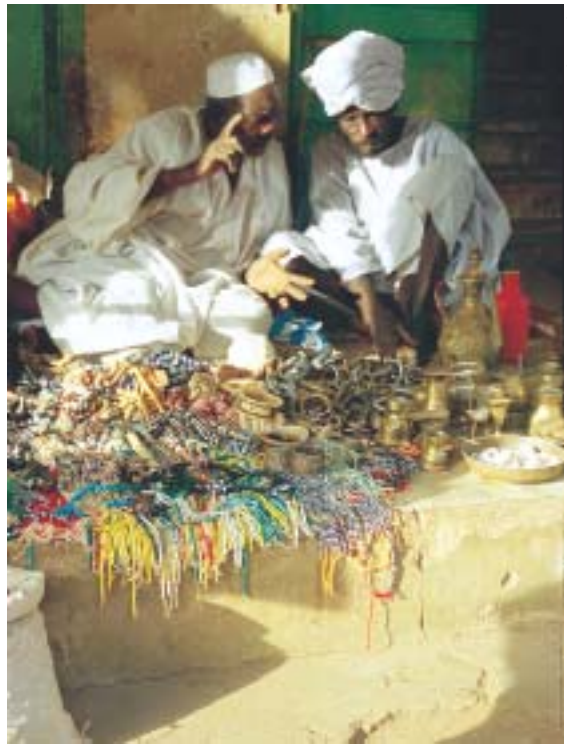
of medium to poor quality. As in 1997, there were no old ivory items seen on display in the shops. In the Omdurman jewellery market there were far fewer old southern Sudanese ivory items than in 1997. Old bangles were the most common in 2005, at about USD 37 for ones of 4 cm width. No items of new ivory were for sale there, although there had been a few in 1997.

Prices for ivory items varied depending on size, amount of carving and quality. The cheapest were letters of the alphabet for USD 2 and rings and earrings for USD 3. Polished tusks of various weights were the most expensive, followed by vases (USD 331) and full-ivory walking sticks (USD 299) (table 3).

According to the shopkeepers, the main customers for ivory items were still Chinese, who were buying more than before—at least 75% of the sales. There are now 3000–5000 Chinese in Sudan, the number varying according to the amount of construction workers needed at any one time. South Koreans are still

Table 4. Ivory items seen for retail sale in Khartoum, Omdurman and Khartoum North in January–February 2005

Item	Percentage of total
Animal figurine	30
Pendant	19
Ring	15
Bangle	8
Human figurine	5
Chopsticks, pair	4
Earrings, pair	4
Cigarette holder	2
Napkin ring	2
Necklace	2
Prayer beads for Muslims	2
Walking stick	2
Jewellery, other	1
Name seal	1
Tusk, carved	1
Vase	1
Misc.: hair clip, key ring, paperknife, etc.	1
Total	100



Esmond Martin

In the Omdurman jewellery market, traders display some of their wares for sale, including ivory bangles from southern Sudan.

Esmond Martin

The Chinese in Sudan were buying 75% of the country's ivory items in 2005, such as this man who was negotiating a good price for several sets of ivory chopsticks in Omdurman. They retailed on average at only USD 13 a pair compared with around USD 90 in Beijing.

the second main buyers; there are several hundred now in Sudan, running businesses such as Daewoo Corporation, Korean International Arab Motors Company, a construction company and a tyre factory. Gulf Arabs and occasionally a European diplomat will buy ivory items. Shopkeepers named the items preferred by the different nationalities and this remained the same as in 1997. Sales are flourishing in the Khartoum area compared with the early 1990s, but Sudanese traders still do not attempt to export their ivory carvings wholesale.

Discussion

Several large changes have taken place in the ivory trade in Sudan between 1997 and 2005. More shops displayed ivory items in early 2005 and many more ivory objects were for retail sale. The main reason is that there are more foreigners now in the country, especially Chinese. This is because the Sudan government has been encouraging more foreign investment in both public and private sectors. At the same time it has been easy for the Chinese to take ivory items out of Sudan. One Sudanese ivory trader admitted that the Chinese were also buying new tusks from traders directly from their homes for export to China. The amount of raw tusks being exported from Sudan to China is not known.

Between 1997 and 2005 the price of tusks in northern Sudan increased. Prices for tusks have almost tripled as more are now coming from the DRC, requiring greater transport costs than from southern Sudan. Also as elephant populations have declined, the animals are harder to find, especially those with tusks of reasonable size. Retail prices for ivory items have also gone up due to the escalation of the price of the raw material, but not as much as tusks. Jewellery, name seals and walking sticks have perhaps doubled in price in US dollars, while animal figurines have stayed about the same. This is because labour charges have not increased so much in dollar terms due to the devaluation of the Sudanese pound. Despite these retail price increases, items still cost much more in Egypt in 2005. For example, in Egypt a 10-cm ivory figurine cost more than triple the equivalent in Sudan; a paperknife was also triple, and a full-ivory walking stick was four times the price (Martin and Milliken 2005). The relative cheapness of ivory items in Sudan remains the main reason for their popularity.

There was another change from 1997 to 2005. There were fewer southern Sudanese-made old ivory items and no new items offered for sale in the Omdurman jewellery market in 2005. This is despite the fact that new ivory items, especially jewellery, are still being made in the south, and old ivory is for sale there. For example, in early 2005 a foreign diplomat visited an ivory craftsman's house in Yei near the DRC–Uganda border. He saw a worktable covered with ivory chips and dust and several newly made beaded necklaces and crosses, presumably for local sale. The artist took the diplomat to a near-by hut and showed him two raw tusks that were available for carving. Old ivory items were recently for sale in southern Sudan in Rumbek. A Kenyan businessman who went to Rumbek in May 2005 was offered several old ivory bangles for USD 4–5 each. One possibility for the lack of southern Sudan ivory in the north

is that the war increasingly severed retail connections between the south and Muslim Khartoum, leaving the Khartoum military and the Khartoum carvers and shops as the main retail link.

Sudanese government officials claim that they have cracked down on the illegal ivory trade. Officials from Khartoum reported through the Sudanese Embassy in Nairobi that 46 pieces of raw ivory had been intercepted in a lorry on its way to Egypt in 2004. They also reported that 'considerable amounts' of ivory have been impounded by Customs authorities in Khartoum and in Port Sudan, and raids have been carried out from November 2004 in various markets in Khartoum State to control the trade in ivory (Sudan 2005). But this would all seem to be merely tackling the tip of the iceberg. Owners of workshops and souvenir shops in Khartoum and Omdurman stated that it was still easy to move worked ivory within and out of Sudan, and ivory businessmen in Egypt confirmed in March and April 2005 that tusks were still coming into southern Egypt from Sudan (Martin and Milliken 2005).

Furthermore, although there has been some improvement in law enforcement, there has been no significant change in the Sudanese laws concerning ivory. For example, many governments have banned all domestic trade in ivory items, except for certified antiques, but in Sudan any item from ivory obtained prior to 1990 is legal, which creates a very easy loophole for carvers and retailers. Internal trade in pre-1990 ivory is still thus legal (Sudan 2005). But in practice over 98% of the ivory items on offer for sale in 2005 were carved from ivory obtained after 1990—and are thus illegal. The government does not recognize this and claims a lot of it is camel bone (Sudan 2005).

Conclusion

Sudan is one of the few countries in the world where the number of ivory craftsmen and the number of ivory items offered for retail sale have increased since the mid-1990s. The Khartoum–Omdurman area has become one of the largest retail markets for ivory objects in Africa and has recently surpassed Egypt, a country with a huge tourism industry (Martin and Milliken 2005).

Although the government has recently tried to seize raw ivory, more needs to be done. It is unrealistic to expect the government to stop the flow of ivory across its borders because many parts of the country are politically unstable and, being the biggest country in Africa, its borders are too long to patrol adequately. Given the Chinese link, it would be worthwhile for greater vigilance at the Khartoum airport of people leaving the country, especially to check the luggage of Asians, the main buyers of ivory items.

To stop the trade in new ivory, the most effective procedure would be to inspect the workshops to prevent craftsmen from using fresh tusks. The retail shops should be checked for ivory items made from post-1990 elephant tusks also. It should be up to the shop owners to prove to the government the age of their ivory products. Those items made from recently killed elephants should be cleared from the shops immediately and prevented from re-entering the trade. As the tusks nearly all end up in this one region of Sudan—Omdurman—this is the place for the government to concentrate its efforts. Such enforcement procedures would be easy to implement and the exercise would not be expensive. There are not many large workshops in Omdurman and only 50 tourist retail ivory outlets heavily concentrated in two small areas of Omdurman and Khartoum. Success would be easy to secure and in a very short time. There would be little economic hardship to the craftsmen and retailers as the craftsmen already work in other materials and the shops sell a wide variety of products.

It also should be made compulsory for the shop owners to put up signs in their outlets saying that it is illegal to purchase ivory for export. Of equal importance, the Chinese Embassy in Khartoum should advise their Chinese contract workers that it is against the law of both countries to take ivory out of Sudan and import it into China. These simple and inexpensive regulations would be effective if the Sudanese and Chinese governments were committed to implementing them.

Acknowledgements

I would like to thank Care for the Wild International for their financial support for this fieldwork and to Lucy Vigne for all her help with the work. Michael Asher kindly assisted with the historical section of this article.

References

Asher M. 2005. *Khartoum: the ultimate imperial adventure*. Penguin, London. p. 5–6.

Economist Intelligence Unit. 1998. *Country profile: Sudan 1998–99*. London. p. 6.

England A. 2004. In Africa, ivory battle pits elephant conservationists against illegal trade. *Financial Times*, 15 November, London.

Martin E. 1998a. Ivory trade in gear again: Sudan new hub of sales to South Korea and China. *BBC Wildlife* 16(2):22.

Martin E. 1998b. New buyers of ivory in the Sudan threaten elephants. *Oryx* 32(3):166–169.

Martin E. 2005. The Khartoum connection. *Swara* 28(1):18–19.

Martin E, Milliken T. 2005. *No oasis: the Egyptian ivory trade in 2005*. TRAFFIC International, Cambridge.

Mubalama L. 2005. Rapport sur L'Enquete du Marché D'Ivoire dans la ville de Kinshasa (les 9–19 mars 2005). Wildlife Conservation Society and MIKE, Kinshasa, Democratic Republic of Congo.

Parker I. 1979. The ivory trade. Report for the US Fish and Wildlife Service and the International Union for the Conservation of Nature and Natural Resources, Nairobi.

Sudan, Embassy of, Nairobi. 2005. Press statement, SEN/3/1. Nairobi, 11 May.

The African and Asian ivory markets in Europe: a survey of five countries

Daniel Stiles[1] and Esmond Martin[2]

[1] PO Box 5159 – 80401, Diani Beach, Kenya; email: kenyadan@wananchi.com
[2] PO Box 15510 – 00503, Nairobi, Kenya; email: rhino@wananchi.com

Abstract

Before the 1989 CITES ivory trade ban Europe was one of the main destinations for African raw ivory. Vendors in Africa and Asia reported in recent market surveys that Europeans were important buyers of worked ivory. This ivory market survey was carried out to ascertain the current status of ivory markets in five important European countries: Germany, the United Kingdom, France, Spain and Italy, in order of their 2004 ivory market scale. The German and UK ivory markets were relatively significant, while those of France, Spain and Italy were small. Only Germany and France still have legal active ivory craftsmen and ivory stockpiles. Most of the ivory items found were legally imported before 1989, or were legal antiques. Some East Asian and African worked items are still imported illegally on a minor scale, but the demand for tusks, whether legal or illegal, is small. These five European countries seem to be complying well with CITES regulations in contrast to most African and Asian countries.

Résumé

Avant l'interdiction du commerce de l'ivoïre par la CITES en 1989, l'Europe était une des principales destinations de l'ivoire brut africain. Les vendeurs africains et asiatiques rapportaient dans les récentes études que les Européens étaient des acheteurs importants d'ivoire travaillé. Cette étude du marché de l'ivoire a été réalisée pour s'assurer du statut actuel des marchés de l'ivoire dans cinq pays européens importants : l'Allemagne, la Grande Bretagne, la France, l'Espagne et l'Italie, dans l'ordre du marché de l'ivoïre en 2004. Les marchés allemand et anglais étaient relativement significatifs, alors que les marchés français, espagnol et italien étaient réduits. Seules l'Allemagne et la France ont encore des artisans et des stocks d'ivoïre légaux. La plus grande partie de l'ivoïre découvert avait été importée légalement avant 1989 ou provenait d'antiquités légales. Certains objets travaillés sont encore importés d'Extrême-Orient et d'Afrique à petite échelle, mais la demande pour des défenses, légale ou non, est faible. Ces cinq pays européens semblent se conformer aux réglementations de la CITES, contrairement à la plupart des pays africains et asiatiques.

Introduction

This report is the fourth in a series of surveys that depicts the status and trends of the elephant ivory markets in various regions of the world. Previous surveys covered Africa (Martin and Stiles 2000; Stiles and Martin 2001), South and South East Asia (Martin and Stiles 2002; Stiles and Martin 2002) and East Asia (Martin and Stiles 2003; Stiles and Martin 2003). This report deals with five countries in Europe: Germany, the UK, France, Spain and Italy, in relative order of market scale (Martin and Stiles 2005). These countries were selected for the size of their economies, and thus their buying power, and on informants' reports in Africa and Asia of the principal European buyers of worked ivory in their regions. The surveys were carried out between April and November 2004.

In conjunction with the October 1989 transference of the African elephant to Appendix I at the 7th Meeting of the Conference of the Parties of CITES, the European Union (EU) prohibited the commercial

imports of raw and worked ivory. The EU allows the import of ivory antiques, defined as items manufactured prior to 1 June 1947, and raw and worked ivory can be exported from EU countries subject to the destination country issuing CITES certificates authorizing the import. The domestic trade in raw and worked ivory is legal, subject to strict EU and national regulations based primarily on European Council Regulation 338/97 and European Commission Regulation 1808/2001. Each EU member state has enacted national legislation or made decrees to enable implementation of these and other EU regulations concerning the import and export of elephant ivory.

These ivory market monitoring surveys are made so that CITES Parties and governmental and non-governmental wildlife conservation bodies can assess the scale of various national ivory markets, and thus their potential effect on elephant populations. In this initial round of surveys the data obtained are compared with any existing data to assess what changes have taken place from previous years, thus suggesting trends in the ivory markets. It is hoped that future surveys using the same methodology will enable standardized monitoring and assessment of country and regional ivory markets as called for by CITES Resolution Conf. 10.10 (Rev. CoP12). The assumption is made that elephant killing is correlated with the market demand for worked ivory.

The CITES policy related to elephants most in need of evaluation is that of permitting renewed and limited international sales of ivory to Japan from three southern African nations in 1999 (Botswana, Namibia and Zimbabwe) and from three more (Botswana, Namibia and South Africa) after the Monitoring of Illegal Killing of Elephants (MIKE) system becomes operational, and certain other criteria are met. The data presented in these reports will be instrumental in achieving this objective. Any changes in the trade indicators of key countries can be compared with elephant killing as signalled by MIKE, and with ivory seizures as recorded by the Elephant Trade Information System (ETIS), administered by TRAFFIC, to ascertain whether significant correlations occur.

Results

Table 1 presents a summary of the status of ivory markets in 2004, and table 2 shows past and present ivory trade indicators in the European places surveyed.

Raw ivory sources and prices

Germany

Between 1952 and 1974 the Federal Republic of Germany imported an average of 25 tonnes of raw ivory a year. The domestic consumption averaged 24 tonnes a year during this period (Parker 1979). During the mid-1970s the quantity of tusks imported expanded considerably to 53 tonnes a year, with almost 78% originating in Kenya (Parker 1979).

From 1979 to 1987 the quantity of tusks imported declined sharply, averaging 19.8 tonnes a year. The main countries providing these tusks were South Africa, Sudan, Namibia, Kenya and Zimbabwe. The decline in imports was due to reduced local ivory consumption and the flood of imported, cheaper worked ivory from Hong Kong. In the late 1980s a great deal of waste ivory imported from the UK and Belgium was used. The price in Germany was DEM 30 (USD 17) to DEM 180 (USD 100) per kilogram (Grimm et al. 1989).

After the ban on imported tusks in 1989 users had two main sources of supply: illegal imports and old stock. According to informants, the quantity of tusks smuggled into the country was quite small. There is no figure for the quantity of old stock of ivory. At the Erbach Ivory Museum a museum officer stated that the museum alone had a stock of 18–20 tonnes.

One ivory carver in Erbach said he paid in 2000 a little less than DEM 200 (USD 91)/kg for raw ivory from a wholesaler in Michelstadt. In 2004 he was offered good-quality tusks for 150 euros/kg. Another Erbach carver said that the price of tusks in 2004 varied from 75 to 200 euros per kilogram. Some Berlin markets had several small, uncarved tusks being offered for retail sale; in the Strasse des 17.Juni flea market a salesman had a 1.5 kg tusk for 150 euros/kg.

United Kingdom

From 1970 to 1977 (the last year for which UK Customs statistics recorded ivory as a separate commodity) an average 20.3 tonnes of tusks was imported each year. From 1975 to 1977 only 3.8 tonnes a year in the UK was consumed (Parker 1979). From 1980 to 1987 an annual average of 21.8 tonnes was imported according to UK CITES annual reports, but only 5.2 tonnes stayed in the country.

In 1985, a major ivory company in the UK said that most of their tusks were from Tanzania and a 15-

Table 1. Ivory trade indicators for Europe in 2004

Place	Wholesale price/kg for tusks (USD)		Workshops (no.)	Craftsmen (no.)	Retail outlets (no.)	Minimum no. of items
	1–5 kg	10–20 kg				
Germany						
Michelstadt	92	244	1	1	4	8639
Erbach	92	244	7–10	7–10	6	6170
Berlin	–	–	0	0	128	906
Frankfurt am Main	–	–	0	0	50	729
United Kingdom						
London	269	270	0	0	776	8325
France						
Paris	55–64	108–132	4	10	63	1123
Dieppe	96–120	–	2	3	3	133
Nice	–	–	0	0	4	39
Marseilles	–	–	0	0	1	8
Bayonne	–	–	0	0	0	0
Biarritz	–	–	0	0	0	0
Auvergne	–	–	?	30–35	?	?
Elsewhere	–	–	?	3	?	?
Spain						
Barcelona	–	–	0	0	24	381
Madrid	–	–	0	0	23	240
Italy						
Milan	–	–	0	0	31	240
Rome	–	–	0	0	19	126
Florence	–	–	0	0	11	95
Total	–	–	14–17	54–62	1143	27154

— not applicable

Table 2. Past and present ivory trade indicators for Europe

Place	Year	Wholesale price/kg for tusks (USD)		Wholesale price/kg for tusks in 2004 using GDP Inflator Index (USD)		Craftsmen (no.)	Retail outlets (no.)	Minimum no. of items
		5–10 kg	15–20 kg	5–10 kg	15–20 kg			
Germany	2000	91	–	98	–	–	–	–
	2004	92	244	92	244	8–10	185[a]	16444[a]
UK	1980	65	–	131	–	–	–	–
	1985	70	100	108	154	–	–	–
	1986	98	135	147	203	–	–	–
	1988	190	260	270	370	–	–	–
	2004	269	270	269	270	0[b]	776[b]	8325[b]
France	1974	–	–	–	–	102	–	–
	1989	118	–	162	–	–	–	–
	1991	96	110	122	140	–	–	–
	2004	108	132	108	132	46–51[c]	71[d]	1303[d]
Spain	2004	–	–	–	–	0	47[e]	621[e]
Italy	2004	–	–	–	–	0	61[f]	461[f]

– not applicable or no data

[a] Berlin, Erbach, Frankfurt am Main, Michelstadt; [b] London; [c] Auvergne, Bayonne, Biarritz, Dieppe, Marseilles, Nice, Paris; [d] Bayonne, Biarritz, Dieppe, Marseilles, Nice, Paris and elsewhere in France; [e] Barcelona, Madrid; [f] Florence, Milan, Rome

kg tusk sold for about USD 100/kg (T. Friedlein, pers. comm. 1985). The market became flooded with tusks from dubious sources such as Burundi, Somalia and the Democratic Republic of Congo (DRC). In 1988 just before the CITES ban, tender prices at Kruger National Park were very high. A 15-kg tusk sold for USD 227/kg and a 24-kg tusk for USD 280/kg.

After the 1989 ban on ivory imports, smuggling took place, but in smaller amounts than previous legal imports. No data on illicit raw ivory entering the UK are available for most of 1990 to 2004 because no investigations were made.

In April–May 2004 we found in London two single tusks and two pairs of tusks in four different shops or stalls. One single tusk weighing 1.2 kg was priced initially at GBP 200 (USD 360). After bargaining, the price came down to GBP 180 (USD 269). One pair weighed 20 kg. It had come from Africa but had been sold recently in the UK at the Portobello Road Antiques Market. The price was USD 270/kg. Five other small tusks and tusk tips were found for sale in London. People wanting to craft ivory would not necessarily have to buy their raw material from antique markets as some tusks are available privately, but no price data were found on this. It is probable that a little raw ivory was left at the factories producing ivory products, but neither is there any information on that.

France

Between 1966 and 1977 France imported about 317 tonnes of raw ivory. In the late 1960s and early 1970s the annual imports totalled 5 to 9 tonnes, but in 1972 the quantity jumped to 63 tonnes, reaching a peak in 1975 of 83 tonnes. By 1977 ivory imports were down to 16 tonnes (Parker 1979). The great increase in ivory imports from 1972 to 1975 is because France became a major transit point for the re-export of African raw ivory. Domestic ivory consumption of raw ivory in France ranged from approximately 3.5 to 7 tonnes a year during this period. Average prices jumped from about USD 7–9/kg from 1966 to 1971 to USD 24–40/kg from 1972 to 1977 (Parker 1979).

The ivory imports to France reported by CITES from 1979 to 1988 show that the main suppliers of raw ivory were, in order of importance, Congo-Brazzaville, Gabon, Tanzania and the Central African Republic. Some 141 tonnes of tusks and raw ivory pieces were imported, an average of 14 tonnes a year. These should be considered as minimum figures, as it is doubtful that all imports were reported to CITES.

France kept in the country only about 8 to 10 tonnes of the raw ivory it imported between 1979 and 1987, indicating an annual consumption rate of about 1 tonne. Sources familiar with the ivory industry believe that this slightly underestimates consumption during this period and that additional sources of raw ivory originated from private stockpiles and privately owned tusks obtained from auction houses (Francis Migeon, ivory carver, and Marco Ciambelli, Director of the Confederation of Craftsmen and Users of Natural Resources (COMURNAT), Paris, pers. comm. 2004).

Table 3 shows representative prices from 1975 to 1989.

At the time of the CITES ban a considerable amount of raw ivory was in private hands. Due to the collapse of the ivory market following the ban, there is currently more raw ivory on offer than there is demand (Migeon, pers. comm. 2004). Ivory lots are offered for sale occasionally at auction houses such as Hôtel Drouot in Paris and Hôtel de Ventes du Palais in Marseilles. Ivory specialist suppliers are another source of tusks, or more commonly, of semi-worked pieces of a particular size needed by a craftsman for a commissioned item. One such supplier is based in Michelstadt in Germany and another, in France, is located near Paris (Jean Colette, Dieppe, pers. comm. 2004, and Marco Ciambelli, pers. comm. 2005).

The average price of raw ivory actually declined between 1991 and 2004 in inflation-adjusted USD prices, supporting a conclusion that the demand for

Table 3. Raw ivory wholesale prices in France, 1975–1989

Year	Price/kg 10 kg tusk (USD)	Price/kg in 2004 GDP Inflator Index	Price/kg 20 kg tusk (USD)	Price/kg in 2004 GDP Inflator Index
1975	38	111	60	175
1980	66	133	84	170
1989	72	99	96	131

Source: Ivory purchasing records of Francis Migeon, Paris, 2004
Exchange rate: 6.56 French francs = 1.2 US dollar or 1 euro

ivory in France is weak (table 2). In 2004 smaller 5–7-kg tusks sold for USD 55–64/kg and larger 40–50-kg tusks sold for USD 180/kg in Paris. An ivory craftsman in Dieppe said that he paid about USD 96–120/kg for small tusks or cut raw ivory pieces obtained from various sources.

According to Maume and Denhez (2000), France had an official stockpile of 50 tonnes of ivory (not specified if raw or worked) in 2000, but since the ivory held in private hands is not known with any certainty, this figure should be regarded with caution.

Spain

Between 1969 and 1977 Spain imported about 106 tonnes of raw ivory. Imports ranged from 2.5 to 4 tonnes a year from 1969 to 1973, rising to about 8 tonnes in 1974, then jumping to 19 tonnes in 1975 and 33 tonnes in 1977. Average annual prices ranged from USD 6 to 19 in 1969 to 1973, then they jumped to USD 28 to 32.50 in 1974 to 1977. The re-export figures show almost nothing but are considered unreliable (Parker 1979). Annual ivory consumption was probably closer to the early import figures during this period, perhaps averaging around 4 tonnes. Traders either hoarded the surplus ivory, or secretly re-exported it. There is no information available on post-1977 imports and exports of ivory in Spain.

No informant could be found who knew anything about raw ivory sources and prices, past or present. Since 1990 a wide number of countries in Africa were sources of origin of seized raw ivory imports, particularly the Spanish-speaking Equatorial Guinea. One assumes that other raw ivory objects would have been successfully smuggled in, but no vendors admitted to knowing anything about it.

The Nature Protection Service (SEPRONA), an arm of the Guardia Civil, seized almost 2.9 tonnes of undocumented ivory in Madrid in July 2004 (Anon. 2004), but this ivory was made up of small pieces of carving waste left over from legal pre-1990 manufacture. The rest of the ivory found at the location, about 500 kg, had been legally acquired and registered (Centre for Technical Assistance and Inspection of Foreign Trade, Madrid, pers. comm. 2004).

Italy

Between 1970 and 1977 Italy imported approximately 55 tonnes of raw ivory. Re-exports were negligible, totalling 0.7 tonnes, indicating that annual domestic consumption was about 6.5 tonnes (Parker 1979). Price varied tremendously, depending on source and ivory quality, but averaged USD 8–11/kg annually from 1970 to 1972, when it jumped to about USD 24–28/kg between 1973 and 1977 (Parker 1979).

Grimm et al. (1989) reported that in 1986 Italy imported 1914 kg of worked ivory and 521 kg of raw ivory, and in 1987 the figures were 988 kg of worked and 354 kg of raw. Most of the imported raw ivory intended for commercial use went to ivory workshops in the areas around Naples, Genoa and Florence. If these figures are a true reflection of the demand for ivory in Italy, it seems that demand was quite low, with an average of about 400 kg being worked a year in Italy in the late 1980s. In 1988, nearly all legally imported ivory was by people bringing in one or two tusks for personal use (Grimm et al. 1989).

The valuation of new ivory used by Customs to calculate duty from 1986 to 1988 was ITL 300,000 per kg, or about USD 180–230, depending on the exchange rate for the lira during this period. The type of ivory is not specified (Grimm et al. 1989).

No information is available on sources and prices of raw ivory in Italy after the CITES ivory trade ban. No informant could be found who knew anything about current imports of raw ivory, if there are any. The fact that ETIS and the United Nations Environment Programme–Wildlife Conservation Monitoring Centre (UNEP–WCMC) CITES database have received no reports of ivory seizures from the Italian government since 1998 precludes acquiring information from these sources. No evidence of ivory working could be found in Italy during this survey.

Ivory workshops

Germany

Before the CITES ivory ban there were ivory crafting centres in Erbach, Michelstadt, Altôtting and Bad Kônig, and individual carvers worked elsewhere. Today, ivory carving is carried out only in Erbach and Michelstadt, both of which have long histories of the craft. The number of elephant ivory craftsmen in Germany has declined by more than 65% since the ivory ban, and total only 8 to 10 today. One works in Michelstadt and the rest are in Erbach, with 5 working in private workshops and 4 working for the government-owned German Ivory Museum. There are also several carvers who work only mammoth ivory.

Esmond Martin

The ivory jewellery in this Erbach, Germany, shop is well carved, but discounts are offered because there are not many interested clients except during Chistmas and summer holidays.

The elephant ivory carvers use a minimum of 300 kg a year.

A school for ivory carving was started in 1892 in Erbach. In 1960 the school moved to Michelstadt. After the ivory ban the number of students declined, but then rose slightly in 1992, averaging 23–24 a year since then. In 1990 the director could not get a licence to carve ivory so the school switched to mammoth. The students now carve only mammoth ivory and wood. People, however, bring ivory objects to the school for repairs (Helmut Jäger, director of the School for Wood and Ivory Handicraft, pers. comm. 2004). In 2004 there were 25 students: 5 males and 9 females learning how to carve mammoth tusks, and 11 students working on wood. To become a master requires five years at the school. In 2004 three people obtained this status.

Most previous students have failed to continue as mammoth ivory carvers, although the school does try to help them succeed, as they see no future in it as an occupation, or as there is little market (Jäger, pers. comm. 2004). Some continue to work as art restorers or specialists in the dental prosthesis industry.

United Kingdom

In the 19th century ivory centres in Birmingham, London and Sheffield produced substantial quantities of brushes, cutlery, human figurines, jewellery, piano keys and walking-stick handles. There was a large decline in ivory manufacturing during the Depression and World War II, but factories in Sheffield continued to use ivory for cutlery handles, while factories in the London area maintained production of ivory brushes and, especially, ivory piano keys (Maugham 1931).

By the mid-1980s only two companies, in Cornwall and Yorkshire, were producing ivory keyboards. The company in Cornwall used 2000–2200 kg of tusks a year. It made each year 1200–1500 keyboards plus a few other items, such as musical instrument parts. The Yorkshire company used about 600 kg of tusks a year from which it made 400–500 keyboards. Almost all the two companies' ivory keyboards were exported, especially to Germany (Friedlein, pers. comm. 1987; Luxmoore et al. 1989).

At least five Scottish firms used to make ferrules, mounts and mouthpieces for bagpipes from ivory. By the mid-1980s, the demand for both ivory piano keys and ivory bagpipe parts was in decline. Since 1990 the main firms formerly making piano keys and bagpipe parts have stopped using ivory. Thus ivory manufacturing has been greatly reduced compared with the 1980s.

Only illegal ivory carving takes place today. For example, the International Fund for Animal Welfare (IFAW) surveyed the ivory trade in the UK in late 2003 and early 2004 and documented several incidents of post-1990 use of raw ivory in their report (IFAW 2004). According to IFAW researchers, in 1996 the owner of a walking-stick shop was found to have bought two tusks for GBP 2000 (USD 3380) from a 'man in the street'. In another incident a year later, in a small industrial unit in Clerkenwell in London, police seized several tusks and an auctioneer's ivory gavel this workshop had recently crafted. The gavel was made to look old in order to sell it more easily from an outlet on Portobello Road (IFAW 2004).

Ivory is still also used in restoration work, using pieces remaining from before 1990.

France

In 1974 a census of ivory craftsmen in France counted 45 active in Paris and the immediate surroundings, 30 in Auvergne, 7 in the Jura and 3 in Dieppe. Ivory companies in Paris and the Jura employed an additional 122 workers. There were also about 25 miniaturists and hundreds of art and furniture restorers scattered around France. The total quantity of raw ivory consumed was unknown, but each sculptor used on average 35–50 kg of ivory a year from 1960 to 1989. The restorers used less than 1 kg a year each.

In 1990, just after the CITES trade ban, there were 10 to 12 full-time and 10 to 12 part-time ivory craftsmen active in France. After the ban, the ivory jewellery factory in the Jura closed its doors due to the drop in sales and negative publicity associated with ivory, as did other ivory factories that manufactured billiard balls, buttons, piano keys, and other utilitarian items.

Today there are only four full-time sculptors left in Paris, three in Dieppe, one in the Hérault department, and 30–35 knife makers spread throughout France, who use ivory occasionally for handles. There are 10 to 12 part-time ivory craftsmen (sculptors, turners, inlayers and restorers) in France, some of whom also carve wood.

The number of professional ivory craftsmen in France has dropped from 102 in 1974 to approximately 48 in 2004, and salaried staff has declined from over 126 in 1974 to probably none in 2004.

Daniel Stiles

Francis Migeon stands with 40-kg plus tusks, a part of his personal stockpile.

Daniel Stiles

Francis Migeon is a fourth generation French ivory Maître d'Art.

Carvers in Paris craft a wide variety of objects: human figurines, small animals, bangles, polychrome eggs made from carving waste and abstract pieces made from odd bits of tusks. In Dieppe, carvers work entirely on commission, usually making *polletais* **(**rustic 19th century human figurines), religious figurines, animal figurines, busts, dice, jewellery and other objects. Each of these craftsmen uses 5–15 kg of raw ivory annually.

The consumption of raw ivory in France has declined from sev-

eral tonnes a year in the 1970s to roughly 350–400 kg in 2004 **(**Migeon, pers. comm. 2005).

Spain

There are no published reports about ivory carving in Spain from 1960 onwards. All informants, including ivory vendors and the WWF/Adena office in Madrid, claimed to know nothing about past or present ivory craftsmen. The general view was that there are none currently active in Spain (SEPRONA, pers. comm. 2004). The number of ivory product seizures since 1992 suggests that there may be ivory craftsmen active, but they understandably keep a very low profile. Over the 11 years from 1992 to 2003, 110 tusks, 80 raw ivory pieces and an additional 51 kg of raw ivory pieces were seized (John Caldwell, UNEP–WCMC, Cambridge, UK, pers. comm. 2004**)**.

Italy

Before 1990 there were a few ivory carvers located in the areas around Naples, Genoa and Florence, using on average about 400 kg a year in the late 1980s. No ivory workshops were found in the three cities surveyed in 2004. Vendors and tourist information offices knew of no ivory carving currently active. Grimm et al. (1989) noted that even as long ago as 1988 the cost of labour of ivory carving was too high to sustain the craft and that craftsmen were becoming importers and wholesalers of worked ivory. Since the ivory import-export business is no longer legal, except for ivory antiques, these people have presumably taken up other occupations.

Retail outlets and prices for worked ivory

Germany

The places surveyed in Germany in September 2004 had 188 outlets selling a minimum of 16,444 ivory items. Michelstadt had the largest number of items—8639, mostly jewellery, in just four shops, almost all having been made after 1970. Erbach followed with 6170 ivory items, mostly made after 1989. But Berlin had few new ivory items—only 41 of 906. These were small items made in Africa and Asia, many of which had been recently smuggled into Germany. The other 865 items were mainly German and Asian antiques. Items in Frankfurt am Main's 50 retail outlets were 98% antiques, 63% of which was jewellery and 15% miniature paintings on ivory sheets. As in Berlin, most of the new ivory items in Frankfurt am Main were seen in flea markets.

United Kingdom

In April–May 2004, 776 shops and stalls in London were displaying for sale at least 8325 ivory items. Antique markets had the largest number of ivory items—7047 or 85% of the total. The market that had the most was the Portobello Road Antiques Market with 2973 items. The antique shops had the most expensive items; a howdah made almost entirely from ivory was priced at USD 531,000.

About 98% of the ivory items seen in London were antiques. The newly made Chinese and South-East Asian objects were pots with ivory lids, netsukes, necklaces and bangles; probably all had been smuggled into the UK. They were in Bermondsey and Portobello Road markets.

The most common ivory items seen for sale in London were jewellery (22%), human figurines (12%), netsukes (10%) and walking sticks with ivory handles

Esmond Martin

The shops and stalls on Portobello Road in London have the greatest variety and number of ivory items offered for sale in the UK.

Esmond Martin

Old magnifying glasses with ivory handles displayed at a street stall on Portobello Road are among the most popular ivory items bought by tourists.

(8%). Of these items, 46% had been made in the UK, 27% in Japan, 15% in China and 12% elsewhere.

France

In the six cities and towns surveyed in France, 71 outlets were found selling 1303 worked ivory items. The vast majority of these were in Paris (89%). Ivory items were found in exclusive boutiques specializing in antique art, shops that carried mainly East Asian objects carved not more than 20 or 30 years ago, second-hand shops, and gift or handicraft shops. Ivory is moderately concentrated in specific areas in Paris: the St Ouen flea market (21 outlets, 348 items), the Louvre des Antiquaires antiques building (18 outlets, 488 items), the Village Suisse shopping centre (11 outlets, 199 items), the Village St Paul handicrafts area (6 outlets, 37 items) and St Germain des Prés (3 outlets, 32 items). The exclusive Carré Rive Gauche art and antiques quarter had at least 3 outlets with 15 expensive antique ivories displayed in windows, but certainly others were kept behind the locked street doors. One Chinese-owned shop was selling over 1000 mammoth ivory items.

The seaside town of Dieppe in Normandy has undergone a great deterioration of its booming ivory industry, which began in the 14th century and peaked in the 19th century. Today there are only three outlets selling 133 ivory items. The main outlet was a carver's showroom, and the other two were second-hand shops selling just a few miscellaneous worked ivory pieces.

The Riviera city of Nice had four shops selling 39 real ivory items, but one outlet specializing in East Asian ivory was selling a number of fake ivory items made from resin. Nearby, the city of Marseilles had only one shop with 8 ivory items.

No ivory was sold in the south-eastern Atlantic coast tourist towns of Bayonne and Biarritz.

The most common type of ivory item seen by far was the human figurine, followed by the imported netsuke and then jewellery items. Utensil handles, cane- and walking-stick handles, animal figurines, boxes and paperknives were also seen in some numbers. Over 50% of the worked ivory seen in France was imported from China and Japan, and only 41 items (3%) were from Africa.

Many vendors were asked the age of the ivory items. They all replied either that the item was an antique, or that it had been imported before 1976, or that it had been manufactured from legal raw ivory. One would have to see the EC Regulation 338/97 certificate for those pieces said to have been imported before 1976, but for antiques no official documentation is required, just evidence of the age. It is therefore possible to sell worked ivory imported illegally since 1989, or manufactured from raw ivory smuggled into France after that date, and present it as an antique. Some of the items from Asia in particular could have been recent illegal imports.

The most expensive item seen was a 1.1-m-tall Japanese painted geisha in the Louvre des Antiquaires priced at 250,000 euros (USD 300,000). The least expensive item seen was a plain ring at USD 59.

Spain

In Madrid and Barcelona, 47 outlets selling 621 ivory items were found. A quick survey was also made in San Sebastian on the northern Basque coast. San Sebastian attracts thousands of visitors each year and

Daniel Stiles

This Indian temple was for sale in a Madrid antique shop.

the city has many gift and souvenir shops, but of 26 visited, none contained ivory.

Barcelona surprisingly had more ivory for sale than Madrid, with 24 outlets displaying 381 items, while Madrid had 23 outlets selling 240 pieces.

Almost all of Barcelona's ivory was found in the Bulevard des Antiquaris, a multistoreyed antiques market containing over 40 shops; 19 of these carried 362 ivory items. Five ivory items were seen in 4 stalls at the Ronda Litoral quayside market. One stall was selling a number of East Asian bone, resin and mammoth ivory items as elephant ivory. Only one other antiques boutique in the Eixample area was found selling ivory, mainly Japanese items.

In Madrid, ivory was found scattered in various parts of the city. Eleven outlets were found with 128 items in 3 antique galleries on Ribera de Curtidores Street, where the Sunday El Rastro market is held. A single shop selling 3 ivory items was also found on this street. The Puerta de Toledo shopping centre had 3 shops selling 13 ivory items. Four shops displaying 50 ivory pieces were visited in the Salamanca quarter, and a further 4 outlets were found with 46 items in the touristy Gran Via–Plaza Mayor area of central Madrid.

Most of the items seen were human figurines; next were netsukes and jewellery was a distant third. Second-hand utilitarian items such as ivory pens, paint spatulas, knitting hooks and utensil handles were also fairly numerous. About 40% of the items were from East Asia and only 8 (1%) were African.

In reply to the question of the age of ivory items, all vendors asked responded that the ivory they were selling was imported before 1989.

The most expensive item for which the price was obtained was a 1.1-m Japanese carved and painted tusk priced at USD 59,998 in a shop in the Bulevard des Antiquaris. The least expensive items found were paperknives at USD 100 and 107.

Italy

In the four cities visited, 61 outlets were found displaying 461 worked ivory items for sale. These fig-

Daniel Stiles

East Asian ivories were for sale in Milan's Central Railway Station.

ures are somewhat misleading, however, as they include ivory seen for sale at the 19th Milan International Antiquarian Exposition, at which antique galleries from other European countries exhibited. If this exposition is excluded, 42 ivory outlets were found with 305 ivory items. In any case, commercial ivory is quite rare in Italy.

A total of 31 outlets selling 240 ivory items was found in Milan, if the International Antiquarian Exposition is included. Of the non-exposition outlets, only 12 were found selling 84 ivory items. The three antique markets contained 29 of the outlets and displayed 217 ivory objects. The Lido Antique Fair had 10 stalls with 60 ivory pieces, and Porta Ticenese, the big weekend market, had only one ivory item. A shop in the Central Railway Station carried 21 ivory items, mainly large pieces from East Asia, and one other gift shop was found selling 2 netsukes. The shop also carried several Japanese resin items mislabelled as ivory.

A total of 19 outlets selling 126 ivory items was found in Rome. All but one of these outlets consisted of antique or gift shops located in the central tourist area around the Spanish Steps and the Pantheon.

A total of 11 shops selling 95 ivory items was seen in Florence. The outlets were found on the Via dei Fossi, the Ponte Vecchio and across from the Pitti Palace.

No ivory was found in a brief survey of Naples.

Human figurines were the most common type of item, followed by netsukes and utensil handles, then walking-stick pommels. At least 23% of the items were East Asian and almost none (3 items) was seen from Africa.

As elsewhere, vendors when asked said that their ivory was pre-1989 in age.

Table 4 compares retail prices of selected items in the five countries.

Discussion

Law-enforcement efforts in Europe

Compared with Africa and most of Asia, western Europe's enforcement of regulations related to ivory is extremely effective. The UK probably has the weakest record, but recent publicity criticizing British authorities' efforts to control illegal ivory trading has

Table 4. Retail asking prices for ivory items in USD in Europe in 2004

Item	Germany	UK	France	Spain	Italy
Animal figurine					
2–4 cm	61–116	22–1665	–	–	192–300
5–10 cm	177–371	100–468	830–1199	5994	480–960
Bangle					
1 cm	22–305	18–167	89–142	137	107–210
2–4 cm	116–488	36–360	192–360	505	480
Brooch					
4–6 cm	35–1366	63–216	264–480	240–490	159–360
Necklace					
Small beads	24–98	27–90	195–227	–	144–480
Large beads	116–354	180–216	360–650	600	360–1320
Pendant	5–104	81–2430	539	–	–
Human figurine					
5 cm	69–439	32–900	384–600	360–2400	264–600
11–20 cm	98–5760	594–6300	2659–6853	302–17760	600–2100
Netsuke					
4–6 cm	732	315–14,400	300–598	462–539	240–600
Tusk, carved					
10–20 cm	–	54	200–450	–	–
21–30 cm	366–1208	216–1260	840–875	–	–
Cigarette holder					
10 cm	–	–	107–119	150–175	120–384
Paperknife					
10–20 cm	49–482	50–477	216–240	100–143	144–1140

— not applicable or no data

spurred the Department for Environment, Food and Rural Afairs (DEFRA) and the Customs Department to be more vigilant (IFAW 2004; Pendry 2005). The IFAW (2004) report was not entirely accurate. While it is true that most of the worked ivory sold in London is undocumented, our survey found that the great majority (~98%) of the items seen were manufactured before the 1989 EU international ivory trade ban, and thus should be legal if they were also imported before 1989. Those items acquired before 1 June 1947 do not require government documents for commercial sale, but they do need proof of age. This EU loophole certainly opens the door to potential abuse. It is not true, as reported by IFAW that 'once inside the European Union (EU) single market, ivory can move freely'. To move for commercial purposes between countries in the EU, ivory items carved after 1 June 1947 require an exemption under Article 8.3 of European Council Regulation 338/97 and a sale certificate under Article 20.3 of European Commission Regulation 1808/2001. Nonetheless, IFAW was quite correct in pointing out that it is easy to obtain an assessment for certification purposes that an ivory item is an antique.

Asian objects are another potential source of illegal worked ivory imports and sales. Many East Asian so-called antique objects were seen in France, Italy and Spain that looked fresh, and the prices did not correspond with those for true antiques. In France, Asian items, old and new, made up over 50% of the total number seen, in Spain over 40% were Asian, and in Italy over 20%. It is known that China smuggles out worked ivory to European destinations (Martin and Stiles 2003); thus it is likely that a certain proportion of the East Asian items seen in Europe is being sold illegally. Internet sales facilitate the marketing of this illegal ivory.

Germany had the strictest ivory trade control, followed by France, Spain, Italy and the UK, in that order. Since Spaniards and Italians were often named as buyers of ivory in Africa and Asia, it was surprising how little ivory was seen for sale in these countries. This could be due, at least in part, to good law enforcement.

The sources and movement of tusks in Europe

Tusks and raw ivory pieces are occasionally smuggled into Europe, as Customs and press reports attest (Newman et al. 2004), but the number of incidents and quantities are not significant. Given the dearth of active ivory craftsmen and the weakness of the ivory markets in Europe, it is surprising that any raw ivory is smuggled in. The auction prices for tusks at the Hôtel Drouot in Paris, for example, are so low that smuggling in tusks from Africa would not seem economic. There does not seem to be any noteworthy demand for tusks in the UK, Spain and Italy, though Belgian Customs reported a seizure of 10 tusks from the DRC bound for Barcelona in June 2004 (Newman et al. 2004). The highly publicized seizure of almost 3 tonnes of raw and worked ivory in Madrid in 2004 turned out to be mostly pre-1990 manufacturing waste. None of it was imported after the CITES ban (SEPRONA and Centre for Technical Assistance and Inspection of Foreign Trade, Madrid, pers. comm. 2004).

The active ivory craftsmen observed in Germany and France all have their own registered, legal stocks of raw ivory and do not need to import raw ivory from outside the EU.

Movement of worked ivory in Europe

The most common type of movement of worked ivory within Europe is of ivory antiques being put on display at international trade fairs. Ivory antiques also move between countries from dealers to dealers and to private buyers. There are associations of antique dealers, and there are websites that facilitate the trade in antique ivory works. The Humane Society of the United States (2002) and IFAW (2004) have both signalled the importance of western European countries as a source of worked ivory for the USA, purportedly all antiques.

There does not seem to be significant movement of recently carved ivory objects within Europe. Most of the buyers of ivory worked in Germany are Germans, and recent ivory worked in Paris and Dieppe is bought mainly by the French. Americans are the second most numerous buyers of worked ivory in these countries. German and French craftsmen do not export their ivories, nor do they sell on the Internet.

It is illegal to import post-1989 worked ivory into Europe, but some East Asian items are probably smuggled in as antiques or as mammoth ivory. There were extremely few African ivory items seen for sale; thus most of the ivory objects seen or heard about in Africa destined for Europe (Martin and Stiles 2000) must have been for private buyers, not for resale.

The UK is by far the main European exporter of legal worked ivory to the USA, and it is the principal European importer of legal ivory from the USA. All of the items in these shipments were presumably antiques. Small numbers of trophy tusks also move legally between Europe and the USA (Williamson 2004).

Effects of the CITES 1999 auctions and views on the reopening of trade

Vendors and craftsmen asked did not think that the 1999 sales of ivory from southern Africa to Japan had any effect on ivory demand in Europe. Most Europeans are aware of the CITES ivory trade ban and of the connection between ivory sales and elephant poaching. This awareness has lowered demand for ivory in Europe and keeps the amount of ivory being worked and sold at low levels.

Ivory vendors and craftsmen in France were in favour of the future ivory sales from Botswana, Namibia and South Africa to another country or countries, and thought that controlled reopening of international trade in ivory would reduce the need for elephant poaching by making available legal ivory. They also thought that reopening trade would be good for the future of their business by reducing the stigma associated with buying ivory. Ivory working in France is considered as being part of the *patrimoine*, or cultural heritage, and the government and crafts associations want to see the art perpetuated. Most vendors in Spain and Italy were non-committal on renewed international ivory sales, though two thought that the ban should remain to save the elephants, and three wanted to see the ban lifted. German and UK vendors had little to say on the subject as they did not think it had any effect on a business that was steadily declining.

Conclusions

The ivory markets of the five countries surveyed pose no imminent threat to elephant populations. Essentially all of the ivory processed in Germany and France today originates from legal, registered stockpiles, and any illegal ivory working that may occur in the UK, Spain and Italy would use trivial amounts. Consumer demand for ivory has dropped significantly from 1989, which has reduced ivory consumption from 30–40 tonnes a year in the five countries during the 1970s and 1980s to less than one tonne annually in the early 2000s. Reduced ivory demand and restricted supply have resulted in the drop of ivory craftsmen and employed staff from the hundreds in the 1980s to about 60 in 2004.

There is probably a small illicit trade in imported East Asian carved ivory items, but quantities of worked ivory for sale from Africa and South and South-East Asia are insignificant.

Acknowledgements

We would like to thank Care for the Wild International and Save the Elephants for their financial support. We would also like to thank certain people who helped provide information and review the report: Steven Broad, Marco Ciambelli, Annick and Jean Collette, Gerhard Emonds, Pierre Ickowitz, David Malecki, Chryssee Martin, Francis Migeon, Tom Milliken, Philippe Ragault, Stéphane Ringuet, Miguel Valladares and Lucy Vigne.

References

Anon. 2004. Spanish police seize ivory from 400 elephants. Reuters, 2 July.

Grimm U, Slamer D, Florio P. 1989. The ivory trade in West Germany, Austria and Italy. In: Cobb S, ed., *The ivory trade and the future of the African elephant.* Ivory Trade Review Group, Oxford.

Humane Society of the United States. 2002. *An investigation of ivory markets in the United States*. Humane Society of the United States, Washington, DC.

[IFAW] International Fund for Animal Welfare. 2004. *Elephants on the High Street: investigation into ivory trade in the UK.* IFAW, London.

Luxmoore R, Caldwell J, Hithersay L. 1989. The UK ivory trade. In: Cobb S, ed., *The ivory trade and the future of the African elephant.* Ivory Trade Review Group, Oxford.

Martin E, Stiles D. 2000. *The ivory markets of Africa.* Save the Elephants, Nairobi and London.

Martin E, Stiles D. 2002. *The South and South East Asian ivory markets*. Save the Elephants, Nairobi and London.

Martin E, Stiles D. 2003. *The ivory markets of East Asia*. Save the Elephants, Nairobi and London.

Martin E, Stiles D. 2005. *Ivory markets of Europe.* Care for the Wild International, West Sussex, UK, and Save the Elephants, Nairobi and London.

Maugham C. 1931. *Markets of London: a description of the way in which business is transacted in the principal markets and in many commodities*. Sir Isaac Pitman & Sons, London.

Maume A, Denhez F. 2000. Ivoire, le traffic continue. *GEO* 259:144–154.

Newman J, Noble R, Park M, Rice M. 2004. *The enforcement imperative: combating the illegal trade in ivory.* Environmental Investigation Agency, London.

Parker I. 1979. The ivory trade. Report prepared for the United States Fish and Wildlife Service and the International Union for the Conservation of Nature and Natural Resources. Nairobi. Unpublished.

Pendry S. 2005. Ivory and tortoiseshell products seized in the UK. *TRAFFIC Dispatches* 23:2.

Stiles D, Martin E. 2001. Status and trends of the ivory trade in Africa, 1989–1999. *Pachyderm* 30:24–36.

Stiles D, Martin E. 2002. The trade in African and Asian ivory in South and South East Asia. *Pachyderm* 33:74–87.

Stiles D, Martin E. 2003. The trade in African and Asian ivory in East Asia. *Pachyderm* 35:82–99.

Williamson D. 2004. *Tackling the ivories: the status of the US trade in elephant and hippo ivory*. TRAFFIC North America, World Wildlife Fund, Washington, DC.

FIELD NOTES

A new historic record of the Sumatran rhinoceros from Nagaland in north-eastern India

Anwaruddin Choudhury

Deputy Commissioner, Baksa, c/o The Rhino Foundation for Nature in NE India
Bamunimaidam, Guwahati 781 021, India; email: badru1@sify.com

The Sumatran rhinoceros, *Dicerorhinus sumatrensis*, once ranged from north-eastern India to Indonesia (Corbet and Hill 1992; Choudhury 1997, 2003; Rookmaaker 2003). It had vanished from most of north-eastern India by the turn of the 20th century (Milroy 1934) and was believed to have become extinct in India (Khan 1989). However, Choudhury (1997) reported stray individuals in Manipur as late as the early 1990s. Historical records are available from most of the north-eastern states: Arunachal Pradesh, Assam, Manipur, Mizoram, Nagaland, Tripura and northern West Bengal, as well as from adjacent areas of Bangladesh (Rookmaaker 2003); however, specimen records with specific locations were few and far between. Hence, any historic record with evidence is extremely important.

I here report a recent record of a specimen from Nagaland in north-east India.

While on a visit to Noklak area (26°12′ N, 95°00′ E) in Tuensang District, Nagaland (fig. 1), on an awareness campaign as part of an Oriental Bird Club–WildWings Conservation Award in February 2004, I received reports of past sightings of a 'two-horned hairy and small rhinoceros'. Noklak is near the northern part of the Saramati mountain range that separates India and Myanmar (Mr Chingla and others, pers. comm.). There had been past reports from the Saramati area, from both India and Myanmar (Tilson and Traylor-Holzer 1993; Rabinowitz et al. 1995; Choudhury 1997). After talking with a cross-section of elderly people, I re

Figure 1. Locality in Nagaland where skull was found.

ceived word of a skull. I visited the Noklak village above the town and located the skull in a villager's house. The rhino reportedly had been speared to death by two hunters, probably around the turn of the 20th century, from the mountain tops north-east of Noklak near the present India–Myanmar border. The skull could not be measured as it was fixed quite high, and being old, any attempt to bring it down would have damaged it. The skull lacked the nasal bone, which was apparently damaged when its reportedly tiny horns were removed. Three molar teeth on the right side were in good condition.

A. Choudhury

The Sumatran rhino skull (arrow) with skulls of domestic buffaloes at a house in Noklak, Nagaland.

The villagers of Noklak area belong to the Keimnugan Naga tribe. They regard this skull with reverence and splash water on it when there has been no rain for many days and on similar occasions they observe. This specimen is probably the first from Nagaland as earlier records were all merely reports of sighting by hunters and villagers. Considering this skull's importance, the grandson of the hunter, in whose house it now is, and the villagers should be convinced to place it in a museum, perhaps at Kohima.

Acknowledgements

I thank the Oriental Bird Club for the OBC–WildWings Conservation Award that enabled me to visit Noklak; H. Shou, my guide in the area; Mr Chingla, the head *Dubashi* who first gave me the information; and Mr Shinj, age 80, the grandson of Musanj, one of the hunters (the other hunter was Musanj's brother, Shanji). Others who deserve mention are the Additional Deputy Commissioner of Noklak, the sister and brother-in law of H. Shou for providing food, Tsangchingla Imlong of Mokochung, Neisatuo Keditsu of Kohima, and Hakim.

References

Choudhury AU. 1997. The status of the Sumatran rhinoceros in north-eastern India. *Oryx* 31(2):151–152.

Choudhury AU. 2003. *The mammals of Arunachal Pradesh*. Regency Publications, New Delhi.

Corbet GB, Hill JE. 1992. *The mammals of the Indomalayan region: a systematic review*. Oxford University Press, Oxford.

Khan M. 1989. *Asian rhinos: an action plan for their conservation*. IUCN, Gland, Switzerland.

Milroy AJW.1934. The preservation of wildlife in India. No.3, Assam. *Journal of the Bombay Natural History Society* 37 (suppl.):97–104.

Rabinowitz A, Schaller G, Uga U. 1995. A survey to assess the status of Sumatran rhinoceros and other large mammal species in Tamanthi Wildlife Sanctuary, Myanmar. *Oryx* 29:123–128.

Rookmaaker K. 2003. Historic records of the Sumatran rhinoceros in north-east India. *The Rhino Foundation for Nature in NE India Newsletter* No.5, p.11–12.

Tilson R, Traylor-Holzer K. 1993. *Sumatran rhino PHVA briefing book*. IUCN/SSC Conservation Breeding Specialist Group, Minnesota Zoo, Minnesota.

Elephant death, possibly by constipation

*Dhaval Vyas,[1] Thomas E. Goodwin,[2] L.E.L. Rasmussen,[2] Bruce A. Schulte[1]**

[1] Department of Biology, Georgia Southern University, Statesboro, Georgia 30460, USA
[2] Department of Chemistry, Hendrix College, Conway, Arkansas 72032, USA
[3] Department of Environmental BioMolecular Systems, Oregon Health and Science University, Portland, Oregon 97239-3098, USA
* corresponding author; email: bschulte@georgiasouthern.edu

Elephants are generalist herbivores with a prolific consumption rate of approximately 4% to 7% of body weight per day (Laws et al. 1970; Ruggiero 1992). They are relatively inefficient in digesting, processing approximately only 40% of the consumed forage (Poole 1996). Hence, their faeces are a rich source of nutrients for other organisms (Laws et al. 1970) and they serve as dispersers of seeds for numerous plants (Dudley 1999). The forage they select is influenced by many factors including age, sex, habitat and season (Stokke 1999; Stokke and du Toit 2000). Social and associative learning may play a role in choice of plant species as young elephants commonly forage in family groups (Stokke 1999). Such learning reduces the likelihood that an individual elephant will ingest large quantities of a toxic or highly indigestible plant (Mubalama and Sikubwabo 2002; Osborn 2002). However, availability of forage may limit choice in diet, such as during drought or after fire. Mistakes in foraging decisions can be costly. As part of our ongoing study of elephant behaviour in Tanzania, we documented an instance of what was probably the ultimate costly mistake of a young male African elephant.

At Ndarakwai Ranch in Tanzania, we regularly observe elephants from an elevated platform located near a waterhole. We age elephants based on size as described by Moss (1996). From this vantage point on 21 December 2004, one of us (DV) noticed an elephant that showed signs of an ailment. An eight- to nine-year-old juvenile male (subsequently named Kwama, which means 'to be stuck' in Kiswahili), a calf and an adult female approached a waterhole we used for focal animal observations. The observer was interested in collecting fresh boluses of faecal material and noticed at 1545 that the juvenile male Kwama was defecating. A defecating elephant will raise its tail and the exiting bolus will be seen protruding from the anus. Kwama was seen rubbing his rear against a tree stump as two juveniles from another group approached to within 20 m and sniffed in his direction. The two juveniles departed without further investigations. Visibility was obscured by vegetation as Kwama moved away from the waterhole.

At 1636, Kwama returned to the waterhole, following the same calf and adult female. A bolus was seen protruding from his anus, just as it was earlier. Although his behaviour was not quantified, his actions did not seem odd nor in any way did he draw particular attention from the observer. Kwama did not appear to be uncomfortable or irritated and his physical appearance of skin tone, shape and height and his movements were similar to those of other juvenile males in his age range. He was seen drinking and interacting with the calf, and at 1647, the trio departed.

Subsequent encounters with Kwama showed that his behaviour had altered and his appearance changed. Elephant family units, at minimum, may include an adult female with her offspring (Moss 1983). The presence of Kwama with the two other elephants indicated a potential family unit. Kwama was seen again by the same observer four days later, on the morning of 25 December 2004. This time he was alone, but still had the half-protruded bolus. Although it is not unusual for males of Kwama's age to separate from their natal group, the sustained presence of the bolus was highly abnormal. Apparently, Kwama was constipated that is, the bolus was 'stuck'. During a 20-minute animal observation that began at 1029, it was evident that his behaviour was deviant from conspecifics of similar age and sex noted from observations at the waterhole.

Compared with other juvenile elephants, Kwama displayed lower levels of common state behaviour such as walking and eating, yet he spent a large portion of his time apparently seeking relief from constipation (table 1). Kwama displayed no bouts of eating and spent only 6 seconds drinking while other

juvenile elephants ate for about half a minute and drank for several minutes. Kwama walked very little. He spent much of the observation period motionless on his side in the mud (8.5 min., table 1), while other juveniles almost never did this. In fact, the longest any other juvenile was observed motionless on its side in the mud was 44 seconds. Kwama also wallowed in mud and rubbed his rear for longer periods than other juvenile elephants, yet he did not perform any mudding bouts. Mudding occurs when elephants use their trunks to disperse mud over the face and body. Other juveniles spent about 70 seconds mudding over the 20-minute observation period. His duration for each of these particular activities was quite different from data acquired from both male and female juveniles or for male juveniles only (table 1).

The short duration of maintenance activities such as eating and drinking and the longer periods of stationary behaviour suggest that Kwama's disorder impaired him from pursuing these activities. Constipation also may have attributed to his solitary status on 25 December 2004. His elevated durations of wallowing and lying in the mud and of rubbing his hind end on substrates indicate that he was trying to rid himself of the bolus. His speed of locomotion during his departure at 1049 from the waterhole was slow and punctuated with bouts of rubbing his anus against trees. In between bouts of rubbing, he would stand with his hind legs spread apart and stay motionless, in a posture indicating tenesmus (fig. 1). Kwama entered a wooded area approximately 100 metres away at 1108 as an adult male approached the waterhole. Attention was diverted from Kwama as observation was focused on the adult male.

Kwama's spoor was followed by the observer and he was found at 1337 rubbing his hind end against an acacia tree. The observer got to within 10 metres and was able to get the first close-up sighting of the bolus. Its coloration resembled elephant faecal material that was several days old. The skin around the protruding bolus appeared stretched and the enclosed portion of the bolus appeared to have a larger diameter than the exposed half (fig. 1). He continued to move slowly but ate grass while walking. During the following days, several sightings of Kwama were reported by staff members and his condition was said to be poor. He was always alone and people could approach to an arm's length with no display of aggression from him. On 3 January 2005, Kwama was found dead with the bolus protruding from his anus; he had been constipated for at least 13 days.

The carcass was in rigor mortis during investigation, indicating that death had occurred in the previous 24 hours. The length of the tusks (33 cm) and length of the hind foot (30 cm) confirmed the age at 8–10 years (Lee and Moss 1995; Moss 1996). There was discoloration in the skin around the anus, which was bulging with faeces. A staff member who volunteered to dissect the anus pulled out several metres of coarse, fibrous faeces (fig. 2). Small, sharp points that resembled thorns were found in the faeces and another staff member recognized these points as features of the sisal plant *Agave sisalam*. The fleshy stems of sisal are often used to manufacture twine for rope; the stems end in sharp points. Sisal is distributed in small patches at Ndarakwai and is not restricted to a specific area. Although Kwama was not witnessed eating sisal, elephants were the only species seen to eat the fleshy sisal stems. Compared with other types of vegetation, qualitative visual censuses indicated that sisal plants exhibited the least amount of browse damage such as chewed stems. This perhaps indicates that this plant is not included in the diet of many herbivores. The vegetation Kwama consumed was in abundance and had also been browsed by other elephants.

It is conceivable that the sisal Kwama ate formed one long, continuous cable-like segment that may have stretched from intes-

Table 1. Comparison of activity (number of times per minute) for the constipated juvenile male elephant, Kwama, based on observation of male and female juvenile elephants (n = 17, 20-minute focus each) and of just male juvenile elephants (n = 8 except for wallow where n = 1). Values are mean ± SE per minute

Activity	Elephant juveniles		
	Kwama	Male and female	Male
Eating	0	0.37 ± 0.22	0.8 ± 0.45
Drinking	0.10	2.2 ± 0.59	2.7 ± 1.08
Walking	0.32	1.75 ± 0.39	2.0 ± 0.78
Reclining on side	8.50	0.09 ± 0.05	0
Mudding	0	1.2 ± 0.35	0.5 ± 0.32
Rubbing	1.15	0.15 ± 0.10	0.21 ± 0.19
Wallowing	1.75	0.25 ± 0.13	0.16

tines to rectum. Occurrences of faecal matter measuring two-thirds of a metre and weighing close to 10 kg have been encountered by the observer (DV). These types of faeces are held together via long, fibrous material, similar to that found inside Kwama, and it is difficult to separate it into sections. The bulging nature of the anus may have been the result of an enormous bolus with a diameter larger that of the anus. Kwama's tendency to soak in the mud and rub on trees may have been attempts to eject the faeces. His continued consumption of fibrous grass may have worsened his condition. Ingestion of foreign matter can cause serious problems for wildlife. However, there were no foreign objects in the faecal matter such as plastic bags that might have contributed to the constipation.

Dhaval Vyas

Figure 1. Juvenile elephant Kwama leaning forward with his hind legs spread in an apparent attempt to discharge the faeces, Ndarakwai Ranch, Tanzania.

Observations were not made about the dentition, but dental problems may have affected mastication, leading to subsequent problems down the alimentary system. Poor mastication of the sharp tips of the sisal stems may have contributed to the impaction of faecal matter. Based on our observations and limited necropsy, the most probable contribution to mortality would be related to the poorly digested, lengthy components of the sisal plant and the likely concomitant problems with nutrient uptake, although other factors such as infection cannot be ruled out.

The incidence of constipation is probably low in wild elephants and other animals, but the selection of forage is certainly an important aspect of their behaviour ecology. Some species may practise self-medication to relieve ailments (Wrangham 1995; Lozano 1998). We have no evidence for or against such a practice in the case of Kwama. In social species, individuals may attempt to assist conspecifics in distress. For example, elephants have been observed to help calves out of mud holes. We saw no other elephants interacting with Kwama that indicated they recognized the problem or attempted to remove the bolus using their trunk. While numerous studies have examined the foraging ecology of elephants (for example, Stokke 1999; Stokke and du Toit 2000; and references therein), few have targeted the relationship between plant defences and species selection (Osborn 2002), especially over the course of development. The developmental process by which a generalist herbivore incorporates species into the diet would be worthy of further study.

Acknowledgements

B.A.S., L.E.L.R. and T.E.G. are grateful to the National Science Foundation for financial support. D.K.V. was provided with additional support from the Georgia Southern University Graduate Student Research Fund. We also appreciate support from our home universities: Georgia Southern University, Hendrix College, and Oregon Health and Science University. We thank Peter Jones and the staff at Ndarakwai Ranch as well as Costech and TAWIRI (permit No. 2004-170-N-2004-32) for permission to work in Tanzania. Special thanks for field assistance to Raphael Kosianga, Hassani Laurenti, Israel Orio, Dixon Amasi, Dirk and Ricarda Erdmann, Enock

Dhaval Vyas

Figure 2. Long fibrous strands of sisal *Agave sisalam,* dissected from the anus of Kwama, that may have affected the blockage of faeces.

Matayo and Thomas Ole Kuya. Dr Dennis Schmitt and two anonymous reviewers made valuable comments on the manuscript.

References

Dudley JP. 1999. Seed dispersal of *Acacia erioloba* by African bush elephants in Hwange National Park, Zimbabwe. *African Journal of Ecology* 37:375–385.

Laws RM, Parker I, Johnstone RCB. 1970. Elephants and habitats in North Bunyoro, Uganda. *East African Wildlife Journal* 8:163–180.

Lee PC, Moss CJ. 1995. Structural growth in known-age African elephants (*Loxodonta africana*). *Journal of Zoology, London* 236:29–41.

Lozano G. 1998. Parasitic stress and self-medication in wild animals. *Advances in the Study of Behavior* 27:291–317.

Moss CJ. 1983. Oestrous behaviour and female choice in the African elephant. *Behaviour* 86:167–196.

Moss CJ. 1996. Getting to know a population. In: Kangwana K, ed., *Studying elephants*. African Wildlife Foundation, Nairobi. p 58–74.

Mubalama L, Sikubwabo C. 2002. Rate of decay of elephant dung in the central sector of Parc National des Virunga, Democratic Republic of Congo. *Pachyderm* 33:43–49.

Osborn FV. 2002. Elephant-induced change in woody vegetation and its impact on elephant movements out of a protected area in Zimbabwe. *Pachyderm* 33:50–57.

Poole JH. 1996. The African elephant. In: Kangwana K, ed., *Studying elephants*. African Wildlife Foundation, Nairobi. p. 1–8.

Ruggiero RC. 1992. Seasonal forage utilization by elephants in central Africa. *African Journal of Ecology* 30:137–148.

Stokke S. 1999. Sex differences in feeding-patch choice in a megaherbivore: elephants in Chobe National Park, Botswana. *Canadian Journal of Zoology* 77:1723–1732.

Stokke S, du Toit JT. 2000. Sex and size related differences in the dry season feeding patterns of elephants in Chobe National Park, Botswana. *Ecography* 23:70–80.

Wrangham R. 1995. Relationship of chimpanzee leaf swallowing to a tapeworm infection. *American Journal of Primatology* 37:297–303.

OPINION

Vasectomy of older bulls to manage elephant overpopulation in Africa: a proposal

Ben Bokhout,[1] Marius Nabuurs[2] and Mart de Jong[3]

[1] Biologist, retired research worker of the Central Veterinary Institute, Vondellaan 21, Ermelo 3852BL, The Netherlands; email: tormentil.bokhout@hccnet.nl
[2] Veterinary surgeon, retired research worker of the Central Veterinary Institute, Jannedorp 13, Achterveld 3791VJ, The Netherlands
[3] Professor of Quantitative Veterinary Epidemiology, ID-Lelystad, PO Box 65, The Netherlands

Abstract

The paper proposes a new, humane and safe approach for managing the problem of overpopulation of the African elephant (*Loxodonta africana*) without disrupting social behaviour. It is based on using vasectomy on a part of the dominant bull population to lower the birth rate in a population. Advantages and disadvantages of male versus female sterilization are described, as well as general, technical, sex-related and financial aspects of vasectomy of elephant bulls. After dominant bulls are selected, treatment of less than 2% of the elephants would stabilize a population in parks with a natural population growth rate. For parks with 100 to 300 elephants, occasional vasectomy of a dominant bull would provide an effective elephant family planning tool.

Résumé

Cet article propose une nouvelle approche, humaine et sûre, pour gérer le problème de la surpopulation de l'éléphant africain (*Loxodonta africana*) sans perturber le comportement social. Il se base sur la vasectomie d'une partie de la population de mâles dominants pour réduire le taux de natalité dans une population. Les avantages et les inconvénients de la stérilisation des mâles par rapport à celle des femelles sont décrits, ainsi que les aspects général, technique, lié au sexe et financier de la vasectomie des éléphants mâles. Après la sélection des mâles dominants, le traitement de moins de 2% des éléphants stabiliserait une population dans des parcs où le taux de croissance est naturel. Pour les parcs qui abritent de 100 à 300 éléphants, la vasectomie occasionnelle d'un mâle dominant pourrait être un outil efficace de planning familial.

Introduction

In some countries unrestricted growth of the African elephant (*Loxodonta africana*) population causes serious problems. In Botswana and Kenya, where elephants roam free, they come into conflict with the human population by causing damage to human life and property (Poole 1993). In Zimbabwe and South

This proposal, although based on scientific literature, does not present evidence that the vasectomy concept will work, as vasectomy had never been performed on elephants before this concept was first presented at an Elephant Symposium of the Elephant Management and Owners' Association (Bokhout et al. 2004). Since then, the operation has been carried out a number of times in South Africa (Mark Stetter, pers. comm. 2005). This paper is intended, rather, to stimulate discussion and experiments to find an alternative solution for the problem of elephant overpopulation.

Africa all elephants are fenced in. Here elephant overpopulation ultimately leads to destruction of their habitat and that of other animals as well, ultimately leading to loss in biodiversity (Whyte et al. 1999).

Several population control methods have been tried—culling, translocation and contraception for female elephants.

Culling as a management tool was practised as early as 1967. Population increases in Kruger National Park (KNP) in South Africa led to culling about 14,500 elephants between 1967 and 1994 (Whyte 2001). Although a controversial control strategy from the start, culling is by far the fastest method for reducing population size. Because of public debate and other factors, culling at KNP was put on hold in 1994 (Whyte et al. 1999).

Up to 1994 young elephants were translocated to other parks after the adults of a herd were culled (Garaï et al. 2004). But moving juveniles without adults led to problems, one of which was that the juveniles became aggressive to other species such as rhino (Slotow et al. 2000). Thus since 1994, only entire cow-and-calf groups have been translocated to nearly 60 reserves (Garaï et al. 2004). Translocation is a humane method, providing new, mostly small areas for elephants to live in.

During the last decades several techniques of contraception for female elephants have been discussed and tried. These include terminating pregnancy, practising hormonal control using oestradiol-17b (oestrogen) implants, and immunocontraception (Poole 1993; Fayrer-Hosken et al. 1997; Whyte and Grobler 1998; Whyte et al. 1999; Fayrer-Hosken et al. 2000; Fayrer-Hosken et al. 2001; Pimm and Van Aarde 2001). Oestrogen implants were reported to induce behavioural aberrance, resulting in substantially increased stress levels on the treated cows and their calves (Whyte and Grobler 1998). The use was suspended as it was considered unacceptable on both humanitarian and ethical grounds. Recently Delsink et al. (2004) reported results of using porcine zona pellucida glycoproteins (pZP) (Fayrer-Hosken et al. 1997). This approach significantly reduced population growth in a small population of elephants.

Male elephant contraception is hardly mentioned or at most is mentioned indirectly (Poole 1993), arguing that even the removal of a large number of males would not reduce existing populations. This paper shows that contraception for elephant bulls may have advantages, on condition that the males are not removed. It focuses on comparing the pros and cons of an apparently promising immunocontraception with pZP in female elephants with those of what is for the present a hypothetical method of selective contraception by vasectomy in older dominant males.

Male versus female contraception

General aspects

In an elephant's life, males need to be sterilized once, whereas females have to be treated at least four times, not counting 'boosters', to prevent births (table 1).

The treatment of older solitary males can be done

Table 1. Technical aspects of female versus male contraception relevant for contraception choice

Aspect	Female sterilization	Male vasectomy	Literature if relevant
Number of treatments per animal	4 to 6[a]	1	Moss 2001
Herd disturbance	Yes	No	—
Tracking down and capturing (1st time)	Easy (herd)	Less easy (solitary)	—
Tracking down and capturing (2nd time)	Difficult	Irrelevant	—
Selection of elephants to be treated	Easy	Fieldwork essential	—
Experience with treatment in elephants	Yes	No	—
Evaluation of treatment	After 2 years	Immediately[b]	—
Influenced behaviour due to hormonal change	Yes / probably	Not to be expected	Whyte and Grobler 1998; WHO 2004
Risks	'New' diseases[c]	Infection	—

[a] based on average number of births during life of a female elephant (Moss 2001) to prevent any births (each sterilization requires at least two treatments separated in time)
[b] fast adjustments of techniques possible (if necessary)
[c] risk that porcine viruses or parts of (viral) nucleic acids within the injected porcine derived product, may induce 'new' diseases in elephants.

far from any herd. Although females can be injected from a distance using projectile syringes, the procedure agitates all members of their family and probably their entire family group (Moss 1983). After a first immunization females have to be tracked down again—a difficult job that requires radio collaring (Whyte 2003) of the immunized females.

Single males are more difficult to trace than a herd with females. However, during the last decades of their life older males prefer to return to the same restricted 'bull area' after each mating period, thereby making it easier to track them down.

Selecting males to be treated depends on their age, ranking and musth period. Determining the first criterion is fairly easy. However, to draw up an inventory of males to be treated requires extensive fieldwork (see Discussion). Selection of females to be treated is based solely on estimating age. Most females conceive their first calf when they are between 11 and 13 years of age (Moss 2001). A number of the selected females will likely already be pregnant before contraception is practised. This means some of the immunized females will calve. Delsink et al. (2004) reported that ca. 60% of the cows were already pregnant before they were immunized during the first year. Up till now hardly any information is available on possible effects of immunocontraception in females (Whyte and Grobler 1998).

Two methods are possible for sterilizing male elephants: castration and vasectomy. As elephants have intra-abdominal testes both methods require surgery within the peritoneal cavity. As castration alters the hormone balance, inducing un-bull-like behaviour (Olson and Byron 1993), it would only lead to more mating by other males. Moreover, vasectomy is much more humane, routinely done on human males all over the world, and ejaculation is normal, albeit without semen. In men, vasectomy produces no change in the function or amount of male hormones produced (WHO 2004), and there is no reason to suppose that in vasectomized elephant males, hormone production would be changed (Cees Wensing, pers. comm.).

Vasectomy calls for surgical experience not yet available for elephants. However, development of vasectomy techniques has one big advantage compared with sterilizing female elephants: techniques can be rapidly refined, for the vasectomy result is immediately visible endoscopically. Before being able to evaluate and improve female sterilization techniques, one has to wait about two years, the average length of the gestation period.

Both male and female contraception run the risk of inducing diseases. As males have to be vasectomized in the bush there is the chance that they may be infected with bacterial or viral agents. The risk that simply darting will infect female elephants is far smaller. However, injection with a pZP glycoprotein product, if it is isolated from pigs and not produced synthetically, is not without danger. We are not able to calculate the risk that porcine viruses or parts of (viral) nucleic acids within the injected product will induce diseases new to elephants, comparable with the induction of bovine spongiform encephalopathy (Race et al. 2002; Smits, pers. comm. 2005).

Sexual- and behaviour-related aspects

The combination of sexual- and behaviour-related aspects of the African elephant forms an important element of the vasectomy concept. Many fewer males than females are involved in producing offspring. Male–female and male–male interaction behaviour also favours the role of small numbers of males.

Unique behaviour studies in Amboseli National Park provide wide knowledge of elephant reproductive patterns in a savanna ecosystem (Moss 2001). These studies provide evidence that based on sex ratio, considerably fewer males than females have to be sterilized to lower the birth rate identically. First, males have not begun sexual cycles, not experiencing their first musth period until they are 25 or 30 years of age (Poole 1989a,b, 1999) whereas females may conceive their first calf when they are between 11 and 13 years (Moss 2001). Further, in any given year a sexually active bull will mate with a number of cows (Poole 1989b). Third, fewer bulls reach the age at which they get the opportunity to mate. Moss (2001) reported that only 39% of males survived to the age when they regularly enter musth and were likely to mate a significant number of times, whereas 82% of females survived to the age of first reproduction. When bulls reach the age when bull dominance peaks (Poole 1989b) at 40 to 50 years, there normally are far fewer bulls than cows (Moss 2001).

Apart from these sex-related aspects the preference for sterilization of older males is based on the following behaviour-related bull characteristics and male–female and male–male interactions.

Bull characteristics

The duration and intensity of a male's musth period is correlated closely with his age (Poole 1989a). Differences in the duration of musth are a strong argument in favour of the vasectomy of older bulls. Sessions of musth among individuals 25–35 years old are short (several days to perhaps a week) while older males experience longer periods (2–5 months) of musth (Poole 1989b, 1999**).** Male elephants during periods of musth have very high testosterone levels (Poole 1989a, 1999). In a number of species such as red deer (*Cervus elephas*), this has been shown to correspond with increased spermatogenesis. Older bulls may therefore be more likely to impregnate a female (Moss 1983).

Male–female and male–male interactions

During oestrus (4–6 days) females show preference for males of older age classes (Moss 1983) and actively stay close to a preferred male (Poole 1989b). They facilitate mating with large males by standing still, while they attempt to outrun younger males (Poole 1989b).

At the beginning of oestrus females become wary of males and elude their pursuers nearly 70% of the time (Moss 1983). During that period and also during late oestrus, the large, older males show little interest in the females, while males 25 to 35 years old sometimes manage to mate (Poole 1989b).

Mid-oestrus is a relatively quiet 3- or 4-day period during which the female and the large musth male guarding her, 35 years of age or older (Poole 1989b), stay close and other males do not chase the female (Moss 1983). The ability of male elephants to guard oestrus females and copulate during mid-oestrus increases dramatically late in life (Poole 1989b). During those days the guarding male mates infrequently (Poole 1989b). Behavioural data suggest that the overall number of times of mating with a female is less important than who guards and mates with her during mid-oestrus (Poole 1989b)—which is the older, dominant bull. It is suggested that guarding serves primarily to avoid harassment. The older bull achieves this situation by chasing off younger bulls, thereby preventing them from mating (Moss 1983). There is behavioural evidence that lower-ranking bulls when chased drop out of musth (Poole 1989a)—again minimizing chances that younger bulls mate.

Thus the behaviour of oestrus females, as part of male–female and the outcome of male–male interactions, results in their mating with males who are old, vigorous and healthy (Poole 1989b), making them the prime target for vasectomy.

According to data taken in Amboseli National Park in Kenya, males 35 years of age or older accounted for 54% of successful mating (Poole 1989b). Based on the Amboseli figures, we have calculated that in parks with 100 to 300 elephants with a natural population growth rate, occasional vasectomy of a dominant bull would provide an effective elephant family planning tool. We further calculated, based on an estimated 3.8% growth rate of the KNP elephant population (Whyte 2001; Blanc et al. 2003), that vasectomy of fewer than 150 to 200 dominant bulls (less than 2% of the elephant population) would lead to a more or less stable population. To obtain the same result by immunocontraception Whyte (2003) calculated that 75% (ca. 3000) of all breeding females (> 30% of the total KNP population) must be constantly under treatment. So, about 15 times more elephants would have to be treated year after year using immunocontraception instead of once-only vasectomy.

An elephant cow will return to oestrus in 15 weeks if she does not conceive. If she mates with a vasectomized bull, she will continue to come into oestrus until eventually she conceives by mating with a younger, lower-ranking bull that has been vasectomized. We are of the opinion that careful selection of dominant bulls will minimize the influence of bulls lower in rank even after a number of years. At present, nobody knows or can accurately predict the outcome of vasectomy; only a scientific pilot study can verify if our supposition is correct.

Surgery

Elephants have been castrated (Olson and Byron 1993; Foerner et al. 1994; Bengis 2004), indicating that vasectomy by laparoscopic surgery is theoretically possible. In 2004 ovarectomy was successfully performed on female elephants **(**Mark Stetter, pers. comm.). This operation, performed in a reserve in South Africa, showed that it is feasible to operate on elephants in the bush.

Based on the anatomy of the male reproductive organ (Short et al. 1967) and castration experience, technical problems that may be encountered are 1) cutting through the peritoneum, as it is very strong,

elastic and covered by a thick layer of fibroelastic tissue (Foerner et al. 1994) and 2) endoscopically locating the vas deferens, as it may be obscured by intraperitoneal fat layers. Attributed to increased activity and metabolic rate and decreased feeding, a male during musth loses a lot of weight, positively correlated with the duration of his musth period (Poole 1989a, 1999). Also for this reason it is logical to perform vasectomy on old males during the month(s) after musth, as the problem of locating the vas deferens will be minimized.

Financial aspects

Vasectomy of elephant bulls involves 1) capture and anaesthesia, and 2) surgery using endoscopic instruments.

Capture and anaesthesia of one elephant costs about USD 1000 (Hofmeyr 2003). Endoscopic instruments are calculated at USD 30,000 to 60,000. If we assume complete depreciation of the instruments after 200 bull operations, the cost per elephant would be USD 150 to 300. The vasectomy team's pay is estimated at USD 1000 per elephant, meaning that all together the prime costs would be less than USD 2500 per vasectomy. Additional costs would come from the fieldwork necessary to register ranking, timing and duration of musth periods of dominant bulls in the population, and to locate bull areas.

Discussion

This paper focuses on comparing the pros and cons of immunocontraception in female elephants (Fayrer-Hosken et al. 1997) with a hypothetical method of contraception in older, dominant males by vasectomy. Based on Amboseli figures (Poole 1989b) we calculated for stabilization of the KNP elephant population with a ratio of 15 to 1, where 15 is the number of frequently treated females and 1 is the once-only vasectomy of older dominant males. Based on the assumption that the average female will produce four calves in her lifetime (Moss 2001) theoretically about 60 times more treatments are necessary using immunocontraception than vasectomy.

The number of treatments can be calculated easily. However, the outcome of the vasectomy concept is not as easy to predict. Let us look at a worst-case, a best-case, and a most-realistic scenario imaginable.

A worst-case scenario will show a birth rate that is the same as or only a bit lower than the average birth rate over the past years. This may be caused by vasectomy of bulls that are lower in rank than the bulls that mate most successfully. Vasectomy will never result in preventing all calves from being born.

A best-case scenario will lead to a birth rate that is about 60% lower than the former average birth rate. That percentage is based on elephant studies in Amboseli combined with observations of musth periods in South Africa. In Amboseli 54% of the successful mating was achieved by a small number of older, dominant bulls (Poole 1989b). In Amboseli the year can be divided into a wet season and a dry season; older males preferably have their musth period and mate in the wet season (Poole 1989a). In the fenced parks in southern Africa elephants have permanent access to water. This may be the origin of frequent fathering by a small number of dominant males (Whitehouse 2002) due to longer musth periods **(**Bradley Schrôder, pers. comm.). These longer musth periods may lead to vasectomized bulls mating more successfully and thus result in lower birth rates. In a best-case scenario birth rates will be further lowered when some medium-ranking males are also treated, as they will mate with any female they find that is not already guarded by a high-ranking male (Poole 1989a).

The most-realistic scenario leads to an estimate of ca. 50% lower birth rate. For even when all relevant bulls are vasectomized the female that mates with a treated bull (a chance of about 60%) will again come into oestrus about 4 months later. At that time, a slightly larger than normal number of females will be in oestrus during the same period. The percentage of mating with younger males will probably grow slightly, because a dominant bull will be less able to guard his female in oestrus or he will want to mate with another oestrus female in the herd, thereby leaving his first female unguarded.

To get a valid indication of the real value of the vasectomy concept, a pilot experiment is necessary. Further theorizing is not useful as there are too many unpredictable variables:

- percentage of successful mating in general is unknown.
- park area in combination with the density of the elephant population influences the possibilities of male–female and male–male communication by sound and other signals (Poole 1989a, 1999).
- herd size: a dominant bull will more easily be able

to guard oestrus female(s) and chase away bulls lower in rank in small herds than in large.
- sex ratio: the larger the number of oestrus females in relation to dominant males the smaller will be the chance of a dominant male mating successfully, as lower-ranking males will get more opportunity.
- percentage of lower-ranking males in relation to dominant males on an annual basis: the larger the first category the greater the chance that its members will 'steal' females and mate successfully.
- percentage of older, experienced females in the population who show a preference for large (that is, old) males (Moss 1983).

Pilot experiment

A pilot will best be executed in a small park with a well-known history. Data of the elephants in the park that should be available are: the number of elephants and their sex ratio, the average population growth rate during past years, and the dominant bulls and their musth periods over the year. The last data set is relevant because the musth periods of older males are asynchronous and each male comes into musth at a specific time every year. As the timing of a dominant male's musth period is relatively consistent from one year to the next (Poole 1989a), this information is necessary to cover a calendar year with vasectomized dominant bulls.

After a park has been chosen, a vasectomy pilot could follow the steps as suggested in table 2. First a surgical team would practise vasectomy on 10 to 20 elephants, not necessarily in the same park, to train the team and to fine tune the surgery, adjust surgical instruments if necessary, and optimize anaesthesia of the bull during surgery. In the meantime inventories and photographic identification (Moss 2001) would be drawn up from the bull's ranking and musth periods.

As soon as enough expertise is available vasectomy would start on the first selected bulls that come out of musth. Surgery would continue until all selected bulls have been treated. When the bulls come into musth again for the first time after treatment a variety of observations would be registered such as the timing and duration of the musth period, guarding and mating behaviour, and the behaviour of oestrus females towards the treated males.

Two years after the last bull has been vasectomized a census would be necessary to learn the actual annual growth rate of the population, including the number of newborn calves. Thereafter the vasectomy pilot project would be evaluated.

As vasectomy uses the natural behaviour of elephant populations, using it to reduce the population will be slow. Reducing population dimensions also depends in large part on the natural death rate. But vasectomy will substantially lower the birth rate.

Acknowledgements

The authors wish to thank Dr M. Th. Frankenhuis, veterinary surgeon, Emeritus Professor of Special Animals and former director, Artis Zoological Gardens; Dr Anna Whitehouse, consultant in South Africa; and Prof. Graham Kerley, Director, Terrestrial Ecology Research Unit, Department of Zoology, University of Port Elizabeth, South Africa, for fruitful discussions.

References

Bengis R. 2004. Care of the African elephant *Loxodonta africana* in captivity. Internet site: www.Wildnet Africa.com. Accessed 15 May 2004.

Blanc JJ, Thouless CR, Hart JA, Dublin HT, Douglas-Hamilton I, Craig GC, Barnes RFW. 2003. *African Elephant*

Table 2. Suggested activities, in sequence, of a vasectomy pilot programme in a small park

Steps to be taken
Form a chirurgical team
Conduct trial surgery to gain experience and refine laparoscopy, endoscopy, vasectomy and anaesthesia of bulls
Inventory bull population (for use in phase 2)
Inventory and select accessible areas for bull treatment
Perform vasectomy of selected bulls after their individual musth period
Study behaviour of vasectomized bulls
Monitor programme two years after completion of the vasectomy surgeries
Perform vasectomy of other bulls based on census

Status Report 2002: an update from the African elephant database. Occasional Paper No 29. IUCN Species Survival Commission. IUCN, Gland, Switzerland.

Bokhout B, Nabuurs M, de Jong M. Vasectomy of older bulls to manage overpopulation of the African elephant. Elephant Symposium, Elephant Management and Owners' Association, September 2004, Pilanesburg National Park, South Africa.

Delsink A, Grobler D, van Altena JJ, Kirkpatrick J, Bertschinger H, Slotow R. 2004. Population regulation of African elephants through immunocontraception. Elephant Symposium, Elephant Management and Owners' Association, September 2004, Pilanesburg National Park, South Africa.

Fayrer-Hosken RA, Brooks P, Bertschinger HJ, Kirkpatrick JF, Turner JW, Liu IKM. 1997. *Wildlife Society Bulletin* 25(1):18–21.

Fayrer-Hosken RA, Grobler D, Van Altena JJ, Bertschinger HJ, Kirkpatrick JF. 2000. Immunocontraception of African elephants. *Nature* 407:149.

Fayrer-Hosken RA, Grobler D, Van Altena JJ, Bertschinger HJ, Kirkpatrick JF. 2001. Reply. *Nature* 411:766.

Foerner JJ, Houck RI, Copeland JF, Schmidt MJ, Byron HT, Olsen JH. 1994. Surgical castration of the elephant (*Elephas maximus* and *Loxodonta africana*). *Journal of Zoo and Wildlife Medicine* 25(3):355–359.

Garaï ME, Slotow R, Carr RD, Reilly B. 2004. Elephant reintroductions to small fenced reserves in South Africa. *Pachyderm* 37:28–36.

Hofmeyr M. 2003. Translocation as a management tool for control of elephant populations. Lecture in 'Managing African elephant populations: act or let die', 7–8 November 2003, Beekbegen, The Netherlands. www. elephant populationcontrol.library.uu.nl. Accessed 12 December 2003.

Moss C. 1983. Oestrus behaviour and female choice in the African elephant. *Behaviour* 86:167–196.

Moss C. 2001. The demography of an African elephant (*Loxodonta africana*) population in Amboseli, Kenya. *Journal of Zoology London* 255:145–156.

Olson JH, Byron HT Jr. 1993. Castration of the elephant. In: Fowler ME, ed., *Zoo and wild animal medicine: current therapy,* 3rd ed. W.B. Saunders, Philadelphia. p. 441–444.

Pimm SL, Van Aarde RJ. 2001. African elephants and contraception. *Nature* 411:766.

Poole JH. 1989a. Announcing intent: the aggressive state of musth in African elephants. *Animal Behaviour* 37:140–152.

Poole JH. 1989b. Mate guarding, reproductive success and female choice in African elephants. *Animal Behaviour* 37:842–849.

Poole JH. 1993. Kenya's initiatives in elephant fertility regulation and population control techniques**.** *Pachyderm* 16:62–65.

Poole JH. 1999. Signals and assessment in African elephants: evidence from playback experiments. *Animal Behaviour* 58:185–193.

Race RE, Raines A, Baron TGM, Miller MW. 2002. Comparison of abnormal prion protein glycoform patterns from transmissible spongiform encephalopathy agent-infected deer, elk, sheep, and cattle. *Journal of Virology* 76(23):12365–12368.

Short RV, Mann T, Hay MF 1967. Male reproductive organs of the African elephant, *Loxodonta africana*. *Journal of Reproduction and Fertility* 13:517–536.

Slotow R, van Dyk G, Poole J, Page B, Klocke A. 2000. Older bull elephants control young males.–*Nature* 408:425–426.

Whitehouse A. 2002. Managing small elephant populations: lessons from genetic studies. In: Kerley G, Wilson S, Massey A, eds.*, Workshop on Elephant Management and Conservation in the Eastern Cape.* p. 41–48. Also www. zoo.upe.ac.za/teru/Elephants. Accessed 3 June 2004.

[WHO] World Health Organization. 2004. Vasectomy. Official Internet site : www/who/int.Accessed 8 May 2004.

Whyte I. 2001. Conservation management of the Kruger National Park. PhD thesis, University of Pretoria.

Whyte I. 2003. The feasibility of current options for the management of wild elephant populations. Paper given at a meeting 'Managing African elephant populations: act or let die', 7–8 November 2003, Beekbegen, The Netherlands. www.elephantpopulationcontrol.library. uu.nl. Accessed 12 December 2003.

Whyte I, Biggs H, Gaylard A, Braack L. 1999. A proposed new policy for the management of the elephant population of the Kruger National Park. Kruger National Park Scientific Services. www.sanparks.org/parks/kruger/conservation/scientific/key-issues/Elepolicy.pdf. Accessed 20 November 2005.

Whyte I, Grobler D. 1998. Elephant contraception research in the Kruger National Park. *Pachyderm* 25:45–52.

TRIBUTE

A tribute to Blythe Loutit

Pierre du Preez

Blythe Loutit, co-founder of the Save the Rhino Trust (SRT) and renowned conservationist and artist, passed away after a long illness on Tuesday, 14 June 2005. She was 64 years old. Blythe was the leading force in the conservation and protection of the desert-dwelling black rhinoceros (*Diceros bicornis bicornis*) in the Kunene Region, north-west Namibia.

The youngest of four children, Blythe was born Blythe Pascoe on 14 November 1940 at Pieter-maritzburg, KwaZulu Natal, South Africa, and grew up on an extensive farm, surrounded by animals and plants. Her mother, Dulcie Pascoe, was a landscape gardener, and Blythe could remember accompanying her on many of her jobs designing gardens.

In 1973 she married Rudi Loutit, a conservationist. Five years later they moved to Ugabmund in Skeleton Coast Park, where Rudi was posted as warden.

Keryn Adcock

Blythe Loutit, conservationist and artist, and her companion, Eccles.

At Girls Collegiate School her art teacher was a naturalist, focusing attention on detail. By all accounts Blythe was more interested in her horses, dogs and the plants around her than in school, dolls and girl friends so it's no wonder that she moved into the world of conservation. She joined the Natal Parks Board, furthering her interest in botany, which led to her introduction to formal illustration. She trained in scientific illustration at the Botanic Research Institute of South Africa and illustrated several books on the flora of Namibia (and South Africa). She also painted landscapes and wildlife.

From 1982 onwards, she worked tirelessly on rhino projects in Namibia and headed SRT, which was set up to stop the slaughter of the desert-adapted black rhino surviving in the Kunene Region (former Damaraland and Kaokoland).

Blythe's life's work in saving the desert-dwelling black rhino started when she and her Irish terrier, Eccles, set off in 'Monty', an old short-wheel-base Land Rover, to investigate the unique vegetation of the area adjoining the Skeleton Coast Park in the Namib Desert. She got stranded with a puncture and a broken jack on a track in the lonely park and there she met Ina Britz. While Ina showed her how to use a high-lift jack, she told Blythe that close by at a remote spring that she had just visited she found three dead rhinos at the water. They had been riddled with bullet holes from an automatic weapon. Their carcasses were horribly mutilated and only bloody tissue remained where their horns had been hacked off.

It was the early 1980s; Damaraland was a 'restricted' area, yet the South African Defence Force and administrative officials were having a free-for-all annihilating its rich animal population. They were killing rare and endangered wildlife—indiscriminately and in any way possible: from helicopters and

land vehicles, at the scarce waterholes and with automatic weapons.

There and then two women decided this massacre of precious wildlife had to end. With assistance from their husbands, conservation-conscious businessmen in Windhoek, and community leaders in Damaraland they established the Namibia Wildlife Trust, which eventually led to the formation of SRT as it is still known today. A small group of people started patrolling and monitoring the area—specifically keeping an eye on the black rhino and elephant populations. It was never easy. Early days were marked by much frustration: many tears flowed over the failure to stop the poaching, raising funds was difficult, and criticism was levelled at the way the trust was being run.

But if one could choose the qualities that most reflected Blythe's personality, those qualities would probably be her sense of humour and her stubbornness—a strong combination. She never gave up.

Much of the trust's work in the early days was supported by children. Blythe had the vision to see that if SRT could get children with their boundless energy involved in a conservation project, it would be to great effect. Rhino friendship patches became the rage at schools, and children sold them to all and sundry to raise the 1000 rand they needed to sponsor their own rhino. It was a child who wrote to the trust in the late 1980s saying, 'If they are killing rhinos only for their horns and the horns are like fingernails, why don't you cut them off?' and that is just what the Department of Nature Conservation did. Two dehorning operations in Damaraland, besides protecting the rhino, raised awareness of their plight to new heights. Much controversy resulted but the trust's profile became more prominent and finding funds became a little easier.

To raise funds for the rhino, Blythe sold her own paintings throughout the years, most significantly at Christies in London and through the David Shepherd Foundation. Blythe illustrated six books on plants and wrote and illustrated several scientific and general publications, including her own book for children, *The Magic Elephant.* A close friend of 25 years, Sharon Montgomery, who worked with Blythe at SRT, wrote in an article in the April 2005 edition of *Flamingo* that while Blythe was famous for her artistic talent, it was her 'passion for rhino that has made her the focus of attention both in Namibia and internationally'.

SRT was the first non-governmental organization to actively involve the local community in its conservation efforts. Tourism, craft-making, guiding and direct employment benefited the area, and SRT became a household word. Blythe's imagination, creativity, stubbornness and sense of humour were the adhesive—without her, there would be no SRT today and the rhino would be very much worse off.

Over the years SRT developed a monitoring system and established a rudimentary computer database for each rhino. Today the black rhino population in the north-western regions of Namibia is one of the best documented in the world. While in 1985 during the first census only 56 rhinos were counted, there are now well over 130 individual rhino records.

Seven rhino generations have been monitored, respected and loved in Damaraland. Blythe has moved on, but her spirit of dedication and her love of rhinos and all other animals will remain. On behalf of all rhino lovers and conservationists, we wish her peace, knowing that she has done during her lifetime what few people could ever have achieved.

Her husband, Rudi, survives her and is continuing her work.

AWARDS AND RECOGNITION

- 1986, Peter Scott Merit Award at the IUCN Species Survival Commission in Costa Rica
- 1988, Endangered Species Trust Award
- 1991, Operation Survival Award
- 1996, presentation of the keynote address at the Species Survival Commission African Rhino Specialist Group General Assembly in Montreal, Canada
- 2001, BBC award for saving a species (*Diceros bicornis bicornis)*

Raoul du Toit adds

At an early stage in my work on rhinos it was very important to meet someone like Blythe who was getting on with the job of rhino conservation in such a straightforward way, with no glamour, unlike a lot of the other people I was working with. Blythe not only gave a friendly, human face to rhino conservation but also showed that if you take one step at a time you can make a big difference, which she certainly did over the years. Despite all the conservation politics that have swirled up at times in Namibia, no one can deny that Blythe's heart was always 100% in the right place and without her, a lot less would have been achieved for the desert rhinos.

Post-war effects on the rhinos and elephants of Garamba National Park

Kes Hillman Smith and Jerome Amube Ndey

PO Box 15024–00509 Langata, Nairobi, Kenya
email: kes@congoconservation.co.ke; amube_jerome@yahoo.com

Efforts to conserve the northern white rhino (*Ceratotherium simum cottoni)* and the elephant *(Loxodonta africana)* in Garamba National Park, Democratic Republic of Congo (DRC), have been beset by periods of war, and the park's position on the border of war-torn Sudan has made conservation even more tenuous. Throughout most of the recent war in DRC, Garamba has been one of the five World Heritage sites in the country benefiting from the very successful project for conservation in regions of armed conflict under the aegis of UNESCO/UNF/ ICCN (United Nations Educational, Scientific and Cultural Organization / United Nations Foundation / Institut Congolais pour la Conservation de la Nature) and NGO partners. But ironically the most serious declines and threats of extinction of the past two and a half years appear to have been linked to post-war instability in power struggles and exploitation of resources particularly from neighbouring countries.

In the first eight years after the start in 1984 of the Garamba National Park project , supported by several non-governmental organizations, the northern white rhino population doubled, from 15 to 30, at an average rate of increase of 9.7%. Elephants increased from 3300 ± 509 in 1984 to 11,175 ± 577 in 1995 with a local density of 2.46 per km^2 (Hillman Smith et al. 1995). These elephants have been found to be a genetically unique intergrade between forest and savanna forms (Roca et al. 2001; Nicholas Georgiadis, pers. comm. 2003). Thus the pachyderms and the unique Congo giraffe (*Giraffa camelopardalis congoensis)* are all of intrinsic value and justify the World Heritage status of Garamba.

Kes Hillman Smith

A 7–9-year-old female northern white rhino, poached in Garamba National Park, July 2004.

The war in southern Sudan increasingly affected Garamba from 1991 onwards with influxes of

armed refugees to surrounding areas and the presence of Sudanese People's Liberation Army (SPLA) camps on the border. Poaching, initially for meat, moved systematically down through the park despite well-organized anti-poaching and local collaboration by the ICCN/Garamba project partnership, which at least kept poaching out of the sector in the south where elephants and rhinos were concentrated. The conservation efforts maintained a stable rhino population of around 30 animals from 1993 to 2003, throughout the war in DRC, but considering that the rate of reproduction of the rhinos remained high, recruitment must have been balanced by offtake.

Elephant, hippo and buffalo populations suffered when rebel forces took over the park headquarters in 1997 because the guards were disarmed and anti-poaching activities ceased. Elephant numbers fell from 11,175 in 1995 to 5874 ± 1339 in 1998. However, the continued support of the International Rhino Foundation (an NGO partner) and of UNF/UNESCO enabled ICCN to maintain sufficient protection to keep the populations of large mammals stable, and elephants even increased from 1998 to 2003 (Hillman Smith et al. 2003).

From mid-2003, poaching increased and switched away from hunting for meat and trophies to solely seeking ivory and rhino horn. As the poachers progressed south through the park, several rhinos and elephants were reported to have moved out to the Domaine de Chasse to the south.

Results of the aerial total counts and a ground survey of minimum numbers of rhinos were as shown in table 1.

Nine rhinos were found dead during 2004, with most animals identified as individuals (fig. 1). One was a female with a young calf and one was a pregnant female (Hillman Smith and Smith 2005).

Elephants and other large mammals have been counted through the systematic sample counts held regularly at the start of the wet season. By 2004 no elephants were found north of the Garamba River. The population estimate from the systematic sample survey in April 2004 was 6354 ± 2082 (fig. 2), but the live-to-dead ratio was 17:1 and as the maps show (fig. 3), fresh and recent carcasses (stages 1 and 2) and carcasses that were older but still less than one year old (stage 3) were distributed throughout the southern sector, including within a few hundred metres of the park headquarters. A rough total count in November 2004 as part of the rhino and poaching survey indicated no more than 2000 elephants within the park, although there may have been more in the Domaine de Chasse. The total count of the southern sector in August 2005 yielded an estimate of only 1202 elephants within the park (de Merode et al. 2005).

Results from the law-enforcement monitoring and informer networks show that Sudanese involvement in the poaching has been at least 70%. Poaching was done mainly by ex-SPLA and deserters; by local people, often with civil authority involvement; and since 2004 by large groups of the fierce 'muharaleen'—Arab horsemen from Sudan, like those involved in perpetuating the Darfur crisis. In recent months, several hundred of the rebel Lord's Resistance Army forces from Uganda have been in the area living off the land. The upsurge in poaching coincided with the ceasefire in Sudan, which left armed forces unoccupied and opened easier passage through parts of Sudan that were previously enemy occupied.

In response to the massive rise in poaching in 2003, an emergency strategy was drawn up at the park,

Table 1. Northern white rhinos in Garamba National Park and Domaine de Chasse

Date	Method	Minimum in park (no.)	Other possibilities
2003			
April	Air total ID	30	
August	Air total ID	22	
November	Air total ID	19	
2004			
July	Air total ID	15	> = 2 in DC Gangala na Bodio, tracks verified
November	Air total ID	4	> = 4 in DC Gangala na Bodio
2005			
July	Ground, tracks	3–6	
August	Air total	4	unknown possible numbers in DCs?

DC – Domaine de Chasse

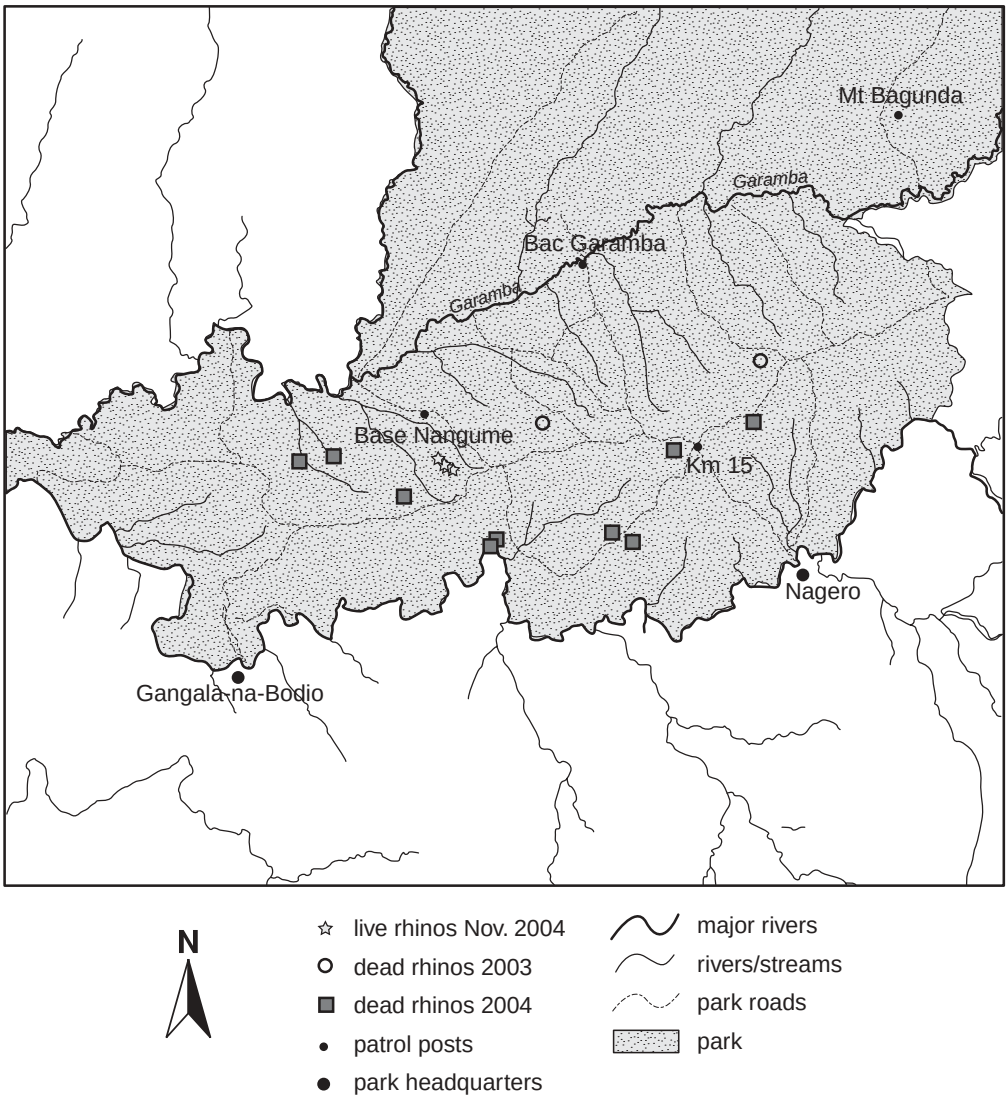


Figure 1. Live and dead rhinos found in Garamba National Park, 2003–2004.

approved by the Administrateur Directeur General of ICCN, and immediately put into effect. It had several approaches, but one of the key priorities was capacity building through field training and leadership with the ICCN field staff to help them combat the threats. The training went well, but at the start of its field application in April 2004, the northern horsemen were detected in the park for the first time and armed contacts led to deaths on both sides. This fierce threat and the deaths of their comrades had a demoralizing effect on the guards.

A major stakeholders' meeting in July 2004 welcomed several more potential donors, and an emergency strategy of over 1 million dollars was drawn up for in situ conservation. Training was again a major priority, this time with a team of experienced francophone trainers who had operated in Central African Republic, plus equipment, and community and technical support. In addition the joint meeting drew up a proposal to hold five of the rhinos in safety elsewhere temporarily until the poaching could be brought under control and the political instability and the resource exploitation from surrounding areas were resolved. This was aimed to prevent extinction of the northern white rhino in the wild—a threat that had become very real. It would assure that DRC would not lose its precious heritage, nor

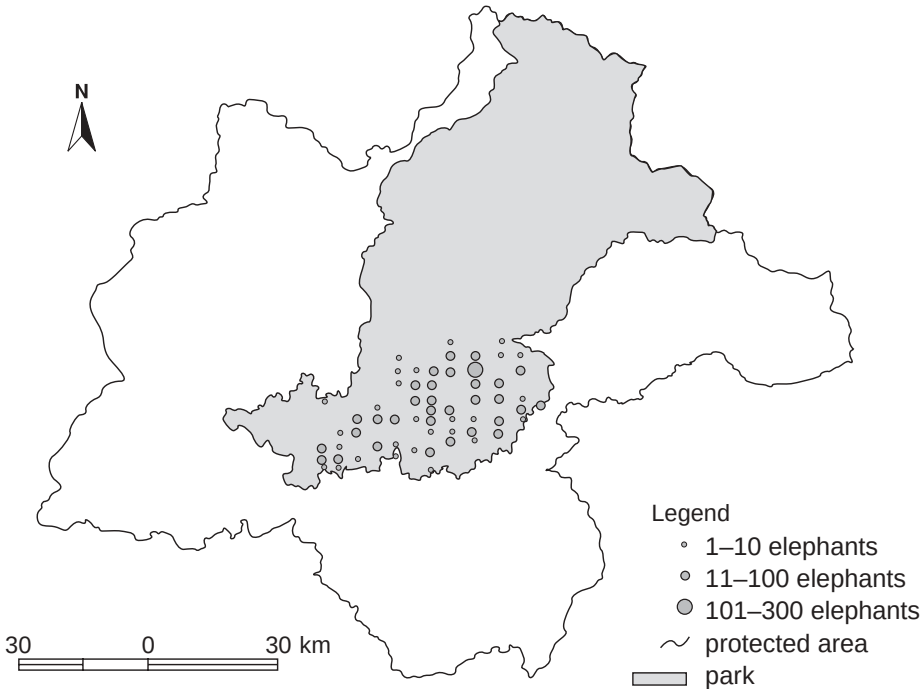


Figure 2. Disribution of live elephants in Garamba National Park from systematic aerial sample aurvey, April 2004.

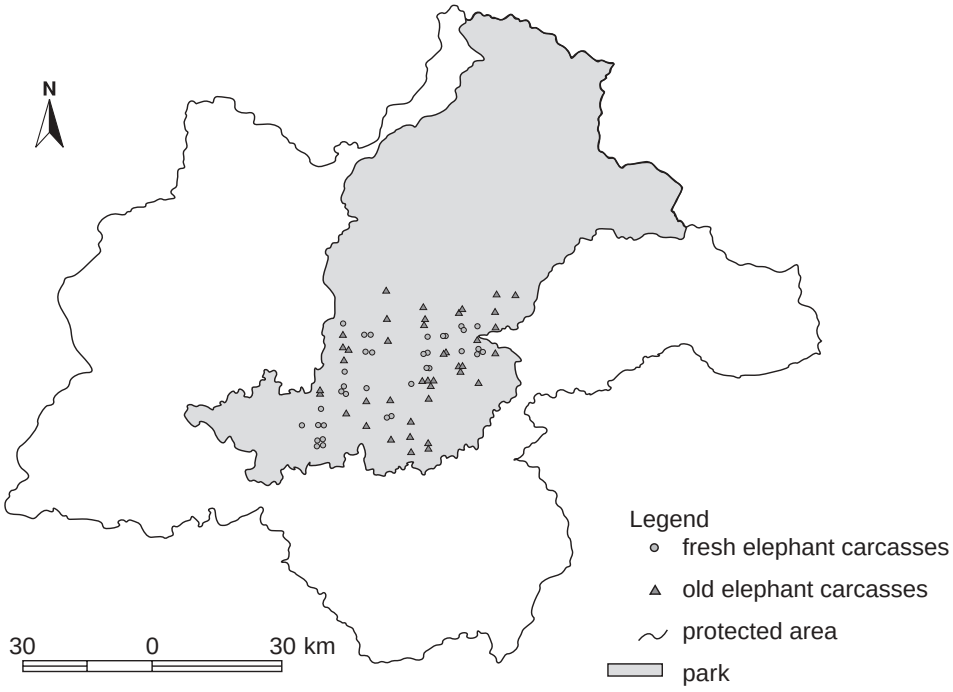


Figure 3. Distribution of elephant carcasses found in Garamba National Park from systematic aerial sample survey, April 2004.

Garamba its World Heritage status. It would guarantee the continued commitment to Garamba of donors who justified their input because of these rhinos and who would be forced to withdraw their support if all the rhinos in the park were allowed to die. ICCN welcomed the option, and members of the IUCN African Rhino Specialist Group did all the background research and evaluation. They documented methods to provide ICCN with the full details to present to the Ministry of Environment.

Although it was hoped that the increase in in situ support would render such action unnecessary, the survey in November 2004, which could find only four rhinos in the park with possible but unknown numbers outside, caused alarm. A diplomatic mission to Kinshasa in January 2005 met with a very positive response from most parties, and Vice President Yerodia announced that all four of the vice presidents and the president himself were in favour of a temporary rescue translocation of five of the rhinos. Funds were made available from sources other than those supporting the park and therefore in no way did this project detract from support to the park.

However, certain parties were canvassing against the move for political reasons, and a televised debate on the issue was held with the general public. With elections looming and government positions unstable the government was swung by misinformed public opinion, and the minister of Environment chose not to sign the protocol of agreement that ICCN and partners, including UNESCO and IUCN, had drawn up. Conservateurs and directors were arrested; the director of ICCN was heavily criticized as were the project partners. The work of the trainers in Garamba was stopped by misinformed personnel, and finally the annual planning meeting for the conservation of the park was stopped because threats from local groups made the conservateur feel that holding the meeting would be too dangerous. The coalition of donor supporters requested ICCN to take action to rectify the situation and a meeting of the World Heritage Commission of UNESCO passed a motion that Garamba would lose its World Heritage status if the rhinos became extinct in situ.

Much positive action has ensued, and the African Parks Foundation, with management rights, is now bringing major support to Garamba, which we hope will turn the tide. Intensive surveys under the auspices of IUCN/SSC and African Parks are planned for early 2006 to consider the range of values leading to World Heritage status, the rhinos, elephants and giraffes, and the park itself. The aftermath and longer-term effects of wars have proved harder to deal with than the wars themselves, but all possible is being done to ensure that the second largest and the most endangered land mammal does not become extinct.

References

De Merode E, Bila I, Tello J, Panziama G. 2005. Aerial survey of Garamba National Park with emphasis on northern white rhinos. Report to ICCN.

Hillman Smith K, Atalia M, Likango M, Smith F, Ndey A. Panziama G. 1995. General aerial count 1995 and evaluation of the status and trends of the ecosystem. Garamba National Park Project report.

Hillman Smith K, Smith F, Tshikaya P, Ndey A, Watkin J. 2003, Poaching upsurge in Garamba National Park, Democratic Republic of Congo. *Pachyderm* 35:146–150.

Roca AL, Georgiadis N, Pecon-Slatter J, O'Brien SJ. 2001. Genetic evidence for two species of elephants in Africa. *Science* 293:1473–1477.

Save the Rhinos—when the European zoo community fights for their survival

Renaud Fulconis

EAZA Rhino Campaign Manager, Save the Rhino International
email: renaud@savetherhino.org

Rhinos have been chosen as the new subject for the 2005/06 campaign of the European Association of Zoos and Aquaria (EAZA). Launched at the beginning of September, this year-long campaign aims to

raise awareness and money for rhino conservation projects in the field. Save the Rhino International, a UK-registered charity, is working with EAZA as the official European partner of the campaign and many of its 297 members all around Europe to develop what we hope will be a very successful event for all rhinos. At the same time, thanks to EAZA, the International Rhino Foundation (IRF) is running a North American campaign, in partnership with the American Zoo and Aquarium Association's Rhino Advisory Group / Species Survival Plans and Ecko United. The North American Save the Rhinos Campaign will launch publicly in January 2006.

Save the Rhinos, the EAZA Rhino Campaign 2005/06 has two main objectives: to involve as many members as possible in raising awareness and in developing educational activities; and to raise money to fund in situ rhino conservation projects.

A campaign core group, chaired by Nick Lindsay of the Zoological Society of London (ZSL), has set a target of 350,000 euros. One hundred per cent of the funds raised will be allocated to 13 selected in situ rhino conservation projects in Africa and Asia. Selecting those 13 projects out of the 53 proposals we had received has not been easy. Some factors we thought were particularly important. Would the project deliver an increase in rhino numbers? Would it build local capacity? Is it endorsed by local NGOs or organizations like AfRSG or AsRSG? Is it part of a national plan? We also considered whether a grant from the campaign would make a significant difference and would deliver value for money. We were truly fortunate to receive help from people like Richard Emslie and Nico van Strien from both Specialist Groups, from Tom Foose and July Dunn (IRF) and Evan Blumer (American Rhino Tag).

Because we received many very good project proposals, we have not only 13 on the selected list but also a further 8 on a waiting list (see list below). These waiting-list projects will be funded if we are fortunate enough to raise more than our goal.

An information pack has been given to all EAZA members to help them prepare their campaign. This 164-page document contains general information on the five rhino species, the threats affecting their survival, and the work of in situ conservation projects through anti-poaching and monitoring patrols, environmental edu

Renauld Fulconis

Diceros bicornis michaeli, Masai Mara Game Reserve, Kenya.

Renaud Fulconis

Southern white rhino baby with its mother at Nakuru National Park, Kenya.

cation programmes, community-based conservation and biological management; it also has a section on awareness, education and fund-raising. Naturally, there are details of the projects that have been selected. Many of the best rhino specialists have contributed to the pack.

EAZA members also received a CD-ROM containing all this information, together with logos and pictures to illustrate any documents produced to promote the campaign. Some CD-ROMs will be sent to zoos in rhino range countries in Africa and Asia; others will be sent to rhino-using countries such as China and Yemen.

The campaign also has its own rhino merchandise, developed by the suppliers with the recommendations of the core group. The items are now being sold in zoo shops with royalties and a percentage of the proceeds going to the campaign.

Finally, the EAZA website (www.eaza.net) carries general information for the participating institutions; while a special campaign website has been created (www.rhinocampaign.net) for the general public. They provide regular updates and suggest ways that people can contribute and participate. This last website (in different languages already) will have sections translated into other European languages soon.

Projects

Africa

1. Rhino monitoring equipment for Kenyan National Parks
2. Environmental education programme at the Laikipia Wildlife Forum, Kenya
3. Re-establishment of black rhino, Zambia
4. Lifting crane for rhino capture truck, Zimbabwe
5. Rhino translocation equipment, Namibia
6. Hluhluwe Game Reserve EAZA rhino security equipment, South Africa
7. Rhino horn-fingerprinting project

Asia

8. Combating the illegal trade in and demand for rhino horn in Yemen
9. Indian rhino vision 2020
10. Conservation of rhino in India and strategy framework to reduce rhino poaching in range countries
11. Rhino protection units for Javan and Sumatran rhinos in Indonesia
12. Establishing two additional rhino protection units, Sabah, Malaysia
13. Enhanced community outreach programme, Sabah, Malaysia

Projects on the waiting list

1. Protecting a remnant black rhino population in the Chyulu Hills, Kenya
2. Assistance for maintenance and upkeep of the sanctuary and the rhinos held at the Mkomazi Game Reserve, Tanzania
3. Conservation work at the Midlands Black Rhino Conservancy, Zimbabwe
4. Training and employment of further rhino monitors for the SADC Rhino Monitoring Unit, Zimbabwe
5. Conservation of the black rhino population of the western Kunene Region, Namibia
6. Nutritional ecology of black rhinos and its effect on carrying capacity and breeding performance, Africa
7. Partial support of AfRSG Secretariat and/or the next AfRSG meeting
8. Security personnel incentive scheme, Kenyan Association of Private-land Rhino Sanctuaries

If you work for a non-EAZA institution or NGO and want to participate in the campaign, please contact:
EAZA conservation campaign coordinator, email:
corinne.bos@nvdzoos.nl

Black rhino released onto Zululand Rhino Reserve

Pam Sherriffs

Black Rhino Range Expansion Project; email: psherriffs@wwf.org.za

In October 2005, 21 black rhinos were released onto a major game reserve, the Zululand Rhino Reserve, in northern KwaZulu-Natal (KZN), South Africa. This reserve covers 24,000 hectares of savanna bushveld made up of more than 30 neighbouring properties whose owners have recently removed their internal fences to create a significant, barrier-free haven for endangered species, including the black rhino.

These rhinos form the second founder population of the Black Rhino Range Expansion Project, a partnership between the global conservation organization WWF (World Wide Fund for Nature) and Ezemvelo KZN Wildlife that aims to boost numbers of the critically endangered species by increasing the land available for their conservation, thus reducing pressure on existing reserves and providing new territory in which they can breed quickly.

'In just two years through this project, the black rhino has acted as a catalyst in creating about 40,000 hectares of barrier-free land for conservation,' says WWF project leader Dr Jacques Flamand. 'Much of the land was already under conservation but in relatively small pieces divided by internal fences, which is not ecologically optimal. The courageous decisions of landowners who have committed themselves to creating these large areas have enormously benefited black rhino and many other species that live alongside them.'

The 21 black rhinos, which are being intensively monitored, stopped exploring the area within two weeks and have settled down, says Dr Flamand. 'There have been no clashes, some have been seen together and they all seem relaxed. So far we can consider it a success.'

The Black Rhino Range Expansion Project's first founder population of 15 black rhinos, released last year onto Munyawana Game Reserve, also in northern KwaZulu-Natal, also settled extremely well. 'There have been no losses through fights or accidents. Matings have been observed so we're looking forward to the prospect of lots of calves. As the idea of the project is to increase the growth rate of the overall black rhino population in KwaZulu-Natal, we're well on the way,' says Dr Flamand. The first black rhino calf, from a rhino that was already pregnant when released, was born at Phinda Private Game Reserve, part of Munyawana, earlier this year.

Initially, the focus of the project is on finding suitable sites within KwaZulu-Natal, but once these have been saturated, the project will look further afield. 'We're looking for strategic partnerships with landholders within the species' historic range. They needn't have been traditionally involved in conservation and we are currently in negotiations with community landholders whose land could become future project sites,' says Dr Flamand.

Black rhinos became critically endangered following a catastrophic poaching wave in the 1960s, 1970s and 1980s that wiped out 96% of Africa's wild black rhino population in only 30 years. At the lowest point, there were just 2450 black rhinos left. Intensive protection efforts by organizations like Ezemvelo KZN Wildlife helped stabilize the situation and the number of black rhinos has gradually increased to around 3600.

'Tight security for the black rhino is essential but it's only one part of the solution,' explains Dr Flamand. 'The other part is ensuring that black rhino numbers increase as fast as possible in order to reduce the threat of extinction from possibilities such as increased poaching, drought, flood and disease. The highest breeding rates are achieved by establishing relatively large populations, such as these, on areas of land with a high carrying capacity for black rhino. This also stimulates breeding on existing reserves from where the black rhino are removed by reducing population pressure there.'

The WWF/ Ezemvelo KZN Wildlife Black Rhino Range Expansion Project is made possible through funding from WWF-Netherlands, through WWF-South Africa, and is supported by the Mazda Wildlife Fund.

Implementation of a rhino endowment model for community participation in rhino conservation, Save Valley Conservancy, Zimbabwe

Raoul du Toit

WWF-SARPO, Harare, Zimbabwe; email: rdutoit@wwfsarpo.org

The Save Valley Conservancy (SVC) is situated in Zimbabwe's south-east Lowveld. It was established in 1991 when a conservancy constitution was adopted that binds 24 former cattle ranches into a single wildlife management unit. Provided the socio-political environment is conducive to its further development, it will remain one of the largest private protected wildlife areas in Africa (over 300,000 hectares). It aims to become a cornerstone of the wildlife tourism industry in the region, which would also involve the Great Limpopo Trans-Frontier Conservation Area (TFCA), linking the conservancy with Gonarezhou National Park and other private and community-based wildlife projects.

From the outset, the conservancy has followed the principle that its land use must be sustainable—ecologically, economically and socio-politically. The ecological and economic attributes of a large conservancy such as this have been well demonstrated. Before a phase of political uncertainties associated with Zimbabwe's 'fast track' land-reform programme, which began in 2000, the conservancy had paid attention to socio-political dimensions, notably by forming the Save Valley Conservancy Trust in 1995 to serve as the agency to catalyse development projects at the interface between SVC and the communities surrounding it. Some 120,000 people in 20,000 families living in 16 neighbouring wards are the intended beneficiaries of the trust.

A memorandum of understanding was signed between SVC and the five relevant rural district councils (Bikita, Buhera, Chipinge, Chiredzi, Zaka). The memorandum establishes a joint committee of these councils and confirms the SVC Trust as their fiduciary instrument for projects related to the conservancy. It establishes the basis of liaison whereby both the rural district councils and SVC, through a positive incentive arrangement, support the objectives of conserving biodiversity and sustainably using biological resources for the benefit of all those who live in this area.

When the SVC Trust had been formed, WWF proposed that it secure funds to purchase wildlife as founder stock in the conservancy, from which the trust would be able to generate a sustainable revenue flow by annually selling progeny at market prices. This would be a win-win situation for all parties since this wildlife endowment would enhance the economic viability of the conservancy's tourism operations by adding to the area's wildlife attractions, and thereby stimulate employment. At the same time adjacent communities would hold a significant stake in the wildlife resources within the conservancy and gain a sense of proprietorship. Additionally, opportunities may arise for the SVC Trust to acquire shares in tourism ventures or possibly in land that can be allocated or leased to the trust for tourism or hunting concessionaires, under the wildlife-based land reform programme. The income derived from the trust's investments would be ploughed into community projects such as socio-economic enterprise, conservation, food security and social welfare.

A proposal was submitted through the World Bank for a medium-sized grant from the Global Environment Fund to set up this wildlife endowment plan for the SVC Trust. However, the political and economic problems that developed in Zimbabwe led to the World Bank withdrawing its support and to a general decline in donor interest, so the wildlife endowment plan did not progress.

During 2005 it became apparent that the nearby Malilangwe Trust needed to decrease the white rhino population on the land it owned, comprising 40,000 ha. The white rhino population, developed from breeding stock the trust had imported from South Africa, had built up to 78—and thus was overstocked as shown by increased fighting between rhinos. It led to two mortalities in 2004. At the same time, Save Valley had a small population of only nine white rhinos—a population that needed to be supplemented in order to achieve genetic and demographic viability.

WWF therefore proposed to Malilangwe Trust that some rhinos be moved to Save Valley under the community endowment concept.

This proposal was made in view of the fact that in Africa the community is involved in too few rhino conservation situations nor does it benefit from them. The communal conservancies in Kunene Region of Namibia are the only significant example of community-based projects that involve rhinos. The KZN/WWF Rhino Range Expansion Project in KwaZulu-Natal aims to establish rhino populations on communal land but this will still take time. The Save Valley project can be a further model for community involvement in breeding an endangered species; once demonstrated, such a method is likely to become more broadly applied in the region.

Restocking the Great Limpopo TFCA with rhinos from Save Valley and having donors pay the SVC Trust for these animals is envisaged as the optimum scenario.

Features of the agreement

All parties to the agreement (which included the Zimbabwe Parks and Wildlife Management Authority, which has management control over Specially Protected species) agreed:

- Proactive management to prevent overstocking of white rhinos (at Malilangwe) and to prevent inbreeding (at Save Valley) is clearly in the interests of the species.
- The rhinos are to be allocated in accordance with a community endowment scheme under which the SVC Trust will be entitled to the tradable asset value of the first three progeny born and to half of the progeny thereafter.
- The remaining half of the progeny will become available for further restocking initiatives in the Lowveld (notably into the Great Limpopo TFCA).

Given that the Malilangwe Trust purchased and imported the founder stock at considerable expense and has further invested in protecting and managing the population, it was agreed that a custodianship arrangement would allocate these 10 rhinos, under which the Malilangwe Trust has the right to reclaim 10 rhinos in future. In addition, the Malilangwe Trust wishes to be consulted on allocating the progeny that are translocated from the conservancy, while the SVC Trust gains the income from their sale. It was agreed as a matter of principle (and as a factor that could well influence further investment of the private sector in rhino importations) that the Malilangwe Trust would retain due rights over the assets in which it had invested.

Undertaking the operation

A rhino capture unit comprising WWF personnel, a veterinarian from the Wildlife Veterinary Unit of the Department of Veterinary Services, and staff of the Malilangwe Trust undertook the capture and translocation of 10 white rhinos during the period from 22 May to 4 June 2005. No injuries or mortalities occurred during this operation, which followed standard rhino translocation procedure, including using a WWF fixed-wing aircraft to survey and coordinate the rhino darting exercises, and a helicopter from which the veterinarian could dart the intended rhinos once they had been identified. The list of rhinos to be translocated was very specific, and it took into account genetic and demographic considerations for both the source population (Malilangwe) and the recipient population (Save Valley).

The 10 rhinos comprised 2 adult males, 4 adult females, 3 subadult males and 1 female calf. Eight were fitted with horn-implant transmitters for radio-tracking, but the horns of the two smallest rhinos were too small for the devices to be fitted.

The rhinos were held in pre-release pens (bomas) on Sango Ranch in the north of Save Valley and were released after they had settled down. Thereafter they have been regularly radio-tracked and by September 2005 had settled well. Three of the translocated rhinos have joined white rhinos that were already in Save Valley. (It is of interest that two of these resident white rhinos had been attached to black rhinos in the absence of companions of their own species but reverted to same-species associations as soon as they had the opportunity.)

The Zimbabwe Minister of Environment and Tourism, the Hon. Francis Nhema, visited Save Valley on 15 June 2005 and officiated in a ceremony to hand the rhinos over to the SVC Trust. This ceremony was attended by local MPs, senior district government officials, and representatives of the Malilangwe Trust, the SVC Trust and the Save Valley Conservancy.

Anticipated outcome

In view of the slow rate at which rhinos reproduce, this will be a long-term programme. Table 1 indicates a likelihood of rhino breeding over 20 years. Until

Table 1. Model: 10 rhinos are introduced; the first 3 calves and half of all succeeding calves go to the Save Valley Conservancy Trust

Year	Rhino numbers	Annual gain	SVC Trust gain
2005	10	0	0.0
2006	11	1	1.0
2007	11	0	0.0
2008	12	1	1.0
2009	13	1	1.0
2010	14	1	0.5
2011	15	1	0.5
2012	16	1	0.5
2013	17	1	0.5
2014	18	1	0.5
2015	20	2	1.0
2016	21	1	0.5
2017	23	2	1.0
2018	24	1	0.5
2019	26	2	1.0
2020	28	2	1.0
2021	30	2	1.0
2022	32	2	1.0
2023	34	2	1.0
2024	36	2	1.0
Total gain to SVC Trust			14.5

Zimbabwe's wildlife operations regain tourist interest and donor confidence, opportunity to sell progeny from the breeding herd will be limited, which also adds to the long-term nature of return from this community investment. Nonetheless, it has clearly established a model for community involvement, and the principle is likely to be as important for building better community relations as the actual financial return on this investment.

New thinking on white rhino bomas in the big game parks of Swaziland

Mick Reilly

Head, Conservation and Security, Kingdom of Swaziland's Big Game Parks
email: conservation@biggameparks.org or conservationhq@biggameparks.org

Traditionally, white rhinos have been confined in solid, close-pole barriers where the animal's will to escape is overcome by its inability to break through the poles. The animal then submits to its new surroundings, where it either starts eating after some days or embarks on a hunger strike.

Hunger strikers are common among white rhinos newly placed in a boma. The dilemma for a boma manager is whether to release the rhino before it loses too much condition or to hold it for another day or two in the hope that it will start eating. Often animals have been caught and moved long distances to a boma, and releasing them in poor condition into an unfamiliar range that is often already occupied is not only undesirable—it may be positively dangerous!

Most white rhinos that adapt to boma life start eating between the third and seventh day of confinement. It is generally accepted that animals that are on hunger strike or are consuming insufficient food should be released by day 7. If a hunger-striking rhino remains confined, it will eventually become weak and die, despite a plentiful supply of good-quality feed being offered.

A hunger strike is not the sole determinant of when to release a rhino from the boma, as other factors such as body condition, age, sex, pregnancy, release site,

veld condition, water availability, gut motility (M99, used in darting, can cause gut stasis), the animal's temperament, its dominance status, and the likelihood of its developing gut ulcers must also be taken into consideration.

Why do white rhinos hunger strike?

To try to understand why white rhinos hunger strike, we must look at the rhino's life, which is generally a routine of eating, drinking, wallowing, socializing, breeding and maintaining personal hierarchy. Capture suddenly interrupts this life. The rhino is released in totally unfamiliar surroundings, still feeling the side effects of various drugs. A solid pole barrier that it cannot break through confines its movements in an area of 100 m^2 or less. This barrier is usually difficult to see through, and a range of unfamiliar smells and sounds constantly emanate from somewhere beyond.

Mick Reilly

Wholly electrified Bonnox wire mesh fencing on wooden posts with used polyurethane piping and (white) Meps bobbin insulators.

Humans also constantly emerge from behind it. Suddenly, everything is a threat. Additionally, unfamiliar food, no longer rooted to the ground, is offered and invariably carries the scent of humans.

Over the next few days, the rhino either accepts its new lot or works itself into a hunger strike, ignoring the hunger pangs.

The alternative boma

After white rhinos were observed reacting to contact with electric fencing by taking a submissive step back with a lowered head and not attempting to horn it, we decided to move away from the solid physical barrier and attempt to boma white rhinos behind an electrified Bonnox wire mesh fencing (see photo).

During 2003, 13 elephants 12 to 14 years old were confined to a boma for five months pending export from Swaziland. During this period they destroyed all the trees, leaving a field of grass to grow during the following wet season. This boma was fenced wih wholly electrified Bonnox mesh, suspended and insulated by upright wooden posts at 5-m intervals. Wooden droppers were hung at 1.5-m intervals. The Bonnox fence was insulated with a combination of used black polythene piping and conventional Meps electric fence bobbins insulators (see photo). The Meps energizer was coupled directly to the wire mesh.

A 1-ha electrified Bonnox fence enclosure was erected, and 5 m inside it a second fence of the same kind. The inner enclosure was then divided in half to create two 0.5-hectare camps. Two separate Meps energizers were coupled to the inner and outer encampments. The two energizers produced between 8000 and 10,000 volts each.

If an animal should break out of the first fence, or if the fence should stop functioning, the second fence would act independently as a barrier.

The lowest horizontal strand of bonnox was ± 100 mm above the ground. Herbicides were used to control vegetation growing under the wire to avoid any voltage loss.

Bomaing white rhinos

During the autumn of 2005, a two-and-a-half-year-old and a three-year-old rhino were captured, using M99 and 15 mg of tranquillizer Azaparone. Still showing the effects of the drugs (although M5050 had been administered to reverse the effects after the rhinos

were loaded onto the recovery trailer), the rhinos were released about an hour after capture into a 0.5-ha electrified boma. These two rhinos were already relatively accustomed to electric fencing. It was decided not to hang capture plastic on the bonnox as wind action on the plastic might provoke the rhinos to attack and dismantling the plastic might cause additional disturbance. Both animals touched the fence at least three times while they stumbled around the boma and immediately moved away from it each time. By the time the effects of the capture drugs had worn off, the rhinos had both learned to avoid the fence.

A thick swathe of grass had grown during the wet season, and both rhinos began to feed within 36 hours. As the grass became scarce, they were offered fresh-cut grass on a conveyor belt at ground level. Both started feeding on this within three weeks, and good-quality eragrostis hay was gradually introduced.

Encouraged by the results with these two young rhinos, we introduced a further five rhinos (two three-year-olds, two six-year-olds and one adult cow) into two adjacent 0.5-ha bomas. The adult cow was isolated while the four younger rhinos were put together. Importantly, these animals came from an area where their exposure to electric fencing was likely to have been very limited.

All rhinos except the one six-year-old were offloaded in the dark, on average about nine hours after capture using M99 and Azaparone. All animals were given Acuphase at or soon after loading, and their sedation was manipulated with M5050 and Azaparone on the trip. The two three-year-old rhinos were transported in a standard antelope truck with two compartments 2.2 x 3 m and doors 1.1 m wide. All the older animals were transported in rhino trailers approximately 3.5 x 1.2 m.

The two youngest rhinos travelled extremely well in the antelope transporter and did not require continual manipulation with M5050 and Azaparone, as did the rhinos in the trailers.

The rhinos in the trailers offloaded without complication. It took over two hours to offload the two three-year-old rhinos in the antelope transporter with larger compartments, however, because they were able to turn around in the compartments and did not want to come out.

Using a prodder and sack to coax the rhinos out of the truck proved problematic, as doing so worked the animals up to the extent that it nullified the effect of the tranquillizers. (It is always best to leave the truck parked with the compartment doors open, allowing the rhinos to leave voluntarily.) The first rhino left the truck and was promptly shocked by the fence at the end of the ramp. About 10 minutes later, the second rhino left and went to the end of the ramp, where she found the first rhino lurking in the dark. Immediately a fight broke out between the two three-year-olds, with one pursuing the other around the boma, already occupied by a freshly offloaded six-year-old. The rhino being pursued bounced off the electrified mesh at an angle twice before running across the boma, hitting the two fences squarely, and breaking out of the boma in less than five seconds! She then disappeared into the night, leaving her pursuer in the boma.

Mick Reilly

The adult cow feeding in the boma.

Reactions to the boma

The remaining three-year-old quickly joined up with the six-year-old, and these two animals made no attempt to break out of the boma that night. The adult cow was isolated in an adjacent boma, separated only by the electrified bonnox mesh.

The breakaway rhino broke six horizontal strands on each fence, leaving the lowest three strands intact. The broken ends projected into the gap, making it too small for a rhino to put its head through without being shocked. Consequently, it was decided not to repair the gaps, so as not to disturb the animals in the bomas until they had settled

down. These breaks did not short out the electricity as an offset wire would have done. In the morning, it was reported that all three rhinos had made contact with the fence a number of times and had immediately moved away from it. No further aggression or attacks on the boma were reported.

By daybreak, the animals were all alert but still sedated by the Acuphase and the after-effects of immobilization. During the first day, as all three rhinos paced the boma boundaries, they came in contact with the fence much less frequently. During the second night, 20 to 32 hours after offloading, the number of contacts with the fence again increased as the animals tried to find a way out of the boma. The two young rhinos started feeding during the second night. We suspected that the adult female also fed, but because she was more unsettled than the others, we avoided any unnecessary disturbance. She was, however, observed taking bites of grass while pacing the boma within 48 hours of being contained.

Water was provided in a ground-level concrete trough that could be filled remotely by an inline valve. All animals drank water within 24 hours of offloading.

On day 4 another six-year-old rhino was introduced into the boma in daylight. She joined the group without any problems.

Six days after the three-year-old rhino broke out of the boma, she was recaptured and returned to the same boma, joining the other three-year-old and the two six-year-olds. She was allowed to stand in the crate under a tree for some hours to stabilize and to ensure that she was not recycling the M99. Her sedation was manipulated using Azaparone and M5050; no Acuphase was used. This time she was offloaded from a trailer without any coaxing, about four hours after capture. The offloading, which took place in daylight, was calm. Although she made contact with the fence, she made no effort to break out the first night. During the second day in the boma (36 to 48 hours) she was observed attempting to break out at a corner. She broke one horizontal strand with her horn before the wire slipped down the horn and touched her skin, shocking her and causing her to squeal and retreat immediately, head lowered and ears back. She returned to the same place and again tried to break the fence, with the same result. This attempt was not a ferocious attack on the fence; rather, she put her horn through the mesh close to the ground and pushed while lifting her head.

She was observed eating the veld grass within 20 hours of recapture. At offloading, two of the animals took bites of grass as they left the trailer.

Eight days after the rhinos were introduced to the bomas, they were offered fresh-cut veld grass. Some was placed standing against bushes and some was placed on a conveyor belt that had been in the boma from the first day. As the natural grass become scarcer, the rhinos began showing interest in the cut grass. By the 13th day, all the rhinos had been observed eating the cut grass. Some fed on the grass placed on the conveyor belt while others fed on the standing grass. All cut grass was then offered on the conveyor belt and good-quality eragrostis hay was mixed with the green veld grass and was readily taken.

Once all the rhinos were feeding well and had settled enough in the bomas to tolerate human activity, the fences were repaired. To avoid sand colic the conveyor belt was lifted onto a pole platform 600 mm high, to avoid the rhinos contaminating the feed with faeces and sand from their feet. All the rhinos fed off this platform cautiously but without any material delay. Surprisingly, none of the rhinos attempted to fight the new structure.

The adult female remained fairly unsettled in her boma. After two and a half weeks, having given the rhinos time to get used to each other, and observing that she was looking at others through the dividing bonnox fence, two rhinos from the adjacent boma were allowed into her boma. No aggression was observed. The following day all the rhinos were put together, with no problems. This calmed the cow considerably.

Once all the animals were eating properly off the platform, horse pellets were dissolved into a watery paste and sprinkled over the erogrostis hay. Then pellets were offered next to the hay. One rhino began selecting the pellets on the third day. Within six days all five rhinos were eating the cubes when they were offered without hay.

Body condition

All the animals were in good body condition when introduced into the bomas, with standard AfRSG condition scores of 4–4.5. As they adapted to the bomas, their continued feeding on the veld grass did not have the acute effects normally experienced by animals introduced to close-pole bomas, where the rhinos normally stop feeding altogether for a number of days, lose condition, and suffer from reduced gut motility

Mick Reilly

Feeding off the conveyor belt lifted 600 mm off the ground.

and depression. As could be expected, the rhinos gradually lost condition as the veld grass became scarcer and they graduated to the cut grass. All showed moderate hunger welts on the stomach at about 10 to 20 days, but these disappeared as their food intake increased. The condition scores of the rhinos dropped to a minimum of 3 for one of the three-year-old animals; the score of the other animals dropped to approximately 3.5 and 4. The animal with the poorest condition had also been observed to have numerous horn scratches at capture, which probably were the result of either weaning or conflict with other rhinos after weaning. It is likely that the additional stress of weaning contributed to lower condition scores.

Perceived advantages and disadvantages

Although this method of bomaing white rhinos is still in its infancy and has not been put through sufficient testing to become a recommended practice, it would appear to have considerable advantage over conventional rhino bomaing (table 1). To our knowledge, it has not been tried elsewhere with rhinos, so few references were available for this experiment (Dr Chap Masterson, Zvakanaka Wild Vet., pers. comm.; Mr Grant Tracy, Tracy & Du Plessis Game Capture, pers. comm.).

Suggested improvements to the bonnox boma

We suggest that to improve the strength of the bonnox, three horizontal cables be added, also electrified, to avoid animals breaking through the bonnox. Care must be taken to avoid entanglement and any electric shorts as a result of adding the cable.

Conclusion

Because the effects of Acuphase last well beyond the sedative effects of the capture drugs used for rhinos, using it is probably central to the success of this boma method, particularly with animals that are five years of age and older. The added advantage of the residual effects of M99 from the capture process cannot be overstated. It is thus inadvisable to release animals into a bonnox boma if Naltrexone has been used as the antidote to the M99 or if the rhino is fighting the crate, as this would result in a far more excitable animal, more likely to break into a run at offloading or when initially shocked. In a nutshell, one wants to offload the rhino in as drowsy a state as possible, but without risking oversedating or recycling the M99.

It is common knowledge that big territorial males are the most problematic. To date, we have not put any of these bulls through the bomas. Until such animals have been tried, from areas where they are not accustomed to electricity, we do not know whether this form of bomaing will be reliable and practical for them. It may well be worth exploring the added use of Periphenazine (Trilifon) in these cases.

Due to the cost effectiveness of boma construction and the fewer adverse effects on the animals' health, we recommend that where practical, this technique be tested further as an alternative to the traditional close-pole boma. It appears that this option is less likely to cause hunger striking and is likely to present fewer health problems. We are confident that this method is desirable. It should be the method of choice for all non-breeding animals and may well be suitable for all adult animals.

Table 1. Comparison of the electrified bonnox boma with the traditional close-pole boma

Experimental electrified bonnox boma	Traditional close-pole boma
Advantages	*Disadvantages*
• Openness of the bonnox fencing is less intimidating to the rhino, as it can see what is happening around and beyond the boma.	• Solid sides harbour more of the unexpected and are probably unsettling.
• Gradual approaches can be made without surprising the rhinos and one normally need not go closer than the rhino's flight zone.	• Animals only see approaching people from a short distance well within normal flight zone and within their normal fight zone.
• The space allows for easier mixing of animals, particularly youngsters.	• Mixed animals in small bomas tend to fight especially if they are unknown to each other.
• Naturally growing grass is readily eaten although volume of intake is lower than in the veld.	• No graduation from natural grass to cut grass, and rhinos normally stop eating for some days.
• Gut motility is sustained and stimulated by continued food intake.	• Combined effects of M99 and not eating can cause serious disruption to gut motility.
• As there is no need to add food for the first week or two, the rhinos do not need to be disturbed.	• Food has to be offered before the rhino settles, thus disturbance is unavoidable.
• Veld grass does not carry human scent.	• Grass offered invariably carries human scent.
• Observers can monitor rhinos from a distance without disturbing them.	• Observers normally have to be close and thus disturb the rhinos continuously.
• Rhinos are unlikely to sustain physical injuries as they retreat from the shock.	• Horn knock-offs and bruised lips from fighting and pushing the physical barrier aggravate the situation.
• In a breakout, the strands are unlikely to short out. Repairs can wait as the size of the hole normally will not allow a rhino through it without being shocked	• Any broken poles, and so on, require immediate fixing to avoid animals breaking out or being caught between the poles—thus creating a disturbance.
• Erection is cheaper and quicker for more enclosed area.	• Construction is expensive and encloses only small areas.
• Boma cleaning can be left until the animals have settled.	• Boma cleaning needs to commence before the settle.
• The large area makes it practical to provide a wallow for hot conditions.	• Providing a wallow normally compromises boma hygiene.
• Less stress is likely to reduce the incidence of stress ulcers.	• Stomach ulcers are a common complication.
• Graduation from veld to cut grass can take place over a couple of weeks. Hunger striking less likely.	• Sudden change from veld to cut grass may be a reason leading to hunger strikes.
• Rhinos leaving the bomas are accustomed to being confined by bonnox fences and associate them with electricity—thus they are far less likely to break out of boundary fences	• Upon release, rhinos are unfamiliar with bonnox fencing and are likely to test the fences; the likelihood of breaking out is accordingly increased.
Disadvantages	*Advantages*
• Difficult to access a rhino in the boma in the event of treatment being necessary, especially if there is more than one animal in the boma.	• Easier to access and pole syringe animals.
• If a rhino is unsettled at offloading, it may be able to break out, even if it is young.	• If constructed properly, no rhino should break out.
• Rhino horn does not conduct electricity, and thus damage can be done before the rhino is shocked.	• Conductivity of the horn is irrelevant.
• Time needed to produce fully boma-trained rhinos is longer.	• Shorter time needed to produce boma-trained rhinos.
• Maintenance of the insulation of the electricity is of utmost importance.	• Less constant maintenance is required.
• As bomas can likely be used only twice in a season without irrigation, system is unsuitable for high-volume rhino bomas.	• Can be used all year, as there is no dependence on naturally growing grass.

BOOK REVIEWS

Tiger bone and rhino horn: the destruction of wildlife for traditional Chinese medicine

Richard Ellis

Island Press/Shearwater Books, Washington, Covelo, London, 2005, 294 pages, ISBN 1 55963 532 0

review by Lucy Vigne

PO Box 15510–00503, Nairobi, Kenya; email: rhino@wananchi.com

I was immediately drawn to this book as so little is understood, let alone written, about traditional Chinese medicine and the devastating effect it now has on endangered wildlife. This is a book that needed to be written. It offers a wealth of information expressed with a light touch but in a factual and fair way. It is aimed at the American audience, but we can all learn from it, whether we are from eastern Asia or the West. Richard Ellis, a leading expert on extinction, has synthesized material from historical records, anecdotes and scientific reports, giving due credit, to produce a very readable book on the painful subject of man's past tendency to kill animals for land clearance and for fun. Nowadays—as animal numbers dwindle precariously—they are being poached for what has become a threatening demand: for medicines for the growing numbers of wealthy Chinese, Japanese, Koreans and Taiwanese round the world.

An attractive hardback, with pleasing typeface and paper, the book has been artistically laid out and carefully edited, encouraging one to turn its pages and read on. The text is divided into seven chapters; rhinos, tigers and bears dominate.

Two chapters on tigers give their history in relation to man's destructive use of them, with sections on the tigers of Siberia (Amur), Indonesia, China and India, and their use in traditional Chinese medicine (TCM). A chapter on bears gives a horrific account of their persecution both in the wild and on farms where the highly prized bile is agonizingly extracted. The longest chapter, on rhinos (pages 71–143), has sections on the unicorn myth, the five rhino species in Africa and Asia and the threats to them, rhino product medicines and trade. Rhinos and the other species are revisited in later chapters, so the reader cannot forget the disturbing issues to be faced if we are to keep them alive. Other well-known species threatened by TCM and documented here include elephant, musk deer, leopard, narwhal, pangolin, saiga antelope, sea horse, seal and sea lion.

Of compelling interest is the contrast displayed here between traditional Chinese and Western medicines, their origins, development and worldwide spread. Traditional Chinese medicine is preventive and tries to harmonize the body and bring balance; Western medicine seeks to cure. The chapter on this subject explains also the differences and similarities of these two schools of medicine and helps us to understand the needs of patients and doctors. The fact is stated that the Chinese do not use rhino horn as an aphrodisiac but to reduce fever, still one of the most common misunderstandings in the West, although I would have preferred a greater emphasis on this mistaken view earlier on in the book. It amazes me that so many well-educated people still get this simple fact wrong, showing the need for books such as this to explain the reality of TCM.

The book gives concrete examples of research conducted on some of these medicines. It offers the evidence that rhino horn, in the small doses given, has not been scientifically proven to work against fever, but that bear bile does contain healing sub-

stances that scientists are now synthesizing. Yet many TCM adherents believe that whether or not their medicines work cannot be assessed from a solely Western perspective. Richard Ellis points out that public statements and education explaining that such medicines are endangering species is the most powerful way to save these animals.

A 21-page bibliography shows the thorough research Ellis has conducted and the wealth of material he has distilled from reliable sources. A bonus is the 47 illustrations, 18 of them the author's own animal drawings. Maps are lacking, however, and it might have been helpful to have places named in the text and animal ranges shown on maps, along with a few more tables of animal numbers for clarity and easier referral.

This is an excellent overview for the layman, and for the scientist who perhaps has not been able to read all the academic journals and popular magazine articles covering these subjects. It is easy, compelling and informative reading in its painful portrayal of man's blind greed for wildlife products. It proclaims the urgent need to address the issue through public awareness, to stop the suffering and illegal killing of wild animals, many of them now endangered, in order for them to provide traditional Chinese medicines.

No oasis: the Egyptian ivory trade in 2005

Esmond Martin and Tom Milliken

TRAFFIC International, Cambridge, 2005; 23 pages, ISBN 1 8585 0 208 X
available from www. traffic.org/publications/index.html

review by Daniel Stiles

PO Box 5159 – 8040, Diani Beach, Kenya; email: kenyadan@wananchi.com

This monograph updates the ivory market status in Egypt, previously last reported in Martin (2000), Martin and Stiles (2000) and Stiles and Martin (2001). The last two CITES Conferences of the Parties called for assessment of both compliance of target countries with CITES Resolution 10.10 (Rev. CoP 12) and the internal ivory markets of African elephant range states (Decision 12.39 and Decision 13.26). Martin and Stiles (2000) demonstrated that Egypt was an important player in the illegal movement, working and selling of ivory in Africa (third overall). Since it is not an elephant range state, this survey was made to ensure that Egypt was not overlooked in implementing Decision 13.26.

This report contains much information not seen in previous publications on Egyptian ivory, such as a detailed treatment of wildlife trade legislation and policy and Egypt's participation in the Elephant Trade Information System, which I found most useful for understanding the context of Egyptian ivory trading over time. The monograph also contains a detailed account of where retail ivory is being sold, including the types and quantities of items.

The authors spent about three weeks in March–April 2005, carrying out work in Cairo, Luxor, Aswan, Hurghada and Sharm el-Sheikh, the main tourist centres in Egypt. Using the ivory market monitoring and assessment methodology developed by Martin and Stiles (2000, 2002, 2003, 2005), the authors' overall findings showed that Egypt was still a country that affected elephant conservation negatively, but that since 1998 ivory market size and activity have decreased. Unfortunately, the report does not contain a table that compares trade indicators from 1998 and 2005 to enable a quick quantitative assessment of the changes. As it took me considerable time searching the report to find the data, I present one here so that the reader can readily appreciate what has happened (table 1). Complete comparative data were available only for Cairo, as it is apparently the only place in Egypt where ivory is worked today. Former ivory craftsmen in Luxor have seemingly stopped work except for ivory repair.

Although the number of active ivory craftsmen and the number of retail items seen for sale have dropped considerably since 1998, usually good news, the other indicators show that there is little basis for thinking the trend downwards is irreversible. The indicators, together with learning from the monograph about Egyptian government actions over the past few years, suggest a situation of strong latent demand, limited only by raw ivory

Table 1. Ivory trade indicators in Egyptian markets, 1998 and 2005

City	Year	Price USD/kg			Ivory craftsmen (no.)	Retail outlets (no.)	Min. no. of items
		1 kg	2–5 kg	6–9 kg			
Cairo	1998	34	62–80	98–137	100	88	11,627
	2005	138–173	173–207	259–311	25–50	79	8,930
Luxor	1998	?	?	?	< 12	33	6,445
	2005	–	–	–	0	25	1,308
Aswan	1998	–	–	–	0	21	3,388
	2005	–	–	–	0	15	373

supply and reinforced by retail price constraints on demand. In other words, if supply became once again plentiful, lowering both raw and thus retail ivory prices, demand would once again take off.

Up to 1999 Egypt had no national legislation to implement CITES obligations. Although selling most ivory was illegal, enforcement was lacking, and ivory was displayed openly for sale (Martin 2000). CITES pressured Egypt, along with other errant CITES Parties, to enact appropriate national legislation. In September 1999 Ministerial Decree No. 1150 made it a violation to sell, import or export a specimen of any species listed on a CITES appendix without complying with the relevant requirements. The Customs Department was issued with the necessary legal basis to enforce the decree. These actions effectively outlawed the import, export or sale of undocumented ivory.

Seizures of illegal ivory imports were made over the next few years, which lowered supply, driving prices up. Table 1 shows that tusk prices have almost tripled since 1998, indicating that high demand persists. The number of retail outlets selling ivory has fallen only slightly. Since the authors visited only six carving workshops, information on their status is not precise. The estimates they made of active carvers are probably fairly accurate, but if they had been able to interview those who have stopped working since the 1998 survey, they would have found that the carvers are most likely ready to resume work if the tusks and retail buyers can be found. Worked ivory is still displayed with impunity in Egypt and seizures of these predominantly illegal pieces are extremely rare.

Another factor affecting the supply of raw ivory to Egypt is the growing ivory market in Khartoum–Omdurman in Sudan (Martin 2005). Most of Egypt's ivory supply must pass through Sudan, with tusks originating mainly in central Africa. More tusks remaining in Khartoum, combined with the Egyptian ivory seizures, largely explain the trade indicator pattern seen in table 1. The rest of the explanation comes from the demand side. Martin and Milliken found that the main buyers of the worked ivory were Spanish, Italian and French. In spite of terrorist actions, tourism remains strong in Egypt, and buyers would appear to be available. Spanish, Italian and French tourists to Egypt numbered 1,631,400 in 2004, along with almost 7 million tourists of other nationalities. The great rise in retail prices of worked ivory has limited demand, resulting in fewer craftsmen working on ivory, fewer shops selling it, and fewer items being displayed.

The monograph makes several recommendations for the government, to improve legislation and enforcement, to raise awareness of wildlife trade laws, and to include Egypt in the CITES Standing Committee assessment of domestic ivory markets. More should also be done to limit demand, such as working with the craftsmen to engage them in elephant conservation as outlined in Stiles (2004).

References

Martin EB. 2000. The present-day Egyptian ivory trade. *Oryx* 34(2):101–108.

Martin EB. 2005. The Khartoum connection. *Swara* 28(1):18–19.

Martin EB, Stiles D. 2000. *The ivory markets of Africa.* Save the Elephants, Nairobi and London.

Martin EB, Stiles D. 2002. *The South and South East Asian ivory markets*. Save the Elephants, Nairobi and London.

Martin EB, Stiles D. 2003. *The ivory markets of East Asia*. Save the Elephants, Nairobi and London.

Martin EB, Stiles D. 2005. *Ivory markets of Europe.* Save the Elephants and Care for the Wild International, Nairobi and London.

Stiles D. 2004. The ivory trade and elephant conservation. *Environmental Conservation* 31(4):1–13.

Stiles D, Martin EB. 2001. The status and trends of the ivory trade in Africa, 1989–1999. *Pachyderm* 30:24–36.

GUIDELINES TO 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.

Submission of manuscripts

Submit manuscripts electronically by email. Alternatively, submit a hard copy and floppy disk or CD by mail.

Email contributions should be sent to:
afesg@iucn.org
with copy to: hvh@wananchi.com

Contributions by post to:
The Editor, *Pachyderm*
IUCN/SSC AfESG
PO Box 68200 – 00200
Nairobi, Kenya
tel: +254 20 3876461; fax: +254 20 3870385

Preparation of manuscripts

Manuscripts are accepted in both English and French languages. Where possible, the abstract should be provided in both languages.

Title and authors: The title should contain as many of the key words as possible but should not be more than 25 words long. Follow with the name(s) of the author(s) with insitutional affiliation and full postal and email address(es). Indicate the corresponding author, to whom proofs and editorial comments will be sent; give post and email addresses for the corresponding author.

Research papers: Should be not more than 5000 words and be structured as follows: 1) Title (as above), 2) Abstract of not more than 250 words (informative type, outlining information from the Introduction, Materials and methods, Results, Discussion, but not detailed results), 3) additional key words (if any), not appearing in the title, 4) Introduction, 5) Materials and methods, 6) Results, 7) Discussion, 8) Conclusions if appropriate, 9) Acknowledgements (optional, brief), 10) References, 11) Tables, 12) Figure and photo captions, 13) Figures and photos.

Papers may be reports of original biology research or they may focus more on the socio-economic aspects of conservation, including market surveys.

Preferably provide figures and maps in their original form, for example, Excel files, maps as eps or tif files (17 x 15 cm, 600 dpi), when submitting in electronic form. Indicate clearly the author or source of figures, maps and photographs.

Field notes: The journal welcomes notes from the field. They may contain figures and tables but should be brief.

Book reviews: *Pachyderm* invites reviews of newly published books, which should be no more than 1500 words long.

Letters to the editor: Letters are welcome that comment on articles published in *Pachyderm* or on any other issue relating to elephant and rhino conservation in the wild.

Journal conventions

Nomenclature

Use common names of animals and plants, giving scientific names in italics on first mention.
Use an 's' for the plural form for animals: rhinos, elephants.

Spelling

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

Numbers

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.

Adams JX. 1995b. Seizures and prosecutions. *TRAFFIC Bulletin* 15(3):118.

Dobson AP, May RM. 1986. Disease and conservation. In: ME Soulé, ed., *Conservation biology: the science of scarcity and diversity*. Sinauer Associates, Sunderland, MA. p. 123–142.

Struhsaker TT, Lwanga JS, Kasenene JM. 1996. Elephants, selective logging and forest regeneration in the Kibale Forest, Uganda. *Journal of Tropical Ecology* 12:45–64.

Sukumar R. 1989. *The Asian elephant: ecology and management*. Cambridge Studies in Applied Ecology and Resource Management. Cambridge University Press, Cambridge.

Cite unpublished material as follows:

Tchamba MN. 1996. Elephants and their interactions with people and vegetation in the Waza–Logone region, Cameroon. PhD thesis, University of Utrecht, The Netherlands. 142 p.

Woodford MH. 2001. [Title]. [*Journal* or publisher]. Forthcoming. [if publication date is known]

Woodford MH. [Title]. [*Journal* or publisher]. In press. [if publication date is not known]

Not accepted as references are papers in preparation or submitted but not yet accepted.

'Pers. comm.' accompanied by the date and name of the person is cited in the text but not given in the reference list.